EUDP IEA Task 41
Delivarable 4.1 – Distributed wind aspects relevant for Danish stakeholders

Anca D. Hansen

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DTU Wind and Energy Systems

IEA Task 41
Delivarable 4.1 – Distributed wind aspects relevant for Danish stakeholders

Report
2023

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Content

Summary

This report constitutes part of the work package deliverable 4.1 of the EUDP IEA Task 41 project, funded by Energy Technology Development and Demonstration Program (EUDP) of the Danish Energy Agency.

The report presents a brief overview of the distributed wind aspects relevant for Danish stakeholders identified through a set of three distributed wind (DW) stakeholders' workshops, organized by DTU Wind during the EUDP IEA Task 41 project.

1. Introduction

This work constitutes part of a work package deliverable 4.1 of the EUDP IEA Task 41 Distributed Wind project. The report has been produced with the intention of giving an overview of the distributed wind aspects relevant for Danish stakeholders. The increased penetration of renewable energy sources (RES), such as wind turbines and photovoltaic units, in distribution networks challenges the distribution system operators (DSOs) to improve and optimize networks' operation as well as the Danish stakeholders.

The distributed wind aspects relevant for Danish stakeholders presented in this report have been identified through a set of three distributed wind (DW) stakeholders' workshops organized by DTU Wind during the EUDP IEA Task 41 project. The workshops have been funded by the EUDP project IEA Task 41. The goal of the workshops has been to initiate good discussions and interactions with relevant Danish players and stakeholders within the area of DW technology and thus to build up and strengthen the stakeholders' network of relevant Danish players within the area of DW technology and to organize and strengthen the Danish influence and participation in IEA collaborations, both bringing the long experience of Danish actors into play and to learn from others around the world. Furthermore, the aim was also to present and promote results of particular Danish interest and to exchange the achieved knowledge and expertise from IEA international collaborative work to relevant players and stakeholders, and especially those who are not directly involved in the IEA work. The target through such forums has been to disseminate information that can be used by both Danish industry, researchers and society at large.

A summary of the EUDP IEA Task 41 Distributed Wind project is given here:
The overall objective of this project is to identify and explore studies of Danish interest of Distributed Wind (DW) for cost effective technology development and integration into a continuously evolving energy system. This is done by collaborating and contributing to the IEA Wind TPC Task 41 international activities on DW turbine technology development and assessment in a series of dedicated work packages (WPs). IEA Wind TPC Task 41 is an international network centered on international collaboration and coordination in the field of DW. The purpose is to accelerate the development and deployment of DW technology as one of the leading generation sources in global renewable markets, the facilitation of easier and faster DW integration into electrical grids, increasing thus the competitiveness of wind and accelerating the replacement of fossils fuels. The IEA collaboration is enforced partly by exchange of information, sharing of results, and conducting analyses and explorative studies in the form of reports and publications and partly by implementing a strong cross IEA Wind TPC Tasks collaboration effort. As in IEA Wind TPC Task 41, DW technology refers to wind turbines deployed in a distributed application, connected at a distribution voltage (nominally 70 kV) or below and behind the meter, in front of the meter, or in an off-grid application. In this context, DW is inclusive of all scales of wind turbine technologies and is agnostic to business model, although in some instances, such as technology standards, more specific industry segregation is included. By supporting the work of the IEA Wind TPC Task through various publications, data sets collections and reports, the EUDP IEA Task 41 project had as goal achieve and consolidate the Danish knowledge and experience within this area, increasing thus furthermore the competitiveness of wind and accelerating the replacement of fossil based fuels.

2 Distributed wind stakeholders’ workshop 1

The first distributed wind stakeholders’ workshop was organized by DTU Wind together with Nordic FolkeCenter on 30.04.2020 within the 3rd International Conference on Small and medium Wind Energy. The workshop, hold online, due to the pandemic Corona, has had particular relevance for small and medium wind turbine manufacturers and other users of the Danish Test and Resources Center.

To initiate good and expanded discussions of relevance for the Danish players and stakeholders and thus influence the research and development in the field of DW on a national level, the first workshop has been organized in two parts. In the first part, DTU Wind had four presentations, disseminating DTU Wind previous project results within different relevant DW topics, i.e. DW standards, DW integration and DW open data. In the second part three break-out DW stakeholders’ sessions with predefined questions to the stakeholders have been organized to initiate good interaction/discussions with the stakeholders and to identify their needs and challenges related with relevant topics like DW standards, DW integration and DW open data sharing.

The main take-away messages from these three break-out sessions are:

- There is a need for improving small- and medium-size wind standards about turbulence classes in urban areas and alike. The mismatch between the turbulence classes that can be found in the standards nowadays and the high turbulence experienced in such areas is believed to be a root cause for many turbine failures.

- It will take time to accept the Open Data Sharing culture. The people’s awareness and interest about is slightly increasing. Furthermore, the industry needs standards and the whole wind energy community must be continuously reminded on the advantages of data sharing for taking a cultural change step.

- Different DW regulatory rules in different countries are challenging both big and small companies.

- Accurate prediction of the power production from small wind turbines power output is still a big need.

In the following, the presentations of 1st workshop as well as the questions, discussions and summary minutes from all three break-out sessions are included, respectively.

Distributed Wind Stakeholders' Workshop
IEA Wind TPC Task 41

Anca Hansen

Distributed Wind stakeholders' workshops – overall goals

- **Build up a strong stakeholder network within the area of DW technology**
  - organize and strengthen the Danish influence and participation in IEA collaborations
- **Present** and **promote results** of particular Danish interest and **exchange the achieved knowledge and expertise** from IEA Wind 41 international collaborative work to relevant players
  - disseminate information that can be used by both Danish industry, researchers and society at large
- **Have expanded discussions of relevance for the Danish players and stakeholders**
  - influence the research and development in the field of DW on a national level.
- **Receive input/feedback** both from Danish wind energy industry and research community
  - resulting in new project ideas and project collaboration
- **Ensure closer collaboration** between **private** and **public** actors, **national** and **international** DW players

Workshop today - goals

- **Identify the NEEDS and CHALLENGES DW stakeholders have on relevant topics:**
  - DW standards
  - DW Integration
  - DW open data sharing
- DTU Wind Energy and Nordic FolkeCenter represent Denmark in IEA Wind Task 41 - our role today is to find out **what are the needs of Danish DW stakeholders and how to improve their business model**
- Recently funded EUDP project on IEA Wind Task 41 - **identify DW players and stakeholders willing to collaborate** in ongoing EUDP project by being involved in dialogs for delivarables
- **Gather INFORMATION / INPUTS / FEEDBACKs on how research can support / improve your business**
  - create new project ideas with collaboration between industry and research community

DTU Wind Energy expertise within DW

- **Expertise**
  - wind turbine standards
  - integration of wind power
  - modelling weather dependent generations and assessing their impacts on power and energy systems
  - wind power variability and predictability
  - resource assessment modelling.
- **Projects**
  - PSO Netvind project
  - PSO Replan project
  - EUDP Small wind marked project
  - EUDP Online WAsP project
  - EUDP IEA Task 41
  - Danida funded project Kenya MiniWind
  - IEA Wind TPC Task 27 Small Wind Turbines in High Turbulence Sites
  - COST Action TU1304 WINERCOST
  - FP7 Integrated Research Programme in Wind Energy, IRPWind
  - WindGrid H2020-MSCA-ITN 2019 project
- **Mutidisciplinary tools:**
  - Global Wind Power DataStation
  - Strider platform
  - FAIRdata catalogue
- **Participate in IEA Wind Tasks:**
  - Task 19: Cold Climate
  - Task 25: Integration of Large Amounts of Wind
  - Task 28: Social Acceptance
  - Task 36: Forecasting
  - Task 41: Distributed Wind

Workshop program

9.40 – 9.50	Welcome	Anca Hansen
9.50 – 10.10	**IEA Task 41 presentation**	Anca Hansen
10.10 – 11.00	**DW research at DTU Wind**	
	- DW Standards	Witold Skrzypinski
	- DW Integration	Kaushik Das
	- DW Open data sharing	Anna Maria Sempreviva
11.00 – 11.05	**Presentation of breakup DW stakeholders' sessions**	Tom Cronin
11.05 – 11.20	**Coffee break**	
11.20 – 12.00	**Break-out DW stakeholders' sessions**	
	- DW Standards	Witold Skrzypinski
	- DW Integration	Tom Cronin
	- DW Open data	Anna Maria Sempreviva
12.20 – 12.35	**Wrap-up in plenum**	
12.35 – 12.45	**Final remarks**	Anca Hansen

IEA Wind TPC Task 41

Danish EUDP project

Anca Hansen

About IEA Wind Task 41

Operating Agent
National Renewable Energy Laboratory
Pacific Northwest National Laboratory

Period
2019-2023
No annual fee needed

Website
https://community.ieawind.org/task41/home

Distributed Wind (DW) Technology
Wind turbines deployed in a distributed application, connected at a distribution voltage (nominally 70 kV) or below – located behind the meter, in front of the meter, or in an off-grid application.

Task 41 Participants	
Austria	Fachhochschule Technikum Wien
Belgium	Vrije Universiteit Brussel
Canada	Canada Natural Resources Canada
CWEA	China Wind Energy Association (CWEA), China General Certification (CGC), Goldwind, and Inner Mongolia University of Technology
Denmark	Denmark Technical University (DTU) & Nordic Folkecenter for Renewable Energy
Ireland	Dundalk Institute of Technology
Japan	New Energy and Industrial Technology Development (NEDO)
Korea	Korea Institute of Energy Research
Spain	CIEMAT
USA (OA)	National Renewable Energy Laboratory Pacific Northwest National Laboratory

IEA Wind Task 41 – motivation

- DW has become a growing portion of the energy supply - expansive pontential for DW markets
- The costs of DW systems have not yet decreased in the similar way as the cost of large utility scale and offshore wind technologies, as well as of solar PV
- Need to understand and answer many questions
  - whether the advances, that have lowered the cost for utility scale turbines, are valid if applied to DW?
  - which of the technological innovations are most appropriate for distributed technologies?
  - why has the DW industry not applied these innovations?
  - which additional research may be needed to understand their applicability?

IEA Wind Task 41 - collaboration

Overall objective

coordinate international research on DW technology, technology development or assessment to allow DW to integrate into future markets, and processes or procedures to support the cost effective development of DW technologies.

IEA Task 41 collaboration

- **accelerate the development & deployment** of DW technology
- **improve** small and distributed turbine standards
- **address** integration challenges
- **share** cost reduction experiences
- **allow** for the expanded sharing of research innovation
- **increase** the competitiveness of wind and accelerating the replacement of fossils fuels

IEA Task 41 outcome will lead to the **expanded global use** of wind energy with focus on DW applications!

IEA Wind Task 41 - five areas of technical collaboration

- Research to support an update of existing wind standards, expanding consumer confidence while allowing needed technology innovation → **WP1**
- Technical data sharing in both process and practice, providing researchers and the wider industry access to global information → **WP2**
- Expanded research and collaboration around the integration of DW technologies, focusing on new and advancing markets such as off-grid, microgrids, and advanced distribution networks → **WP3**
- Outreach and expand collaboration of ongoing R&D activities that could address specific challenges associated with DW technologies → **WP4**
- DW innovation and downscaling of utility scale technology → **WP5**

EUDP project funding

- Essential for **DTU Wind Energy for being part** of the IEA Wind TPC Task 41
- Support **DTU Wind Energy** work in the IEA Wind TPC Task 41 to create common publications in peer-reviewed journal based on the results and experiences stemming from other past and ongoing research.
- Strengthen collaboration between DTU Wind Energy, Danish stakeholders and international partners
- Participation in international collaboration also helps promote Danish acquisition of knowledge about the newest trends and methodologies.
- Attract the best international players to project consortia with Danish partners, providing that results are anchored in Denmark and create added value for Danish players.

EUDP project

Period: 2020 – 2023

Website: https://www.vindenergi.dtu.dk/english/research/research-projects/iea-wind-tcp-task-41

Overall objectives

- identify and explore studies of **particular Danish interest of DW** for cost effective technology development and integration into an continuously evolving Danish electrical system.
- strengthen the **Danish players and stakeholders**, contributing to further increasing the penetration of wind power into the electricity, while still maintaining the high level of security of supply.

This will done by DTU Wind Energy by collaborating and contributing to the IEA Wind TPC Task 41 international activities through communication, exchanging information, sharing results and carrying out concrete analyzes and investigations in the shape of reports and publications.

Project is organized into 5 work-packages closely following the IEA Wind TPC Task 41 planned work-packages

EUDP project – overall targets

- build up a stakeholder network of relevant Danish players within the area of DW technology
- organize and strengthen the Danish influence and participation in IEA collaborations
- achieve and consolidate the Danish knowledge and experience within DW area
- promote and disseminate the results of IEA Wind Task 41 activities to the Danish stakeholders
- provide recommendations and guidelines to IEA deliverables that can be used by both Danish industry, researchers and society at large
- form the basis for eventually new Danish standards aligned to international efforts, set of specifications of DW data sharing catalog and support the integration of DW into Danish electrical system
- collaborate with ongoing IEA Wind Task activities that address specific challenges associated with DW technologies (Task 19, Task 25, Task 26, Task 28, Task 36).

EUDP project - delivarables

DW players and stakeholders
willing to
be involved in
dialogs
for some delivarables ?

No.	Delivarables	Delivery date
D1.1	Report on recommendations for potential standards changes that will be used to drive additional national and international research	Nov 2021
D1.2	Compendium on recommendations for potential conformity assessment requirements	Aug 2020
D2.1.	Report on the adopted metadata and taxonomies specific for DW and metadata catalogue.	Oct 2020
D2.2	Guideline for best practices for compiling DW distributed object catalogues. Data Management Plan Template, for Danish actors.	May 2021
D2.3	Report on suggested improvements for time series simulation tools when working with DW.	Nov 2021
D3.1	Report on control strategies of wind turbines in future distribution systems based on the delivarable D15 of IEA Wind Task 41 and tailored to the requirements of Danish stakeholders.	Nov 2022
D3.2	Contribution to the D14 delivarable report of IEA Task 41	May 2020
D3.3	Contribution to the D16 delivarable report of IEA Task 41	Nov 2020
D3.4	Contribution to the D17 delivarable report of IEA Task 41	Nov 2021
D4.1	Report describing specific DW aspects/gaps relevant for the Danish players and stakeholders.	Nov 2022

Thank you

IEA Task 41 Workshop
Distributed Wind
Standards

Witold Skrzypiński
wisk@dtu.dk

Table of contents

- What is the problem in big picture?
- How can we solve it?
- What has been done?
- Specific identified problems.
- Questions for YOU.

Problem formulation by IEA

Design-and-testing standards for distributed wind are:

–A barrier to innovation.

–Source of increased cost of energy.

Certification of turbine models, especially those above 200 m^2:

–Hinders bringing advanced technologies to the market in a timely fashion.

–So expensive that it outweighs the value that it provides.

Possible solution

- IEC 61400-2 standard generally serves as a baseline for small wind turbines.
- IEC 61400-2 open to revision in early 2022.

- To allow a revision of the standard, efforts need to be undertaken now to:
  - Understand the key concerns with the existing standard.
  - Conduct the needed research to document a problem.
  - Conduct research to allow justification for any potential revisions.

Requires a strong international effort.

What has been done?

Two international meetings were held in 2019:

- **February – USA**
  - Companies from USA.
  - Focused on US standards: AWEA 9.1, SWT.
- **June – Ireland**
  - Participants from: Austria, Denmark, Germany, Ireland, Korea, Spain, and Taiwan.
  - Focused on the IEC 61400-2.
- **Two additional meetings planned…**

The following problems were identified:

1. **Meeting test-duration requirements slows innovation and time to market.**

   <u>Number one</u> challenge for international companies.

2. **Use of Simplified Loads Methodology (SLM) made the design heavier due to high safety factors. SLM does not address fatigue – a common failure mode for small turbines.**

   Need VAWT SLM with fatigue case.

3. **Tower dynamics are not well addressed in IEC 61400-2.**

4. **Power performance results are rarely matched at consumer sites, leading consumers to assume that <u>small wind does not work</u>.**

   A typical small wind turbine site has higher wind shear than that assumed.

