U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Offshore Wind Turbine Radar Interference Mitigation (WTRIM) Series

Technical Interchange Meetings (TIMs)

Lillie Ghobrial, DOE Wind Energy Technologies Office

July 13, 2020

OSW Turbine Radar Interference Mitigation Webinar Series

Objective

- Building relationships between key industry stakeholders and federal agencies
- Sharing perspectives on potential impacts of wind turbine induced radar interference on critical radar missions and offshore wind development
- Identifying research and development (R&D) needs to address these impacts

Webinar attendees will

- Achieve a better understanding of agency perspectives on potential impacts of offshore wind on radar missions and industry perspectives on offshore wind development
- Hear about government and industry-led wind-radar interference research, including potential impacts of offshore wind on radar missions and technical mitigation options
- Share perspectives on the strengths and weaknesses of the current state of knowledge of potential technical impacts and mitigations
- Help identify research needs for offshore wind-radar mitigation and assist in identifying a pathway forward for future government-industry collaboration
- Network with professionals representing domestic and European offshore wind developers, OEMs, radar vendors, the WTRIM Working Group, and technical radar experts.

Future Wind-Radar Webinar Agenda & Information

July 27, 2020

Oceanographic High Frequency (HF) Radar Impacts and Mitigation Efforts- NOAA IOOS

- *HF radar missions, past mitigation efforts*
- *Technical and operational issues regarding offshore wind turbine impacts*
- *Mitigation Solutions*
- *Register by July 24*

August, 2020

Air Surveillance Radar/Air Traffic Control

- *Technical and operational issues regarding each system in an OSW environment*
- *State of Current Understanding*
- *Mitigation Options*

TBD, Fall, 2020 (TBD)

Forward Looking Research & Collaboration and Government/Industry Roundtable

Webinar Information (Past & Future) is on the DOE Website:

https://www.energy.gov/eere/wind/articles/offshore-wind-turbine-radar-interference-mitigation-webinar-series

Submit Your Questions & Input

Lillie.Ghobrial@ee.doe.gov

Agenda

Monday, July 13th, 2020 11AM-1PM Eastern	
11:00 a.m.	Welcome, Meeting Objectives *Speaker: Lillie Ghobrial	U.S. Department of Energy Wind Energy Technologies Office (WETO)*
11:10 a.m.	Introduction to Marine Navigation Radar and Potential Offshore Wind Turbine Impacts *George Detweiler	U.S. Coast Guard*
11:40 a.m.	Navigation Radar Studies Overview (Including from the EU) *George Detweiler	U.S. Coast Guard*
12:00 p.m.	Offshore Wind Farm Developer Perspective *Ed LeBlanc	Ørsted*
12:15 p.m.	Mariner Perspective *Tom Dameron	Responsible Offshore Development Alliance (RODA)* *Eric Hansen	RODA*
12:30 p.m.	Panel: Q&A *Moderator: Lillie Ghobrial	U.S. DOE WETO* *George Detweiler	U.S. Coast Guard* *Ed LeBlanc	Ørsted* *Tom Dameron	RODA* *Eric Hansen	RODA* *Angel McCoy |Bureau of Ocean Energy Management*
1:00 p.m.	Closing and Information for Next Webinar *Lillie Ghobrial	WETO*

United States Coast Guard

Introduction to Marine Navigation Radar and Potential Offshore Wind Turbine Impacts

Navigation Radar Studies Overview

WTRIM Offshore Wind Turbine Radar Interference Mitigation Webinar Series

July 13, 2020

Homeland Security

BACKGROUND - OBJECTIVES

- Promote and Maintain a Safe, Secure, Efficient Environmentally Sound, and Resilient Marine Transportation System (MTS)
- Ensure Safe and Efficient Navigation Routes to and from US Major Ports
- Ensure a Safe, Secure and Resilient Flow of National Defense and Commercial Vessels - Vital to Both Our Nation's National and Economic Security
- Balance Competing Interests Offshore, e.g.., MTS, Wind Farms and Other Renewable Energy Installations (OREI), Fishing, Recreation, Tourism, etc.
- Protection of
  - All Mariners
  - Property (Wind Farm(s) or Other Structures/Equipment)
  - Environment

