

MA&D – Siting and Wind-Radar Mitigation

2019 Wind Program Peer Review

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April 30 – May 2, 2019



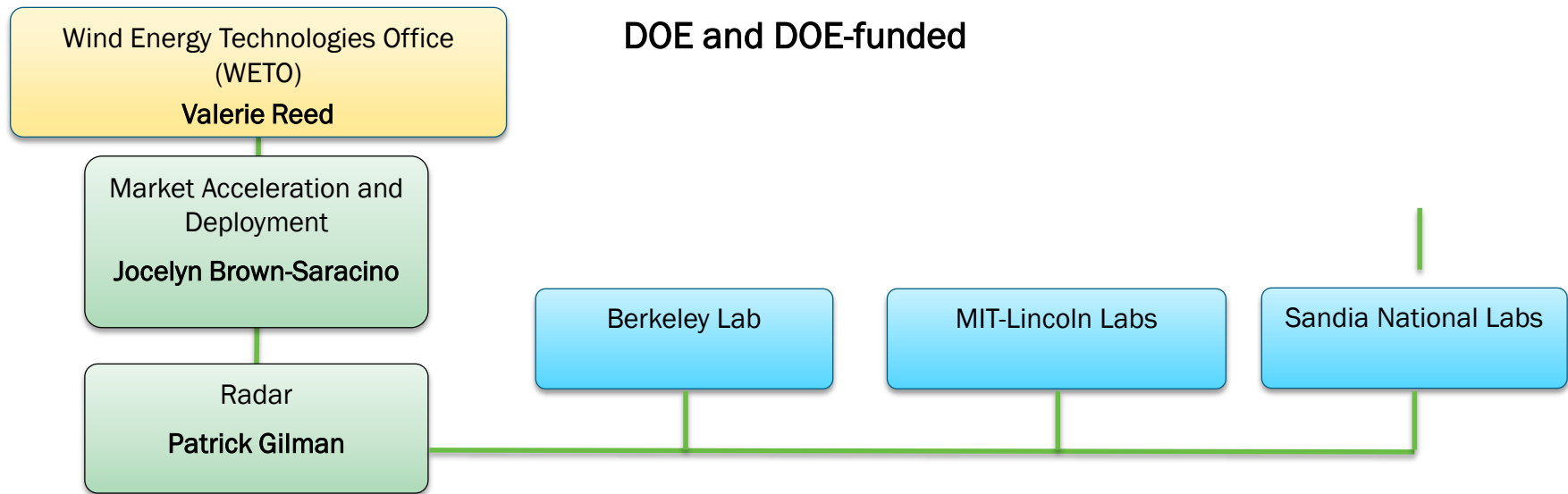
Wind Office Strategic Priorities

Clean, low-cost wind energy options nationwide

	Land-Based Wind	Offshore Wind	Distributed Wind
Technology Development & Scientific Research	Atmospheric Science & Wind Plant Systems Engineering	Atmospheric Science & Wind Plant Systems Engineering	Atmospheric Science
	Standards and Certification	Standards and Certification	Standards and Certification
	Technology Innovation	Technology Innovation	Technology Innovation
	World Class Testing Facilities	World Class Testing Facilities	
	Tech to Market Commercialization	Tech to Market Commercialization	
	Integrated Systems Design	Integrated Systems Design	
		Offshore Specific R&D Advanced Technology Demo Projects	
Market Acceleration & Deployment	Advanced Grid Integration	Advanced Grid Integration	Advanced Grid Integration
	Workforce and Education Development	Workforce and Education Development	Workforce and Education Development
	Stakeholder Engagement	Stakeholder Engagement	Stakeholder Engagement
	Environmental Research	Environmental Research	
	Siting & Wind Radar Mitigation	Siting & Wind Radar Mitigation	
Analysis & Modeling	Evaluate and Prioritize R&D	Evaluate and Prioritize R&D	Evaluate and Prioritize R&D
	Model Development and Maintenance	Model Development and Maintenance	Model Development and Maintenance
	Techno-economic Analysis	Techno-economic Analysis	Techno-economic Analysis
	Electricity Sector Modeling	Electricity Sector Modeling	Electricity Sector Modeling