The following problems were identified:

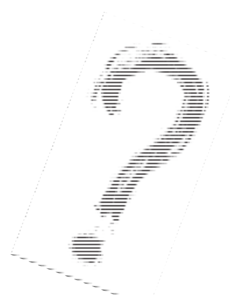
5. **Medium turbines are kept out of the market for certified turbines because of the limit in IEC 61400-2 of rotor swept area, i.e., 200 m^2.**

   Need certifications for small wind turbines up to 100 kW or 500 m2 and classifications for micro wind with reduced requirements.

6. **Many of the current requirements, e.g., normal turbulence model or turbulence intensity, do not reflect the reality that micro and small turbines are installed in, i.e., locations with high turbulence intensity due to human clutter.**
7. **Acoustic testing is considered the most difficult of all the small turbine test methods, and the output data are not self-explanatory to consumers.**

Three questions for you:

1. *What problems related to standards/certification/legislation have you experienced in your daily business?*
2. *Which of the listed issues are relevant to your daily business?*
3. *What would you like us to focus our work on?*



DTU

Kaushik Das, Tom Cronin, Anca D Hansen

Integration of Distributed Wind to the Power System

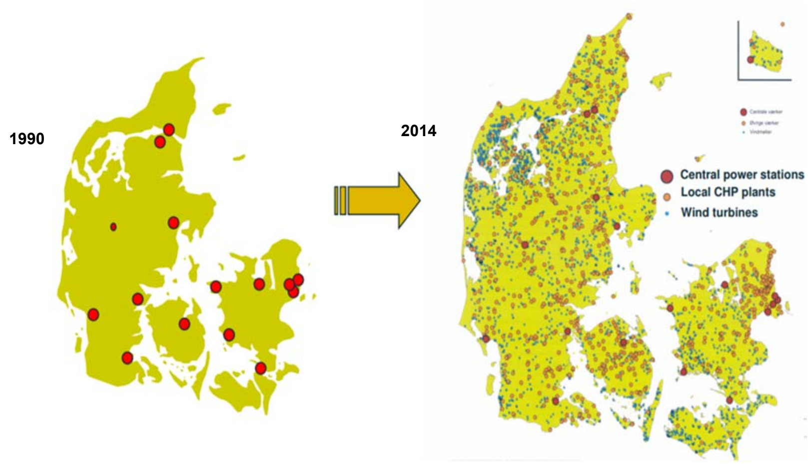
DTU

Definition of Distributed Wind in IEA Task 41

- Wind turbines deployed in a distributed application
- Connected at a distribution voltage (nominally 70 kV) or below
- Behind the meter, in front of the meter, or in an off-grid application.
- In this context, DW is inclusive of all scales of wind turbine technologies and is agnostic to business model, although in some instances, such as technology standards, more specific industry segregation is included.

RES generation in distribution systems

Centralized Plants Vs Distributed Generations



Henning Parbo, "Distributed Generation Trends and Regulation: The Danish Experience", EPRG Workshop on Distributed Generation and Smart Connections

Integration Challenges/Opportunities for DW stakeholders

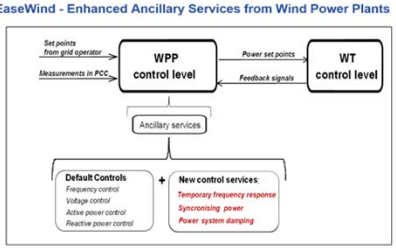
- **From System Operator's perspective:**
  - Loss minimization, TSO/DSO co-ordination, voltage profile management etc.
  - Might also be (market) opportunities for DW turbines owners

- **From DW Turbine Manufacturers' Perspective:**
  - Stricter requirements for DW turbines in grid connection code
    - In terms of frequency support, volt/var control, harmonics etc.
  - Evolving system support capabilities for all wind turbines such as grid forming capabilities, blackstart, load following, power oscillation damping etc.
    - Many of these services are relevant and useful for DW mainly with respect to minigrid, microgrid and islanded systems
  - Evolving global markets for DW turbines connected to weak grids
    - Advanced control and operational strategies need to be developed
  - Evolving technologies such as hybrid systems with storage and/or solar

A project case study from System Operator’s perspective

System Service Capabilities of Wind Turbines

EaseWind - Enhanced Ancillary Services from Wind Power Plants



RePlan- Ancillary Services from Renewable Power Plants

- develops controllers for the delivery of ancillary services from WP and PV plants , incorporating **communication** properties
- the services with great concern in the future include **voltage**, **frequency** and **rotor angular stability support**.
- uses state-of-the-art methods for simulation of renewable generation patterns and wind power forecast methods
- suitability **to coordinate** the provision of the services from WP and PV plants, identifying and analyzing their strengths and limitations
- impact of **communication** and **power availability forecast error** in providing coordination and ancillary services
- investigates and verifies ancillary services provision from WP and PV plants in **laboratory facilities** (large or real small power systems)

Deliverables and publications at http://www.replanproject.dk/

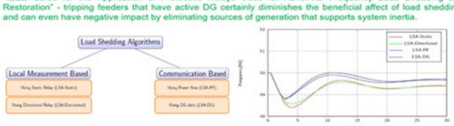
iTesla - Innovative Tools for Electrical System Security within Large Areas

WP6: To review and assess the potential for more robust defence and restoration plan (led by DTU)

Improved Underfrequency Load Shedding (UFLS) Scheme Considering Distributed Generation

Impacts of high penetration of distributed generation on UFLS:
- Unintentional disconnection of DG
- Not disconnecting required amount of load
- Poor frequency response

"IEEE Guide for the Application of Protective Relays Used for Abnormal Frequency Load Shedding and Restoration" - tripping feeders that have active DG certainly diminishes the beneficial affect of load shedding, and can even have negative impact by eliminating sources of generation that supports system inertia.



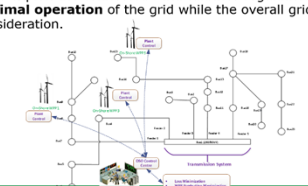
Kaushik Das, A Nitsas, M Altin, A Hansen, P Sørensen, "Improved Load Shedding Scheme considering Distributed Generation", IEEE Transactions on Power Delivery, 2016

NetVind project

- Achieve **effective integration** of renewable energy in the MV grid
  - Minimizing unnecessary losses due to the new production
  - Use already installed power electronics in the wind turbine.
- The aim of the project is to exploit the connected wind turbines regulation capabilities **to obtain optimal operation** of the grid while the overall grid stabillity is taken into consideration.

Partners:
ENIIG Forsyning A/S (leader)
DTU Wind Energy
Danish Energy Association

Project period:
Sep, 2016 – Sep, 2018
Ongoing



The project is supported by ForskEL

NetVind project

Using wind power plant control in distribution grid operation

Objective

- to improve the operation of a real distribution network with a high penetration of wind power by exploiting the WPP control capabilities.

DSO's challenges

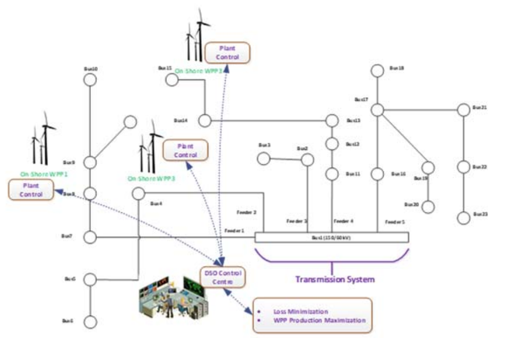
- how to operate the distribution systems by using WPPs as controllable components

Partners

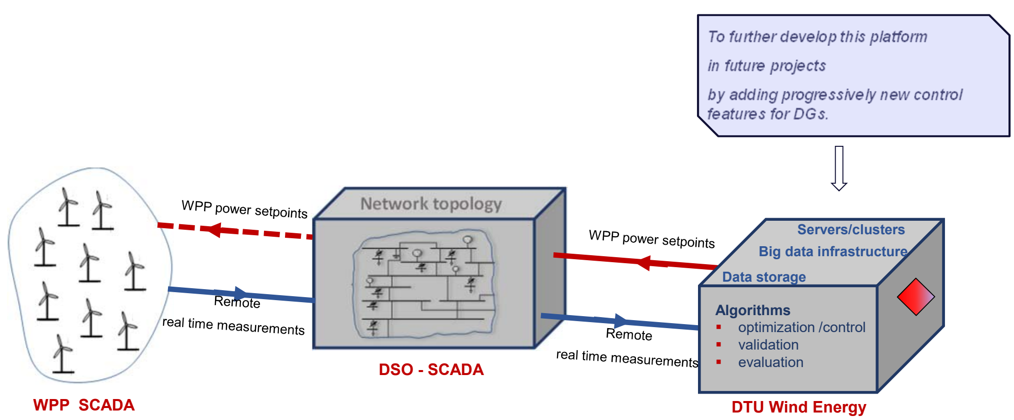
ENIIG Forsyning A/S (leader)
DTU Wind Energy
Dansk Energi

Project period:

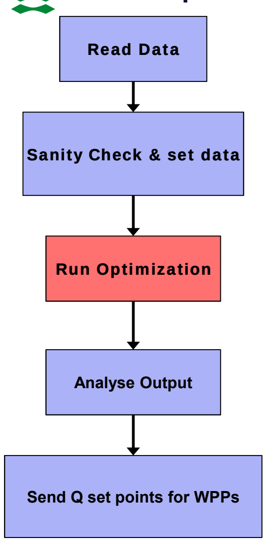
Sep, 2016 – Sep, 2018



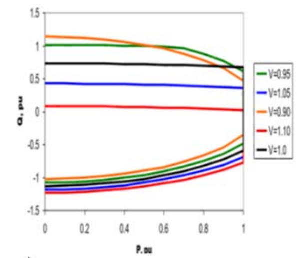
Architecture

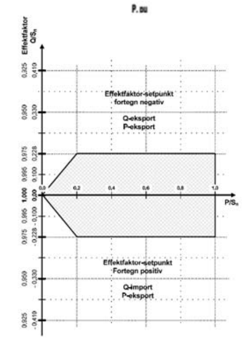


Optimization



- Control variables:
  - Reactive power set point of WPPs
- Objective:
  - Minimize active power loss in 60 kV feeders
- Constraints
  - Network constraints
  - Reactive Power Flow Limit to the Transmission Network
  - Power loading limit of the feeders
  - Power loading limits of the transformers
  - Voltage Limits
  - WPP constraint
  - WPP capability / Grid code requirements





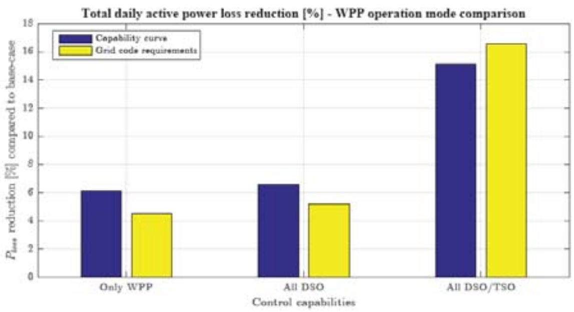
Loss Minimization Results

Without Optimization			With Optimization		
			Loss reduction [%]		Energy Saving [MWh]
Power loss [MW]	Number of Hrs	Energy loss [MWh]	Mean	Uncertainty	
0-500	6321	949	6.18%	0.25%	58.6 ± 2.38
500-1000	967	695	1.42%	0.10%	9.9 ± 0.69
1000-1500	674	833	2.93%	0.11%	24.4 ± 0.92
>1500	798	1539	4.63%	0.08%	71.3 ± 1.23
Sum	8760	4016			164.2 ± 2.92

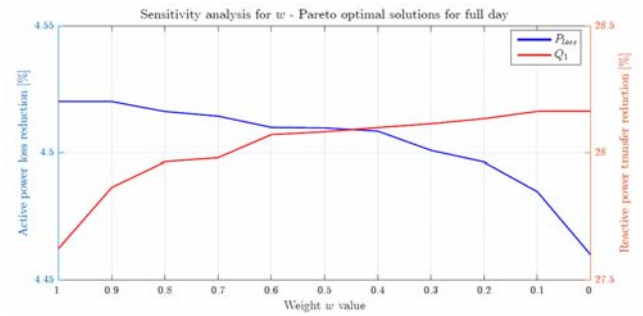
Using optimization method, estimated energy saving is 164.2 + 2.92 MWh
for 1 year based on the representative data only using reactive power capability of DW

Looking Beyond

What is the impact of co-ordinating the control of tap-changing transformers together with DW?



Does loss minimization impact the reactive power transfer between TSO and DSO?



Observability and Controllability of all the voltage levels are required considering all the assets

Ongoing PhD project within EU Marie Curie WindGrid :

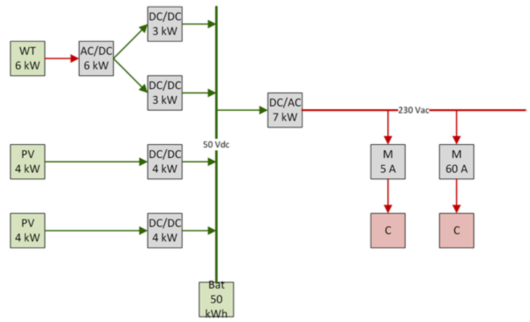
- **Incorporate forecast uncertainty from weather dependent generation & loads (using weather data/models, AMR, SCADA) in observability of the distribution network**
- **Investigate the impact of forecast uncertainty for WPPs and loads on the performance of the whole distribution networks**
- **Develop enhanced control method for controlling the DW to improve performance of the whole distribution network**

A project case study from DW Turbine manufacturer’s perspective

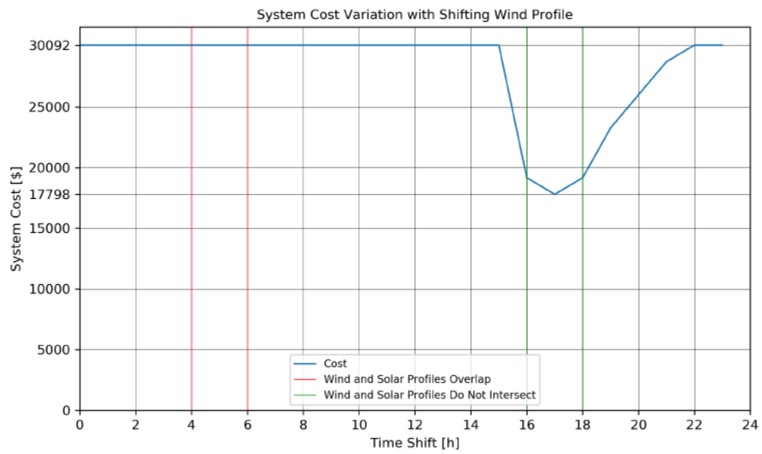
The concept of a mini-grid

A collection of components in a power system:

- Consumption (consumers)
- Generation
  (conventional and renewable)
- Balancing components
  (e.g. dump load and storage)
- Control system
  (local and supervisory)



Simulation results for system costs



Breakout stakeholders' sessions - DW integration

- What is the biggest challenge seen by you in order to integrate more distributed wind into the power system?
- Which support (tool, knowledge, seminars) from IEA Task 41 /DTU Wind Energy would help your business?
- Which specific grid services, do you think, distributed wind can provide and in which markets?

DTU

IEA Wind Energy Task 41: Distributed winds

Pacific Northwest NATIONAL LABORATORY
U.S. DEPARTMENT OF ENERGY BATTELLE
PNNL is operated by Battelle for the U.S. Department of Energy

WORK PACKAGE 2: DATA CATALOG

Danielle Preziuso
Pacific Northwest National Laboratory

FAIR DATA Principle: The culture of sharing.

