

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.

June 20 – 21, 2018

WIND-WILDLIFE

Technology Development & Innovation Open House

National Wind Technology Center
Boulder, Colorado

ATTENDEES

Name	Organization
Laura Nagy	Avangrid, Director of Permitting and Environmental Affairs
Lee Walston	Argonne National Lab
Jeff Lask	Enercon, VP Env'tl Services Group
Joan Heredia	Enel, Sr Director Env'tl Permitting
Danna Small	Pattern, Mgr, Env'tl and Natural Resources for Operations
Mark Robertson	Vineyard Wind, Senior Manager of Environmental Affairs
Karen Smith	Argonne National Lab
Heidi Hartmann	Argonne National Lab
Paul Cryan	USGS
Robb Diehl	USGS
Deb Luchsinger	Enercon
Diana Leiker	APLIC, Tri State Generation and Transmission
Michele Boyd	Solar Program, DOE
Morgan Pfeiffer	USDA/Airports
Karen Voltura	Colorado Parks and Wildlife
Tim Hayes	Duke Energy
Greg Aldrich	Duke Energy
Myron Miller	GE
Jacque Nader	Siemens
Christina Calabrese	EDPR
Tom Allain	Vestas
Albert Fisas	GE
Andrew Gilbert	BRI
Garry George	Audubon, Renewable Energy Director
Rene Braud	Pattern Energy
Marilyn Teague	Sempra
Joy Paige	Defenders of Wildlife
Pasha Feinberg	Defenders of Wildlife
Matt Trapeni	Pattern Energy
Don Ronning	Lite Enterprises

David Cooper	Frontier Wind
Steve Laufenberg	NaturEner USA (Montana)
Agustín Riopérez	DT Bird
Mark Hayes	Normandeau
Leslie Strong	Tradewind Energy
Anne-Marie Griger	RES Americas
Leif Bang	Avangrid Renewables
Michael Schirmacher	BCI
John Aquilino	Invenergy, Sr. Manager, Environmental and Wildlife Permitting
Andrea Giampoli	Invenergy
Esteban Fernandez - Juricic	Purdue University
Paige Koutelas	Olsson Associates
Crissy Sutter	Natural Power
Karen Baud	ERO Resources
Shelley Vierra	Boulder Imaging
Robert Belford	Enercon
David Mehlman	The Nature Conservancy
Isabel Gottlieb	AWWI
Stu Webster	AWWI
Abby Arnold	AWWI
Paige Johnson	AWWI
Elise DeGeorge	NREL
Bethany Straw	NREL
Heidi Tinneland	NREL
Corrie Christol	NREL
Raphael Tisch	DOE
Jocelyn Brown-Saracino	DOE
Tom Ryon	NREL
Jason Roadman	NREL
Jeremy Stefek	NREL
Jeroen Van Dam	NREL
John Yarbrough	NREL
Galen MacLauren	NREL
Donna Heimiller	NREL

MEETING OVERVIEW AND PURPOSE

Elise DeGeorge kicked off the meeting and discussed the goals and objectives of NREL's Technology Development and Innovation (TD&I) project, which is to enable the wind industry to identify wind plant-appropriate wind-wildlife mitigation technologies to facilitate more efficient and cost-effective wind energy deployment across the United States. This would be done by fostering collaborative partnerships with technology developers of mitigation solutions to 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 DOE's National Renewable Energy Laboratory's (NREL) National Wind Technology Center (NWTC) facilities and expertise to support the research and development of these technologies. Technologies may consist of stand-alone systems, integrated, multi-component systems or the integration of solutions into standard turbine controls.



