Committee for the Environment

Report on the Committee's Inquiry into Wind Energy Volume 7

Other papers submitted to the Committee and List of Witnesses

Ordered by the Committee for the Environment to be printed 29 January 2015

Mandate 2011/16 Seventh Report - NIA 226/11-16

Membership and Powers

The Committee for the Environment is a Statutory Departmental Committee established in accordance with paragraphs 8 and 9 of the Belfast Agreement, section 29 of the Northern Ireland Act 1998 and under Standing Order 48.

The Committee has power to:

- Consider and advise on Departmental budgets and annual plans in the context of the overall budget allocation;
- Consider relevant secondary legislation and take the Committee stage of primary legislation;
- Call for persons and papers;
- Initiate inquires and make reports; and
- Consider and advise on any matters brought to the Committee by the Minister of the Environment

The Committee has 11 members including a Chairperson and Deputy Chairperson and a quorum of 5. The membership of the Committee since 9 May 2011 has been as follows:

Ms Anna Lo MBE (Chairperson)
Ms Pam Cameron (Deputy Chairperson)[1]
Mr Cathal Boylan
Mr Colum Eastwood[2]
Mrs Sandra Overend[3, 4]
Mr Alban Maginness[5, 6]
Mr Ian McCrea[7, 8, 9, 10]
Mr Barry McElduff[11, 12]
Mr Ian Milne[13, 14]
Lord Morrow
Mr Peter Weir

1 With effect from 10 September 2013 Ms Pam Cameron replaced Mr Simon Hamilton as Deputy Chairperson
2 With effect from 18 June 2012 Mr Colum Eastwood replaced Mr John Dallat
3 With effect from 23 April 2012 Mr Tom Elliott replaced Mr Danny Kinahan
4 With effect from 04 July 2014 Mrs Sandra Overend replaced Mr Tom Elliott
5 With effect from 23 April 2012 Mrs Dolores Kelly replaced Mr Patsy McGlone
6 With effect from 07 October 2013 Mr Alban Maginness replaced Mrs Dolores Kelly
7 With effect from 20 February 2012 Mr Gregory Campbell replaced Ms Paula Bradley
8 With effect from 01 October 2012 Mr Alastair Ross replaced Mr Gregory Campbell
9 With effect from 07 May 2013 Mr Sydney Anderson replaced Mr Alastair Ross
10 With effect from 16 September 2013 Mr Ian McCrea replaced Mr Sydney Anderson
11 With effect from 08 May 2012 Mr Chris Hazzard replaced Mr Willie Clarke
12 With effect from 10 September 2012 Mr Barry McElduff replaced Mr Chris Hazzard
13 With effect from 07 April 2013 Mr Francie Molloy resigned as a Member
14 With effect from 15 April 2013 Mr Ian Milne replaced Mr Francie Molloy

Table of Contents

List of abbreviations

The Minister	The Minister for the Environment
The Department	Department of the Environment
AM	Amplitude Modulation
AONB	Area of Outstanding Natural Beauty
CIEH	Chartered Institute of Environmental Health
DETI	Department of Enterprise, Trade and Investment
DOE	Department of the Environment
EIA	Environmental Impact Assessment
ETSU	Energy Technology Support Unit
EU	European Union
HSENI	Health and Safety Executive Northern Ireland
MW	Megawatt
NIAPA	Northern Ireland Agricultural Producers Association
NIE	Northern Ireland Electricity
NIRIG	Northern Ireland Renewables Industry Group
NREAP	National Renewable Energy Action Plans
PAD	Pre-application Discussion
PfG	Programme for Government
PHA	Public Health Agency
PPS	Planning Policy Statement
QUB	Queen’s University Belfast
RES	Renewable Energy Systems
SPPS	Single Planning Policy Statement
ToR	Terms of Reference
UFU	Ulster Farmer’s Union
UU	University of Ulster

List of Other Papers

Papers relating to the Review

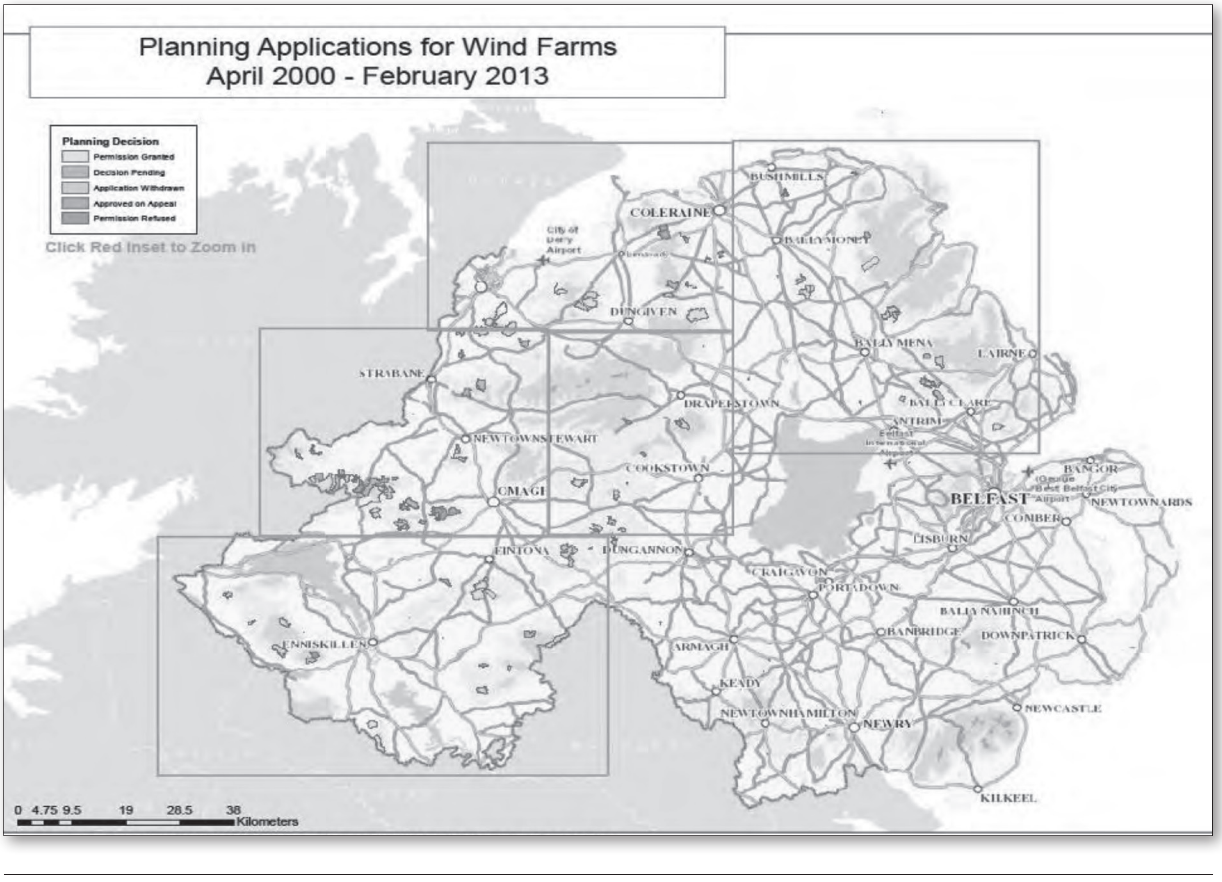
1. Department letter re Planning Policy Statement 18
2. Department reply re request for information re Wind Turbine Applications
3. Windwatch briefing paper from informal meeting
4. Department reply to issues raised by Windwatch
5. Fermanagh Trust research Report on Community Engagement
6. Windwatch briefing paper on 27th June 2013
7. Omagh and Strabane District Councils briefing paper on 27th June 2013
8. Department reply to issues raised by Omagh and Strabane District Councils
9. DARD letter to Committee re Wind Energy
10. Emails from West Tyrone Against Wind Turbines
11. Letter from ORRA Action Group
12. Omagh and Strabane District Councils response to Committee
13. NIRIG briefing paper on 12th September 2013
14. NIRIG briefing note on Wind Turbine Noise on 12th September 2013
15. NIRIG follow up information from briefing on 12th September 2013
16. NIRIG response re correspondence from Windwatch
17. DETI response to written evidence from Omagh and Strabane District Councils
18. Wind Energy Review submission – Mr John Wilson
19. Wind Energy Review submission – Mr Ralph Erskine
20. Wind Energy Review submission – Prof Geraint Ellis
21. Wind energy review submission – SSE Renewables

Papers relating to the Inquiry

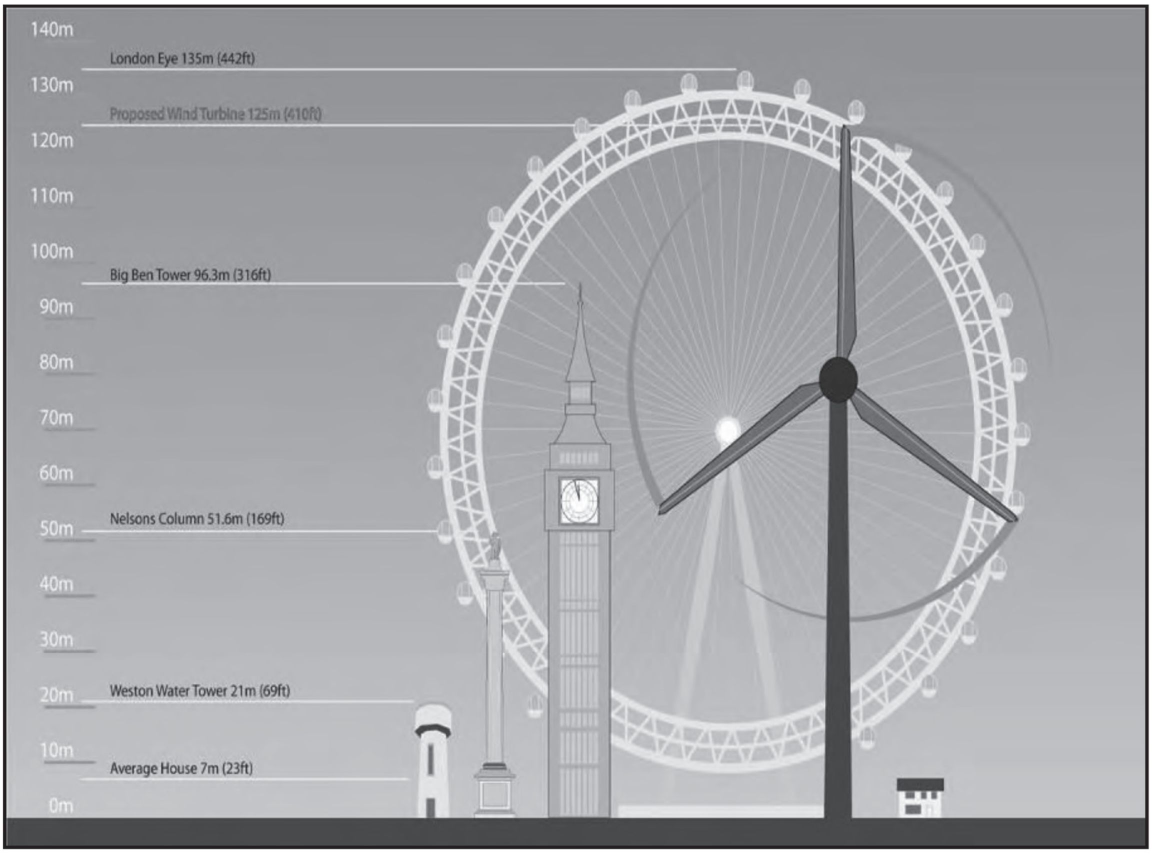
22. Action Renewables report – Communities & Renewable energy: A Study
23. Association for Public Service Excellence presentations
24. Letter from Omagh District Council re draft guidance on community benefits
25. SSE Airtricity re NI Community Fund
26. Simple Power
27. NIFPO Ltd letter re potential impact of proposed Offshore Wind Farm Development on NI Fishing Industry
28. Follow up from the Chartered Institute of Environmental Health
29. Report from Specialist Advisor Ursula Walsh

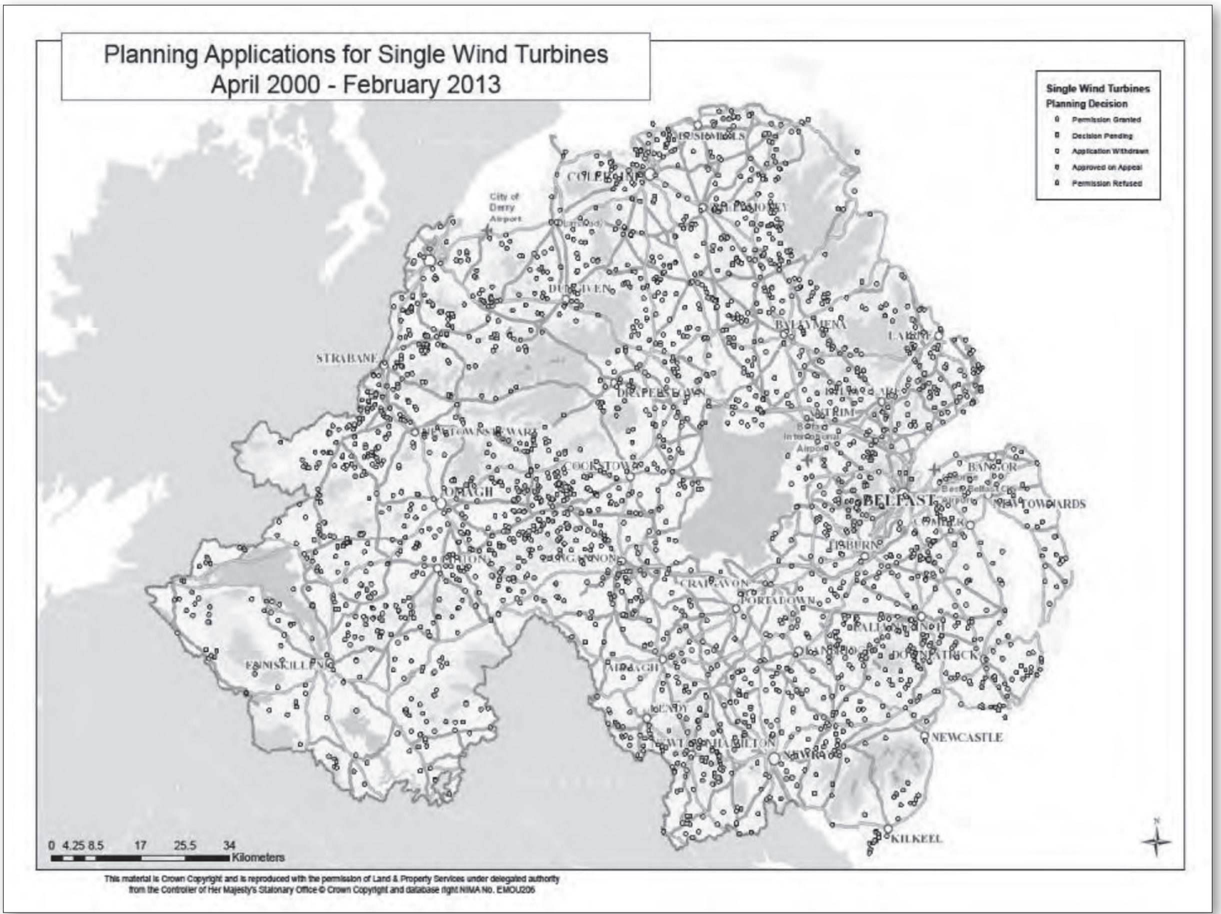
30. Report: ‘Wind Turbines in Denmark’ – Danish Energy Agency
31. NIRIG briefing paper 23rd October 2014
32. Windwatch – Comments on UU survey ‘Living with wind turbines’
33. Windwatch – 20 questions for the wind industry
34. Windwatch – briefing paper by Prof. Alun Evans
35. Windwatch – briefing paper Pat Swords
36. NIRIG follow up letter from briefing on 23rd October 2014

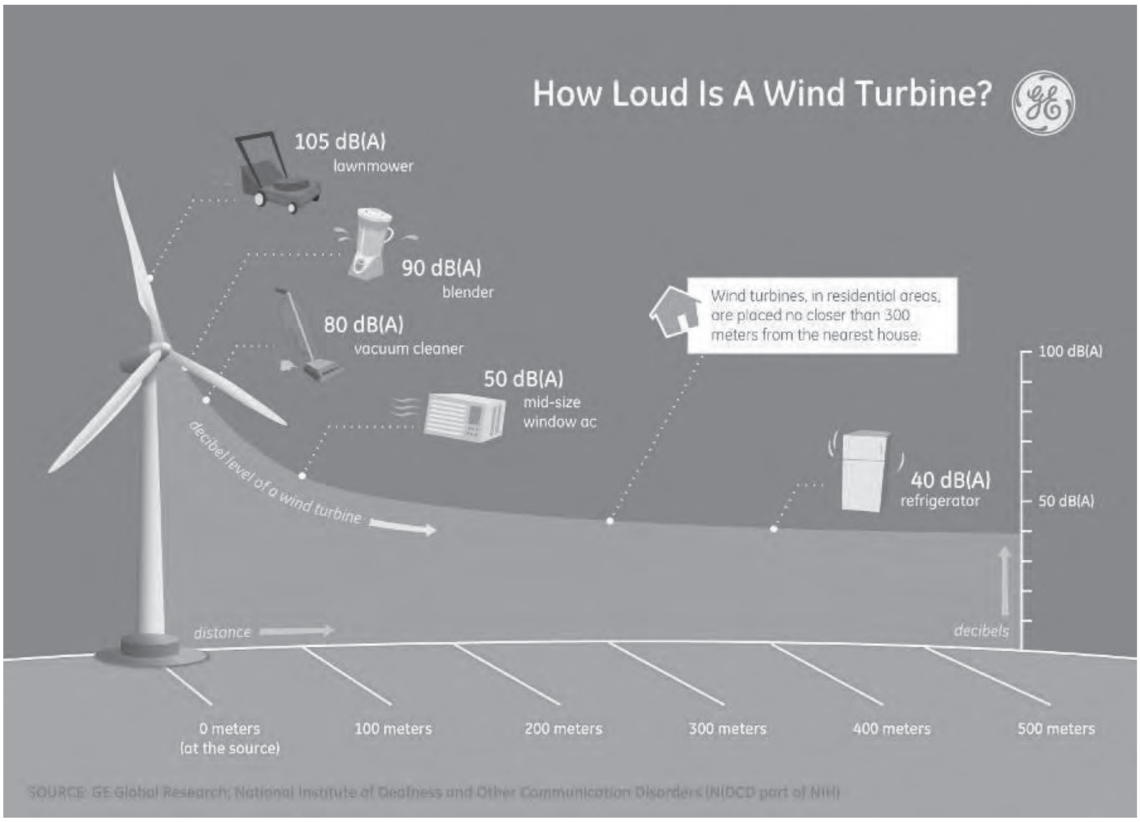
Association for Public Service Excellence presentations