Findable **A**ccessible **I**nteroperable and **R**e-usable data

Anna Maria Sempreviva
Technical University of Denmark
DTU Wind Energy

DTU

PURPOSE

- Disseminate the sharing culture in wind energy sector
- Inform on the opportunities from adopting the FAIR data principle

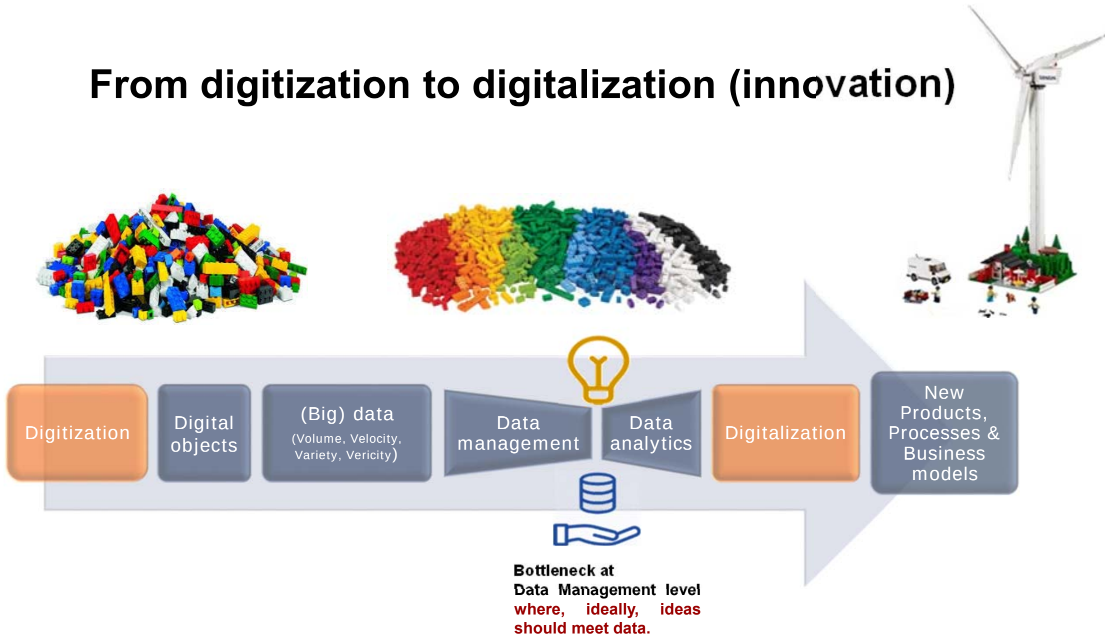
CONTENT

- Context:
  - The digital transformation: the pathway to innovation
  - FAIR, the culture of sharing: other's ideas meet your data
- Data Catalogue: collecting information on data availability on key topics
- Existing data platforms: metadata and taxonomies
- Conclusive remarks

Equivalences of terms in different environment

RESEARCH DATA	
(Academia)	Data, Codes, Workflows
(Research Data Alliance)	Digital Objects
(Industry)	Assets

From digitization to digitalization (innovation)



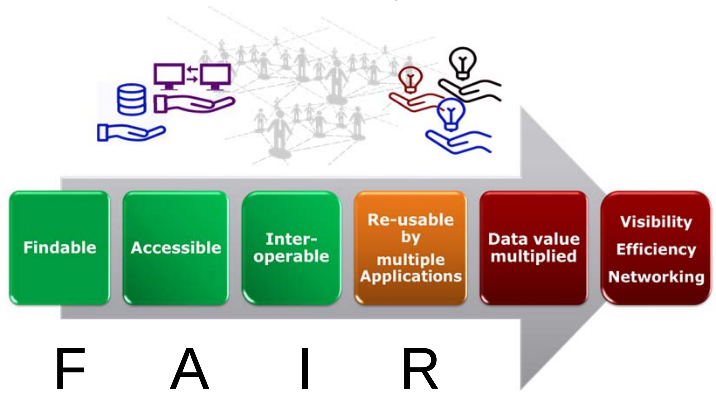
FAIR supports innovation: Find the data

- 2014 H2020 Open Data
- 2016 H2020 FAIR Data Principle changes the focus: **From Available to Findable data**

ISSUE: How to make data findable but safe?

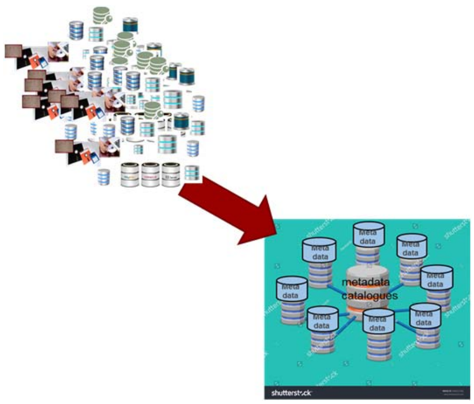
SOLUTION: Create a searchable data catalogue for **distributed** data

Other's ideas meet your data



DTU

FIND THE DATA



Issue: data findability

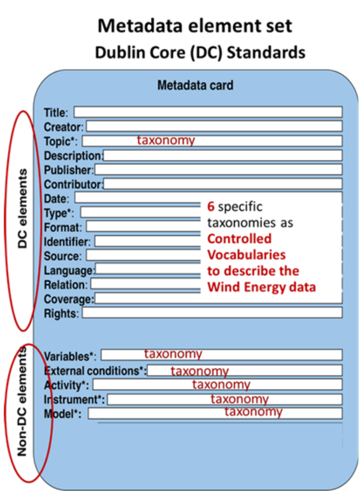
- Datasets are distributed in the “cloud”, saved in and organized in different ways
- Datasets often miss **documentation (Metadata)**

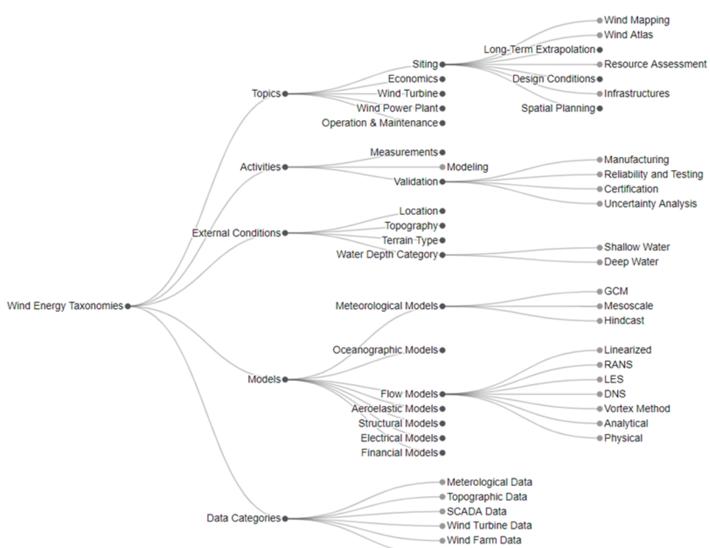
Action: 3 ingredients

- Create **metadata** and
- Assign to metadata relevant controlled vocabularies (**Taxonomies**) to tag data
- Design **a data portal** for metadata catalogues

DTU

IRPWind Project 2014-2018 - Metadata & taxonomies





IEA Task 41 WP2 data catalog: Find the data

Deliverable D11:

- Fall 2020: Development of **data sharing**, **storage** and if needed **security protocols** for metadata to be stored on the platform. Specification of a potential **data sharing portal** that expands on the catalog.

Goals

Identify:

- Data contributors and users
- Needed shared resources
- Data availability on key topics
- Recommended practices for data collection, reporting, accessing, and storage

Catalog and Make Available:

- Metadata for distributed wind data sets

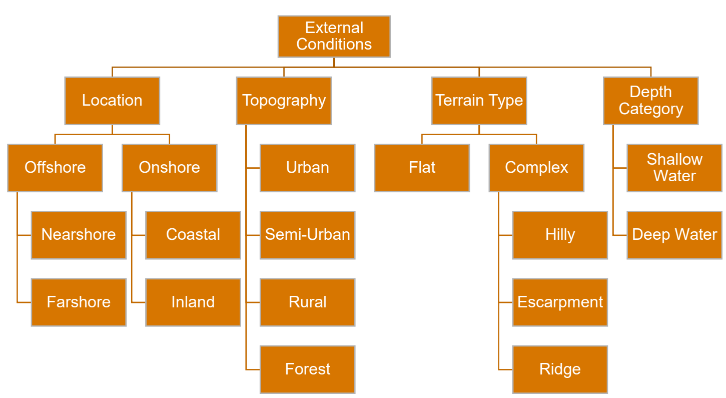
Consider:

- Including a catalog of data processing and decision support tools

PNNL-SA-152844

Taxonomy

- For some of the metadata elements, PNNL expanded the wind energy taxonomy developed by IRPWind to include some terms specifically relevant to the distributed wind energy community.



This is an example from the wind energy taxonomy. The full taxonomy is in Wind Energy Taxonomy Excel file.

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Existing Databases, Portals, and Catalogs

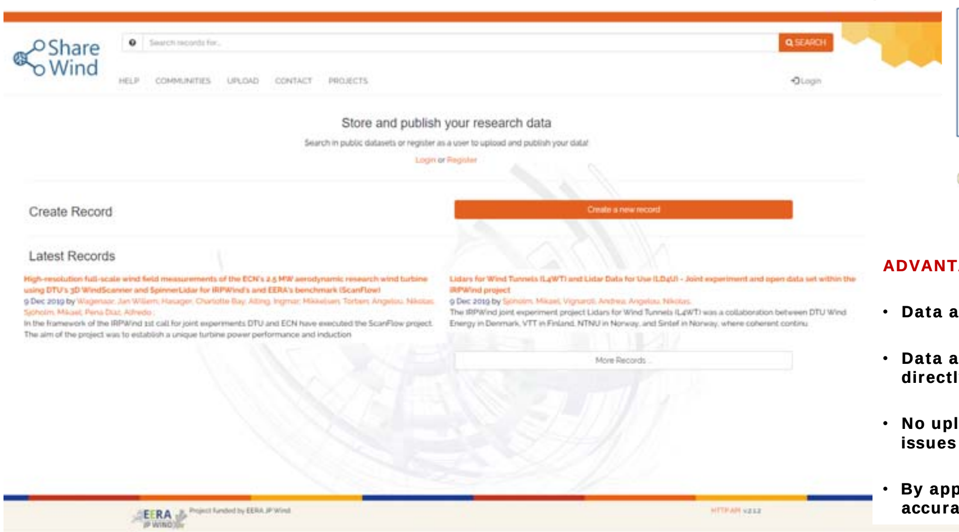
- Work to Date:
  - Establish and evaluate wind-related databases and catalogs that already exist
  - Identify opportunities for collaboration or to build upon existing work
  - Lessons learned from previous work
  - Outline a process for metadata collection and options for hosting Task 41 catalog

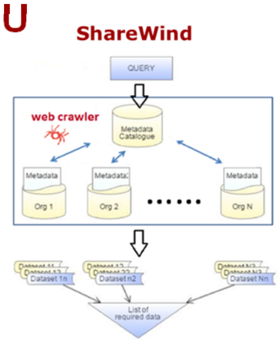
Tethys	Data Archive and Portal (DAP)	OpenEI	ShareWind

PNNL-SA-152844

DTU

IRPWind Project 2014-2018. ShareWind.EU Data portal and metadata catalogue





ADVANTAGES

- **Data are kept at the owner premises**
- **Data are visible without being directly accessible**
- **No uploading data and storage issues**
- **By applying filters users can accurately locate needed data**

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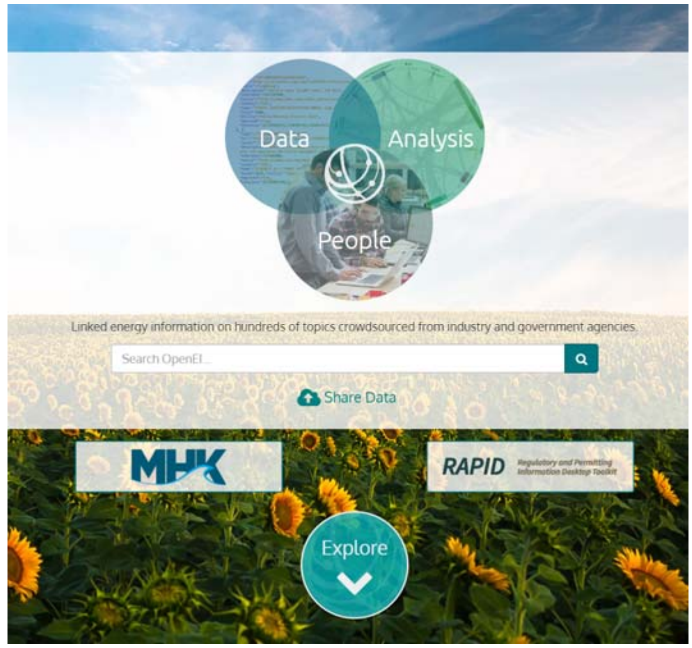
Open Energy Information (OpenEI) - Overview

- A wiki platform for the energy community, including policymakers, developers, and researchers
- Renewable energy and energy efficiency focus
- Sponsored by US DOE, NREL, and a third party renewable energy search engine, reegle



PNNL-SA-152844

DTU

Conclusive remarks

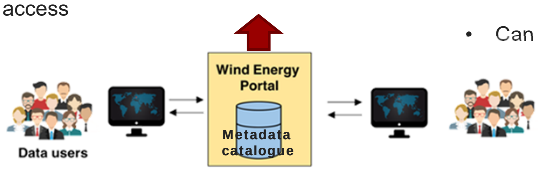
A web data portal with a data catalog has a two-fold purpose

- **To connect safely users to data owners**
- **Give information on the availability of shared resources and of Data on key topics**

Data owner /creator

- Can make visible data via metadata
  - without uploading any data, and
  - maintain control on data access

Data
Market Place?
€ £ $?
Services?
Co-creation?



Data user

- Can find data accurately by searching the same terms used by the data owner
- Can retrieve information on available data
- Can save time dedicated to the task

Thank you for your attention!

NEXT

Would you share your data?

BREAKOUT SESSION

- Have you a data catalogue Visible/Findable from outside your company?
- If no, would you use an established taxonomy to tag your data?
- If yes, how did you tag your data?

Could you please describe using three keywords the FAIR data principle

(e.g. ambitious, innovative, interesting, impossible, appealing, not-applicable, …..

Under which conditions would you share your data?

- Against a fix/variable amount of money;
- Against services;
- Against involvement in projects; for free if data is not used in competitive goals.

PESTEL Analysis

Political, Economic, Social, Technological, Environmental, Legal

- **Barriers/obstacles and framework conditions affecting FAIR impact**
- Sharing data, tools and workflows: a strategy to inspire efficient collaboration - Metadata catalogue: **Distributed data bases.**

	Barriers/Obstacles/Risks	Methods to resolve issues
Political	*Governmental funding agencies demand open data but at the same time Governments cut funding to universities demanding universities providing business models to support research.* *IPR and Patents are success criteria for universities*	Take actions to communicate that FAIR data is a good balance between Open data and IP protected data
Economic	*Data as competitive advantage*	Communicate the benefits of open data as a way of lowering project costs, enabling a faster project progress and enhancing replication in other markets
Social	*Managerial practices and skills, culture of open data*	Implement training programs for both early stage researchers and senior researchers.
Technological	*Lack of interoperability: access to data, data and software compatibility, lack of metadata*	Establish agreed standards to support interoperability and secure a better quality of data
Environmental	*Critical mass of data available*	System for recognition/ rewards to for their work. Ensures awareness and thereby generates interest in protecting the environment by being able to conduct research with open access data and develop innovative solutions.
Legal	*Constraints to the access to nationally funded research infrastructures by international consortia,* *Copyright and ownership* *Variety of EU directives, regulations and national laws and policies, as well as multinational initiatives, not fully coordinated such as the Research Data Alliance*	Greater coherence to the incentive, legal and regulatory frameworks governing research data and tools. Establish an information base of guidelines and instructional materials to secure legal reuse of data Delegate a body e.g. the EOSC, to play a coordinating role, of active initiatives

3 Distributed wind stakeholders' workshop 2

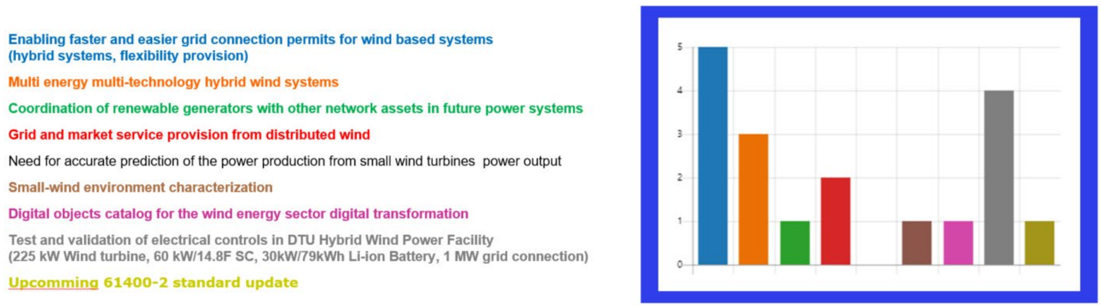
This workshop, organized by DTU Wind and hold online on 23 March 2021, due to the pandemic Corona had a particular target to identify how research can support and strengthen the Danish industry to deploy more wind power and renewable energy at distribution grid to meet the Danish vision of green transition. The workshop supported the work in the IEA Wind TPC Task 41 and provided results anchored in Denmark, thus creating added value for Danish players.

