

Standards Development Work Benefitting the Distributed Wind Industry

Joseph Spossey – RE Innovations

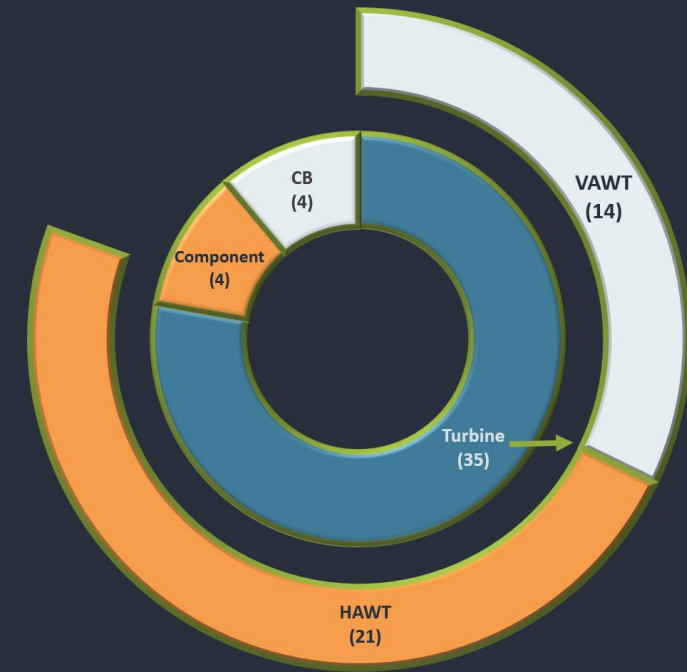
DW25 – Day 2, Market Issues

Tuesday, February 25th, 2025

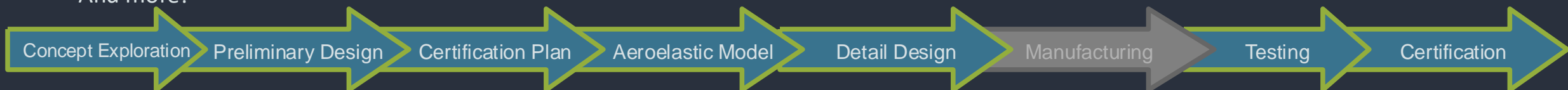


WHAT WE DO

- Distributed Wind Services
 - Certification Plans or Guidance Documents
 - Assistance for, or participation in, grant proposal opportunities such as CIP, SBIR, and others
- Wind Turbine R&D Services
 - Design Load Case Calculations - Simulation Modeling and Simplified Methods for various sizes / archetypes
 - Component Structural Design
 - Power Curve and Annual Energy Production Determination
 - Electrical Product Conformity and System Specifications
- Standardized & Custom or Prototype Type Testing
- Wind Turbine Certification Support
 - Small Wind Turbines – ACP or IEC 61400-2
 - Medium Wind Turbines – ACP, IEC 61400, and IECRE
 - Design assessments for design conformity
- Certification Project Management
 - Product or System Certification planning, scoping and guidance
 - Gap analysis and documentation assistance
 - Manage / Liaise directly with CB
- Other Services
 - Project / Offshore Wind Turbine Evaluations & Due Diligence
 - Accreditation and Audit Support Services
 - And more!



- 58 Projects
- 45 Customers
 - 32 US & Territories / 13 International
 - 18 Current or Previous CIP, SBIR, or other NREL/DOE
 - 1 active NREL Subcontract, SUB-2023-10216
 - **DW Certification Guideline is now public!!**



DW Certification Overview



Distributed Wind Certification Best Practices Guideline

January 16, 2023 – January 15, 2026

Joseph Spossey

RE Innovations

NREL Technical Monitor: Brent Summerville

NREL is a national laboratory of the U.S. Department of Energy
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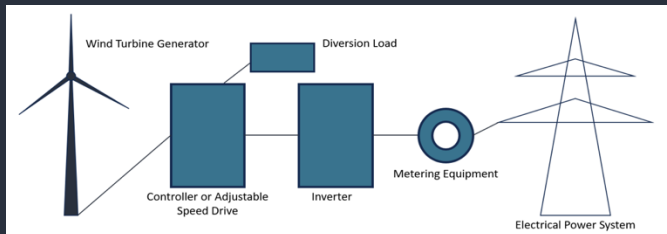
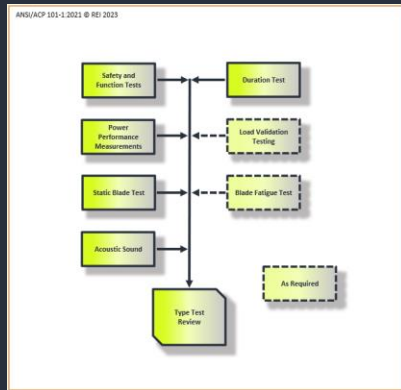
Subcontract Report
NREL/SR-5000-88371
February 2024

