Report 2021

Task 41

This 25-kW wind turbine from Canadian manufacturer Eocycle Technologies, Inc. provides electricity for a farm in Spain.

Distributed Wind

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IEA Wind Task 41 is an international group of researchers from eleven member countries and associations dedicated to advancing wind technology as a cost-effective and reliable distributed energy resource.

OUR OBJECTIVES ARE to coordinate international distributed wind energy research, facilitate collaboration on priority research topics, and increase the visibility of wind technology as a distributed energy resource.

In 2021, Task 41 members published recommendations on potential standards changes applicable to distributed wind turbines, created a metadata catalogue for its members, researched advanced controls for distributed wind, and facilitated collaboration with outside university researchers.

One highlight is Task 41's research to identify the advanced controls needed to enable distributed wind to provide grid services and to deter-

Table 1. Task 41 Participants in 2021

	COUNTRY/SPONSOR	PARTICIPATING INSTITUTIONS
1	**Austria**	University of Applied Sciences Technikum Wien
2	**Belgium**	Vrije Universiteit Brussel
3	**Canada**	- Nergica - University of Calgary
4	**China Wind Energy Association (CWEA)**	- CWEA - Inner Mongolia University of Technology
5	**Denmark**	- Nordic Folkecenter for Renewable Energy -Technical University of Denmark (DTU)
6	**Greece**	Center for Renewable Energy Sources and Saving
7	**Ireland**	Dundalk Institute of Technology
8	**Italy**	University of Perugia
9	**Republic of Korea**	Korea Institute of Energy Technology Evaluation and Planning
10	**Spain**	Centre for Energy, Environment and Technology
11	**United States (Operating Agents)**	- National Renewable Energy Laboratory - Pacific Northwest National Laboratory

mine what other design requirements may be needed specifically for high renewable-contribution isolated power systems. With advanced controls, distributed wind can provide additional benefits beyond electricity, such as enhancing grid reliability and resilience.

Introduction

Task 41 was initiated in January 2019 to advance wind technology as a cost-effective and reliable distributed energy resource. Individuals, businesses, farms, and communities install distributed wind to offset retail power costs or secure long-term power cost certainty, support grid operations and local loads, and electrify remote locations and assets not connected to a centralized grid. The objectives of Task 41 are to coordinate international distributed wind energy research, facilitate collaboration on priority research topics, and increase the visibility of wind technology as a distributed energy resource. Expected results and results to date include the following:

- Research to support updates to design and testing standards for small and mid-sized wind turbines
- The creation of a distributed wind metadata catalogue
- Research to enable efficient and reliable integration of wind into distribution systems, isolated grids, and microgrids
- Outreach and collaboration with other IEA Tasks, international organizations, and universities
- Research on applying advances of large-scale wind technology innovations to smaller-scale wind technology.

In addition to the participating countries that have formally joined Task 41, Task 41 includes observers from India, Poland, and Singapore.

Progress and Achievements

To expand distributed wind research and engage with the next generation of distributed wind researchers, Task 41 initiated the University Research Collaboration in 2020, which has since grown to approximately 160 professors and students. This group has decided to focus the students' research on the two topics of aeroelastic modelling and hybrid power plants and systems. In July 2021, participating students showcased their research plans during a virtual symposium. Students will be invited to share their results with Task 41 members at future events.