This workshop targeted to generate, define, and discuss potential new collaboration ideas/projects of particular Danish interest in various relevant distributed wind (DW) topics, for example, DW standards, DW integration, support of DW in MV-LV networks, and DW open data.

To initiate good and expanded discussions of relevance for the Danish players and stakeholders and thus influence the research and development in the field of DW on a national level, prior the workshop the participants were asked to fill in a *form* easily to approach, where they could directly indicate & suggest which topics they were interested in, which were their preferences for the workshop type and for their availability. The following topics were presented for discussions:

- Enabling faster and easier grid connection permits for wind-based systems.
- Multi-energy multi-technology hybrid wind systems
- Coordination of renewable generators with other network assets in future power systems
- Grid and market service provision from distributed wind
- Power curves and rating of small turbines
- Small-wind environment characterization
- Catalog of available digital objects (data, workflows, algorithms, models) supporting the digital transformation of the wind energy sector
- Test and validation of electrical controls in DTU hybrid Wind Power Facility

The results of the survey are depicted in the following.



The main take-away messages from the workshop discussions are:

- There is a clear need to enable faster and easier grid connection permits for wind-based systems (hybrid systems, flexibility provision).

- Testing and validation of electrical controls in DTU hybrid Wind Power Facility are of high relevance for the Danish stakeholders.

- Hybrid power plants do not bring a high value to grid operators in Danish perspective, i.e., EnergiNet sees large PV plants as valuable. Furthermore, the grid capacity is a strong limiting factor.

- Small wind power market is more active outside Denmark as well as in small islands, even though small wind turbines can be in general integrated in the existing grid, without grid strengthening. The cost of small wind turbines is higher than their benefits, i.e., using new technologies is quite expensive compared with the limited benefits. In this respect a decreasing cost of component would be beneficial.

- Coordination of renewable generators inside or between hybrid wind systems could be a solution for improvement of the wind business in distribution grids. Furthermore, a TSO/DSO co-ordination in Denmark could be a short-term solution avoiding transmission grid reinforcements.

- There is a lack of public awareness for community wind / solar hybrid power plants.

- The regulatory restrictions in respect to distributed wind & hybrid power plants are challenging both big and small companies.

- There is a potential in increasing the value of small, distributed wind and hybrid power plants for communities, i.e., small wind *can* support electric heating, EV charging is already a bottleneck in CPH, control the small networks rather than adding to transmission network loads, local power consumption in MV possible minimizing TSO/DSO interaction.

One of the most important conclusions of this workshop was that a demonstration project for the value of hybrid in the grid could push the regulation in the right direction.

In the following, the presentations of workshop 2 are included.

2^{nd} Danish Distributed Wind Stakeholders Workshop

IEA Wind TPC Task 41

Anca Hansen

Workshop program

14.00 – 14.10	Welcome Short presentation of the participants	Anca D. Hansen
14.10 – 14.25	IEA Wind TPC Task 41 & Danish EUDP project	Anca D. Hansen
14.25 – 14.50	Discussions on perspectives & challenges	Kaushik Das
14.50 – 15.00	Coffee break	
15.00 – 15.25	Discussions on potential solutions/ approaches	Tom Cronin
15.25 – 15.50	Wrap-up and action tasks	Mark Kelly
15.50 – 16.00	AoB	

Distributed Wind stakeholders’ workshops – overall goals

- **Build up** a strong stakeholder network within the area of **distributed wind (DW) technology**
  - organize and strengthen the Danish influence and participation in IEA collaborations
- **Identify** how research can support and strengthen the Danish distributed wind (DW) players and stakeholders.
  - have **expanded discussions** of relevance for the Danish players and stakeholders
  - generate and define **potential new collaboration ideas** of particular Danish interest in various relevant DW topics, i.e. DW standards, DW integration, support of DW in MV-LV networks, and DW open data.
  - **receive input/feedback** both from Danish wind energy industry and research community - influence the research and development in the field of DW on a national level.
- **Ensure** close collaboration between **private** and **public** actors, **national** and **international** DW players
- **Result** in new project collaborations
- **Support** the work in the IEA Wind TPC Task 41

DTU Wind Energy expertise within DW

- **Expertise**
  - wind turbine standards
  - integration of wind power
  - modelling weather dependent generations and assessing their impacts on power and energy systems
  - wind power variability and predictability
  - resource assessment modelling.

- **Projects**
  - PSO Netvind project
  - PSO Replan project
  - EUDP Small wind marked project
  - EUDP Online WAsP project
  - EUDP IEA Task 41
  - Danida funded project Kenya MiniWind
  - IEA Wind TPC Task 27 Small Wind Turbines in High Turbulence Sites
  - COST Action TU1304 WINERCOST
  - FP7 Integrated Research Programme in Wind Energy, IRPWind
  - WindGrid H2020-MSCA-ITN 2019 project

- **Mutidisciplinary tools:**
  - Global Wind Power DataStation
  - Strider platform
  - FAIRdata catalogue

- **Participate in IEA Wind Tasks:**
  - Task 19: Cold Climate
  - Task 25: Integration of Large Amounts of Wind
  - Task 28: Social Acceptance
  - Task 36: Forecasting
  - Task 41: Distributed Wind

About IEA Wind Task 41

Operating Agent

National Renewable Energy Laboratory

Pacific Northwest National Laboratory

Period

2019-2023

No annual fee needed

Website

https://community.ieawind.org/task41/home

Distributed Wind (DW) Technology

Wind turbines deployed in a distributed application, connected at a distribution voltage (nominally 70 kV) or below – located behind the meter, in front of the meter, or in an off-grid application.

Task 41 Participants	
Austria	Fachhochschule Technikum Wien
Belgium	Vrije Universiteit Brussel
Canada	Canada Natural Resources Canada
CWEA	China Wind Energy Association (CWEA), China General Certification (CGC), Goldwind, and Inner Mongolia University of Technology
Denmark	Denmark Technical University (DTU) & Nordic Folkecenter for Renewable Energy
Ireland	Dundalk Institute of Technology
Japan	New Energy and Industrial Technology Development (NEDO)
Korea	Korea Institute of Energy Research
Spain	CIEMAT
USA (OA)	National Renewable Energy Laboratory Pacific Northwest National Laboratory

IEA Wind Task 41 – motivation

- DW has become a growing portion of the energy supply - expansive pontential for DW markets
- The costs of DW systems have not yet decreased in the similar way as the cost of large utility scale and offshore wind technologies, as well as of solar PV
- Need to understand and answer many questions
  - whether the advances, that have lowered the cost for utility scale turbines, are valid if applied to DW?
  - which of the technological innovations are most appropriate for distributed technologies?
  - why has the DW industry not applied these innovations?
  - which additional research may be needed to understand their applicability?

IEA Wind Task 41 - collaboration

Overall objective

coordinate international research on DW technology, technology development or assessment to allow DW to integrate into future markets, and processes or procedures to support the cost effective development of DW technologies.

IEA Task 41 collaboration

- **accelerate the development & deployment** of DW technology
- **improve** small and distributed turbine standards
- **address** integration challenges
- **share** cost reduction experiences
- **allow** for the expanded sharing of research innovation
- **increase** the competitiveness of wind and accelerating the replacement of fossils fuels

IEA Task 41 outcome will lead to the **expanded global use** of wind energy with focus on DW applications!

EUDP funding

Danish IEA Task 41 project

- Essential for **DTU Wind Energy for being part** of the IEA Wind TPC Task 41
- Support **DTU Wind Energy** work in the IEA Wind TPC Task 41 to create common publications in peer-reviewed journal based on the results and experiences stemming from other past and ongoing research.
- **Strengthen collaboration** between DTU Wind Energy, Danish stakeholders and international partners
- Participation in international collaboration also helps promote Danish acquisition of knowledge about the newest trends and methodologies.
- Attract the best international players to project consortia with Danish partners, providing that results are anchored in Denmark and create added value for Danish players.

Danish IEA Task 41 project

Period: 2020 – 2023

Website: https://www.vindenergi.dtu.dk/english/research/research-projects/iea-wind-tcp-task-41

Overall objectives

- identify and explore studies of **particular Danish interest of DW** for cost effective technology development and integration into an continuously evolving Danish electrical system.
- strengthen the **Danish players and stakeholders**, contributing to further increasing the penetration of wind power into the electricity, while still maintaining the high level of security of supply.

This will done by DTU Wind Energy by collaborating and contributing to the IEA Wind TPC Task 41 international activities through communication, exchanging information, sharing results and carrying out concrete analyzes and investigations in the shape of reports and publications.

Project is organized into 4 work-packages closely following the IEA Wind TPC Task 41 planned work-packages

Danish IEA Task 41 project – overall targets

- build up a stakeholder network of relevant Danish players within the area of DW technology
- organize and strengthen the Danish influence and participation in IEA collaborations
- achieve and consolidate the Danish knowledge and experience within DW area
- promote and disseminate the results of IEA Wind Task 41 activities to the Danish stakeholders
- provide recommendations and guidelines to IEA deliverables that can be used by both Danish industry, researchers and society at large
- form the basis for eventually new Danish standards aligned to international efforts, set of specifications of DW data sharing catalog and support the integration of DW into Danish electrical system
- collaborate with ongoing IEA Wind Task activities that address specific challenges associated with DW technologies (Task 19, Task 25, Task 26, Task 28, Task 36).

Danish EUDP IEA Task 41 project

- **WP0**: Management, coordination and dissemination
- **WP1:** DW technology design standards for small and mid-sized wind turbines
- **WP2:** Data information catalog for DW research
- **WP3:** Integration of DW into evolving electricity systems
- **WP4:** Outreach and expand collaboration of ongoing R&D DW activities

Milestones

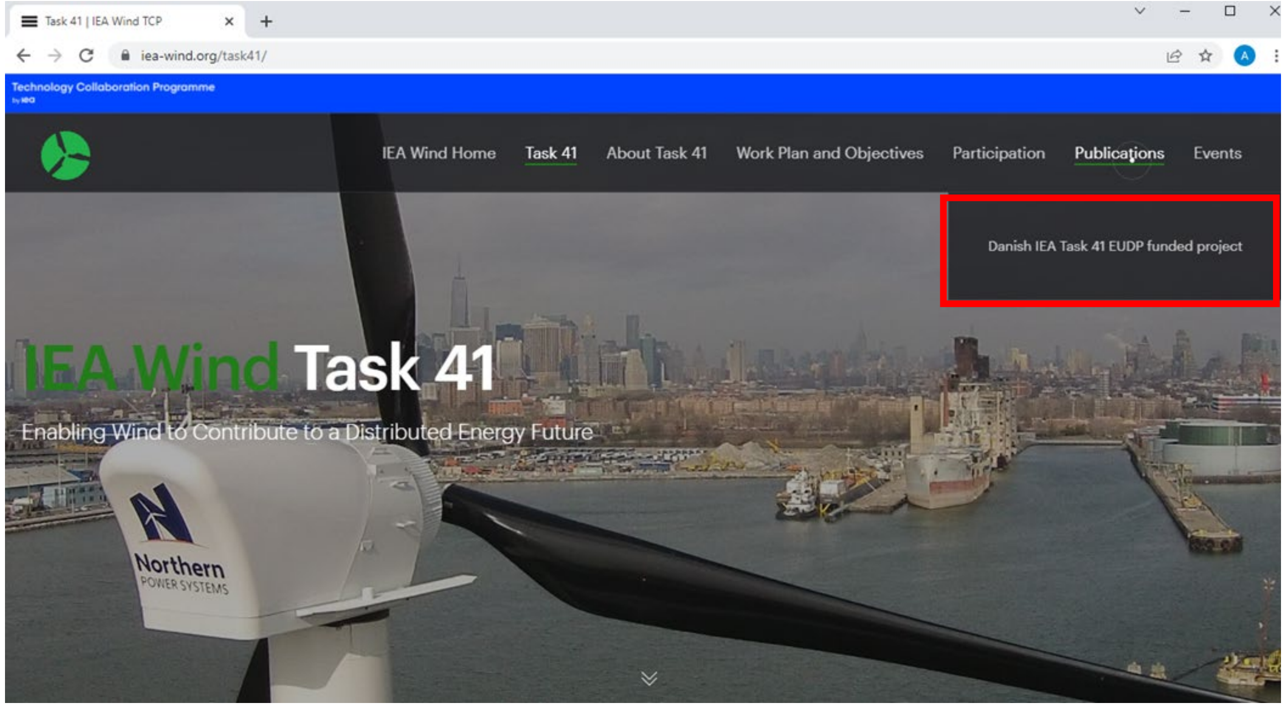
Manpower / WPs		No.	Milestones	Delivery date
Anca	WP0	M1	Project description & visibility on Vindenergi.dtu.dk, Twitter, LinkedIn	March 2020
Anca	WP0	M2	1st (kick-off) Danish stakeholders workshop	May 2020
Mark	WP1	M3	Small and medium size wind turbine standards assessment	March 2021
Mark	WP1	M4	Technical justification for the changes proposed in M3 developed	Nov 2022
Mark	WP1	M5	Conformity assessment for DW suggested	Dec 2022
Anna Maria	WP2	M6	Data catalogue specification	June 2020
Tom	WP3	M7	Completion of review of micro-grid modelling tools	May 2020
Aeishwarya	WP3	M8	Distribution system model for control strategy assessment	June 2021
Anca	WP0	M9	2nd annual Danish stakeholders workshop	Oct 2021
Anca	WP0	M10	3rd annual Danish stakeholders workshop	Oct 2022
Anca / All	WP0	M11	Final report summarizing the project results	Dec 2022

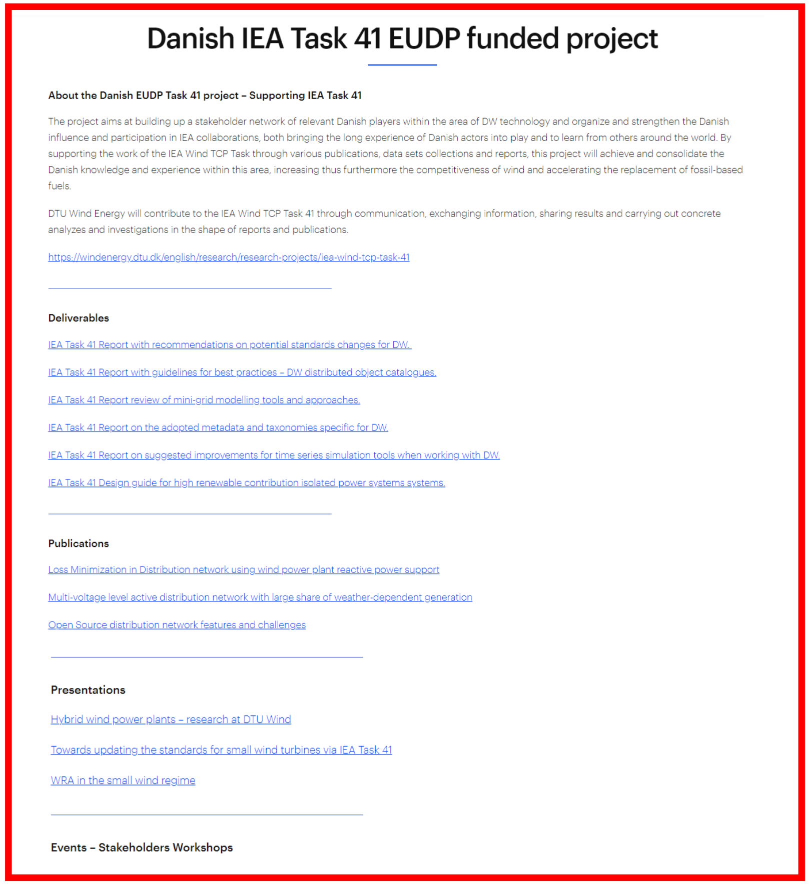
Delivarables

Manpower / WPs		No.	Delivarables	Delivery date
Anca	WP0		1st EUDP reporting	July 2020
Anca	WP0		2nd EUDP reporting	July 2021
Anca	WP0		3rd EUDP reporting	July 2022
Mark	WP1	D1.1	Report on recommendations for potential standards changes that will be used to drive additional national and international research	March 2021
Mark	WP1	D1.2	Report on suggested changes to the current standards, and suggested conformity assessment	Dec 2022
Anna Maria	WP2	D2.1.	Report on the adopted metadata and taxonomies specific for DW and metadata catalogue.	Oct 2020
Anna Maria	WP2	D2.2	Guideline for best practices for compiling DW distributed object catalogues. Data Management Plan Template, for Danish actors.	May 2021
Matti	WP2	D2.3	Report on suggested improvements for time series simulation tools when working with DW.	Nov 2021
Aeishwarya	WP3	D3.1	Report on control strategies of wind turbines in future distribution systems based on the delivarable D15 of IEA Wind Task 41 and tailored to the requirements of Danish stakeholders.	Nov 2022
Tom	WP3	D3.2	Contribution to the D14 delivarable report of IEA Task 41	May 2020
Tom	WP3	D3.3	Contribution to the D16 delivarable report of IEA Task 41	Nov 2020
Tom	WP3	D3.4	Contribution to the D17 delivarable report of IEA Task 41	Nov 2021
All	WP4	D4.1	Report describing specific DW aspects/gaps relevant for the Danish players and stakeholders.	Nov 2022
Anca / All	WP0		Final report summarizing the project results	Dec 2022

Danish EUDP IEA Task 41 project

- https://windenergy.dtu.dk/english/research/research-projects/iea-wind-tcp-task-41
- http://iea-wind.org/task41/





Danish IEA Task 41 EUDP funded project

About the Danish EUDP Task 41 project – Supporting IEA Task 41

The project aims at building up a stakeholder network of relevant Danish players within the area of DW technology and organize and strengthen the Danish influence and participation in IEA collaborations, both bringing the long experience of Danish actors into play and to learn from others around the world. By supporting the work of the IEA Wind TCP Task through various publications, data sets collections and reports, this project will achieve and consolidate the Danish knowledge and experience within this area, increasing thus furthermore the competitiveness of wind and accelerating the replacement of fossil-based fuels.