The overall purpose of this open house was stated as follows:

- Gather information on needs and gaps from environmental instrumentation manufacturers that have technology in development, turbine OEMs, developers, utilities, consultants and agencies
- Share lessons learned from adjacent industries that have developed solutions to deter wildlife
- Discuss advancement of early-stage concepts/technologies and opportunities to optimize technology components and transition to more advanced technology validation programs

INTRODUCTIONS

Each person 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 as presented by the participants (asterisks refer to number of similar mentions):

- Balancing proper planning while not losing sight of the big picture (e.g. renewable energy deployment, climate change)
- Bridging gap of effective technology with regulation
- Quantifying technology effectiveness
- Applying technologies to emerging US offshore wind industry
- Clarifying good and bad with varying technologies and different sites
- Avoiding losing technologies to 'valley of death'
- Linking technology science across industries ***
- Linking biological stimuli and geospatial elements to technology development
- Partnering with NGOs for solutions
- Integrating and informing policies
- Sharing data and solutions within the industry and with adjacent industries (e.g. solar)
- Balancing cost-effectiveness with reliability and efficacy ****
- Communicating importance of collaboration***
- Leveraging artificial intelligence (e.g. for automated identification)****
- Keeping information/understanding updated
- Quantifying efficacy of informed curtailment
- Encouraging increased investment in mitigation technologies

- Minimizing technology solution footprint (weight and size)
- Leveraging available technology in adjacent industries (e.g. DOD radar technology)

PRESENTATIONS

A series of presentations were held beginning with one delivered by 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 discussed 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 supporting monitoring & mitigation technologies stems from the concept of technology readiness levels (TRL), with the Office aiming to support a full pipeline of technologies to ensure that there are effective and affordable solutions in the future. Jocelyn discussed NREL’s new initiative on low- to mid-TRL technology development & innovation as an important new piece of WETO’s approach to supporting technical solutions to wind environmental impacts. For more information see Jocelyn’s presentation located here: <insert link here>

Jeroen van Dam delivered a site presentation: For more information on NWTC assets and capabilities, see Jeroen’s presentation located here: <insert link here>.

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

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

Jason reviewed the various ways one can partner with NREL:

- 1) Through a DOE solicitation
- 2) Through a Work for Others agreement:
 - a) NREL pays people to work for them
 - b) NREL & partner work together (no money exchanged) – usually done through a Cooperative Research and Data Acquisition (CRADA) agreement
 - c) Someone pays NREL to do work for them

Each is covered by Intellectual Property protections.

John Yarbrough presented on NREL’s capabilities in computational sciences.

John Yarborough’s background is in applied physics specializing in photovoltaics, biofuels and data analytics. He is currently working with Paul Cryan, USGS, on automating data analysis. Artificial intelligence is both exciting for its potential as well as intimidating to both the amount and complexity of the data out there. Significant animal behavioral insight can be obtained in utilizing machine learning, data analytics and visualization. Machine learning can help humans determine and study the factors influencing risk/behaviors of bats in and around

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windfarms. John is currently using OpenCV and TensorFlow, which are open source software installed on NREL's Tanger graphics processing unit (GPU) cluster to enhance our ability to analyze, understand and display data. Along with these open source software options, NREL also has a supercomputer, Peregrine, along with an Insight Center allowing for data to be explored in an immersive, high resolution environment.

When asked what data collection methodology works best with Artificial Intelligence and machine learning, John replied on the importance of determining the question first, then designing the experiment and data collection to maximize the chances of answering the question. Ultimately, the primary goal would be to develop a real-time machine learning algorithm using various sources of data types to train and execute image processing and analysis.

Donna Heimiller and Galen Maclaurin presented on NREL's capabilities in geospatial analysis, mapping and visualization. They discussed the 'Competing Uses' data set that includes a visual display of standard exclusions that incorporate wildlife information and exclusion zones (e.g. national wildlife refuges) with additional critical wildlife habitat, radar, and public acceptance exclusions and mitigation costs to identify where wind energy development may be less likely, more costly, or prohibited. It includes elements as to what would happen if specific factors are changed. Donna and Galen also discussed NREL's Renewable Energy Potential (reV model). The reV framework allows for quantification of potential system performance and operational characteristics at a high spatial and temporal resolution, at national and regional scales. The reV model interfaces with SAM tools and provides outputs to models such as ReEDS, NEMS, dGen, PLEXOS, and RPM that inform the wind industry and stakeholders on impacts of technology development costs, system performance, and scenarios such as targeted wildlife curtailment impacts.

LUNCHTIME PRESENTATIONS

A lunchtime discussion introduced the first two TD&I projects, which are on track to begin this summer, one on the use of flickering ultraviolet light to deter bats from wind turbines and a second on the use of Next Generation Weather Radar (NEXRAD) to inform on turbine curtailments to reduce wind energy impacts on flying animals. Then, participants discussed current needs and gaps in wind-environmental instrumentation development and opportunities to optimize technology components and develop more advanced technologies.