Who We Are: WTRIM Working Group

2014 Memorandum of Understanding (MOU) established the WTRIM Working Group to collectively develop and deploy mitigation approaches, allows significant leverage of DOE funds



Wind Turbine Radar Interference Mitigation (WTRIM) Working Group

BOEM

FAA

NOAA

DHS

(Observer)

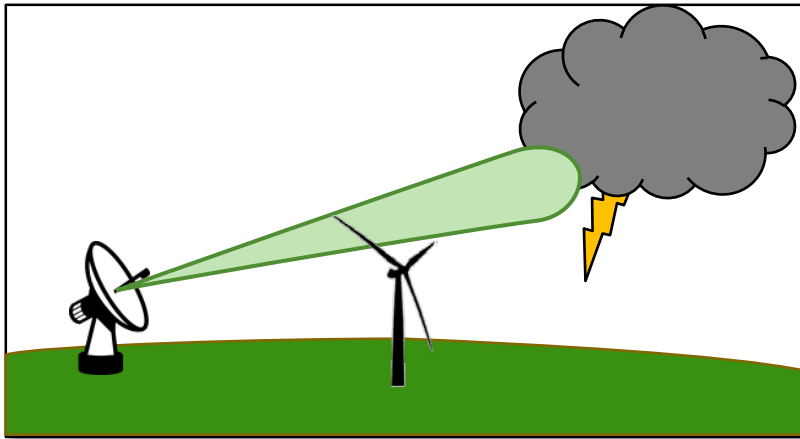
DOD Siting
Clearinghouse

Other DOD & FAA Elements (Subject Matter Experts): NORAD, AFRL, 84RADES, SPAWAR, LRR-JPO, OE/AAA

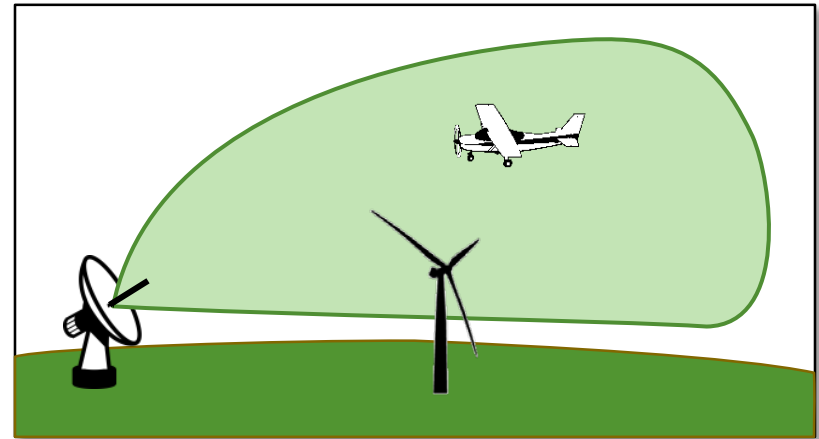
Wind-Radar Interference Background

As wind turbines get larger, more numerous and move into new areas of the country, conflicts with existing radar systems are likely to increase in number and severity. Additionally, Federal agencies must be able to predict and quantify the impact to their missions with high fidelity