DTU Wind Energy will contribute to the IEA Wind TCP Task 41 through communication, exchanging information, sharing results and carrying out concrete analyzes and investigations in the shape of reports and publications.

https://windenergy.dtu.dk/english/research/research-projects/iea-wind-tcp-task-41

Deliverables

IEA Task 41 Report with recommendations on potential standards changes for DW.

IEA Task 41 Report with guidelines for best practices – DW distributed object catalogues.

IEA Task 41 Report review of mini-grid modelling tools and approaches.

IEA Task 41 Report on the adopted metadata and taxonomies specific for DW.

IEA Task 41 Report on suggested improvements for time series simulation tools when working with DW.

IEA Task 41 Design guide for high renewable contribution isolated power systems systems.

Publications

Loss Minimization in Distribution network using wind power plant reactive power support

Multi-voltage level active distribution network with large share of weather-dependent generation

Open Source distribution network features and challenges

Presentations

Hybrid wind power plants – research at DTU Wind

Towards updating the standards for small wind turbines via IEA Task 41

WRA in the small wind regime

Events – Stakeholders Workshops

Topics open list

- Enabling faster and easier grid connection permits for wind based systems(hybrid systems, flexibility provision)
- Multi energy multi-technology hybrid wind systems
- Coordination of renewable generators with other network assets in future power systems
- Grid and market service provision from distributed wind
- Need for accurate prediction of the power production from small wind turbines power output
- Small-wind environment characterization
- Digital objects catalog for the wind energy sector digital transformation
- Test and validation of electrical controls in DTU Hybrid Wind Power Facility (225 kW Wind turbine, 60 kW/14.8F SC, 30kW/79kWh Li-ion Battery, 1 MW grid connection)

Result of hour survey

Enabling faster and easier grid connection permits for wind based systems
(hybrid systems, flexibility provision)

Multi energy multi-technology hybrid wind systems

Coordination of renewable generators with other network assets in future power systems

Grid and market service provision from distributed wind

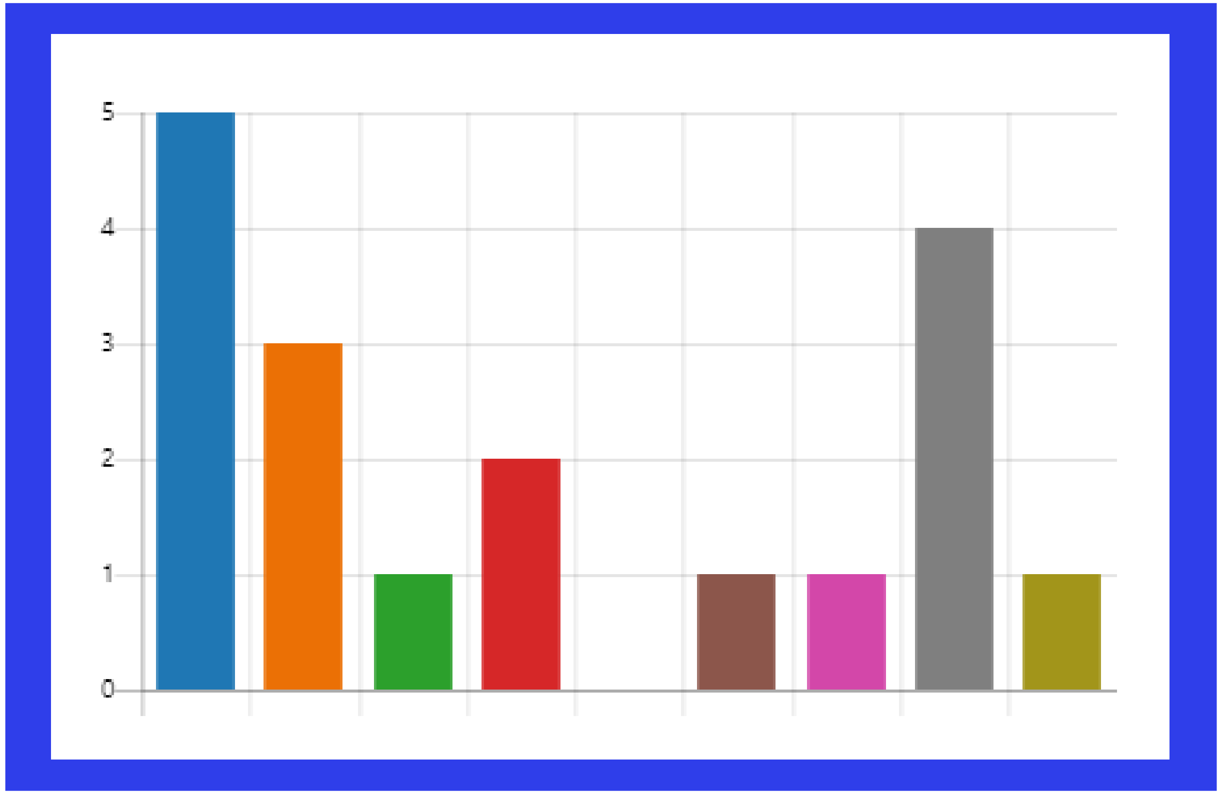
Need for accurate prediction of the power production from small wind turbines power output

Small-wind environment characterization

Digital objects catalog for the wind energy sector digital transformation

Test and validation of electrical controls in DTU Hybrid Wind Power Facility
(225 kW Wind turbine, 60 kW/14.8F SC, 30kW/79kWh Li-ion Battery, 1 MW grid connection)

Upcomming 61400-2 standard update



Thank you

Acknowledgments to EUDP

Small-wind environment characterization

Objectives

- metrics for characterization of obstacle/environment-affected turbulent flow ;
- filling in details of proposed high-turbulence classes and/or confirming it.

Description:

Many small turbines sit in turbulent flow conditions, due to their relatively low hub-heights compared to nearby built structures and terrain; their performance and lifetime (loads) can be heavily impacted. From syntheses of obstacle modelling and validation, engineering turbulence parameterizations, basic turbulence, micrometeorology, and scaling analysis—along with evaluating more performance and associated wind measurements, we aim to identify site-dependent (potentially turbine-dependent) metrics for characterizing the flow environment.

This supports the update and pre-validation of new small turbine/turbulence classes, as well as power-performance measurements, reporting, and requirements.

Stakeholders

Various small turbine manufacturers; Nordiske Folkecenter for turbines, NREL, IECRE

Potential funding source(s):

Innovation Fund/Small-Scale

Digital data catalogue for wind energy sector

Objective

To establish a catalog of the digital objects needed to make the wind energy sector at the forefront of the digital transformation.

Description

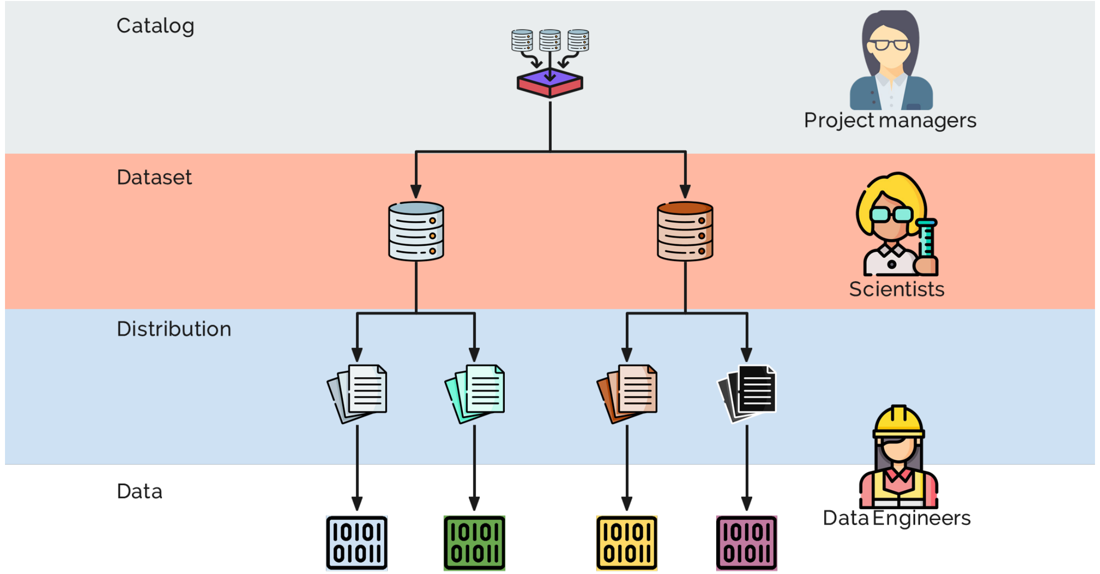
Data, models, workflows and data science tools created by the digitization of assests and in research processes are spread within several organizations and in each organization sometimes are stored in differen places. Organise data in catalogs is a much painless process than create huge databases because it needs only ttThis can be done at Organization level and inter – organization level: for the former the goal is the internal efficiency of an organization and for the latter is a innovation/research process efficient and fast by share data with other stakeholders and join force to co-create solutions.

Stakeholders

Various wind turbine manufacturers

Potential funding source(s)

Horizon Europe has calls about digitalization



4. Distributed wind stakeholders' workshop 3

The overall target of this workshop 3 was to further discuss how research can support and strengthen the Danish industry to deploy more wind power and renewable energy at distribution grid to meet the Danish vision of green transition. The workshop provided space for sharing experience on the challenges, the Danish players & stakeholders are facing in various relevant distributed wind (DW) topics, such as: DW standards, DW integration and network support, human dimensions of Distributed Wind. Beside this, in the workshop, we also target to initiate the discussion for a new EUDP IEA Task 41 project proposal. The workshop supported the work in the IEA Wind TPC Task 41 and provided results anchored in Denmark, thus creating added value for Danish players.

The main take-away messages from the workshop discussions are:

- There are several opportunities in distribution networks with large share of RES, as e.g.
    - Available large amount of data related to weather forecasts, load profiles, generation from WPPs and PVs can be collected for optimal operation.
    - Wind power plants are more controllable through power electronics -> these capabilities can be utilized for optimal operation in the network along with already available network assets. This would reduce the need for network reinforcements to some extent.
    - Distribution networks can potentially provide flexibility in terms of active and reactive power exchange or as reserve capacity for the transmission network. The interactions between TSO/DSO can prove further beneficial to incorporate RES in the Distribution network.
- Distribution network no longer have a passive role because the network has controllable active and reactive power capabilities which can prove beneficial economically.
- Possibility to have joint ownership of small wind turbines, as otherwise there are few and expensive to fit on the market.
- There is a need for Danish manufactures onboard in working with standards.
- There are still persistent obstacles for Danish small wind, such as prohibitive rules for installations of wind turbines smaller than 500kW, expensive testing requirements, not well-tested power curves.
- The benefits of distributed wind cannot be taken for granted but are produced through social and material practices.
- There is a crucial need for identifying and reviewing of distributional justice of distributed wind.

- Social acceptance does not only refer to local acceptance or community acceptance, but also includes the role of political institutions, policymakers, legislations, planning authorities that co-determine (enable or hamper) the uptake of distributed wind

In the following, the presentations of workshop 3 are included.

Workshop
EUDP IEA Task 41 Distributed Wind (DW)

Anca Hansen

Workshop program

- 10.00 - 10.05 **Welcome** Anca Hansen
- 10.05 - 10.15 **Short presentation of EUDP IEA Task 41** Anca Hansen (DTU Wind)
- 10.15 - 11. 05 **Experience sharing on DW challenges for Danish players**
    - 10.15 - 10.25 Aeishwarya Baviskar (DTU Wind)
    - 10.25 - 10. 35 Tonny Brink (Nordic FolkeCenter)
    - 10.35 - 10.45 Florin Iov (Aalborg University)
    - 10.45 - 10.55 Mark Kelly (DTU Wind)
    - 10.55 - 11.05 David Philipp Rudolph (DTU Wind)
- 11.15 - 11.25 **IEA task 41 - Task Extension Proposal** Anca Hansen (DTU Wind)
- 11.25 – 11.55 **Collaboration discussions for a new EUDP IEA Task 41**
- Final remarks

Distributed Wind workshop – today goals

- **Share experience on needs and challenges,** the Danish players & stakeholders are facing in various relevant DW topics:
    - DW standards
    - DW integration and network support
    - DW human dimensions
- **Identify** how research can support and strengthen the Danish distributed wind (DW) players and stakeholders
    - discuss the relevance for the Danish players and stakeholders
    - generate / define **potential new collaboration ideas** of particular Danish interest in various relevant DW topics
- **Initiate** the discussion for a new EUDP IEA Task 41 project proposal
- **Support** the work in the IEA Wind TPC Task 41

EUDP IEA Wind TPC Task 41

About IEA Wind Task 41

Operating Agent

National Renewable Energy Laboratory

Pacific Northwest National Laboratory

Period

2019-2023

No annual fee needed

Website

https://community.ieawind.org/task41/home

Distributed Wind (DW) Technology

Wind turbines deployed in a distributed application, connected at a distribution voltage (nominally 70 kV) or below – located behind the meter, in front of the meter, or in an off-grid application.

Task 41 Participants	
Austria	Fachhochschule Technikum Wien
Belgium	Vrije Universiteit Brussel
Canada	Canada Natural Resources Canada
CWEA	China Wind Energy Association (CWEA), China General Certification (CGC), Goldwind, and Inner Mongolia University of Technology
Denmark	Denmark Technical University (DTU) & Nordic Folkecenter for Renewable Energy
Ireland	Dundalk Institute of Technology
Japan	New Energy and Industrial Technology Development (NEDO)
Korea	Korea Institute of Energy Research
Spain	CIEMAT
USA (OA)	National Renewable Energy Laboratory Pacific Northwest National Laboratory

IEA Wind Task 41 - 5 workpackages

- **WP1** - Research to support an update of existing wind standards
- **WP2** **-** Technical data sharing in both process and practice
- **WP3** - Research & collaboration on the integration of DW technologies
- **WP4** - Outreach & expand collaboration of ongoing R&D activities regarding specific challenges of DW
- **WP5** - DW innovation and downscaling of utility scale technology

EUDP IEA Task 41 project

Period: 2020 – 2023

Participants: DTU Wind

Website: Danish IEA Task 41 EUDP funded project | IEA Wind TCP (iea-wind.org)

Overall objectives

- identify and explore studies of **particular Danish interest of DW** for cost effective technology development and integration into an continuously evolving Danish electrical system.

- strengthen the **Danish players and stakeholders**, contributing to further increasing the penetration of wind power into the electricity, while still maintaining the high level of security of supply.