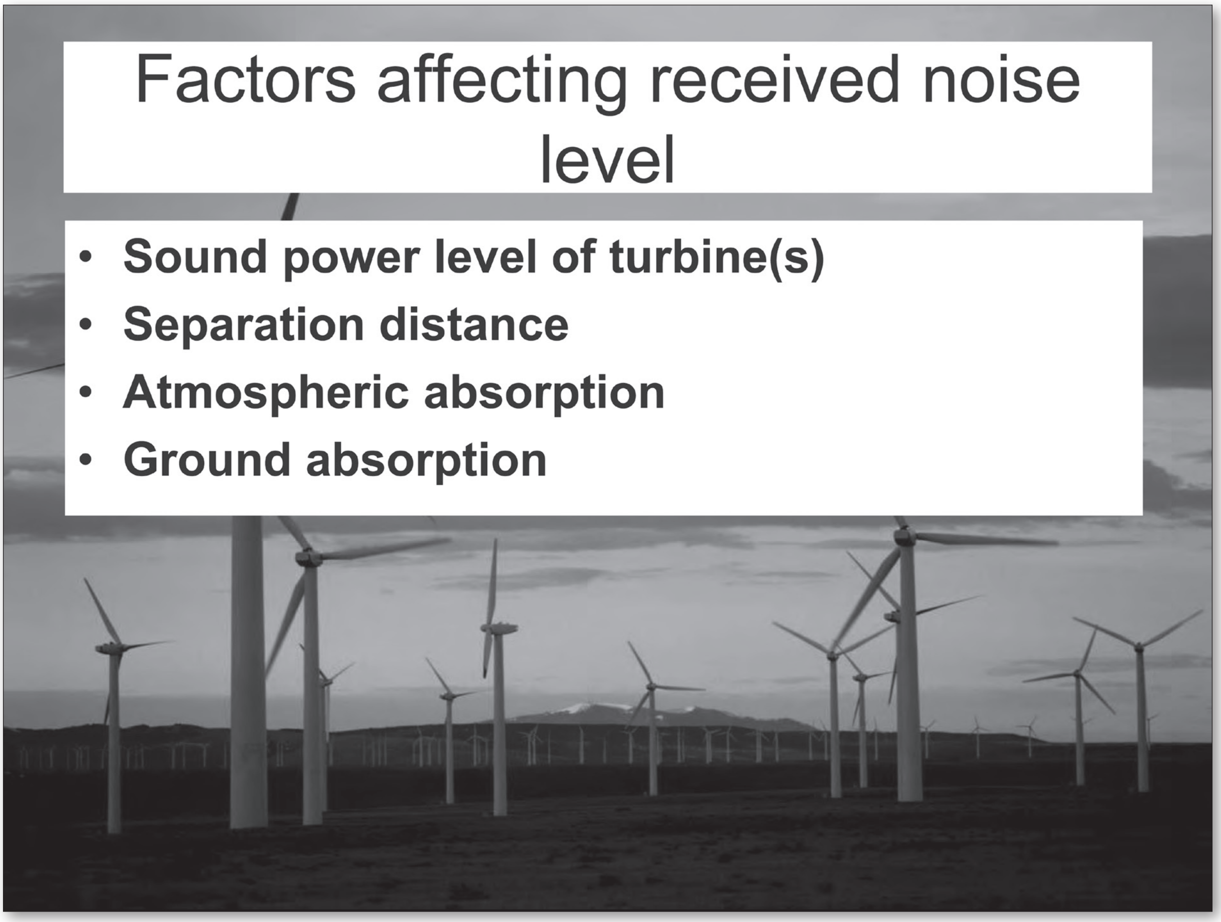
Altahullion Wind Farm

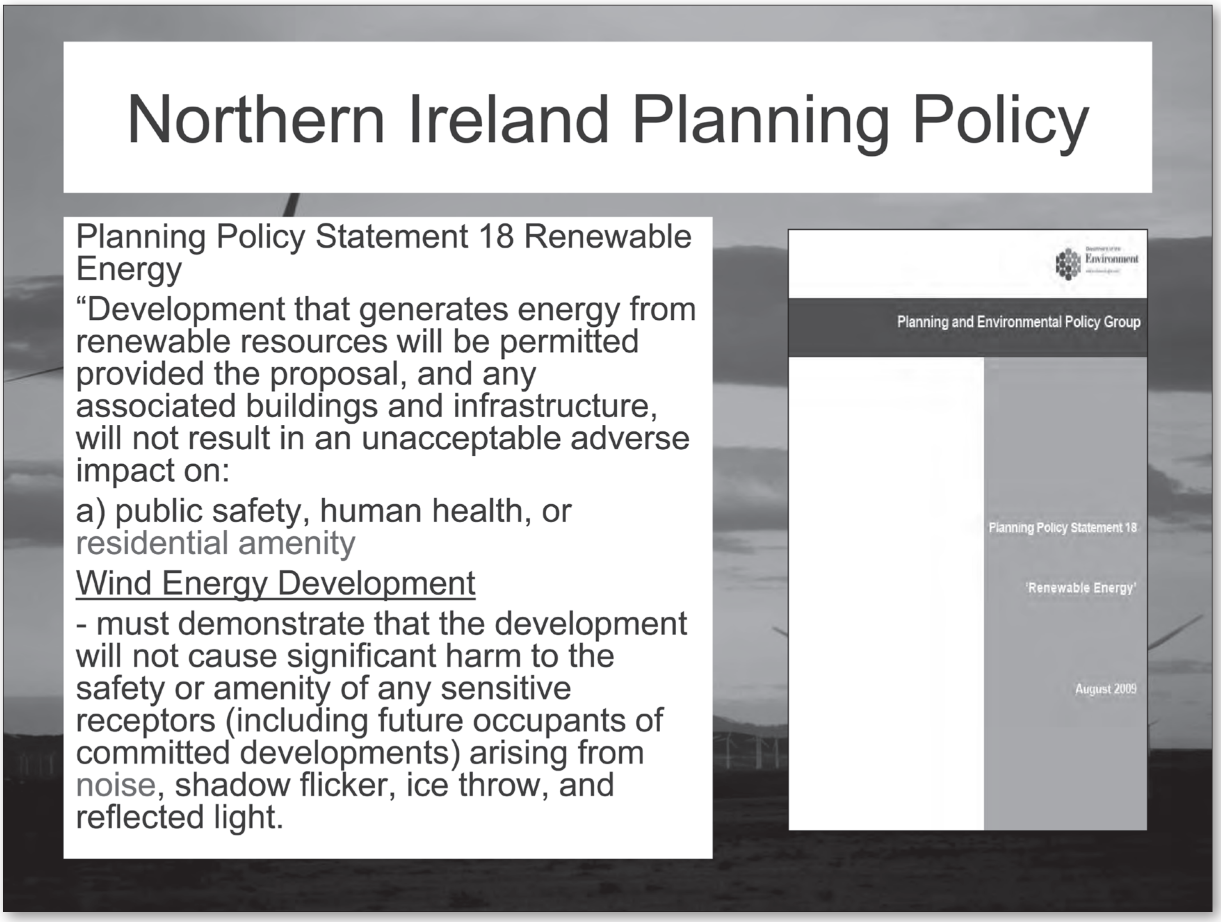


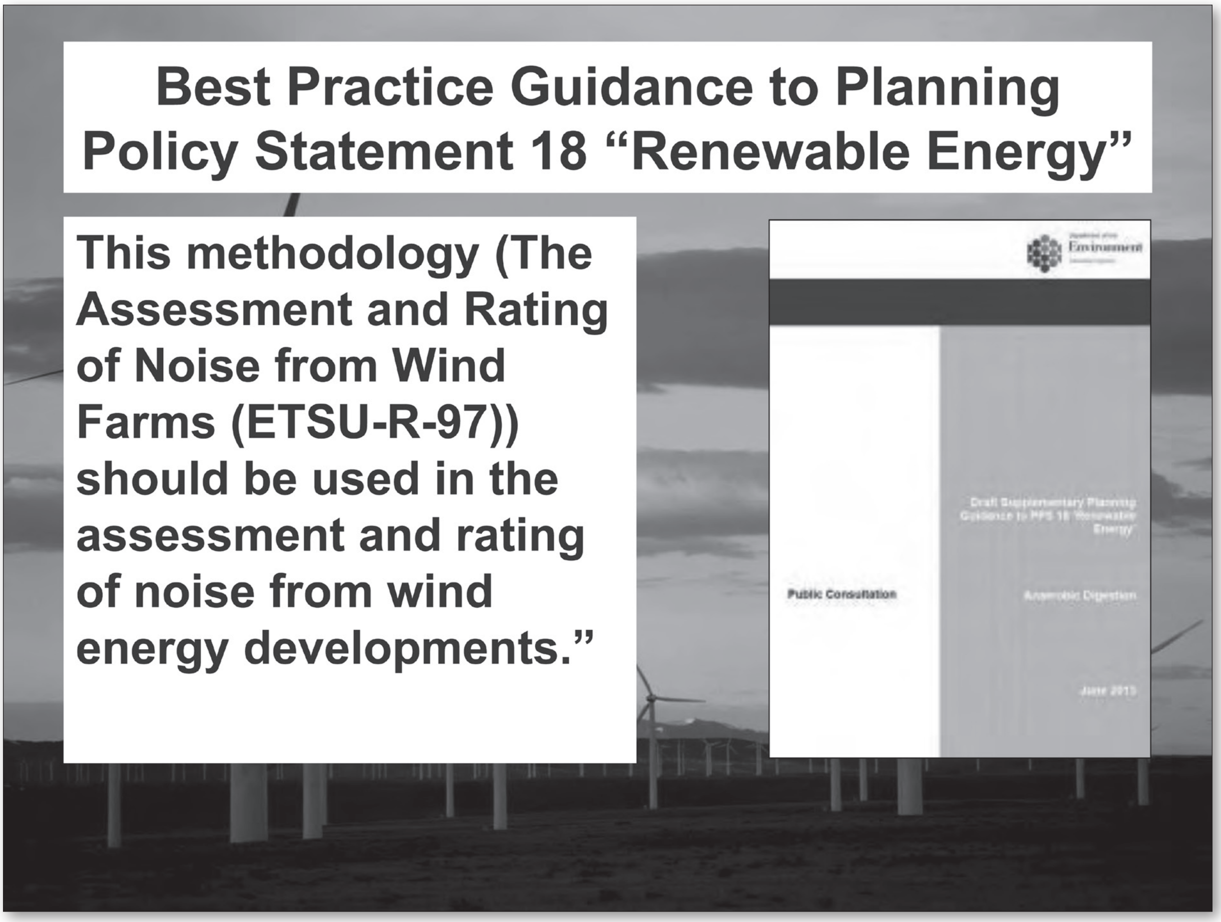


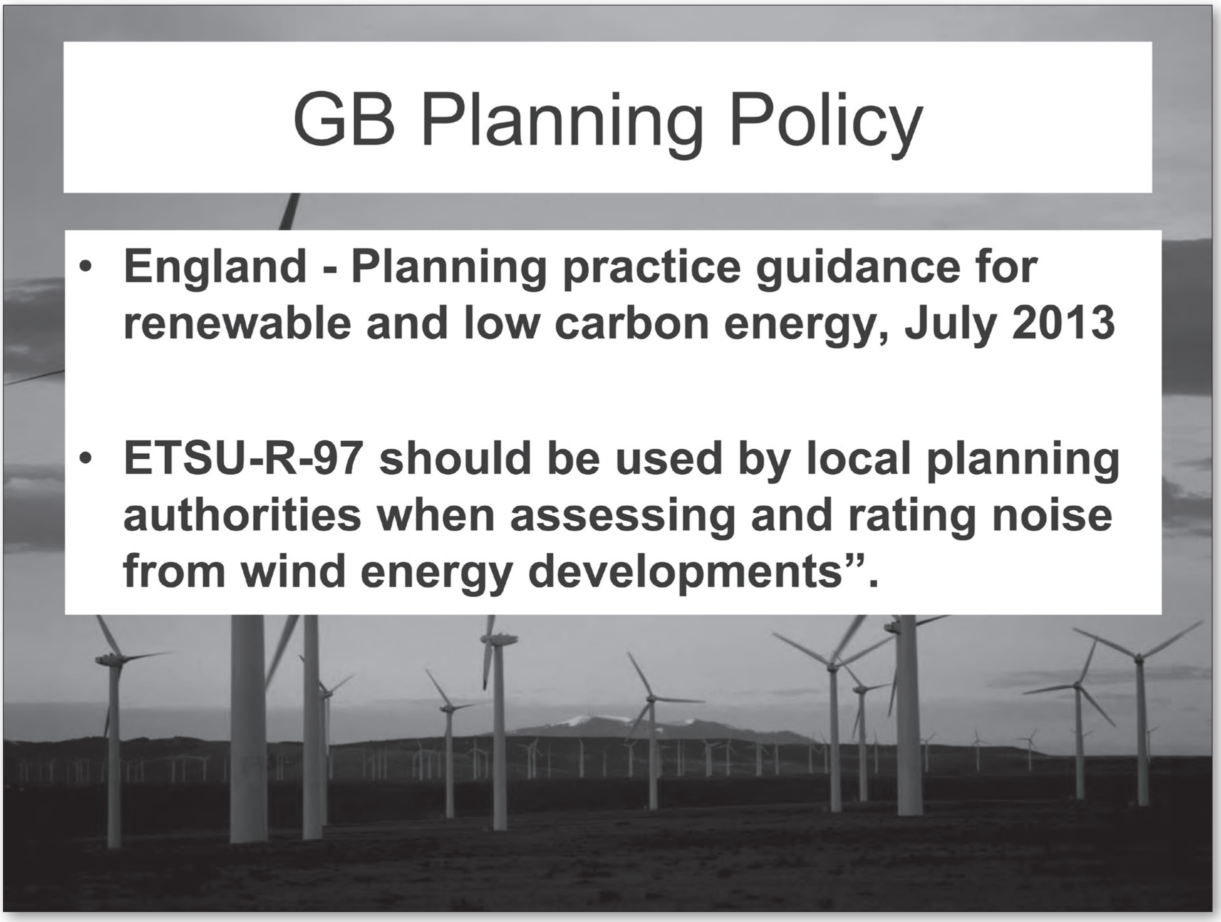


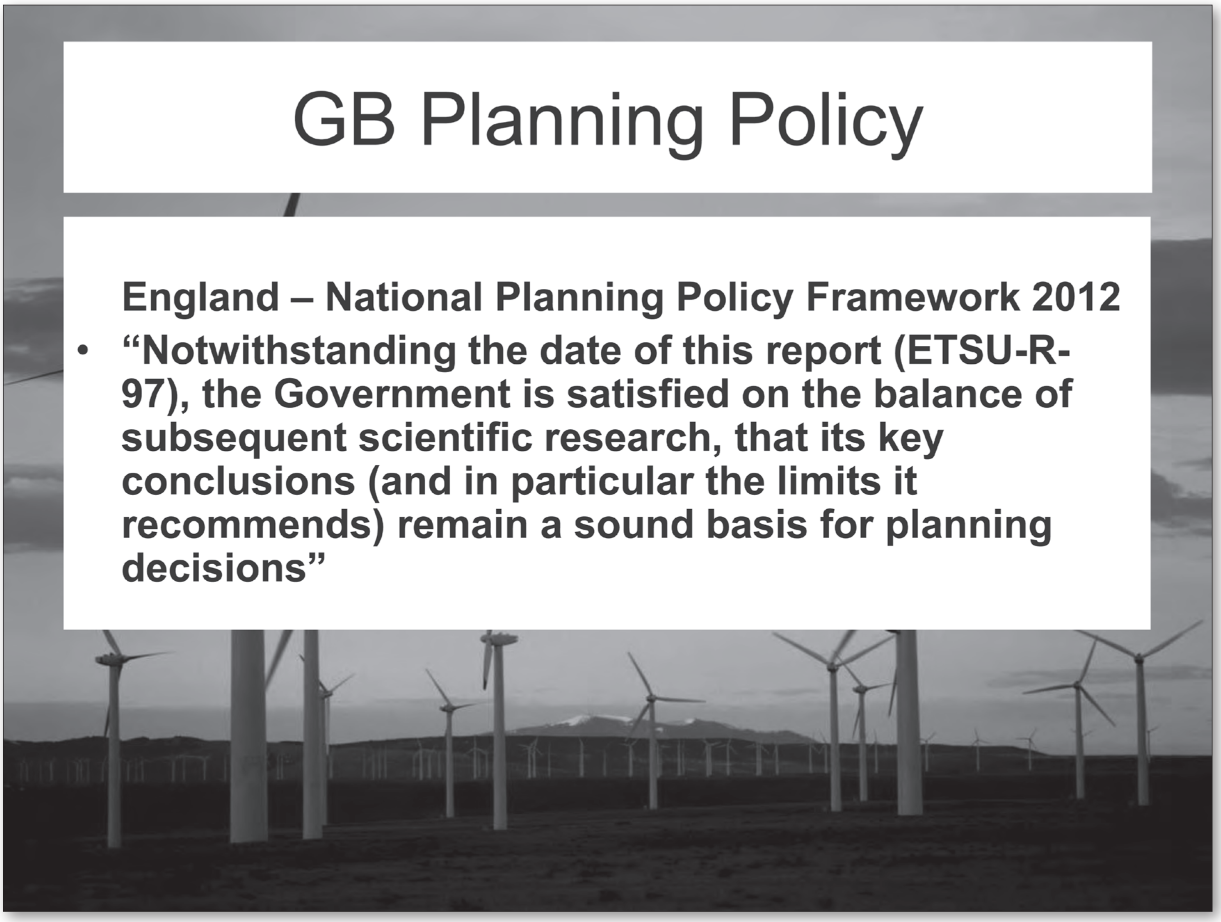
https://www.wind-watch.org/video-aberdeenshire.php aberdeenshire.mp4

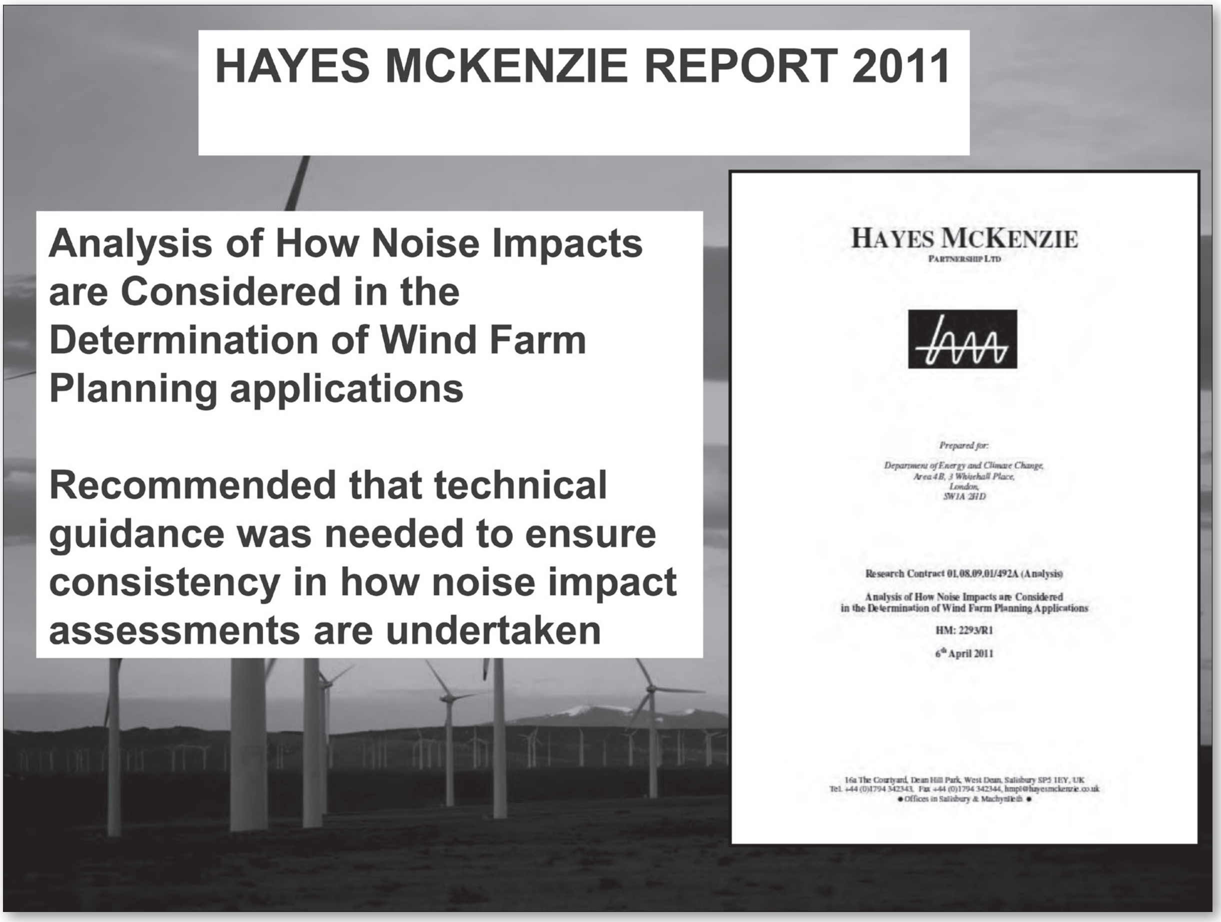


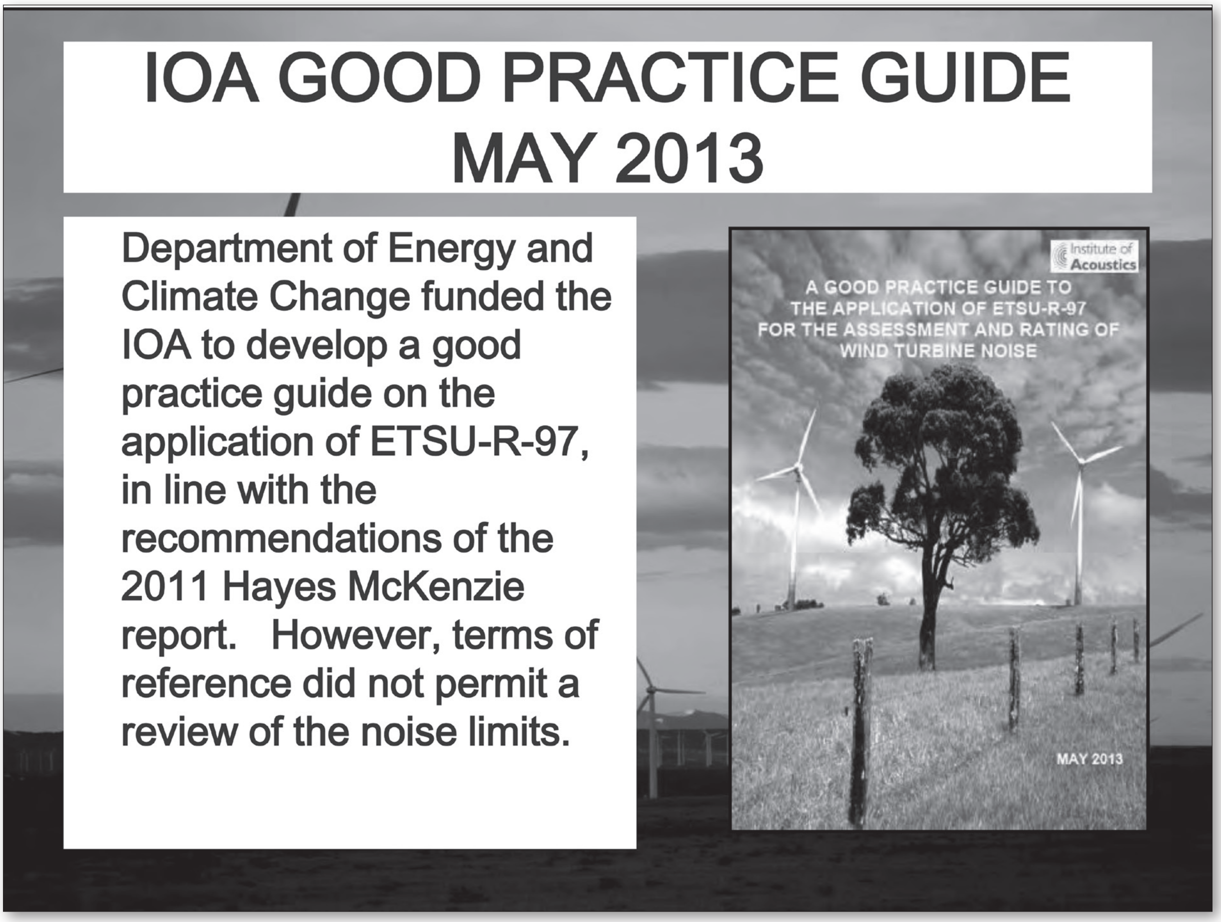

Northern Ireland Planning Policy
Planning Policy Statement 18 Renewable Energy
"Development that generates energy from renewable resources will be permitted provided the proposal, and any associated buildings and infrastructure, will not result in an unacceptable adverse impact on:
a) public safety, human health, or residential amenity
Wind Energy Development
- must demonstrate that the development will not cause significant harm to the safety or amenity of any sensitive receptors (including future occupants of committed developments) arising from noise, shadow flicker, ice throw, and reflected light.
Environment
Planning and Environmental Policy Group
Planning Policy Statement 18
'Renewable Energy'
August 2009

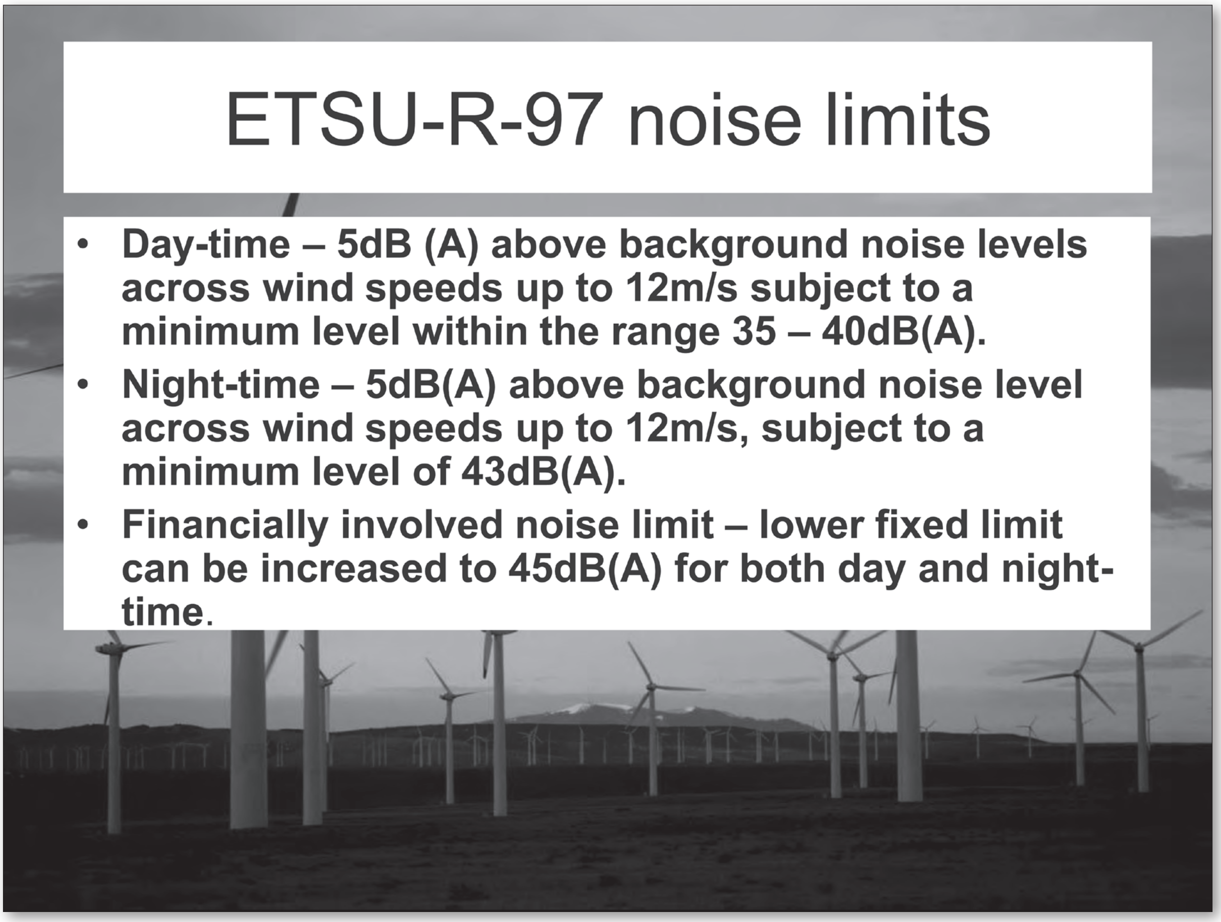

Best Practice Guidance to Planning Policy Statement 18 "Renewable Energy"
This methodology (The Assessment and Rating of Noise from Wind Farms (ETSU-R-97)) should be used in the assessment and rating of noise from wind energy developments."
Environment
Public Consultation

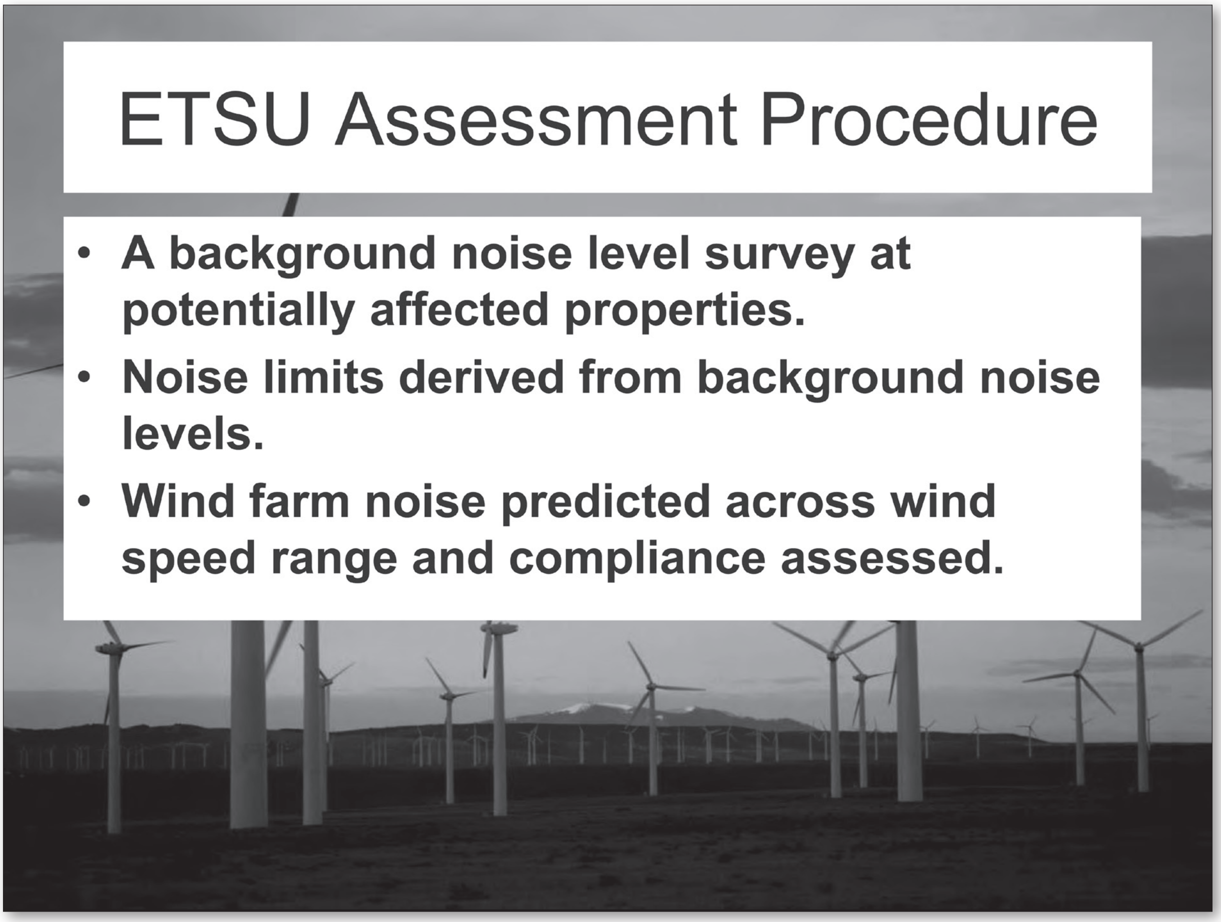

GB Planning Policy
• England - Planning practice guidance for renewable and low carbon energy, July 2013
• ETSU-R-97 should be used by local planning authorities when assessing and rating noise from wind energy developments”.