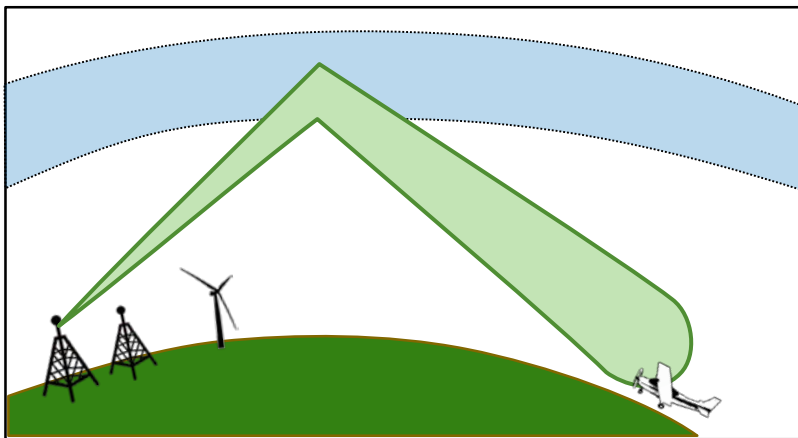
Weather Radar



Air Surveillance Radar



Over the Horizon Radar

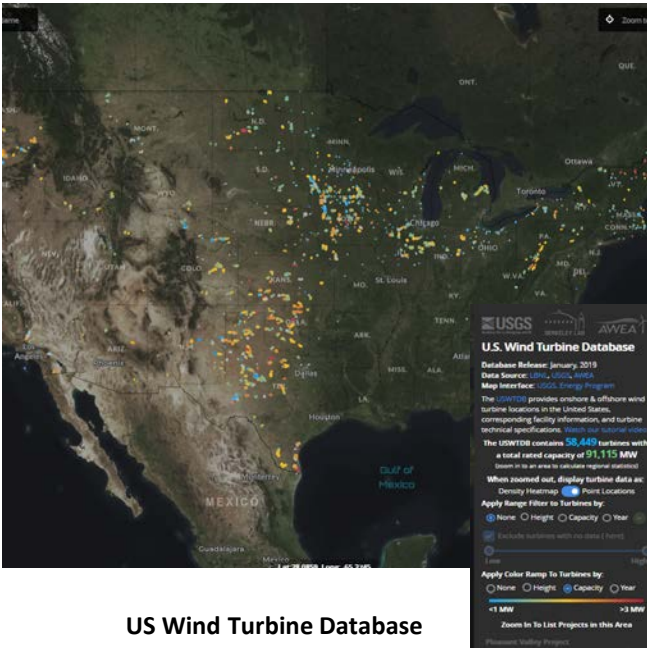


Wind turbines impact radars:

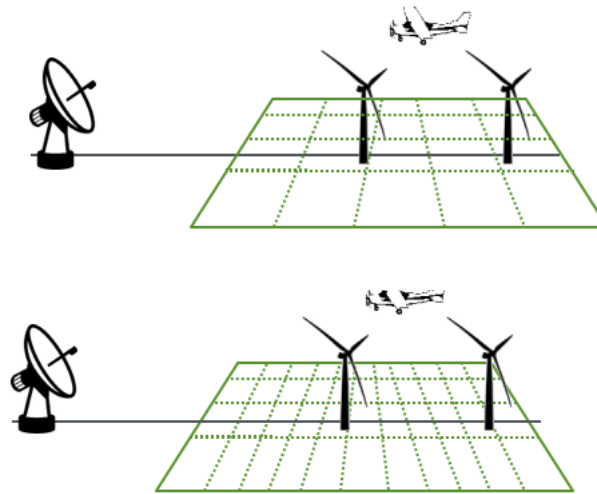
- Turbines present unique mix of moving and static clutter
- Decrease probability of detection
- Increase false alarms
- Corrupt track quality
- Flight safety (FAA)
- Homeland security (DHS)
- Homeland defense (DOD)
- Weather observation (NOAA)

Federal WTRIM Strategy

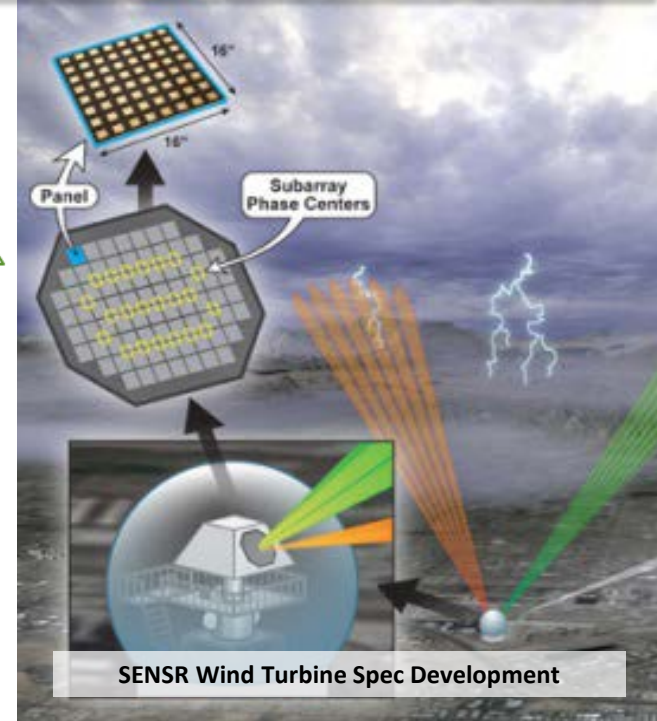
Strategic Objectives: By 2025, eliminate wind turbine radar interference as an impact to critical radar missions, ensure the long-term resilience of radar operations in the presence of wind turbines, and remove radar interference as an impediment to future wind energy development.



