Global Wind Summit 2018

Hamburg, 26th September 2018

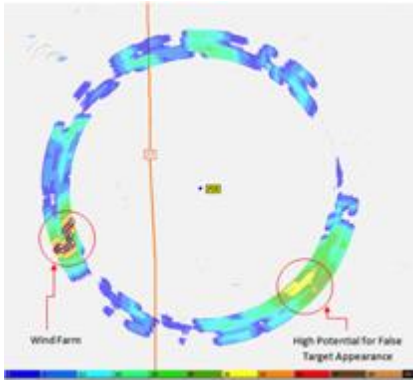
Wind Energy and Aviation Session

Group Captain Maurice Dixon (Royal Air Force Retired)

Wind Turbine Impact on Military Radars
A Growing Perfect Storm – or a Perfect Opportunity?

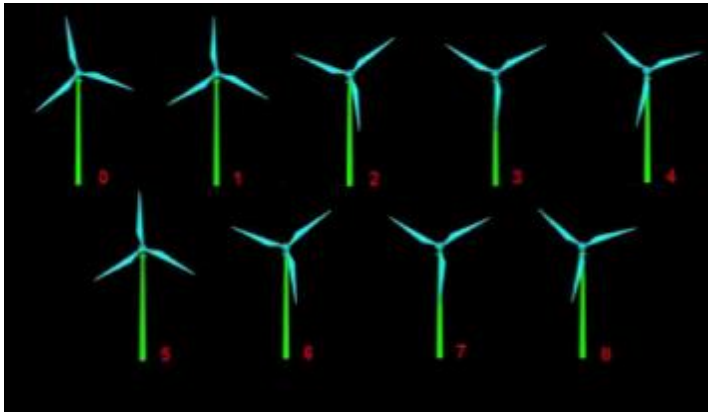
http://image.digitalinsightresearch.in/uploads/imagelibrary/nri/airforce/news/air%20defence%20radar.jpg

http://cimsec.org/wp-content/uploads/2014/06/vattenfall-turbinesflickr-600x372.jpg

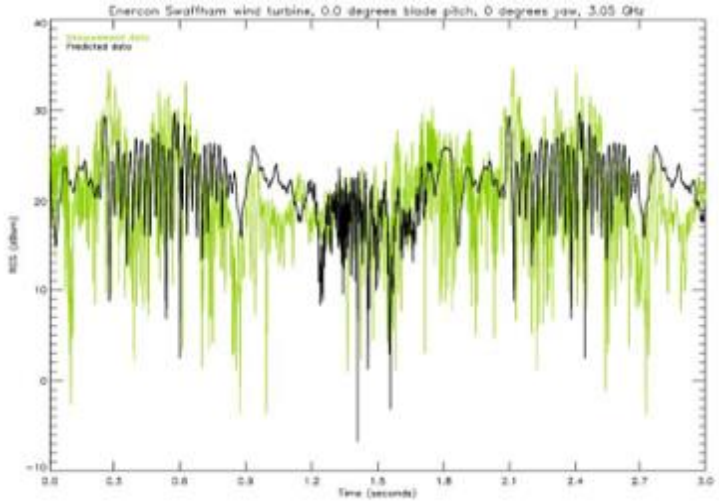


http://www.atdi.us.com/images/wind_turbine_false_targets.png

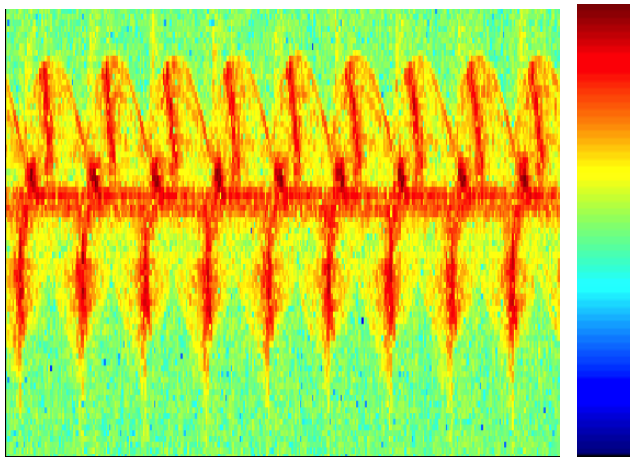
The Wind Turbine Interference Problem - Summary