Contract No. DE-AC36-08GO28308

- NREL Subcontract SUB-2023-10216 RE Innovations LLC (free report download available at www.reinnovationsllc.com)
- Section 2 User's Guide
 - Defining DWT Certification
 - Certification process overview
 - DWT Designer Quick Guide Table →
 - Certification time / cost estimates
- Section 3 Use of Certified DWTs
 - DWT types and applications
 - Market drivers
 - Incentives
- Section 4 NA 3rd Party Certification
 - NA Product Certification Overview
 - Common certification terminology
 - National Electrical Code overview
 - NRTLs, Standards, and Accreditations

DWT Designer Quick Guide			
Turbine Component or Subassembly	Applicable Standards	Electrical	Structural
Rotating Hub	UL 6141, IEC 61400-1, IEC 61400-2	5.3.1	7.2
Wind Turbine Generators	UL 1004-1, UL 1004-4	5.3.2	n/a
Wind Turbine Motors	UL 1004 series, IEC 60034-1, and others	5.3.2	n/a
Control System and Equipment	UL 6141, UL 1741, IEC 60204-1	5.3.3	n/a
Motor Drives	UL 61800-5-1	5.3.4	n/a
Adjustable Speed Power Drives	UL 61800-5-1 and UL 1741 if conversion	5.3.4	n/a
Converters	UL 1741	5.3.5	n/a
Inverters	UL 1741, IEEE 1547, IEEE 1547.1	5.3.5	n/a
Gearboxes	UL 508, IEC 61400-4, IECRE OD-501-2	5.3.6	6.2, 7.2
Diversion Loads	UL 499	5.3.8	n/a
Emergency Stop	UL 6141, IEC 61400-1, IEC 61400-2, IEC 60204-1	5.4.1	n/a
Disconnect Devices	UL 6141, IEC 60204-1	5.4.3	n/a
Lightning Protection Systems	NFPA 780, IEC 61400-24, UL 1449	5.4.4	n/a
Rotor Blades	IEC 61400-1, IEC 61400-2, IEC 61400-5, IECRE OD-501-1	n/a	6.2, 7.2
Blade to Hub/Shaft Connectors	IEC 61400-1, IEC 61400-2, IEC 61400-8	n/a	6.2, 7.2
Towers	ANSI/ACP 61400-6-2021, IEC 61400-6, IECRE OD-501-3	n/a	6.2, 7.2
Connection to Tower	IEC 61400-1, IEC 61400-2, IEC 61400-8	n/a	6.2, 7.2
Main Shaft/Drivetrain	IEC 61400-2	n/a	6.2, 7.2
Structural for Components	IEC 61400-1, IEC 61400-2, IEC 61400-8, IEC TS 61400-30	n/a	6.2, 7.2
Casted, Forged, or Welded Structures	See "Structural for Components"	n/a	6.2, 7.2
Nacelle Frame	See "Structural for Components"	n/a	6.2, 7.2
Pitch and Yaw Systems	See "Structural for Components"	n/a	6.2, 7.2
Bearings and Bushings	See "Structural for Components"	n/a	6.2, 7.2
Brakes, Couplings, and Locking Devices	See "Structural for Components", UL 6141, IEC 60204-1	5.2	6.2, 7.2
Bolts and Connections	See "Structural for Components"	n/a	6.2, 7.2
Cooling and Heating Systems	See "Structural for Components", UL 6141	5.2	6.2, 7.2
Hydraulic Systems	See "Structural for Components"	n/a	6.2, 7.2
Housings (Spinners and Nacelle Covers)	See "Structural for Components"	n/a	6.2, 7.2
Teetering/Other Hub	See "Structural for Components"	n/a	6.2, 7.2
Control and Safety System Components	UL 6141, IEC 61400-1, IEC 61400-2, IECRE OD501-5, UL 61010-1	5.3.3	6.2, 7.2

