

Introductory Note

IEA Topical Expert Meeting N°. 53

Radar, Radio and
Wind Turbines

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AEA Energy & Environment

INTRODUCTORY NOTE

- Harnessing wind resources is important in tackling climate change
- The 20 IEA wind member countries reported 51.4 GW of installed capacity
- 20% increase over the figures produced for 2004



Key statistics of IEA Wind Member Countries 2005*

Total installed wind generation (onshore and offshore)	51,364 MW
Total offshore wind generation	686 MW
Total new wind generation installed	8,927 MW
Total electrical output from wind	98.74 TWh
Wind generation as % of national electric demand	1.2%

* Include estimates

Source: Wind Power monthly 2006

Different attitudes towards wind power

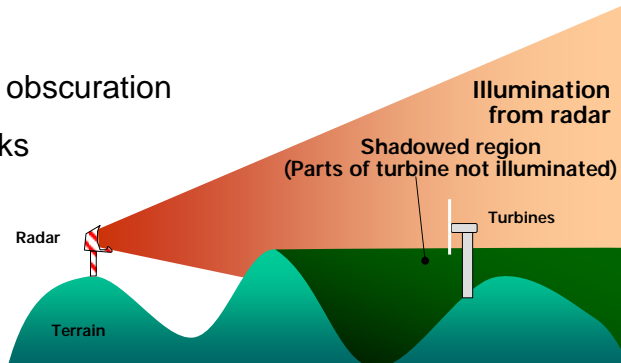
- Politics/history
- Economics
- Electricity demand
- Geography
- Technology
- Civil and military aviation interests



Wind turbines interfere with radar performance

Interference arises from:

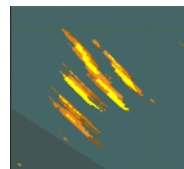
- Clutter
- Overhead obscuration
- False tracks
- Shadow



45th IEA R&D Wind TEM was held March 2005

Observations:

- Restrictions on siting of turbines due to potential hazardous effects on aviation and related defence interests
- These effects were not fully understood
- Lack of consensus throughout Europe as to the severity of such effects and how they should be calculated
- Concluded that mitigating technologies were available but that they needed to be proven and 'fit for purpose'



IEA Topical Expert Meeting No. 53

Objective is to promote wind turbine technology through co-operative activities and information exchange on R&D topics of common interest

Aspirations:

To gather existing knowledge on topics and provide suggestions/recommendations on how to proceed with:

- Compilation of the most recent information on the topic
- Input to define IEA Wind RD&D's future role in this topic



Progress in the UK

The Government Role

DTI committed funds to develop wind energy in the UK through its Emerging Energy Technology Programme but also recognises the need to take full account and support air safety and national defence

- Aviation Steering Group
- Stakeholder engagement
- Partnerships
- Mutually advantageous for all parties



Military Air Defence

Activities undertaken by the MOD for military Air Traffic Control (ATC) and Air Defence (AD) Radar:

- Through their radar replacement/upgrade programmes
- MOD trials to increase their understanding of wind turbine interference with military radar systems
- Development of existing software



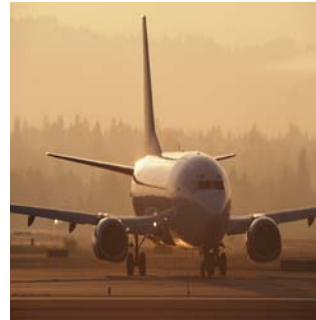
Military and Civil Air Traffic Control

- Trials during 2005 and 2006
- Product testing of the BAE Systems Advanced Digital Tracker and the Sensis SPE-3000
 - MOD supplying Watchman radar, staffing, aircraft
 - DTI funding for instrumented aircraft, safety consultant and manufacturers
 - Analysis of data in progress



NATS En Route plc. (NERL)

- Monitor aircraft mainly in controlled air space. Comprehensive infrastructure of radars, communications and navigational systems
- Existing radar being replaced
 - But not with windfarm mitigation technology
- DTI funded scoping study (2006)
 - To identify solution, timescale and cost
 - Future work programme currently being progressed



Stealth Technology

Stealth technology

- No single mitigation solution for all sites
- Two DTI funded projects underway
 - BAE Systems and QinetiQ
 - Radar absorbent material to reduce radar cross section
 - Modelling and full scale tests
- Reports due by end 2007



Conclusion

- Growth of the wind energy sector has generated new issues
- Opportunities exist for member countries of the IEA to collaborate
- TEM 53 provides one such opportunity to debate issues and work as a partnership



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Wind turbines, radar, and seismometers: the MOD position

IEA Topical Expert Meeting 53: Radar, Radio, and Wind Turbines

29 - 30 March 2007

Julian Chafer FRICS

Head of Safeguarding
Defence Estates



- Safeguarding: a brief summary
- Turbines and radar: awareness
- Wind energy safeguarding process
 - Air Traffic Control radar
 - Air Defence radar
- Current risks and issues
- Other research, trials etc.
- Seismometers (Eskdalemuir)
 - Wave and tidal energy
 - Conclusions



Safeguarding: a brief summary

Why do we safeguard?

To protect personal safety and the current and future use of the MOD estate (including airspace and offshore areas) by ensuring that the MOD is consulted about all potentially unacceptable development proposals (through pre-planning consultations, planning applications, consultations on draft development plans etc.)

Unacceptable effects include:

- Interference with aircraft (low flying and airfields);
- Interference with radar / communications / technical equipment;
- Limiting or preventing the storage of explosives.



Safeguarding: a brief summary

Where do we get our power from?

- England and Wales:
 - s 74 Town and Country Planning Act 1990;
 - Town And Country Planning (Safeguarded Aerodromes, Technical Sites And Military Explosives Storage Areas) Direction 2002.
- Scotland:
 - s 43 Town and Country Planning (Scotland) Act 1997;
 - Town And Country Planning (Safeguarded Aerodromes, Technical Sites And Military Explosives Storage Areas) Direction 2003.
- Northern Ireland:
 - No statutory power.



Turbines and radar: awareness

Evidence:

- Interference on radar screen at RNAS Culdrose.



Trial:

- 1994 (organised by RAFSEE);
- Sea King helicopter;
- Small turbines;
- Limited flight time.



Turbines and radar: awareness

Conclusions:

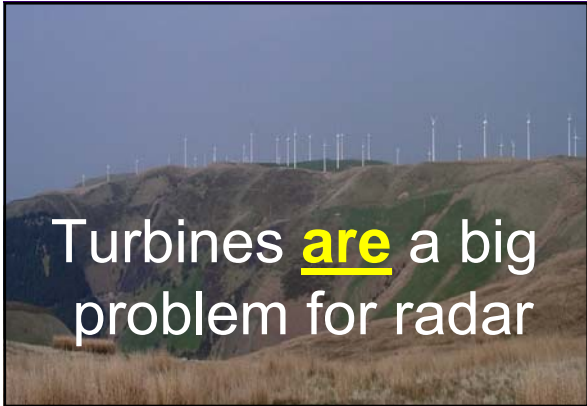
- Turbines affect radar;
- Need to be consulted about turbines in line of sight to, and within 60% of the maximum instrumented range of, a radar.



Criteria:




- Air traffic control radar = turbines within 66km = ✓
- Air defence radar = turbines within 74km = ?!





MOD wind energy safeguarding process

- Pre-planning process agreed with DTI and CAA (and with support of BWEA);
- Accepted as "best practice";
- Developer completes consultation proforma and sends it (preferably by e-mail) to Defence Estates;
- Details recorded on database and circulated to Technical Advisers (TAs);

MOD wind energy safeguarding process

- Radar path profile produced by Radio Site Protection team at RAF Henlow;
- TAs respond to DE;
- DE collates TAs' responses and replies to developer;
- May be need for meetings etc. to try and resolve issues.