Turbine Blades Rotate

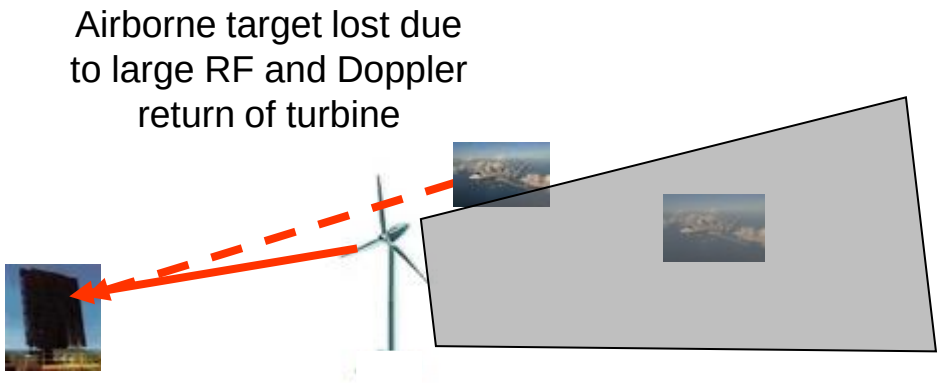


Radar Cross Section Area versus Time

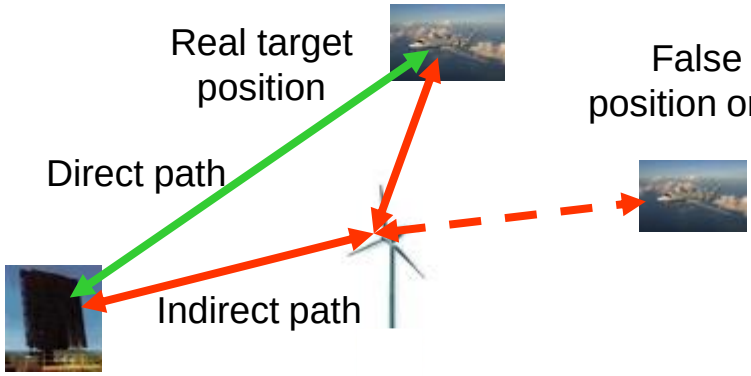


Doppler versus Time over 3 Revolutions

Radar Interference Consequences - Summary



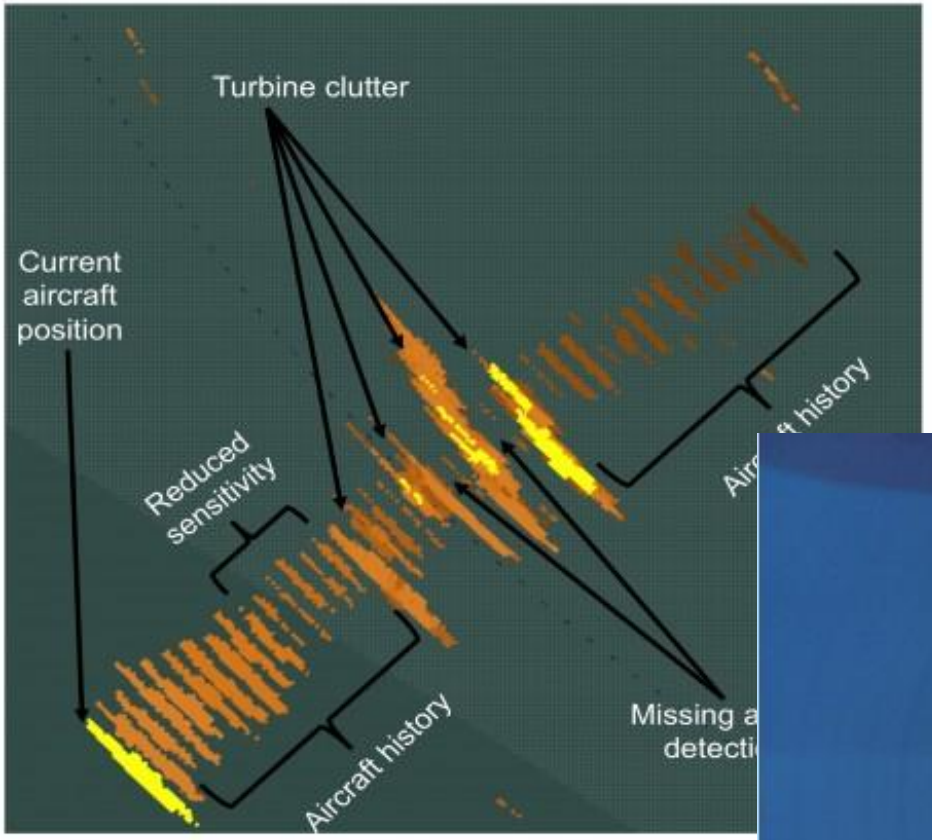
Lost Plots and Tracks and Target Masking