DW Certification Overview



	"Micro" up to 1,000 W Peak Power	1 – 30 kW Peak Power	30 – 65 kW Peak Power	65 – 150 kW Peak Power
ACP STRUCTURAL DESIGN				
Simplified Loads Methodology	Not required	Recommended only for turbines < 10 kW	Not allowed	Not allowed
Simulation (Aeroelastic) Model	Not required	Allowed	Required	Required
Structural Analysis	Not required	Required	Required	Required
Minimum Code Validations	Not required	See Section 6.3.4	See Section 6.3.4	See Section 6.3.4
Safety Factors	Not required	Required	Required	Required
ACP TYPE TESTING				
Duration Testing	Required	Required	Required	Required
Power Performance	Required	Required	Required	Required
Loads Validation Testing	Not required	See Section 6.3.4	See Section 6.3.4	See Section 6.3.4
Acoustics Testing	Not required	Required	Required	Required
Safety and Function Testing	Required	Required	Required	Required
Blade Testing	Not required	Static test only	Static test only	Static test required; fatigue
Labeling	Required	Required	Required	Required

- Section 5 DWT Electrical Product Safety Certification
 - Turbine System Certification; UL 6141 vs. UL 6142
 - Detailed common electrical component certification requirements
 - PMGs
 - VFDs / Motor drives
 - Controllers and control equipment
 - And more!
- Common Systems Certification
 - Emergency stop
 - Lightning protection systems

Applicability of UL 1004-1 Subclauses for DWT Generators			
Subclause	Title	Required	Comment
1 - 5	Various - General	Yes	As applicable
6	Current and Horsepower Relation	Yes	
7	Motors Provided with Controls	NO	Motor requirements
8	Mechanical Assembly	Yes	
9	Frame and Enclosure	Yes	
10	Grounding	Yes	
11	Grounding Identification	Yes	
12	Ventilation Openings	Yes	If ventilated
13	Accessibility of Uninsulated Live Parts, Film-Coated Wire and Moving Parts	Yes	
14	Protection Against Corrosion	Yes	
15	Cord-Connected Motors	NO	Motor requirements

- Section 6 DWT Certification → ANSI/ACP 101-1 below 150 kW
 - General requirements, Structural design Requirements
 - Type Testing Requirements, and more!
- Section 7 DWT Type Certification → IEC 61400, above 150 kW
- More updates soon to come in updated version in early 2025

2024

IBC[®]

INTERNATIONAL
BUILDING CODE[®]



Standards Work Benefitting Permitting & Enforcement

- The International Building Code is the dominant non-residential building code in the U.S. It is revised every 3 years.
- Published by the International Code Council (ICC), the parent organization of the Small Wind Certification Council (SWCC)
- IBC has sections on solar and towers, but does not mention wind energy at all
- DWEA submitted an IBC Code change request for 2027 edition; review process will start in March 2025 and run ~ 18 months
- The changes:
 - Add ground-mounted distributed wind energy systems and definition
 - Clarify product certification requirements
 - Specify reference to TIA-222-G, H or I “except for section 12. 17 fatigue”
 - Allow dry PE-stamped structural analyses; set back > total height
 - Clarify FAA compliance with 14 CFR Part 77
 - Clarify property line setback boundaries > 10ft
 - Clarify Inverters shall be listed to UL 1741
- The Result:
 - Decrease in cost, estimated \$500 - \$2000 per installation, or > if dry stamp allowed

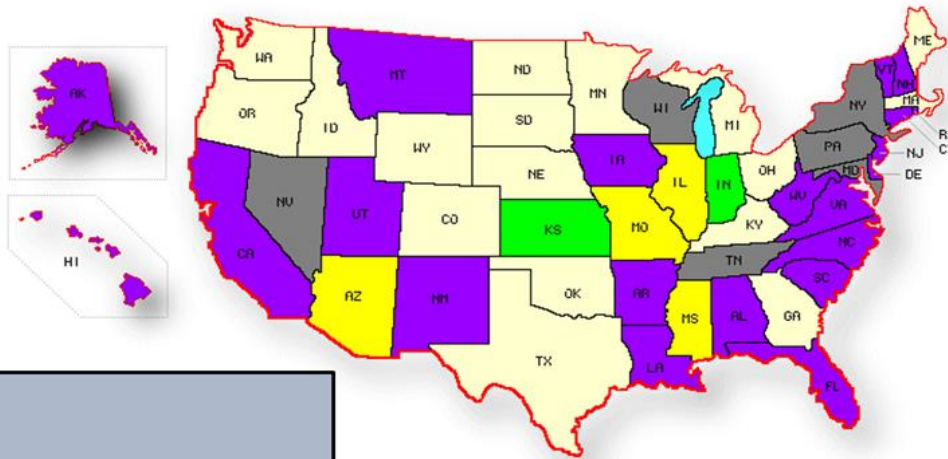
How YOU Can Help Permitting & Enforcement