Danish EUDP IEA Task 41 project

Project is <u>organized into 5 work-packages</u>

- **WP0**: Management, coordination and dissemination
- **WP1:** DW technology design standards for small and mid-sized wind turbines
- **WP2:** Data information catalog for DW research
- **WP3:** Integration of DW into evolving electricity systems
- **WP4:** Outreach and expand collaboration of ongoing R&D DW activities

Milestones

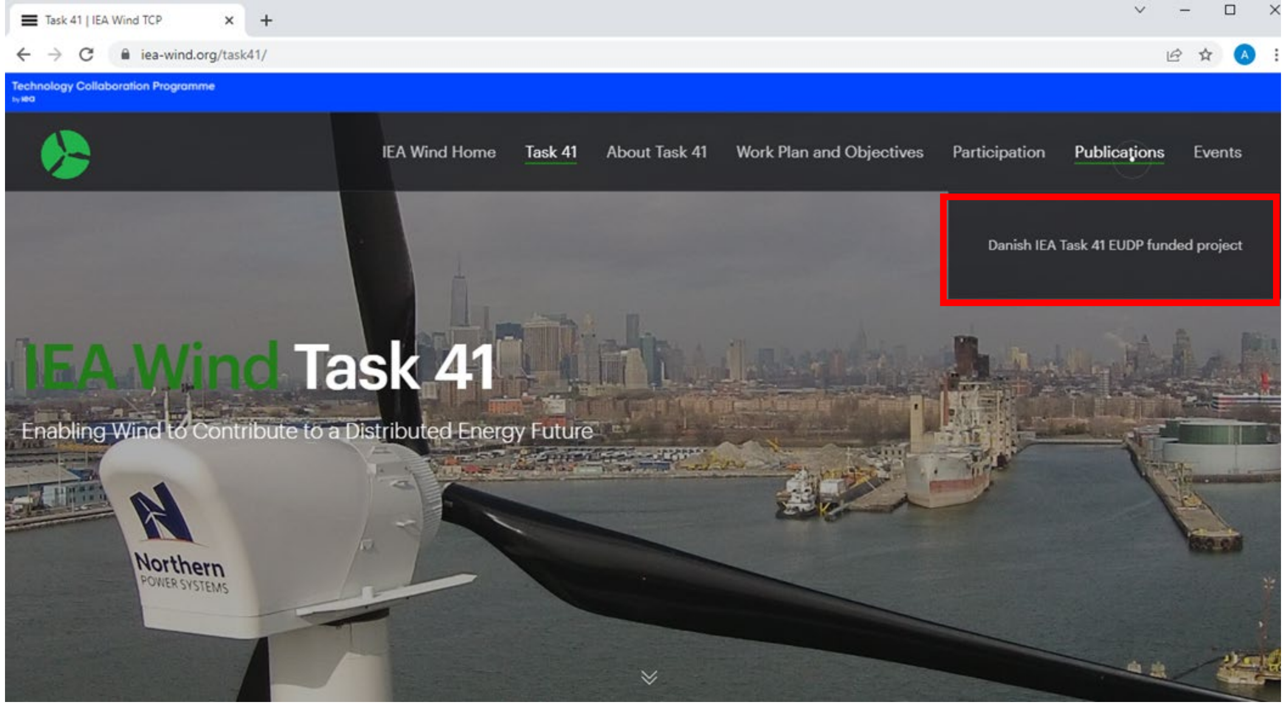
Manpower / WPs		No.	Milestones	Delivery date
Anca	WP0	M1	Project description & visibility on Vindenergi.dtu.dk, Twitter, LinkedIn	March 2020
Anca	WP0	M2	1st (kick-off) Danish stakeholders workshop	May 2020
Mark	WP1	M3	Small and medium size wind turbine standards assessment	March 2021
Mark	WP1	M4	Technical justification for the changes proposed in M3 developed	Nov 2022
Mark	WP1	M5	Conformity assessment for DW suggested	Dec 2022
Anna Maria	WP2	M6	Data catalogue specification	June 2020
Tom	WP3	M7	Completion of review of micro-grid modelling tools	May 2020
Aeishwarya	WP3	M8	Distribution system model for control strategy assessment	June 2021
Anca	WP0	M9	2nd annual Danish stakeholders workshop	apr-22
Anca	WP0	M10	3rd annual Danish stakeholders workshop	Oct 2022
Anca / All	WP0	M11	Final report summarizing the project results	Dec 2022

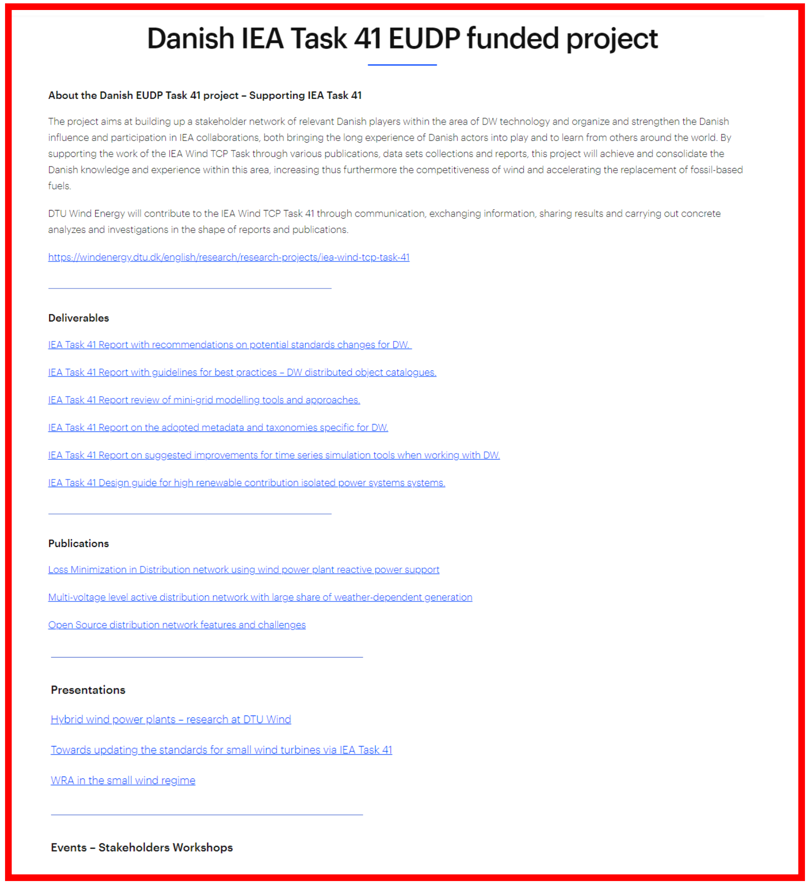
Delivarables

Manpower / WPs		No.	Delivarables	Delivery date
Anca	WP0		1st EUDP reporting	July 2020
Anca	WP0		2nd EUDP reporting	July 2021
Anca	WP0		3rd EUDP reporting	July 2022
Mark	WP1	D1.1	Report on recommendations for potential standards changes that will be used to drive additional national and international research	March 2021
Mark	WP1	D1.2	Report on suggested changes to the current standards, and suggested conformity assessment	Dec 2022
Anna Maria	WP2	D2.1.	Report on the adopted metadata and taxonomies specific for DW and metadata catalogue.	Oct 2020
Anna Maria	WP2	D2.2	Guideline for best practices for compiling DW distributed object catalogues. Data Management Plan Template, for Danish actors.	May 2021
Matti	WP2	D2.3	Report on suggested improvements for time series simulation tools when working with DW.	Nov 2021
Aeishwarya	WP3	D3.1	Report on control strategies of wind turbines in future distribution systems based on the delivarable D15 of IEA Wind Task 41 and tailored to the requirements of Danish stakeholders.	Nov 2022
Tom	WP3	D3.2	Contribution to the D14 delivarable report of IEA Task 41	May 2020
Tom	WP3	D3.3	Contribution to the D16 delivarable report of IEA Task 41	Nov 2020
Tom	WP3	D3.4	Contribution to the D17 delivarable report of IEA Task 41	Nov 2021
All	WP4	D4.1	Report describing specific DW aspects/gaps relevant for the Danish players and stakeholders.	Nov 2022
Anca / All	WP0		Final report summarizing the project results	Dec 2022

Danish EUDP IEA Task 41 project

- https://windenergy.dtu.dk/english/research/research-projects/iea-wind-tcp-task-41
- http://iea-wind.org/task41/





Danish IEA Task 41 EUDP funded project

About the Danish EUDP Task 41 project – Supporting IEA Task 41

The project aims at building up a stakeholder network of relevant Danish players within the area of DW technology and organize and strengthen the Danish influence and participation in IEA collaborations, both bringing the long experience of Danish actors into play and to learn from others around the world. By supporting the work of the IEA Wind TCP Task through various publications, data sets collections and reports, this project will achieve and consolidate the Danish knowledge and experience within this area, increasing thus furthermore the competitiveness of wind and accelerating the replacement of fossil-based fuels.

DTU Wind Energy will contribute to the IEA Wind TCP Task 41 through communication, exchanging information, sharing results and carrying out concrete analyzes and investigations in the shape of reports and publications.

https://windenergy.dtu.dk/english/research/research-projects/iea-wind-tcp-task-41

Deliverables

IEA Task 41 Report with recommendations on potential standards changes for DW.

IEA Task 41 Report with guidelines for best practices – DW distributed object catalogues.

IEA Task 41 Report review of mini-grid modelling tools and approaches.

IEA Task 41 Report on the adopted metadata and taxonomies specific for DW.

IEA Task 41 Report on suggested improvements for time series simulation tools when working with DW.

IEA Task 41 Design guide for high renewable contribution isolated power systems systems.

Publications

Loss Minimization in Distribution network using wind power plant reactive power support

Multi-voltage level active distribution network with large share of weather-dependent generation

Open Source distribution network features and challenges

Presentations

Hybrid wind power plants – research at DTU Wind

Towards updating the standards for small wind turbines via IEA Task 41

WRA in the small wind regime

Events – Stakeholders Workshops

Challenges and Opportunities for Distributed Wind Integration

...from the perspective of distribution networks

IEA Task 41-Distributed Wind Workshop

Date: 20th Jan 2023
Presented By: Aeishwarya Baviskar

Background

- **Growing number of variable renewable energy installations**
  - Cumulative wind installed capacity in Europe 205 GW [1]
  - Solar installations in the EU grew by 104% in 2019 [2]

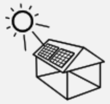
- **Large volume of variable renewable sources at MV/LV**
  - Total amount of distributed wind in Denmark ≈ 3.1GW [3]
  - 50% of the total energy consumption in Denmark comes from variable renewable sources (47% Wind and 3% Solar)(2019) [3]
  - 49% of EU's cumulative photovoltaic capacity consists of rooftop solar (19% residential and 30% commercial) [2]

- **Onshore wind is one of the cheapest form of new electricity around the world!**

Country	Wind in the energy mix [%]
Denmark	48%
Ireland	33%
Portugal	27%
Germany	26%
UK	22%

+470 GW centralized renewable

+40 GW self-consumption



~70%

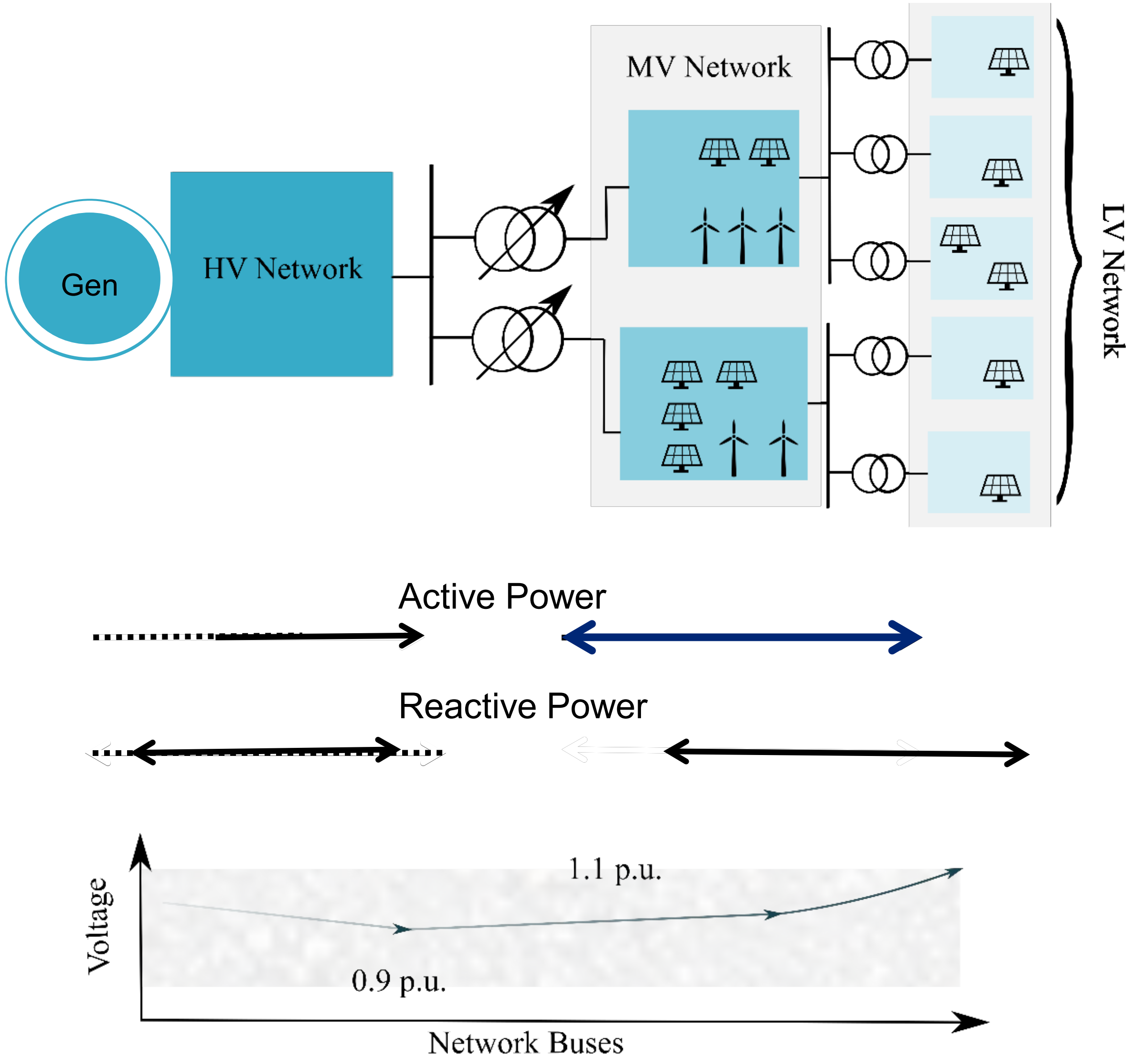
renewable capacity **connected to distribution grids**

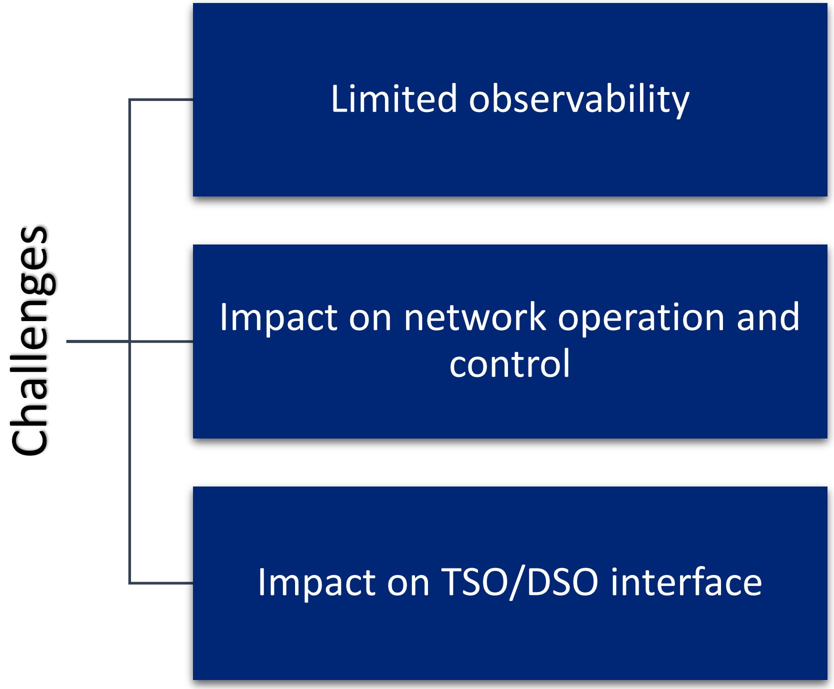
[1] Colin Walsh, "Wind energy in Europe in 2019," Tech. Rep., 2019.

