U.S. DEPARTMENT OF ENERGY

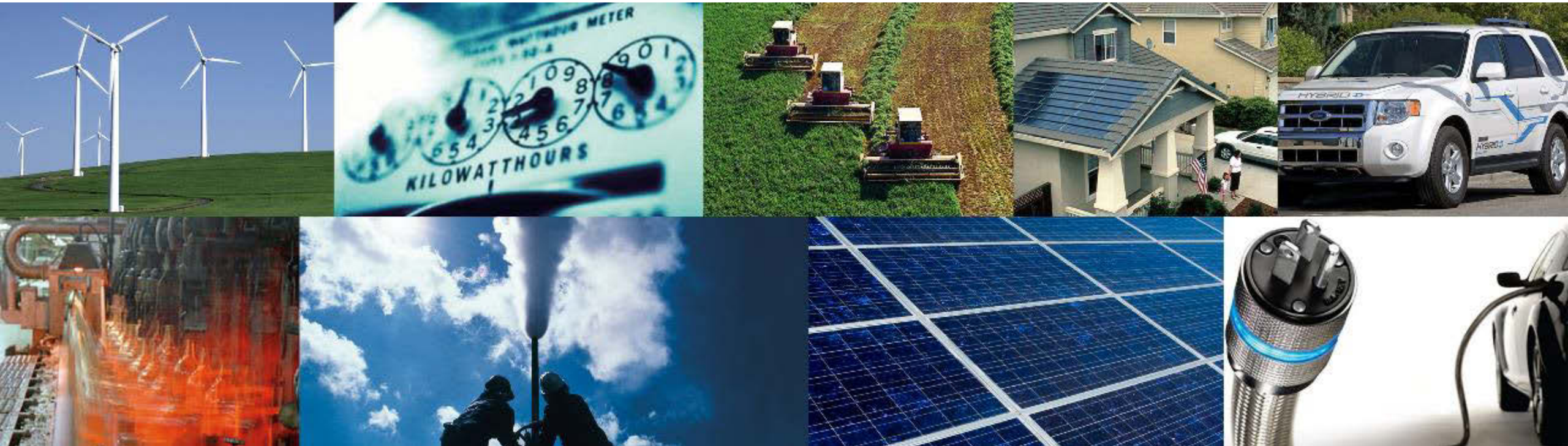
Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Offshore Wind Turbine Radar Interference Mitigation (WTRIM) Webinar

#1 of a Series of Technical Interchange Meetings (TIMs)

Patrick Gilman, DOE Wind Energy Technologies Office

April 20th, 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.

20 April Agenda – Webinar #1

Monday, April 20, 2020	
11:00 a.m.	**Welcome, Workshop Objectives, and Background** Speaker: Patrick Gilman | U.S. Department of Energy Wind Energy Technologies Office (WETO)
11:10 a.m.	**Wind Turbine Radar Interference Mitigation (WTRIM) Working Group and Offshore Wind Research Priorities** Speakers: Patrick Gilman | WETO Steve Sample | DOD Military Aviation and Installation Assurance Siting Clearinghouse
11:30 a.m.	**Industry Perspective on Offshore Wind Turbine Radar Interference Mitigation in the EU/UK** Speakers: Daniel Mortensen and Hywel Roberts | Ørsted Joe Bryan | Muswell Orange, LLC
12:40 p.m.	**Q&A** Moderator: Patrick Gilman | WETO
1:00 p.m.	**Closing and Information for Next Webinar**

Future OSW TIM Engagements in the Series (High-Level Agenda)

Monday, May 18, 2020 (Webinar)

- *Offshore Wind Project Review and Approval Process in the U.S. from the WTRIM Perspective*
- *State of Understanding of U.S. Offshore WTRIM Issues from an Agency Perspective Part 1*

Monday, June 15, 2020 (Webinar)

- *State of Understanding of U.S. Offshore WTRIM Issues from an Agency Perspective Part 2*
- *State of Understanding of Offshore WTRIM Issues from a Civil Perspective (TBD)*

TBD, Fall, 2020 (TBD)

Forward Looking Research & Collaboration Gov't-Industry Roundtable

Submit Your Input

We are taking feedback and future webinar topic suggestions

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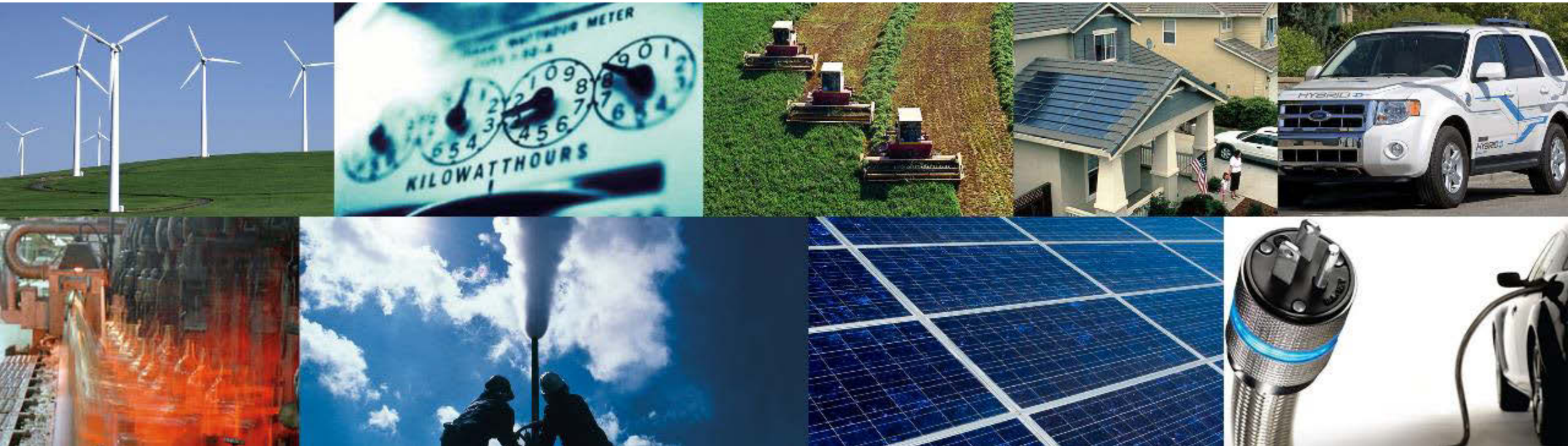
Wind Turbine Radar Interference Mitigation Working Group and Offshore Wind Development

Patrick Gilman, DOE Wind Energy Technologies Office

Steve Sample, DOD Military Aviation and Installation Assurance Siting Clearinghouse



Wind Energy Technologies Office (WETO)

The U.S. Department of Energy's (DOE's) Wind Energy Technologies Office (WETO) invests in energy science research and development (R&D) activities that enable the innovations needed to advance U.S. wind systems, while continuing to address market and deployment barriers, including siting and environmental impacts. WETO is dedicated to driving down the cost of wind energy with more efficient, more reliable, and more predictable wind energy systems

What We Do

- WETO's research and development activities are aimed at improving performance, lowering costs, **and reducing market barriers** for U.S. wind energy.

- The Office works with national laboratories, industry, universities, and other agencies to conduct R&D activities through competitively selected, directly funded, and cost-shared projects. Our efforts target both land-based and offshore wind power at the utility scale as well as systems on the distribution side, and focus on novel research not being undertaken by the U.S. wind industry due to perceived cost, risk, or focus on near-term investment returns.

More wind deployment could mean increased radar interference and we remain proactive to ensure peaceful co-existence of radar near wind development

WTRIM Working Group

Purpose of the Wind Turbine Radar Interference Mitigation (WTRIM) Working Group

- **Purpose** – Mitigate the technical and operational impact of wind turbine projects on critical radar missions
- The interagency Memorandum of Understanding (MOU) establishes a general framework of cooperation and coordination between DOD, DOE, FAA, NOAA, BOEM, and DHS

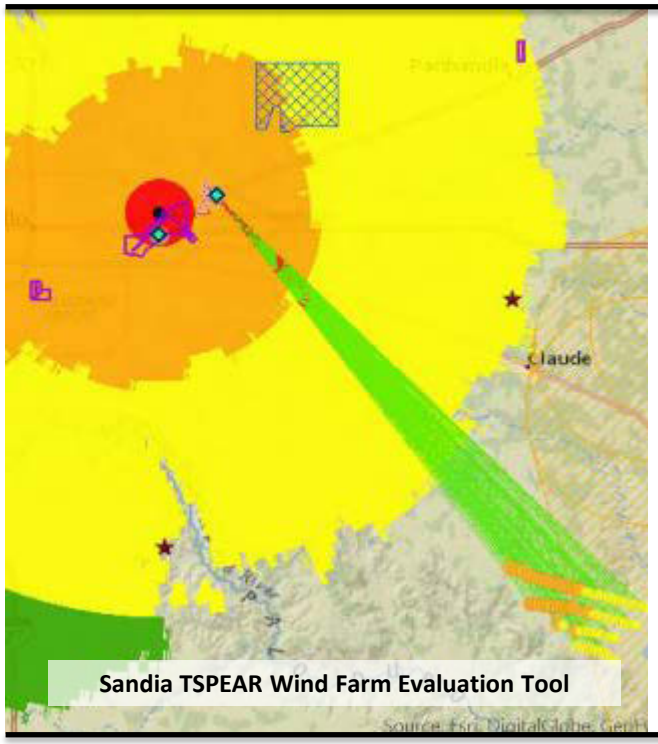
MOU Goals

- Develop near (5 years), mid (10 years), long-term (20 years) mitigation solution recommendations
- These will be primarily technology driven; can extend to policy and legislative proposals if determined as necessary
- Determine funding requirements to implement workable solutions

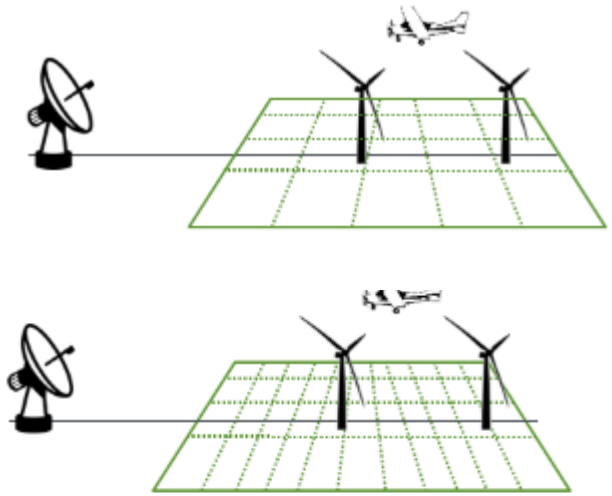
Updating & Extending the MOU in 2020

Federal WTRIM Strategy

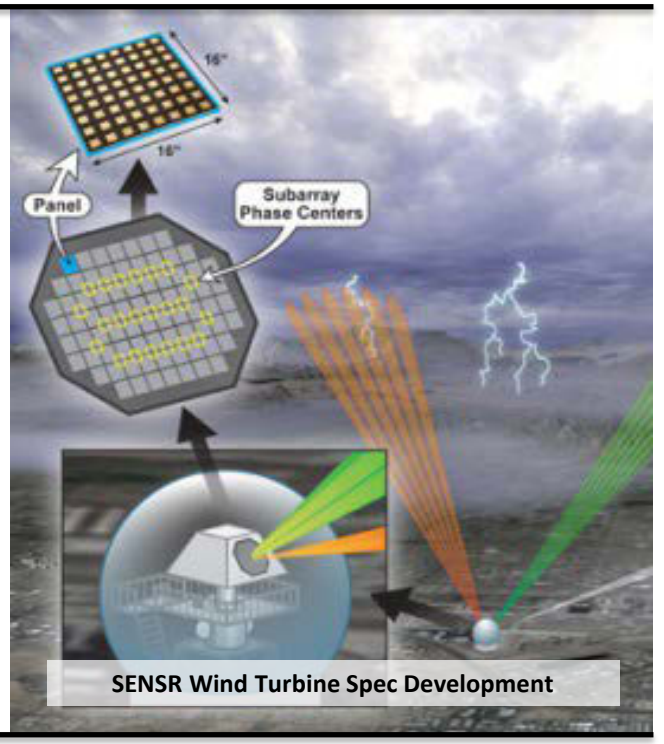
Strategic Objectives: Eliminate wind turbine radar interference as an impact to critical radar missions, ensure the long-term resilience of radar operations in the presence of wind turbines, and remove radar interference as an impediment to future wind energy development.



Sandia TSPEAR Wind Farm Evaluation Tool



MIT-LL Increased Range Resolution Demonstration



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

OSW Development and Wind Turbine Radar Interference

As offshore wind deployment continues to grow, it is expected there will be more potential for interference with existing radar systems

Key Findings of Recent OSW Studies

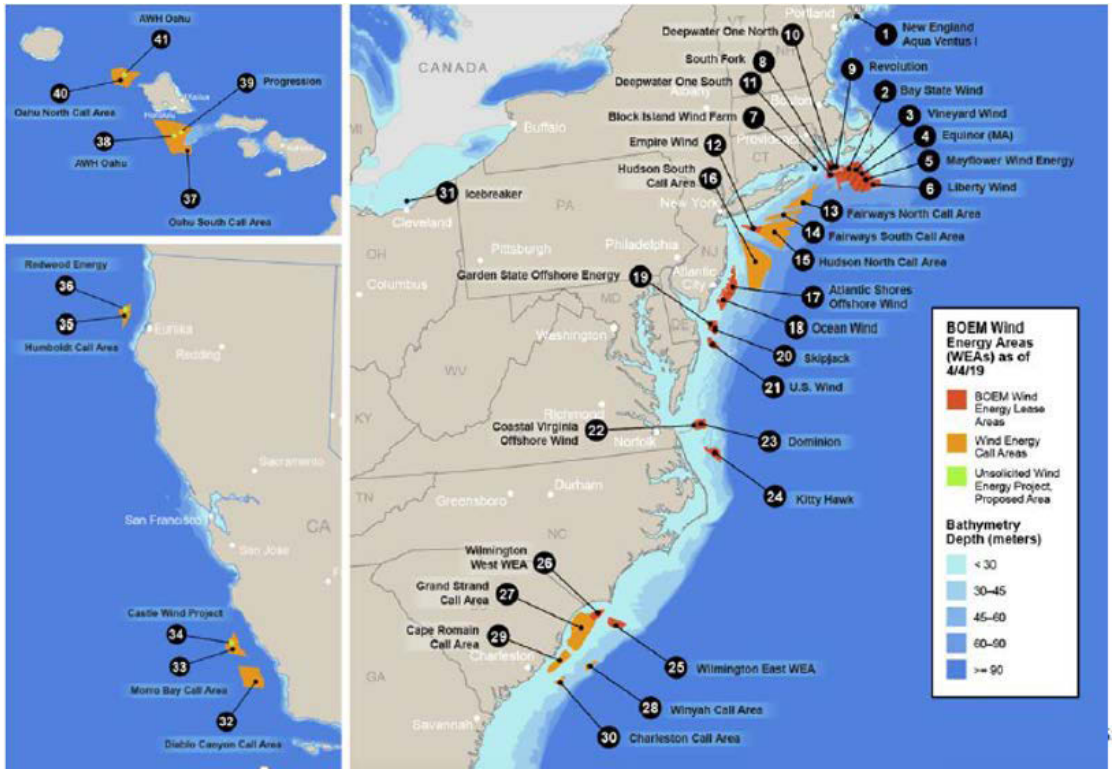
- Early WTRIM-funded studies indicated a potential for radar interference from offshore wind turbines (UT Austin study)
- Additional studies following installation of BIWF found real interference effects on HF and air surveillance radars (BOEM study and MIT LL study)
- Studies also identified mitigation areas to explore further (e.g., overlapping coverage [MIT LL study], signal processing techniques [BOEM study])

