January, 2007

To Members of the Executive Committee, IEA RD&D Wind, Task 11

INVITATION TO TOPICAL EXPERT MEETING # 53
ON
RADAR, RADIO AND WIND TURBINES

Dear Colleague,

At the Executive Committee meeting #58 in Adelaide, it was decided to arrange a Topical Expert Meeting on "Radar, Radio and Wind Turbines". Date and venue for the meeting is as follows:

29th and 30th of March 2007
Oxford, UK

The meeting will begin at 09.00 on Thursday and end around 14.00 on Friday.

Would you please forward an invitation to 2-4 people from your country that will be able to discuss the subject in detail and give a short presentation relevant to the topic? An introductory note, to the meeting, has been prepared by the UK's Department of Trade and Industry and Future Energy Solutions, see attachment.

Proceedings from the meeting will be distributed soon after the symposium. To assist in this the participants are urged to bring along one copy of the material they want to have included in the documentation, or send a copy in advance.

Details on travel and accommodation can be found on the following pages. Contact person is Georgina Webb by email georgina.webb@aeat.co.uk.

Please inform me and Georgina Webb of the names of the participants from your country as soon as possible. A registration form is attached to this letter.

Best regards

Sven-Erik Thor
E-mail: sven-erik.thor@vattenfall.com

Attachments:
1. IEA Background and meeting format
2. Practical arrangements
3. Introductory note

Postal address:
Vattenfall AB, Windenergy
162 87 Stockholm
Sweden

Visiting address:
Jämtlandsgatan 99
Råcksta

Telephone:
+46 8 73 969 73

Telefax:

IEA Background and Meeting Format

The objective of IEA RD&D Wind Task 11 is to promote wind turbine technology through cooperative activities and information exchange on RD&D topics of common interest. The Topical Expert Meetings and Joint Action Symposia are of the workshop type, where information is presented / discussed freely in an open manner. See the following web page for more details: http://www.ieawind.org/Task_11/Task_11_HomePage.html and click on "General description and meeting format"

More information can be obtained from:

IEA RD&D Wind general	www.ieawind.org
Annex XI information	http://www.ieawind.org/summary_page_xi.html
IEA official home page	http://www.iea.org/

Practical Arrangements

There is no cost for participating in the symposium, except for your personal travel and accommodation costs.

Date and venue

Date: March 29 – 30, 2007
Thursday and Friday

The meeting will be held at The Oxford Thames Four Pillars Hotel, please see attached for a map and directions. Registration on day 1 will begin at 08.30hrs on Thursday 29 March 2007, with the meeting starting promptly at 09.00hrs. On day 2 the meeting will reconvene at 09.00hrs and will end at 12.30, followed by a lunch for those who wish to stay.

Dinner

You are also invited to a dinner, hosted by the DTI, on the evening of 29th March. If you would like to attend, again please tick the relevant box on the Registration Form.

Registration

If you would like to attend this meeting and the evening dinner, please complete the attached Registration Form and return to Georgina Webb by email georgina.webb@aeat.co.uk or fax +44 (0) 870 190 6318 by 19th March 2007.

Meeting place and Hotel

Please book your accommodation directly to the hotel:

Oxford Thames Four Pillars Hotel
Henley Road
Sandford on Thames
Oxford, OX4 4GX
Tel: (01865) 334444
Fax: (01865) 334400
Email: thames@four-pillars.co.uk

