

A large eagle is shown in flight, its wings spread wide, against a bright blue sky. In the background, several wind turbines are visible, their blades partially obscured by the eagle's wings. The overall scene is dynamic and emphasizes the connection between nature and renewable energy.

July 20, 2017

WIND-WILDLIFE

Technology Development & Innovation Open House

National Wind Technology Center
Boulder, Colorado

ATTENDEES

Name	Organization
Arie Feltman-Frank	National Renewable Energy Laboratory (NREL)
Barb Neary	Arcadis
Bethany Straw	NREL
Bob Thresher	NREL
Chase Taylor	Pinyon Environmental
Chris Bley	InspectTools
Christina Calabrese	EDP Renewables
Corrie Christol	NREL
Crissy Sutter	Natural Power
Daly Edmunds	Audubon Rockies
Elise DeGeorge	NREL
Isabel Gottlieb	American Wind Wildlife Institute (AWWI)
Jared Quillen	DeTect, Inc.
Jason Roadman	NREL
Jeff Smith	H.T. Harvey & Associates
Jeff Zirpoli	H.T. Harvey & Associates
Jeroen Van Dam	NREL
Jim Lindsay	Florida Power and Light
Jocelyn Brown-Saracino	U.S. Department of Energy (DOE)
John Goodrich-Mahoney	Electric Power Research Institute
Karen Voltura	Colorado Parks & Wildlife
Karin Sinclair	NREL
Karyn Coppinger	Invenergy LLC
Kathanne Lynch	Johnson Resources
Kristen Nasman	WEST Inc.
Lee Jay Fingersh	NREL
Milu Velardi	ERO Resources
Raphael Tisch	Allegheny Science & Technology, in support of DOE
Ryan Henning	CH2M Hill
Shari Matzner	Pacific Northwest National Laboratory
Shelley Vierra	Boulder Imaging
Suzanne Tegen	NREL
Taber Allison	AWWI
Tom Ryon	NREL

MEETING OVERVIEW AND PURPOSE

Elise DeGeorge, NREL, kicked off the open house and discussed the objective of NREL's Technology Development and Innovation (TD&I) project, which is to facilitate the incubation of innovative wildlife impact mitigation technologies allowing for more efficient and cost-effective wind energy deployment across the United States. This goal would be achieved by fostering collaborative partnerships with developers of mitigation solutions to

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support the characterization and re-engineering of emerging technologies that detect and/or deter birds and bats at wind energy facilities. Technology partners would utilize the facilities and expertise from the U.S. Department of Energy's (DOE's) National Wind Technology Center (NWTC) at NREL to support the advancement of these technologies. Technologies may comprise stand-alone systems; integrated, multicomponent systems; or the integration of solutions into standard turbine controls.

It was stated that technologies in the low- to mid- technology readiness levels (TRLs) will be considered for this effort, with a focus on TRL's 3 through 51. This spans from proof of concept (TRL3) through to laboratory scale system validation (TRL5). Note that TRLs 6 and 7, demonstration of pilot scale and actual system prototypes, are not covered by this solicitation. Through the course of the project, technologies are expected to advance at least two technology readiness levels. NREL's engineering evaluations will support (and optimally be a pipeline to) field studies being conducted at operating wind energy facilities by other organizations.

Attendees were informed of the Special Notice announcing an upcoming request for proposals located on FedBizOpps. There is a link to the Notice on NREL's TD&I website at www.nrel.gov/wind/technology-development-innovation.html under the "Partnerships."

The overall purpose of this open house was to:

- Provide an in-depth overview of the NWTC environmental instrumentation characterization and development resources and information on how to partner with NREL
- Gather information on wind environmental instrumentation development needs and gaps
- Discuss advancement of early-stage concepts/technologies and opportunities to optimize technology components and transition to more advanced technology validation programs.

INTRODUCTIONS

Attendees introduced themselves and talked about the role they play in the wind-wildlife space, their hopes and concerns related to technology advancement, and what they would like to get out of the open house event.

Included below are some common themes presented by the participants:

- Desire to make sure that mitigation technologies were developed in consultation with environmental and biological experts to ensure they are both effective, and limit potential externalities
- Interest in using technology to characterize animal behavior around turbines
- Interest in using approaches such as drones and artificial intelligence to advance mitigation technology options
- Need to make mitigation technology more affordable, integrated with the turbine, and trusted by regulatory agencies
- Need for effective solutions that work across species, geographies, and stakeholder needs
- Need for a mechanism to foster partnerships across industries and sectors.