GB Planning Policy
England – National Planning Policy Framework 2012
• “Notwithstanding the date of this report (ETSU-R-97), the Government is satisfied on the balance of subsequent scientific research, that its key conclusions (and in particular the limits it recommends) remain a sound basis for planning decisions”


HAYES MCKENZIE REPORT 2011
Analysis of How Noise Impacts are Considered in the Determination of Wind Farm Planning applications
Recommended that technical guidance was needed to ensure consistency in how noise impact assessments are undertaken
HAYES MCKENZIE
PARTNERSHIP LTD
Prepared for:
Department of Energy and Climate Change,
Area 4B, 3 Whitehall Place,
London,
SW1A 2HD
Research Contract 01.08.09.01/492A (Analysis)
Analysis of How Noise Impacts are Considered
in the Determination of Wind Farm Planning Applications
HM: 2293/R1
6th April 2011
16a The Courtyard, Dean Hill Park, West Dean, Salisbury SP5 1EY, UK
Tel. +44 (0)1794 342343, Fax +44 (0)1794 342344, hmp1@hayesmckenzie.co.uk
● Offices in Salisbury & Machynlleth ●

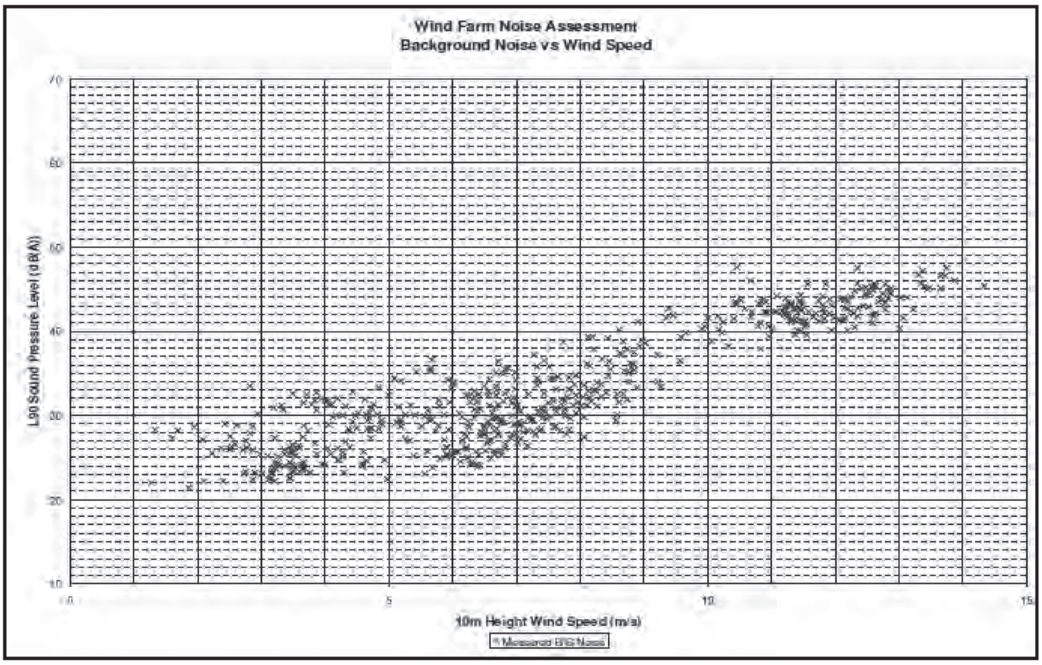

IOA GOOD PRACTICE GUIDE
MAY 2013
Department of Energy and Climate Change funded the IOA to develop a good practice guide on the application of ETSU-R-97, in line with the recommendations of the 2011 Hayes McKenzie report. However, terms of reference did not permit a review of the noise limits.
Institute of Acoustics
A GOOD PRACTICE GUIDE TO
THE APPLICATION OF ETSU-R-97
FOR THE ASSESSMENT AND RATING OF
WIND TURBINE NOISE
MAY 2013

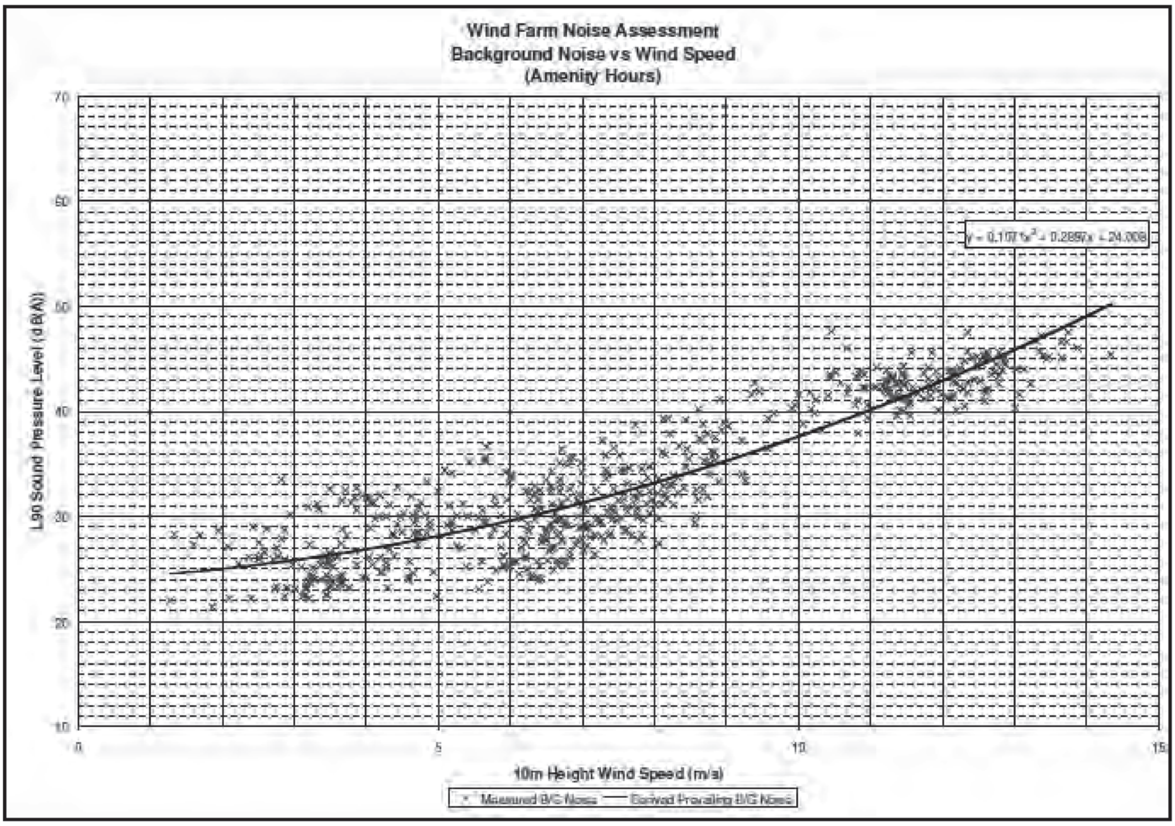

ETSU-R-97 noise limits
• Day-time – 5dB (A) above background noise levels across wind speeds up to 12m/s subject to a minimum level within the range 35 – 40dB(A).
• Night-time – 5dB(A) above background noise level across wind speeds up to 12m/s, subject to a minimum level of 43dB(A).
• Financially involved noise limit – lower fixed limit can be increased to 45dB(A) for both day and night-time.


ETSU Assessment Procedure
• A background noise level survey at potentially affected properties.
• Noise limits derived from background noise levels.
• Wind farm noise predicted across wind speed range and compliance assessed.

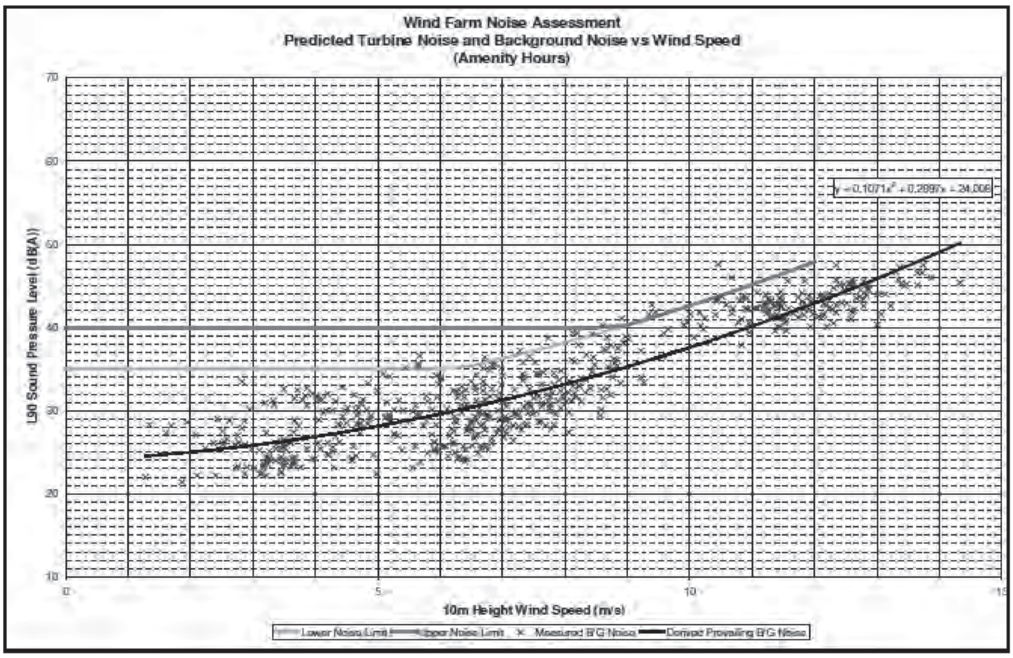
Measurement of Background Noise Levels

Background noise levels plotted against wind speed

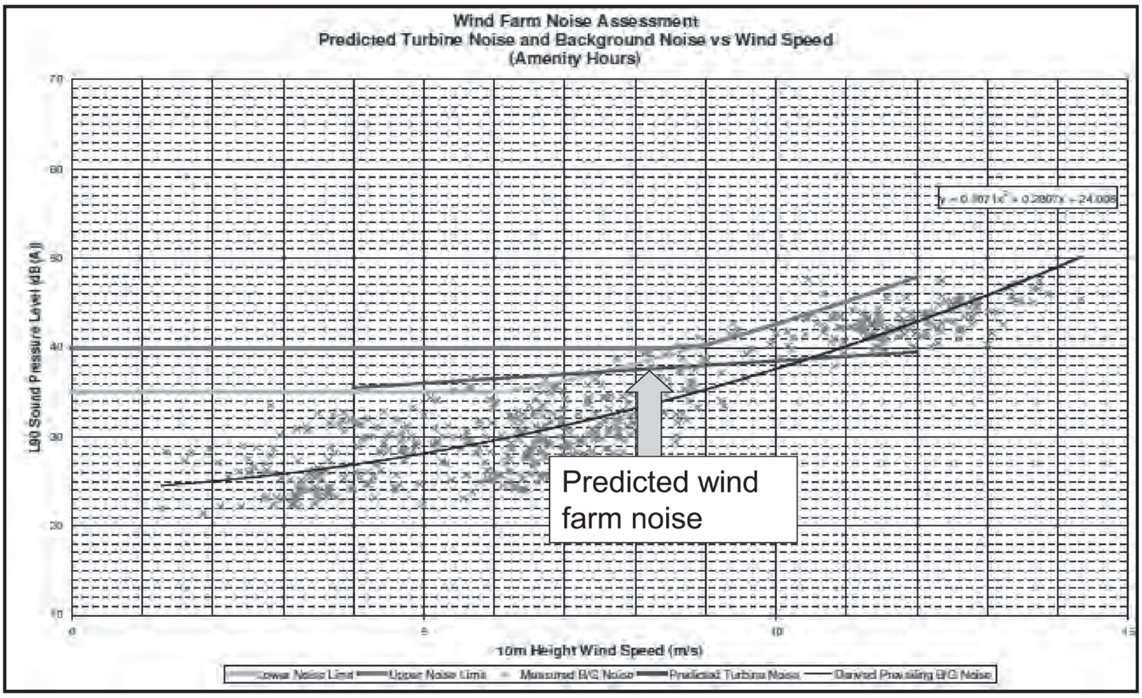




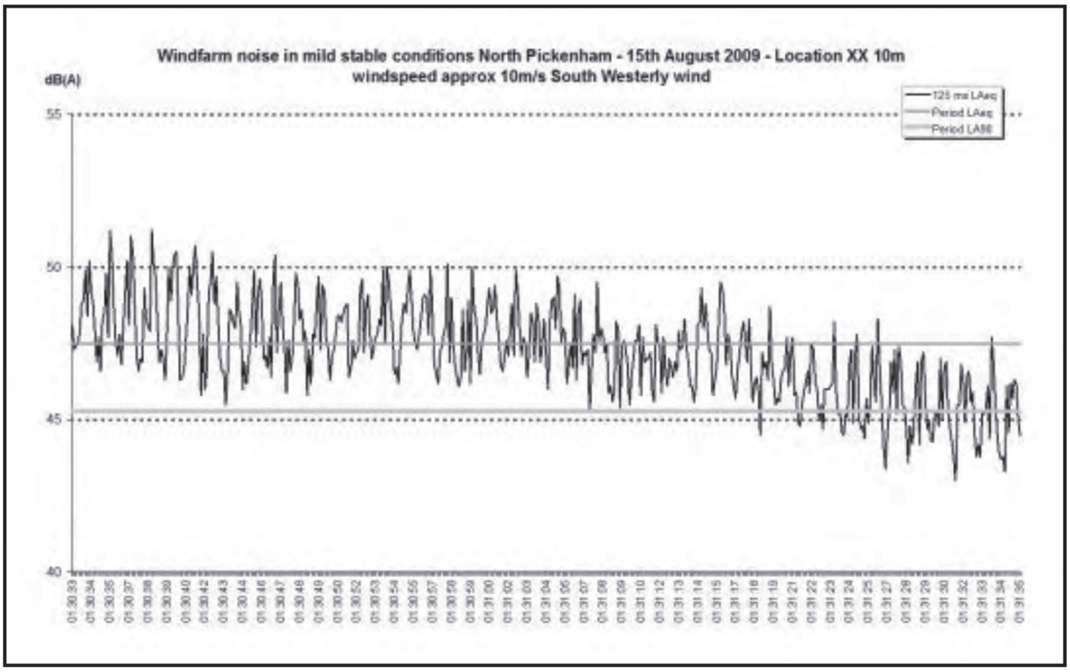
ETSU derived limits (day-time)

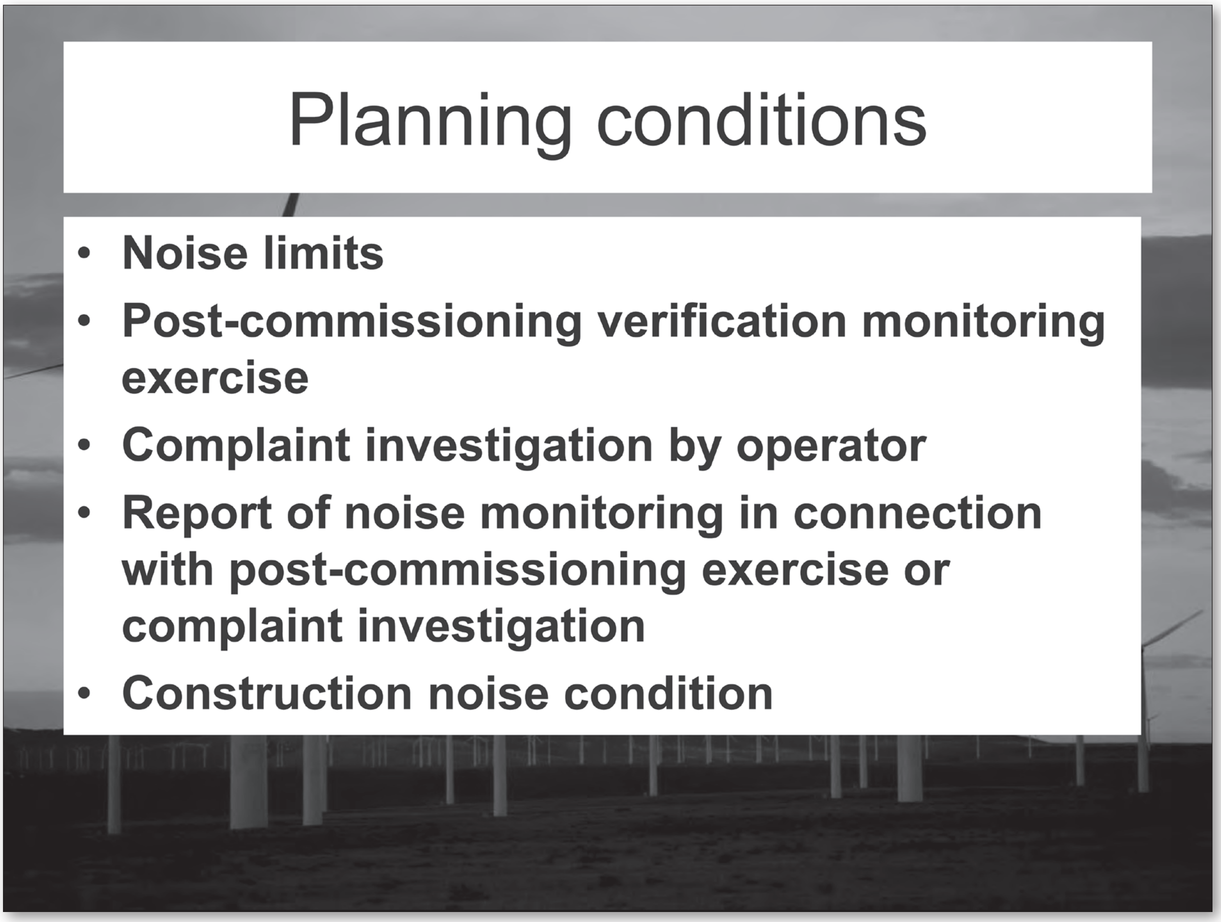


Assessing compliance



Amplitude Modulation




Planning conditions
• Noise limits
• Post-commissioning verification monitoring exercise
• Complaint investigation by operator
• Report of noise monitoring in connection with post-commissioning exercise or complaint investigation
• Construction noise condition

APSE

Wind Farms - planning issues, community benefits and case studies

Omagh
12 December 2013

Stephen Cirell Consultancy Ltd

Wind as part of an energy management strategy

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LEEDS
CITY COUNCIL

WALKER MORRIS

one and all onen hag oll
CORNWALL
COUNCIL

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Coverage

- a whole organisation approach;
- the role of renewable energy;
- wind and other technologies;
- best practice examples;

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The hierarchy in energy

- Use less energy;
- Improve energy efficiency;
- Create new energy from renewables;

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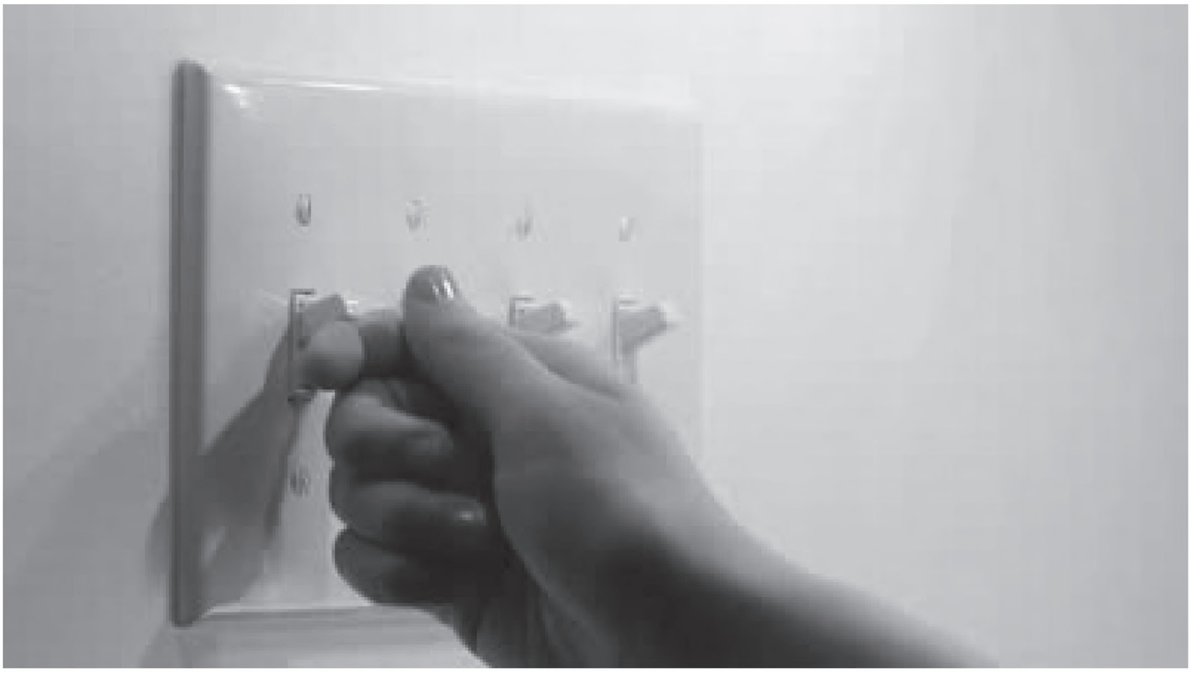