Resources: Offshore Wind Radar Reports

- *MIT LL Ground-based Coastal Air Surveillance Wind Turbine-Radar Interference Vulnerability Study*
  - Analyzed coastal air surveillance radar line-of-sight coverage for all BOEM offshore renewable energy lease areas and wind planning areas in 2017 and data from coastal radars near Block Island Wind Farm
  - Identified the coastal radar sites and types that are more likely to be impacted by offshore development and examined overlapping coverage from different radar systems for the BOEM offshore renewable energy lease areas and wind planning areas.
  - Reviewed several mitigation measures: network fusion, upgrades, infill systems, etc.
- BOEM's *Impact Assessment and Mitigation of Offshore Wind Turbines on High Frequency Coastal Oceanographic Radar*
  - Study done to understand the impact of these wind farms on the coastal HFR network
  - Realize potential techniques to mitigate the impact WTRI on core radar data products
- DOE's UTA *Assessment of Offshore Wind Farm Effects on Sea Surface, Subsurface and Airborne Electronic Systems*
  - Study performed to identify baseline WTRI impacts (electromagnetic and acoustical) to surface, subsurface & airborne electronic systems.

Offshore Wind Trends and Statistics

- 29,180 MW committed from 8 states by 2035 (and growing) with 13,956 MW committed by 2030
- Project developers aiming to have 13 projects totaling 9,112 MW operational by 2026
  - 176 projects installed world-wide thru 2018 (22,592 MW)
- Typical offshore turbines larger than land-based turbines
  - Currently tip heights up to 260m, 150-220m diameter rotors, capacity factor 40-50%
  - Fixed bottom support structures in shallow water (<50m) current East Coast projects
  - Floating support structures in transitional and deep water typical for West Coast
- Over $70 billion investment projected by 2030



- 15 Lease Areas in the U.S. giving developers exclusive site control (Dec 2018)
  - The COP review process, including NEPA regulations, provide opportunity for project specific review and analysis of potential impacts to radar systems and mitigation options
- BOEM has identified 13 Call Areas (Potential future wind energy areas under public review)
- Unsolicited lease applications are reviewed for a determination of competitive interest and any project under consideration by BOEM will be reviewed for potential impacts as described in regulations 30 CFR 585.203.

Offshore Technology is Evolving Rapidly

Currently Operating in European Projects

Vestas V164-9.5 MW Turbine

Total Height:	220 m (720 ft)
Rotor Diameter:	164 m (538 ft)
Blade Weight (each):	33 - 35 tons
Turbine Weight:	1,300 tons
Foundation Weight:	4,000 tons

Offshore turbines are massive machines that continue to grow in scale as the market matures

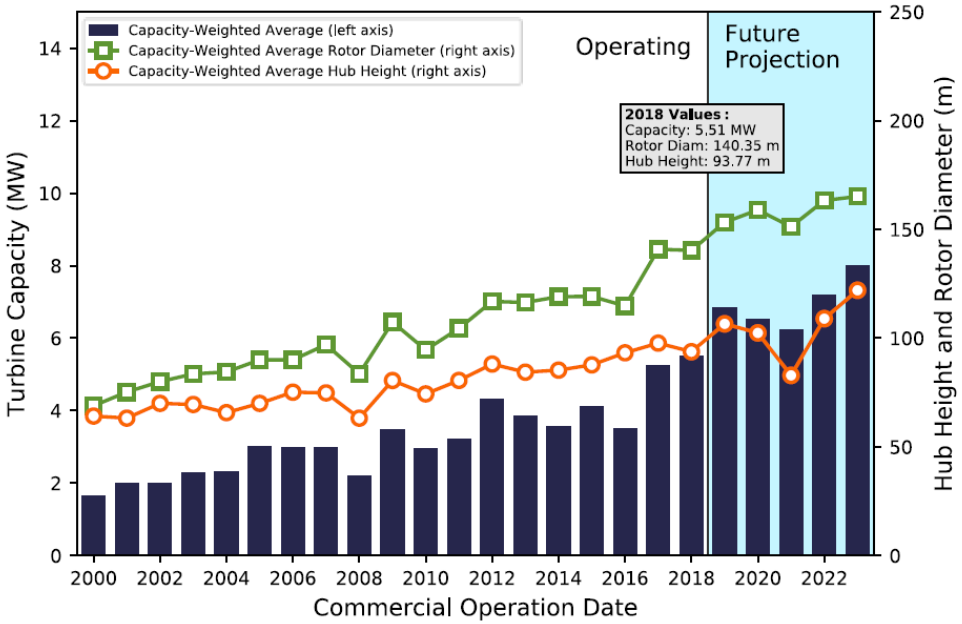


Figure 22. Offshore wind turbine rating, hub height, and rotor diameter

In Prototype Testing with U.S. Project Procurement Commitments:

General Electric 12 MW Haliade-X (for 2021/2022 Production)

Total Height: 260 m (853 ft)

Rotor Diameter: 220 m (720 ft)

Siting Clearinghouse

- **A Single DoD Voice**
  - Parallel multi-service review of energy projects
  - Timely, repeatable, predictable process
  - Support renewable energy where compatible with military missions
  - Oversight and coordination of mitigation process
  - Outreach and early consultation with industry, local, state, and Federal stakeholders

Siting Clearinghouse

Energy, Installations and Environment

Ron Tickle
Executive Director

Steve Sample
Deputy Director

The Team:

Karla Hodge- Executive Support and Website
Lou Husser – Technical Solutions
Mike Lignowski- Review Processes
Nathan Owens- Informal Reviews and Mapping
Dan Townes- State Engagement
Sandra Wimper- Funding

Siting Clearinghouse Functions

1. Review Projects
   - -Formal FAA project reviews
     - -Offshore Projects
2. Develop Technical Solutions
   - -Wind Turbine Radar Interference Mitigation Forum
   - -Coordinate DoD efforts
3. Organize DoD's Outreach
   - -Informal Reviews
   - -State Protections
   - -Industry Discussions

Government Offshore Wind Radar Equities

Department of Homeland Security (DHS)

- *Includes Customs and Border Protection; and Coast Guard*
- **Mission:** Homeland Security, Search and Rescue, Spill plume tracking,
- Coastal HF Coastal
- Terminal Radar

National Oceanic and Atmospheric Administration (NOAA):

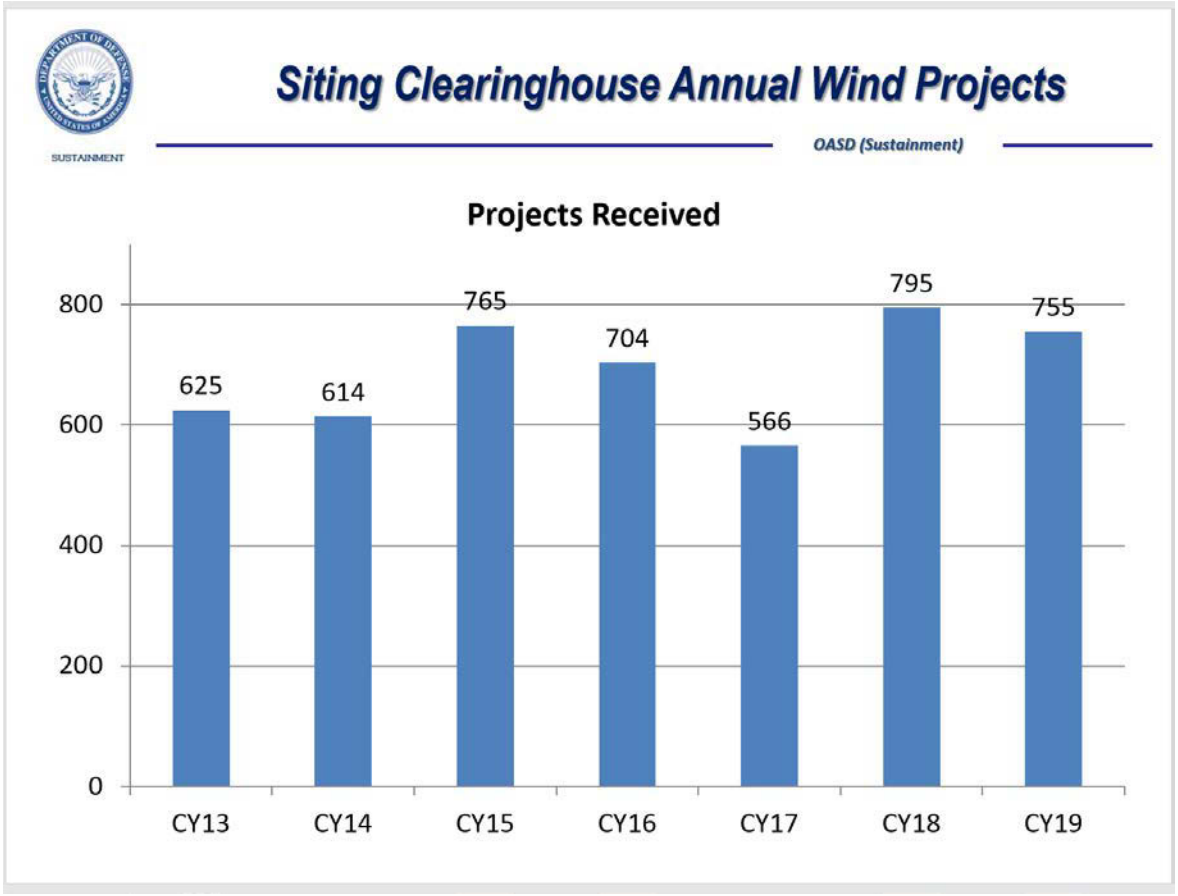
- *Includes U.S. Integrated Ocean Observing System (IOOS) and National Weather Service (NWS)*
- **Mission:** Weather observation, Surface Wave and Current tracking
- Coastal HF Radar
- NEXRAD

Federal Aviation Administration (FAA)

- **Mission:** Air Traffic Control, Surveillance, Flight Safety
- Terminal Radar
- Long-range Radar

Wind Turbine Compatibility with DoD Mission

- Radar Interference
  - Air Traffic Control
  - DoD Unique Radars
  - Testing Missions
  - Weather Radar (NEXRAD)
- Low-level Flight Obstruction
- Lighting (primarily NVG training)
- Missile Silo Impacts
- Security Concerns



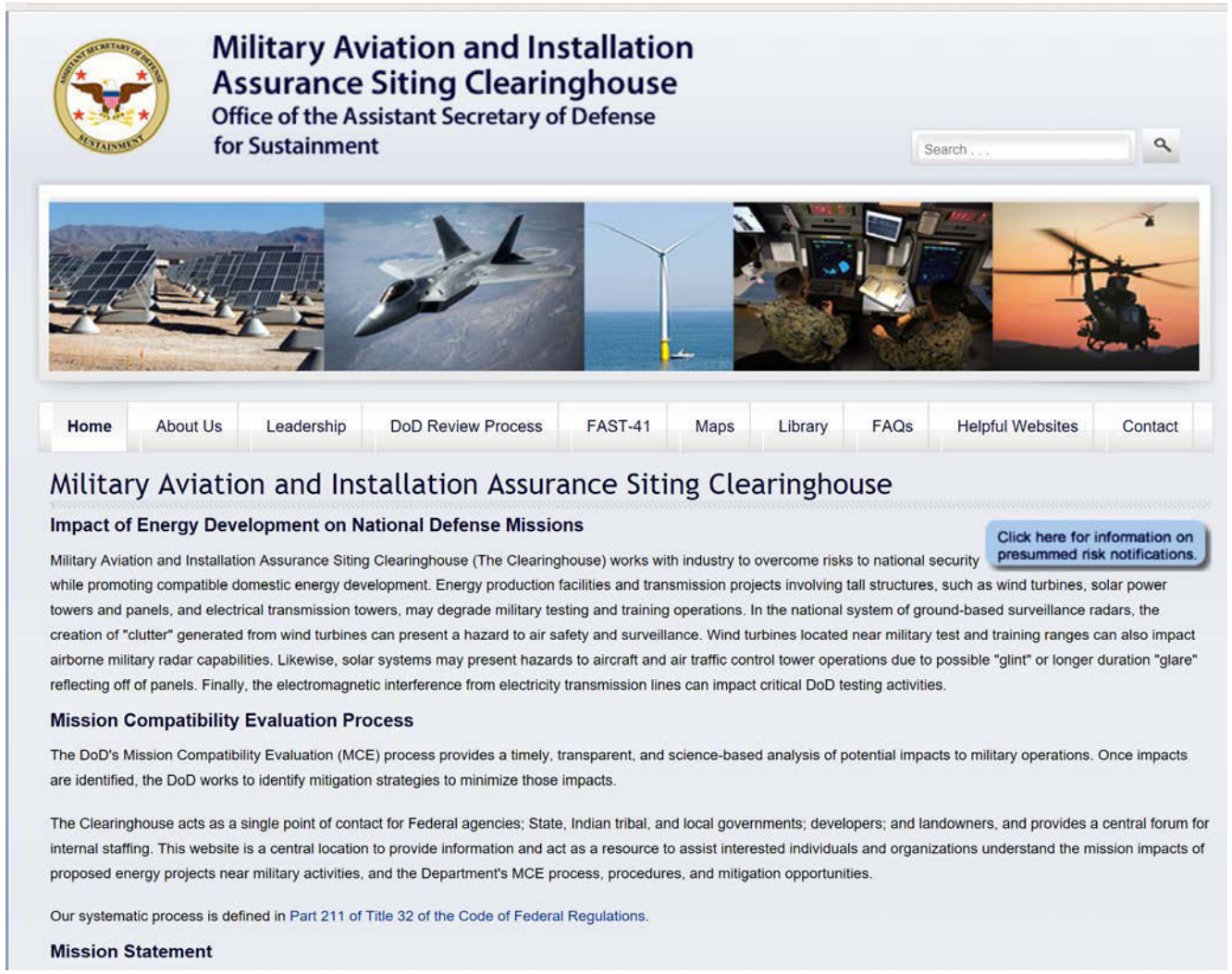
DOD Offshore WTRIM Drivers

- **Following are types of DoD managed radars that can prove vulnerable to offshore associated WTRIM**
  - Near-shore Military “terminal area” air traffic control radars
  - “Enroute” Air Traffic Control radars (in support of DoD, FAA)
  - Air defense long-range surveillance radars (CARSRs, DASRs,…)
  - Weather radars (NEXRAD)
  - Ground-based military unique radars (ADAMS, ROTHR, BMD)
  - Missile Tracking radars (Wallops Island, Cape Canaveral…)