HISTORY

- In 2007 – Coast Guard Became Aware That OREIs May Affect Performance Of Electronic Navigation Systems (Black Boxes In The Bridge Suite)
- Developers as part of their Navigation Safety Assessment should provide researched opinion of a generic and, where appropriate, site specific nature concerning whether or not: Structures Could Produce Radio Interference such as:
  - Shadowing, Reflections Or Phase Changes, With Respect To Any Frequencies Used For: Aviation
  - Marine Positioning
  - Navigation, or
  - Communications, including
  - Automatic Identification Systems (AIS), Whether Ship Borne, Ashore, Within Aircraft, Or Fitted To Any Of The Proposed Structures.

HISTORY

- Structures Could Produce Radar Reflections, Blind Spots, Shadow Areas or Other Adverse Effects:

  - Vessel To Vessel;
  - Vessel To Shore;
  - Vessel Traffic Service Radar To Vessel;
  - Radio Beacons (RACONS) To/From Vessel;
  - Aircraft and Air Traffic Control.

NAVIGATION STUDIES OVERVIEW

- 2008 - Cape Wind Project – Coast Guard Conducted a Workshop Where Marico and Dr. Brookner Presented Their Studies To Date.
- Neither Study Fully Evaluated the Impact of Actual Wind Turbines Proposed for Cape Wind.
- Coast Guard then Commissioned a separate Study –
  - Technology Service Corp. (TSC)
  - No Actual Built U.S. Windfarms to Study
  - TSC Did Simulations Of Scenarios Using Input From:
    - Marico Study
    - Brookner Study
    - North Hoyle Study (UK)

      - Findings – Visible And Noticeable –
      - Mitigations Needed

NAVIGATION STUDIES OVERVIEW

- *Results of the Electromagnetic Investigations and Assessments of Marine Radar, Communications and Positioning Systems Undertaken at the North Hoyle Wind Farm* by QinetiQ and the Maritime and Coast Guard Agency (MCA), November, 2004
- *Assessment of Likely Effects on Marine Radar Close to and within the Proposed Nantucket Sound Offshore Wind Farm* by Marico Marine August, 2008
- *Deleterious Effects of Cape Cod Proposed Wind Farm on Marine Radars* by Dr. Eli Brookner March 2008
- *Report of the Effect of Radar Performance of the Proposed Cape Wind Project* by Technology Services Corporation (TSC) December, 2008
- *Investigation of Technical and Operational Effects on Marine Radar Close to Kentish Flats Offshore Wind Farm* by Marico for the British Wind Energy Association (BWEA) April 2007
- DOE Study - *Assessment Of Offshore Wind Farm Effects On Sea Surface, Subsurface And Airborne Electronic Systems Final Report De-ee0005380* – University of Texas, September 30, 2013
- *Effects of wind farms on radionavigation and communications – trials report* by the General Lighthouse Authorities, April 2004
- *Effects of wind turbines on Maritime Radio Navigation and Communications Systems – Study ,* by the General Lighthouse Authorities, May 2004

TSC SUMMARY OF RESULTS

- Wind farms do have an effect on radar navigation.
- Difference between target being visible and that target being noticeable.
- Targets outside easily detected. Targets inside compete with false targets.
- More wind turbines the greater the number of potential false targets. Very small percentage of reflections result in blips.
- Secondary reflections occur past the opposite side of the wind farm… cannot occur within the first 1/3 nautical mile past any wind turbine.
- The spreading in cross range of the of the signal from the turbines due to sidelobes/beamwidth also decreases with decreasing distance to the radar.
- Mitigations could include reducing the radar cross section (RCS) of the turbines, and increasing RCS of a vessel in a farm.

UNIVERSITY OF TEXAS SUMMARY OF RESULTS

- Marine radars and ocean monitoring HS sensors may experience interference under certain proximity and operating conditions as a result of a wind farm's configuration.
- A more thorough assessment on individual systems may be made by combining results of the UT study with system-specific information.