And then....?

- For ten years we relied on the RAFSEE report;
- Not a robust basis for negotiations with developers;
- Turbine design/manufacture changing;
- Turbines getting bigger;
- Renewable energy targets set for 2010 and beyond;
- Developers becoming more assertive;
- We needed more reliable and up-to-date evidence.





All radar

Evidence:

- Trial Swift Crofter;
- Trial Mistral Crop;
- Trial Quixotic Zephyr;
- Trial Blind Guardian;
- Trial Celtic Storm.









All radar

Conclusions:

- Turbine Radar Cross Section (RCS) > aircraft RCS;
- Turbines have an effect regardless of distance;
- Most significant effects are:
 - Air Traffic Control (ATC) radar = clutter and false plots;
 - Air Defence (AD) radar = overhead obscuration.

Air Traffic Control radar

MOD position:

- We cannot and will not allow anything to unacceptably interfere with the top quality ATC service we provide;
- Everyone must be clear about, understand, and accept the differences between the UK and other countries and between military and civil air traffic control.

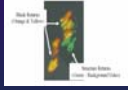








Air Traffic Control radar

Trials:

- 1994 RAFSEE report;
- Trial Quixotic Zephyr;
- "Clatter" trial 2005;
- "Clatter" trial 2006 (Trial Celtic Storm).

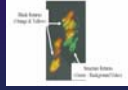
Air Traffic Control radar



Issues:

- The problem is what we can see → clutter, false plots, seduced tracks;
- Cannot have a standard policy (differences between airfields, aircraft, local environment etc.).

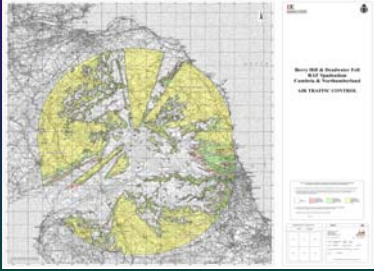


Way forward:

- No hardware/software "fixes" yet proved;
- Most effective mitigation is to keep turbines out of radar line of sight and away from where we control aircraft.



Air Traffic Control Radar – RAF Spadeadam


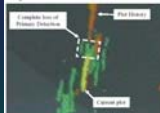


Air Defence radar

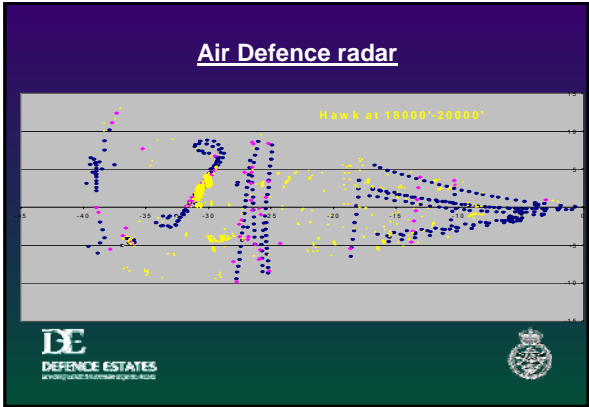
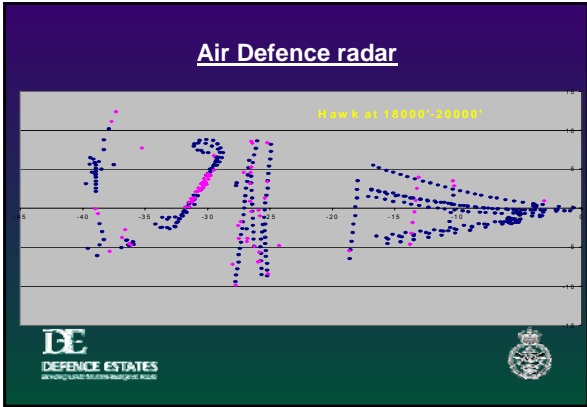
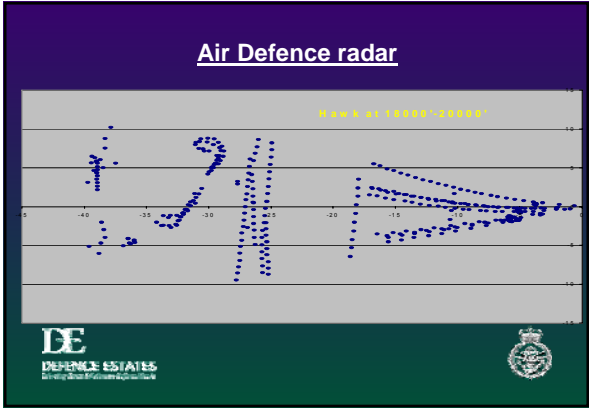
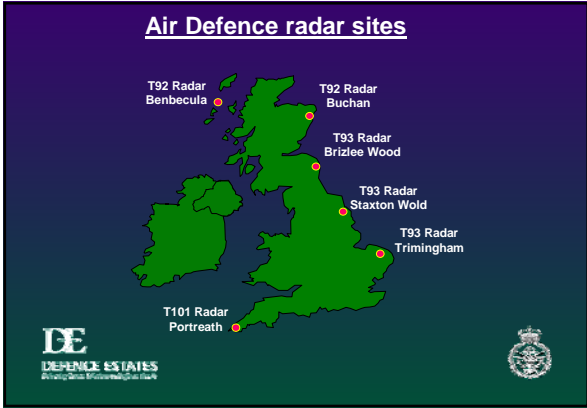
MOD position:

- We cannot and will not allow anything to unacceptably reduce our ability to protect UK airspace (and support training for aircrew preparing for deployed operations).

Issues:

- The problem is what we can't see → "shadow" and overhead obscuration.

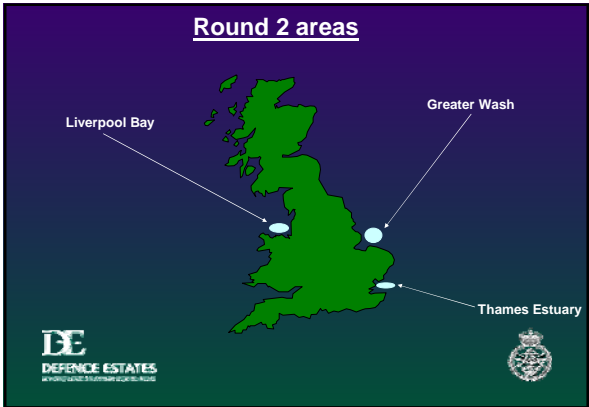







Air Defence radar and Round 2 offshore wind farms

- "Round 1" offshore wind farms relatively small;
- "Round 2" much larger;
- Concentrated in three areas;
 - Liverpool Bay;
 - Thames Estuary; and
 - Greater Wash.
- Serious AD radar concerns with the Greater Wash sites.

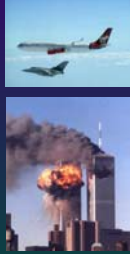
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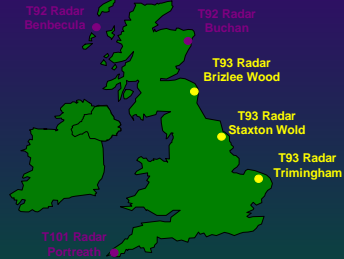
Air Defence radar and Round 2 offshore wind farms

AD radar upgrade / replacement programme:

- MOD upgrading / replacing T93 radars;
- 2 x "T102" radar and 1 x T101 radar;
- Wind turbines mitigation is a **desirable** requirement for T102;
- Contract let to BAE Systems in Dec 06;
- Aiming to have first T102 radar tested and in place early 08.