Jocelyn Brown-Saracino, upon request, shared links and information on DOE-funded activities in the wind wildlife mitigation space <see link here>.

PANEL DISCUSSIONS

Panel 1: Stakeholder Perspectives

There were two panel discussions. In the first panel, industry stakeholders shared their perspectives on how they can be further involved in the identification, development and utilization of wind wildlife mitigation solutions. For example, OEMs, regulatory agencies and utilities can join earlier in the concept design process to ensure compatibility, effectiveness and buy-in.

Facilitator: Stu Webster, AWWI

Panel Participants (Brief Bios included in Appendix B):

- Myron Miller, General Electric
- Karen Voltura, Colorado Parks & Wildlife
- Jacques Nader, Siemens
- Christi Calabrese, EDPR Renewables
- Tim Hayes, Duke Energy

Stu began the panel with questions to Karen Voltura on meaningful metrics for mitigation solutions. Some common themes included:

- When is good good enough in testing effectiveness?
- Need to understand impact/opportunity of reducing curtailment
- Can a bat deterrent effectively reduce cost, or can a bat deterrent plan pay for itself?
- Important to show reduction in fatalities
- Need regulatory guidance – it is hard to design a mitigation system, not knowing the goal.
- Need to improve behavioral models; improve predictions.

Karen discussed the complications of permits due to changes in population.

Tim and Christi discussed key insights for engaging industry partners. It is important to understand the developer and OEM's management goal to generate as much power for as little \$ as possible. Fatalities are raising issues at top level of management. They need to address the issue, but they need to also know the impact on power production. There needs to be a business case for what industry partners will try on their sites.

Jacque discussed the most relevant elements of a turbine platform for integration. Hardware, materials, towers, nacelle, etc. are similar. There are well understood how to integrate and apply to systems. With respect to software, turbines are becoming "smart", can communicate to each other, 24/7 monitor, lots of data generated. This data can be leveraged to better understand the challenges.

Christi discussed the challenges with bringing in new mitigation technology at wind farms. For one, there needs to be species of concern at a site for it to be a 'good' host site. Putting projects into place was a lot more challenging than imagined. It's like a 'mini' development project as so many parts of company need to be involved. Integration considerations and complications include: development, engineering, cyber security, NERC, FERC, construction, lease amendments, etc.

Karen discussed communications challenges. She has been in meetings with developers where regional issues were identified. The agency would like to take a regional approach with respect to eagles; there is no state regulatory permitting in Colorado, it's county-specific. Cumulative impacts are hard to evaluate.

There are questions around scale and uncertainty when it comes to mitigation product development. There is a lot of customer interest in certain products, but no one has implemented. A product could be field tested with good fatality reduction data, but they still won't purchase them. This is believed to be related to uncertainty. Will it be effective enough? Will it be cost-effective enough? Many haven't seen enough (and sufficient) data to prove that the product is worth the investment. There needs to be a good business case as developers are cautious not to price out of the market. Government funded incubator projects are very helpful.

Myron discussed his efforts with his GE's bat deterrent. The deterrent demonstrated fatality reduction, and there was interest, but no purchases due to the uncertainty around effectiveness and insufficient proof that it will cover their needs.

Jacque discussed the importance of getting OEM's engaged in product development. He expressed the importance of having R&D turbines at NWTC to avoid the need to curtail at commercial wind farms for product testing.

The group discussed the importance of artificial intelligence and machine learning in the wind industry. The turbine can monitor conditions and be taught to react to changes in environment. There is a lot of data that can and should be filtered out to include only the data that matters. This next step needs to be done in a collaborative fashion – one organization cannot do this on its own.

There needs to be more discussion of what others are doing externally as well as internally within their own organizations (e.g. amongst commercial, operation, procurement, environmental groups). Attention needs to be placed on making a future use business case, e.g. will it be worth it today to see cost reduction in 5-years (including the cost of compliance). The value of this needs to be better communicated.