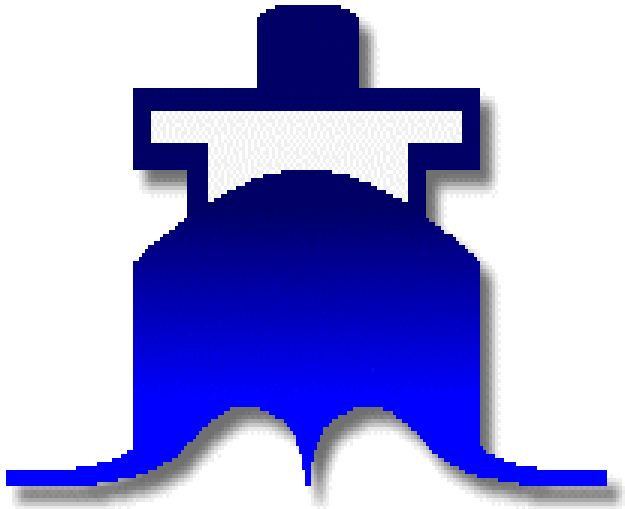
TODAY

- Block Island Wind Farm (5 Turbines) Linear – Inside 3 Nm
- Assessment of the Impact of the Proposed Block Island Wind Farm on Vessel Radar was conducted by QinetiQ, August 2015
- Grimsby Trip: Provided real time experience on a vessel in a wind farm
- Viewed radar and AIS screens
- Real time traffic in/around existing wind farms
- BOEM
  - Study of potential impact of wind turbines on vessel radar systems and potential mitigation
  - 15 Active Leases – 21 GW Potential
  - Massachusetts To North Carolina
  - More Areas Being Considered – NY Bight
  - 1.7 Million Acres
  - Construction To Commence In 2020 And Beyond
  - Developers to provide impact info in their Navigation Safety Risk Assessments

WHAT'S NEEDED

- Navigation Safety Risk Assessments - Developers
- New / Updated Study(ies) by Developers and Appropriate Government Agencies including Europe.
- Simulations based on actual wind farms. Especially those with larger wind turbines.
- Mitigation Measures development such as standard array
- Radar manufacturers develop radars that would be impacted minimally if not at all by wind farms.

QUESTIONS?



George.H.Detweiler@uscg.mil
202.372.1566

Orsted U.S. Offshore Wind

PUBLIC

Presentation to the Federal Interagency Wind Turbine Radar Interference Mitigation Work Group (WTRIM)

13 July 2020

Edward G. LeBlanc

Northeast U.S.

Marine Affairs Manager

Ørsted

Marine (Vessel) Radar

Radar Mitigation and US Offshore Wind Development

- Significant issue among certain class of vessels in U.S. (E.g., commercial fishing vessels)
  - Not such an issue in UK or EU?
  - The radar impact of one wind farm is just that—one wind farm. Impacts will differ.
  - Pre-construction modeling and post-construction studies both arrive at the same conclusion:
    - Where there may be impacts, effective mitigations are available
  - **Though Coast Guard states it "is it not aware of an authoritative scientific study that confirms or refutes the concerns that WTGs will degrade marine radar."**

- **Challenges:**
  - **Clutter**
  - **Saturation**
  - **Shadowing**
  - **Time / distance**

Race Bank

- 91 turbines
- 6 MW
- Siemens
- Water depth 6 to 24m
- Min. separation between towers 726m
- Min. separation of 630m quoted in consent

The project has a capacity of **573** MW

This means it will provide enough power for around **500,000** homes!