[2] M. . Schmela, B. Aurelie, C. Naomi, G. P. Mariano, H. Mate, and R. Raffaele, "Global market outlook," Tech. Rep., 2018. [Online]. Available: www.africa-eu-renewables.org

[3] "Energinet." [Online]. Available: https://energinet.dk/

Challenges for integration of Distributed Wind





Challenges for integration of Distributed Wind

- Generating source at low voltage nodes increases the voltage at the end of the lines
- High voltages at the end of the line affect the operating characteristics of network assets such as voltage regulators

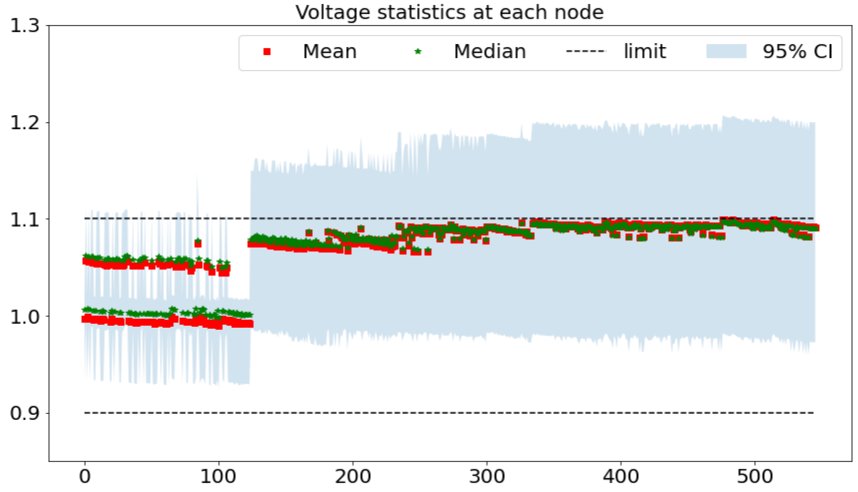


Fig. Distribution of voltage at all nodes in the 10kV-0.4kV network at Bus 46 for load and generation profile over a year

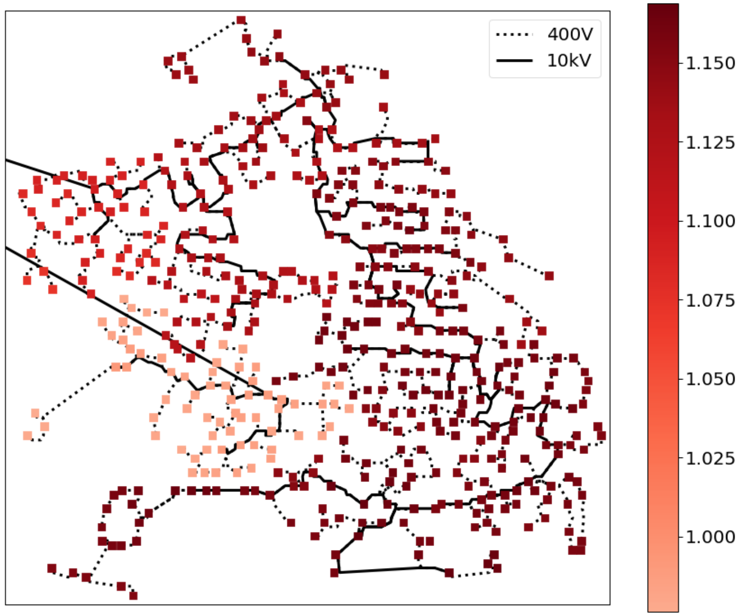


Fig. Voltage profile for 10kV-0.4kV network at Bus 46 at one time instance
Load Demand: 1.62 MW | Generation: 32.6 MW

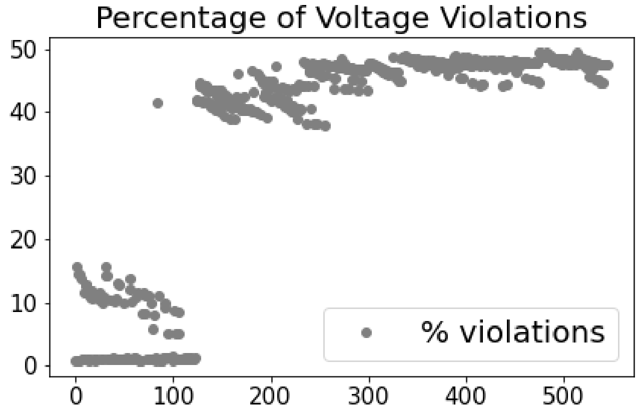


Fig. Percentage voltage violations at all nodes in network at Bus 46

Challenges for integration of Distributed Wind

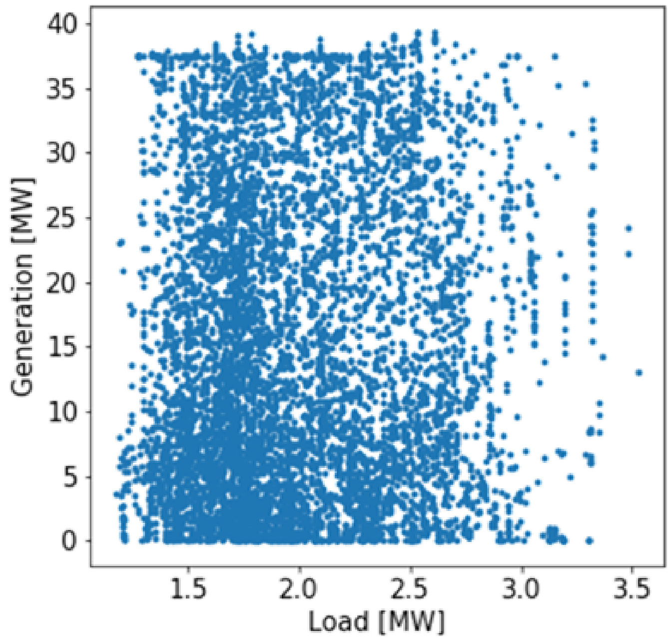


Fig. Scatter plot showing the lack of correlation between load demand and renewable generation

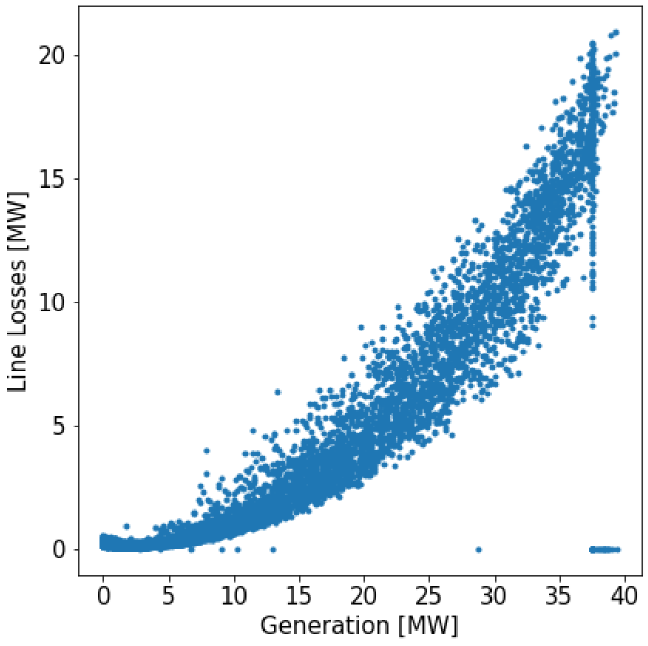


Fig. Scatter plot showing correlation of line losses and renewable generation in the network

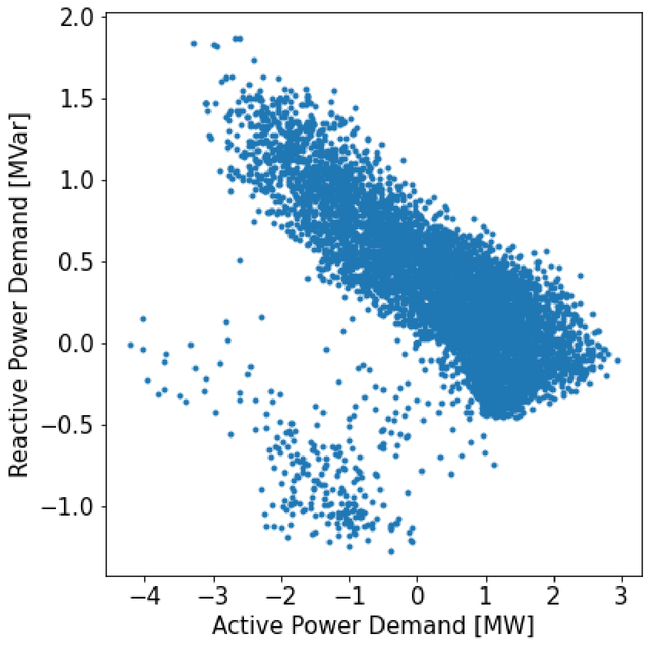


Fig. Scatter plot showing the active and reactive power flow at the 60kV-10kV substation

- Load demand and renewable generation in the network do not correlate at most time-stamps
- However, the active power losses in the distribution network proportionally increase with the renewable generation
- Reverse active and reactive power flow from the distribution network to the transmission network also increases.

Opportunities in distribution networks with large share of RES

1. Availability of large amount of data and detailed models (weather, technology, etc.)

2. Control of already available network assets together with RES to mitigate the adverse impact on network operation

3. Co-ordination between TSO/DSO for flexibility provision, optimal operation and grid support

Thank you!

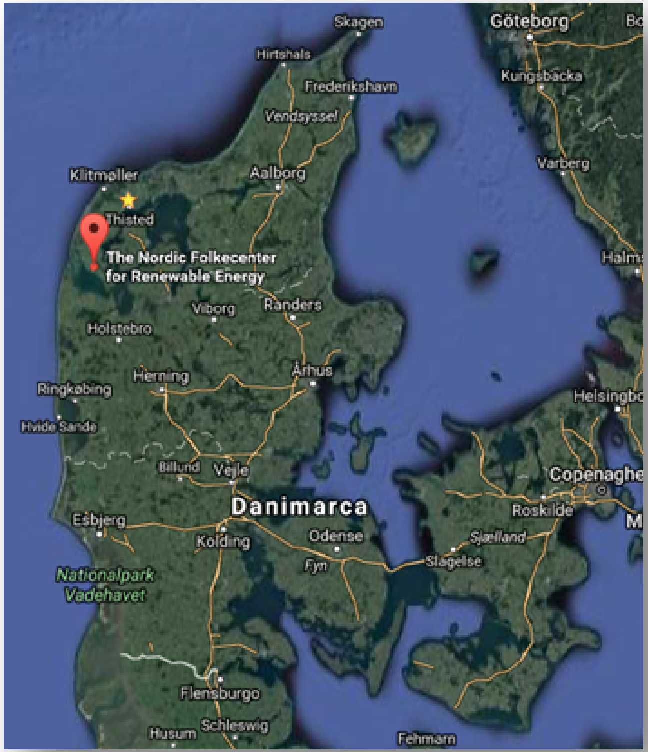
DANISH TEST AND RESOURCE CENTRE FOR SMALL WIND TURBINE

Tonny Brink
Nordic Folkecenter for Renewable Energy

Workshop DW @ DTU
20. Januar 2023

The Nordic Folkecenter for Renewable Energy

- NGO founded in 1983
- Focus: Renewable Energy
- Bridge between education and industry
- Well known at international level
- Multi-cultural and multi-disciplinary environment
- Has hosted hundreds of interns, professors, researchers from different fields and from all over the world
- 6000+ visitors/year (1,7 mio. Online)



Goal: Favour the transition towards a 100% renewable energy society

DANISH TEST AND RESOURCE CENTRE FOR SMALL WIND TURBINES

Small Wind Test and Lab

Dansk Standard, S-588, TC88, IEA – Task 41

Strategy for S-588 Vindenergisystemer

Purpose

To ensure that TC 88/S-588 initiates and participates in all standardization projects related to Wind Energy

Active participation in Technical areas

- IEC TC 88 Wind energy generation systems
- CLC TC 88 Wind Turbine
- IECRE – The IEC System for Certification to Standards Relating to Equipment for Use in Renewable Energy Applications
- All Wind energy related projects under IEC TC 14 Power transformers
- All Wind energy related projects under ISO TC 60 Gear
- All standardisation projects related to Wind energy in other Technical Committees.

Denmark has since 2013 held the secretariat for IEC TC 88 Wind energy generation systems

DS
DANSK STANDARD

Kilde:Dansk Standard

DANISH TEST AND RESOURCE CENTRE FOR SMALL WIND TURBINES
Small Wind Test and Lab

DANISH TEST AND RESOURCE CENTRE
FOR SMALL WIND TURBINES
Small Wind Test and Lab

Danish members of S-588 Vindenergisystemer

Blade Test Centre A/S
Brüel & Kjær Vibro A/S
Codan Forsikring A/S
COWI A/S
Danmarks Vindmølleforening
DIALIGHT A/S
DNV-GL Denmark A/S
DTU Vindenergi
Energinet
Energistyrelsen
Envision Energy (Denmark) ApS
ExxonMobil Nordic
Fonden Lindoe Offshore Renewables Center
Force Technology
Fredericia Maskinmesterskole
HOFOR A/S
Ingeniørhøjskolen Aarhus Universitet
K 2 Management A/S
LM Wind Power A/S
MHI Vestas Offshore Wind A/S
Nordic Folkecenter for Renewable Energy
PolyTech A/S
Siemens Gamesa Renewable Energy A/S
Suzlon Energy A/S
Svend Ole Hansen ApS
Sweco Danmark A/S
Vattenfall A/S
Vestas Wind Systems A/S
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DS
DANSK STANDARD

Roll Call of TC88 MT2 experts and observers

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Member	Brink	Tonny	DK	tb@folkecenter.dk
Member	Brownstein	Ian	US	ian@xflowenergy.com
Member	Bülk	Morten	DE	mbuelk@tuev-nord.de
Member	Byrne	Raymond	IE	raymond.byrne@dkit.ie
Member	Chang	Andrew	US	andrew.chang@ge.com
Member	Choi	Jungsik	KR	energy1@korea.kr
Member	Connor	Christopher	US	cconnor@nps100.com
Member	Cruz Cruz	José Ignacio	ES	ignacio.cruz@ciemat.es
Member	Falzon	Adam	AU	auswindstandards@outlook.com.au
Member	Hashimoto	Jun	JP	jun_hashimoto@jema-net.or.jp
Member	jia	yan	CN	jia-yan@imut.edu.cn
Member	Jones	Patrick	GB	PATRICK@RYSE.ENERGY
Member	Kaczynski	Tim	DE	tkaczynski@tuev-nord.de
Member	Kelso	Richard	AU	richard.kelso@adelaide.edu.au
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Member	Spossey	Joseph	US	Joseph.spossey@reinnovationsllc.com
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Member	Van Dam	Jeroen	US	jeroen.van.dam@nrel.gov
Member	WANG	Yiming	CN	jimmy@ginlong.com
Member	Wastling	Mike	GB	mike.wastling@britwind.co.uk
Member	Wöbbeking	Mike	DE	woebbeking@gmx.de

35 experts

Apologies:

