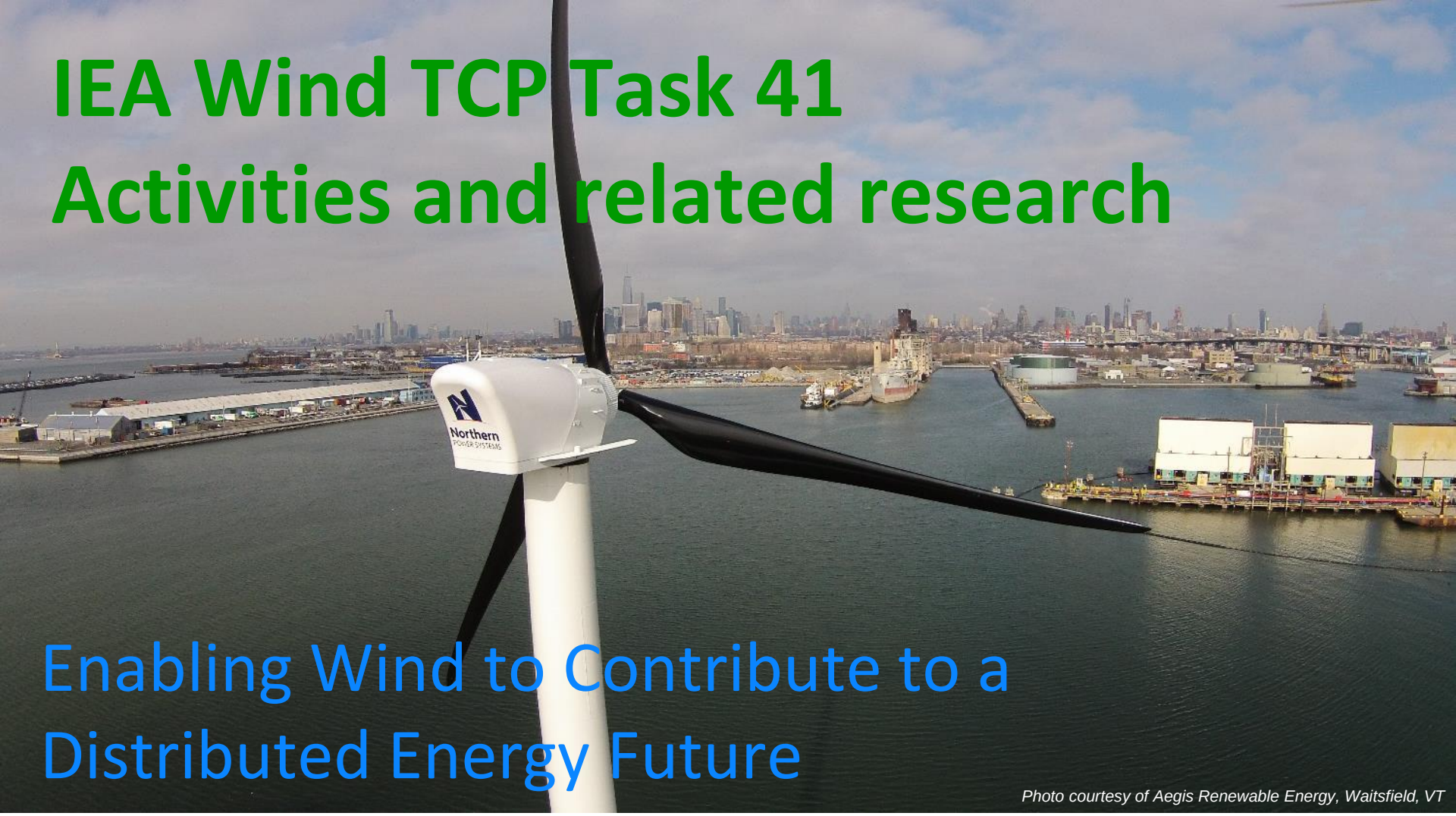
IEA Wind TCP Task 41 Activities and related research