NWTC SITE TOUR

Jeroen van Dam (NREL) delivered a short presentation on the NWTC site. For more information on NWTC assets and capabilities, see Jeroen's presentation: <https://www.nrel.gov/wind/assets/pdfs/open-house-about-tdi.pdf>.

Next, groups of attendees embarked on a site tour including going up the Controls Advanced Research Turbines (CARTs) and visiting the composites laboratory.

¹ <https://energy.gov/sites/prod/files/em/TRAGuideDraftwEM-60Comment2.pdf>

PANEL DISCUSSIONS

Low- to Mid-Stage Technologies and How NREL/NWTC Resources Can Support Advancement of Mitigation Technology and Serve as a Pipeline to High-Stage Characterization

A series of panel presentations were held, beginning with Jocelyn Brown-Saracino on “U.S. Department of Energy’s (DOE’s) role in early-stage technology development and benefits.”

Jocelyn discussed the DOE Wind Energy Technologies Office (WETO)’s *Wind Vision*, including its analysis of environmental costs and benefits of future wind energy deployment. She described WETO’s strategic plan for addressing wind environmental impacts to ensure coexistence of wind and wildlife, including a focus on support for the development of monitoring and mitigation technologies.

WETO’s approach to encouraging monitoring and mitigation technologies stems from the concept of TRLs, with the Office aiming to support a full pipeline of technologies to ensure that there are effective and affordable solutions available in the future. Jocelyn discussed NREL’s new initiative on low- to mid-TRL technology development and innovation as an important new piece of WETO’s approach. She also referenced research performed by NREL’s Jochem Weber and Jesse Roberts, including its emphasis on optimizing technologies for affordability as well as efficacy and the importance of early assessment of stakeholder needs in defining essential technology functionality. <https://www.nrel.gov/wind/assets/pdfs/wec-technology-readiness-performance-matrix.pdf>, <https://www.nrel.gov/wind/assets/pdfs/cost-time-risk-assessment-different-wave-energy-converter-technology.pdf>, and <https://www.nrel.gov/wind/assets/pdfs/wec-technology-performance-levels.pdf>. For more information, see Jocelyn’s presentation: <https://www.nrel.gov/wind/assets/pdfs/open-house-environmental-tpls.pdf>

Lee Jay Fingersh (NREL) presented on “Technological components of archetypical wind-wildlife mitigation approaches.” Lee Jay discussed the various components of a solution system and the concept that TRL is often isolated for specific components within a system (e.g., cameras may be a higher TRL, but as a “system” the TRL drops). Systems are only as high a TRL as their aggregation of components.

NREL can help ensure continuous performance in the following ways:

- Analysis of existing data
 - Geographic, statistical, imagery, technology
- Engineering capabilities
 - Controls, supervisory control and data acquisition, analysis, communications
- Field experiments
 - Day/night, meteorological towers, turbines, unmanned aircraft, species on site, technologies.

The NWTC is relatively isolated, so a wider range of experiments can often be performed at the site than in an urban environment or operational wind facility. For more information, see Lee Jay’s presentation: <https://www.nrel.gov/wind/assets/pdfs/open-house-mitigation-systems.pdf>.

Jason Roadman (NREL) presented on “Previous NREL environmental instrumentation testing.” He provided three examples of incubator projects as follows:

- Impact detection for turbine blades on the CART 3 turbine
- Infrared/IR cameras and microphones for bats
- Eagle detection (visual/radar) with falconry.

Jason reviewed the various ways one can partner with NREL:

- Through a DOE solicitation
- Through a work-for-others agreement:

- NREL pays people to work for them
- NREL and partner work together (no money exchanged) – usually via a cooperative research and development agreement
- Someone pays NREL to do work for them.

Each is covered by intellectual property protections. For more information on previous wind-wildlife work performed at the NWTC, see Jason’s presentation: <https://www.nrel.gov/wind/assets/pdfs/use-of-incubator-programs.pdf>.