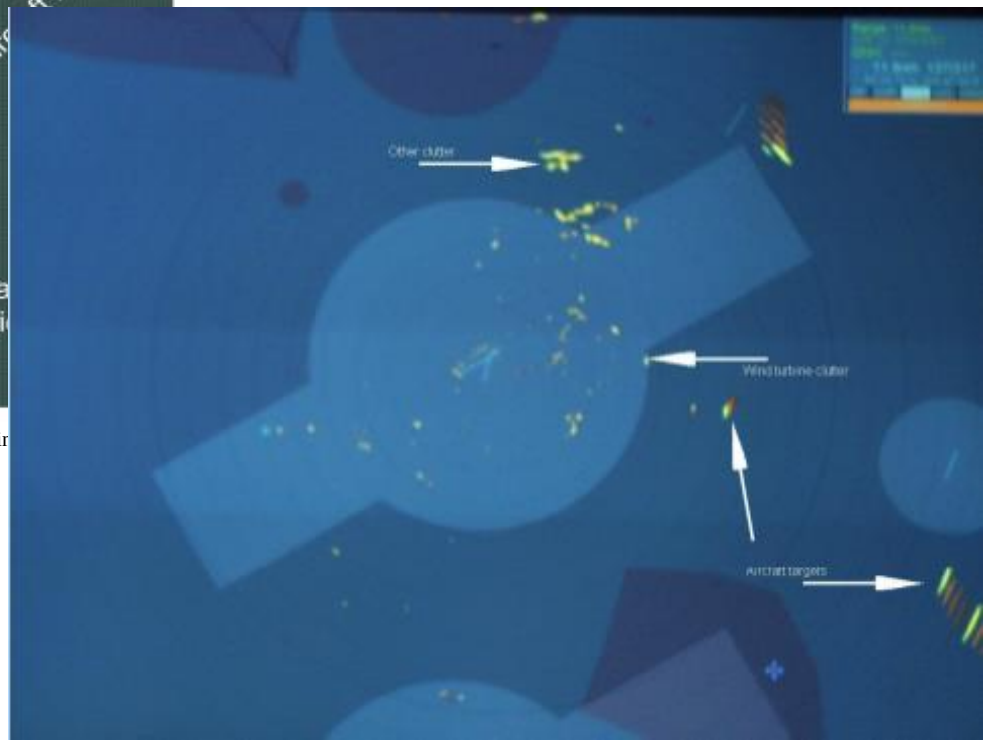
False Plots and Ghost Targets

Track Seduction or Track Initiation by Turbines

The Wind Turbine Radar Display Problem - Summary



https://www.internationalairportreview.com/article/12201/wind-farms-and-radars-livir



Screen shot from an RAF Radar showing the turbine and aircraft returns

Importance of Military Radars

Air Traffic Management for
Airspace Safety and Aircrew Training

Air Defence for
Airspace Security

Naval Air Traffic Management,
Air Defence and Maritime Security

Coastal, Border and Land Security

Wind Turbine Interference – Military Surveillance Consequences

- Peacetime flying and flying training: Air Traffic Management of military airbases, especially military flying training: 2D PSR, SSR, ILS, PAR.