Enabling Wind to Contribute to a Distributed Energy Future

Photo courtesy of Aegis Renewable Energy, Waitsfield, VT

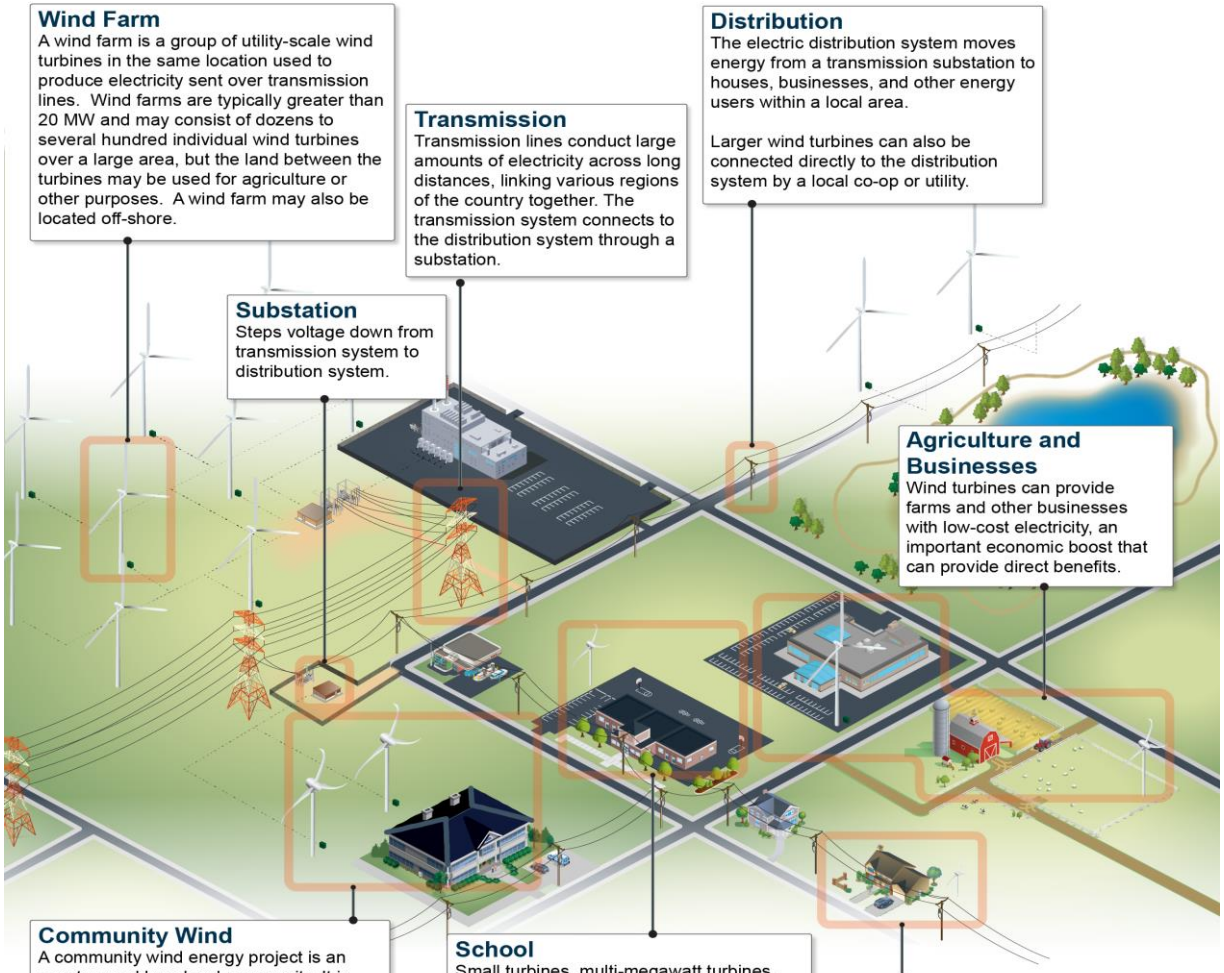
Ian Baring-Gould, National