Travel Directions

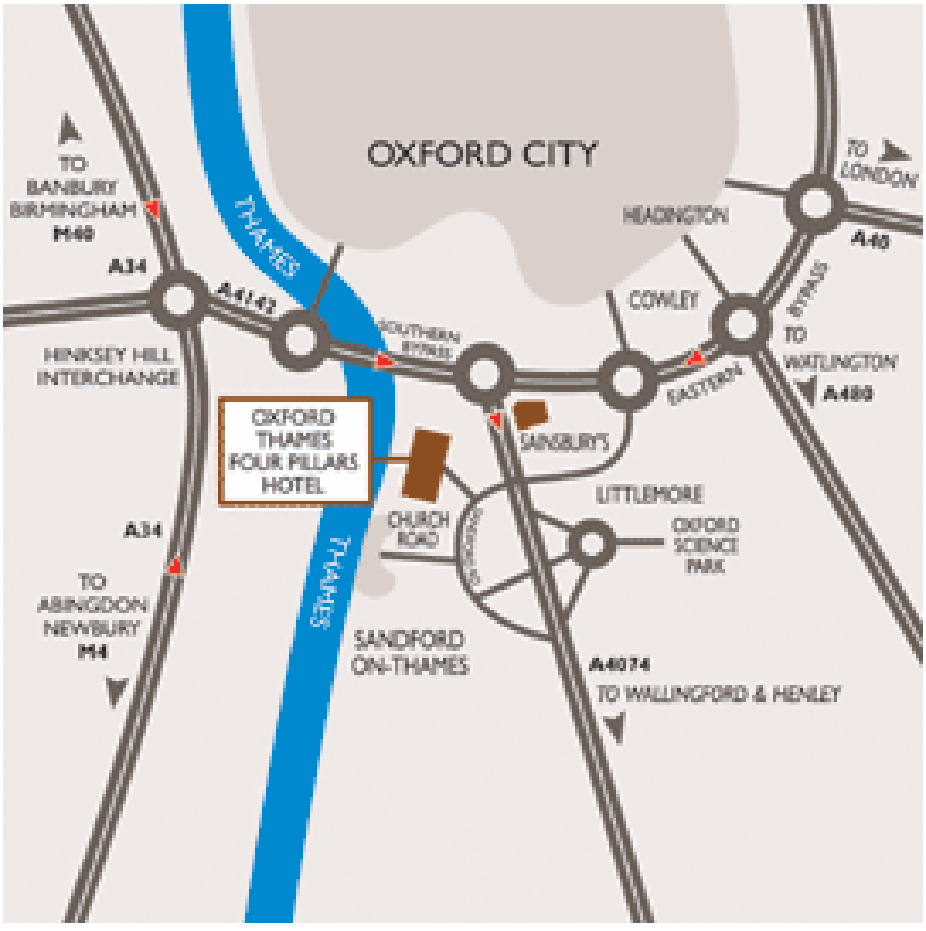
Driving

From London leave M40 at junction 8, A40 Oxford, at roundabout (Headington), 1st exit left ring road A40 towards Cowley (A4142). Carry on past BMW Works, over flyover, next roundabout with traffic lights, take exit left (signposted Littlemore). Road is called Oxford Road. Stay on this road for 1 mile, the Hotel is on the right on Henley Road.

Driving From North M40, junction 9, A34 towards Oxford, exit at Hinksey Hill Interchange, onto A4142. At 2nd roundabout by Sainsbury's take the 3rd exit (Henley/Sanford/A4074). Take 1st exit (Oxford Science Park/Sandford) and at the end of the slip road, follow signs on roundabout to Sandford. At 'T' junction (Henley Road) turn right. The Hotel is another 1/2 mile on the left.
Driving From South leave M4 at junction 13 onto A34 and then follow the instructions above. Private car parking is available.

Trains
First Great Western Trains have regular services from London Paddington to Oxford. Journey time approx 1 hour, cost approx £35 return. www.trainline.co.uk

Busses
Oxford Tube offer frequent buses from central London. Journey time approx 1 hour 40 minutes, cost £17 return.
The Oxford Bus Company offer buses from both Heathrow and Gatwick airports. Journey time approx 1 hour 40 minutes, cost £18 return for Heathrow and £26 for Gatwick. www.oxfordbus.co.uk



IEA Radar, Radio and Wind Turbines
The Oxford Thames Four Pillars Hotel, Oxford
29 - 30 March 2007

REGISTRATION FORM

Please complete one registration form per delegate.

Title (Dr/Mr/Mrs/Ms) _____ Initials _____ Surname _____

Position/Job Title _____

Company/Organisation _____

Address _____

Postcode _____ Country _____

Telephone _____ Fax _____

Email _____

Further Information and confirmation details will be sent via email so please ensure your email address is clearly written

I wish to attend as a delegate

- Thursday 29 March 2007 Yes No
- Friday 30 March 2007 Yes No

I will attend the evening dinner on 29 March Yes No

Special dietary requirements_____

Please return completed form to Georgina Webb, Events Manager by 19 March 2007, by fax +44 (0) 870 190 6318, email georgina.webb@aeat.co.uk or post to Georgina Webb, IEA Event , AEA Energy & Environment, Gemini Building, Harwell, Oxon, OX11 0QR.

Agenda and confirmation, including directions will be sent out by email week commencing 26 March 2007.