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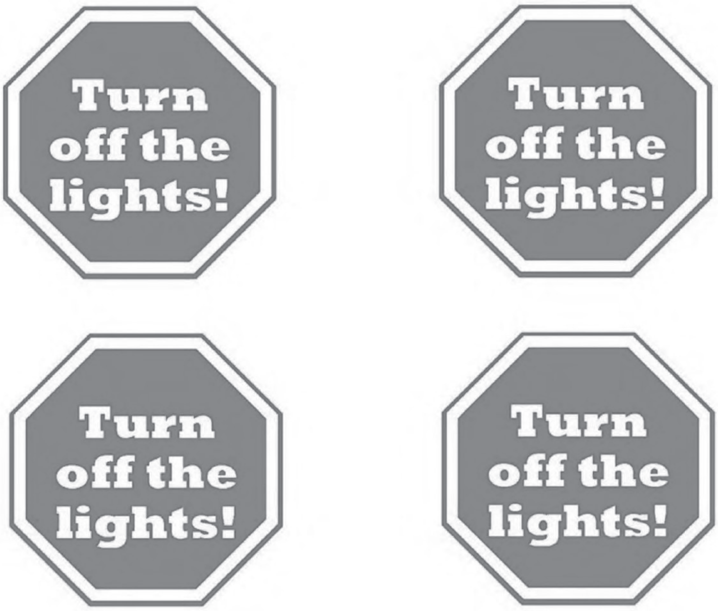

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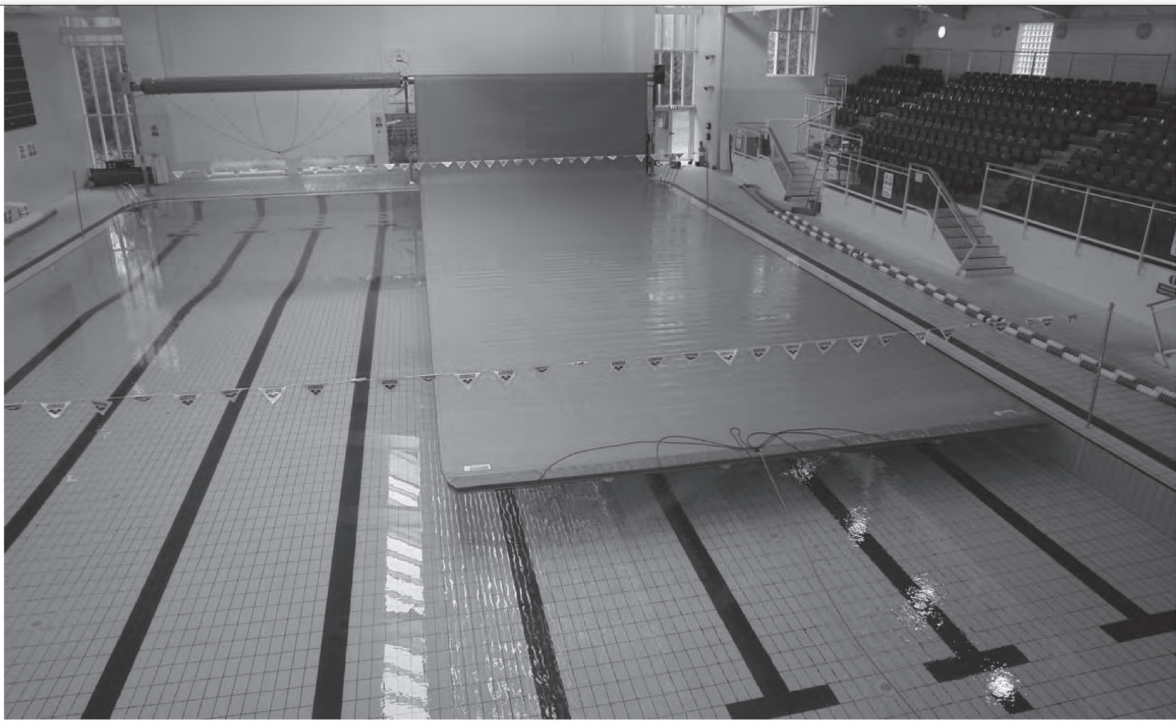

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Conclusions
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web: www.stephencirell.co.uk
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Public Sector Energy is a new service to keep everyone in the public sector up to date on what is happening in the green agenda.

It is focussed on delivery of renewable energy and energy efficiency projects, rather than the theory of what might work.

Every week you will get an email that draws together in one place all the stories that you need to know about, together with some advice and guidance from Stephen Cirell.

It is completely free, you just need to register with

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Wind as part of an energy management strategy

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APSE

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A Local Authority Owned Scheme

Can You Do It Yourself?

Stephen Cirell

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LEEDS
CITY COUNCIL

WALKER
MORRIS

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Coverage

- the different routes;
- the context of the DIY option;
- the stages of the work;
- conclusions;

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DIY
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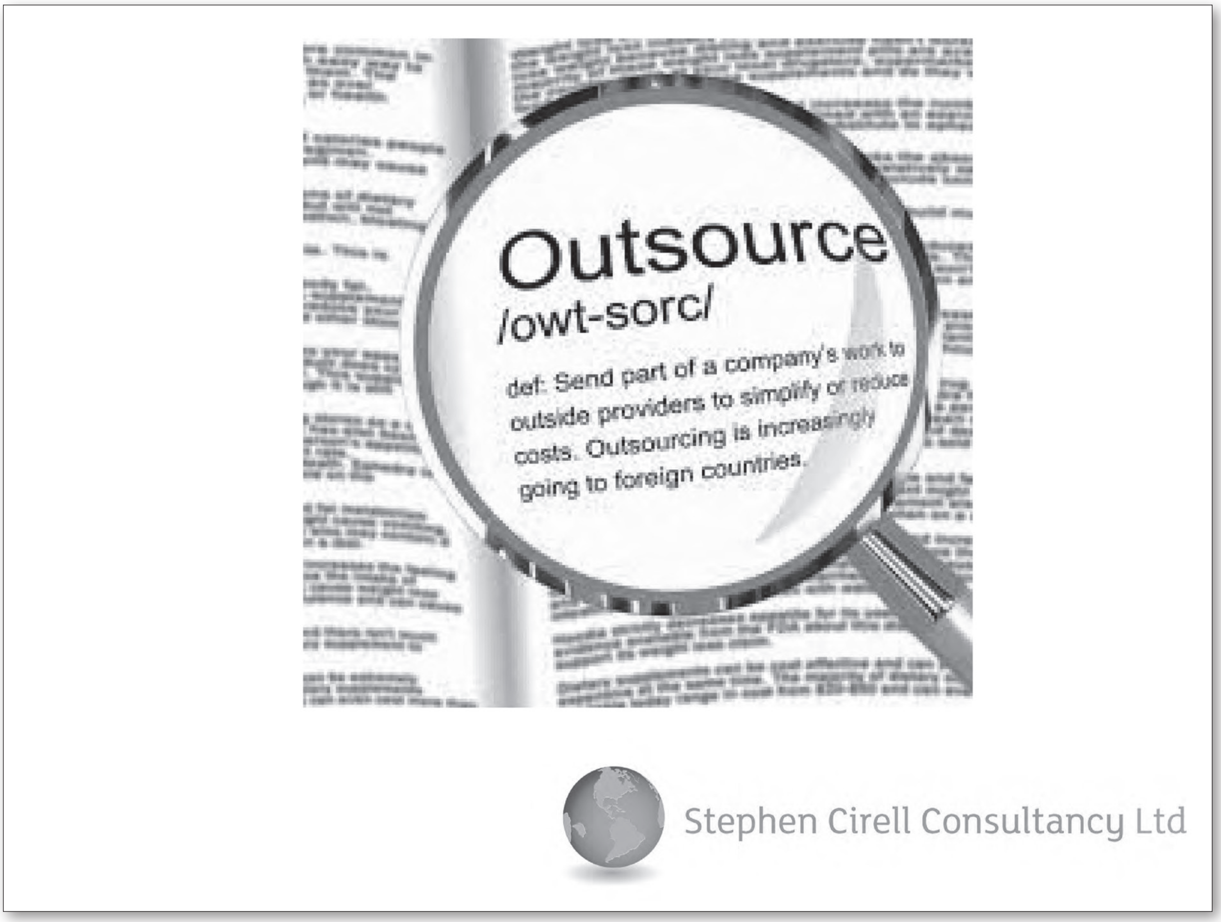
Outsource
/owt-sorc/
def: Send part of a company's work to
outside providers to simplify or reduce
costs. Outsourcing is increasingly
going to foreign countries.
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The Stages

- concept
- preliminary work
- business case
- approvals

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The Stages (2)

- technical advisers
- planning consent
- procurement of contractors
- construction and commissioning

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The Stages (3)

- maintenance
- operation

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The Alternatives

- sell land
- lease land
- sell with planning consent
- joint venture to develop
- crowd funding

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Conclusions

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A Local Authority Owned Scheme

Can You Do It Yourself?

Stephen Cirell

Stephen Cirell Consultancy Ltd

The Fermanagh Trust

Realising community benefits from wind schemes

12th December, 2013

www.fermanaghtrust.org

The Fermanagh Trust

About Us

- Fermanagh's Community Foundation
- Registered charity
- Dedicated to creating a partnership of donors, non-profit making organisations and the community to find solutions to the pressing community needs
- Support community and voluntary endeavours - community and voluntary sector, good relations, social enterprises
- Range of funds and initiatives – Shared Education, renewable energy and local communities, social enterprise development
- Power of communities
- Social, community, economic or environmental initiatives

The Fermanagh Trust

Community Engagement

- Involves working with relevant stakeholders to inform, listen to and consider views
- What does community engagement actually look like?

- Circulating letters to householders (and local organisations)
- Calling at homes in the vicinity of proposed development
- Speaking to local councillors?
- Holding an exhibition in a local venue to show the plans a few weeks before planning application

The Fermanagh Trust

How can communities benefit from wind farm development?

- Four main categories:

- Local contracting and jobs
- Benefits in kind
- Community funds
- Community ownership

- Note - rates also bring an income stream to Executive and district councils

The Fermanagh Trust

Community Funds

- Common form of community benefit is the provision of a community fund
- Can support a range of activities to the host community – funding towards community facilities, schools, energy efficiency etc
- Normally provided over the life cycle of a wind farm (typically 25 years)
- Different approaches to the administration of funds - local charitable trusts, community foundations and social enterprises, or in house
- Open to community groups rather than individuals

The Fermanagh Trust

Community Ownership

- Full ownership
- Part ownership
- Community/Developer joint venture
- Co-operative

Challenges can include the ability to access finance during the development process, time and commitment from the community, communities often lack the technical or 'know-how' to progress a project

However the economic and social opportunities can be huge

The Fermanagh Trust

Earlsburn (Fintry)

- Village of Fintry in Scotland devised their own proposal for an additional 'community' turbine, which brought the site up to 15 turbines
- The community turbine is owned by the village (300 households) and the village will pay this back over the first 15 years of operation
- Fintry Development Trust was set up to manage the revenue from the operation of the turbine

The Fermanagh Trust

Earlsburn (Fintry)

- During the first 3 years of the turbine operating, the village gained an income of approximately £230,000
- Revenues from turbine go towards improving household energy efficiency, making a significant contribution to reduce the number of households in fuel poverty in the village
- Taking into account future fluctuations in factors such as wind speeds and electricity prices, it is estimated that the village will receive **a profit in the region of £400,000 to £600,000 per annum once all costs have been repaid**

The Fermanagh Trust

Research

- Launch of report 'Maximising Community Outcomes from Wind Energy Developments' in January 2012
- **The research aimed to explore the opportunities that exist for communities to engage with commercial onshore wind energy development**
- The report made 11 recommendations aimed at communities, developers, local councils and Government

The Fermanagh Trust

Findings

- Community benefits are viewed as key components of the way in which communities can engage with wind energy development
- Effective community engagement is critical to working with local communities
- Community benefits are typically voluntary annual financial contributions from developers into a community fund
- Greater economic and social opportunities may be available through community ownership
- Different models of community ownership exist including: full ownership; part ownership, community / developer joint venture; and the co-operative model

The Fermanagh Trust

Findings

- Community ownership is challenging but presents substantial financial opportunities
- Community ownership can contribute to the long term sustainable future of communities and help address issues such as fuel poverty
- Provision of community benefits - the report found a disparity in the level of community benefit between GB and NI
- No innovative approaches towards the provision of community benefits / community ownership in NI
- Major expansion in onshore wind energy as part of efforts to achieve renewable energy targets / clustering

The Fermanagh Trust

Findings

- Scotland and Wales have a very productive approach and recognise the important roles which communities have to play in renewable energy development
- Scottish Government's Community Benefit Register
- Potential of forestry sites
- Local authority guidance / policy on community benefits and community engagement with wind energy development
- Joined up approach in Scotland and Wales

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Recommendations

- **Communities**

- A not for profit organisation to take the lead role in establishing good practice guidance including a policy on community engagement and promoting a toolkit on community benefits

- All local communities to take an active role in relation to a wind farm development being considered in their community exploring the range of community benefits which can be provided

- Local community based organisations to examine and where possible develop and implement wind farm developments based on one or more of the community ownership models outlined in this report

The Fermanagh Trust

Recommendations

- **Developers**

- Community Benefit Funds - local communities should be offered by developers a **minimum** initial payment of £2,000 per MW of installed capacity and a **minimum** annual payment of £2,000 per MW of installed capacity and that payment is index linked

- Community ownership - developers should consider offering some form of community ownership as part of a community benefits package

- Community engagement – large scale commercial developers should develop clear protocols on effective community engagement for wind farm developments

Recommendations

- **Local Councils**

- Local Councils to formally establish guidance protocols (based on good practice) which provide a framework for engagement by developers with the Councils and local communities

Recommendations

- **Government**

- Department of Enterprise, Trade and Investment to actively support local communities and their potential, positive role in implementing wind farm projects and the contribution they make in the development of a low carbon society

- The Department of Agriculture and Rural Development to ensure models of good practice , as evidenced in Scotland and Wales, are followed in relation to both engaging and working in partnership with rural communities and the private sector when developing wind farms on land managed by the Forest Service

- The Department of Enterprise, Trade and Investment to develop a public register of community benefits from wind farm projects similar to that currently being established by the Scottish Government

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Recommendations

- **Government (cont…)**

- A Government Department to take the lead role in developing a more coordinated approach involving the government, the private sector and communities towards wind farm developments, which builds upon principles of sustainable development

The Fermanagh Trust

Progress on Recommendations

- The Fermanagh Trust has engaged extensively with stakeholders following the publication of the report. This has included: Government Departments, district councils, third sector and community organisations and the private sector

  - Communities : getting informed and organised

  - Developers : some positive signs / exemplars

  - Local Councils : leadership from Omagh / Strabane / Ballymena

  - Government : DOE Ministerial led Planning and Community Benefits Summit
    DETI, DARD, DoE 'Communities and Renewable Energy: a Study'

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External Environment

- DETI, DoE and DARD commissioned report 'Communities and Renewable Energy: a Study'
- DECC Onshore Wind Call for Evidence
- DECC Community Energy Strategy
- RenewableUK
- Scottish Renewables
- Community benefit funds of £5,000 per MW per annum

The Fermanagh Trust

Scotland

- Scottish Government has set a target of achieving 500MW of community and locally owned renewable energy by 2020
- CARES Scheme
- Renewable Energy Investment Fund
- Political support at both a central and local authority level
- Forestry Commission Scotland – includes opportunities for communities to invest in renewable energy developments on the Forest Estate
- Scottish Government's Register of Community Benefits

The Fermanagh Trust

Concluding Remarks

- Wind energy development can present significant opportunities for local communities
- It is important for communities to actively engage with developers
- There are increasing challenges as a result of the concentration of wind farms
- Government and communities must be proactive:
  - Community energy
  - Community benefits
  - Community engagement

Landscape / visual assessments for wind turbine applications

Mansil Miller, Assistant Director : Landscape, Landscape Architects Team, NIEA

Landscape / visual assessments for wind turbine applications

The Guidelines for Landscape and Visual Assessment advise that visuals should be printed at an appropriate scale for comfortable viewing and that they must meet the appropriate standards as described in the Landscape Institute's Advice Note 01/11 – Photography and Photomontage in Landscape and Visual Impact Assessment.

It refers to and recommends Visual Representations of Windfarms – Good Practice Guidance commissioned by Scottish Natural Heritage, a more technically comprehensive document (both documents can be downloaded from the respective websites).

Landscape / visual assessments for wind turbine applications

The guidance recommends that the minimum height of visuals should be 200mm, although heights down to 130mm may be acceptable.

This dimension combined with the viewing distance and the horizontal field of view dictate the dimensions and format of the image, which typically if representing a panoramic view would be much greater than A3 size. (The viewing distance is the distance that one should view the image from so that, theoretically, the image appears at the same scale as when viewed in the field from the recorded viewpoint).

Landscape / visual assessments for wind turbine applications

The reasons the guidance advises that images should be produced at this size is to try and reproduce as accurately as possible the image one would see in the field and to be easily understood and usable by members of the public and those with a non-technical background.

Landscape / visual assessments for wind turbine applications

Although we are used to assessing documents with visual information submitted that has not conformed to the guidelines, we tend to forget that the public also has to access these documents and we should in future be insistent that visual information is produced at an appropriate size and scale.

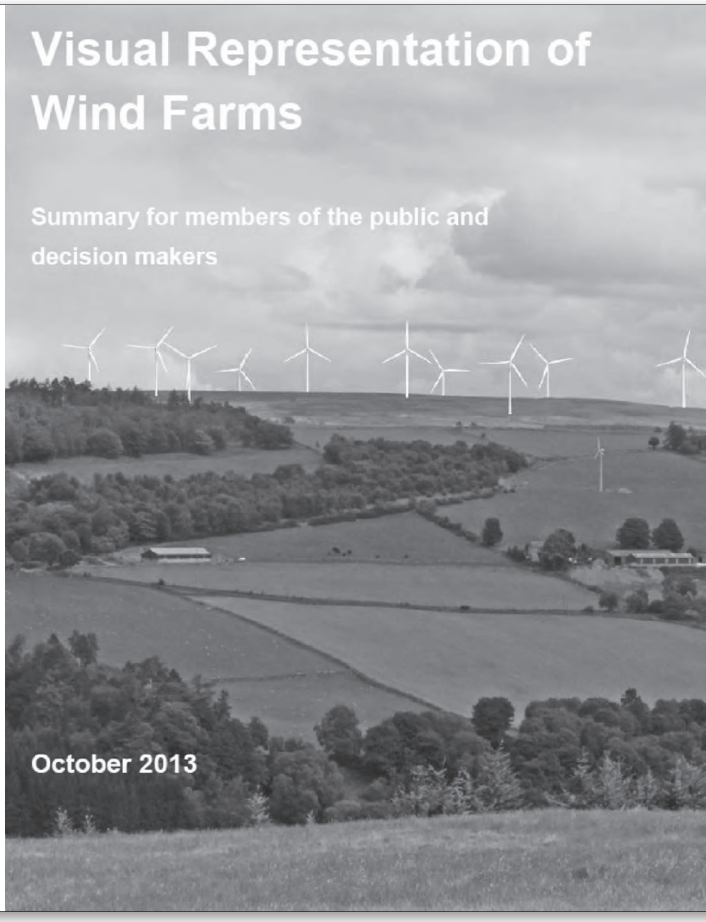
Landscape / visual assessments for wind turbine applications

Scottish Natural Heritage have currently issued draft revised guidelines (to follow) which will be published before January 2014 and which place even more emphasis on increased image size to provide a better representation of the proposal and to compensate for the fact that the printed image cannot represent the contrast and depth that the human eye can see in reality.

Landscape / visual assessments for wind turbine applications

The public are entitled to ask for larger scale and clearer visuals in compliance with the current guidelines or even with the draft guidelines as the purpose of the planning process is to provide clarity for effective decision making. It is true that little research has been done to compare the visual impact post development of wind farms with the visualisations submitted for a planning decision. However this is a deficiency recognised by the latest best practice guidance (GLVIA April 2013).

More research in this area particularly in terms of representing cumulative and sequential visual impacts as well as the visual effect of moving rotor blades should lead to more clarity as to the nature and extent of visual impacts and to better planning decisions in the future.



Strabane District Council
Comhairle Ceantair an tSratha Báin
Stràbane Destrick Cooncil

Omagh District Council

Draft Guidance Protocol on the payment of community benefits from Windfarms in West Tyrone

My presentation

- Context
- Community Benefit
- Our Guidance Protocol

Concerns

- High wind energy resource
- Saturation/ Cumulative impacts
- West Tyrone against Windfarms
- Noise complaints (health)
- shadow flicker/TV reception
- Impacts on biodiversity
- Landscape heritage (Sperrins AOONB)
- Industrialisation of the landscape
- Lucrative industry which is heavily subsidised
- Rural communities suffering social and economic deprivation and fuel poverty

Community Benefit

- Tokenistic
- An unclear and fragmented picture
- Substantially low levels of payments
- Higher levels of payments in Scotland, England and Wales.
- Industry treating NI communities less favourably

DECC Call for Evidence on community benefits and onshore wind

- An increase in the recommended community benefit package in England from £1,000 per MW of installed capacity to £5,000 MW for the year of the windfarm
- Compulsory pre application consultation
- Register of community benefits
- Clear evidence on the impacts

Our Guidance Protocol:

- Developers to pay £5,000 per MW per annum (index linked) to regenerate and sustain rural communities locally.
- 70% allocated to the community living within 5 miles of the site and the remaining 30% being allocated within 8 miles of the site

Conclusion

- First time a policy of this nature has been introduced
- Out for a period of 12 week consultation
- It is a means of support for host communities and councils
- Principles of sustainable development and fair and equitable treatment.

Rachelle Craig
Corporate Policy Officer
Strabane District Council
rcraig@strabanedc.com

Letter from Omagh District Council re draft guidance on community benefits

Omagh
District Council

Strabane
District Council
Comhairle Ceantair
an tSratha Báin

13 November 2013

Re: Consultation on the draft guidance protocol on community benefits derived from wind farms in West Tyrone

Dear Colleague,

On the 06 June 2013, the Department of Energy and Climate Change (DECC) released their report on their 'Call for Evidence on Community Benefits from Onshore Wind'. The Report recommended an increase in the recommended community benefit package in England from £1,000 per MW of installed capacity per year, to £5,000 MW/Year for the lifetime of the windfarm.

Omagh District Council and Strabane District Council have established a collaborative wind farm working group due to the concentration and proliferation of wind farm developments in West Tyrone. The working group aims to ensure that the benefits from hosting the onshore wind industry are fully realised and any adverse impacts are robustly addressed.

There is a significantly high level of onshore wind energy development in West Tyrone. West Tyrone accounts for 14% of Northern Ireland's landmass (1,992 Km^2). It currently hosts: 44% of all proposed and approved applications for large wind farms in Northern Ireland. Due to Northern Ireland Electricity's clustering policy, West Tyrone will continue to witness a major extension in the number of wind farms over the next 10 years.

A report by the Fermanagh Trust entitled 'Maximising Community Benefits from Onshore Wind in Northern Ireland', published in early 2012, provided clear evidence that host communities in Northern Ireland are receiving a significantly lower level of community benefits compared to that offered in mainland UK, Scotland and Wales.

The working group has developed the attached draft guidance protocol on the payment of community benefits. This draft document states that the developer should commit to making an initial payment based on installed capacity coupled with contributions payable annually - set at a standard rate of £5,000 per megawatt of installed capacity per annum, index linked. The protocol states that all contributions will be directed exclusively to local projects within 8 miles of the exterior boundary of the wind farm. It stipulates that 70% of the fund should be allocated to the community living within 5 miles of the site and the remaining 30% being allocated to the community living within 8 miles of the site[1].