- **Except for some specialized radars, WTRI vulnerability diminishes with distances over the horizon and absence of certain types of weather and sea-surface phenomenon**

Each lease site requires assessing

Siting Clearinghouse



https://www.acq.osd.mil/dodsc/

WTRIM information exchange webinar

A project developer's view

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Ørsted

Daniel Mortensen and Hywel Roberts
Webinar 20/04/2020

Agenda

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- Introduction to Ørsted (Hywel Roberts)
- Offshore wind / ATC radar interaction
  - UK overview
  - Civilian
  - Military
- Offshore wind / air defense radar interaction (Daniel Mortensen)

Permitting specialist

10 years offshore O&G

Ørsted since 2012

Ørsted

Ørsted: offshore wind global footprint and overview

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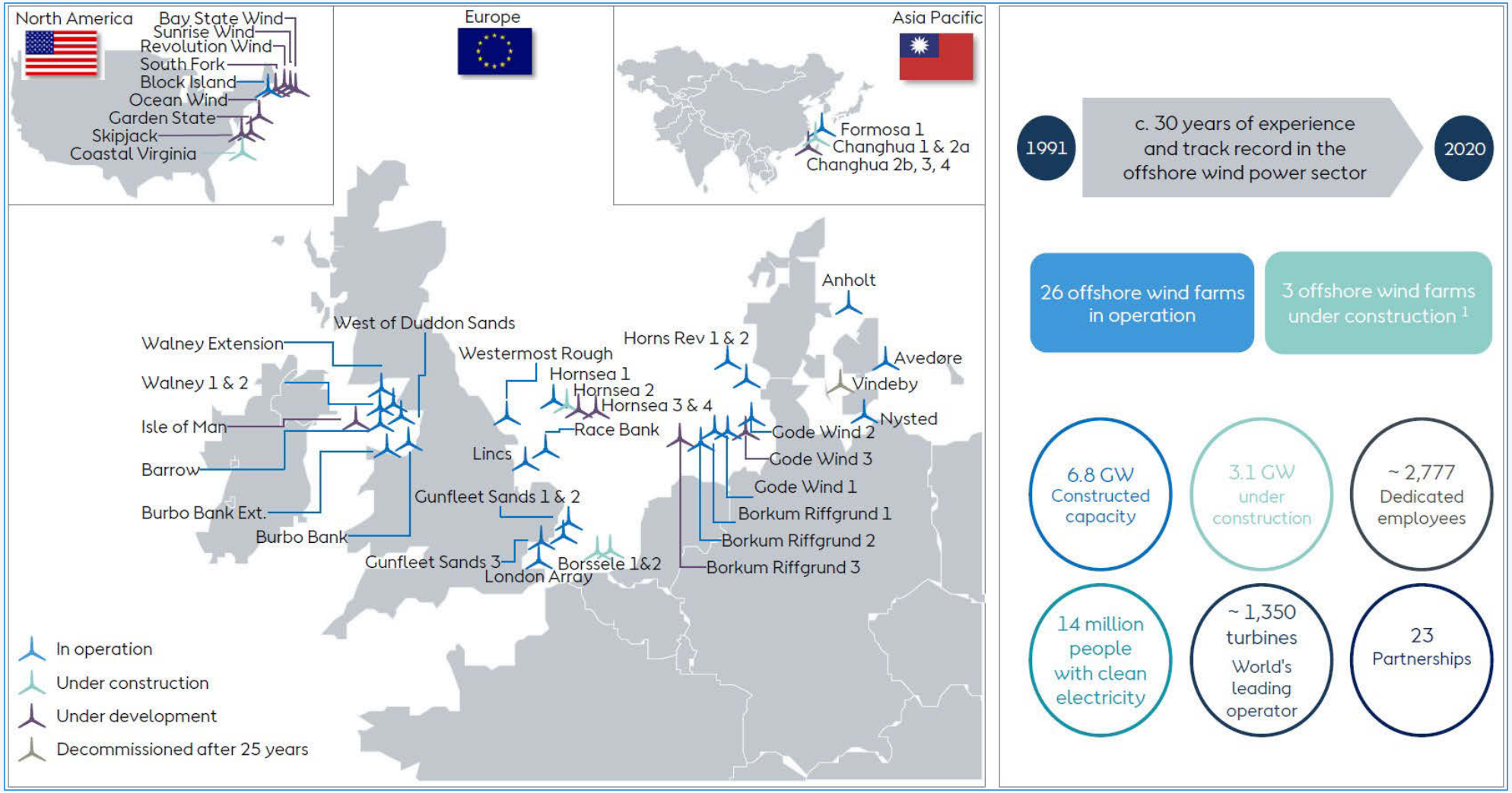

1991 — c. 30 years of experience and track record in the offshore wind power sector — 2020

26 offshore wind farms in operation

3 offshore wind farms under construction [1]

6.8 GW Constructed capacity

3.1 GW under construction

~ 2,777 Dedicated employees

14 million people with clean electricity

~ 1,350 turbines World's leading operator

23 Partnerships

Ørsted: share of global constructed and under construction capacity in gigawatts

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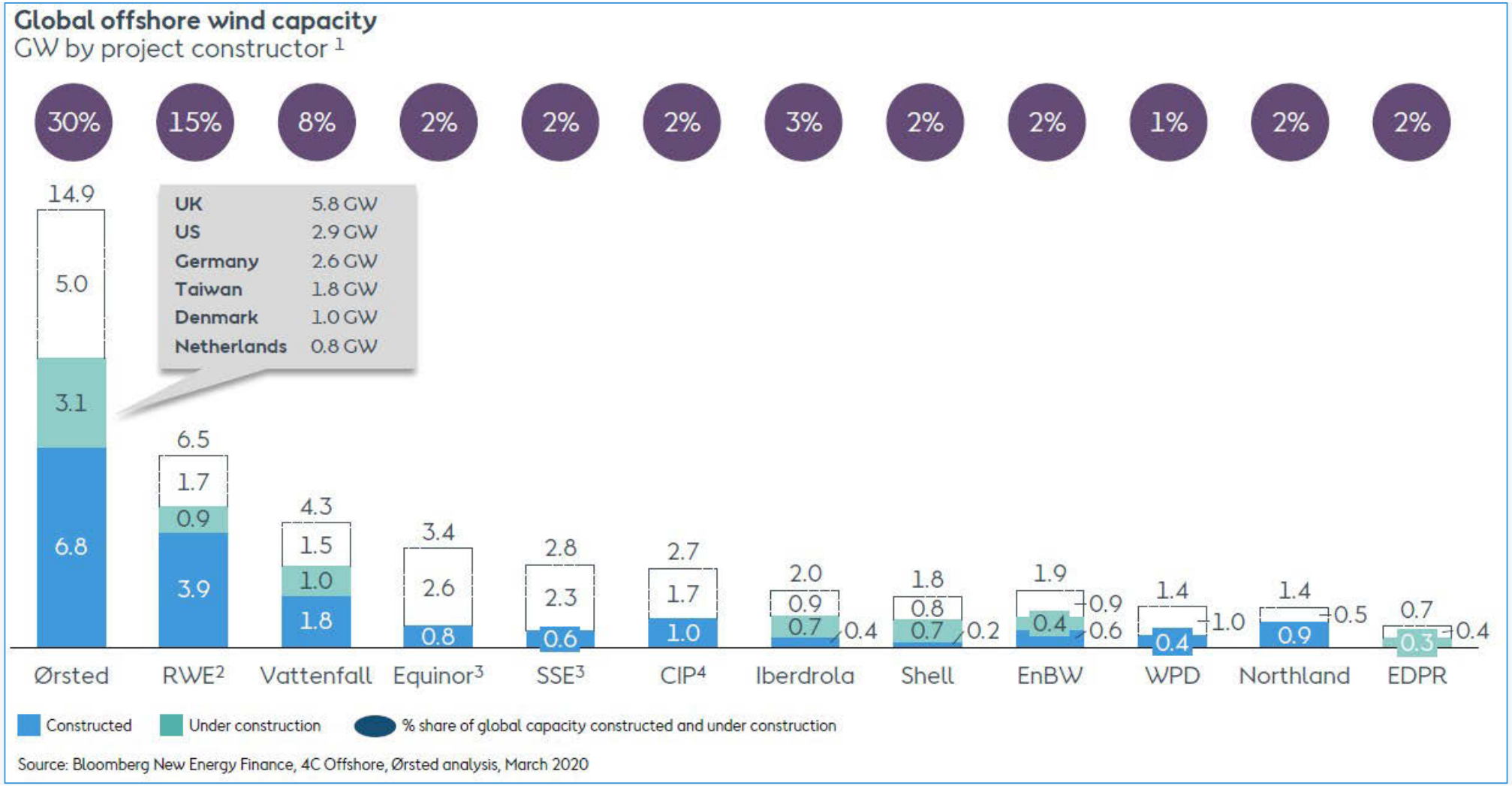

UK overview: wind farms

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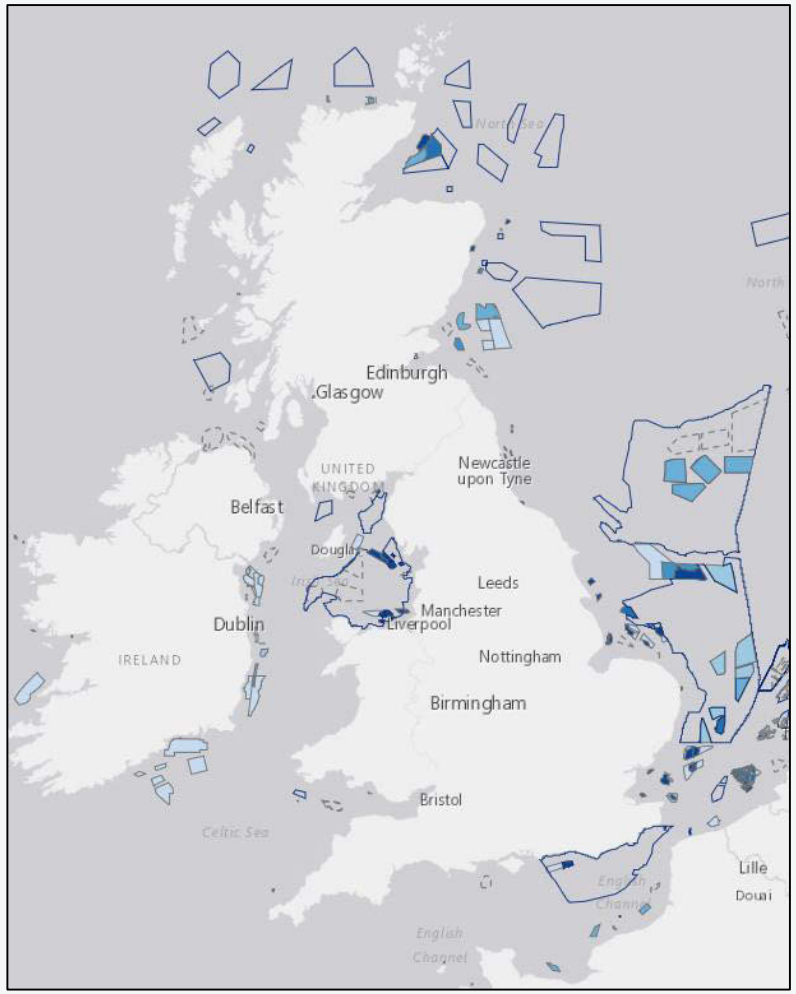
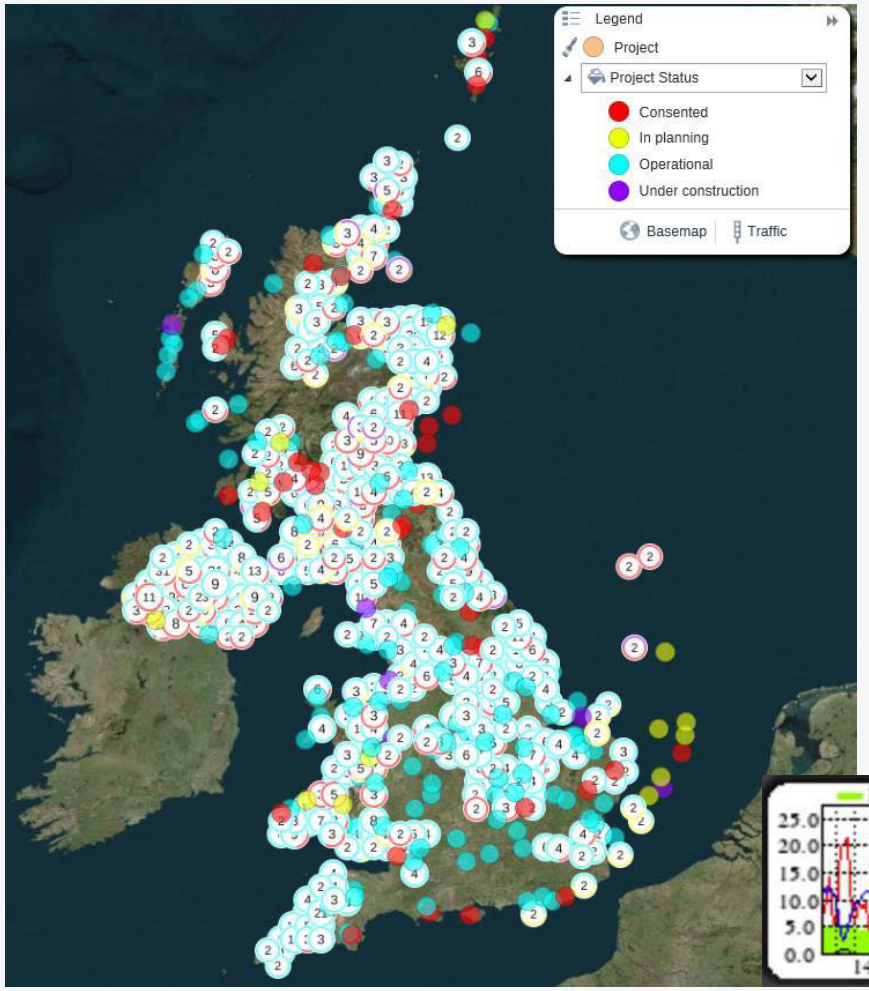
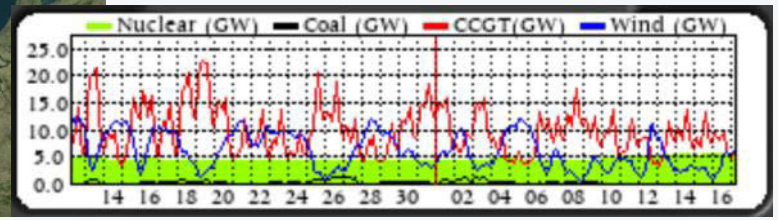