- Get Involved! Stakeholder engagement is necessary
- Reach out to an expert with ideas for revisions
- Current needs: **CALL FOR VOLUNTEERS!**
 - North American Adoptions Sub Committee – DW Stakeholder Group
 - Supporting US Technical Advisory Group (TAG) to IEC Technical Committee 88 Wind energy generation systems, under the IECRE
 - US TAG Administrator = ARESCA (American Renewable Energy Standards and Certification Association)
- Adopting IEC 61400 standards in the US (ARESCA 61400)
- National Deviations specific to small and distributed wind turbines for North America
- Typically, electrical or other country specific matters
- In our case, several exclusions or clarification on certification of DW turbines in the US and North America



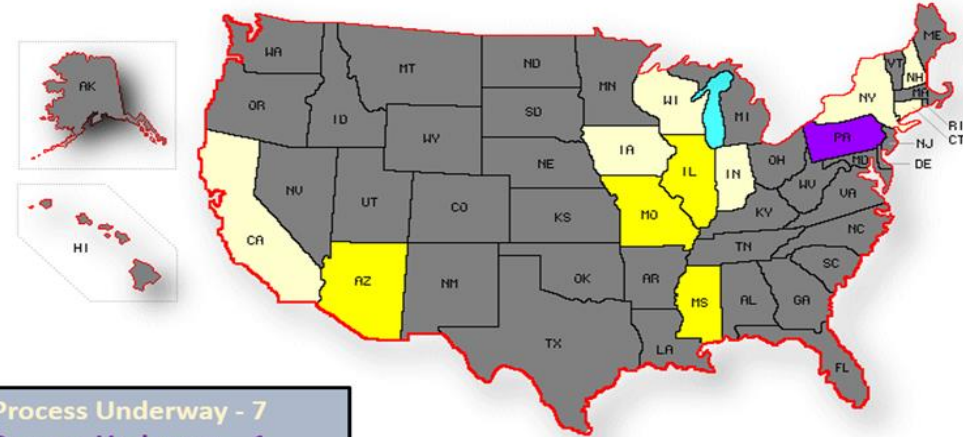
Updates to Adoptions and Enforcement – NEC

**NEC® in Effect
2/1/2025**



2023 NEC® - 17
2020 NEC® - 21
2017 NEC® - 6
2008 NEC® - 2
County/Municipality NEC® regulation only - 4

**NEC® Update Process In Progress
2/1/2025**



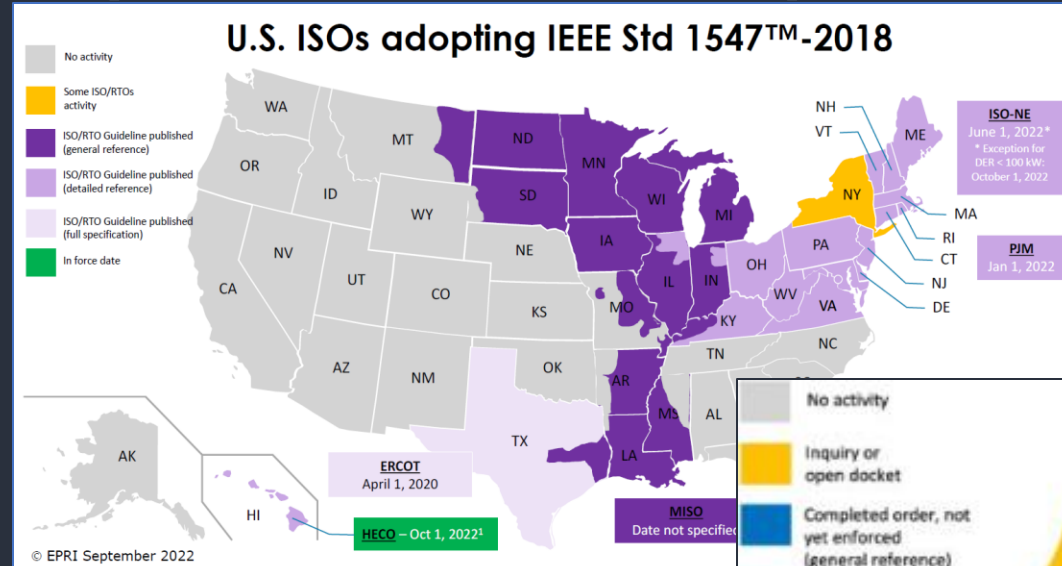
2023 NEC® Update Process Underway - 7
2020 NEC® Update Process Underway - 1
Current Update Process Completed - 38
(See NEC® in Effect Map for Updated Edition)
County/Municipality NEC® regulation only - 4