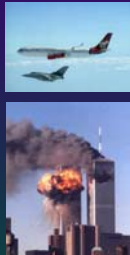


Air Defence radar sites



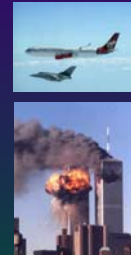
Air Defence radar and Round 2 offshore wind farms

- Possible "mitigation" (**not** solution);
 - Beam independent clutter maps to reduce effect of ground returns on upper beams;
 - High resolution clutter maps to prevent large dead zones around turbines; and
 - Advanced processing in background averager to reduce influence of noise spikes.
- It is hoped that these could reduce the cylinder of dead air around / above each turbine.

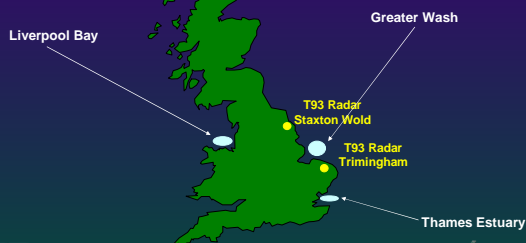


Air Defence radar and Round 2 offshore wind farms

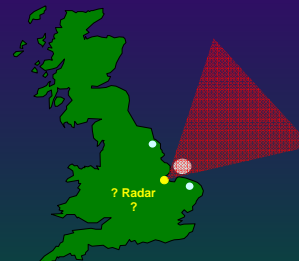
- And if the T102 doesn't "do the job".....?
- In-fill radar could be a way forward;
- Trial Blind Guardian proved the possibility;
- QinetiQ retained to study the practicality;
- Report due May 07.



Round 2 areas



Possible in-fill Air Defence radar: Greater Wash



Wind energy safeguarding: current risks

- Current pre-planning consultation process not compulsory (but is best practice);
- Even if we do see everything at pre-planning most schemes change before planning (and we are often not told);
- Planning guidance differs between England, Scotland, and Wales;
- Limited awareness/understanding among planning officers and councillors;
- We need to be sure we are seeing everything;



Wind energy safeguarding: current risks

- Must make wind energy safeguarding a statutory process;
- This will oblige all planning authorities to consult MOD about all planning applications for one or more turbines;
- Need clear safeguarding criteria (particularly with respect to smaller turbines);
- In the interim I will be writing to all Chief Planning Officers to remind them of the issues, risks, concerns etc.



Wind energy safeguarding: some issues

- We are clear about the effects of turbines on primary radar;
- But what about:
 - Secondary radar;
 - ILS;
 - PAR etc.?



Wind energy safeguarding: some issues

- Easier to handle the effects of turbines if they reflect less radar signal;
 - Stealth technology;
 - Lightning conduction;
 - Wind farm design and layout etc.
- What about effects of smaller turbines ("microgeneration")?

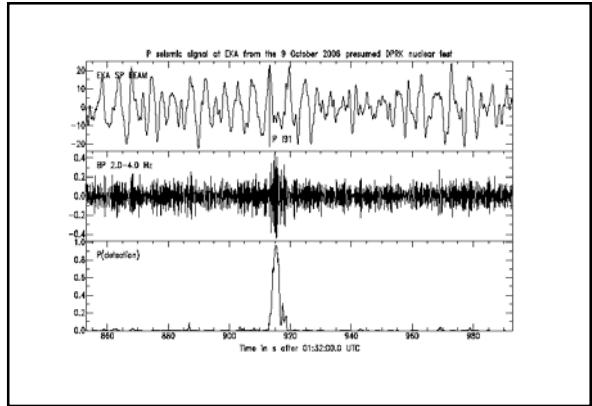
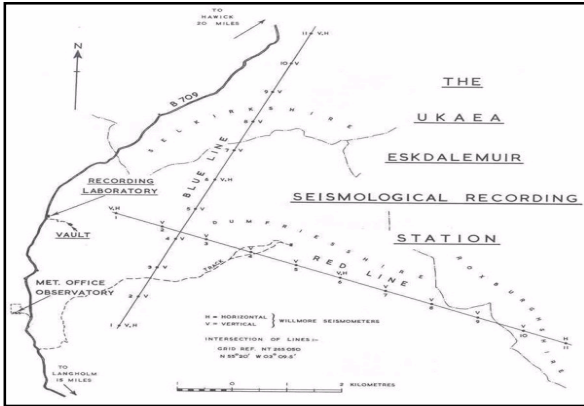


Turbines and radar: research, trials etc.

What work is going on?:


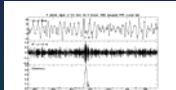
- Eurocontrol Wind Turbine Task Force;
- NATO Sensors and Electronics Technology panel Exploratory Team (11 – 13 Jun 07);
- IEA conference.







Eskdalemuir


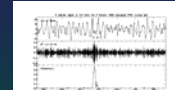
- Longest steerable seismometer array in the world;
- Eskdalemuir is seismically one of the quietest places on Earth;
- But also good for wind energy!;
- Lots of wind, good grid connections, and not many people around to complain;
- Array to be upgraded;
- Evidence of low frequency noise/vibration from turbines.






Eskdalemuir

- Precautionary consultation zone of 80 km imposed (5000 sq. km);
- Research commissioned from Professor Peter Styles, School of Earth Sciences and Geography, Keele University;
- Work included review of existing research (UK and USA) and tests at Dun Law, Ardrossan, and Cristal Rig wind farms.


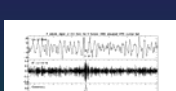








Eskdalemuir

Results:

- Turbines generate detectable vibrations;
- Key wavelength(s) affected;
- But turbines generate 60%+ capacity only 20% of the time;
- "Noise Budget" = windy day median noise level;
- Eskdalemuir's capability to detect explosions will reduce (but remain acceptable);
- Need statutory wind energy safeguarding for the first time.


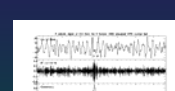








Eskdalemuir

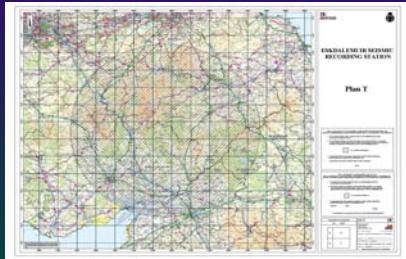
Conclusions:

- Wind turbines of current design are a problem;
- No turbines closer than 10km to the array;
- Seismic noise "budget" set for 10-50km zone;
- Accept risk that this will be exceeded 20% of the time (but on the windiest days);
- Turbines 50+ km from array not a problem (17.5+ km likely to be of greatest benefit);
- Approx. 1.6 GW given MOD "approval".

Eskdalemuir statutory safeguarding area



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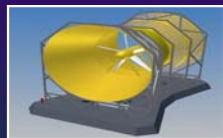
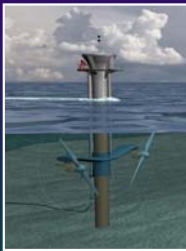
Wave and tidal energy – a summary

- Still in early stages;
- Technology relatively immature;
- But could be effects on;
 - Navigation routes (surface and sub-surface);
 - Cables, pipelines etc.;
 - Ranges and training areas;
 - Vessel-mounted radar / sonar / comms systems.