Hybrid Power Plants – Challenges & Opportunities

August 24-26, 2020

iea wind

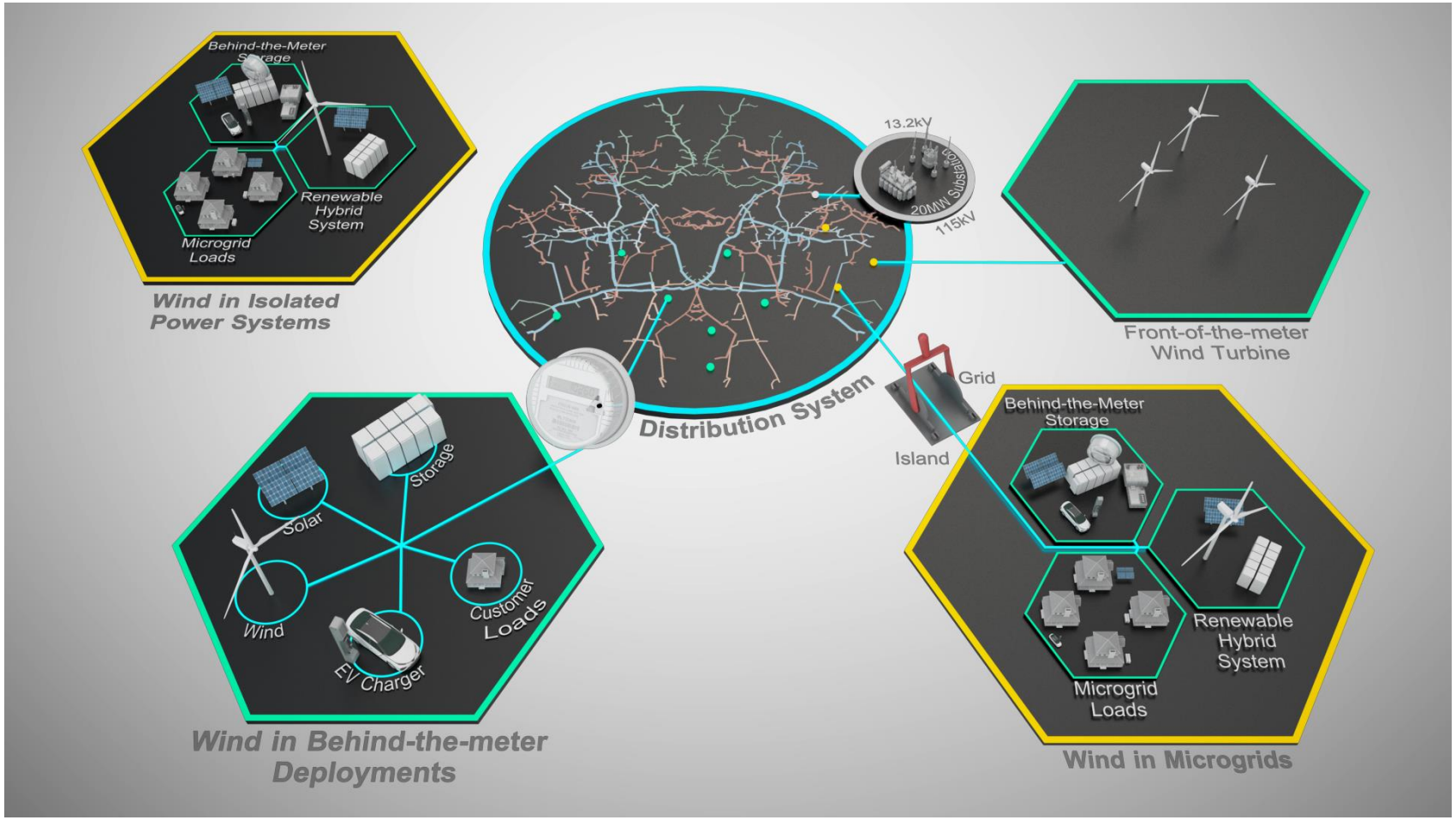
How Does Task 41 Define Distributed Wind?