Onshore Wind Projects	
Turbines	8,588
Operational Projects	2,536
Operational Capacity	13.6 GW

Offshore Wind Projects	
Turbines	2,016
Operational Projects	37
Operational Capacity	8.5 GW



Source: http://www.gridwatch.templar.co.uk/

UK overview: overcoming challenges and achieving coexistence

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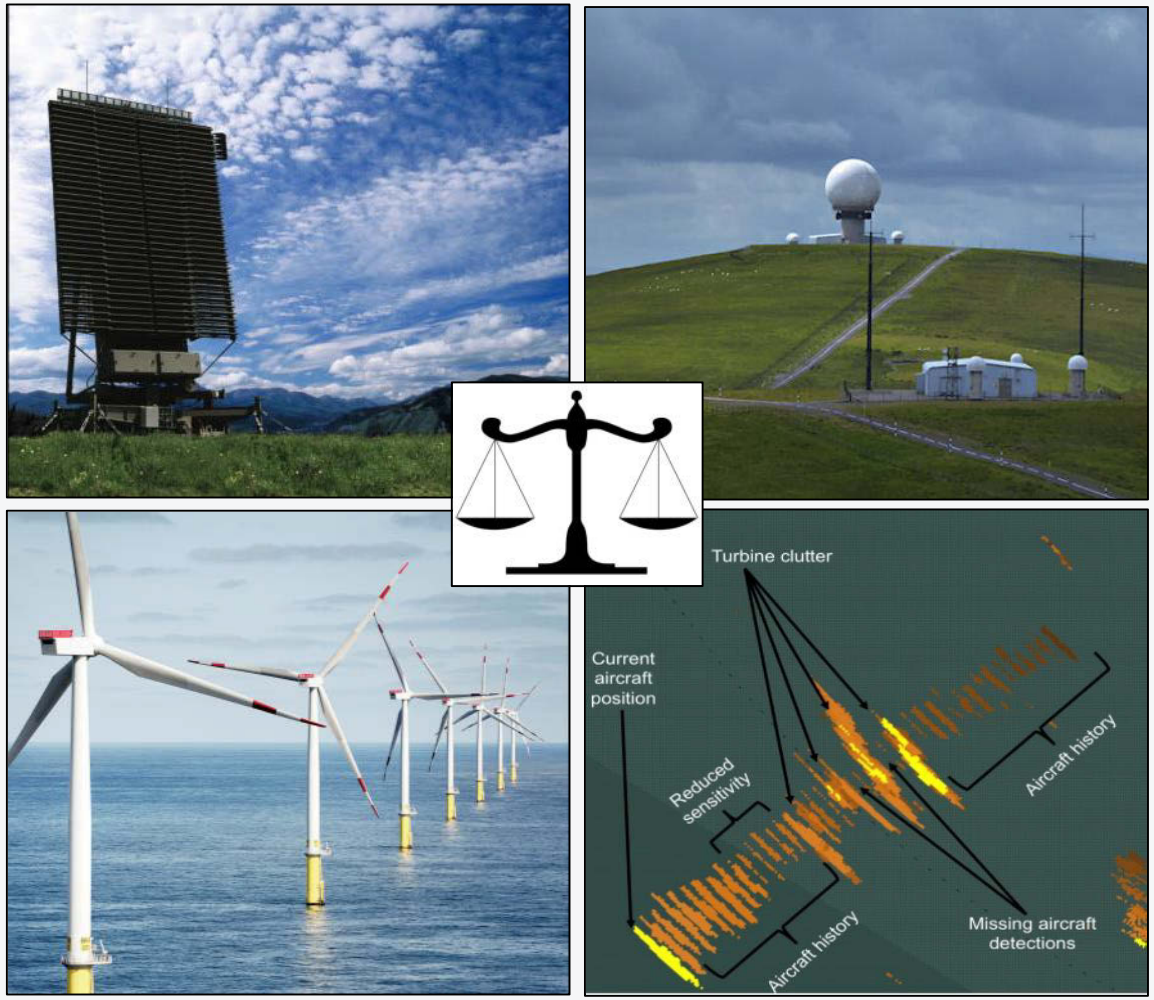
- Complex clutter, desensitisation and impairment of tracking function
- Co-existence requires credible mitigation options:
  - Operational
  - Technical
- Competing national policies (aviation, defence and energy) make this is a challenge for society
- Resolution can only be achieved with:
  - Early engagement
  - Cooperation
  - Collaboration



ATC interaction

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- Civilian
  - Liverpool Airport
  - NATS en-route radar
- Military
  - Technology demonstration
  - Warton Aerodrome

Civilian ATC: Liverpool John Lennon Airport

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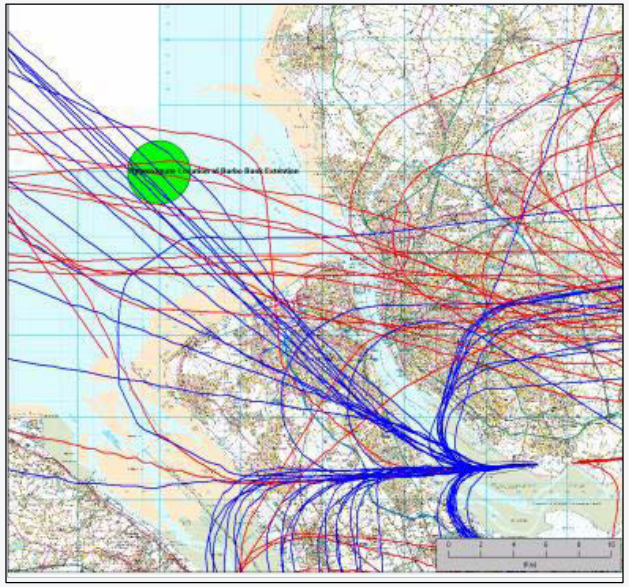
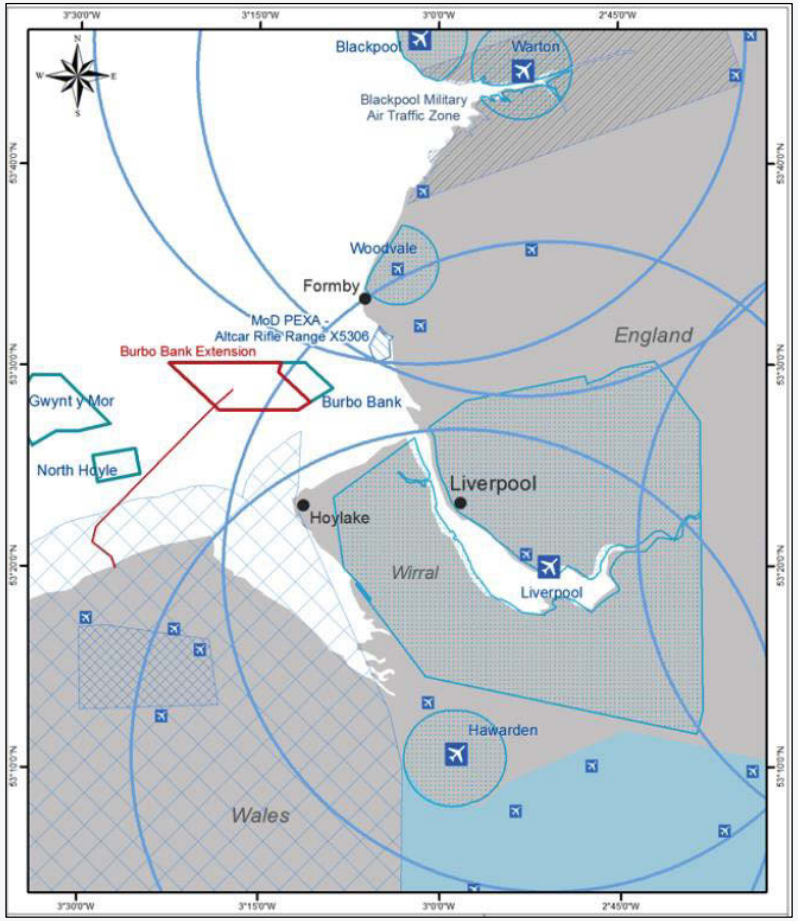
- Burbo Bank Extension
- Raytheon ASR 10 PSR
- Mitigation candidates:
  - Infill, blanking, upgrade





Radar System	Range (nm)	Percentage of boundary in LoS	Highest percentage LoS
Blackpool Airport	17.9	100%	92.8%
Hawarden Airport	19.0	77%	52.5%
Liverpool Airport	14.8	100%	89.3%
Manchester Airport	33.3	81%	23.9%
Warton Aerodrome	18.8	100%	93.4%

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Civilian ATC: NATS en-route radar

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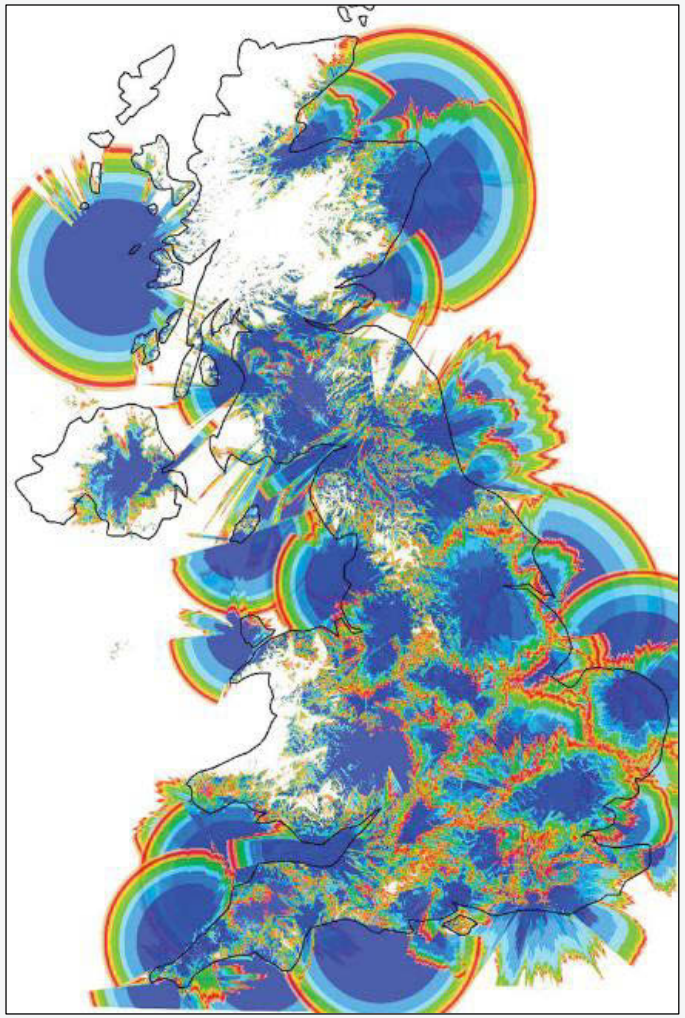