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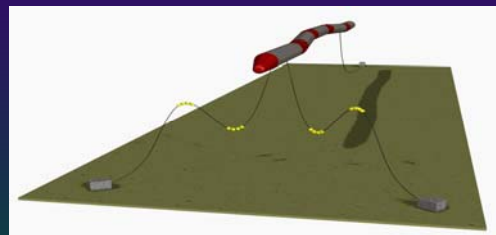
Wave and tidal energy – a summary



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Wave and tidal energy – a summary



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Wave and tidal energy – a summary



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Conclusions

- Turbines cause huge problems for radar;
- ATC radar: no solutions available (yet);
- AD radar: new radar may cope better;
- Need to look more closely at RCS (stealth technology, lightning conduction etc.);
- More research needed into SSR, ILS, PAR, microrenewables etc.;
- Need awareness and co-ordination of work being done by others;
- Seismometers: sound process in place...but we are close to the limit;
- Wave and tidal energy: make our position clear as early as possible.

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Addressing radar issues on wind farm developments

Nicola Brown

Insyte Professional Services



Insyte

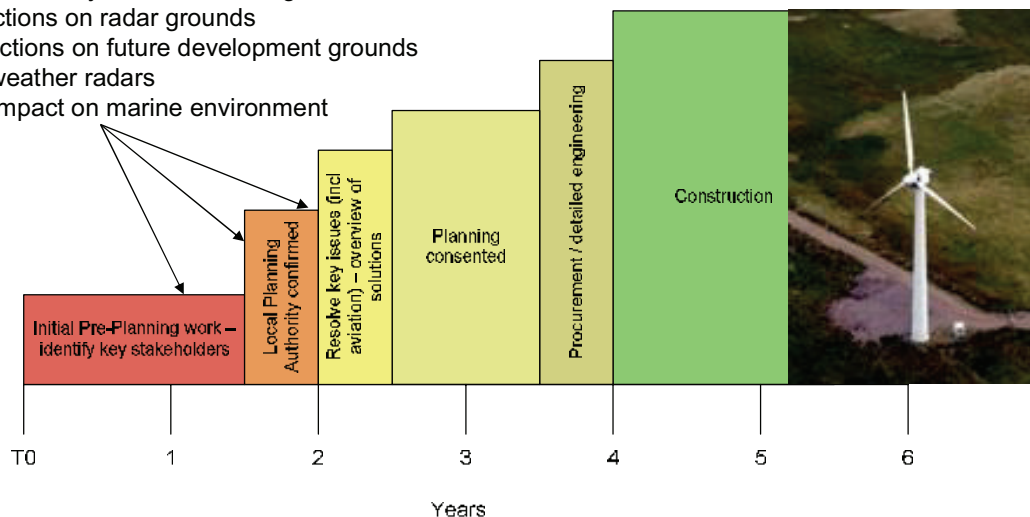
IEA R&D Wind Task 11

1

The UK wind farm procurement process

- Radar concerns need to be understood by developers early

Defence Estates objections on radar grounds
 NATS objections on radar grounds
 Airport objections on future development grounds
 Impact on weather radars
 Offshore - Impact on marine environment



Insyte

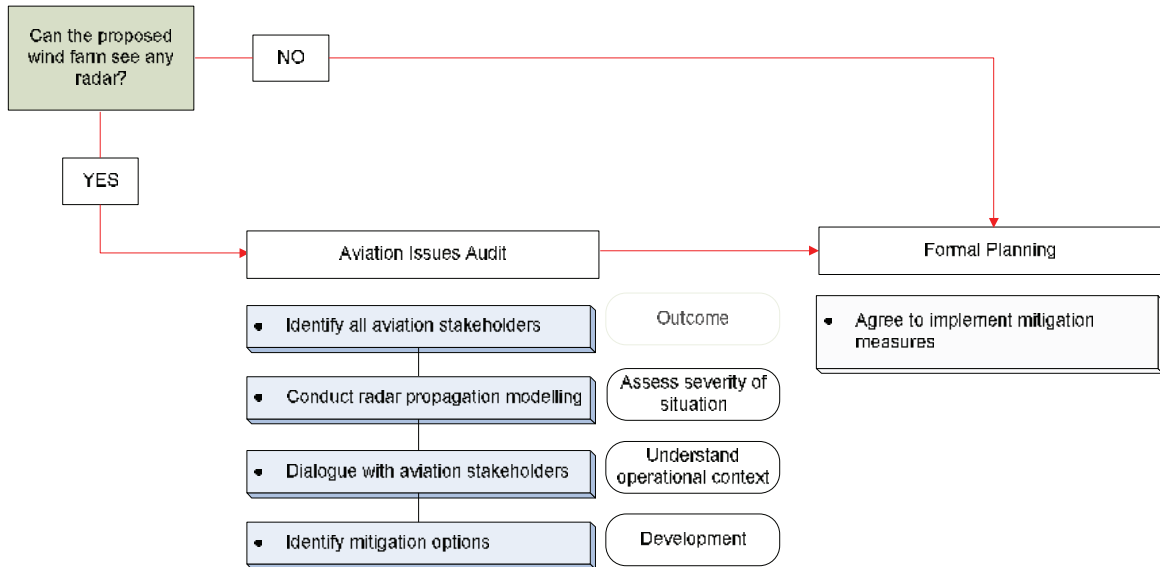
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IEA R&D Wind Task 11

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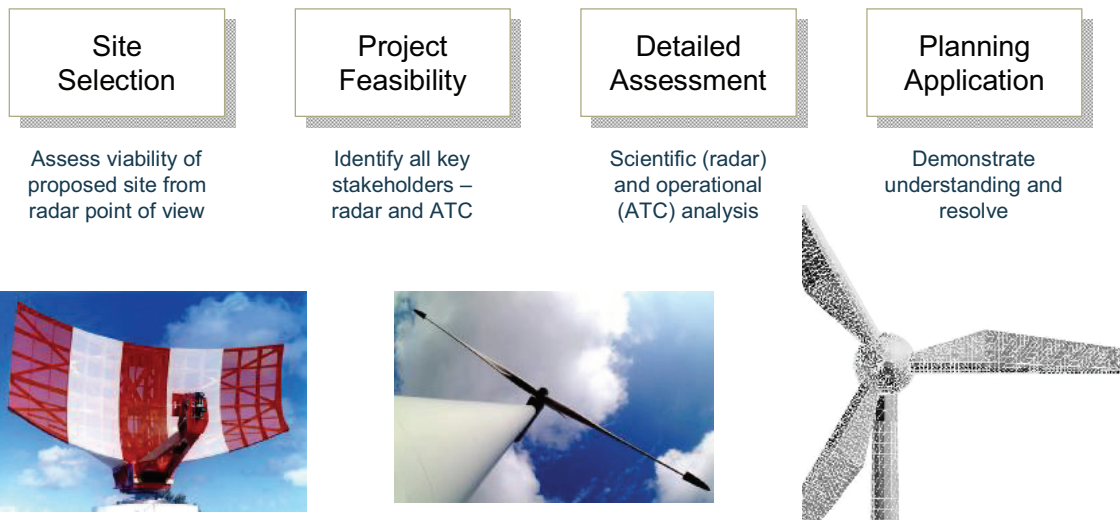
An aviation issues audit

- The need for early assessment of the aviation concerns by stakeholders



Identifying the issues

- Engaging with all key stakeholders early in the planning process:



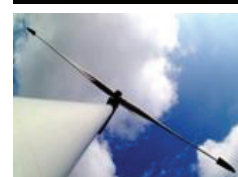
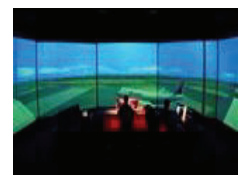
Essential to wind farm co-existence with radar