- Low-level flying and parachute training – obstacles, visibility, turbulence.

- Reduces operating and training airspace due to airspace denial.

- Quick Reaction Alert – Air Defence of national and NATO airspace.

- Challenges to rapid and high confidence detection, identification and prosecution of low-to-high level unknown air targets within internal airspace, air threats from external routes, and conflict scenario combat targets.

- Need to amend air combat and air surveillance training, tactics, doctrine and plans to evolve with the complex clutter challenge; **but only to a point**.

- ***Need to adapt and evolve to operate in evermore 'complex clutter interference' with deployed and mobile radars – overseas deployment sites cannot be safeguarded. "Operate in peace as one has to in war".***

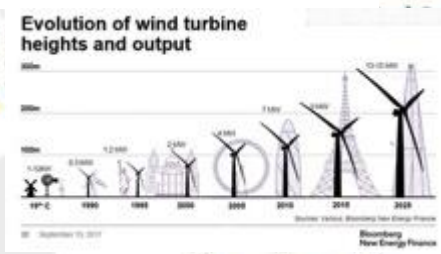
Future Military Vision of Fossil Fuel Free Operations in WTs

CAPABILITY VISION - Reducing Operational Dependence on Fossil Fuel

Wind Energy and Aviation – Three Conflicting Requirements

More Wind Farms to De-carbonise National Energy Systems

More and Larger Wind Turbines



Wind Islands & Floating Wind Turbines

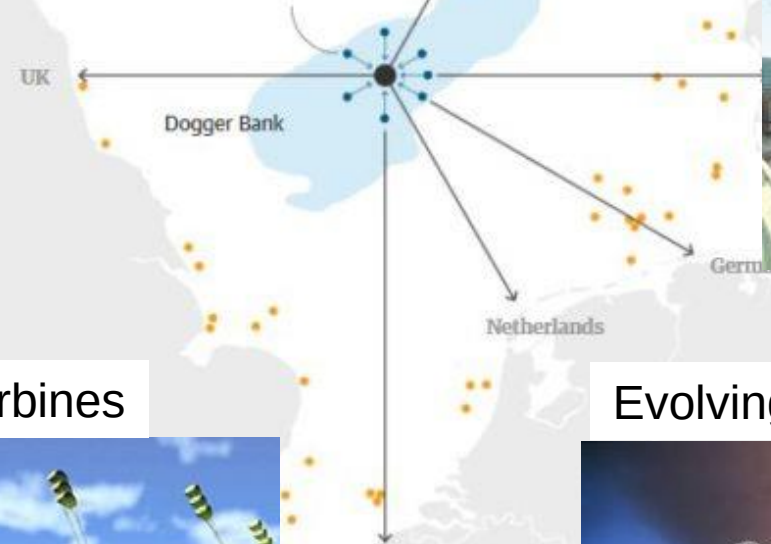
Proposed large wind farms way out at sea will connect to an artificial island