- National Electrical Code In Effect Map
- Wind Electric Systems Article 694
- Interconnection equipment Article 705
- Can check on NEC adoption here:
<https://www.nfpa.org/education-and-research/electrical/nec-enforcement-maps>

- NEC Update Process Map
- See map to left for NEC version
- 38 states completed (2020 or newer)
- 8 states in process of update (2020 or newer)

Updates to Adoptions and Enforcement – IEEE 1547

- IEEE Std 1547™-2018 Adoption; Supporting info at link below
- <https://sagroups.ieee.org/scc21/standards/1547rev/>
- These essentially show where UL 1741-SB is required,
- ...but please refer to the link for much more information related to interconnection adoption



- Map Above Not Updated
- Map to Right Updated
 - January 2024
- Not necessarily a complete list, check the link for updates in 2025

Standards Work Benefitting DW Industry

	Micro wind turbines up to 1 kW Peak Power	1-30 kW Peak Power	30-65 kW Peak Power	65-150 kW Peak Power
STRUCTURAL DESIGN				
SLM	Not required	Not recommended for turbines with Peak Power greater than 10 kW	Not allowed	Not allowed
Aeroelastic model	Not required	Allowed with validation through power, rotor speed. Validate weight of major components.	Allowed with validation through power, rotor speed, blade first flapwise (static) natural frequency*. Validate weight of major components.	Allowed with validation through power, rotor speed, blade first flapwise (static) natural frequency, tower loads*. Validate weight of major components.
Structural Analysis	Not required	Required	Required	Required
TYPE TESTING				
Duration Testing	Required	Required	Required	Required
Power Performance	Required	Required	Required	Required
Loads Testing	Not required	Not required	Not required	Required (only load components listed for aeroelastic model validation, see above)
Acoustics Testing	Not required	Required	Required	Required
Safety and Function Testing	Required	Required	Required	Required
Blade Testing	Not required	Static test required	Static test required	Static test required; accelerated fatigue testing according to IEC 61400-23 is not required but is encouraged
Labeling	Required	Required	Required	Required

- ANSI/ACP 101-1 2021 The Small Wind Turbine Standard
 - Replaced AWEA 9.1 (2009) and the cancelled AWEA-SWT-1 (2016)
 - Lessen the burden of certification; increase the value to the consumer
 - Simplification of type testing, and varying requirements based on size
- Amendment 1 Revision → near approval
 - Clarify technical requirements
 - Clarify SLM and aero elastic design validation requirements
 - Added new table for design validations based on size
 - Acceptable methods for design validations
 - Clarify control and protection system design requirements
- What's the point?
 - Experiences gained → add clarity
 - Clearer requirements = less ambiguity → OEM & CB common interpretations
 - Reducing costs → Reducing time to market → Increasing the value
 - Easier to provide ITC or other eligible products to consumer

Standards Work Benefitting DW Industry

- Maintenance Team MT2 for the upcoming 4th revision of IEC 61400-2
 - Convenor: Brent Summerville, NREL
 - Secretary: Joe Spossey, REI
 - 61400-2: 2013 (Ed. 3) currently turbines < 200 m² rotor swept area
 - Covers design, engineering, and some testing of small wind turbines
- New scope of IEC 61400-2 Ed.4 (CD Stage) increased to cover medium wind turbines up to 1200 m²
- CD scheduled for release late 2025
- Again, reducing time and cost