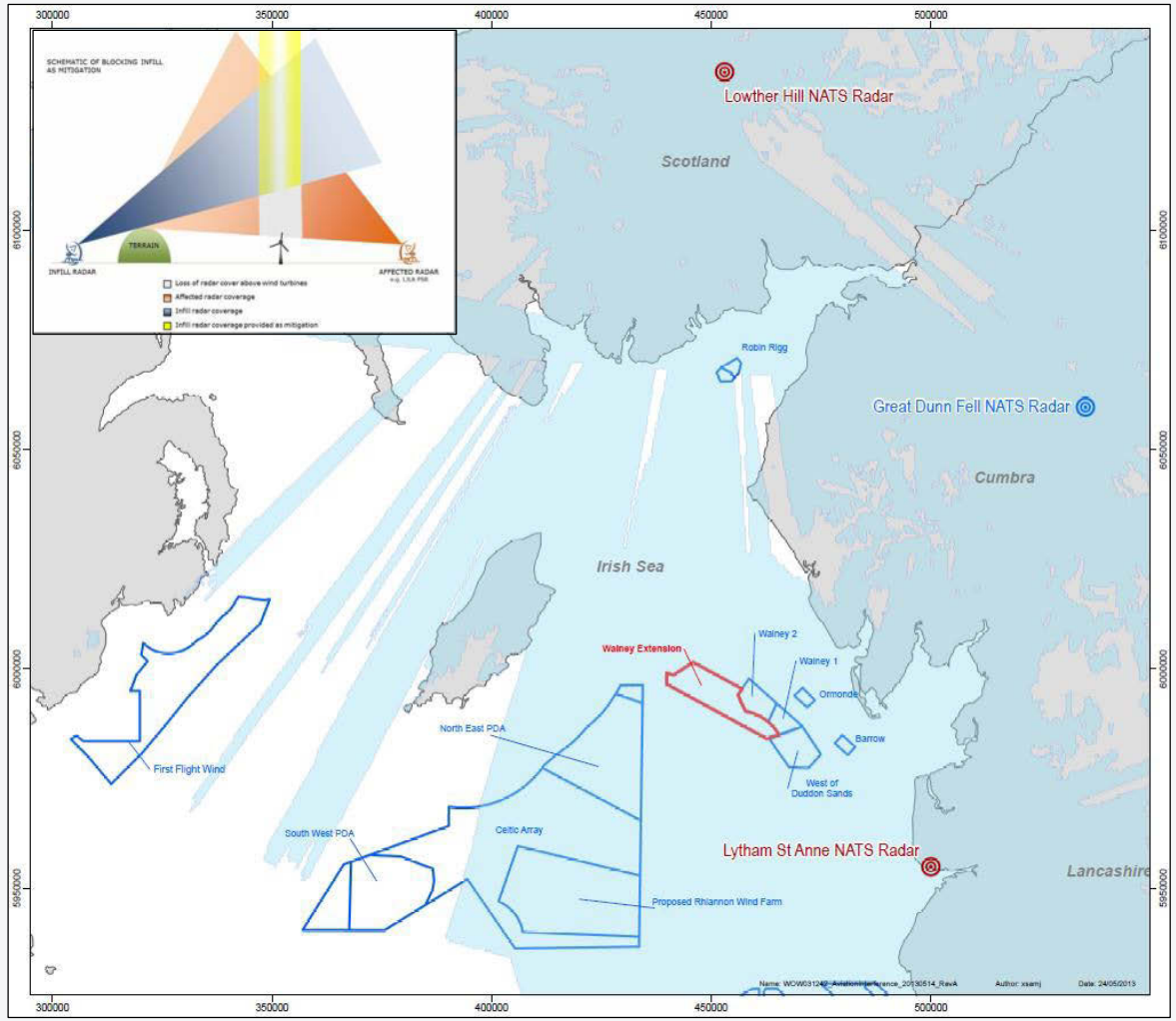

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Military ATC: Introduction

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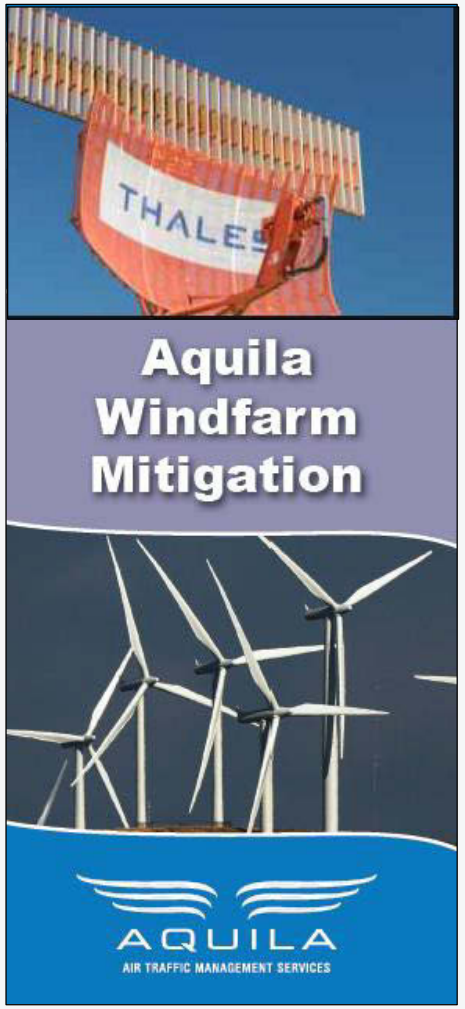

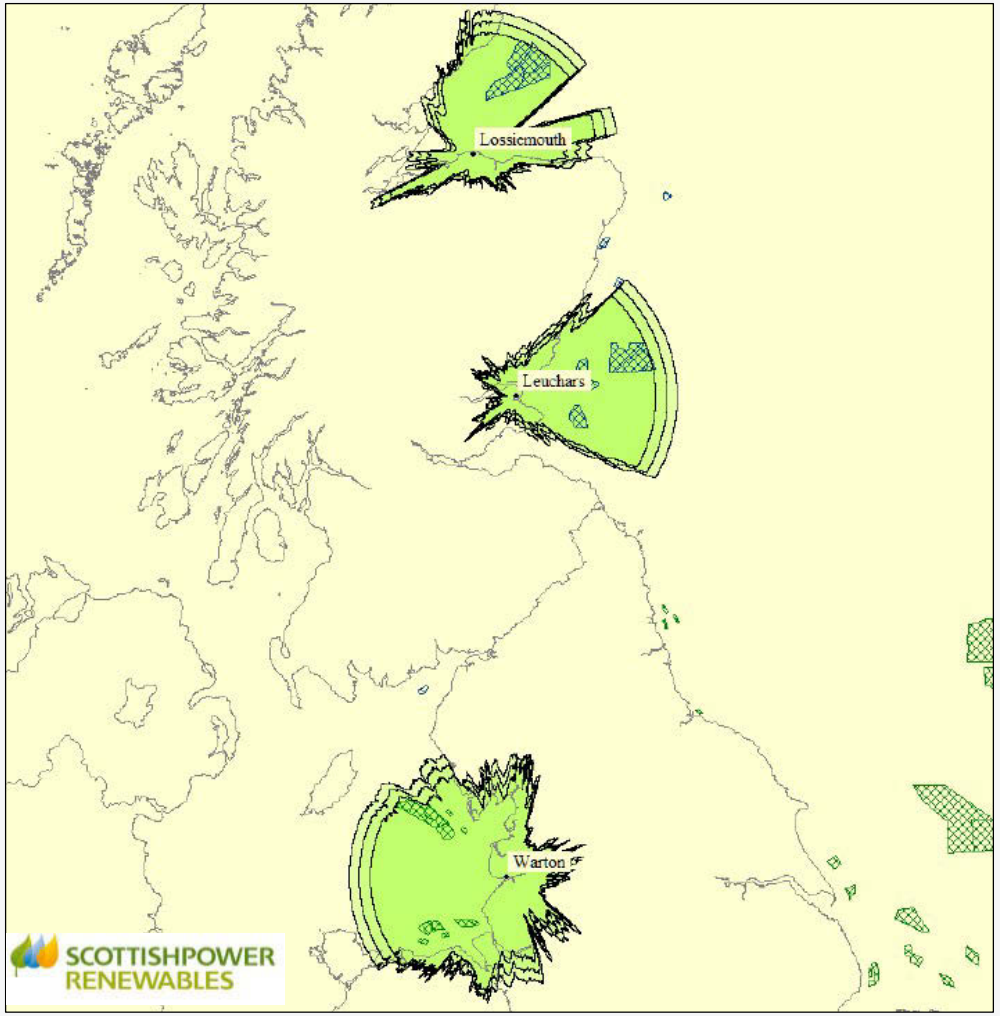

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Military ATC: Ministry of Defence Technology Demonstration

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- **Aim:** to assess maturity of existing mitigation solutions
- **Approach:**
  - MoD led, funded by offshore wind farm developers
  - June to August 2013
  - tactical S-band BAe Watchman radar deployed for demo
  - within radar LoS of two offshore wind farms (132 turbines)
  - six companies selected to participate via open competition
  - each mitigation solution assessed over 10-day period
- **Result**:
  - more than one technology showed improvement
  - none fully met the assessment criteria
  - interim mitigation solution employed (ACP/TMZ/NAIZ)

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Military ATC: Ministry of Defence Technology Demonstration

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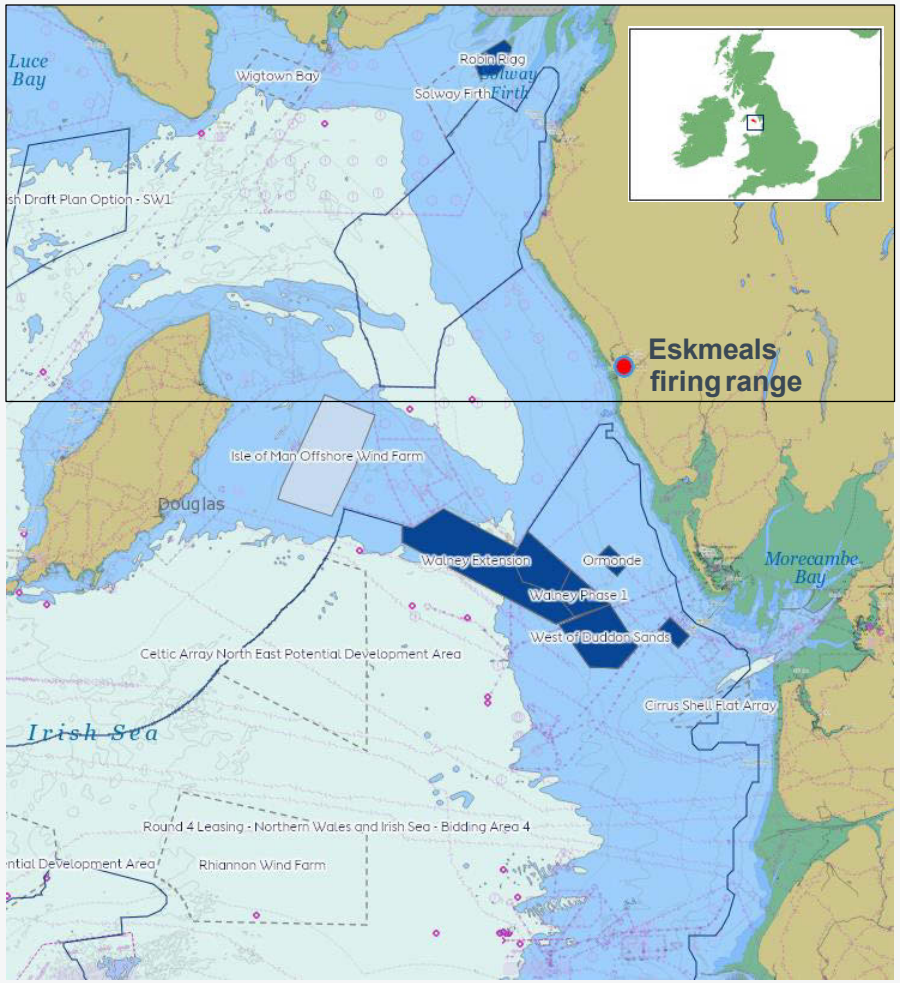

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Military ATC: BAE Warton

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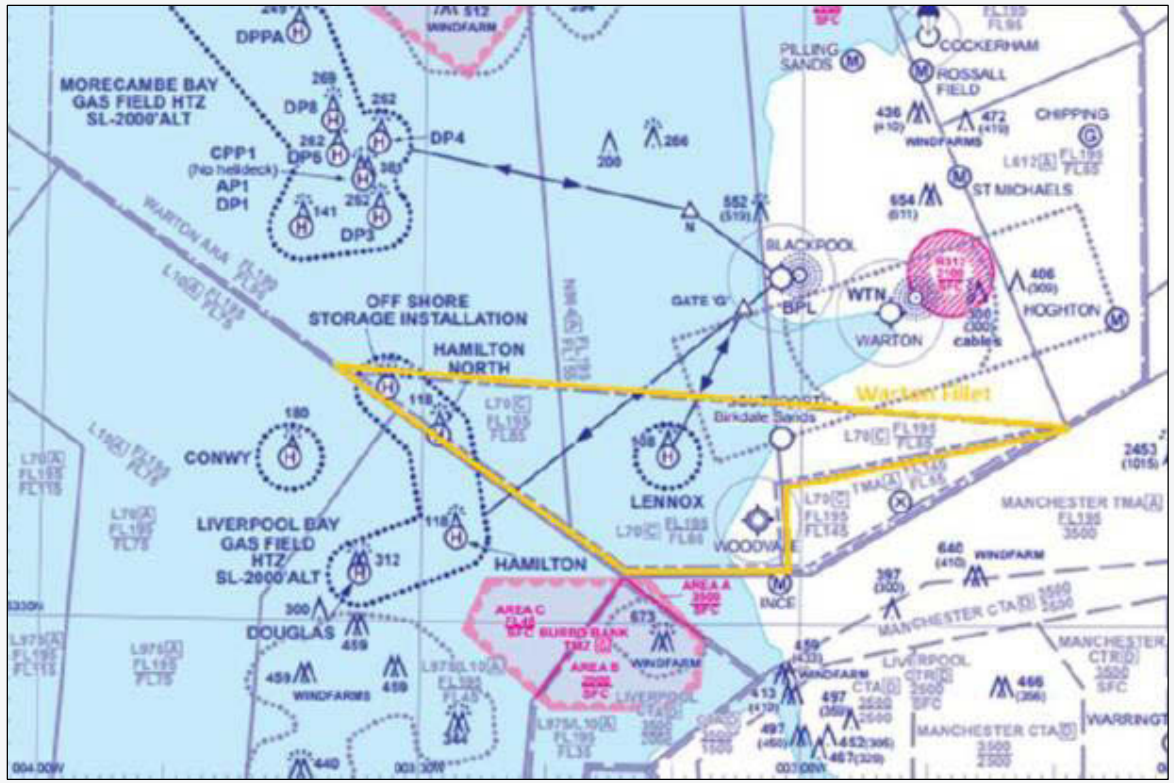


Ørsted

Our vision

Let’s create a world that runs entirely on green energy

Ørsted

Coexistence between Air Defence Radar and Offshore Wind

Structure:

1. Background on UK Air Defence Radar
2. Ørsted situation on UK Air Defence Radar
3. Concepts under consideration
4. Lessons Identified on Coexistence

Case:

UK Offshore Wind market, one of the longest history lines of coexistence with Air Defence Radars, fast growing capacity of Offshore Wind and political ambitions to a significant larger portion of electricity to be supplied by Offshore Wind

Generation Capacity
History ≈85GW / 2014 (All types)
Target: 40GW / 2030 (Offshore Wind)

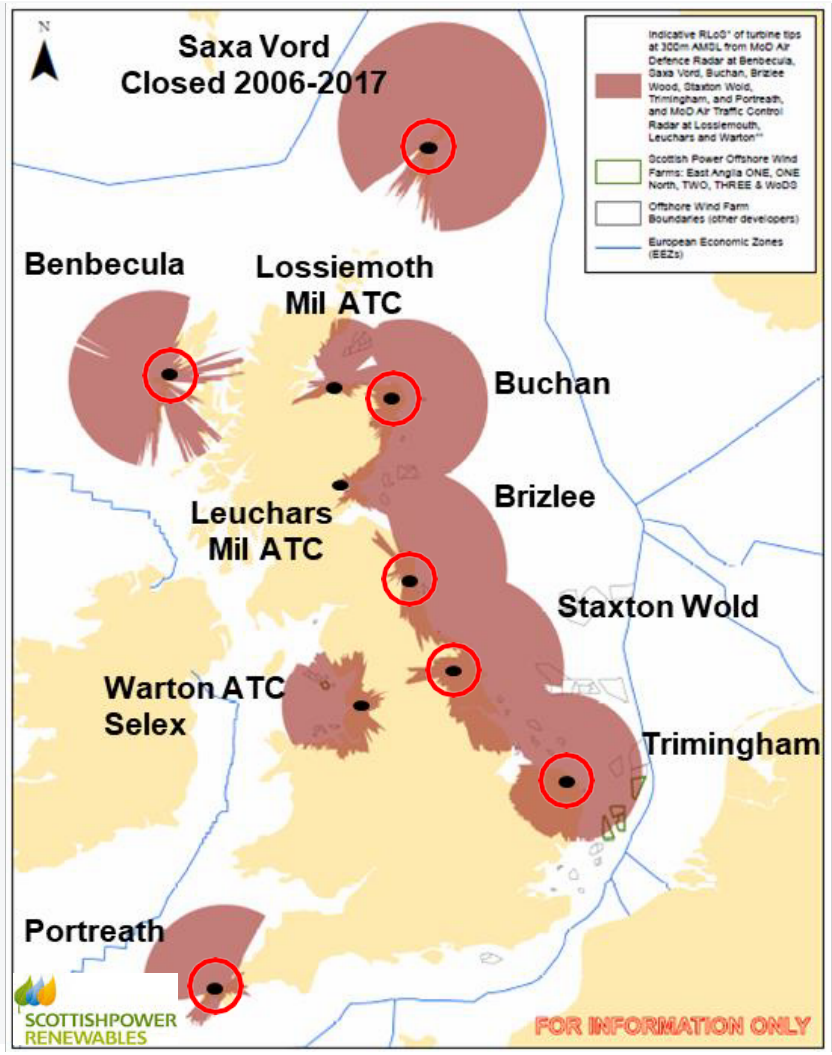
Military Background		Offshore Wind Background	
- 2001	Naval Academy LT	- 2013	Harbour Logistics
- 2004	SSK (Ships Eng.)	- 2014	Marine & Aviation
- 2005	Naval Academy LCDR	- 2016	Centralised Marine & Helicopter Coord.
- 2009	Navy SOF, S9/S5	- 2018	Substations, Development
- 2011	Int. Armaments Coop	- 2020	Project Development
- 2012	Defence Academy CDR		
- 2012	FF (Ships Eng.)		