Strabane District Council and Omagh District Council would welcome your comments on the attached document. Please submit them in writing to:

The Corporate Policy Officer
Strabane District Council
47 Derry Road
Strabane
Co. Tyrone
N. Ireland
BT82 8DY

Or via email to rcraig@strabanedc.com

Please submit all comments by Monday 06 January 2013. The draft policy shall be reviewed following the feedback received and then presented to both Councils for final approval.

Thank you for your consideration in this matter.

Kind Regards,

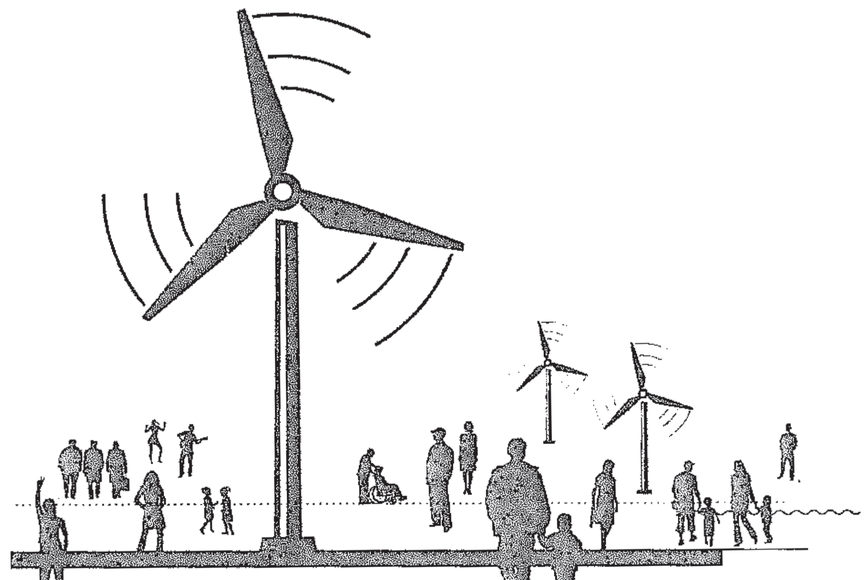
Daniel McSorley
Chief Executive of Omagh and Strabane District Councils

[1] Where it is not possible to allocate 70% of the funding within 5 miles of the outer boundary of the wind farm. any unallocated funding shall be distributed within the wider proximity threshold of 8 miles.

Omagh
District Council

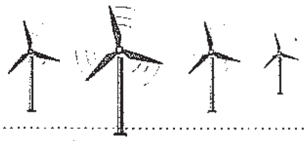
Strabane
District Council
Comhairle Ceantair
an tSratha Báin

Draft guidance protocol on community benefits derived from wind farms in West Tyrone



September 2013

1. Introduction and rationale



1.1 **Strabane District Council and Omagh District Council are committed to maximising community benefit from renewable energy development.** Both councils assert that community benefit schemes should be an integral part of all wind farm developments in West Tyrone. This guidance protocol gives an overview of both councils' minimum requirements that will be expected to apply to all future wind farm developments locally. It also is to be used as a framework of good practice which all existing wind farms will be measured against.

2. Definitions and scope

2.1 This approved guidance protocol is based on developments where the turbines are above 50 metres in base to tip height. Schemes which are below the minimum of 2 or fewer turbines and either below 5 megawatts or below 50 metres in height from base to tip are not considered as part of this framework. Community benefits from smaller schemes, as defined above, are encouraged but are not currently part of this guidance protocol.

2.2 This guidance protocol sets out the principles Strabane District Council and Omagh District Council hold in relation to wind farm development in the West Tyrone area as a whole. However, this guidance protocol has been developed to provide sufficient flexibility to allow for the negotiation of tailored solutions that address individual community circumstances. A key focus of this document is to encourage negotiated engagement between communities and developers and both Councils recognise that the potential exists for individual schemes to negotiate different/better terms.

2.3 This guidance protocol refers specifically to monetary benefits that are focused directly upon, and are more tangible to the local community living near a wind farm. They must include, but are not in any way limited to, a community fund which receives an annual lump sum or regular payments from the wind farm. Communities in West Tyrone can also benefit from local contracting and associated employment benefits, skills training and educational visits.

3. Guidance protocol statement

3.1 Strabane District Council and Omagh District Council require commercial wind farm developers located in West Tyrone to contribute to a dedicated community benefit fund which will be used to help regenerate and sustain rural communities locally. For the lifetime of the operation of the wind farm all contributions will be directed exclusively to local projects within 8 miles of the exterior boundary of the wind farm, with 70% of the fund being allocated to the community living within 5 miles of the site and the remaining 30% being allocated to the community living within 8 miles of the site[1]. The developer will commit to making an initial payment based on installed capacity coupled with contributions payable annually and set at a standard rate of £5,000 per megawatt of installed capacity per annum, index linked.

4. *Guidance protocol criteria*

4.1 The following criteria present the framework for a formalised approach providing certainty to communities that live near onshore wind farms. These criteria have been agreed by Strabane District Council and Omagh District Council and apply to all schemes which fulfil the criteria outlined in 2.1 above.

4.1.1 A community benefit scheme will receive support to a minimum value of at least £5,000 per megawatt of installed capacity per annum and will be index-linked with the retail price index for the lifetime of the project.

4.1.2 The developer will commit to making an initial payment based on installed capacity coupled with annual payments also based on installed capacity.

4.1.3 70% of the community benefit fund should be allocated to the community living within 5 miles from the outer boundary of the wind farm. The remaining 30% should be allocated to the community living within 8 miles from outer boundary of the site.

4.1.4 The developer will commit to undertaking early and transparent dialogue with the respective Council and engaging in detailed community consultation and engagement.

4.1.5 Payments and benefits in kind under a community benefit scheme will commence not later than twelve months from the date of completion or commission of the wind farm (unless agreed by the developer to be paid earlier) and shall be provided on or before each anniversary date of the first payment or equivalent.

4.1.6 Payments and benefits in kind shall be provided for the duration of the commercial operation of the wind farm, irrespective of any change of ownership should it arise. Annual payments may be wholly or partially aggregated over the permitted operational life, as agreed through consultation with the community.

1 Where it is not possible to allocate 70% of the funding within 5 miles of the outer boundary of the wind farm, any unallocated funding shall be distributed within the wider proximity threshold of 8 miles.

5. *Statement of community benefit*

5.1 At the time of submission of a planning application, or in advance of it if desired, the developer will sign and submit to the respective Council and relevant community and voluntary organisations a **"Statement of Community Benefit"** setting out the developer's commitment to provide benefits in accordance with the criteria identified above. This will ensure an open and transparent understanding of the minimum level of benefits that will accompany the project. The overall level of benefit shall be no less than that set out in this guidance protocol.

6. *Annual information returns*

6.1 In order to maintain clear evidence of the developer's commitment to providing community benefits in line with this guidance protocol, the developer should provide information to the Council and relevant community and voluntary organisations on request. This information will be used to record and verify the developer's continued commitment to engaging with local communities and to providing community benefits in line with the criteria outlined above.

6.2 An example of some of the information requested would be, but is not in any way limited to:

6.2.1 Value of benefits provided by the wind farm
6.2.2 % revenue allocated to community benefits schemes

6.3 In the event that a project is subsequently not taken forward into construction, the developer should duly notify the respective Council. The terms articulated in this guidance protocol should accompany the terms of sale and be upheld in any new ownership arrangement.

7. *Review*

7.1 This guidance protocol, including the minimum value of community benefit to be provided in connection with each wind farm, will be kept under regular review to ensure that it reflects best practice and market conditions. It will be reviewed at least once per year and revised at least once every five years.

SSE Airtricity letter re NI Community Fund

Airtricity

Minister Arlene Foster,
Department of Enterprise, Trade and Investment,
Netherleigh,
Massey Avenue,
Belfast,
BT4 2JP.

18th of November, 2013

Re: SSE Airtricity Northern Ireland Community Fund

Dear Minister Foster,

As you may be aware, SSE Airtricity operates a Community Fund in the vicinity of our wind farms as we believe the communities in which we locate our wind farms should be able to see and experience the benefit of that wind farm in their locality. We are a signatory of NIRIG's Community Commitment Protocol.

Over the last number of months we have been conducting a review of this scheme, prompted by the announcement by DECC and Renewables UK on Community Funds in GB and as highlighted by your letter of 17th June 2013 to NIRIG on this subject. We have also discussed this question at the Northern Ireland Assembly's ETI committee.

After careful consideration, Airtricity SSE has decided to increase our Community Fund for all newly constructed projects to £5,000 per Mega Watt (MW) per year. We will apply this new level from our 46MW expansion of capacity project at Glenconway, outside Limavady, which will begin operation in coming weeks meaning that the first round of funding will be allocated in 2014. As with our funds in other parts of the UK, the Northern Irish funds will be divided into a local and a regional element. The local fund will operate as our existing Northern Irish funds do, with an annual call for applications with priority given to energy efficient projects.

The regional fund will support projects of a more strategic nature and will include an education and training bursary element. Further details on the regional element of the fund will be announced next year when the new fund is officially launched.
As noted in your letter of 17th June, there are a number of challenges faced by wind farm developers in Northern Ireland, including grid constraints and curtailment.

Airtricity is a trading name of Airtricity Energy Supply (Northern Ireland) Limited which is a member of the SSE Group
The Registered Office of Airtricity Energy Supply (Northern Ireland) Limited is 2nd Floor 83-85 Great Victoria Street Belfast Northern Ireland BT2 7AF Registered in Northern Ireland No. NI041956

The planning process, and associated delays, presents a risk and increased costs for developers. In this regard, we strongly support proposals to improve Northern Ireland's planning process and we encourage initiatives to deliver the grid infrastructure and ancillary/system services necessary to reduce constraint and curtailment at the earliest opportunity as failing to address these issues will threaten the delivery of Northern Ireland's 2020 renewables target.

If you have any queries on this issue please do not hesitate to contact me.

Regards,

Paul Cooley
General Manager Ireland, SSE Renewables

Airtricity

Miss Anna Lo, MLA, Chairperson
Room 378,
Parliament Buildings,
Stormont,
Belfast,
BT4 3XX.

18th of November, 2013

Re: SSE Airtricity Northern Ireland Community Fund

Dear Chairperson Lo,

I am pleased to inform you that our Northern Ireland Community Fund will now increase to £5,000 per Mega Watt (MW) per year. This revision will be applied to all newly constructed SSE projects going forward and will be divided into a local and a regional element, with the local fund supporting energy efficient projects and the regional fund will support projects of a more strategic nature including education and training.

We will apply this new level from our 46MW expansion of capacity project at Glenconway, outside Limavady which will begin operation in coming weeks, meaning that the first round of new funding will be allocated in 2014.This increase will now bring our Northern Ireland Community Fund in line with that of our SSE GB Community Funds. Please find attached a letter to Minister Arlene Foster outlining in further detail our reasoning pertaining to this proposed change.

Should you have any queries with regards to this proposed change, do not hesitate to contact me.

Regards,

Paul Cooley
General Manager Ireland, SSE Renewables

Simple Power letter re Electricity Policy Review

simple power

Mr Patsy McGlone MLA
Chairman
DETI Committee
Northern Ireland Assembly
Parliament Buildings
Stormont, BT4 3XX

21st November 2013

RE: Electricity Policy Review – response to comments by CBI re (farm-based) small scale wind renewables sector

Dear Mr McGlone,

The DETI committee recently took evidence from the CBI as representatives of large energy users, as part of the Electricity Policy Review.

As part of the evidence the CBI representatives commented on the economics and contribution to carbon reduction of large wind projects (greater than 1MW) compared with small scale wind projects (up to 250kW) which are almost exclusively farm-based.

We would like to place before the committee some facts in relation to small scale wind which were not part of the CBI presentation and correct a specific comment in the CBI submission.

The Northern Ireland Executive's energy strategy for NI, The Strategic Energy Framework (SEF), was published in September 2010 and set the target of 40% of electricity consumption to be provided by renewable sources by 2020. As part of the target the SEF recognised that many renewable technologies, including small scale renewables would have a part to play.

A follow-up energy plan in the form of the *Onshore Renewables Electricity Action Plan 2011-2020 (OREAP)* was published in October 2011. In her introduction to the OREAP the DETI Minister, Arlene Foster MLA, reiterated the role in the energy strategy of several small scale technologies including wind, PV, hydro and biomass.

The OREAP goes on to deal in some detail with the potential renewable capacity that could be achieved by 2020 from a number of different technologies. The OREAP did recognise that small-scale renewable generation is more expensive than large scale but also noted that such technologies contributed to wider government policy objectives other than simply carbon abatement.

The OREAP goes on to examine the size of the generation contribution likely from the various technologies and suggests target levels for each. The OREAP suggested that 120MW–160MW would come from the small scale wind sector.

In our view small scale wind, if properly harnessed, has the potential to make a very significant contribution to the farming and rural economy in Northern Ireland over the next 20-30 years. We estimate it could be worth at least £200million to farm businesses over that period if the sector can achieve scale as envisaged within the OREAP.

Arthur House, 41 Arthur Street, Belfast BT1 4GB T +44 (0)28 9024 1199 W www.simplepower.co @Simple_Power

This assessment was based on a projection of planning applications for these technologies. Over two years later and it is now apparent, due primarily to grid connection issues and the lack of availability of finance, the OREAP target is some way off. For example, the latest OFGEM statistics indicate just over 14MW of small scale wind generation between 0-250kW is installed and connected to the Northern Ireland grid. Nonetheless, we estimate that a substantial proportion of the OREAP target is potentially achievable by 2021 if Government support is maintained.

Apart from the role of small scale renewables in meeting the 2020 target we would ask that the DETI Committee and Northern Ireland Assembly carefully considers the important social and economic benefits from this technology. Smaller scale schemes allow the direct participation of individual farmers in the renewable industry, which would not be the case if only large wind projects were supported. At a time when there is significant pressure on farm incomes, small scale wind projects have become a valuable form of farm diversification and source of additional income. Due to the distributed nature of small scale wind projects, the benefits are also widely and more equitably distributed across the rural community.

In their evidence the CBI representatives made specific reference to the need to *'spend a lot more money on the grid to support the large number of small projects'*. This statement is factually incorrect - in fact the opposite is the case. As part of their charge for connection to the 11kV network connection, farmers and developers of small scale wind projects are required to pay for any network reinforcement costs that are needed due to their connection.

Therefore the general customer population connected to the rural 11kV network actually receive what is in effect a network upgrade for free. To date there have been no additional network costs incurred by customers at any level due to small scale wind. There has been a recent allowance for NIE to spend a very small amount on removing some network restrictions. Also it is our view, based on projects being carried out in GB, that smart solutions are available to connect generation to the distribution network at very little cost. It should be noted that this contrasts with the position on large wind which has required significant network investment to allow it to be connected.

To help give a more complete overview of the sector I have **attached a Stakeholder Briefing document** which gives background to the small scale wind sector, the benefits it brings to the farming/rural economy and action needed from DETI to support it going forward.

We hope you find this additional information useful and if you require any further clarification please do not hesitate to contact me.

Yours sincerely,

PHILIP RAINEY
Chief Executive

Cc Minister Arlene Foster MLA, DETI
Minister Michelle O'Neill MLA, DARD
Mr Paul Frew MLA, Chairman, DARD Committee
Minister Mark Durkan MLA, DOE
Mrs Anna Lo MLA, Chairperson, DOE Committee

SMALL-SCALE WIND GENERATION IN NORTHERN IRELAND

simple power

STAKEHOLDER BRIEFING PAPER

1. Introduction

i. In response to comments made by contributors to the DETI Committee's review of electricity policy Simple Power has compiled this briefing document to inform and update decision makers about the present status of the market for small-scale wind power and the factors affecting its development in Northern Ireland.

ii. This briefing is also prompted by the current review being undertaken by DETI officials of the ROC Incentive scheme in Northern Ireland and in part by the delays now very apparent in the development of the small scale wind market.

iii. In summary the paper highlights that:

a. The small-scale wind sector is of major economic importance to the farming and rural economy in Northern Ireland – potentially worth £200million over the next 20-30 years;

b. The main reason for delays in growth in generating capacity in the sector is to do with grid connection;

c. Given rising costs associated with development of turbine sites on farms, it is essential the current level of Government support, upon which projects and investments are based, is retained until at least 2021, when it would be hoped the sector will achieve the generation target for small scale wind (between 120-160MW) as set out in the 2011 Onshore Renewable Energy Action Plan (OREAP).

2. NI small-scale onshore wind targets

i. The October 2011 Draft Onshore Renewable Energy Action Plan ("OREAP") 2011-2020 set out specific actions to achieve the objectives of the Strategic Energy Framework (SEF). It identified that "*...onshore wind is one of the most cost effective and established renewable technologies.*" The OREAP found that small scale wind developments were likely to contribute in the region of 120-160

1

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MW of capacity towards Northern Ireland's target of 40% of consumption coming from renewable energy by 2020.

ii. With large scale offshore wind projects unlikely to be operational ahead of 2020, continuing challenges for large scale onshore wind due to grid capacity constraints, delays with RP5 grid investment and limited biomass and anaerobic digestion deployment, small-scale wind can clearly play a significant role for Northern Ireland in reaching its 40% renewables target.

3. Small scale wind & Simple Power

i. The Northern Ireland small scale wind sector is characterised by many single site farmers and several multi-site developers. Simple Power was designed as an 'aggregator', to offer farmers a risk-free route to securing an income from a wind turbine on their land and bring the benefit of professional project management, process standardisation, finance and scale to site development. Simple Power believes that many Northern Ireland farmers could not otherwise benefit from the small scale wind incentive scheme, due to the multiple risks, time and financial commitments involved.

ii. Simple Power's business model has proved attractive to farmers and the company now has some 200 sites across Northern Ireland agreed or under option. Under its original business plan in 2010, Simple Power had planned to have some 200 turbines operational on farms across Northern Ireland by mid-2017. As of today, the company has only three turbines erected and connected to the grid. The reasons behind this slow pace of development are the same reasons affecting all individual farmers and small companies in the sector namely:

a. Difficulty securing planning approvals for viable sites
b. Securing cost effective and timely grid connections
c. Securing access to finance at reasonable cost

The most challenging of these has been issues associated with grid connection. These three reasons are also discussed in greater detail later in the document.

simple power

SMALL-SCALE WIND GENERATION IN NORTHERN IRELAND

iii. It is also important to note that the investment decisions made by farmers and developers in this sector have been made on the basis of the current level of 4 ROCs support combined with the expectation of a reasonable grid connection cost.

iv. It is the widely held view of stakeholders in the small wind sector, based on experience to date, that the OREAP target of 120-160MW of generation will not be achieved until 2021 at the earliest and it will **only** be achieved within that timeframe if the level of support through ROCs or FIT is maintained at the current level.

4. Small scale wind economic benefit for NI farming community

i. On top of the contribution that widespread deployment of small scale wind can have on meeting renewable energy targets, we understand that the Northern Ireland Executive is aware and supportive of the assistance that this can bring to farm business and the wider rural economy.

ii. With price pressures from supermarket multiples and very high operating costs many farm net incomes are now materially below £30,000 per annum. In this context, a £15,000 per annum lease income from a wind turbine developer (or £30,000+ of net income from developing the turbine themselves) is a very significant sum for many small farmers.

iii. Indeed, meeting the OREAP target using 250kW turbines alone (combining owner operator and developer lease incomes) should be worth at least £10 million per annum to farmers across Northern Ireland – with a cumulative benefit of at least £200million when sustained over a 20 year period. It is hard to see how any other known renewable technology can provide such equitable and distributed benefit to the rural economy in Northern Ireland in the next 20 years.

iv. In addition to the benefit for farmers, the skilled jobs benefit from small-scale onshore wind – as a result of turbine erection, operation and maintenance - is substantial. On top of this, many planning, legal and consulting firms across NI are now heavily involved in working with the small-scale renewable sector.

3

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5. Small-scale wind turbine installed generating capacity

i. Although a significant number of sites for small turbines have been approved by DoE Planning, a DETI update on the sector [*AQ 22284/11-15*] showed that as of 26th April 2013, some 15.5MW of '*live and preliminary accreditations under NIRO*' were available for generation by small scale wind turbine stations of between 0-250kW. A previous DETI update in December 2012 [AQ 17648/11-15] indicated that some 12.9MW of '*live and preliminary accreditations under NIRO*' were available for generation by small scale wind turbine stations of between 0-250kW in Northern Ireland. Thus in almost four months the sector had added barely 3MW in capacity.

ii. There is no published DETI evidence to accurately state how much capacity has been added since then, however (as of 15th November 2013), the OFGEM website confirmed that there is just over 14MW of installed and connected single turbines of generating size between 0-250kW in Northern Ireland. This is the favoured size of turbine installed by farmers and multi-site developers in Northern Ireland.

iii. Irrespective of which figure one chooses to refer to, it is clear that at a time when the sector should be flourishing, it is struggling to achieve any generating scale against its OREAP target of 120-160MW.

6. Key reasons for delays in sector development

i. Looking more closely at the three major factors (referred to earlier) delaying back the roll-out of small scale turbines we can make the following observations:

a. **Planning**

i. While a lot of sites are approved, the most economically viable sites are often, as might be expected, situated on the tops of hills. A good indication of the importance of site location is the recent news story regarding a £48,000 small turbine built in Aberystwyth by the Welsh Government, which due to location and poor wind speed is generating £5 of electricity per month and will take some 453 years to break even!

ii. DOE Planners prefer lower sites with lower visual impact – but the associated lower wind speeds make many of these unviable. Some observers of the small scale wind sector have expressed concern that a large number of sites are approved. It is Simple Power's view that the vast majority of sites (for single turbines) will never be developed due to poor wind speed and prohibitive grid connection costs – rendering financing almost impossible.

b. The NIE Network

i. Wind turbines <250kW would normally be connected to NIE's 11kV network. However, the best wind sites are often located where the 11kV network is relatively weak, having been designed originally to provide supply to widely dispersed rural farms and dwellings.

ii. Therefore the result of seeking connection on many parts of the 11kV network has often been high costs and long delays, especially in the west of the Province where the wind resources are best. In 2010 when 4 ROCs support was introduced and the sector began to develop connection offers were at viable levels - typically averaging between £70,000-£125,000. These costs also reflected the current average cost in Great Britain. Unfortunately, in 2013, grid connection offers over £300,000 are not uncommon in Northern Ireland and a recent grid application by Simple Power (for a site in Rosslea) received a quotation of £1million. Such high costs render the projects unviable. This situation is likely to continue in the short-term, however, there are smart solutions available in GB that could reduce the cost burden significantly (see section *6.b.viii* below).

iii. It should also be noted that, unlike in GB where grid connection applications can be made in parallel with planning applications, grid connection offers in Northern Ireland can only be made by NIE after planning consent has been secured for a site. This adds further delay and – as in the case of the Rosslea site – means resources are often wasted pursuing planning consents for sites which are ultimately too expensive to connect to the grid.

iv. The dispute between NIE and the Utility Regulator over RP5 has also directly and indirectly (the latter through diversion of resources in debating the matter) created further delay in getting a satisfactory solution to the weak infrastructure. It is hoped that the recent determination by the Competition Commission will help to resolve this issue. Furthermore, the recent commitment by NIE to upgrade 40 of its 60 substations across Northern Ireland should be help create more capacity for grid connections.

v. Even where connection quotations are at viable levels, the delay is sometimes unavoidable, e.g. obtaining wayleaves can also undermine a project. For example, Simple Power has met farmers who have had to wait 2 years for a connection. Simple Power has two turbines in Co. Tyrone, installed in March 2013. One of the turbines (near Ballygawley) was only connected in October 2013 (7 months late) and the other turbine (near Donemana) is still awaiting connection almost 8 months after being promised to be grid connected by NIE.

vi. The combined effect of higher grid costs and connection delays – which can be up to 24 months from grid application to energising a turbine (after planning approval and business planning/finance raising processes of probably more than a year) – is that small scale wind projects are very stretched and costly to pursue.

vii. While some delays are to be expected with higher numbers of grid applications being submitted, it is Simple Power's view that NIE has yet to get the processes and resources in place to adequately manage the volume of applications they have received. In addition, a contestability regime on distribution network connections should be introduced in Northern Ireland, bringing it into line with the practice in GB.

viii. Simple Power has also gone to significant lengths to investigate new technologies which allow cheaper connection of single wind turbines in Great Britain. New technologies are being utilised in parts of

England and Scotland which can greatly reduce the cost of upgrading 11kV lines. Simple Power has briefed NIE on these innovations and NIE has expressed interest in determining their suitability on the network in Northern Ireland. Further information should be available soon on these technologies.

ix. As a final point in relation to pressures on grid capacity, Simple Power questions the policy of equal ROCs (or FIT) support for the installation of second hand wind turbines (some of which are over 20 years old), which utilise grid capacity less efficiently than new turbines and are unlikely to generate for the full term of the 20 year tariff life.

c. Finance

i. Uncertain project completion dates and a risk-averse funding market have resulted in serious difficulty raising finance for farm businesses and small company multi-site developers. Unless a farmer is able to offer sufficient security for their renewable project (which usually means that the finance is raised against their land, rather than the renewable project), it is very unlikely that finance will be available to them. A funder will not even review a development proposal that doesn't have planning approval, a Power Purchase Agreement ("PPA"), a connection offer, turbine supply and construction contracts, third party operating and maintenance management, substantial warranties and insurance.

ii. With the above complexities and risks attached to small-scale wind projects, even where finance is offered, the risk profile is high and thus certainty around government support mechanisms and tariff levels until 2021 is crucial.

iii. Any further erosion, or even perceived potential erosion, in the level of support for the scheme (in addition to the fall from a £50+ ROC price 2-3 years ago to nearer £40 now) will have a further negative effect on financing, including requiring the re-appraisal of all of NI's small scale wind projects in progress. Any reduction in the current tariff support (4 ROCs) will deal an almost fatal blow to the small scale wind sector. Indeed, given the increasing development costs for the sector and the drop in value of ROCs since 2010 (see below), there is strong case for DETI allowing a marginal increase in the level support for small-scale wind in Northern Ireland.