Graphic: National Renewable Energy Laboratory / U.S. Department of Energy

- Wind turbines connected at a distribution voltage (nominally 70 kV or lower) in a behind-the-meter, in-front-of-the-meter, or off-grid application
- Distributed wind is inclusive of all sizes of wind turbines and is agnostic to business model.

Distributed Wind Use Cases



Distributed Wind Use Cases

Photo credit: Northern Power Systems

Isolated or islanded power that is not connected to a larger power system.
Toksook Bay, Alaska, USA

Photo credit: Hank Doster / One Energy Enterprises LLC

Behind-the-meter installations to provide local energy services.
Ball Corporation, Findlay, Ohio, USA

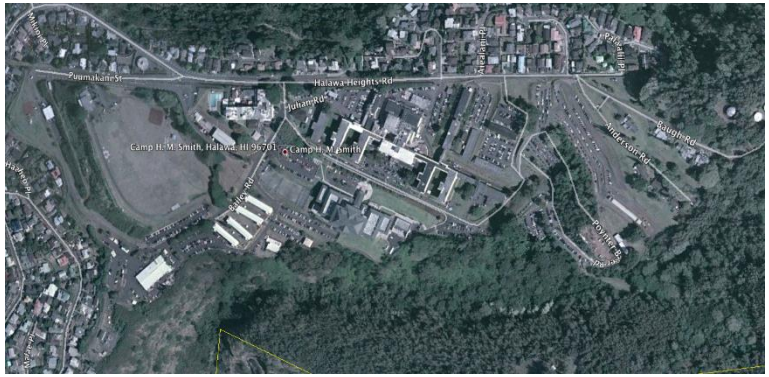


Photo credit: NREL

Grid-connected microgrids that can operate independently from the grid if needed during disruption.
U.S Marine Corps Camp Smith, Hawaii, USA

Photo credit: Dennis Schroeder, NREL 57714

Utility-owned and -operated turbines providing local services.
Kaupuni Village, Hawaii, USA

Task Objectives and Expected Results

Project Objectives and Outcomes

- Expand international collaboration to lower the costs and deployment barriers for distributed wind technologies
  - Update domestic and international distributed wind turbine standards
  - Develop research and data catalog for distributed wind
  - Publish state-of-the-industry report on the integration of distributed wind systems
  - Identify downscaling opportunities for distributed wind
- Promote expanded engagment in the wider distributed energy research and deployment markets
  - Produce best practice guide for high-renewable-contribution isolated power systems
  - Expand collaboration across IEC TCPs on wind deployment and integration

Target Audience

- Wider distributed wind and distributed energy industry
- IEA wind and wider TCP research efforts
- Domestic and international investment and development community

Current Term: Jan 2019-Dec 2022.

Work Package Overview

WP0: Management and Coordination

WP1: Progressing Distributed Wind Technology Design Standards for Small- and Mid-Size Wind Turbines

WP2: Data Information Catalog

WP3: Expand Learning and Support of the Integration of Distributed Wind into Evolving Electricity Systems

WP4: Outreach and Collaboration with Other R&D Activities

WP5: Innovation and Downscaling of Utility-Scale Technology

Microgrids, Infrastructure Resilience, and Advanced Controls Launchpad (MIRACL)

Improve and validate capabilities of wind technologies, at all scales, to integrate in a seamless “plug-and-play” manner with other technologies into micro and distributed grids through cyber-informed engineering principles with energy security, resiliency, and reliability in focus.