Background on UK Air Defence Radar - Situation before Offshore Wind

Radar Line of Sight Down to app. 300m AGL

Type 92 (FPS-117)

3D <470km



BAE Type 93

3D <550km

BAE Type 101/102

3D <550km

Open source information, and not confirmed by RAF

Background on UK Air Defence Radar - Story line

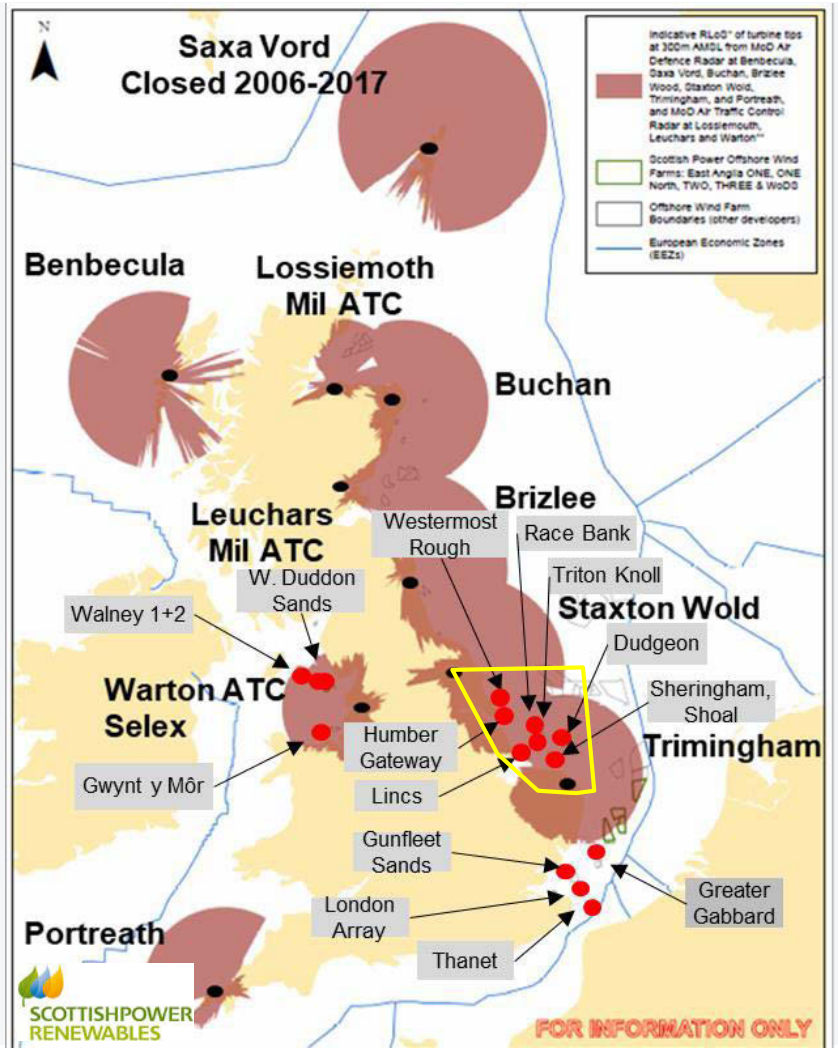
2007

- Planning of leasing round 2 projects, including Sheringham Shoal is well under way.
  FID scheduled SEP 2008

- MOD object to 6 windfarms in the Greater Wash area, including Sheringham Shoal, which is the most progressed project

- This was a showstopper for 6 projects and app. 2.5GW

- BAE and Statoil (Equinor) join up to find a solution



UK Lease Round 1 projects

- 25-30 turbines
- 2-3,6 MW turbines
- 60-150 MW Capacity

UK Lease Round 2 projects

- 50-175 turbines
- 3-3,6 MW turbines
- 185-630 MW Capacity

UK Lease Round 3 projects

- 50-200 turbines
- 6-18 MW turbines
- 1-3 GW Capacity

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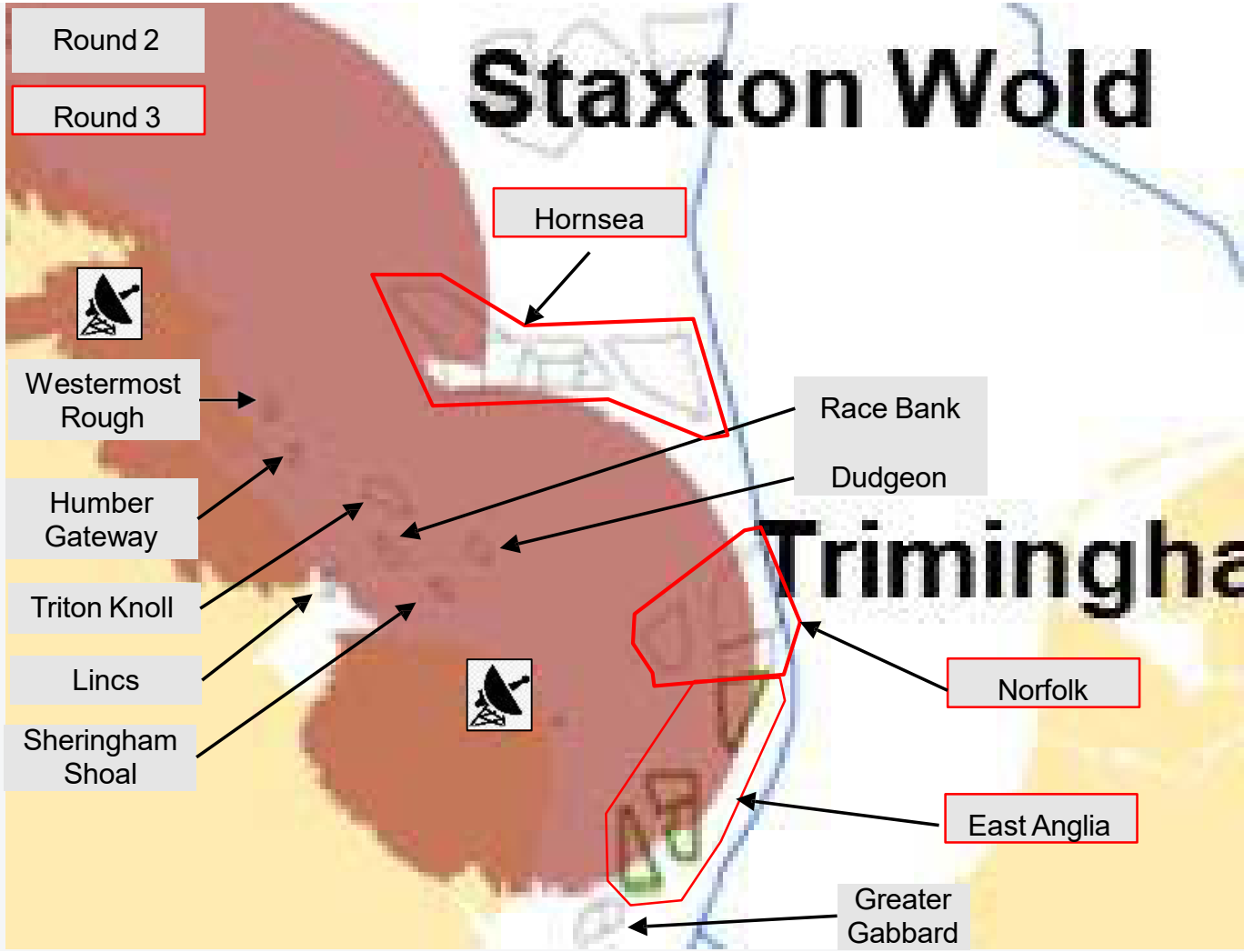
Background on UK Air Defence Radar - Story line

2008

- MOD agree with BAE & Statoil (Equinor) to explore a suggested software solution to reduce the impact from the turbines
- It was agreed to modify a new, already ordered, BAE radar to Trimingham
- Reducing the impacted area to only the windfarm (close surroundings) and up to 2300 feet vertically
- Objection was lifted



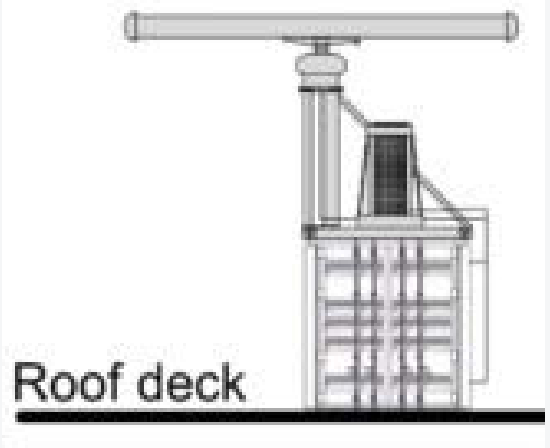
Background on UK Air Defence Radar - Story line

2009

- The radar for Trimingham fails the acceptance tests and the existing radar could not be modified

- Plan B offered:
  Gap-infill radar placed on the offshore substation to cover the ‘hole’ in the air space created by the wind farm, and feeding this picture in to the central radar screen for the area

- Flight trials in Denmark over Horns Rev windfarm shows promising results (out side windfarm)



Background on UK Air Defence Radar - Story line

2009

- MOD introduce TPS-77 pencil beam radar with SW modifications.
  A solution that was believed to solve the problem for all planned windfarms.
  (but to costly for one project)

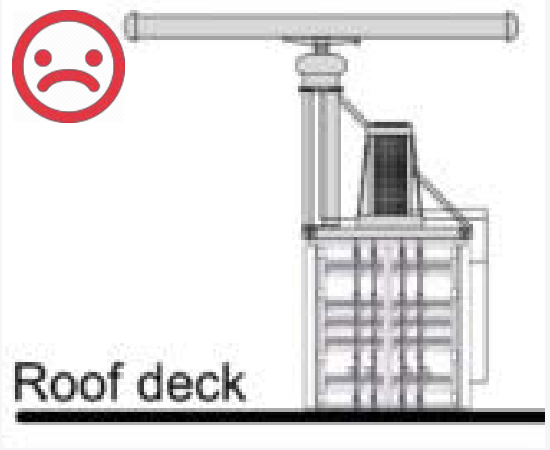
- Involvement of the Crown Estate (TCE) to introduce TPS-77 as a regional solution

2010

- Agreements are made between MOD, The Crown Estate and Developers to install TPS-77 as the mitigation solution

THE CROWN ESTATE

Manage UK seabed and leasing rounds



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Background on UK Air Defence Radar - Story line

2012

- The TPS-77 is successfully installed and tested

•Sheringham Shoal is operational

2016

- The TPS-77 Trimingham achieves full operational capability, and proves “sufficient operational mitigation” for Sheringham Shoal
- It was the first of 3x TPS-77 that was to be installed in UK and 2x FPS-117 being upgraded

Background on UK Air Defence Radar
- Situation after the agreements in 2010…

Type 92 (FPS-117)