- Understanding of operational (ATC) environment
- Knowledge of the impact of a proposed site on local radar
- Understanding mitigation solutions available



In summary - technology is not the only option

- Wind Farm developers need to understand what else they can do to remove the effects of their wind turbines on the radar:
 - Location, location, location!
 - Understand natural terrain screening through radar impact assessments
- Radar operators to understand what they can do in terms of adapting operational procedures in the case of turbine interference
 - Within reason
 - Air safety is paramount



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Insyte

IEA R&D Wind Task 11

7

Offshore Wind Energy in the Netherlands - the policy framework

Imar Doornbos

30/3/07 Titel van de presentatie

1

Outline

- I. Introduction
- II. Institutions involved
- III. Decision making procedures
- IV. Main issues
- V. Air traffic
- VI. Next steps

30/3/07 Titel van de presentatie

2

I. Introduction

- densely populated
- extensive use of the North Sea:
 - * major harbour operations
 - * shipping lanes
 - * oil and gas industry
 - * building materials
 - * areas of ecological importance
- large scale offshore wind ambitions



I. Introduction

- Ambitions (BLOW, 2001):

- * 1500 MW on shore
- * 6000 MW offshore



- White Paper Environment & Physical Planning (2004)

- * 6000 MW OWE = "Overriding reasons of substantial national importance" (2004)

I. Introduction

White paper on Environment & Physical Planning (2004)

(separate North Sea paragraph)

- Integral Appraisal Procedure new activities
 - Shipping lanes
 - Military activities
 - Oil and gas production facilities
 - Fisheries
 - Building materials
 - Cables and pipelines
 - Natura2000 areas
 - **Wind energy:**
 - * exclusion policy
 - * 'open horizon' (12 nm borderline)
- "overriding reasons of substantial national importance"*
- * Oil & gas
 - * 6000 MW Wind energy



I. Introduction

- Ambitions (BLOW, 2001):
 - 1500 MW on shore (more or less realised)
 - 6000 MW offshore (2007: 2 windfarms, 228 MW)
- Wbr Environmental license (2004):
 - * some 60 applications
 - * (a handful now in final stage of appraisal procedure)
- MEP financial support frozen (2005)
- New Government - ambitions 2020:
 - (2% energy efficiency – 20 % renewables – 30% CO2-reduction)
- LT Energy Transition approach (TOW 2020)

II. **Institutions involved**



(a) Financial support

- * Ministry of Economic Affairs

- * energy agency SenterNovem
- * TSO-subsiidary EnerQ



(b) Environmental permit

- * Ministry of Transport & Waterworks (North Sea Directorate)

- * advisory bodies:
 - other departments (*T&W, EA, ENV, AgF&Nat, DEF*)
 - North Sea research centre RIKZ

II. **Institutions involved**

(operational) (c) Grid integration & Operations



- * TSO TenneT
- * DTE (regulating body)

(LT vision) (d) Energy Transition (TOW)



- * public-private co-operation
- * advise on transition activities 2020
- * innovation and other opportunities for NL

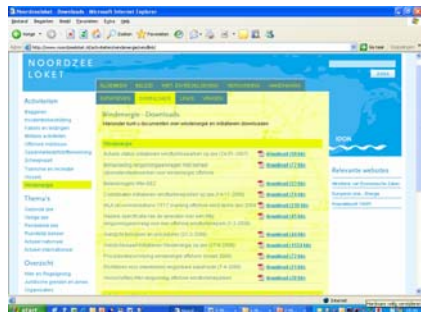
III. Decision making procedures (€ support)



- frequent ECN assessments on required support levels
- originally: 'first come, first served'
- outline new support scheme left to new Government (2006)
- probably: feed in premium – differentiated per RES

III. Decision making procedures (Wbr)

- transparent approach
- structured approach (steps, deliverables, deadlines)
- public participation possibilities



III. Decision making procedures (Wbr)

- limited validity of Wbr license ('use it or lose it');
- financial guarantees for removal of the installation;
- restricted transfer possibility;
- Integral Appraisal Framework (NR):
 - * safety
 - * monitoring & evaluation of ecological impacts
 - * certified installation
 - * maintenance
 - * impact on other users
 - * lightning plan
 - * provisions for accidents
 - * etc.
- evaluation ROUND 2 approach (2007)

IV. Main environmental issues

- shipping safety;
- impact on other users
(aircraft & helicopter operations);
- ecological impacts
 - * sea mammals
 - * underwater noise
 - * accumulative impact

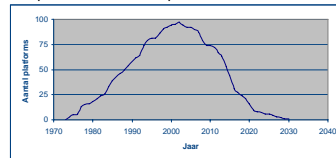


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 - * underwater noise
 - * accumulative impact



Graph: nr. of fields in exploitation:



V. Air traffic

- visibility and access (flight lanes and Helicopter Protected Zones)
- radar (visibility, wind farm design)
- radio communication



VI. Conclusion



- New Government: ambitious renewables targets
- decision making procedures Wbr finalised approx. Summer, 2007



4/3/2007

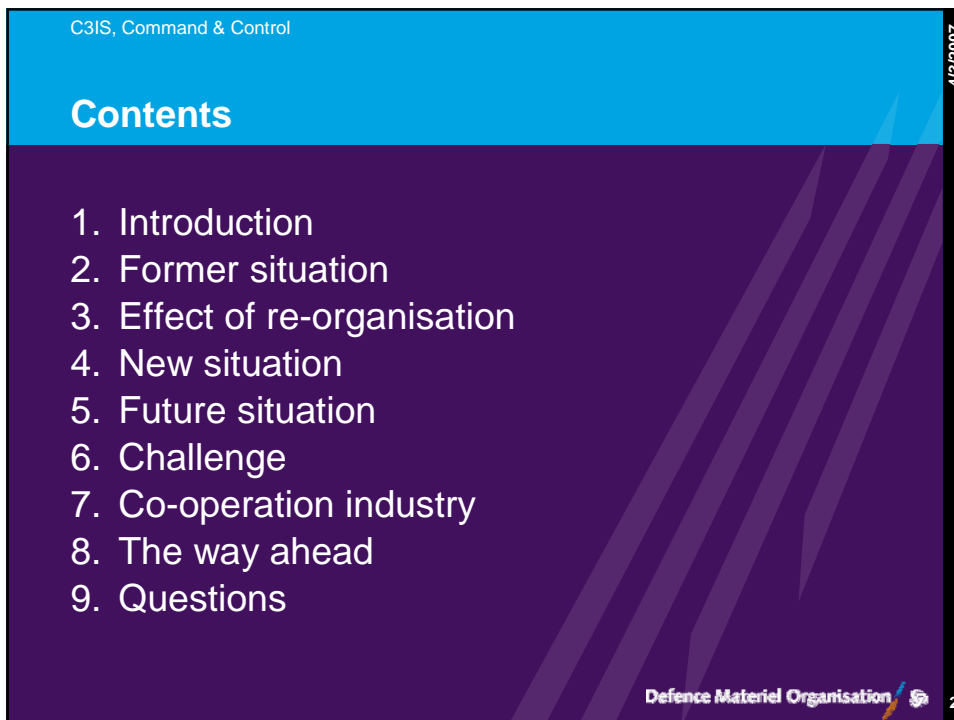
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Change and Challenge