Discussion topics summary

Topic	Priority	Status	Reference
Improvements in Aeroelastic Modeling (including VAWTs)	high	a little on VAWTs in meeting 8, present update in meeting 10	NREL/RRD report: https://www.nrel.gov/docs/fy22osti/81724.pdf
Loads test / validation & verification (2 requires compliance with -13; Simplification desired_	high	tied to scope discussion, tiered approach	
Redefine scope of -2	high	meeting 2, 3, 4, 5, 7, 8, **9**; awaiting TC88 input	IEA Task 41 report: https://orbit.dtu.dk/en/publications/recommendations-on-potential-standards-changes-for-distributed-wi
Duration test	high	meeting 5	NREL ACP 101-1 report: https://www.nrel.gov/docs/fy21osti/79775.pdf
Material safety factors (characterization)	high	meeting 4, 7; formed SC	J. Spossey document
Improvements in Simplified Loads Methodology	high	meeting 7	NREL/Wood report: https://www.nrel.gov/docs/fy22osti/83708.pdf
Turbulence (including averaging period)	med	meeting 10	IEA Task 27 reports, plans for Task 41
Blade testing (static, fatigue based on tiered sizes)	**med**	**meeting 9**	**Look at standard, look at ACP 101-1 tier table, etc.**
Safety and function testing	**med**	**meeting 9**	**Look at standard, opportunities to clarity, improve, lessons learned?**
Tower dynamics / interactions	med		
Title of MT2 (replace "Safety of Small Wind Turbines")	low	Small Wind Turbines?	
VAWT simplified loads methodology	low	Meeting 8	English version of JSWTA 0001 annex in meeting 7 minutes
Novel designs (e.g. diffuser aumented), or others not defined	low	invite Accelerate Wind, etc.?	
Electrical	added	meeting 6; forming SC.	Summary IEA pres from Trudy F.
Overall 'safety' - however we define that - for me this is a major issue for market acceptance and reputational damage -Alistar Mackinnon	added	Alistair	
Harmonization of the requirements / Time 2 Market / Utilization of the scheme for SWT - Osvald	added	IECRE, MCS guests	
Utilization of IEC 61400-1 loads design methodology for -2 compliance?	added	Tied to scope expansion, tiered approach	
Add uncertainty calculation methods to any measurements	added	TC88 decision	
Risk assessment (annex?)	added	Sharman	
Errata	added		CORRIGENDUM 1 and Wood SLM report

Scope of Work update

Report of Comments on 88/919/Q (posted on TC88 dashboard)

- Proposal for scope of revision of IEC 61400-2:2013, Wind turbines - Part 2: Small wind turbines
- Circulation Date: 2022-10-21, Closing Date: 2022-12-02

Ctry	Comment
AT	We agree with an increasing of the rotor area to max. 1000 m² for small wind turbines, but the maximum power shall then also be limited to approximately 200 kW.
CA	CA approves the proposed scope of work for the 4th revision with no comments.
CZ	The Czech NC approves the proposed scope of work for the 4th revision.
DK	DK support the proposed scope of work for the 4th revision and an increase of the rotor swept area to approximately 500 m2.
ES	Spain is in favour to increase the scope of the 61400-2 standard from 200 m2 to 500 m2 rotor swept area, defining at least four different subclasses for different wind turbines sizes ranges. Spain proposes to start a new mid-size standard from 100 kW to 1 MW rated power wind turbines. If this proposal is nor viable, one option would be to extend IEC-61400-2 scope up to 1 MW including at least one more subclass
GB	To date, no valid justification has been put forwards by MT 2 to support a scope increase to 61400-2 on technical and/or safety grounds. Therefore, the UK votes no to an increase in scope above the existing 200m2 swept area limit. Furthermore, the UK is very concerned regarding the longer-term reputational risks to the wider wind energy sector that might potentially arise if the scope is increased.
IT	The Italian National Committee agrees to start now the revision of the current Third Edition of Standard 61400-2 and approves the related scope and timetable. Particularly, the Italian NC is in favour of extending the range of applicable rotor swept areas up to 1000 m2 , given the steady trend towards larger rotors for the same rated powers and the fact that wind turbines up to 200 kW capacity have often been included among small units by supporting legislation, e.g. in Italy. In doing that, harmonisation with 61400-1 as far as medium wind turbines are dealt with in that Standard (now from 200 to 1000 m2 swept areas) should also be borne in mind
JP	We agree with the expansion of the rotor swept area up to 1000 m2. However, we propose not to specify the upper limit on rated output (e.g. 100 kW). We cannot understand why there is a great gap between the upper limit of rotor swept area and that of rated output [kW]. Specifically, we do not understand the reason for setting an upper limit on the rated output. “Swept area 1000 m2 or less” and “1000VAC/1500VDC or less” would be more appropriate.
NL	The NL NC supports the proposal for scope of revision of IEC 61400-2:2013
US	Approved; no comment
ZA	The scope of amendment is approved

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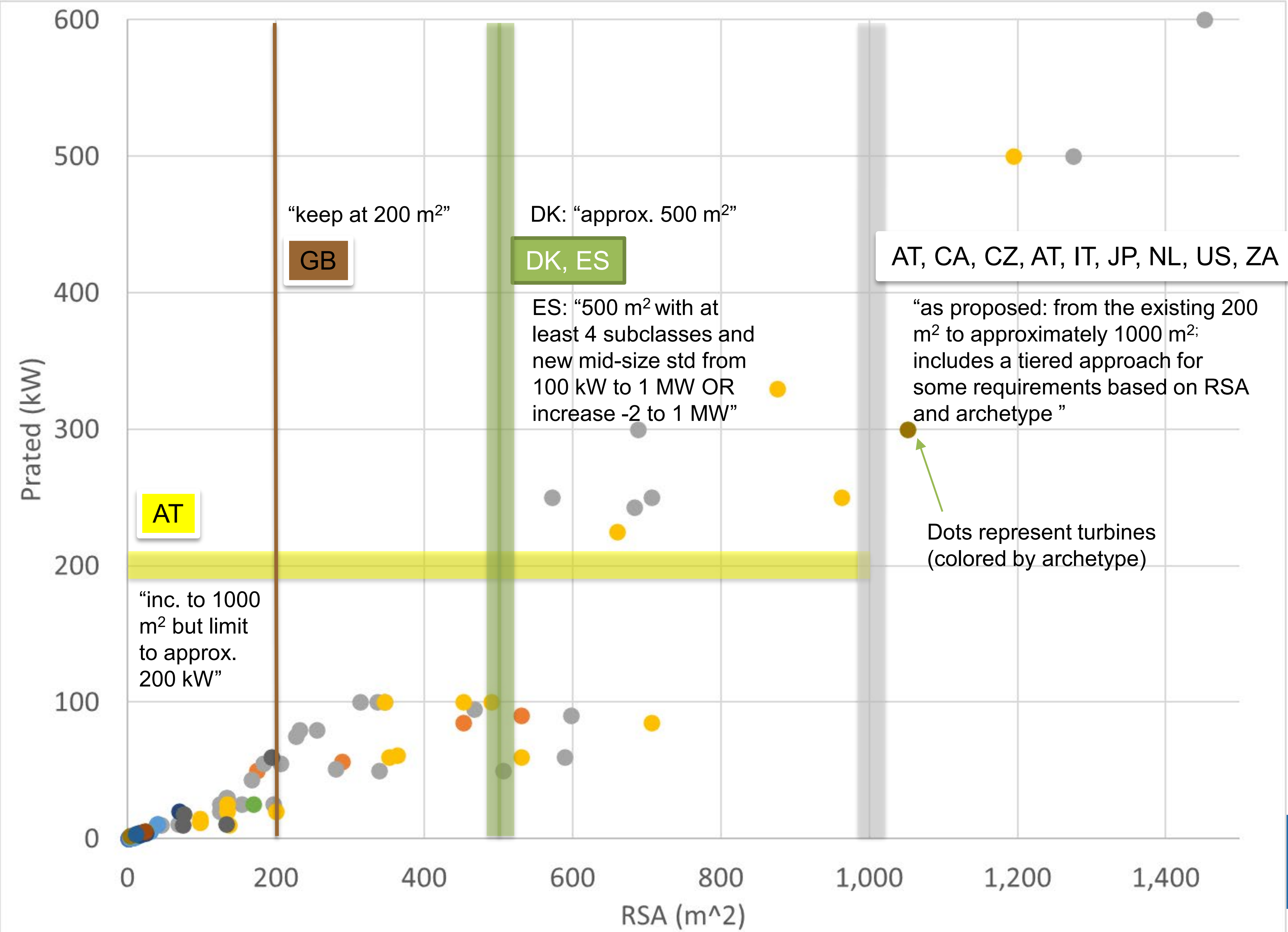
Graphical summary of comments received.



Scope cont’
TC88 Guidance

Conclusion from TC88 from 88/931/RQ

- On basis of the replies the conclusion is that:
  - the revision of IEC 61400-2:2013, will be initiated
  - as there is no clear majority directly approving the proposed scope, MT 2 will have to further discuss and decide on the scope for revision, taking the comments received into consideration.

Next meetings and topic(s)

Meeting	Date	Format	Topics
1	24-May-22	Virtual	Kickoff meeting, set schedule,overview of scope of work for this revision
2	23-Jun-22	Virtual	Scope of work prioritization, started scope increase discussion
3	28-Jul-22	Virtual	Scope increase discussion, IECRE overview
4	25-Aug-22	Virtual	Scope increase discussion, material safety factors
5	22-Sep-22	Virtual	Scope discussion tabled, MCS guests, duration test
6	27-Oct-22	Virtual	Electrical requirements
7	22-Nov-22	Virtual	Scope increase update, MSF SC update, Simplified loads methology
8	20-Dec-22	Virtual	TC88 update, VAWT SLM
9	24-Jan-23	Virtual	Scope of work, Blade testing, Safety & function testing
10	2&3-Mar-23	Hybrid; Arlington, VA, USA; with DWEA	VAWT design....TBD
11	Apr-23	Virtual	TBD
12	May-23	Tentative F2F opportunity: Wind Energy Science Conference 2023, 23-26 May in Glasgow	In person or virtual? Abstract prepared for small wind mini-symposium - SWT the next 10 years. (Paddy, Mark, Brent, Joe).

Meeting 10 DWEA conference info, agenda, and hotel info here:
https://distributedwind.org/

	Kickoff	SOW Approved	CD	CDV	FDIS	IS
Current estimate	2022-05-24	*2023-xx-xx	2023-xx-xx	2024-xx-xx	2025-xx-xx	2025-12-12 (stability date)
Actual	2022-05-24					

**to update once SOW is accepted; IEC timing recommendations next slide*

Initiating of Revision Process (RR)

When scope of work is agreed upon, RR submitted, clock starts running.

Target dates recommended by IEC:

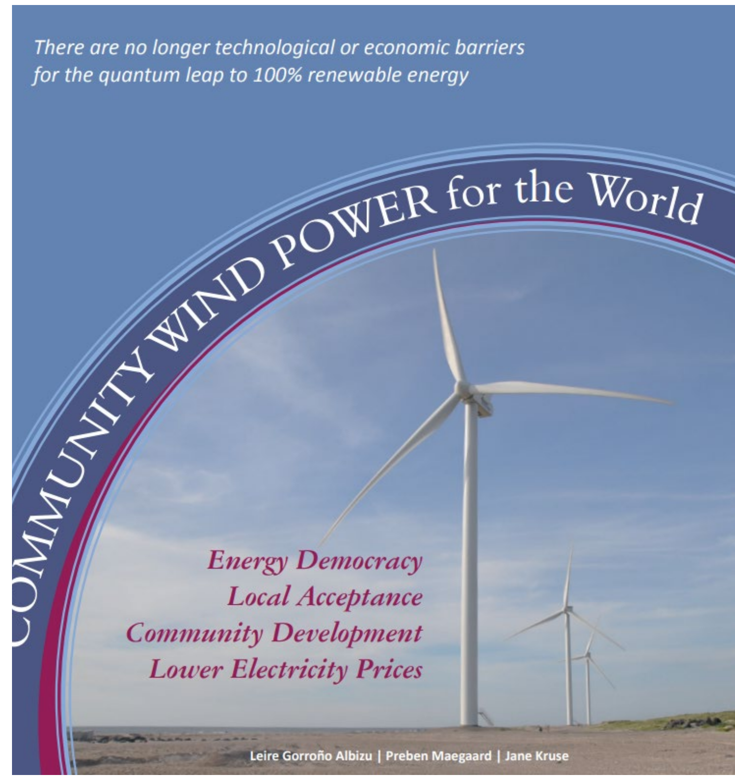
Committee Draft (CD):	12 months;
Committee Draft for Vote (CDV):	24 months;
Final Draft International Standard (FDIS):	33 months;
Published International Standard (IS):	36 months.

Per TC88:

When you have agreed on the scope for the revision in MT 2, it shall be sent to TC 88 via an RR (Review Report). Then the clock starts running.

So, you will have time now to discuss the received comments with MT 2 and decide on the final scope for revision. (The scope shall of cause still be inside the limits of the proposed scope in the Questionnaire)

WIND ENERGY AS A LEVER FOR LOCAL DEVELOPMENT IN PERIPHERAL REGIONS



******MissionGreenFuels partnerskab* (eller IM2 Partnerskabet)
AAU - https://vbn.aau.dk/da/organisations/institut-for-kommunikation-og-psykologi

Problems

- Few and expensive turbine to fit the market (standards)
- Joint ownership on small wind turbines
- No Danish Manufactures onboard in working with standards
- Still No Market???

Tonny Brink, Nordic Folkecenter for Renewable Energy

Educated as a Marine Engineer, he is Folkecenter's Chief Technical Director. He has got 35 years of experience in the international wind industry, working for Vestas Wind Systems A/S and Folkecenter. This has provided him with broad knowledge in service and maintenance site management and construction and operational project management. Hold positions and responsibilities: Travel Technician, Site Manager, Logistics Coordination, Area Service Manager, Technical Support Dept., People Manager, Technical After Sales/Customer Reporting, WTG Performance and Diagnostic analysis, Communication, Planning, Controlling, Technology Transfer, Project Management and Execution Leader.

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DANISH TEST AND RESOURCE CENTRE FOR SMALL WIND TURBINES

Small Wind Test and Lab

IEA Wind Task 41

20.Jan.2023 Workshop for DK stakeholders

Mark Kelly, Assoc.Prof.

Persistent issues for DK small/distributed wind

- Prohibitive rules for installation of <~500 kW
  – basically, just self-powering?

- Expensive certification requirements
  – 61400-2 needs to be updated

- Validated aeroelastic modelling: lacking (& expensive)

- Loads characterization & testing

- Power curves still not well-known/tested
  – turbulence & obstacle issues

potential / emerging possibilities?

- community / collective agreements for TSO/endpoints
- battery-sharing
- hop-on with (new) solar,bio,EC/H2; hybrid re-labelling? (→Florin, *et al*.)

- crowd-sourced reporting of performance
  - simple metrics on surroundings (distance to obstacles)
    - WAsP-online/mywindturbine.com project (almost) started this

- mass-produced microturbine applications (reselling…'voluntary' Chinese standards)

- urban turbines
  - e.g. Ventum now in DK (shrouded VAWT)

- ANSI/ACP SWT-1 standard (from USA) for P_{peak}< 150 kW
  - some 'relief'
  - acceptance in DK (outside USA) ?

possibilities for DK sellers of SW/DW turbines ?

- Experience of DK manufacturers, vs. current situation / needs
  - Gaia case
  - Thy
  - re-distributors (Viking? …)

- Representation in DK/588, TC88…

- More student projects with uni's & Folkecenter ☺

ongoing / coming up…

- connecting event:
  - Distributed Wind Energy Assoc. Distributed Wind 2023 Business Conference, 27-28 Feb. 2023
    - will have a hybrid attendance option

- Task 41 continuation...
  - work towards in-situ description (turbulent flow)
    - universal metrics
      - obstacle/environment characterization
        - » → turbulence + stats
      - power-curve effects

Task 41: Social acceptance foci by DTU

Focus A: Benefits of distributed wind

- Benefits cannot be taken for granted, but are produced through social and material practices
- Review of distributional justice of distributed wind
  - What are goals, impacts and social benefits of distributed wind in different countries?
  - Who benefits?
  - How are benefits created through different types of projects?
  - How benefits are represented by different stakeholders and for what purpose?
  - What are social, political and regulatory challenges for creating benefits?

Task 41: Social acceptance foci by DTU

Focus B: Socio-political acceptance

- Social acceptance does not only refer to local acceptance or community acceptance, but also includes the role of political institutions, policy-makers, legislations, planning authorities that co-determine (enable or hamper) the uptake of distributed wind

  - What regulatory challenges does the uptake and advancement of different projects face?
  - Data acquisition through secondary data (i.e. planning documents, policy documents, EIAs) and interviews with different stakeholders across selected countries

5. Conclusions

During EUDP IEA Task 41 Distributed Wind project a set of three distributed wind (DW) stakeholders' workshops have been organized by DTU Wind. This report presents and promotes all the good discussions, the main take-away messages and interactions with relevant Danish players and stakeholders within the area of DW technology during these workshops. The reports also highlights some potential new collaboration ideas/projects of particular Danish interest in various relevant distributed wind topics, for example, DW standards, DW integration, support of DW in MV-LV networks, and DW open data.