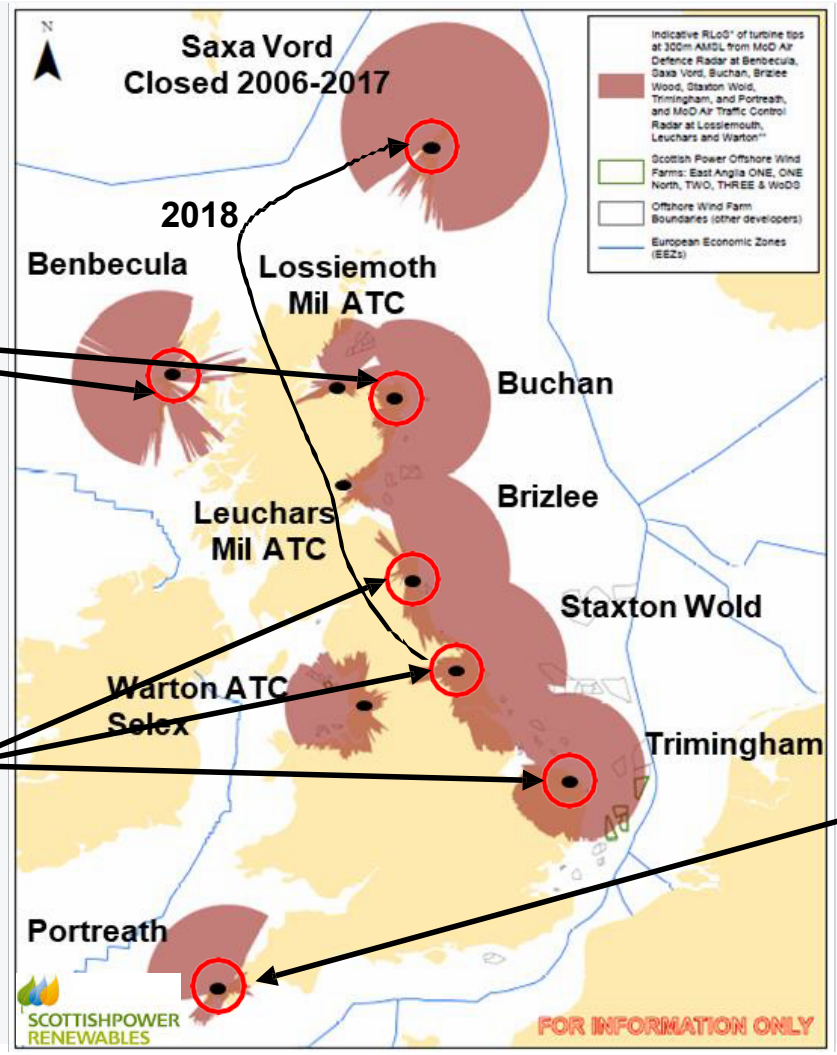
3D <470km

Upgraded

New

TPS-77

3D <470km



Radar Line of Sight
Down to app. 300m AGL

BAE Type 101/102

3D <550km

Open source information, and not confirmed by RAF

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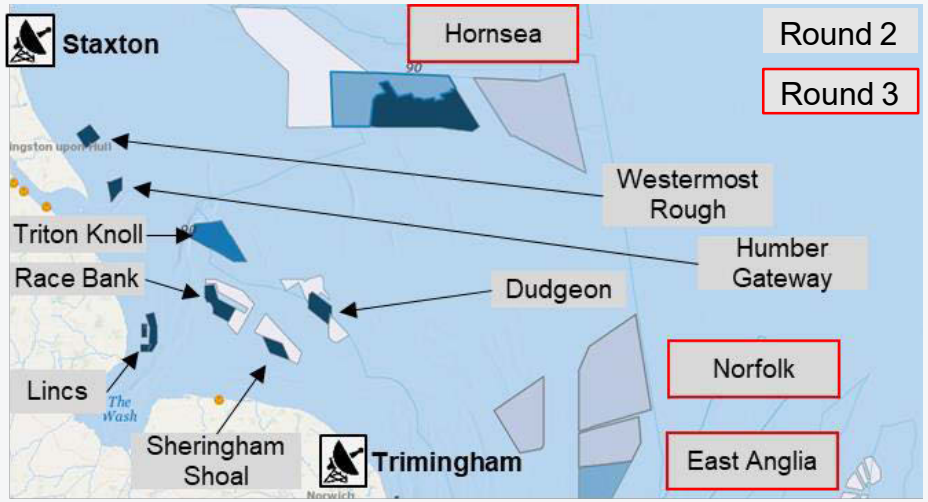
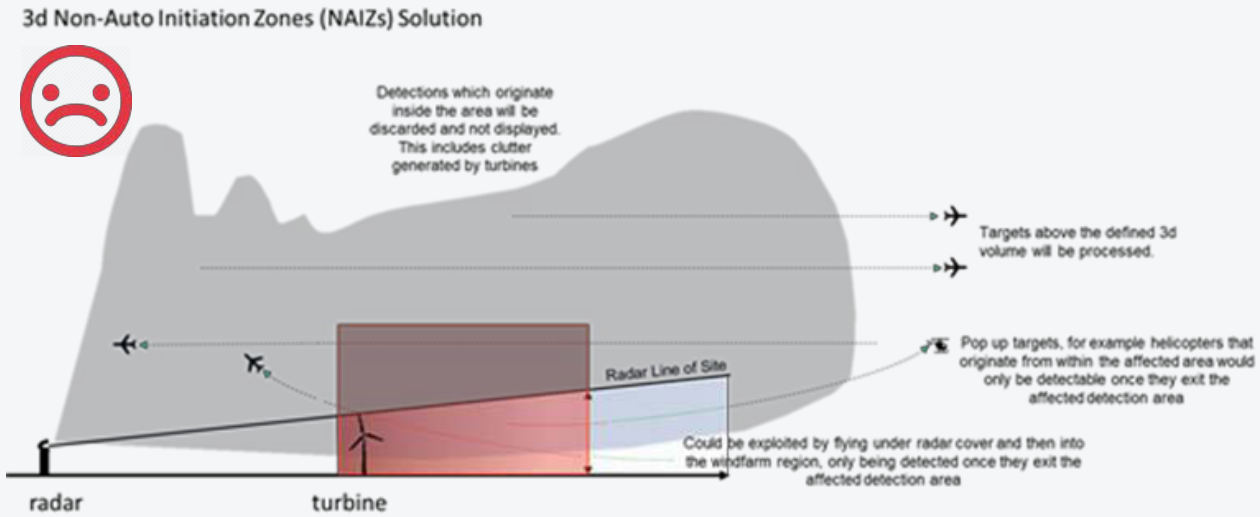
Background on UK Air Defence Radar - Story line

2018

- MOD informs that trials conducted on TPS-77 Staxton Wold, which determine that the wind farms had a detrimental effect on radar operations, specifically probability of detection and the aviation specification performance

Further upgrades to the radar software are being scoped and it is hoped that this will improve the situation

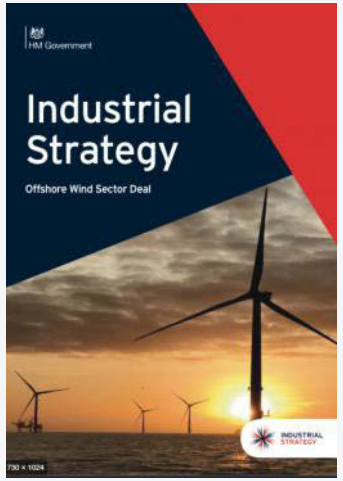




Background on UK Air Defence Radar - Story line

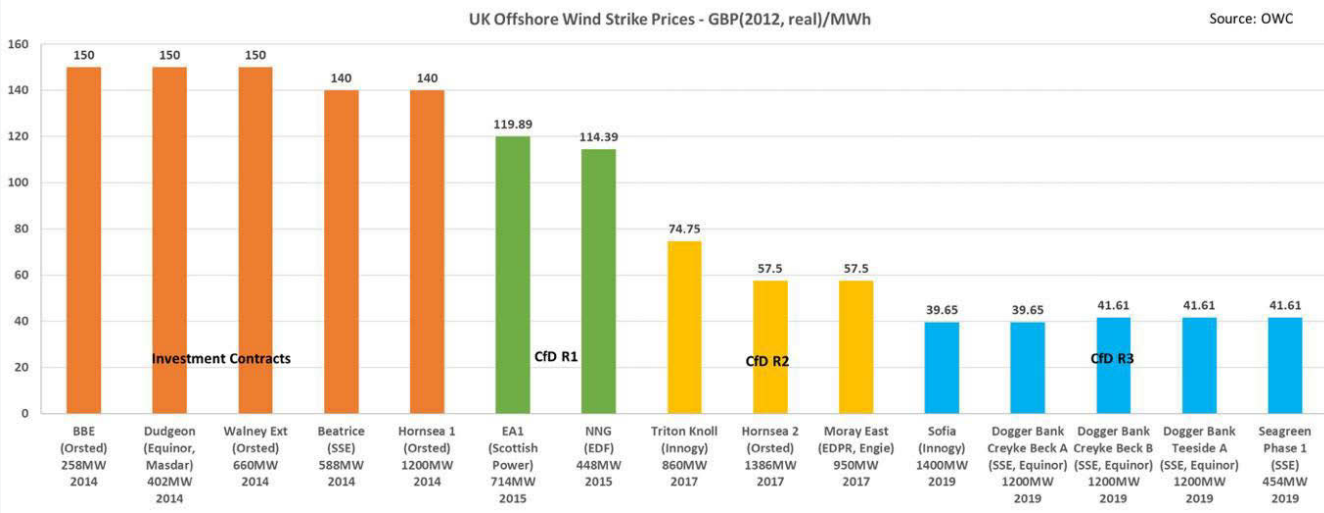
2019

- Offshore wind: Sector Deal between government and the offshore wind industry.
- Government will join industry in establishing the Low Carbon System Accelerator to facilitate proactive cross-departmental collaboration to address barriers such as grid and aviation …
- The newest auction round in UK, CfD 3 resulted in very low electricity cost increasing the motivation for further deployment of clear and reliable offshore wind energy



30GW / 2030

40GW / 2030



Background on UK Air Defence Radar - Story line

2019

- MOD, BEIS and OWIC (Developers) establish a joint program and taskforce.

  Acknowledging the risks to UK defence and seeking to identify acceptable mitigation solutions to allow the deployment of offshore wind.

- Looking into:
  - Mature technology
  - Future technology
  - Operational risk and Capability
  - Concept demonstration

Department for Business, Energy & Industrial Strategy

Ministry of Defence

OffshoreWind IndustryCouncil

ROYAL AIR FORCE

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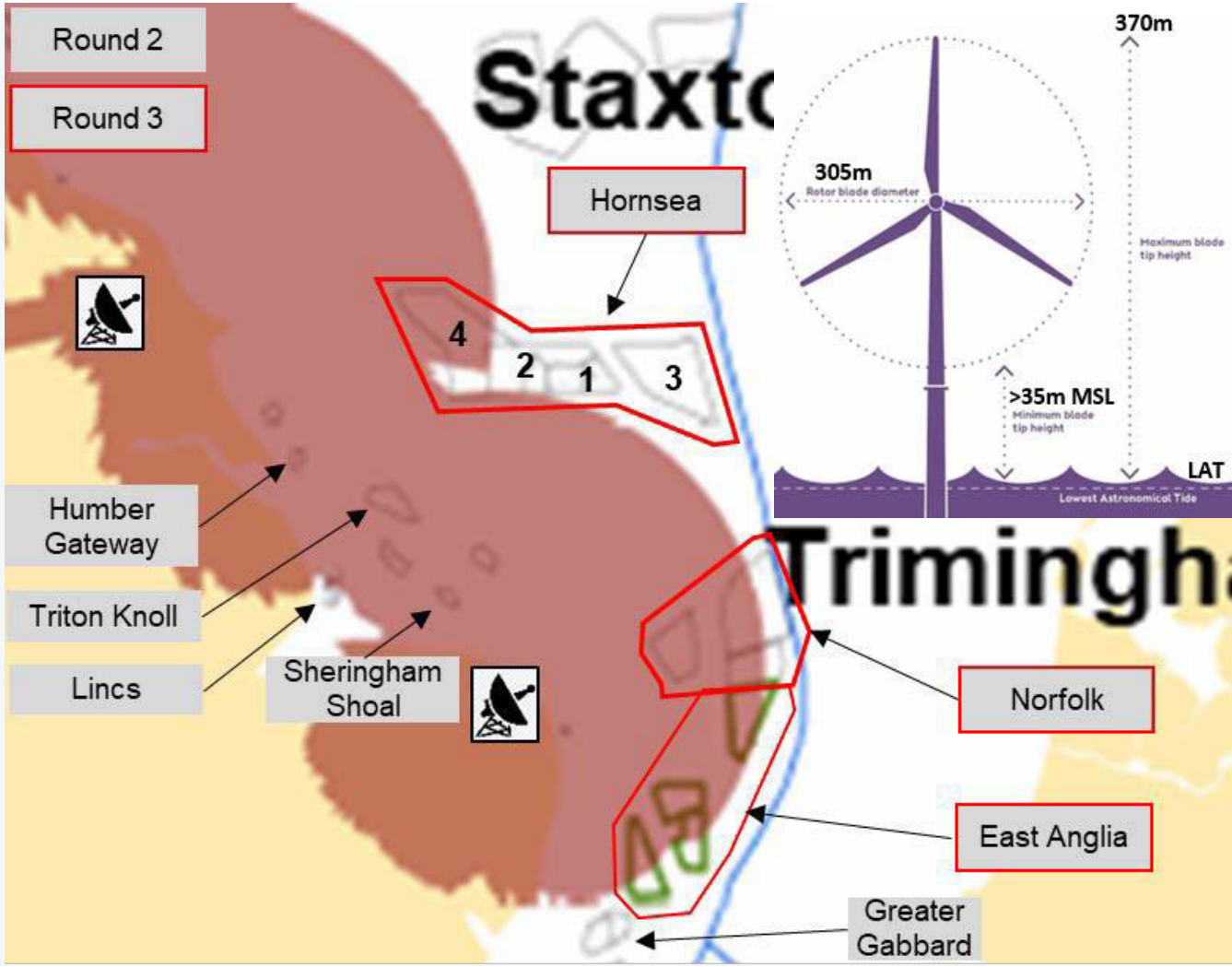
Ørsted situation on UK Air Defence Radar

2020 Hornsea 4

- Engaged in identifying a mitigation solution with high confidence for successful deployment and performance during operation of windfarm
- Time constrained to secure certainty before Bid/FID (typical 5-6 years before operation)
- Recommending multiple concepts to be investigated to allow for parallel comparison and selection
- Looking for technology "of the shelf" to reduce risk



FID: Final Investment Decision

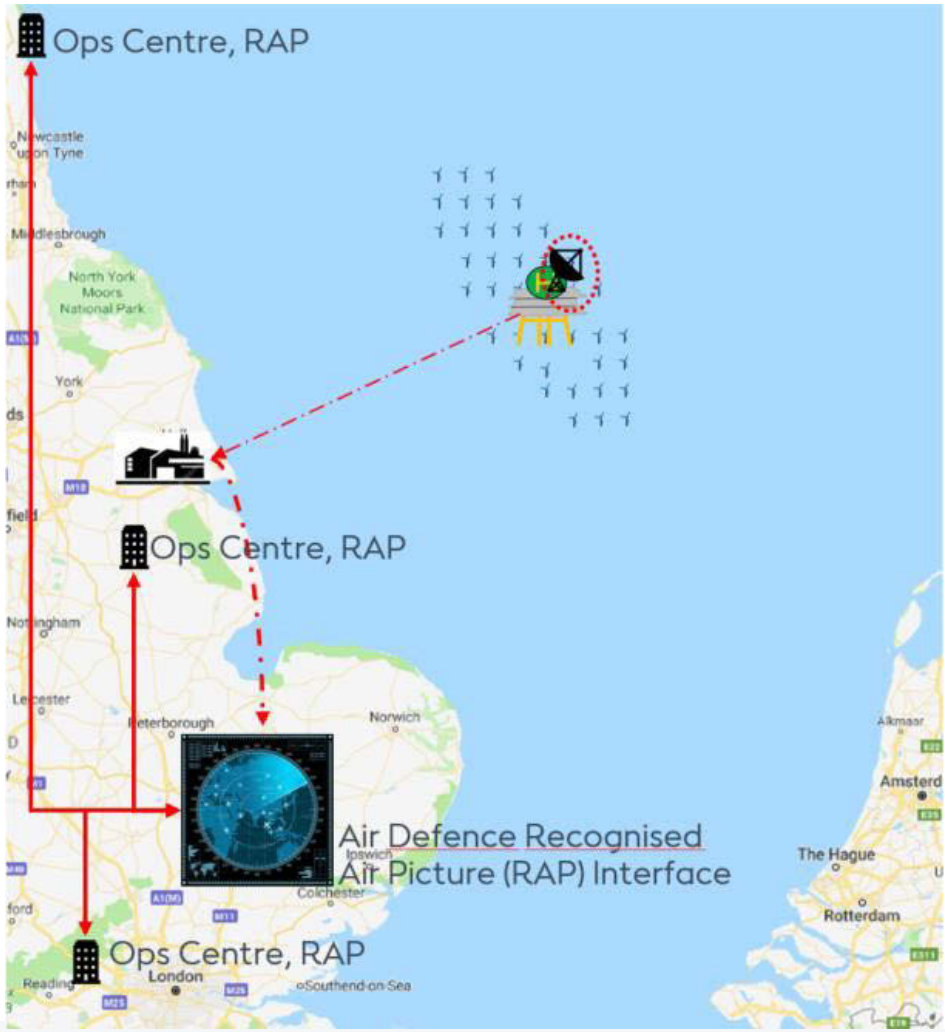
Concepts under consideration - Infill 2D from offshore

Conceptual and Indicative

Concept

- Place 1-2 Air Traffic Control radars at offshore substation or turbines
  - Proven technology and capability
  - Extended coverage
  - Secure fibre connection
  - Radar sensor give input to Air Defence Recognised Air Picture (RAP).