SIMRAD

11:15:20 19.2m

4G-049A
3 NM
HU
RM

G 44
S 0(Sh
R 0

IR High Th 40%
TE On Boost High

MARKERS
VRM1 VRM2
EBL1 EBL2

GUARD ZONE 1 GUARD ZONE 2
Off Off

AIS VESSEL
CHANNEL CHIEFTAIN 7 safe
SOG 3.10 kn COG 176 °T
CPA 1.19 NM TCPA 0:00:40
RNG 1.21 NM BRG 200 °T

AIS VESSEL
A2B COMFORT safe
SOG 14.00 kn COG 324 °T
CPA 3.04 NM TCPA PAST
RNG 3.92 NM BRG 263 °T

AIS VESSEL
236669000 safe
SOG 12.10 kn COG 294 °T
CPA 4.37 NM TCPA 0:02:27
RNG 4.57 NM BRG 49 °T

SOG kn
20.5
DEPTH m
19.3
TIME
11:15:20
POS
N 53°20.176'
E 0°43.989'
STW kn

BARO mb
1013.7
OUTSIDE °C
20.00

VESSEL CONTROL
MERCURY

Race Bank

- 91 turbines
- 6 MW
- Siemens
- Water depth 6 to 24m
- Min. separation between towers 726m
- Min. separation of 630m quoted in consent

The project has a capacity of **573** MW

This means it will provide enough power for around **500,000** homes

Marine (Vessel) Radar Studies

Radar Mitigation and US Offshore Wind Development

- **Kentish Flats, 2007**
- **U.S. Coast Guard Cape Wind, 2008**
- **University of Texas Austin**
- **Various Developer Studies**

- **All identified essentially the same issues**
- **All identified essentially the same mitigations**

Marine (Vessel) Radar Studies

Radar Mitigation and US Offshore Wind Development

–Mitigation Options:

- **Operational**
  Training
- **Modification**
  Antenna Location
- **Addition**
  Radar features (ARPA, AIS)
- **Replacement**
  New generation pulse compression radars

Q&A

Edward G. LeBlanc
U.S. Northeast
Marine Affairs Manager
EDWLE@orsted.com
978.447.2737

Ørsted

Marine Navigation Radar: Mariners' Perspectives

WTRIM webinar July 13, 2020

Fishing Industry Panelists

Capt Tom Dameron

- Surfside Foods, LLC
- Overboard Solutions
- RODA Board member

30 years on the water, USCG 1600-ton Master's License, extensive experience in the surfclam and ocean quahog fisheries

Capt Eric Hansen

- Hansen Scalloping Inc,
- F/V Endeavor, F/V Intrepid
- RODA Board member

28 years on the water, 40 years in the scallop industry, sits on numerous fisheries and offshore wind workgroups

- Radar is a vital navigation component for safety at sea. Captains of fishing vessels need to be able to maneuver their vessels in the worst of conditions and to be able to navigate "blind", when there is no visibility at night, due to bad weather, or dense fog.
- As required by regulation, all fishing vessels maintain a proper radar lookout by radar (if available on board) to obtain early warning of risk of collision. Captains use radar to get the information of vessel movements and the risk of collision tracking bearing, distance, CPA (closest point of approach), and TCPA (time of closest point of approach) for all other traffic in the vicinity.

- The X band marine radar antenna used on most all fishing vessels radiates a narrow vertical fan-shaped beam of microwaves perpendicular to the long axis of the antenna, horizontally out to the horizon.
- The fan-shape is typically only 1 - 2 degrees (depending on the antenna size) Azimuth or horizontal and 25 - 30 degrees Altitude or vertical.
- This beam shape allows a vessel to pitch and roll in a sea and still put enough beam energy on a target to get a return of microwaves reflected from them, generating a picture of the ship's surroundings on the radar display screen.
- Generally surface vessels reflect microwaves back to the antenna, displaying on the radar screen, somewhat relative to their size.