INTRODUCTORY NOTE

IEA TOPICAL EXPERT MEETING # 53
ON
RADAR, RADIO AND WIND TURBINES

prepared by the UK's Department of Trade and Industry and Future Energy Solutions

BACKGROUND

Harnessing wind resources worldwide is important in tackling climate change with the development of the wind industry increasingly being viewed as a key renewable energy source. At the close of 2005, 87% of the 59.2 GW[1] of worldwide wind generating capacity was located in the member countries of the IEA Wind Implementing Agreement. The 20 IEA Wind Member Countries reported about 51.4 GW of total installed wind generation capacity, which represented a greater than 20% increase in total capacity over 2004 (Table 1). Located in Europe, North America, Asia, and the Pacific Region, the member countries view wind energy as an important energy source and are planning activities and setting targets (stretching out to 2015 in some cases) to increase the contribution of wind energy to their electrical generation mix.

TABLE 1 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%
* includes estimates	

However, it is recognised that wind turbines can have an adverse effect on the aviation domain. Therefore developments must take place in a way which takes full account of national air defence and air safety with both the wind energy and aviation communities understanding the needs of each other.

In some Member Countries planning objections relating to radar interference have sterilized areas of land from wind energy deployment. Elsewhere there is increasing concern about the accumulative impacts of wind turbines on aviation interests. In the US a report was recently submitted to the US Congressional Defense Committee outlining the effect of windmill farms on military readiness.

The aviation community worldwide has procedures in place which are designed to assess the potential effect of developments such as wind farms on its activities and, where necessary, to identify mitigating measures. Both wind energy and aviation are important to Global interests. Furthermore, defence remains one of the prime responsibilities of any

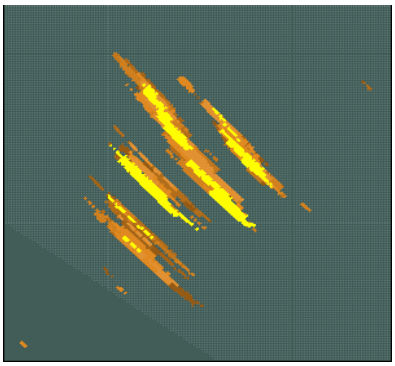
[1] Windpower Monthly (world statistics issue) Wind Power Monthly, April 2006, published in Denmark by Wind Power Monthly News Magazine A/S, managing editor – Lyn Harrison, v. 22, #4, ISSN 0109-7318.

Government. All communities involved in wind energy and aviation have legitimate interests that must be balanced to identify a way ahead that gives the best results, taking into account each country's overall national context. Neither aviation nor the wind industry is static and developments can be expected in both domains that may change the effects they have on each other.

THE PROBLEM

As wind turbines increase in size and number their potential impact on aviation operations increase. It is therefore essential that the safety of aerodromes, aircraft and airspace continue to be guaranteed. Interactions between wind turbines and aviation activity are potentially complex and can result in phenomenon commonly known as clutter, scattering or masking (shadowing). There are basically two ways in which the construction of a wind turbine or wind farm may impact upon aviation operations:

- the physical obstruction caused by a tall structure, and
- the effects that the supporting structure and rotating turbine blades can have on CNS systems (including radar) and other equipment



The potential impacts of wind farms on air traffic management include the cumulative effects on airspace management and surveillance infrastructure and affect the following systems:

a) Primary Radar.
b) Secondary Surveillance Radar (SSR).
c) Microwave links associated with a) and b).
d) Navigation Aids (Navaids).

International Experience

In March 2005 the 45th IEA R&D Wind Topical Expert Meeting (TEM) was held, entitled "Radar, Radio, Radio Links and wind turbines". The objective of this meeting was to promote wind turbine technology through cooperative activities and information exchange on R&D topics of common interest. These TEMs and Joint Action Symposia are of the workshop type, where information is presented/discussed freely in an open manner.

A total of 27 participants attended the 45th TEM with representatives from; Norway, Sweden, the Netherlands, UK and USA. A broad spectra of organisations were present encompassing: government agencies, R&D establishments, private companies and developers.

Presentations were centered round the following topics:

- National policies, experience and regulations
- Radar interference and related issues
- Other topics including radio links and direction finding
- Mitigating technologies/preventive measures

Many of the presentations highlighted that one of the major constraints on the deployment of wind energy is the restriction on siting turbines due to the potentially hazardous effects they may have on aviation and related defense interests. Objections have arisen over the potential effects on radar systems for both air traffic control, air defence and other navigational systems. However, it was apparent that the interference/disturbance caused by wind turbines on various radar systems was not fully understood and there appeared to be a

lack of consensus throughout Europe as to the severity of such effects and how they should be calculated.