US Wind Turbine Database



MIT-LL Increased Range Resolution Algorithm



SENSR Wind Turbine Spec Development

Strategic Theme 1:
 Improve capacity to evaluate the impacts of wind energy on sensitive radars

Strategic Theme 2:
 Develop and deploy mitigation measures to increase resilience of existing radars to wind turbines

Strategic Theme 3:
 Encourage the development of next-generation radars resistant to wind turbine interference

Wind-Radar: Key Activities Over Time

2016 – 2020

Strategic Theme 1: Improve Capacity to Evaluate Impacts

Validate Existing Modeling and Simulation Tools

Maintain and Improve Modeling and Simulation Tools

Maintain and Improve US Wind Turbine Database

Evaluate Potential Offshore Development Impacts on Coastal Radars

Strategic Theme 2: Develop and Deploy Mitigation Measures

Mitigation Software Upgrade Development and Improvement

Pilot Mitigation Projects

Offshore Wind Specific Mitigation Development

Turbine-Side Mitigation Evaluation

Turbine-Side Mitigation Development

Strategic Theme 3: WTRIM-Resilient Next-Generation Radars

Ensure Wind Turbine Resilience in Next-Gen Design Specs

2016

2017

2018

2019

2020

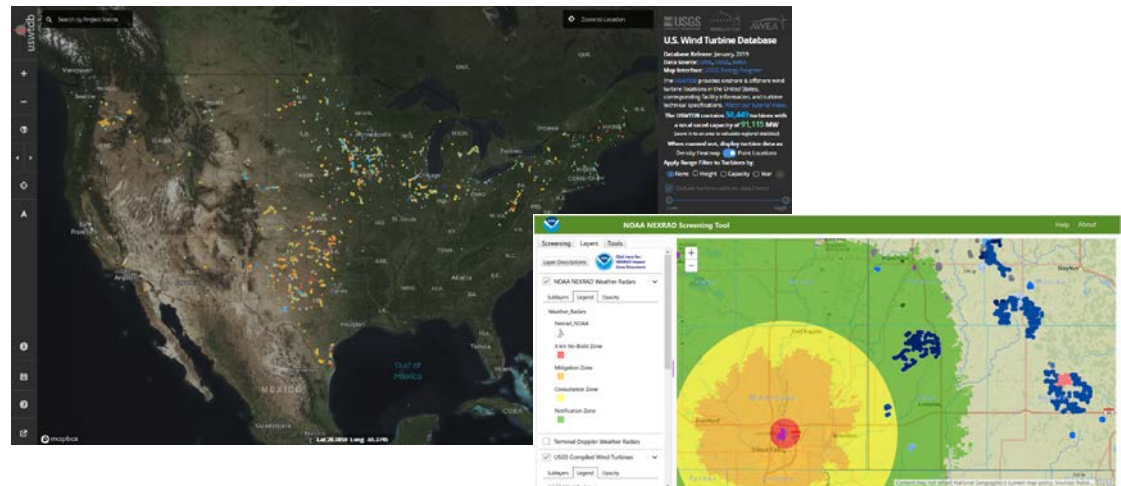
Strategic Theme 1: Improve capacity to evaluate the impacts of wind energy on sensitive radars

Accomplishments

- NOAA NEXRAD Public Screening Tool (SNL)
- WTRIM Modeling & Simulation Tools Catalog (SNL)
- US Wind Turbine Database (LBNL) Release
- and integrated machine learning, turbine visual classification (MIT LL)
- Evaluated potential offshore impacts on coastal radars (MIT LL)
- WTRIM Working Group Facilitation (SNL)

Future Priorities

- Ensure all potential radar conflicts can be evaluated by developing, verifying, and improving modeling and simulation tools.