Panel II – Adjacent Industry Panel

The second panel leveraged lessons learned from other industries that also have been heavily impacted by the concerns brought on by wildlife fatalities, including airports, power transmission, offshore wind power, solar electricity, and oil and gas. New detection and deterrence technologies were suggested, along with their applicability to wind turbines, such as the use of radar to detect birds at airports. This served as a great opportunity for cross-industry collaboration for mitigation techniques.

Facilitator: Stu Webster, AWWI

Panel Participants (Brief Bios included in Appendix B):

- Diana Leiker, Tri State Generation and Transmission Association (APLIC member)
- Michele Boyd, DOE Solar Program
- Morgan Pfeiffer, USDA Wildlife Services' National Wildlife Research Center
- Andrew Gilbert, Biodiversity Research Institute
- Deb Luchsinger, Enercon

Following introductions, Morgan discussed the compiled wildlife research in the airport environment. Discussed the role of sensory ecology and the idea of reverse engineering to identify effective solutions.

Andrew discussed the offshore environment and how monitoring and mitigation is performed. He discussed technologies for site characterizations: people on boats, planes, newer technologies, the use of satellite tags to look at broad scale movement (both pre- and post-construction)

The group discussed what have other industries done to avoid wildlife impacts. It was noted that much of these industries are very heavily regulated (state, county, or national). Many related to avian species (landing on toxic ponds). Mitigation has included motion detection cannon. A novel approach has included motion triggered drones dressed up to look like an eagle, to scare birds away from (tailing) ponds. Vegetation control can be

helpful (crops, etc.). For bats, you could isolate the areas where bats are roosting, relocate, or close-down at feeding time. It should be noted that some technologies are just not applicable due to the nature of the avoided risk.

APLIC has identified efficiencies in vegetation management, etc. including going out in the fall to clear nests to help keep infrastructure safe and for new construction. It is sometimes difficult to make avian issues a main concern when placed alongside cultural or other issues. It is important to build avoidance into planning, but this is often hard to do with broad landscape-scale projects such as wind farms. You could capitalize costs as well if (mitigation is) part of another work order (such as maintenance).

The group discussed assessment of potential avian impacts in the solar industry. At this time, the solar industry is focused on identifying the issues. They are still struggling with the question of measuring “Solar avian mortality” and all the factors that could affect this, this includes an understanding of the population level effects and understanding the ‘lake-effect’ at solar facilities and whether this is an attraction to birds. The solar industry is not at the point where they have considered cost of mitigation; they are still trying to figure out how much to spend to figure out if something works.

What is the motivation that keeps conventional industries investing? Working groups in oil and gas and other similar industries have expanded greatly (including industry and society groups on wildlife impacts, regulatory oversight, etc.). As consciousness expands, so do professional organizations. The Colorado School of Mines, for example, has programs dedicated to developing “cleaner” ways to extract minerals. It has historically been cheaper to pay fines than perform mitigation activities. However, regulators increased fines which drove mitigation and siting. Public opinion has also driven mitigation (e.g. poor perception as neighbors). In a recent example in the hydropower industry, in compliance with impingement rules to mitigate effects of a new intake structure whose pile driving could impact fish hearing, the use of a bubble curtain to dampen sound was required.

Given maturity of risk reduction technology for transmission lines, how standard have they become for new installation? How has this changed the overall cost? The answer to this is dependent on the size of the company. These (mitigation technologies) are not standards and increase costs, how do these costs increase compare to those incurred by wind farms seeking to be more environmental. The answer is that it depends on how much line is being updated/built.

What can be learned from the offshore industry? In the hostile offshore environment, what about equipment durability, test, approaches, etc.? Anything that can go wrong will go wrong. Heat is a major issue (closed door, now impervious to water, can overheat) - heat management is key. Also important is Failsafe Systems for power (primary and backups) and casing durability. It can be hard to determine why failures occurs. Overdesigning devices is the way to go if it is going in the marine environment, but this greatly drives up cost and weight.

The questions that the wind industry is dealing with are light years ahead of where we were when first got started. There is a commitment from science, wind community to figure it out, and some of this figuring out is happening voluntarily. There is an investment to understanding risk (private and public-funded). The group discussed how NREL can best contribute, including:

- Maintaining access to test sites, and controller technologies
- Publishing results and sharing data so industry can benefit
- Building a framework around business case; what could help make permitting process go faster?
- Validating technologies. Continue testing and producing data to prove effectiveness.