The presentations concluded that mitigating technologies and computer software solutions such as radar filters and intelligent processing of multiple sensor data are available and being progressed with the aim of finding workable solutions to the radar problem that are acceptable to aviation regulators worldwide.

PROGRESS IN THE UK

In the UK, the Department of Trade and Industry (DTI) has set up a 'Wind Energy, Defence and Civil Aviation Interests Working Group' to investigate the issue and improve understanding within both the aviation and wind energy industries.

Great strides have been made in understanding the technical elements of the problem but also in improving the planning consultation processes. There is now a strong robust working relationship between the two industries, particularly within the military community. One example of close cooperation has led to planning consent for the Whitelee wind farm in Scotland. When built it will have a capacity to generate 322 megawatts (MW) of electricity, and will be one of Europe's largest wind farms.

Since 2002 a much clearer understanding of the effects causing interference of aviation systems by wind turbines has been developed. This is enabling a prioritised programme of work to be developed to mitigate interference. It is clear that there is no single solution, but potential solutions have been identified to mitigate interference for:

- Air Defence
- Air Traffic Control (military and civilian airports)
- En-route communication and navigation

In the UK a programme has been agreed to deliver these potential solutions so that they can be safely adopted by the aviation industry and therefore ensure that objections from the Aviation industry do not prevent developers constructing enough wind farms to meet government objectives. Main activities include:

- **MoD and NATS pre-consultation process**:
  Early consultation with aviation stakeholders will help wind turbine developers identify, understand, and (hopefully) resolve problems before the formal planning stage.
- **Development of mitigation solutions and trials which include**:
  - a series of AD and ATC trials undertaken by the MOD to enable a better understanding of the wind turbine interference with radar systems
  - development and demonstration of software mitigating technologies to optimise radar systems in mitigating radar/wind interactions
  - feasibility studies to investigate the potential of in-fill radar
  - projects supported by the UK government investigating the use of radar absorbent materials to demonstrate the benefit of stealthy wind turbines

In parallel with this work guidelines have been created to assist wind energy developers and planning authorities, which outline the interactions between wind farms and aviation[2].

[2] 'Wind Energy and Aviation Interests – Interim Guidelines' (ETSU W/14/00626/REP), DTI, October 2002.

BENEFITS OF IEA COOPERATION

It has become apparent that individual countries have rather different ways of approaching the issue of wind farms and their effects on aviation and radio transmission. Unsurprisingly, countries with large installed wind energy capacity, have well-developed and efficient systems for dealing with planning and approval issues. In contrast countries, where wind energy is still in its infancy, systems are still evolving.

Along with benefits, the growth of the wind energy sector has generated new issues. The member countries of IEA R&D Wind are always considering new opportunities for international collaboration to increase knowledge, understanding and to be proactive when dealing with new issues, before or as they arise. In view of the different approaches to the problems associated with wind farms and the aviation community it is important that the wind industry provide the opportunity for specialists from both the wind and aviation community to debate issues with the common objective to work as a partnership. One such opportunity is this IEA Topical Expert Meeting being held to inform participants of the issues that exist, how these are being resolved and the latest developments on mitigating interference.

TOPICS

The following list shows possible items, but not limited to, which will be discussed at the symposium.

- National policies, experience and regulations
- Radar interference and related issues
- Other topics including radio links and direction finding
- Mitigating technologies/preventive measures

TENTATIVE AGENDA

The tentative agenda covers the following items:

1. Introduction by host
2. Introduction by Operating Agent, Recognition of Participants
3. Collecting proposals for presentations. The participants are encouraged to inform the Operating Agent on the contents of their presentation in advance and if possible provide a copy. The participants are also encouraged to in advance suggest relevant discussion matters that would have their interest.
4. Presentation of Introductory Note.
5. Individual presentations
6. Discussion
7. Summary of meeting

EXPECTED OUTCOMES

One of the goals of the meeting will be to gather the existing knowledge on the subject and come up with suggestions / recommendations on how to proceed with the following:

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

INTENDED AUDIENCE

The national members will invite potential participants from research institutions, utilities, government other organizations willing to participate in the meeting by means of presenting proposals, studies, achievements, lessons learned, and others..