- Availability:
  - Modern 2D ATC radars have proven windfarm tolerance



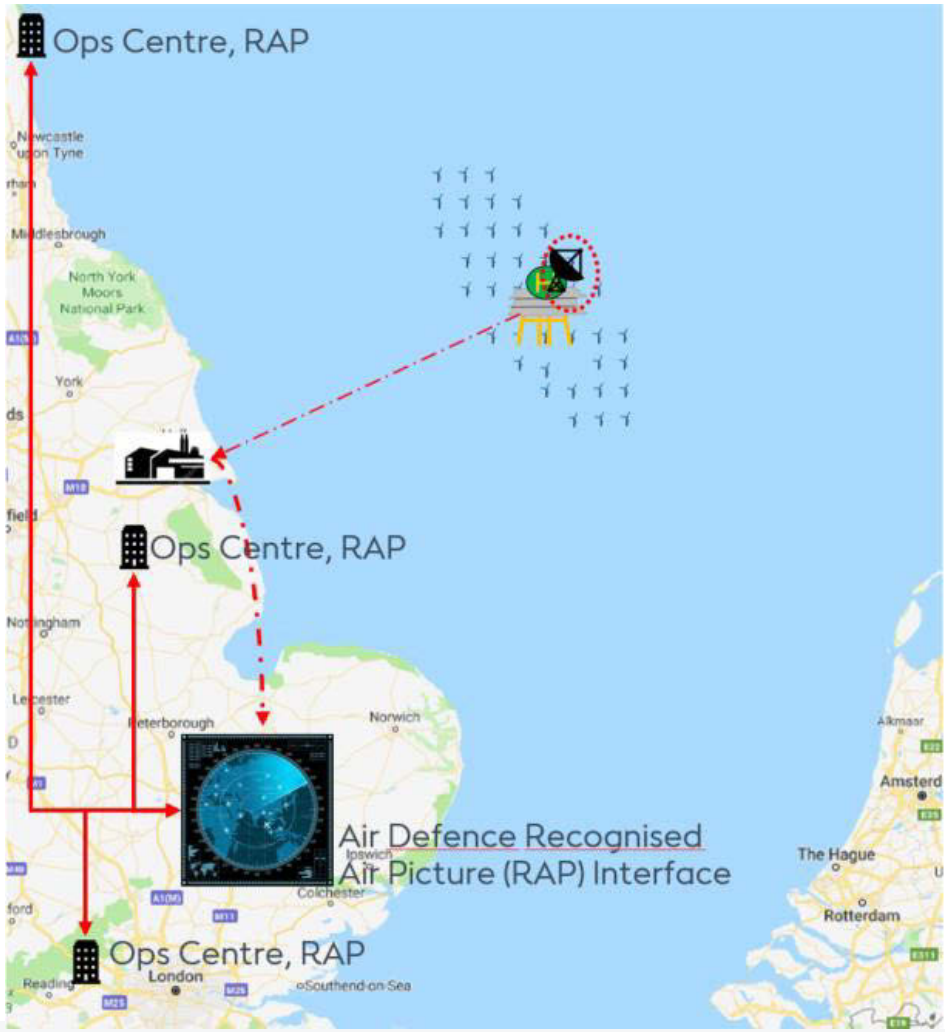
Concepts under consideration - Infill 3D from offshore

Conceptual and Indicative

Concept

- Place additional radar at offshore substation or turbine
  - Radar capacity focused on windfarm mitigation
  - Extended coverage
  - Secure fibre connection
  - Radar sensor provides input to Air Defence Recognised Air Picture (RAP).

- Availability:
  - Modern Active Electronically Scanned Array 3D SR radars expected to have the capability



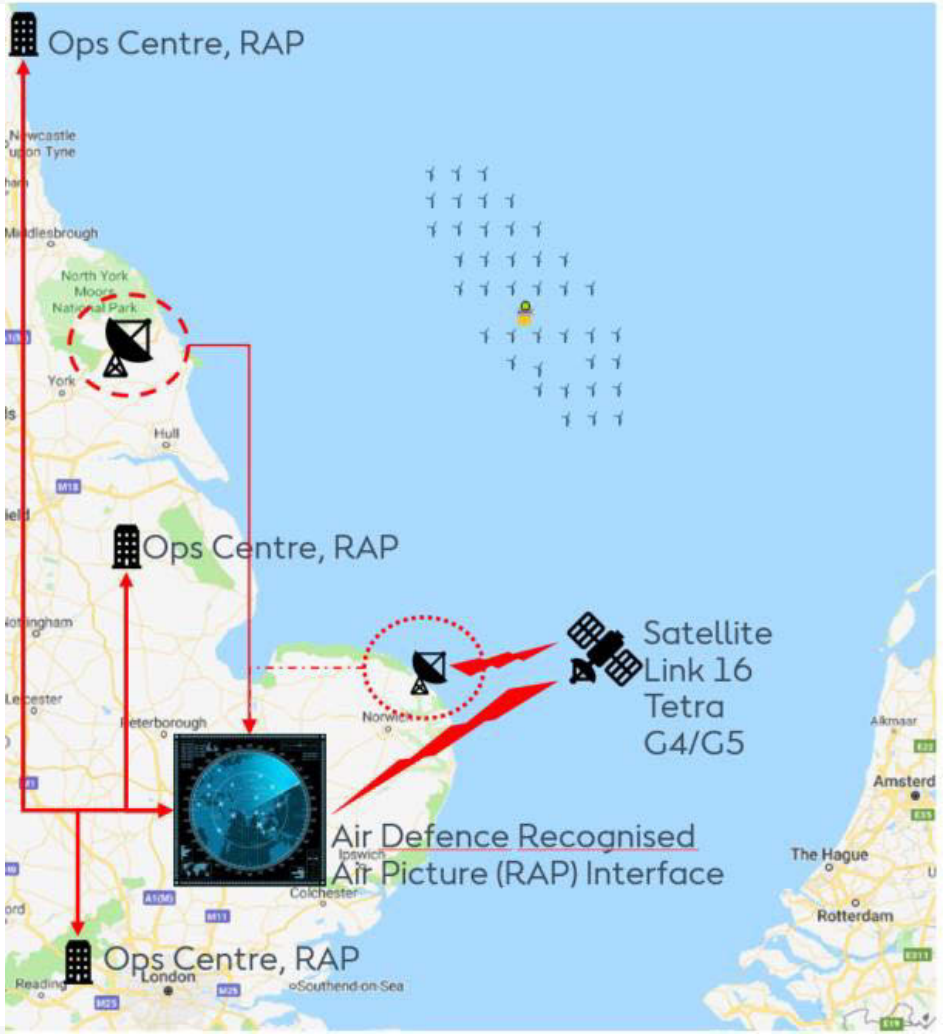
Concepts under consideration
- Infill 3D from new onshore radar head location

Conceptual and Indicative

Concept

- Place additional radar at new more optimal onshore location
  - Radar capacity focused on windfarm mitigation
  - On new site either permanent or deployable
  - Using secure wireless comms or new communication infrastructure
  - Radar sensor give input to Air Defence Recognised Air Picture (RAP).

- Availability:
  - Modern Active Electronically Scanned Array 3D MR radars might have the capability



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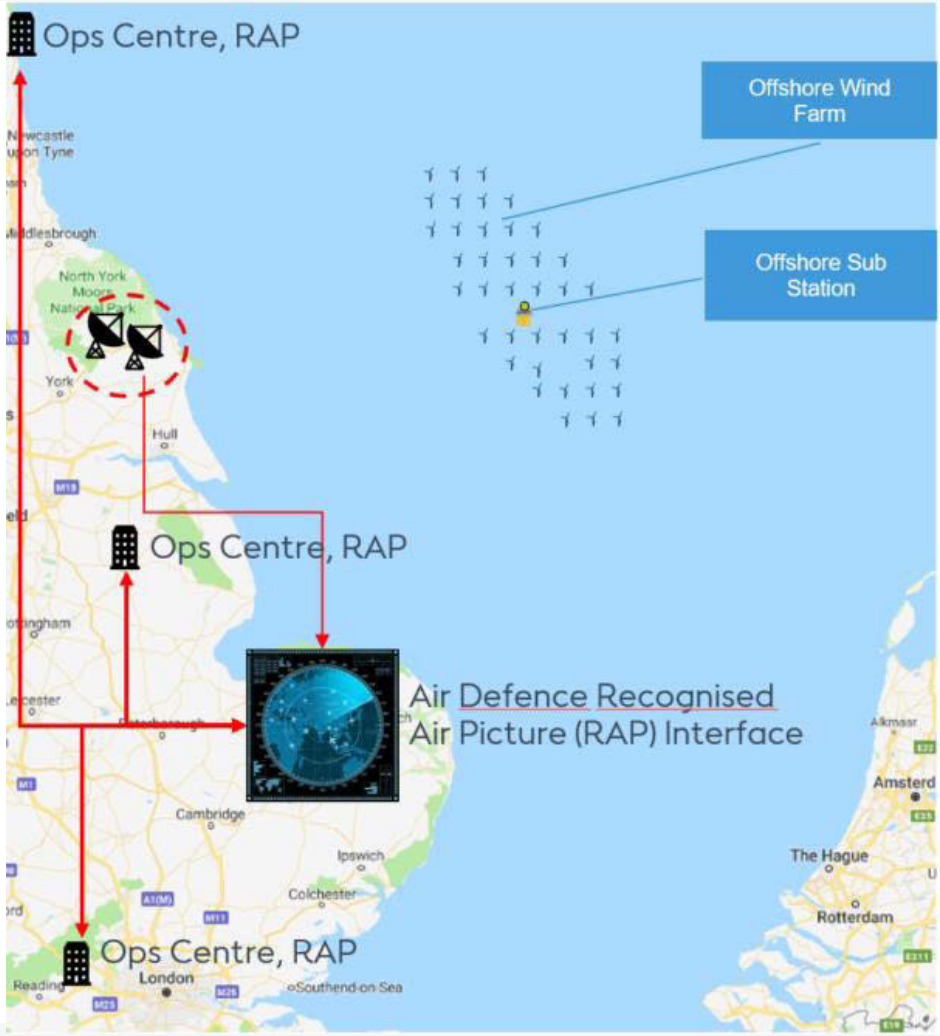
Concepts under consideration
- Infill 3D from existing radar head location

Conceptual and Indicative

Concept

- Place additional radar next to existing radar
  - Radar capacity focused on windfarm mitigation
  - On existing Military property
  - Existing secure communication infrastructure
  - Radar sensor give input to Air Defence Recognised Air Picture (RAP).

- Availability:
  - Modern Active Electronically Scanned Array 3D MR radars might have the capability



Concepts under consideration
- Regional 3D long range radar head

Conceptual and Indicative

Concept

- Replacement of radar head with wind farm tolerant radar
  - On existing Military property
  - Existing secure communication infrastructure
  - Radar sensor give input to Air Defence Recognised Air Picture (RAP).

- Availability:
  - Modern Active Electronically Scanned Array 3D LR radars might have the capability

Lessons Identified on Coexistence between Air Defence Radar and Offshore Wind

- Offshore turbines and wind farms have grown into size and coverage that requires new approaches to sustainable solutions for coexistence with Air Surveillance and Control
- Early engagement with radar responsible authorities on impact and mitigation measures is crucial for “non freeze” situations in offshore wind deployment
- Investing in understanding the impact and mitigations for coexistence of defence and offshore wind
- We have tried since 2008 to fix the kit, and it seems timely to consider new approaches to a growing issue involving two important areas for a nation - Defence and Power Supply

- Development of new technology does not seem to be required
  - Adaption might be relevant / required
  - Deployment methods might be required
- Possible need for a reliable radar model environment for estimating performance of different radars, turbines and windfarm layouts
  - Sharing understanding of impact and radar performance
  - Contribute to development of cross market technical and operational requirements

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Disclaimer

- The purpose of this slide package is to give a view on coexistence between Air Traffic Control (ATC) (civil and military) radar, Military Air Defence Radar (ADR) and offshore wind seen from an offshore windfarm developer perspective.
- The background and cases used to exemplify the subjects are based on the knowledge and information possessed by the authors at time of writing, and could be expected to be viewed differently by other parties related to the cases.
- The presentation represent the immediate view of the authors.

Our vision

Let’s create a world that runs entirely on green energy

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Questions or Comments?

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

18 May Agenda, Webinar #2

Monday, May 18, 2020	
11:00 a.m.	**Welcome, Meeting Objectives** Speaker: Patrick Gilman | U.S. Department of Energy Wind Energy Technologies Office (WETO)
11:10 a.m.	**Offshore Wind Project Review and Approval Processes in the U.S. from a WTRIM Perspective** Speakers: Jennifer Miller |BOEM Steve Sample | DOD Military Aviation and Installation Assurance Siting Clearinghouse George Detweiler | US Coast Guard Joe Bryan or Muswell Orange | Ørsted
11:30 a.m.	**State of Understanding of Offshore WTRIM Issues from an Agency Perspective Part 1** Speakers: Individual briefers for several key radar systems most likely to be impacted (Terminal, Long Range, Surface Wave HF, HF Over-the-Horizon, Marine, Airborne, etc.) • Address both technical and operational issues regarding each system or class/type of system • Identify how their systems are impacted differently in an offshore environment than in a terrestrial environment, note significant variances in their class/type of systems, typical users of each system or class/type of radar, and the potential for differing skill levels of mariners to use them, etc.
12:30 p.m.	**Q&A** Moderator: Patrick Gilman | WETO
1:00 p.m.	**Closing and Information for Next Webinar**

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