Power hub, on the island, distributes the electricity to surrounding Nc

Vertical Axis Wind Turbines

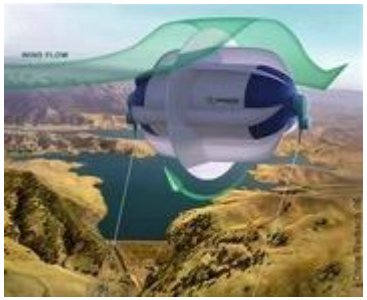
QR5

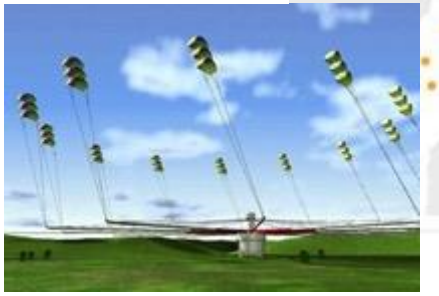
4 Navitas



Building Integrated Turbines

Airborne Wind Turbines





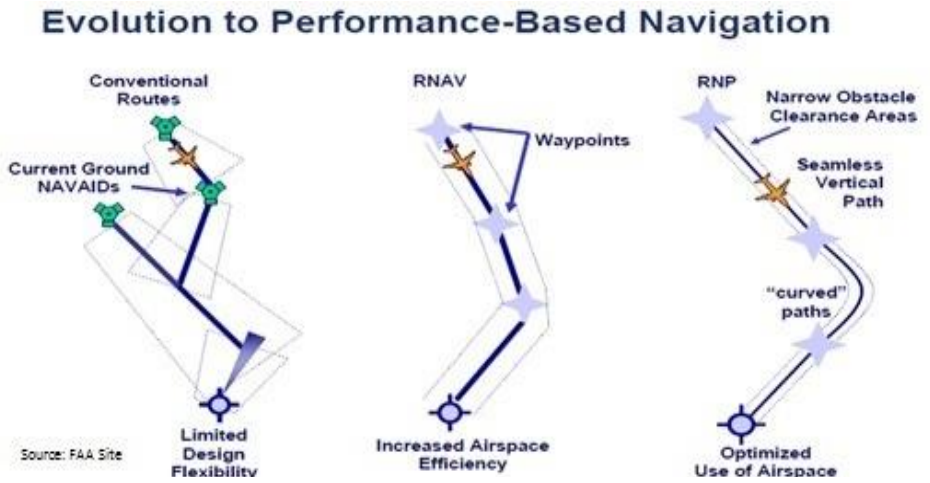
Evolving Novel Wind Turbines

Wind Energy and Aviation – Three Conflicting Requirements

Growing Aviation Traffic, Types and Efficient Flight Paths

Increasing Demand for Flights

Demand for More Efficient Routing



More Personal Sustainable Aviation

Increasing Unmanned Air System Use

Wind Energy and Aviation – Three Conflicting Requirements

Need to Detect, Identify, and Prosecute Illusive Air Targets

More Adversary Activity




More Stealthy Aircraft



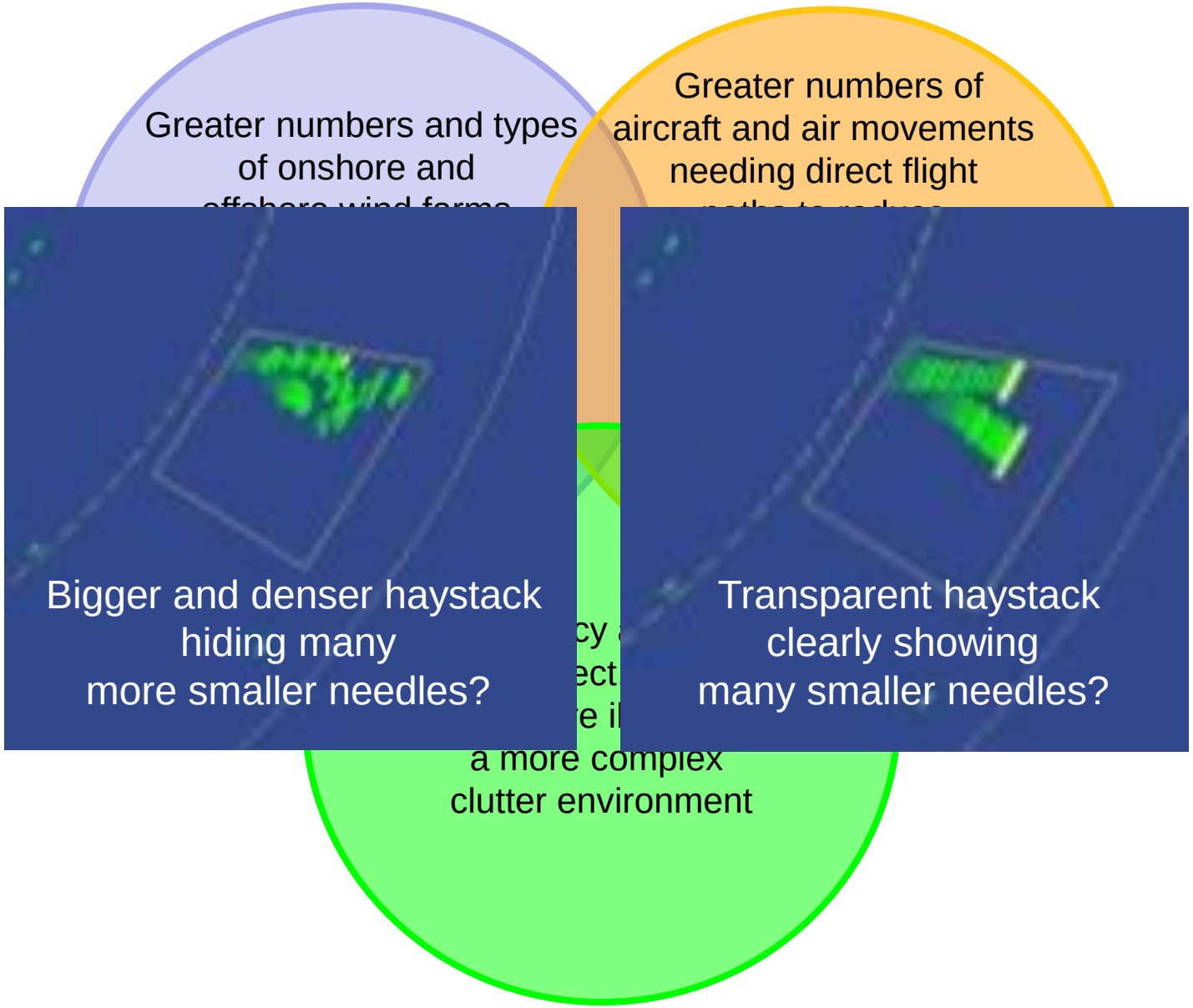

Higher Flying Air Systems




Higher Performance Systems




Perfect Storm? Or Perfect Opportunity?



In Simplistic Terms

THE PROBLEM - Electromagnetic Interference (**EMI**), also called **radio-frequency interference** (**RFI**), is an unwanted signal at the signal receiver, and in general, methods are sought to **reduce the level of the interference**.

Generating **Radar clutter** which is unwanted signals, echoes, or images on the face of the display tube which **interfere with observation** of desired signals.

WIND TURBINES ARE CONTRIBUTING EVERMORE COMPLEX CLUTTER INTERFERENCE TO THE EVER NOISIER RF SPECTRUM, HEIGHTENING THE SURVEILLANCE CHALLENGE

THE SOLUTION - Electromagnetic Compatibility (**EMC**) is defined as the ability of devices and systems to operate in their electromagnetic environment without impairing their functions and without faults and vice versa. EMC ensures that **operation does not influence the electromagnetic environment to the extent that the functions of other devices and systems are adversely affected.**