Major Gert van Elderen and Capt André Hilberts
Project manager

C3IS, Command & Control

1




C3IS, Command & Control

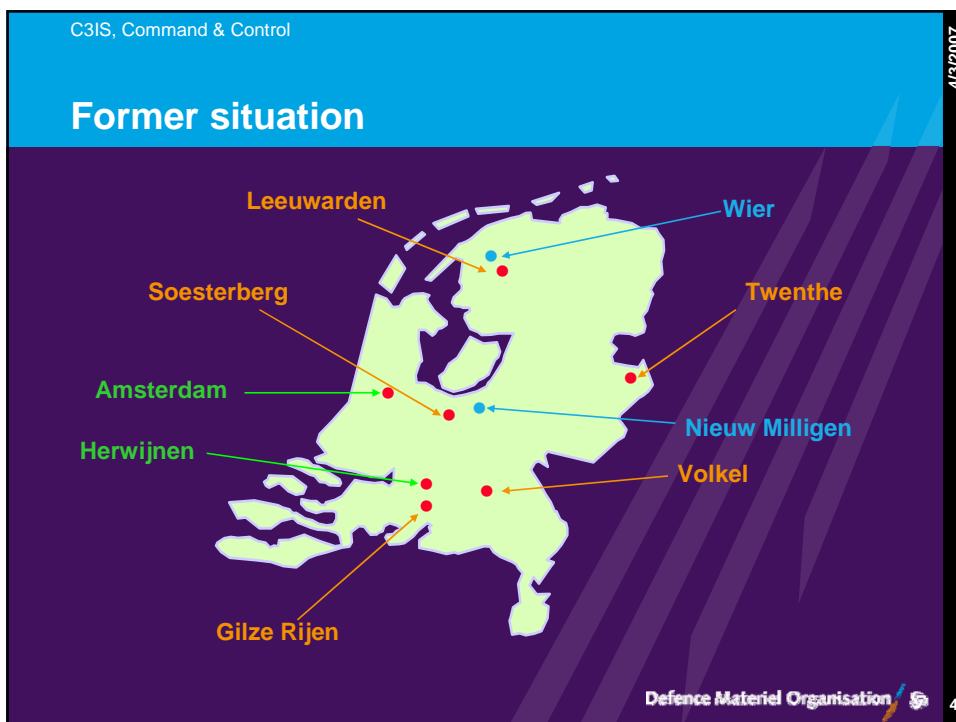
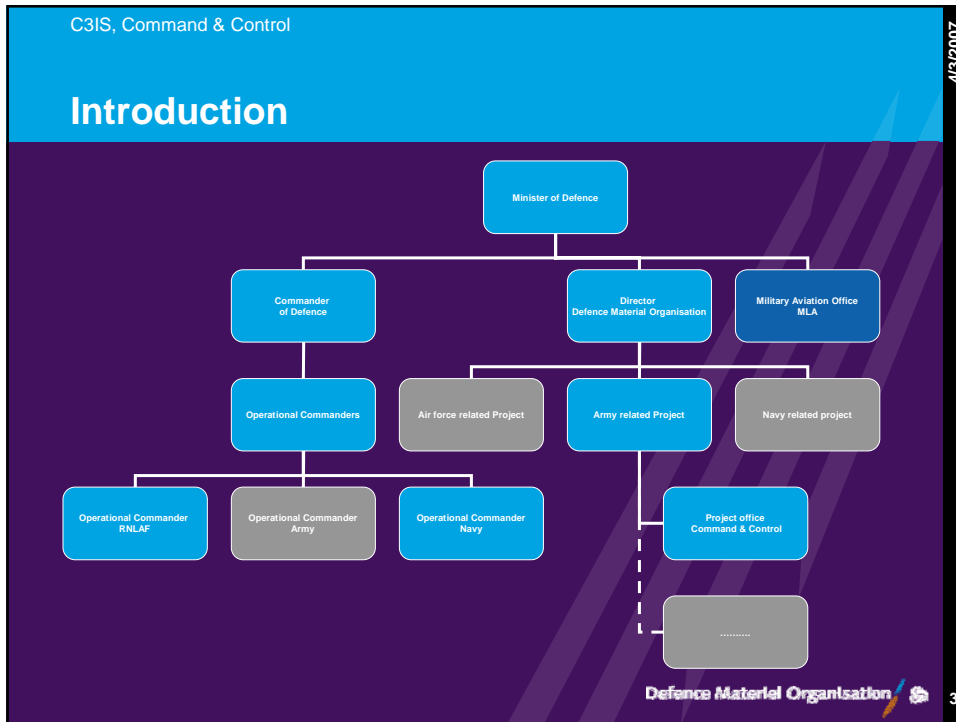
4/3/2007

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1. Introduction
2. Former situation
3. Effect of re-organisation
4. New situation
5. Future situation
6. Challenge
7. Co-operation industry
8. The way ahead
9. Questions

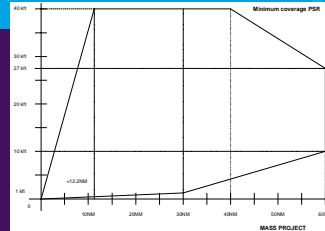
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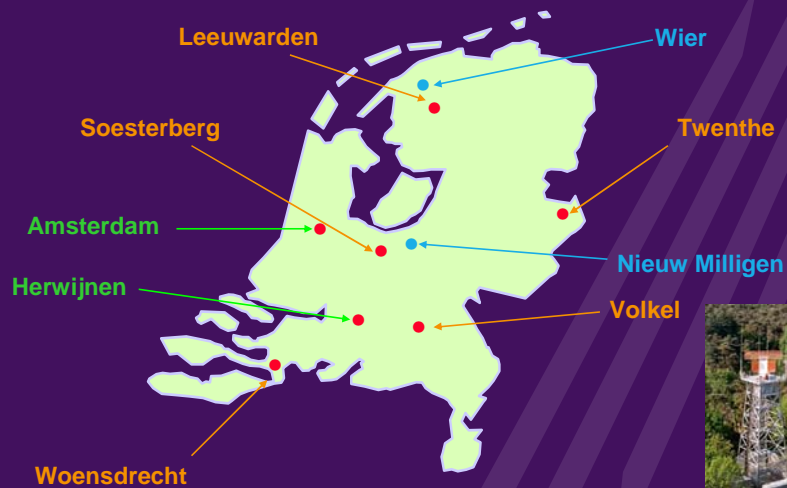


Effect re-organisation

- Military Requirement national coverage 1000 Ft
- Re-placement of old ASR/SSR radar sensors by modern ASR/MSSR radar sensors
- Realisation of national radar network
- Combing of Military and Civil radar systems
- Concentration of Military ATC radar operators



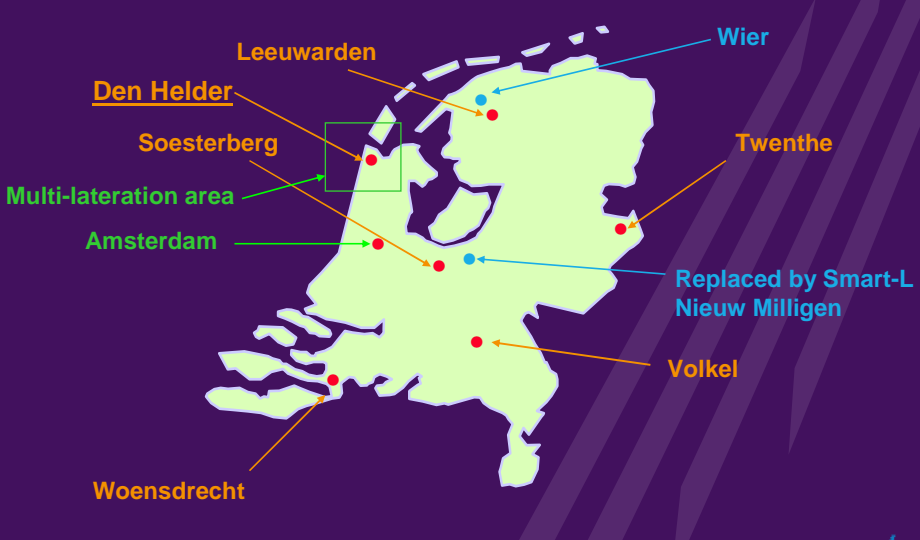
New situation



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“Possible” Future situation



Leeuwarden

Den Helder

Soesterberg

Multi-lateration area

Amsterdam


Woensdrecht

Wier

Twenthe

Replaced by Smart-L Nieuw Milligen

Volkel

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7


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Challenge

Needs for air traffic safety ->
Grow of sensor systems due the fact of increasing air travel