To wrap up the panel presentations, Isabel Gottlieb from the American Wind Wildlife Institute (AWWI) presented on “Linkages to American Wind Wildlife Institute (AWWI) Technology Verification program.” AWWI’s technology verification program focuses on TRL 7 through 9. Categories of technologies verified include detection, deterrents, informed curtailment, and collision. Some challenges faced include:

- Wind facilities are often hesitant to invest without demonstration of buy-in from federal agencies
- Studies are expensive
- Research is not always accessible or relevant.

With independent, third-party research, stakeholders need to be on board. Results are more likely to be accepted if conducted by an independent third party with no financial stake in the outcome. AWWI helps with test set-up and coordination. Study design goes out for peer review, field work (conducted over months or years) is performed by outside consultants and results are then analyzed, presented in a peer-reviewed report, and published. Upcoming projects include eagle detection technologies, bat deterrent technologies, smart curtailment, as well as technologies for other target species.

The vision of coupling the AWWI program with NREL’s TD&I project includes providing an avenue in which components can be tested back at NREL if wind farm testing does not go as planned. The importance of publishing negative results was discussed. For more information on AWWI’s technology verification program and how it links to NREL’s TD&I initiative, see Isabel’s presentation: <https://www.nrel.gov/wind/assets/pdfs/evaluation-high-trl-minimization-technologies.pdf>.

BREAKOUT GROUP DISCUSSIONS

Workshop attendees were assigned to one of three breakout groups for smaller group discussion including:

- Gaps and challenges
- Technology advancement
- Partnerships.

These topics were discussed through the lens of low- to mid-TRL technology development. Take-aways are provided below.

I - Gaps and Challenges: Identify Gaps and Challenges to Developing Successful Minimization Technologies

This group considered the following question: “In your opinion, what gaps and challenges to developing successful minimization technologies exist?” Key ideas included:

- Need understanding of the core issues we are trying to solve and how the regulatory context comes into play
- Need to understand how technologies logistically get deployed

- Beyond funding, need to use resources to pull together early-stage technology developers and think about how we can help increase communication early on so development is more informed
- Field test design is critical, including understanding species behavior and individual behavior; poorly designed studies may indicate mitigation solutions are not effective, when in fact the study design was at fault
- There are large challenges to wind facilities hosting monitoring and mitigation research because of the risk, time commitment, and cost that hosting poses to host sites; initial testing at NREL may help with this issue, as technologies can undergo initial performance testing prior to asking a wind farm to host further testing
- Data access and sharing can impede collective advancement in terms of mitigation solution development; the group discussed the AWWI Research Information System, in which many wind companies have agreed to submit fatality data into the system; however, there are conditions that go with having access to ensure data confidentiality
- Some of the best sites for testing technology solutions are the highest-risk sites and thus have the largest challenges associated with hosting research; the group discussed the importance of matching willing host sites with groups developing and testing solutions
- The industry needs a range of viable solutions—such as more technology developers working on different solutions to keep the pipeline of options full; not all options will work for each project
- For some environmental impacts, mitigation solutions may reduce but not eliminate risk; need to have a conversation regarding acceptable level of risk (e.g., if you can get a high-risk site down to a low-to-moderate-risk level is that enough?)

II - Advancement Opportunities: Identify Viable (Wind) Industry Advancement Opportunities

This group considered the following questions: “What technology opportunities exist or are needed to minimize wildlife impacts and enable the wind industry to advance? Leveraging effective components: what technology components are effective (e.g., machine learning), and can these components be applied across or incorporated with existing technologies?” Key ideas were as follows:

- It is important to learn how other industries are applying detection and deterrent technologies to minimize risks to wildlife (e.g., aviation, aquaculture, military, fishing), and for other applications (enemy/ballistic detection, crowd control, non-lethal suppression, etc.)
- Artificial intelligence and surveillance may be key areas for investment; new deterrent approaches could involve drones, such as the use of lights, noise makers, or other
- It is important to differentiate between songbirds, broad migratory fronts of birds versus insects, and big birds versus planes and similar, each of which has historically proven to be problematic
- Could partner radar with a camera-based system to link initial siting information with closer tracking
- There is a need to advance GPS technologies for bats; smaller/lighter longer lasting tags
- It was felt that false positives should be categorized (are all birds created equal?)
- There should be a focus on the coupling of radar with other mitigation solutions
- The group recognized the challenge in understanding when deterrence becomes harassment; when does it arise to the level of take?
- Critical to develop a biological understanding and avoiding habituation to deterrents; why do different species habituate?
- There may be an opportunity for the wind industry to work more closely with birding groups and other wildlife groups, to better understand how other industries mitigate wind-wildlife impacts, and if there are approaches that can be transferred to the wind/wildlife space.
- There is a need to understand unintended consequences; how do bird and bat deterrent technologies affect other species?