7. Current ROC incentive levels in NI and project returns

i. The current ROC and LEC tariffs in NI, together with the wholesale energy price, are worth a total of approximately £220 per MW hour of generation for a 250kW wind turbine. A standard 250kW turbine on a site with an average annual wind speed of 6 m/sec pays back in around 8-9 years for a farmer allocating no cost/rent against the land that the turbine is sited on. This is a reasonable investment return for a farmer, although perhaps not for the risk associated with such projects. For a professional developer, who is better able to manage the risk profile, the payback, after deducting a £15,000 p.a. lease is around 9-10 years.

ii. All of these 'potential' returns assume a "reasonable" grid connection cost but, as explained, NIE prices are coming in considerably higher than developers and farmers were expecting. Unless NIE takes certain steps to improve grid access, many potential sites will not proceed as the high connection costs mean the investment risk profile itself becomes too high.

8. Comparison with incentive levels in GB

i. Research shows that support under the FIT regime in Great Britain is currently worth a similar amount as the NIROC per MWh – and it should be noted that the FIT scheme provides certainty of income, unlike the market-related ROC scheme. In addition, in GB, this level of support is available for turbines with capacity of up to 500kW. Obviously the economics of a 500kW turbine with this level of support are considerably better than for a 250kW turbine (pay back periods are nearly halved).

ii. Any comparison between GB and NI support levels needs to recognise this disparity, although Simple Power does not believe that lifting the tariff to a 500kW turbine capacity is the right solution for equalisation, given the grid

NIFPO Ltd letter re potential impact of proposed Offshore Wind Farm Development on NI Fishing Industry

Dear All

I enclose for your information two reports detailing the potential impact of the proposed windfarm development on the Northern Ireland Fishing Industry.

The first report was commissioned by the Northern Ireland Industry through Seafish and covers the impact on the Nephrops fleet. It shows annual revenue losses of between £400,000 and £1,000,000 depending on the siting of the windfarm. This report does not cover losses from other fishing activity in the zone nor that of the smaller trawlers which were not covered by the position reporting technology (VMS) on which the analysis is based. This report concludes that area B would be least impacted in terms of lost fishery but does not account for Scallops and Potting losses which the second analysis confirms is significant in Area B compared with the other locations within the windfarm zone.

The second analyses is based on data provided by some 65 fishing vessel skippers collected by NIFPO and complied by AFBI in Belfast. It shows the fishing activity by Nephrops, Scallop and potting fleets. It confirms the location of the Nephrops fishery and illustrates that Scallop and Potting activities take place in that part of the Windfarm zone where Nephrops trawling is of lesser or no importance.

The scale of potential losses to all sectors of the Northern Ireland fishing industry (catching, processing & ancillary support) is likely to be of a scale where the continued existence of one or more dependant fishing communities will be compromised. This would be compounded as competition for space by other seabed users and environmental concerns eventuates.

It should be noted that whereas the UK (at present) does not prohibit fishing in a completed windfarm zone it is the only European country not to prohibit such activity but during construction of the farm access within it is prohibited. The practicality of the fishing with trawl & scallop dredge within the completed windfarm is problematic to say the least and it is safe to say that unrestricted operation would not be possible.

Regards
Dick James
NIFPO Ltd
1 Coastguard Cottages
Portavogie
Co. Down
BT22 1EF

Habitat Analyses Part2

Landscape analysis using fishing data acquired from the 'NIFPO commercial fisheries report' April 2013

Laurence Rooney

December 2013

Contents

Habitat Analyses

Information on fishing intensity was derived from data collected for and presented in 'NIFPO Commercial Fisheries Report' produced by First Flight Wind.

See report for complete methodology.

In summary admiralty charts were supplied as part of a survey of the fishermen at NIFPO and a smaller number at ANIFPO. Sixty five charts were returned, upon which, each fisherman identified areas they fished. The fishing areas are described; quantitative intensities are derived - Not to be confused with VMS (Vessel Monitoring System data) which is purely objective.

These charts were compiled in GIS and overlapping areas received a higher intensity. AFBI digitised the final charts for the analyses below.

Fishing intensities are between 1 and 50 on the derived intensity scale.

Data was digitised and spatial analysis carried out using ArcGIS 10.0

Coordinate system – WGS84

Projection – WGS84_UTM Zone_30N

Note - slight misalignment with the habitat/landscapes file means there is a 1% error margin within in the calculations. This means areas are approximate.

Scalloping:

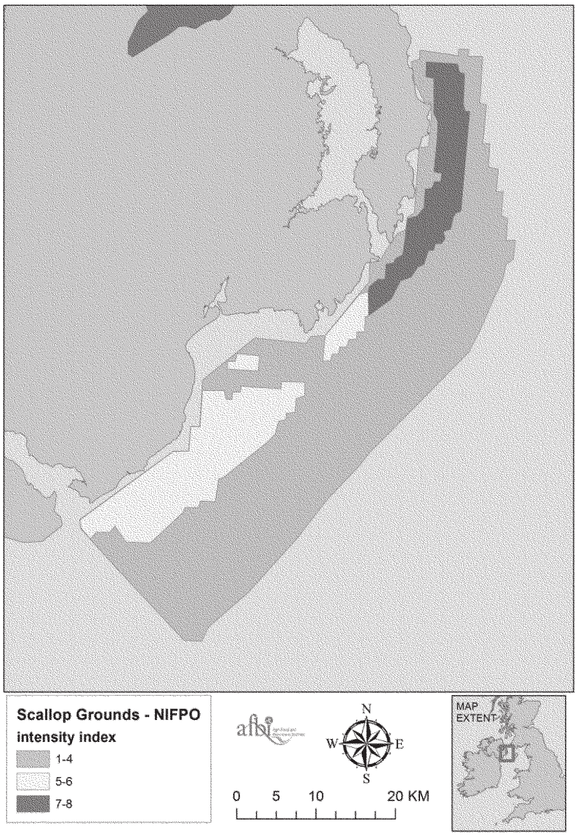


Figure 1: Areas fished for scallops and the relative intensity of fishing (Source NIFPO: FFW report)

Scalloping area:

intensity - overall	KM2
1-4	940.96
5-6	239.62
7-8	123.51
Total scallop fishing area	**1304.09**

Habitat composition:

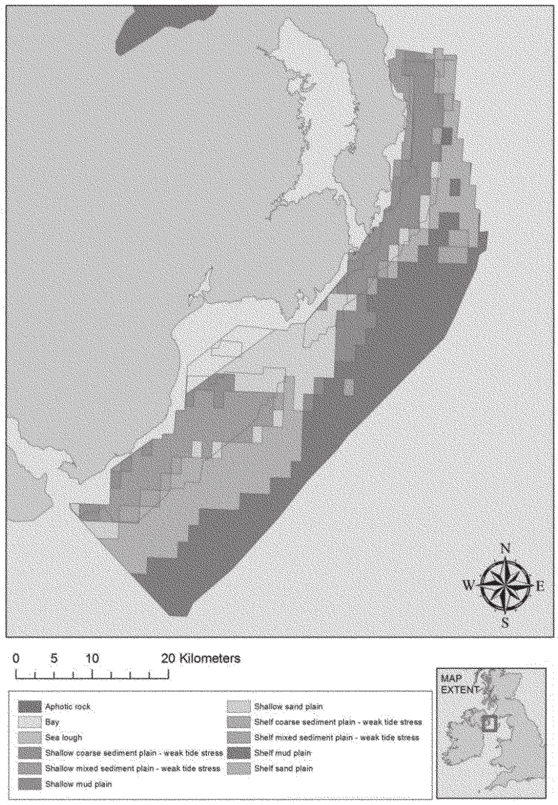
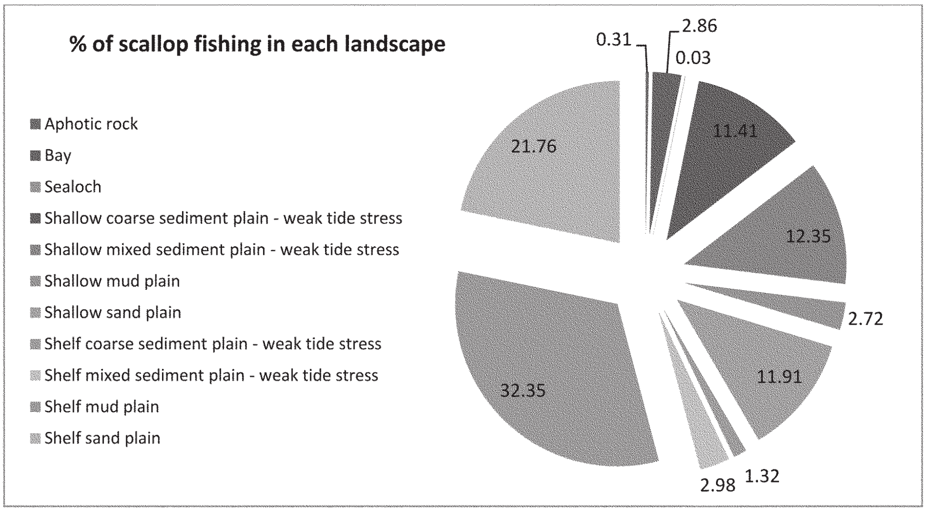


Figure 2: The landscape types where scallop fishing occurs. (Scalloping source NIFPO: FFW report)

KM2 of Scallop fishing in each habitat	Area KM2			
Landscapes \ Intensities	**1-4**	**5-6**	**7-8**	**Total**
Aphotic rock	3.99	0.00	0.01	**3.99**
Bay	25.55	11.69	0.00	**37.24**
Sea lough	0.44	0.00	0.00	**0.44**
Shallow coarse sediment plain - weak tide stress	28.85	24.82	95.17	**148.85**
Shallow mixed sediment plain - weak tide stress	35.80	121.67	3.55	**161.02**
Shallow mud plain	33.71	1.68	0.07	**35.46**
Shallow sand plain	97.32	45.38	12.60	**155.29**
Shelf coarse sediment plain - weak tide stress	13.87	0.00	3.36	**17.23**
Shelf mixed sediment plain - weak tide stress	19.66	17.19	2.02	**38.86**
Shelf mud plain	421.87	0.00	0.00	**421.87**
Shelf sand plain	259.86	17.19	6.73	**283.78**
Total habitat	940.92	239.62	123.51	**1304.05**

% of Scallop fishing in each habitat		%		
Landscapes \ Intensities	**1-4**	**5-6**	**7-8**	**Total**
Aphotic rock	0.42	0.00	0.01	**0.31**
Bay	2.72	4.88	0.00	**2.86**
Sea lough	0.05	0.00	0.00	**0.03**
Shallow coarse sediment plain - weak tide stress	3.07	10.36	77.06	**11.41**
Shallow mixed sediment plain - weak tide stress	3.81	50.77	2.88	**12.35**
Shallow mud plain	3.58	0.70	0.05	**2.72**
Shallow sand plain	10.34	18.94	10.20	**11.91**
Shelf coarse sediment plain - weak tide stress	1.47	0.00	2.72	**1.32**
Shelf mixed sediment plain - weak tide stress	2.09	7.17	1.63	**2.98**
Shelf mud plain	44.83	0.00	0.00	**32.35**
Shelf sand plain	27.62	7.18	5.45	**21.76**
Total	*100.0*	*100.0*	*100.0*	***100.00***



Wind Resource Zone (WRZ)

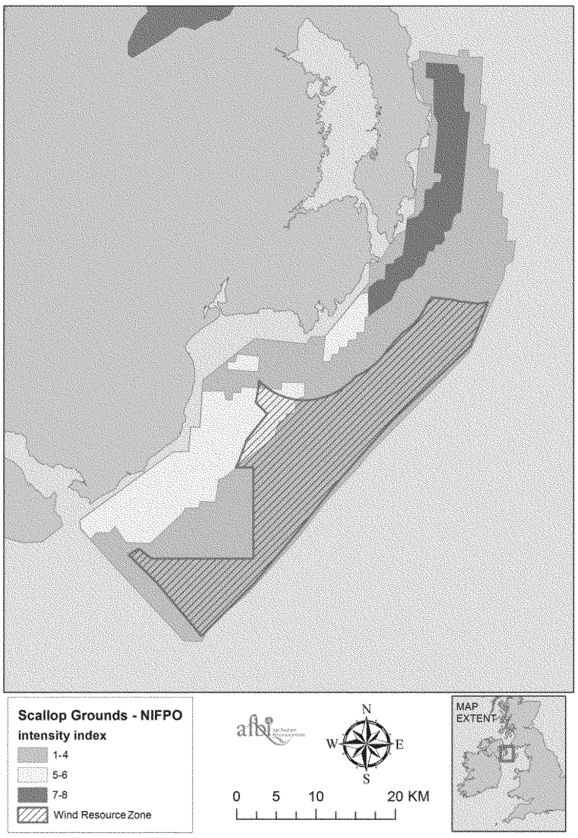


Figure 3: Areas where scallop fishing occurs and the relative intensity of fishing with the wind resource zone (WRZ) overlaid. (Scalloping source NIFPO: FFW report)

Windfarm composition:

Windfarm composition				
Intensity	**1-4**	**5-6**	**7-8**	**Total**
KM2 total area	940.95	239.62	123.51	1304.09
KM2 total area in wind farm	412.3	26.1	0	438.4
% of total scallop area in wind farm	*43.81*	*10.91*	*0.00*	***33.62***

Potting

Figure 4: Areas where pot fishing occurs and the relative intensity of fishing (Source NIFPO: FFW report)

Potting Area:

intensity - overall	KM2
1-8	1339.02
9-20	410.95
Total scallop fishing area	**1749.97**

Habitat Composition

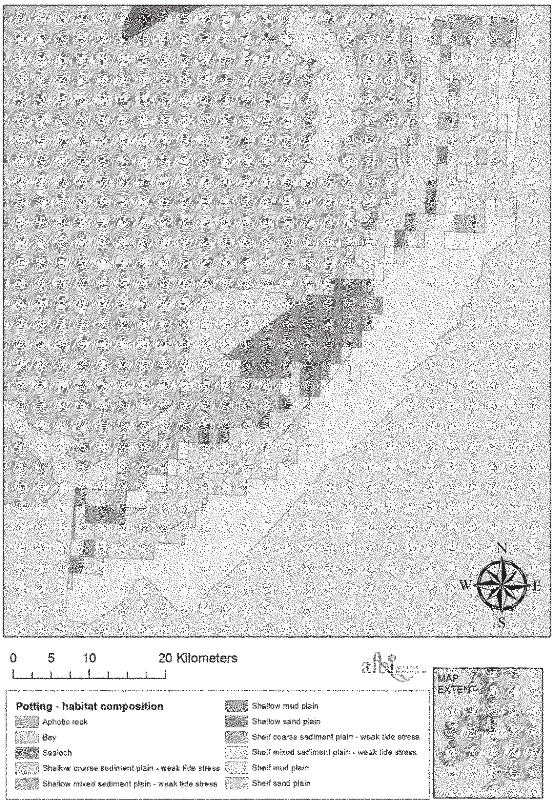
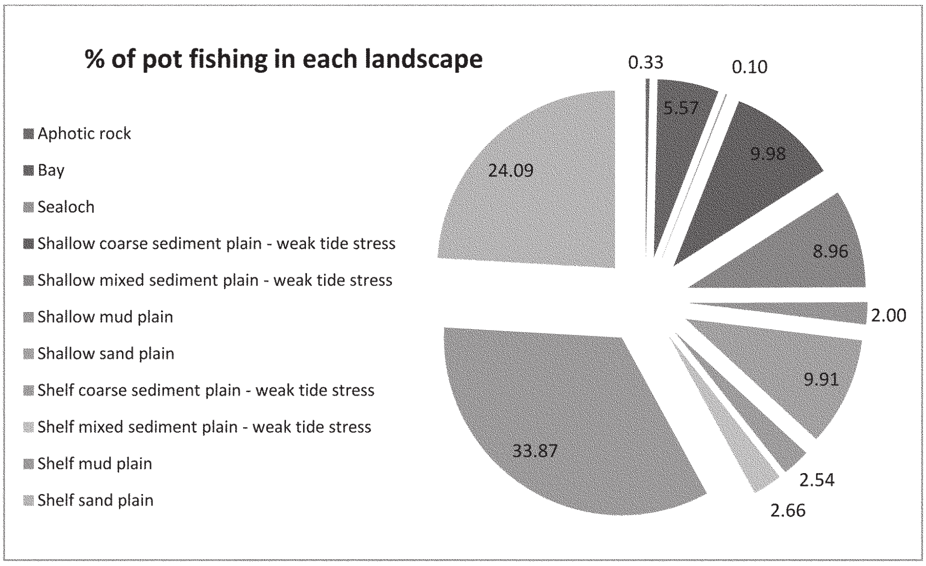


Figure 5: The landscape types where pot fishing occurs. (Potting source NIFPO: FFW report)

KM2 of Pot fishing in each habitat	Area KM2		
Landscapes \ Intensities	**1-9**	**10 - 20**	**Total**
Aphotic rock	5.78	0.00	5.78
Bay	78.55	18.92	97.47
Sea lough	1.82	0.00	1.82
Shallow coarse sediment plain - weak tide stress	161.55	13.03	174.58
Shallow mixed sediment plain - weak tide stress	54.82	101.92	156.74
Shallow mud plain	14.59	20.39	34.98
Shallow sand plain	46.85	126.51	173.36
Shelf coarse sediment plain - weak tide stress	44.50	0.00	44.50
Shelf mixed sediment plain - weak tide stress	26.72	19.81	46.53
Shelf mud plain	587.06	5.62	592.68
Shelf sand plain	316.76	104.74	421.49
Total habitat	1339.00	410.95	1749.95

% of Pot fishing in each habitat	%		
Landscapes \ Intensities	**1-9**	**10 - 20**	**Total**
Aphotic rock	0.43	0.00	**0.33**
Bay	5.87	4.60	**5.57**
Sea lough	0.14	0.00	**0.10**
Shallow coarse sediment plain - weak tide stress	12.06	3.17	**9.98**
Shallow mixed sediment plain - weak tide stress	4.09	24.80	**8.96**
Shallow mud plain	1.09	4.96	**2.00**
Shallow sand plain	3.50	30.78	**9.91**
Shelf coarse sediment plain - weak tide stress	3.32	0.00	**2.54**
Shelf mixed sediment plain - weak tide stress	2.00	4.82	**2.66**
Shelf mud plain	43.84	1.37	**33.87**
Shelf sand plain	23.66	25.49	**24.09**
Total	*100.00*	*100.00*	***100.00***



Wind Resource Zone (WRZ)

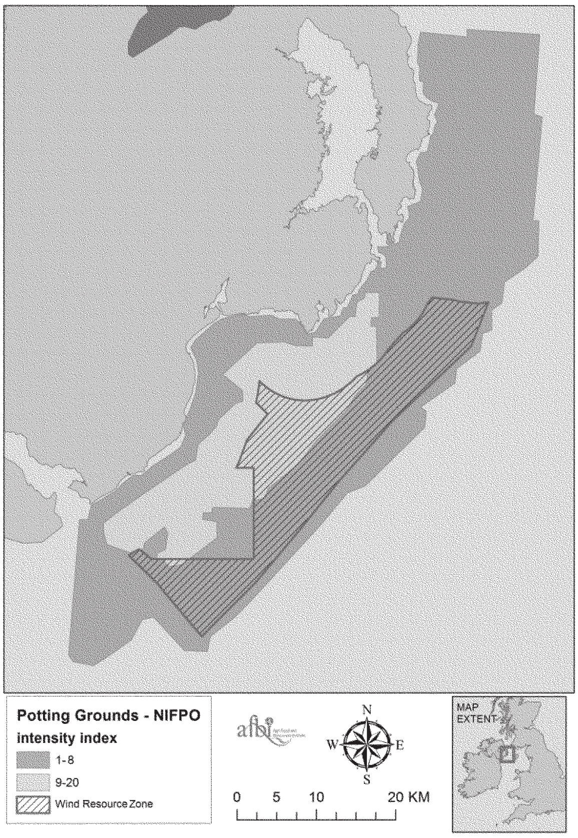


Figure 6: Areas where pot fishing occurs and the relative intensity of fishing with the wind resource zone (WRZ) overlaid. (Potting source NIFPO: FFW report)

Windfarm composition			
Intensity	**1-9**	**10 - 20**	**Total**
KM2 total area	1339.02	410.95	1749.973
KM2 total area in wind farm	439.39	103.80	543.19
% of total scallop area in wind farm	*32.81*	*25.26*	*31.04*

Demersal Trawling

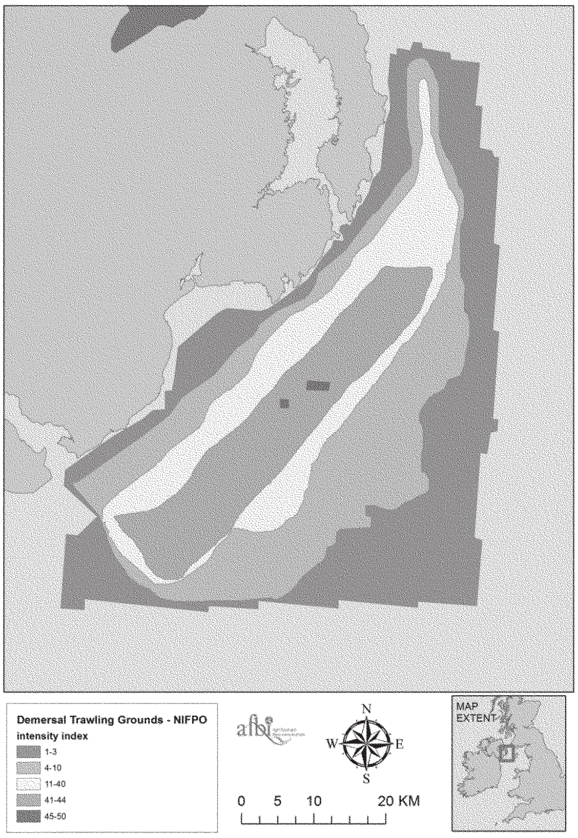


Figure 7: Areas where demersal fishing occurs and the relative intensity of fishing (Source NIFPO: FFW report)

Demersal fishing area:

intensity – overall	KM2
1-3	991.65
4-10	787.64
11-40	511.08
41-45	457.51
45-50	5.30
total	2753.19