Needs for alternative energy ->
Grow of Wind turbines due the fact of international (European) agreement

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Co-operation industry

Improve of information exchange in early stage

Investigation of wind turbine situation plan:
Improving answering the “Why Not question”

Determine a clear and understandable norm

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The way ahead

Certifying the norm by law

Close co-operation between involved parties
Industry developments
Air surveillance developments

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Questions

4/3/2007



Wind Radar Interference

Status and Changes in the USA

Gary Seifert PE EE

March 2007

Wind Radar Interference Status and Changes in the USA

- Overview
 - Historical Overview
 - Key Stakeholders, and Impacts
 - Recent Developments
 - Current Efforts
 - Next Steps



Historical Overview

- Years of “Out of Sight, Out of Mind”
- RAF Test showed the impact beyond the boundaries of wind farms
- Highlighted the differences between the metrics of the DOD and FAA
- FAA has legislative authority
- DOD has advisory authority
- Other agencies have advisory control
- Multitudes of existing successful wind-radar coexistence



Key Stakeholders

- Green Energy Advocates
 - DOE
 - Renewable Energy Goals
- Department of Homeland Security
- Department of Defense
 - Air Traffic Control
 - Long Range Radar/Air Defense
 - Logistics
- Federal Aviation Agency



Key Stakeholders cont.

- Weather
- Federal Lands Bureaus
- State Land Bureaus
- Local Planning Control Agencies
- Regional Economic Development Agencies
- Radar Manufacturers



Impacts

- Vastly different and dependent on the mission of who is being impacted
 - Air Traffic safety
 - Can the planes be tracked?
 - Primary
 - Secondary
 - Combined
 - ADSB?
 - Does the clutter make safe air space management difficult?
 - Managing Increased commercial Traffic



Impacts

- DOD/DHS
 - Sort out the bad from the clutter
 - Usually the Bad does not use a transponder
 - React and safeguard
- Other DOD
 - ATC concerns similar to FAA
 - Significant push to increase use of and support of renewable energy
 - Train personnel for operations
- Significant impact on rural economics

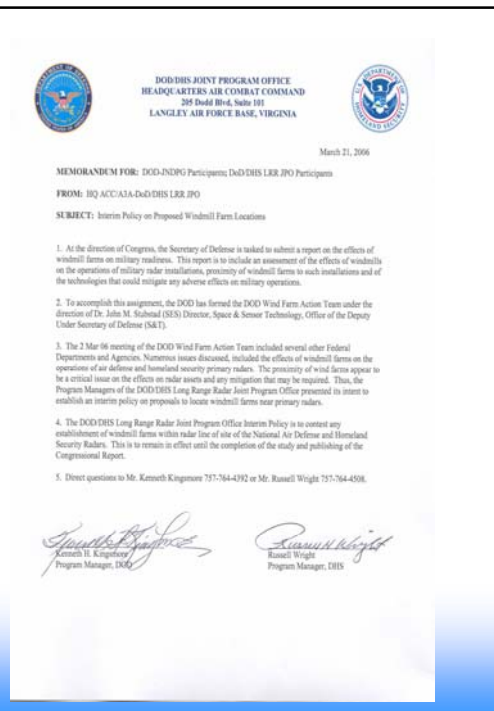


March 21 Letter “Rocked the Wind World”

Central Region of FAA
applied guidance literally

6 states impacted, halting
more than \$1,000,000,000
of project construction for
2007

Received the attention of
DOD, DOE, AWEA,
Congress and Whitehouse



Current Efforts

- Mission and Radar system impacts - a valid concern
- DOD Wind Radar Study issued
 - The Effect of Windmill Farms On Military Readiness
 - <http://www.defenselink.mil/pubs/pdfs/WindFarmReport.pdf>
 - Result - Need more study if wind turbines are in line of sight
 - “Case By Case Assessment” recommended
- DOD R-Y-G screening tool under development
- Multi agency team working policy issues
- Technical team investigating mitigation



DOD Guidance – Case by Case



DOB/DHS JOINT PROGRAM OFFICE
HEADQUARTERS AIR COMBAT COMMAND
285 Dodd Bldg, Suite 181
LANGLEY AIR FORCE BASE, VIRGINIA



July 10 2006

REPORT TO THE CONGRESSIONAL DEFENSE
COMMITTEES

MEMORANDUM FOR: Mr. Swancy
FA Headquarters
501 Independence Ave. SW
Room 3018
Washington, DC 20501

FROM: HQ ACC/AJA

SUBJECT: Intent of the DOD/DHS IPO March 21, 2006 Memorandum

The Effect of Windmill Farms On Military Readiness
2006

Dear Mr. Swancy,

We want to reiterate our position as discussed during the conference call held 1 June 2006, regarding the intent and meaning of the interim policy on proposed windmill farm locations, set out in a memorandum issued by this office on March 21, 2006.

As discussed during the call, DOD/DHS IPO does not oppose windmill farms nor do we advocate any type of blanket "moratorium" on the siting of such facilities. Simply put, our policy is that any proposal for a windmill farm should be properly evaluated and reviewed to ensure there are no potential adverse impacts on military and other national security operations.

Accordingly, we will continue our standard practice and procedure of reviewing any such proposals on a project-by-project basis. Where our assessment of a particular project suggests potential adverse impacts to military or other national security operations, we shall raise those concerns with the appropriate regulatory authority in order to mitigate or prevent the adverse effects of that project.

If you have any questions regarding this matter, please direct your questions to Mr. Kenneth Kingman, 757-764-4392 or Mr. Russell Wright, 757-764-4508.

Sincerely,

Kenneth P. Kingman
Program Manager, DPO

Russell Wright
Program Manager, DDES



Office of the Director of Defense Research and Engineering

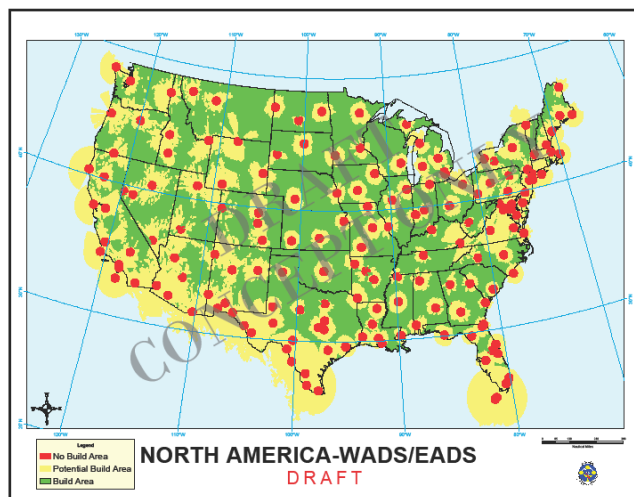


Recent Developments

- DOD started development of a red, yellow, green guidance mapping system
 - Red – Very restrictive and not likely to be allowed
 - Yellow – Negotiable based on height
 - Green – Good to go up to 750' for Air Defense Radar concerns
- Based on 750' AGL mapping
- Red based on 20 NM Exclusion Zone
- Allows developers to assign risk up front
- Under comment and review



R-Y-G Concept - Under Development



Ongoing Activities cont.

