U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

2021 PROJECT PEER REVIEW

U.S. DEPARTMENT OF ENERGY
WIND ENERGY TECHNOLOGIES OFFICE

Fusion Joining of Thermoplastic Composites Using Energy Efficient Processes (Technology Commercialization Fund)

WETO – Materials, Manufacturing and Design Innovation

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NREL

Presentation date

NREL Transforming ENERGY

FY21 Peer Review - Project Overview

Project Summary:

- Fusion joining of thermoplastic wind turbine blades eliminates adhesives = stronger, more reliable blades, faster cycle times in manufacturing facility -> lower cost blades, segmented blades and on-site manufacturing
- However, lightning strike event can damage a blade catastrophically and the addition of a conductive material for thermal welding makes this much riskier
- This team designed and validated lightning protection system (LPS) in high voltage and high current laboratory for a 5m long thermoplastic, thermally welded blade tip subcomponent.
- Project partners – GE/LM and NTS Pittsfield

Project Objective(s) 2019-2020:

- This project designed and validated a lightning protection system for a thermoplastic wind turbine blade so that the issues associated with the addition of conductive heating elements in the bond line can be investigated and ultimately mitigated.

Overall Project Objectives (life of project):

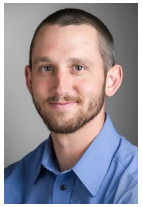
- Demonstrate that a thermally welded blade can be protected from a lightning strike so that this new technology can be implemented at scale

Project Start Year: [2019]
Expected Completion Year: FY [2020]
Total expected duration: 1 years

FY19 - FY20 Budget: $150,000

Key Project Personnel: Robynne Murray, Ryan Beach, Peter Broome, David Barnes

Key DOE Personnel: Lillie Ghobrial and Tyler Christoffel


GE Renewable Energy

LM WIND POWER

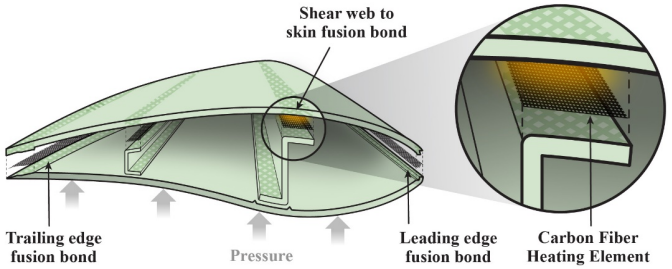
a GE Renewable Energy business

NTS

Project Impact

Thermal welded thermoplastic blades, critical that conductive bond lines can be protected from lightning

We proved that a thermally welded blade can be protected from lightning strike



This work will benefit the entire wind industry, opens industry to advantageous technology

Segmented blades joined using method which can lead to stronger and lighter bonds

Blade sections joined on site, reducing transportation constraints = decreased AEP

Technology enables blade materials to be recycled and re-used

Program Performance – Scope, Schedule, Execution

- Due to COVID shutdowns halting work on the NREL site, project was delayed 3 months, ***but still met all the milestones successfully and on budget.***
- Collaboration NREL, GE, LM and NTS -> rigorous scientific approach
- Design of 5m tip based on state-of-the-art carbon fiber blade designs and the high current and high voltage testing was performed to the IEC standard 16400-24.

Milestone Name/Description	Details	Planned End Date	Actual End Date
WETO.1.5.0.403 Q1 – Complete design of subcomponent including manufacturing plan and blade model and provide summary document to DOE, by December 31, 2019.	Summary Document delivered to DOE	12/31/2019	12/31/2019
WETO.1.5.0.403 Q2 - Develop joining method at larger-scale including a materials and equipment list and provide summary document to DOE, by March 31, 2020	Summary Document delivered to DOE	3/31/2020	3/31/2020
WETO.1.5.0.403 Q3 – Make blade subcomponent using fusion joining and including a lightning protection system, and provide photographs of final part to DOE by June 30, 2020	This milestone slipped due to COVID shut downs at the lab, however, photos and summary were presented to DOE in November, 2020	6/30/2020	10/30/2020
WETO.1.5.0.403 Q4 - Validate lightning protection system for the subcomponent from a high voltage testing facility, and provide final report to DOE by September 30, 2020	This milestone slipped due to COVID shut downs at the lab, however, final Report was delivered to DOE in December, 2020	9/30/2020	12/30/2020

Program Performance – Accomplishments & Progress

High current and high voltage testing: ~80% of current went into aluminum foil, remainder into down conductor = good

Damaged area of blade tip was only in the first layer of the biaxial fabric (easily repairable)

No damage observed at the down conductor attachments and receptor locations, or in the carbon fiber

Lightning protection system worked effectively to protect the mock welded thermoplastic blade bond lines!

Stakeholder Engagement & Information Sharing

Work was relevant and applicable to industry, maximizing the impact

Published in Wind Engineering

With the increased interest in thermoplastics, NREL team is well positioned to be an important player in this field

NREL has thermal welding patents, and will be a part of the progress toward commercialization

Key Takeaways and Closing Remarks

Project Impact: De-risking fusion joined blades by validating that they can be protected from a lightning strike – leading to uptake of thermoplastics in the wind industry with many benefits

Project Performance: Met all milestones within budget

Stakeholder Engagement: Work is relevant and applicable to industry, maximizing the impact across the entire sector. Follow on research is being pursued.

Published paper in Wind Engineering.

Lightning protection system worked effectively to protect fusion welded thermoplastic blade bond lines!

Thank you!

Overview Guidance

Purpose:

- To supplement your project summary document and highlight key aspects of your project to the Peer Review panel
- Slides should not be excessively wordy – save that for the project summary document
- Please use graphics and images to help communicate key aspects of your project

Only Allowable Acronyms:

- DOE, EERE, WETO, Your Lab Name.
- Please spell *EVERYTHING* out (at least the first time it's used)

Presentation Length (13 Minutes):

- 7-10 slides including media, must be done within the 13-minute allocation

For the "criteria" section (slides 4 – 8) please feel free to add extra slides as needed (DO NOT exceed 10 slides total for the presentation). If you present on each of the criteria (slide headers), the peer reviewers will have the information they need to assess your project.