Habitat Composition

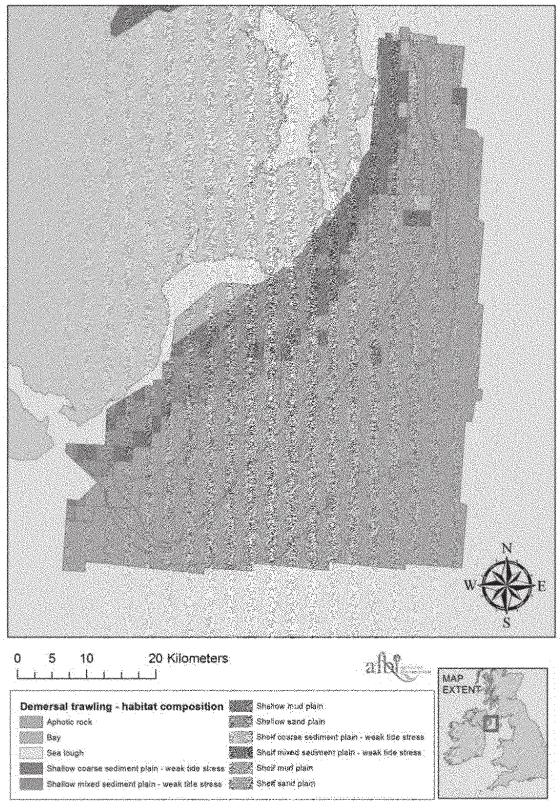
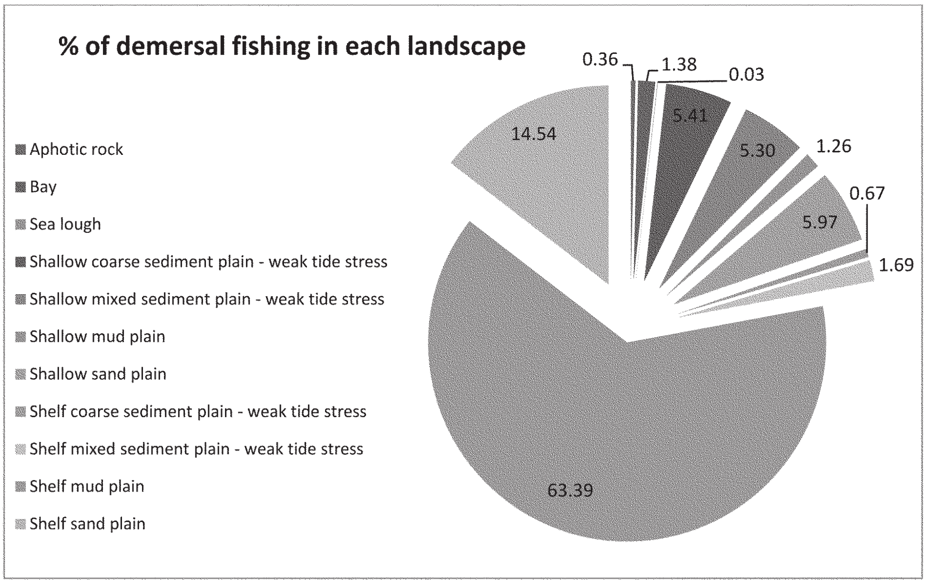


Figure 8: The landscape types where demersal fishing occurs. (Demersal source NIFPO: FFW report)

KM2 of Demersal fishing in each habitat						
Landscapes\Intensities	**1-3**	**4-10**	**11-40**	**41-44**	**45-50**	**Total**
Aphotic rock	4.83	2.91	2.30	0.00	0.00	**10.04**
Bay	37.93	0.00	0.00	0.00	0.00	**37.93**
Sea lough	0.90	0.00	0.00	0.00	0.00	**0.90**
Shallow coarse sediment plain - weak tide stress	92.80	51.37	4.64	0.00	0.00	**148.81**
Shallow mixed sediment plain - weak tide stress	41.74	75.67	28.42	0.02	0.00	**145.84**
Shallow mud plain	0.00	0.39	19.47	14.73	0.00	**34.59**
Shallow sand plain	33.24	56.29	67.50	7.47	0.00	**164.50**
Shelf coarse sediment plain - weak tide stress	4.20	5.64	8.49	0.00	0.00	**18.34**
Shelf mixed sediment plain - weak tide stress	5.87	16.23	21.62	2.91	0.00	**46.63**
Shelf mud plain	664.35	542.28	207.61	327.05	3.98	**1745.26**
Shelf sand plain	105.79	36.88	151.05	105.37	1.33	**400.42**
Grand Total	991.66	787.66	511.09	457.54	5.31	**2753.26**

% of Demersal fishing in each habitat						
Landscapes\Intensities	**1-3**	**4-10**	**11-40**	**41-44**	**45-50**	**Total**
Aphotic rock	0.49	0.37	0.45	0.00	0.00	**0.36**
Bay	3.83	0.00	0.00	0.00	0.00	**1.38**
Sea lough	0.09	0.00	0.00	0.00	0.00	**0.03**
Shallow coarse sediment plain - weak tide stress	9.36	6.52	0.91	0.00	0.00	**5.41**
Shallow mixed sediment plain - weak tide stress	4.21	9.61	5.56	0.00	0.00	**5.30**
Shallow mud plain	0.00	0.05	3.81	3.22	0.00	**1.26**
Shallow sand plain	3.35	7.15	13.21	1.63	0.00	**5.97**
Shelf coarse sediment plain - weak tide stress	0.42	0.72	1.66	0.00	0.00	**0.67**
Shelf mixed sediment plain - weak tide stress	0.59	2.06	4.23	0.64	0.00	**1.69**
Shelf mud plain	66.99	68.85	40.62	71.48	74.96	**63.39**
Shelf sand plain	10.67	4.68	29.55	23.03	25.12	**14.54**
Total	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	***100.0***



Wind Resource Zone (WRZ)

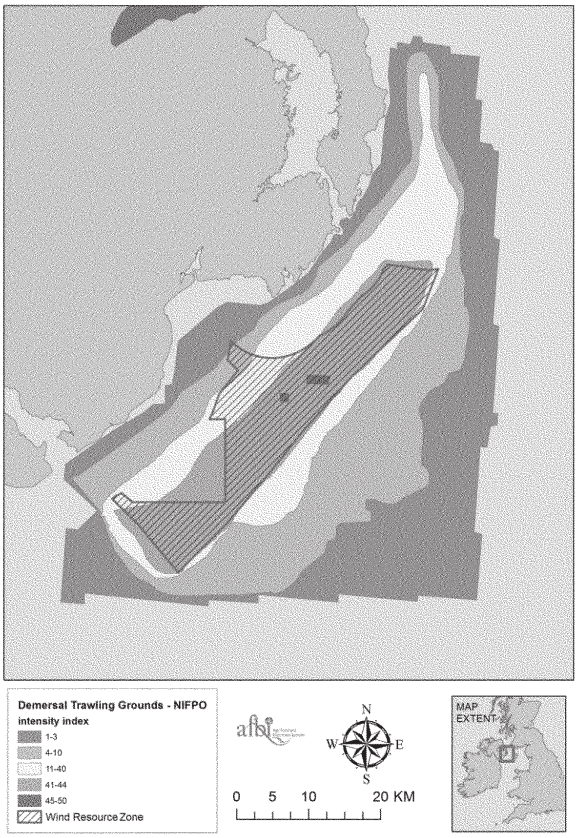


Figure 9: Areas where demersal fishing occurs and the relative intensity of fishing with the wind resource zone (WRZ) overlaid. (Demersal source NIFPO: FFW report)

Windfarm composition						
Intensity	**1-3**	**4-10**	**11-40**	**41-44**	**45-50**	**Total**
KM2 total area	991.65	787.64	511.08	457.51	5.30	2753.19
KM2 total area in wind farm	0.43	9.30	60.54	363.01	5.30	438.58
% of total scallop area in wind farm	*0.04*	*1.18*	*11.84*	*79.35*	*100.00*	*15.93*

SEAFISH
the authority on seafood

Fisheries Resource Access Mapping Project (FishRAMP):

The Co. Down Wind Resource Zone

Contributors: Matthew Service and Laurence Rooney (AFBI); Rod Cappell (Poseidon); Lynn Gilmore (Seafish) and the NI Seafood Industry.

August 2013

EXECUTIVE SUMMARY

This report presents an assessment of the importance to the Northern Ireland fishing industry of the Wind Resource Zone (WRZ) off the County Down coast. This work is an early output from FishRAMP being undertaken by the Agri-Food and Biosciences Institute (AFBI) and Poseidon with input from the NI seafood industry through the Seafish Northern Ireland Advisory Committee (SNIAC) as well as funding and support from Seafish and DARD.

An estimated 120 km^2 (or 27%) of the WRZ may be required for the planned 600 MW wind farm. The final plan and expected footprint is not yet determined.

This exercise considered four 120km^2 areas within the WRZ as indicative areas for location of the development: Northern (area A), Central (Area B), Southern (Area C) and an offshore area of the WRZ that overlaps parts of areas A & B (area D).

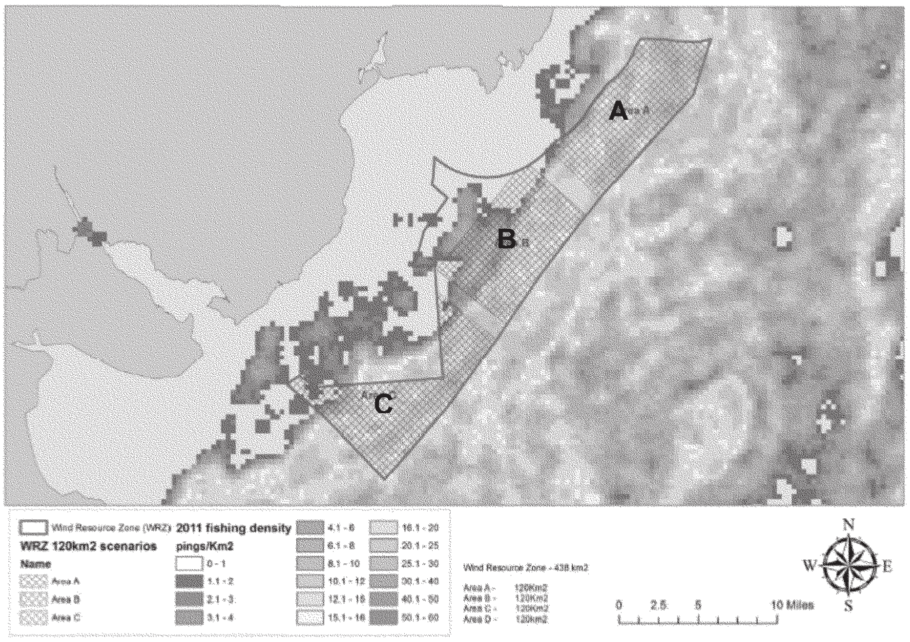


Figure A Wind Resource Zone (red) and potential wind farm development areas (A, B & C), each 120km²

© AFBI, 2013

VMS data show fishing activity across 99-100% of areas A, C and D. Area B shows an average of 93% of the area being fished.

In the last five years (2007-2011) the amount of fishing activity in the WRZ has increased in all the areas considered.

Fishing intensity in Area D, containing more offshore area than areas A, B and C, is 70% greater than average fishing intensity across the WRZ as a whole.

For the trawl fleet the (2007-2011) average landed value ranges from an estimated £900,000 per annum in Area D (offshore North) to nearly £500,000 per annum in the central area B in the centre of the WRZ.

Area B in the centre of the WRZ is the only area of the four considered that has a lower than average value per km^2 compared to the WRZ as a whole.

Spatial data on pot fishing effort is not available and therefore estimated values are not possible. Based on the numbers of pots landed per port, however, it can be assumed that Area C in the South is likely to account for the greatest value due to its proximity to Kilkeel.

As with the trawl fleet, the level of potting activity in the central area B is assumed to be less as it is further from shore and data indicates fewer pots being landed to adjacent ports (Ardglass/Annalong) compared to Kilkeel in the south and Portavogie in the north.

This document reports the estimated value of catches from certain areas. It does not estimate the impact on revenue resulting from a development in these areas, which can also have positive impacts for some vessels through providing vessel services to developers.

Overall impact will depend upon the scale and extent of displacement from these important fishing grounds.

Developments can impact vessel owners through lost revenue, but will also impact crew, processors, ancillary industries and their associated employees and local communities.

Seasonal fishing patterns are dictated by the need to disperse effort across grounds throughout the year. Displacement from wind farm areas would result in additional pressure on remaining grounds that are already fished, which could lead to lower catch per unit effort and may be unsustainable in the longer term.

These aspects of displacement and impact are discussed in the full FishRAMP report.

Contributors: Matthew Service and Laurence Rooney (AFBI); Rod Cappell (Poseidon); Lynn Gilmore (Seafish) and the NI Seafood Industry.

August 2013

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Section 1: Poseidon Wind Resource Zone Economic Analysis

INTRODUCTION

Background

This report presents an assessment of the importance to the Northern Ireland fishing industry of the Wind Resource Zone (WRZ) off the County Down coast. The Department of Enterprise, Trade and Investment, Northern Ireland (DETI NI) awarded development rights to First Flight Wind (FFW).

This work is an early output from the Fishing Resource Access Mapping Project (FishRAMP) being undertaken by the Agri-Food and Biosciences Institute (AFBI) and Poseidon with input from DARD, Seafish and the NI seafood industry through the Seafish Northern Ireland Advisory Committee, which considers many potential spatial constraints facing the Northern Ireland fishing industry from offshore developments and proposed marine protected areas.

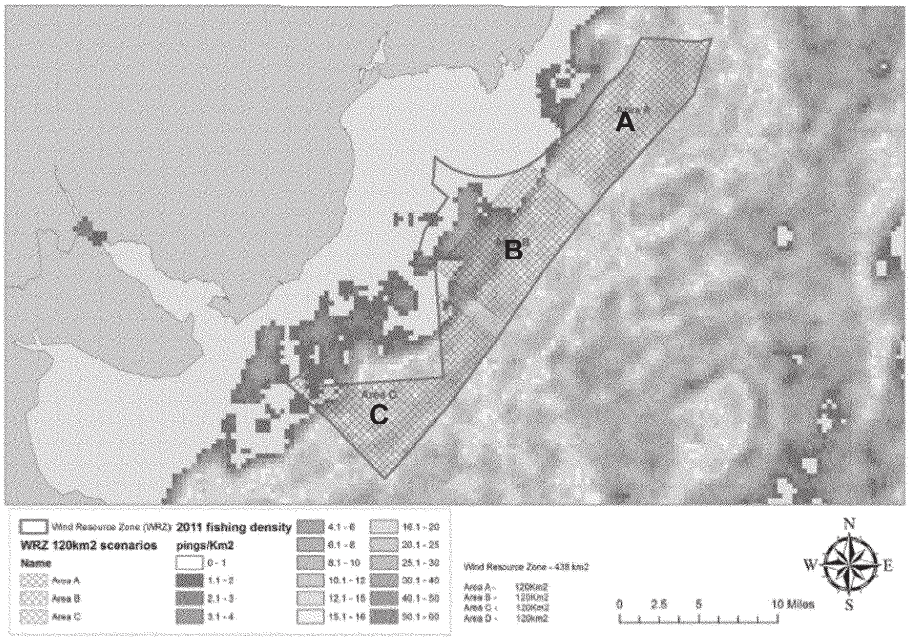


Figure 1 Wind Resource Zone (red) and potential wind farm development areas (A, B & C), each 120km^2

Source: AFBI, 2013

FFW is exploring the potential to develop a 600MW wind farm somewhere within the WRZ. The size and location of the area to be developed within the WRZ will be defined by the size, number and spacing of turbines proposed as well as any physical or operational constraints identified across the WRZ. For this research, an early estimate suggested by FFW of approximately 120 km^2 is used as an estimate of the footprint for the development area (Figure 1), which represents around 25% of the WRZ (which has a total area of 438 km^2).

Objective

The objective of this work is to assess indicative, comparative values associated with potential development areas within the WRZ.

The report will estimate the proportion of total fleet revenue associated with the proposed areas. Total fleet revenue is based on the total annual value of landings for the wind farm areas within the WRZ (not the whole WRZ), but note that this varies year on year due to various factors affecting the fleet's fishing opportunities & market prices.

METHODOLOGY

Approach

The analysis involved two stages:

1. AFBI overlaid vessel monitoring system (VMS) data for Northern Ireland (NI) fishing vessels over 15m with the WRZ and four indicative 120km^2 areas (see Figures 1 and 2).
2. Poseidon used DARD landings data to determine average landed values for relevant fleet segments and estimates the proportion attributable to the WRZ and the four indicative development areas based on AFBI estimates of fishing intensity.

Scope

The scope of this assessment is limited to:

- The NI fleet above 15m in length (*Nephrops* is the main target species, but whitefish, scallops and other species make up important additional components). UK, ROI or other nationality vessels and vessels from other regions and countries that fish in the WRZ are not included. The activity of the potting fleet in the WRZ is mentioned, but will be considered further in the full FishRAMP report.
- The value of catch associated with the WRZ located in the Irish Sea off the County Down coast. A valuation of other Irish Sea renewable development areas on this fleet is not included in this report, but will be considered in the full FishRAMP report.
- Data from the years 2007 to 2011. This enables a five-year average and short-term trends to be established, but it should be noted that this period includes the global economic downturn, which severely impacted the export-orientated trade in *Nephrops (*although prices have recovered in recent years). Effort limitations (days at sea) have also been in place for the entire period as part of the cod recovery plan for the Irish Sea.

In light of the above, the following should be noted:

- The valuation is based on average values per area that are assumed to be proportional to fishing intensity. Consultation with the industry is necessary to explore the relative scale and quality of the catch from the areas concerned, e.g.

different sized Nephrops or different catch composition (e.g. more or less by-catch of high value whitefish).

- These grounds are accessible for Nephrops vessels under 15m and therefore, while not represented in the VMS, it is assumed that the same relative fishing intensities relate to this fleet component. This may be an underestimate as these grounds close to port may be comparatively more important to the smaller vessels than the over 15m vessels, some of which fish further afield.
- The proposed development area has not been reported by FFW. Those used in the report are indicative 120km^2 areas in the (A) northern, (B) central and (C) southern areas of the WRZ. A fourth area (D, see Figure 2) is also presented in the northern on the eastern edge of the zone, avoiding the western (inshore) edge of the WRZ. These are intended to explore the differing levels of activity within the zone and therefore the differing impacts dependent on location. They do not represent known or expected development areas.

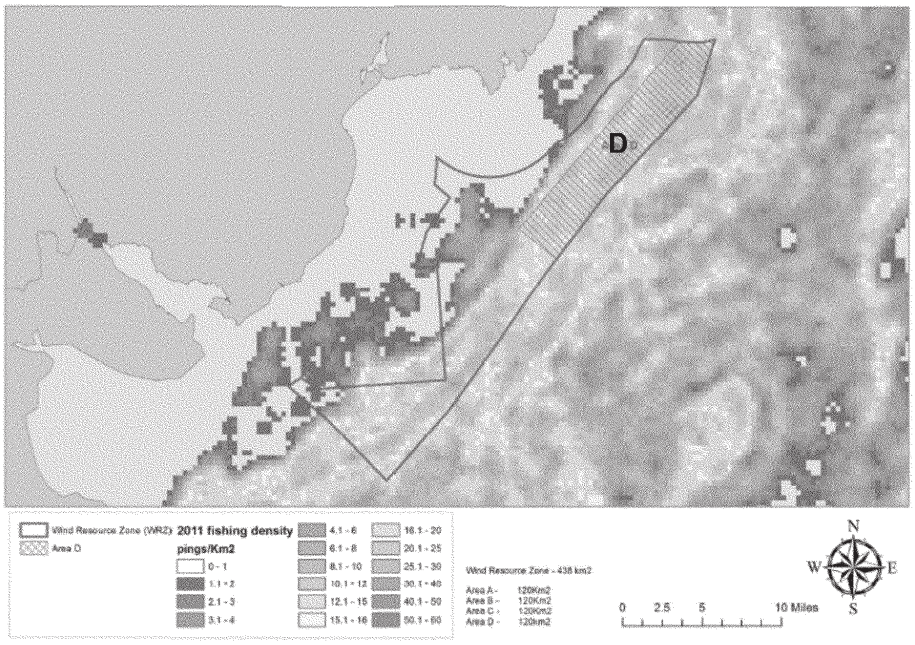


Figure 2 WRZ and indicative development area D

Source: AFBI, 2013

Methodology

Fishing effort

VMS data on the over 15m fleet were provided by DARD for the years 2007 to 2011 and interpreted in GIS by AFBI. The data were presented anonymously for data protection purposes and therefore could not be readily translated into fishing effort in kilowatt hours as point to point readings could not be established. Instead a proxy for fishing effort must be used, 'fishing intensity'.

VMS data points for each year were filtered down to "fishing" data points - using speed as an indicator. Speeds greater than 2 knots and less than 6 knots were designated as fishing. Exclusions of all data around ports that may have appeared as fishing were made to reduce bias; this was done on a case-by-case basis. The same process was applied to any data that appeared to be from sea lough mussel dredging.

Point density analysis was done using ArcGIS on each year's total fishing data.

The activity in the WRZ and the indicative development areas as a proportion of total fleet activity was then determined.

Landings data
DARD provided landings data for the years 2007-2011 by species, vessel category (under 15m and over 15m), homeport and ICES rectangle. The value of landings in the areas is calculated by applying the estimated fishing intensity in the WRZ as a proportion of total estimated activity to the total value of catch. The calculations exclude the value of mackerel landings, which originate outside the Irish Sea, and crab & lobster, which are from potting vessels not in the VMS data.

The above works on the assumption that the value of catch is consistent and is a function of fishing effort, i.e. catch per unit effort is constant. In reality this is not the case, but a precise catch value per area is impossible to establish across a fleet with currently available data.

RESULTS

Fishing intensities

Figure 3 illustrates the percentage of annual fishing intensity (a proxy for effort) within the four indicative development areas for NI over 15m vessels. The following can be determined:

- The % of annual intensity has remained relatively stable, although Area C (the southern part of the WRZ) has become more significant in recent years (2010-11);
- Area A and Area D (both in the north of the zone) account for the highest % of fishing activity, averaging 4.69% and 4.86% of fishing intensity 2007-2011 respectively. Area D shows marginally more fishing activity by the over 15m fleet than Area A;
- Area B, the central area, shows the lowest level of fishing intensity, averaging 2.67% between 2007-2011.

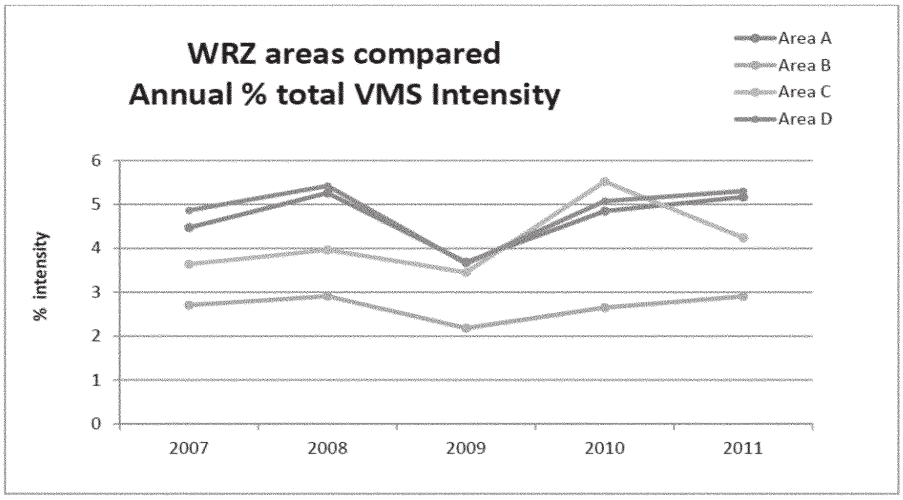


Figure 3 Percentage of annual total fishing intensity per area 2007-2011

Source: AFBI, 2013

Trawler fleet

Table 1 presents estimates of landed values by NI trawlers landing into NI ports from the indicative development areas. These figures exclude mackerel landings, which are not caught in the Irish Sea, and crab & lobster landings, which are landed by the NI potting fleet and discussed in the section below. The remaining landings do, however, account for 83% of total landed value.