- DOE, FAA, DOD working group focused on mitigation and paths forward
- No consistent permitting process in place – Yet!!!
 - No single agency
 - FAA being very supportive and prompt
 - Developers/utilities now have access to radar siting feedback early in development process (Kenneth Kingsmore at DOD/DHS JPO)
- Working issues to help local planning and zoning agencies obtain guidance and help



Next Steps

- Radar Manufacturers developing mitigation processes
 - Modern Radar Systems have better capabilities to address impacts
 - Stockton and Anchorage Airport/FAA evaluating upgrades & software tuning to the ASR-11
 - ASR-9's improved Doppler filter reduced impacts on Palm Springs, Boston, and other airport radar systems
 - BAE and SENSIS offering improved Automatic Tracking Software upgrades
 - QinetiQ developing assessment tools predicting radar performance
 - Refine R-Y-G process
 - Address processing of low beams separate from high beams in a multitude of radar systems
 - Support radar system optimization



Summary

- Remember, in all cases where the radar sees the wind turbine, there is some interference
 - Remember, turbines are big reflectors
 - They are both fixed and moving target systems
 - Doppler is an issue
 - Impact is the important question, not interference
 - Does the interference impact the mission
- Case by case assessment often the best first step
- The fine art of compromise is needed
- Technology improvements show great promise
- Location is key



Questions?



Gary Seifert EE PE
Idaho National Laboratory

gary.seifert@inl.gov

208-521-8385



IEA RD&D Wind
– Annex XI
Oxford 2007

Topical Expert meeting #53 on Radar, Radio and Wind Turbines

The Swedish Energy Agency

Susanna Widstrand, Ph.D.
Programme Manager



Outline

- Swedish Energy Policy
- The Swedish Energy Agency
- Radar - wind power projects



Susanna Widstrand

Outline

- Swedish Energy Policy
- The Swedish Energy Agency
- Radar - wind power projects

Swedish Energy Policy

Security of supply

- Self-sufficiency in power generation at competitive prices
- With the least possible impact on people and environment

Sustainability

- Promote the development of a ecologically and economically sustainable energy system
- Contribute to a broader cooperation about energy-, environment- and climate issues in the Baltic Sea region

Competitiveness

- Liberalization of Electricity and Gas Markets

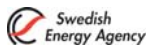
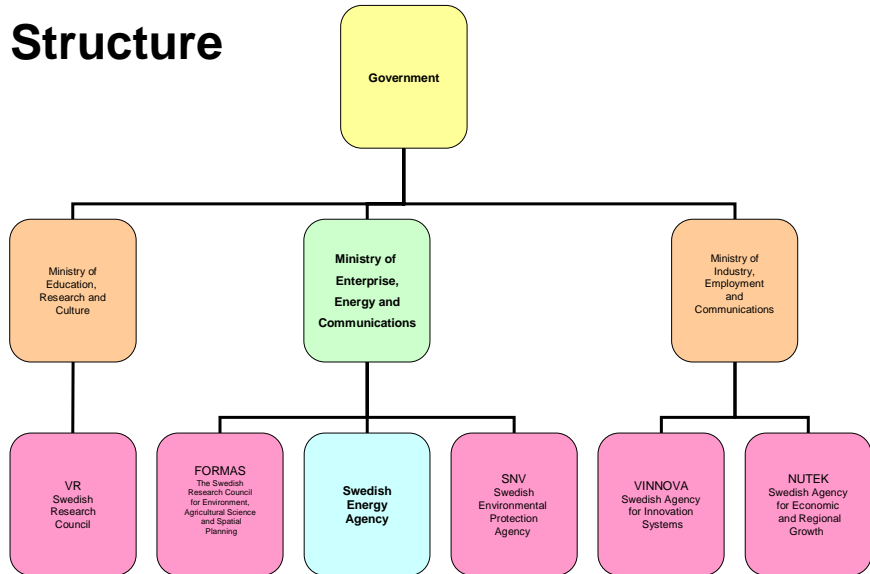
Planing goal of Sweden

- 10 TWh electricity from wind year 2015 (Prop 2002)
- Today 1 TWh

Outline

- Swedish Energy Policy
- [The Swedish Energy Agency](#)
- Radar - wind power projects

Structure



Susanna Widstrand

Swedish Energy Agency Eskilstuna

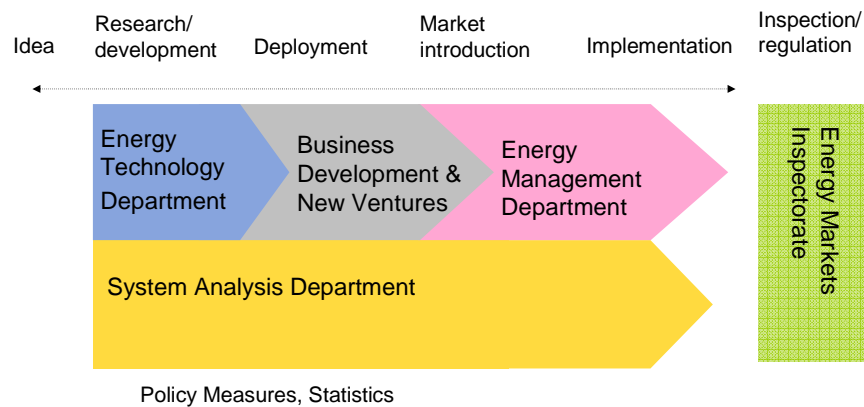


- Formed in 1998
- Office in Eskilstuna 120 km west of Stockholm
- Small office for meetings in Stockholm
- Employs around 300 people



Susanna Widstrand

The Departments of the Swedish Energy Agency



Energy Technology Department

- 3 units
- **Power production unit**

Wind power section

Susanna Widstrand (wave power, fusion)

Anders Björck

Christina Bergström

Swedish Energy Agency

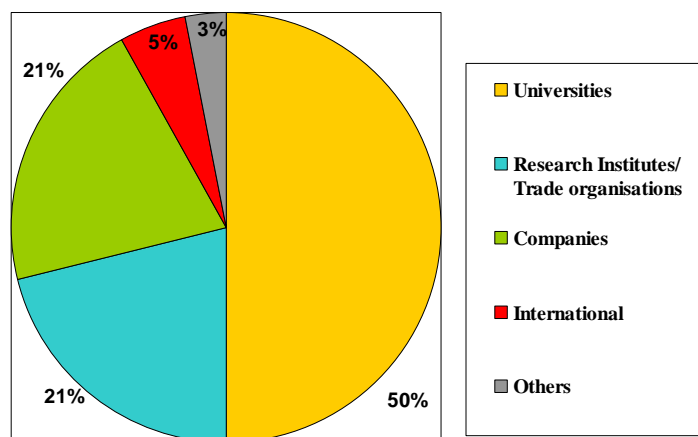
A mission-oriented agency

- Responsible (and authorized) to implement Swedish Energy RD&D policy
- Covers basic energy-related science towards implementation
- Funds per year: 88 Million € for Energy RD&D
- No specific time for application entries
- Some 50 programmes and additional 700 projects running
- In-house priority settings and evaluation of proposals



Susanna Widstrand

Receivers of funds 2002-2004, 220 Million €



Susanna Widstrand