WIND TURBINES AND SURVEILLANCE SYSTEMS MUST BECOME MORE ELECTROMAGNETICALLY COMPATIBLE

We Have Started Down The Right Road – Sort Of

In UK - TPS-77
Air Defence Radar mitigates
Sheringham Shoal Wind Farm

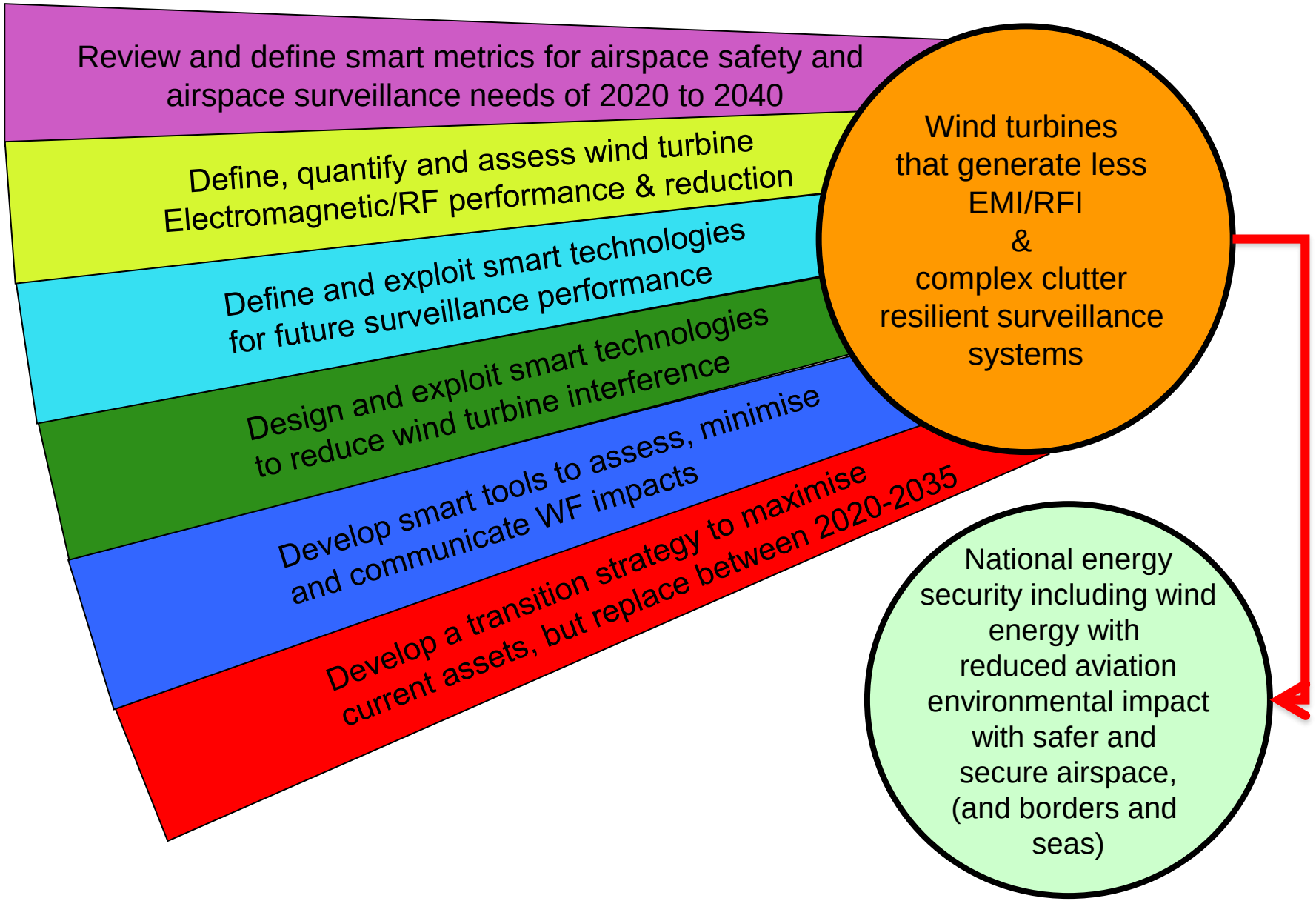
https://www.lockheedmartin.com/en-us/products/ground-based-air-surveillance-radars.html

In France - EDF Vestas/Qinetiq
'Stealth Wind Turbines' mitigates
Weather Radar

https://www.qinetiq.com/Blogs/2018/05/Stealth-Wind-Farm-Case-Study

These are only **interim**, **partial** and/or **bespoke** mitigations
HOWEVER
We now need a step change to provide more permanent solutions

Radar and Wind Turbine Co-existence Roadmap Via Positively Disruptive Collaborative Approaches