III - Partnerships

This group focused on the question of what partnerships are needed, or need to be reinforced, to advance early-stage technologies. Key partnerships included:

- Federal agencies (high priority): such as the U.S. Fish and Wildlife Service (especially regional offices); agents take different approaches to same set of rules, depending on their interpretation
- Patent lawyers (high priority): high cost and burden; cannot advance too far on the technology development without funding sources and need patents to help protect intellectual property ahead of searching for funding
- Nongovernmental organizations (NGOs): need to engage conservation groups (such as TRCP, Audubon) as early on as possible; need NGO buy in; this may reduce chance of lawsuits, as well as make it easier for the regulators and public to buy into the project
- Wind industry: this includes project developers, original equipment manufacturers (especially regarding installing/integrating instrumentation/technology on turbine itself); need to understand how the technology might impact operation and maintenance (including as an after-market addition)
- Public: need to understand the priorities of the stakeholders; this can vary by region
- Academia: can be engaged in proof of concept, peer review, and validation; knowledge of species ecology can also be critical to achieving an effective technology solution
- Foundations (non-NGO): can be a valuable funding source
- Technology companies (vendors): project developer with a need for a solution (especially as prescribed by regulatory agency) may go directly to the vendor to find a solution
- Consultants: many work directly for the wind industry and may have good insight into what the field issues are and what kind of solution(s) would be effective
- Financial institutions/banks (low priority): key issues revolve around what is the risk/benefit of the technology solution to the project? Financial institutions can be beneficial for risk abatement
- Other investors (other industries): could leverage solutions developed for other applications
- State and local government: local jurisdictions in many areas defer to the state, but not always
- Public benefit corps (municipalities, public utility districts): lower priority.

CONCLUSIONS AND NEXT STEPS

The group discussed the convergence of current needs with what can be provided at the NWTC as part of NREL's TD&I project. There are many opportunities that access to the NWTC site and its researchers can provide including, but not limited to, opportunities to characterize and further develop integrated communications systems for informed curtailment, the use of artificial targets to serve as a wildlife proxy, alternative turbine designs, and acoustic deterrents on blades.

The group agreed that it is indeed important to perform characterization and validation activities early on in the technology development process to prioritize the improvements needed. At the same time, it was deemed crucial to share information—to the extent possible—on the approaches taken to advance mitigation technology.

Participants suggested that future open house forums target the mitigation technology vendor community and adjacent industries so that early technology concepts can be discussed and assessed for applicability in reducing wind-wildlife risks in the wind sector.

The open house adjourned at 4 p.m. The agenda follows (Appendix A).

Appendix A. AGENDA

Time	Topic	Speaker
9:00 –9:30 a.m.	Arrival and Continental Breakfast	
9:30–10:15 a.m.	Introductions and Overview	
	<ul style="list-style-type: none"> • Open house goals and purpose • Group introductions 	NREL
10:15–12:30 p.m.	NWTC Tour	
	<ul style="list-style-type: none"> • Overview of NWTC resources for advancing technologies • Tour of experimental research turbines, utility-scale turbines, manufacturing laboratory, meteorological towers, and other test laboratories 	NREL
12:30–1:00 p.m.	Lunch	
1:00–2:30 pm	Presentations: Low- to Mid-Stage Technologies and How NREL/NWTC Resources Can Support Advancement of Mitigation Technology and Serve as a Pipeline to High-Stage Characterization	
	<ul style="list-style-type: none"> • DOE’s role in early-stage technology development and benefits • Technological components of archetypical wind-wildlife mitigation approaches • Previous NREL environmental instrumentation testing • Linkage to AWWI Technology Verification program 	NREL/DOE/AWWI
2:30–2:45 p.m.	Break	
2:45–3:30 p.m.	Group Breakout Discussions	
	<ul style="list-style-type: none"> • Break into three groups to discuss and present on assigned and relevant topics, including gaps and challenges, opportunities, and partnerships 	NREL/DOE/AWWI
3:30–4:00 p.m.	Final Remarks and Adjournment	