Conduct the research, testing, and standards development to help ensure that Distributed Wind (DW) technology can continue to play an active/larger role in high-renewable-contribution, distributed energy-driven, energy systems of the future.

Integrate and enhance DOE laboratory facilities to support R&D driven by industry needs.

MIRACL - Research Topics

- **Improving Distributed Wind Valuation and Representation in Tools (PNNL):** Improving distributed wind assessment in distribution and (mirco) grid planning and assessment tools, methods, and models.
- **Cyber Security and Resilience (INL):** Development of DW focused micro-grid and resilient system design requirements, testing platforms, and integrated solution capabilities to support DW integration into future grid systems.
- **Assessment of Potential Integration Control for Wind Technologies in Microgrid and DER Applications (NREL & SNL):** Conduct research on advanced controls to allow the expanded integration of DW technologies into high contribution isolated and weak grid systems.

REopt Renewable Energy Integration and Optimization

GridLAB-D™

CyberPARC
Partnership for Advancing Resilient Control Systems

MIRACL Controls Research Overview

Rethinking how distributed wind will work within and in support of the larger energy systems—including grid-interconnected, microgrids, and isolated systems—through advancements in:

- Turbine availability through fault-tolerant controllers (Better integration of wind into energy systems)
- Grid services from advanced controls in high-wind contribution systems (How to use wind to provide grid services over the range of use cases)
- Wind-storage systems (AC and DC coupled) (Understand how wind can be firmed using storage technologies).

Photo by Lee Jay Fingersh, NREL 21664

NREL's three-bladed and two-bladed controls advanced research turbines (CART3 and CART2)

Major research phases: modeling (MATLab & PSCAD), lab-based physical hardware-in-the-loop, industry partner validation/demonstration with operational systems.

Strong Synergies and Collaboration Options

- IEA Wind Task 41 is focused on smaller scale power systems, but considers some of the multi-technology questions that are applicable for hybrid power plants
- Efforts under the US DOE MIRACL project offer many leverage points, most specifically for larger behind-the-meter and front-of-the-meter deployments.

Research Needs – Larger Hybrid Plants

- Turbine specific research (strong overlap with existing work)
  - Fault tolerant controls
  - Provision of grid services from turbines (what can be provided under what conditions)
  - Cyber security
- Distribution scale hybrid power plants (behind or in front of a meter)
  - Beyond many of the questions already identified (valuation, demonstration, policy) better understanding of the ability of hybrid power plants to provide expanded grid support
  - Optimization of different technologies and storage to provide grid support given that different technologies can provide different support.
  - Valuation of resiliency (this is the third value chain)
- Demonstration in both research and utility settings

Thank You!

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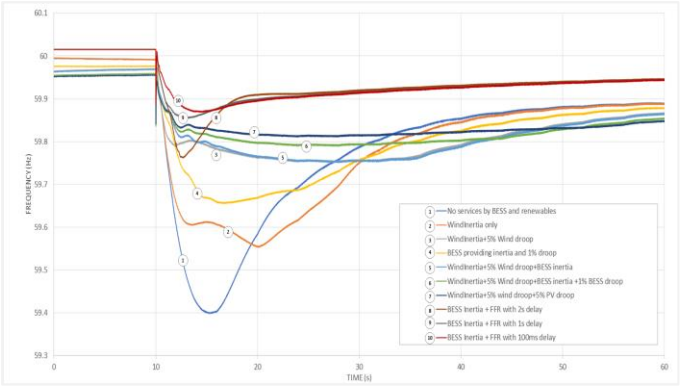
The IEA Wind TCP agreement, also known as the Implementing Agreement for Co-operation in the Research, Development, and Deployment of Wind Energy Systems, functions within a framework created by the International Energy Agency (IEA). Views, findings, and publications of IEA Wind do not necessarily represent the views or policies of the IEA Secretariat or of all its individual member countries.