- Supporting collaborative work, because no single company can do it alone
 - Providing forums for discussion and collaboration.
 - Further developing collision risk models which can identify high risk sites, and help focus development of technologies
 - Promoting education - reaching out to organizations like AFWA/WAFWA
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THURSDAY MORNING SITE TOUR

The Open House concluded with a tour of the Controls Advanced Research Turbine, utility-scale turbines, meteorological towers, and test laboratories at NWTC. Attendees saw the field test sites, including the UV light deterrent system on the DOE-owned GE 1.5-MW turbine, the CoMET, the blade test facility and the 5-MW dynamometer.

A follow-on forum focused on the integration of mitigation solutions on wind turbines was held on Thursday, June 21 in the afternoon with meeting notes prepared by AWWI in a separate document.

Appendix A – AGENDA

Time	Speaker/Facilitator	
	Wednesday June 20th, 2018	
8:30 -9:00 am	Arrival and Continental Breakfast	Catered by NREL
9:00-10:15 am	Introductions and Overview	
	<ul style="list-style-type: none"> • Agenda overview • Open House goals and purpose • Overview of Technology Development and Innovation Project • DOE’s role in early stage technology development and benefits • Attendee Introductions <i>(Name, organization, role you play in the wind wildlife space or in adjacent industries, greatest hope for technology advancement, greatest concern for technology advancement, what you hope to get out of this open house)</i> 	Elise DeGeorge, NREL Jocelyn Brown- Saracino, DOE
10:15-11:00 am	<ul style="list-style-type: none"> • Overview of NWTC resources for advancing technologies • Technology Validation and Development at the NWTC – Case Studies 	Jeroen van Dam, NREL Jason Roadman, NREL Lee Jay Fingersh, NREL
11:00-11:45 am	Expanded NREL Capabilities – Computational Science, Geographic Information System/Mapping/Visualization	John Yarbrough, NREL Donna Heimiller, NREL Galen Maclaurin, NREL
11:45-12:00 pm	Open Discussion	
12:00 -12:30 pm	Lunch catered by NREL	
12:30-1:30 pm	Lunchtime Discussion on Current TD&I Projects	Paul Cryan, USGS Robert Diehl, USGS
1:30-3:00pm	Stakeholder Perspectives Panel	
	<ul style="list-style-type: none"> • Vendor/OEM Perspective-What are the challenges that the vendor community faces in moving their solutions into the commercialization space? How can early TRL testing at controlled sites minimize these challenges? • Developers/Utility Perspective-What/how can developers/utilities best contribute to the development of mitigation solutions, particularly in the early development stage? What are their interests and concerns? • Turbine OEM Perspective-What are the concerns of turbine OEMs? What is the importance of 	Facilitator: Stu Webster, AWWI Panel Participants: Myron Miller, GE Karen Voltura, State of Colorado Parks and Wildlife Jacques Nader, Siemens Christi Calabrese, EDP Renewables Tim Hayes, Duke Energy

	<p>tradeoff analysis when incorporating mitigation solutions to turbines? How would OEMs like to be involved in early concept development?</p> <ul style="list-style-type: none"> Regulatory Agency Perspective-How should agencies optimally be involved in the commercialization pipeline to support technology approval and adoption? 	
3:00 – 3:15 pm	Break (snacks provided)	
3:15-4:45 pm	Lessons Learned from Adjacent Industries on Application of Wildlife Impact Mitigation	
	<p>Subset of topics for discussion:</p> <ul style="list-style-type: none"> Brief overview of each Industry’s common and/or promising detection/deterrence technologies/techniques Are you researching/applying any advanced technologies in your field? Anything that could be applicable to wind facilities? What is the process your industry goes through to take a technology/technique from concept to widespread adoption? Is there an evaluation process? How does it work? Discussion of how they work with the supply chain Is there a regulatory framework that drives implementation of wildlife risk reduction measures? Does it drive innovation of new technologies/techniques? How is innovation/evaluation of risk minimization measures funded? Challenges and lessons learned from your experiences 	<p>Facilitator: Stu Webster, AWWI</p> <p>Panel Participants: Diana Leiker, Tri State Generation and Transmission Association (APLIC member) Michele Boyd, DOE Solar Program Morgan Pfeiffer, USDA Wildlife Services’ National Wildlife Research Center Andrew Gilbert, Biodiversity Research Institute Deb Luchsinger, Enercon</p>
4:45- 5:00 pm	Additional Discussion as Needed	
5:00 pm	Happy Hour (No Host) Location - Flatz at Renaissance Flatirons Hotel	
	Thursday June 21st, 2018	
8:00 -8:30 am	Arrival and Continental Breakfast	
8:30 -9:00 am	NWTC Tour Preparation	
	<ul style="list-style-type: none"> Overview of NWTC resources for advancing technologies Safety presentation and get ready for site tour 	Jeroen van Dam, NREL Don Young, NREL
9:00 -12:00 pm	Tour to include CART, Utility-Scale Turbines, Met Towers, Test Laboratories	Jeroen van Dam, NREL Jason Roadman, NREL Other NREL Experts
12:00 pm	Adjourn	