Data are the main component of a problem-solving cycle, whether it is

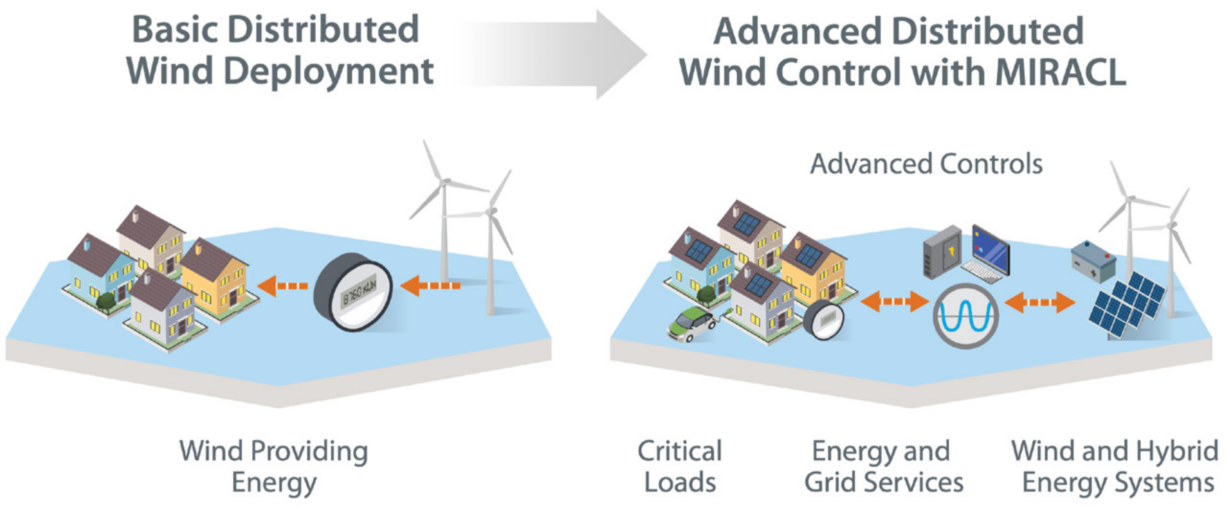

Figure 1. Traditional distributed wind deployments, as shown on the left, supply energy in kilowatt-hours to distribution systems. However, coupled with advanced controls (as shown on the right), wind alone or with other distributed energy resources can provide grid stability.

scientific, social, technological, or innovative in nature. Researchers around the world are conducting research and creating data sets relevant to the distributed wind; however, researchers often do not know about others' research and data sets. The Task 41 goal of creating and documenting a catalogue of distributed wind metadata (information about data) for Task members was achieved in 2021. A metadata catalogue shows researchers what is available but, at the same time, mitigates potential data sensitivity and intellectual property concerns. In the specific case of Task 41's data catalogue, when a Task participant would like to access specific data, they can consult the catalogue, identify relevant data sets, and then approach the data owner about conditions for use.

Task 41 members completed a recommendations report on potential standards changes applicable to distributed wind turbines [1]. It is anticipated that these recommendations will be considered by standards experts working on the fourth revision of IEC 61400-2.

As more wind capacity is added to distribution systems, isolated grids, grid-connected microgrids, and hybrid power plants and systems, the need for distributed wind turbines to provide additional grid services and support grid stability becomes more important. Task 41 members completed research reports about this need in 2021. The research includes determining what advanced controls are needed to enable distributed wind to provide grid services and what other design requirements may be needed specifically for high renewable-contribution isolated power systems [2], [3].

Because of their unique characteristics, wind turbines can allow for additional benefits to a distribution system beyond solely providing energy to the system, such as enhancing grid reliability and resilience. Traditional distributed wind deployments, as shown on the left in Figure 1, supply energy in kilowatt-hours to distribution systems. However, coupled with advanced controls, wind alone or with other distributed energy resources can provide other services, such as grid stability, as shown on the right.[1]

Highlight

Task 41 supports research into the integration of distributed wind in evolving electricity systems. Through investments in distributed renewable energy technologies, energy storage, and electric vehicle charging, future distribution networks are likely to resemble an active network with multiple weather-dependent assets. These assets, when coupled with active control and connected at different voltage levels, can create changes in power flow that affect voltage profile, power losses, and reactive power flow. Researchers at the Technical University of Denmark developed a multi-voltage level distribution network model to study the performance, operation, and control of future weather-dependent distribution networks in terms of grid requirements and specifications, and flexibility requirements. Their research results were published in a paper titled "Multi-Voltage Level Active Distribution Network with Large Share of Weather-Dependent Generation" [4]. Such research helps promote active participation of distribution networks in providing flexibility services through controllable power electronics-based distributed generation such as wind.

Outcomes and Significance

The desired outcome of Task 41 is to enable wind as a cost-effective and reliable distributed energy resource in a world increasingly reliant on distributed energy resource-generated electricity. While much research has already been conducted on solar photovoltaics and battery storage systems as distributed energy resources, wind can offer additional, and to some extent, unrealized resource diversity and resilience benefits to distribution systems, microgrids, and isolated grid systems. Through collaborative research, Task 41 members intend to unlock these benefits to increase wind technology's effectiveness as a distributed energy resource. These efforts, in turn will allow distributed wind to play a significant role in the decarbonization of our economies.

Next Steps

Task 41 members are drafting a work plan extension proposal for a second 4-year time period that will be initiated in January 2023 once approved. In addition to follow-on research related to our current work plan, the new work plan will include research on the human dimensions of distributed wind and how the Task can help facilitate responsible deployment of distributed wind in emerging market countries.

References

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Distributed Wind Controls: A Research Roadmap for Microgrids, Infrastructure Resilience, and Advanced Controls Launchpad (MIRACL). https://www.nrel.gov/docs/fy21osti/76748.pdf.

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[4] A. U. Baviskar, K. Das, M. J. Koivisto and A. D. Hansen (2022).
Multi-Voltage Level Active Distribution Network with Large Share of Weather-Dependent Generation. https://orbit.dtu.dk/en/publications/multi-voltage-level-active-distribution-network-with-large-share-.

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[1] The sine wave represents how wind, using advanced controls (such as inverters), can support grid frequency for distribution systems.