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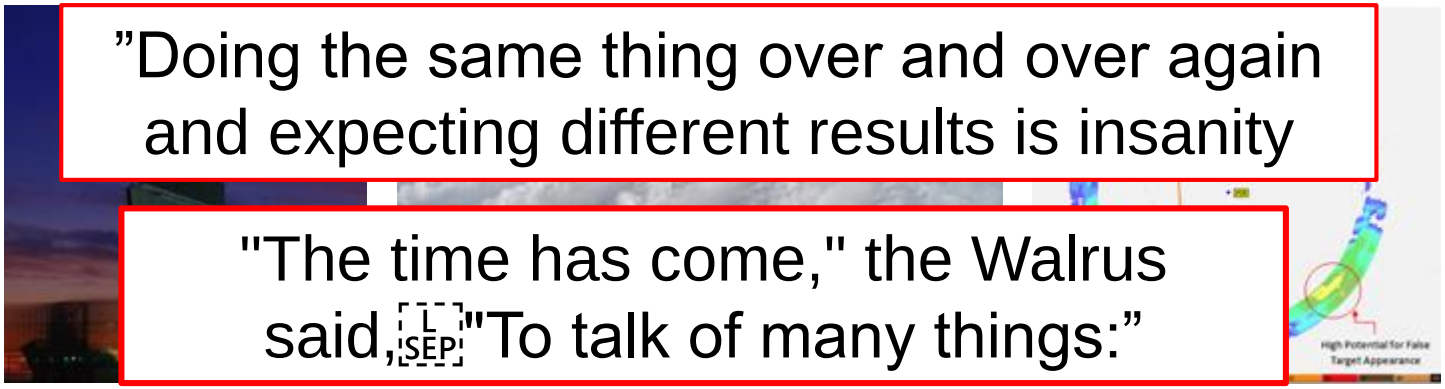

Attributed to Albert Einstein

http://image.digitalinsightresearch.in/uploads/imagelibrary/nri/airforce/news/air%20defence%20radar.jpg http://cimsec.org/wp-content/uploads/2014/06/vattenfall-turbinesflickr-600x372.jpg http://www.atdi.us.com/images/wind_turbine_false_targets.png

Lewis Carroll
(from *Through the Looking-Glass and What Alice Found There*, 1872)

Maurice Dixon – What Does He Know About This?

RAF Communications-Electronics Officer – supported and deployed static and mobile Air Traffic Management (ATM), Air Defence (AD), Missile Guidance (MG) and Electronic Warfare (EW) radars

Acquisition and Support Team Leader for UK MOD ATM, AD and EW training radars

Initiated UK MOD trials into wind turbine induced radar interference and technical mitigation options which led to the TPS-77 - Sheringham Shoal interim solution in 2009

Technical Assessor for clean energy technology trials in Cyprus – PowerFOB Jul 2011 - including HAWT and VAWTs

UK MOD and NATO SET-128 “Impact of Wind Turbines on Radar” representative

Designed MOD Wind farm - radar trial at Eskmeals in summer 2013

Sustainable
Working
And
Living
Environments
Ltd

Wind Turbine interference advice/trials to militaries

Radar mitigation technology development support

Small HAWT and VAWT development support

Wind Farm proposal – support with military objections

European Defence Agency Wind Turbine v Radar briefing

Developing remote community hybrid smart-grids inc WTs

Wide Range of Military Radar Sensors

Air Traffic Management

Air Defence

Airborne

Land and missile defence

Maritime

What Mitigation Options Are Available to Militaries?

Operational & Procedural Mitigation

- Procedurally safeguard vital radars and areas
- Procedurally deal with the ‘known clutter’ locations
- Operationally amend activity routes and paths
- Use of Mandatory Transponder Zones in WF areas
- Operator Airspace Risk Management as allowable
- Turning off wind turbines to remove interference

Technical Mitigation

- Maximise current radar capabilities available
  - Clutter mapping
  - Range Azimuth Gating
  - Sector blanking
  - Non-Auto Initiation Zone (NAIZ)
- Masking of wind farms
- Radar upgrades
- New Complex Clutter-resilient radar procurements
- Wind turbine design and manufacture changes