Appendix B - PANEL MEMBER BIOGRAPHIES

Stakeholder Perspectives Panel

1. Myron Miller, GE- Myron is the Technical Leader of Wind Advance Technology at GE Renewable Energy. Previously he spent over eight years as a Program Manager for Frontier Wind. He earned his Bachelor in Science in Mechanical Engineering from the University of Minnesota- Twin Cities.
2. Karen Voltura, State of Colorado- Karen has been an Energy Liaison and Land Use Specialist at Colorado Parks and Wildlife since 2016. Before that, she spent five years as the Director/Program manager for Wind Energy and Environmental Applications. Previously, she spent eight years as the Director of the Airport Wildlife Management Services. She attended the University of Notre Dame and received her PhD in Zoology from the University of Oklahoma.
3. Jacques Nader, Siemens- Jacques is the Head of Siemens' Global Blade Design R&D Center of Excellence, he has held this position for six years. He has Master of Science degrees both in Mechanical and Civil engineering as well as an MBA from the University of Maine.
4. Christi Calabrese, EDP Renewables- Christi is Director of Permitting and Environmental Affairs for EDP Renewables, she has held this position for almost four years. She has a Bachelor of Science degree in zoology from the University of Florida and a Masters Degree in Marine Resources Management from Texas A&M Galveston.
5. Tim Hayes, Duke Energy- Tim has been the Environmental Director at Duke Energy Corporation for over seven years. He has been with Duke Energy and its predecessor companies Cinergy Corp., PSI Energy and Public Service Company of Indiana for 27 years. He has a Bachelor of Science from Indiana State University Life Science.

Adjacent Industry Panel

1. Diana Leiker, Tri State Generation and Transmission (APLIC member)-Diana is the Senior Environmental Planner for Tri-State Generation and Transmission, she has held this position for almost nine years. Previously she spent four years as Associate Natural Resource Specialist/ Project Manager for EDAAW/AECOM. Diana attended Colorado State University and received a degree in Natural Resource Management, Natural Resources/ Conservation Biology.
2. Michele Boyd, DOE Solar Program- Michele is the Technology Manager and Policy Analyst for ManTech International at the Solar Energy Technologies office, US Department of Energy. She spent four years as a Government Relations Manager at Abengoa Solar. She has a Bachelor of Science in Biology and received her M.S in Environmental Policy.
3. Morgan Pfeiffer, USDA Wildlife Services' National Research Center- Morgan is a postdoctoral Research Biologist at USDA WS National Wildlife Research Center. She earned a Bachelors in Science at the Pennsylvania State University in Wildlife and Fisheries Science. She also received her PhD from the University of KwaZulu-Natal for Zoology.

4. Andrew Gilbert, Biodiversity Research Institute- Andrew has been the Data and IT Director for the Biodiversity Research Institute for over seven years. He earned his Masters Degree in Wildlife Ecology from the University of Maine.
5. Deb Luchsinger, Enercon- Deb is the Renewable Energy Program Manager at Enercon Services. Prior, she spent over 12 years as the Utility Services Manager also for Enercon Services. She earned her PhD in Atmospheric Science/Climatology from the University of Denver.