- The exception to this are objects that cover a large vertical area. Because of a radar's narrow vertical fan-shaped beam, a wind energy generator, with heights of 850+', reflect microwaves back to the antenna at energy levels the radar wasn't designed to properly analyze and display.
- These are high energy returns
- Because of the high energy return, microwaves reflected off of vessel structure and are picked up by the radar receiver and displayed as a target an equal distance but different bearing from the actual obstacle.
- This leads to the potential for shadowing, false echoes and increased propagation of turbine signals
    - **All of these results will increase risk for the mariner and impact navigational safety**

Concerns in a wind farm

Overwhelming amount of information on a screen

- 6 mile range = 112 turbines spaced at 1nm
- Masking of other vessels and potential hazards in the area such as recreational boaters, sailboats, etc.
- Radar needs to discern all targets at all times ranging in size from turbines to fixed fishing gear buoys

Technology limitations:

- Radar units on fishing vessels less advanced than in other sectors
- Fishermen are not radar experts, learn on the job
- Limited positions for antenna placement

UK Thanet Offshore Wind Farm

This radar is set to 1.5 mile range. There were no other vessels in the vicinity.

Additional considerations

Moving targets and radar signals:

- Radar signal bouncing of moving blades
  - Experience of SAR helicopters showing up as large signals

New technologies:

- Limited studies from Europe and Cape Wind demonstrate impacts; what about for newer, bigger turbines?
- Potential of Pulse Compression radar

Panelists

Lillie Ghobrial
Wind Energy Technologies Office

Edward G. LeBlanc
Ørsted, U.S. Northeast

Angel McCoy
Bureau of Ocean Energy Management
U.S. Department of the Interior

George Detweiler
U.S. Coast Guard

Capt Tom Dameron
Surfside Foods, LLC
Overboard Solutions
RODA Board member

Capt Eric Hansen
Hansen Scalloping Inc,
F/V Endeavor, F/V Intrepid
RODA Board member

Questions or Comments?

Send additional questions to: Lillie.Ghobrial@ee.doe.gov

Future Wind-Radar Webinar Agenda & Information

July 27, 2020

Oceanographic High Frequency (HF) Radar Impacts and Mitigation Efforts- NOAA IOOS

- *HF radar missions, past mitigation efforts*
- *Technical and operational issues regarding offshore wind turbine impacts*
- *Mitigation Solutions*
- *Register by July 24*

August, 2020

Air Surveillance Radar/Air Traffic Control

- *Technical and operational issues regarding each system in an OSW environment*
- *State of Current Understanding*
- *Mitigation Options*

TBD, Fall, 2020 (TBD)

Forward Looking Research & Collaboration and Government/Industry Roundtable

Webinar Information (Past & Future) is on the DOE Website:

https://www.energy.gov/eere/wind/articles/offshore-wind-turbine-radar-interference-mitigation-webinar-series

Submit Your Questions & Input

Lillie.Ghobrial@ee.doe.gov

Backup Slides

Offshore Wind Technologies Market Report: Summary

- The U.S. offshore wind energy project development and operational pipeline grew to an estimated potential generating capacity of 25,824 megawatts (MW), with 21,225 MW under exclusive site control
- Four U.S. regions experienced significant development and regulatory activities
- State-level policy commitments accelerated, driving increased market interest
- Increased U.S. market interest spurred strong competition at offshore wind lease auctions
- Several U.S. projects advanced in the development process
- Industry forecasts suggest U.S. offshore wind capacity could grow to 11–16 gigawatts by 2030
- Offshore wind interest accelerated in California
- New national R&D consortium aims to spur innovation
- Global offshore wind annual generating capacity installed in 2018 set a new record of 5,652 MW
- Industry is seeking cost reductions through larger turbines with rated capacities of 10 MW and beyond
- Floating offshore wind pilot projects are advancing
- *2018 Offshore Wind Technologies Market Report*.

LCOE forecasts for offshore wind indicate fixed bottom wind may be near $50/MWh and floating wind may be as low as $60 MWh by 2032 (COD)

Additional Resources

2018 Wind Market Reports

- 2018 Offshore Wind Market Report
- 2018 Wind Technologies Market Report

WINDExchange Wind Turbine Radar Interference

- Wind Turbine Radar Interference Mitigation Fact Sheet
- All public OSW-Radar Summaries
- Federal Interagency Wind Turbine Radar Interference Mitigation Strategy

American Wind Energy Association

Bureau of Ocean Energy Management Renewable Energy Fact Sheet