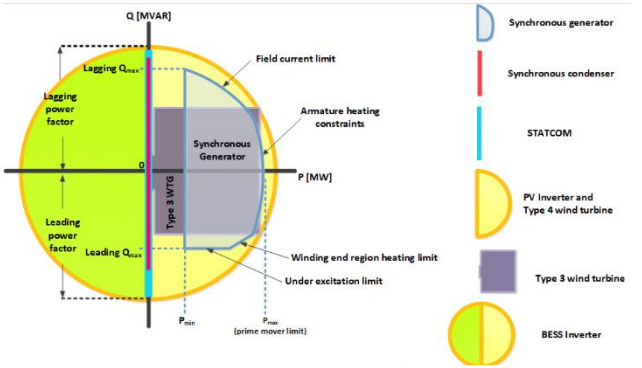
Control from Wind in Microgrids and Distribution

- Inertial Response
- Power Output (Curtailment) Control
- Voltage Support
- Reactive Power Support
- Frequency Regulation
- Automatic Generation Control (AGC)
- Blackstart capability/valuation
- Hybrid Solutions

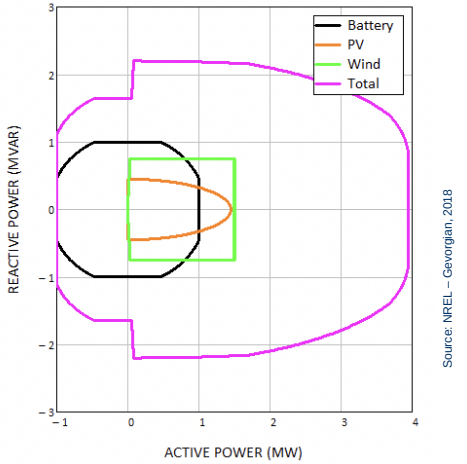


Source: GMLC - WGRID-49

Frequency Regulation Example



Source: NREL – Gevorgian, 2018



Source: NREL – Gevorgian, 2018

Reactive Power from Various Sources

Work Package 1: Standards

Support distributed wind technology design standards for small and mid-sized wind turbines to allow for accelerated innovation and improved consumer confidence

- Convene industry stakeholders to identify issues with current standards as they relate to small and mid-sized turbines in distributed wind installations through forums in the United States, Europe, and Asia
- Report on recommendations for potential changes to the existing standard IEC 61400-2

Work Package 2: Data Catalog

Develop an information sharing catalog for distributed wind research and data

- Identify potential data contributors and users; what shared resources are needed; what data is available on key topics; and recommended practices for data collection, reporting, accessing, and storage
- Catalog and make available meta data about distributed wind data sets so researchers can contact data owners directly about using the data
- Consider including a catalog of data processing tools and decision support tools

Work Package 3: Integration

Work with distributed wind and DER industry players to expand integration of wind into grid and off-grid power systems for expanded controllability, cyber security and advanced grid services

- Develop a best practice guide for the design of isolated power systems
- Report on state of the industry for isolated microgrid power systems
- Research into the value wind can provide in supporting high variable renewable grids
- Review how wind is represented in distributed grid and microgrid systems tools and models
- Summarize national and international electrical standards to support external standards development

Work Package 4: Outreach and Collaboration

Support expanded collaboration with ongoing research efforts and with the wider DER community

- Identify and engage with industry and government research efforts
- Expand engagement with other DER industries (PV, storage, grid) to expand understanding of wind, including in areas such as energy access, energy system resiliency, and community power
- Help define and coordinate larger distributed wind research and encourage opportunities for research collaboration
- Engage with other IEA tasks that can inform Task 41

Work Package 5: Down-scaling

Expand collaboration and research on utility-scale technology innovation for applicability to reduce lifecycle costs of energy (LCOE) for small and mid-sized turbines

- Assess advances in cost reductions and performance enhancements at utility scale for application to small and mid-size wind turbine technology
- Summarize international LCOE cost reduction roadmaps
- Share LCOE reduction best practices and experiences