Highlights

- **IEC 61400-2 name**
 - **From:** Wind turbines – Part 2: Small wind turbines
 - **To:** Wind turbines – Part 2: Micro, small, and medium wind turbines
- **Testing**
 - Duration Test > Operational Test
 - to demonstrate the expected autonomous operation over a range of wind speeds
 - at least 1000 h of power production in winds of any velocity;
 - at least 10 hours in wind speeds of 15 m/s and above, with the turbine in its normal operating mode
 - Safety & Function Test
 - Improvements in clarity, additional guidance for developing a test plan
- **Design**
 - Overhaul of clause 7 with increased scope, turbine size categories, language from IEC 61400-1
 - SLM
 - Working to incorporate D. Wood recommended changes
 - <https://www.nrel.gov/docs/fy22osti/83708.pdf>
 - Simulation modeling
 - Incorporating much of IEC 61400-1, similar DLCs but with more clarity
 - Currently conducting survey of design driving DLCs
 - Loads testing only for model validation
 - Minimum measurements for validation based on turbine size category, archetype
 - Turbulence
 - Considering an I_{ref} (turbulence intensity) of
 - .18 for Medium
 - .20 for Small
 - .24 for “Novel” or turbines design for more turbulence conditions



Standards Work Benefitting DW Industry

- Maintenance Team MT12 IEC 61400-12 series for Power performance
 - Covers the -12 series entirely
 - -12-1 Ed 4 Power performance measurements of electricity producing wind turbines
- Overall simplification of method, reduction of options, add clarity
- Updates Benefitting the industry relate specifically to -12-1 Annex H
 - Joe Spossey (US, leader)
 - Mike Bergey (US)
 - Arlinda Huskey (US)
 - Luis Cano (ES)
 - Power performance testing of small wind turbines per IEC 61400-2
 - Medium turbine simplified testing to align with small turbines
- Reduction of time and cost for test

Revision ID #	Revision Topic
IEC61400-12-1 [64] 1	Optional Site Calibration
IEC61400-12-1 [64] 2	Obstacle Assessment Clarification and Exclusions
IEC61400-12-1 [64] 3	Power Measurement Devices and Location
IEC61400-12-1 [64] 4	Temp / Pressure Location
IEC61400-12-1 [64] 5	Database Update
IEC61400-12-1 [64] 6	Micro turbine exceptions
IEC61400-12-1 [64] 7	Reformat Annex
IEC61400-12-1 [64] 8	Reference Power and AEP
IEC61400-12-1 [64] 9	Novel turbine testing
IEC61400-12-1 [64] 10	R&D testing
IEC61400-12-1 [64] 11	Status / RPM Signals
IEC61400-12-1 [64] 12	Simplify uncertainty analysis and specify typical values
IEC61400-12-1 [64] 13	Post test anemometer calibration
IEC61400-12-1 [64] 14	Minimum tower height for testing of HAWTs
IEC61400-12-1 [64] 15	Remove turbulence intensity reporting

Standards Work Benefitting DW Industry



UL 6142

STANDARD FOR SAFETY

Small Wind Turbine Systems

- “Modest Proposal” (Bergey DW24):
 - Aggressively modify UL 6142 → Started this process (see below)
 - Start development of UL 1741-DW → Research phase, SNL, NREL, and OEM participants
- UL 6142 Small Wind Turbine Systems – Updates:
 - (a.k.a., Turbines NOT permitting entry)
 - A small Task Force was created under STP6142; RE Innovations proposed updates / edits
 - Effort currently on hold as we organize another stakeholder committee for input
 - Drastically reduce the burden to certify
 - Eliminate double dipping with IEC or US wind turbine standards
- Next steps will include stakeholder engagement
 - Led by NREL / DWEA
 - Reach out to get engaged or review proposed changes



Standards Work Benefitting the DW Industry

- Reducing market barriers
- Reducing time and cost
- Improving the quality (via increased # of certified product)
- Establishing codes/standards not based on PV or utility wind
- Get engaged!



THANK YOU FOR YOUR TIME!

QUESTIONS?

Joseph M Spossey

Chief Executive

Director – Wind Turbine Testing & Certification

RE Innovations LLC

+1 315 484 6140

joseph.spossey@reinnovationsllc.com

www.reinnovationsllc.com