Collaborators: SNL, MIT LL, LBNL, AWEA, USGS, WTRIM Working Group Agencies

Strategic Theme 2: Develop and deploy mitigation measures to increase resilience of existing radars to wind turbines

Accomplishments

- Travis AFB, PMP
- Analysis of Alternatives, Canon AFB
- Lightning Protection and Radar Impact Mitigation
- AMOSS Radar Study
- Demonstrated improved performance through advanced signal processing



Future Priorities

- Develop certification framework for off-the-shelf mitigation solutions
- PMPS: Other mitigation types in operational setting
- Turbine-Side Mitigation Development
- Offshore Wind Specific Mitigation Development

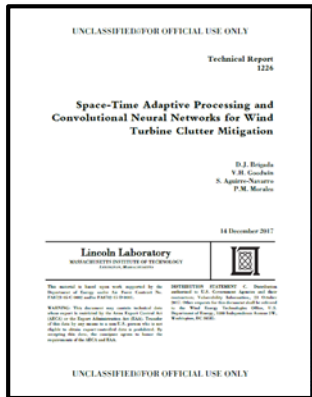


Collaborators: SNL, MIT LL, AFRL, C-Speed, Wind Developers, WTRIM Working Group

Strategic Theme 3: Encourage the development of next generation radars resistant to wind turbine interference

Accomplishments

- Advanced Signal Processing for Wind Turbine Clutter Mitigation for future systems (MIT LL)
- SENSR Program



Future Priorities

- Ensure that relevant radar development programs are aware of WTRIM issues and include as a key design requirement
- Ensure Next Generation radars are resistant to future wind technology



Collaborators: SNL, MIT LL, NREL, SENSR Program, WTRIM Working Group Agencies

Wind Radar: Future Priorities (FY19 and beyond)

Strategic Area	Future Priorities	Collaborators
<p>Improve capacity to evaluate the impacts of wind energy on sensitive radars</p>	<ul style="list-style-type: none"> • Evaluate potential impact of offshore wind development on coastal radars; develop & improve tools for offshore environment • Maintain and improve modeling and simulation tools, including the U.S. Wind Turbine Database • Continue to identify modeling and simulation gaps, and develop new tools • Continue WTRIM Working Group Facilitation & Collaboration 	<ul style="list-style-type: none"> • WTRIM Working Group (see org chart) • Labs: SNL, MIT LL, LBNL • Agencies: DOD, BOEM, FAA, NOAA, DHS, & other DOD/FAA elements • AWEA, USGS,
<p>Develop and deploy mitigation measures to increase resilience of existing radars to wind turbines</p>	<ul style="list-style-type: none"> • Pilot Mitigation Project Initiative (completing Travis AFB and Canon AFB PMPs and identify new PMP sites to test potential off-the-shelf mitigations) • Offshore Wind specific mitigation development • Work with DOD, NOAA, and NWS - NEXRAD radar mitigation evaluation and development • Turbine-side mitigation evaluation & development (e.g. Wind Farm spacing) • Develop hardware/software upgrades to existing radars (e.g. advanced multi-radar fusion and tracker prototyping) • Command and control/automation system improvements 	<ul style="list-style-type: none"> • WTRIM Working Group • Labs: SNL, MIT LL, LBNL • Agencies: DOD, BOEM, FAA, NOAA, DHS, and other DOD & FAA elements • Wind developers, OEMs
<p>Encourage the development of next generation radars resistant to wind turbine interference</p>	<ul style="list-style-type: none"> • Continue to engage in outreach and R&D to ensure that relevant radar development programs are aware of WTRIM issues and include as a key design requirement • Continue support for SENSR program 	<ul style="list-style-type: none"> • WTRIM Working Group • Labs: SNL, MIT LL, NREL • Agencies: DOD, BOEM, FAA, NOAA, DHS

Notes: WTRIM= Wind Turbine radar Interference Mitigation; DOD= Department of Defense; FAA= Federal Aviation Administration; NOAA=National Oceanic and Atmospheric Administration; NWS= National Weather Service; BOEM= Bureau of Ocean Energy Management