Table 1 Estimated landed values by NI trawl fleet from WRZ areas*

Year	Whole WRZ	Area A	Area B	Area C	Area D
2007	£1,787,873	£826,918	£500,536	£672,731	£899,369
2008	£2,030,391	£972,659	£537,940	£733,086	£1,002,436
2009	£1,544,531	£681,498	£403,404	£638,335	£675,229
2010	£2,131,908	£896,555	£490,029	£1,020,495	£938,483
2011	£2,173,448	£955,663	£537,387	£784,038	£980,661
5 year average	£1,933,630	£866,659	£493,859	£769,737	£899,236

*excludes mackerel and potting fleet (crab & lobster) landings

source: Poseidon analysis

The table above illustrates the significant variation in landed values between the four indicative development areas considered. The fishing intensity (and so value of landings) attributed to Area D is 70% greater than the average for the WRZ as a whole. While the

120km^2 areas each represent 27% of the 438km^2 of the whole WRZ, the values are above this for all areas, other than the central Area B:

Area A	45%
Area B	26%
Area C	40%
Area D	47%

Potting fleet

The potting fleet is not captured within the VMS data and is therefore not included in the valuations above.

Available data on the potting fleet cannot accurately estimate fishing effort and therefore value per area. However a comparative indication can be considered using landed pots per port, derived from DARD collation of monthly shellfish returns.

While most potting effort occurs within six miles of shore and only a small proportion of the WRZ lies within the six-mile limit potting effort is known to occur further offshore, there is likely to be overlap between potting effort and the WRZ., . There is some delineation between grounds that are regularly trawled and where pots are set, but seasonal variations mean that some overlap is possible.

It is also noted that industry has reported recent substantial price increases, particularly for *Nephrops* and lobster (partly due to poor Scottish landings). The historic values attributed to inshore landings may therefore underestimate current values.

There is a concentration of potting effort associated with Kilkeel. Therefore despite the lack of potting effort data, it can be assumed that the southern Area C, which is closest to Kilkeel and closest to shore, is likely to represent the area with greatest potting effort and therefore potentially of greatest value to the potting fleet. Data indicate fewer pots being landed to adjacent ports (Ardglass/Annalong) compared to Kilkeel in the south and Portavogie in the north. As with the trawl fleet, therefore the level of potting activity in the central area B is assumed to be less as it is further from shore.

Similarly Area D being on the offshore side of the WRZ and representing the greatest value for the trawl fleet is likely to have comparatively lower level of landings from the potting fleet.

The comparative importance of these areas to potting with the most important first is therefore expected to be: C, A, B, D.

Impacts

This document reports the estimated value of catches from certain areas. It does not estimate the impact on revenue resulting from a development in these areas. The Environmental Impact Assessment (EIA), which should involve extensive consultation, would be used to assess the significance of impacts, which are likely to extend beyond a potential loss of revenue. There is also the potential for benefits to the sector resulting from renewables developments. However ancillary services (guard work etc.) should be clearly distinguished from the impact on commercial fisheries.

A wind farm may have several impacts on commercial fisheries, including:

- Damage or disturbance to target resources
- Exclusion from the whole or certain areas of the development
- Displacement of fishing effort (potentially leading to reduced catches, unsustainable fishing effort in remaining areas and increased gear conflict)
- Additional gear snagging risk
- Additional steaming times (reducing profit with increased fuel costs)

The above impacts may occur over a short timescale (construction/decommissioning) or a longer timescale (operation), which may be localised in their nature or impact further afield.

Displacement
One impact that does extend further afield is displacement; this not only impacts vessels fishing in the affected area, but also those vessels fishing where excluded vessels are displaced to. A key determinant in the extent of displacement is whether fishing will be permitted and operationally possible within the array. The larger turbines favoured in Round 3 developments can result in fewer, more widely spaced turbines that may be more than 1km apart. With sufficient cable burial, trawling within wind farms is feasible. Such project design details are therefore critical to determining the extent of impacts such as displacement.

Displacement from wind farm areas would result in additional pressure on the grounds that remain open. The NI fleet is already targeting these areas with the bulk of fishing intensity seen in the near-shore grounds. Seasonal fishing patterns are dictated by the need to disperse effort across grounds throughout the year. Forcing vessels off important grounds will result in vessels fishing inshore grounds harder, which would lead to lower catch per unit effort and may be unsustainable in the longer term.

Socio-economics
Marine Management Organisation (MMO) figures for 2011 give 578 full time NI fishermen and 688 in total (full and part-time). The NI trawl fleet represents the vast majority of jobs in the NI catching sector.

The NI processing sector employs around 500 full time equivalents (FTE), mostly in scampi processing. Around 80% of live weight equivalent (LWE) prawn landings are tailed with the remaining 20% landed as whole prawns. Local scampi processors purchase nearly all (95-99%) of the tails landed by the fleet. Close to 75% of whole prawns landed by the fleet are also purchased by these processors. Local marketing chains are highly dependent on the presence of a few local processors as buyers; there is a co-dependence between the NI fleet and NI processors.

As the NI processing industry retains nearly all NI fleet landings, the impacts on the UK economy from reductions to NI landings can be expected to predominantly occur in Northern

Ireland. Any significant loss of landed value would have a major impact on the NI fishing industry and the sectors and communities that depend upon it. Those impacts would be felt acutely in the three main fishing ports of Portavogie, Ardglass and Kilkeel (the largest port) respectively located west of the northern, central and southern areas of the WRZ.

These figures illustrate that developments impact vessel owners through lost revenues, but also by crew, processors, ancillary industries and their associated staff and local communities.

SECTION 1 CONCLUSIONS

- An estimated 120 km^2 (or 27%) of the Wind Resource Zone licensed by DETI to First Flight Wind may be required for the planned 600 MW wind farm. The final plan and expected footprint is not yet determined.
- This exercise considered four 120km^2 areas within the WRZ as indicative areas for location of the development: Northern (area A), Central (Area B), Southern (Area C) and North-central (area D).
- VMS data show fishing activity across 99-100% of areas A, C and D. Area B shows an average of 93% of the area being fished.
- In the last five years (2007-2011) the amount of fishing activity in the WRZ has increased in all the areas considered.
- Fishing intensity in Area D, containing more offshore area than areas A, B and C, is 70% greater than average fishing intensity across the WRZ as a whole.
- For the trawl fleet the (2007-2011) average landed value ranges from an estimated £900,000 per annum in Area D (offshore North) to nearly £500,000 per annum in the central area, B.
- Area B in the centre of the WRZ is the only area of the four considered that has a lower than average value per km^2 compared to the WRZ as a whole.
- Spatial data on pot fishing effort is not available and therefore estimated values are not possible. Based on the numbers of pots landed per port, however, it can be assumed that Area C in the South is likely to account for the greatest value due to its proximity to Kilkeel.
- As with the trawl fleet, the level of potting activity in the central area B is assumed to be less as it is further from shore and data indicates fewer pots being landed to adjacent ports (Ardglass/Annalong) compared to Kilkeel in the south and Portavogie in the north.
- This document reports the estimated value of catches from certain areas. It does not estimate the impact on revenue resulting from a development in these areas, which will depend upon the scale and extent of disturbance to and displacement from these important fishing grounds. There is also the potential for positive impacts on non-fishing revenue for certain vessels in providing vessel services to developers.
- Seasonal fishing patterns are dictated by the need to disperse effort across grounds throughout the year. Displacement from wind farm areas would result in additional pressure on remaining grounds that are already fished, which could lead to lower catch per unit effort and may be unsustainable in the longer term.

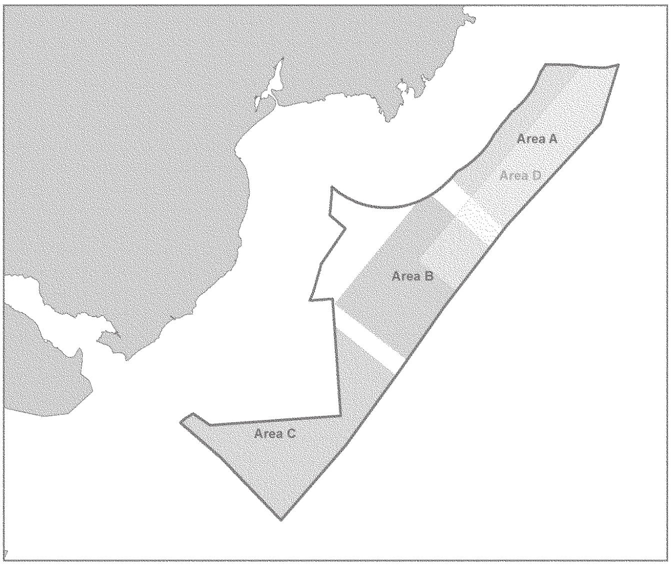
Section 2 : AFBI Wind Resource Zone Mapping Study, 2013

SUMMARY

Fishing intensity in the NI wind resource zone (WRZ) has steadily increased from 2007. The area fished in 2011 represents over 95% of the total designated area. It appears that there is increasing fishing pressure within this area.

In 2011, almost 12% of fishing intensity in over 15m boats registered in Northern Ireland was within this area.

The required size for the windfarm will be approximately 120Km^2 which represents around 25% of the designated resource zone (438km^2). Four scenarios were explored to see what the impact may be if the 120km^2 site was placed at different areas within the WRZ.



Four areas 120km2 areas investigated

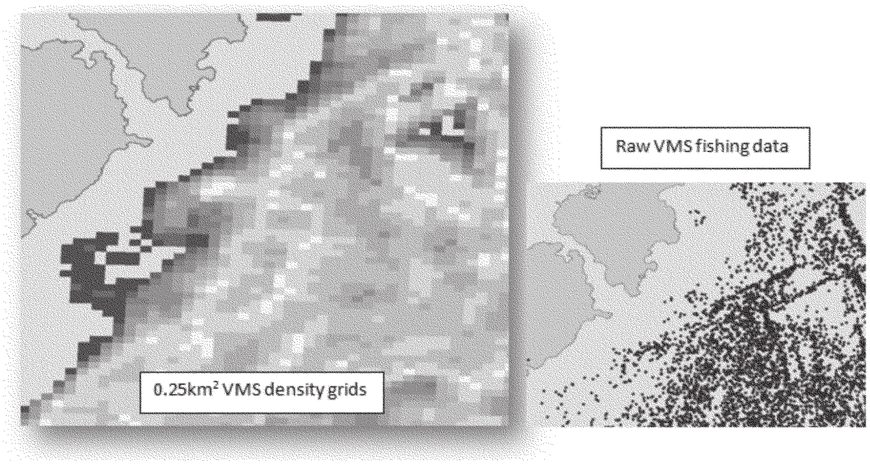
Area B has proved to be the area with least impact. Marginally less of the area is fished compared to the other sites and the percentage of fishing intensity within this area is less than 3% of the total annual intensity each year.

DATA AND METHOD DETAILS

Anonymised Vessel Monitoring System (VMS) data was provided by DARD. Pings (signals from a vessel's VMS stating its position) were collected every two hours from vessels over 15 metres. This was for the whole Northern Irish fleet.

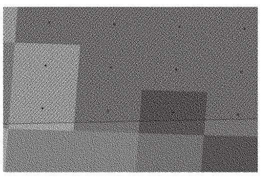
VMS densities were derived for each year 2007-2011, from all data points designated as fishing from each year. Fishing was determined by speed – between 2 and 6 knots inclusive. Exclusions of all data around ports that may have appeared as fishing were made to reduce bias; this was done on a case-by-case basis.

The cell sizes for the densities are 500x500m grids – creating 0.25Km^2 grids.



Density values for each cell were derived as pings per Km^2, though this should be read as a relative index of pressure as opposed to representing the actual number of pings in each square kilometre.

The four 120km^2 grids have been investigated to see what fishing pressure is in those areas and how it has changed between 2007 and 2011



The area of each 120km2 site within the WRZ occupied by the VMS each year is approximate due to the scale of the VMS grids. If more than 50% of a grid falls into the investigated area the whole 0.25Km^2 grid is counted.

Results described below:

Area (Km^2)	Total area of VMS grids in investigated area
Mean density/Km^2	Mean density across investigated area
% intensity	% intensity of total annual VMS
Total pings/km^2	Sum of densities in investigated area (not actual number of VMS pings)

THE CO. DOWN WIND RESOURCE ZONE

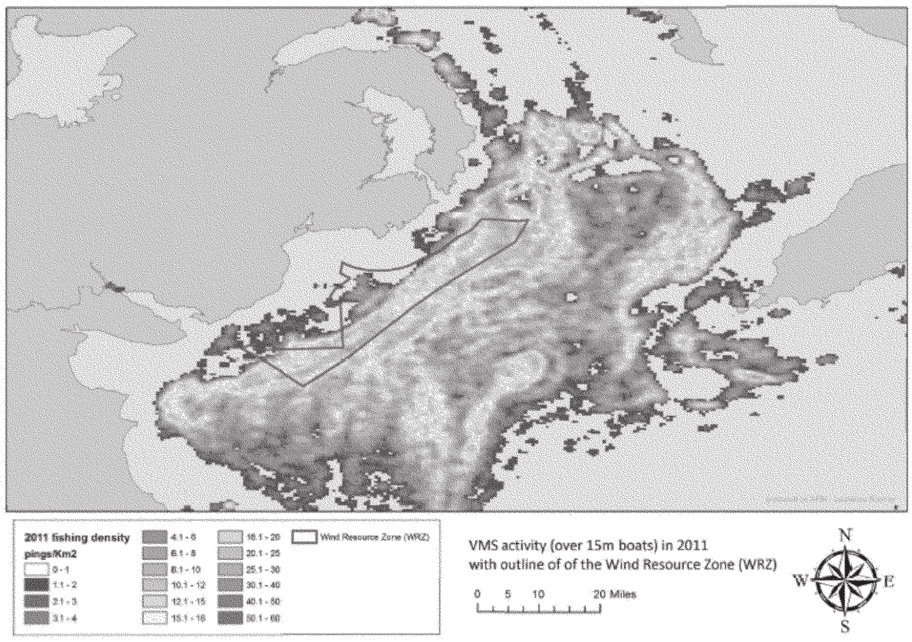


Figure 4 Outline of the Wind Resource Zone (WRZ) with the underlying VMS density analysis for 2011

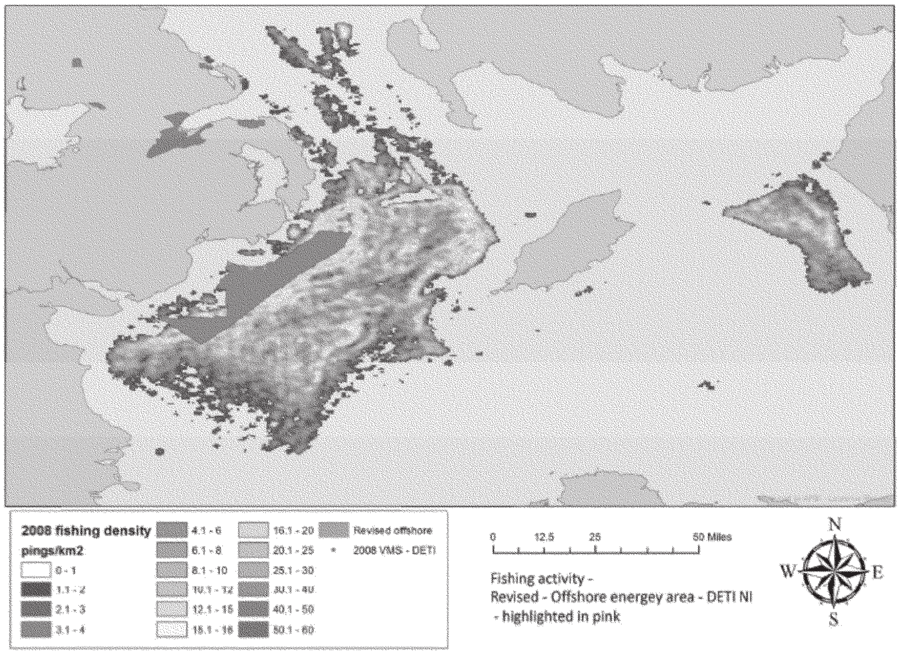


Figure 5 VMS data and the WRZ (highlighted in pink)

Table 2 Wind Resource Zone results:

Year	Area (Km^2)	Mean Density (mean total ping /Km^2)	% of annual Intensity	Total pings/km^2
2007	377.63	37.20	9.67	14788.04
2008	400.19	46.60	10.98	19628.58
2009	400.90	41.23	8.35	17398.18
2010	380.71	52.29	11.53	20954.66
2011	422.04	58.45	11.75	25968.04

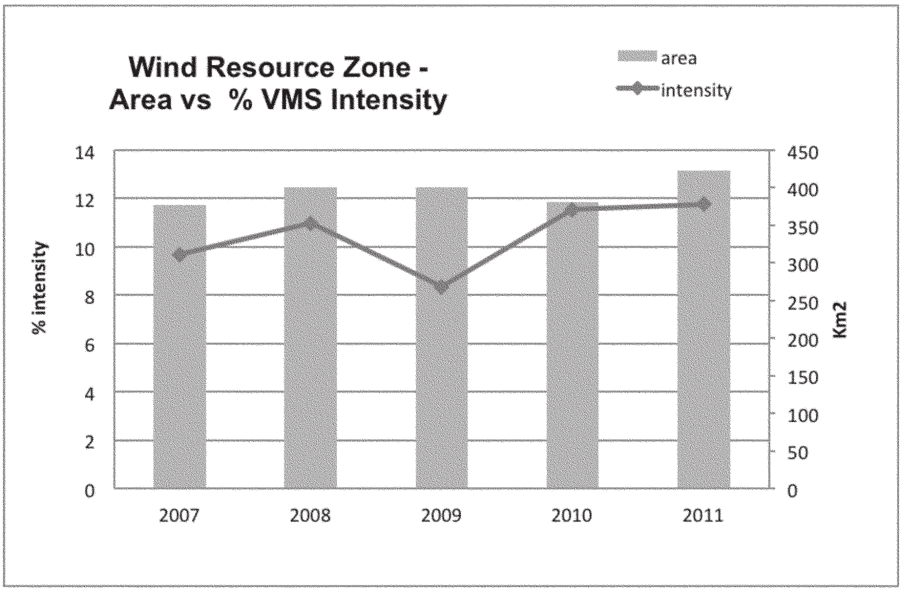


Figure 6 Amount of VMS activity and VMS intensity within WRZ area

Despite a dip in 2009, fishing intensity in the Wind Resource Zone has shown a general increase from 2007. The total area fished within area has remained roughly the same but has also increased from 2007.

The area fished in 2011 over 95% of the total Wind Resource Zone area was actively fished.

120KM^2 PLACEMENT SCENARIOS

The required size for the windfarm will be approximately 120Km^2, dependant on the final design, which represents around 25% of the designated resource zone (438km^2). Four scenarios were explored to see what the impact may be if the 120km^2 site was placed at different areas within the WRZ. The first three are **Area A**, **Area B** and **Area C** – see figure 7. The fourth, **Area D**, is described in figure 8.

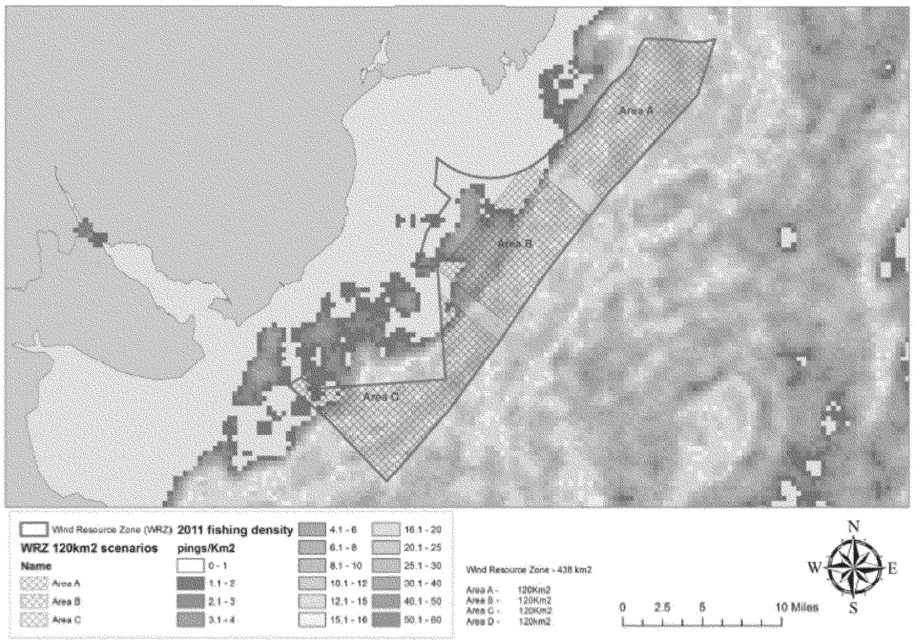


Figure 7 Three scenario areas (120km2 each)

Table 3, 4 & 5 – 120km^2 scenario results

Area A:

Year	Area (Km^2)	Mean Density (mean total ping /Km^2)	% of annual Intensity	Total pings/km^2
2007	120.75	46.72	4.47	5642.04
2008	119.75	64.77	5.26	7756.58
2009	119.00	53.21	3.69	6332.46
2010	120.50	60.33	4.85	7269.24
2011	120.75	78.00	5.17	9418.79

Area B:

Year	Area (Km^2)	Mean Density (mean total ping /Km^2)	% of annual Intensity	Total pings/km^2
2007	109.50	31.19	2.71	3415.15
2008	116.00	36.98	2.91	4289.86
2009	116.75	32.11	2.18	3748.42
2010	106.75	37.22	2.65	3973.14
2011	111.00	47.71	2.91	5296.36

Area C:

Year	Area (Km^2)	Mean Density (mean total ping /Km^2)	% of annual Intensity	Total pings/km^2
2007	118.75	38.65	3.64	4590.03
2008	116.25	50.29	3.96	5846.08
2009	118.75	49.95	3.45	5931.39
2010	118.00	70.12	5.52	8274.15
2011	118.50	65.21	4.24	7727.29

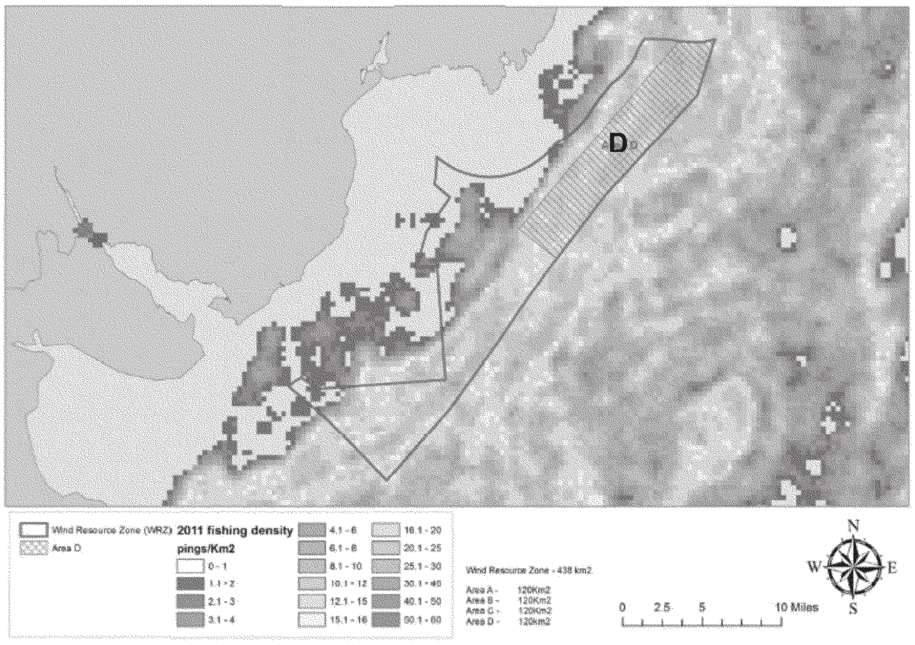


Figure 8 Area D scenario

Table 6 120km^2 scenario results, Area D:

Year	Area (Km^2)	Mean Density (mean total ping /Km^2)	% of annual Intensity	Total pings/km^2
2007	120.25	51.03	4.86	6136.38
2008	120.00	66.62	5.42	7994.03
2009	119.50	52.50	3.65	6274.21
2010	120.00	63.41	5.08	7609.20
2011	120.75	80.04	5.30	9665.16

The total pings/km2 and annual % of total VMS intensity are illustrated in figures 9 and 10.

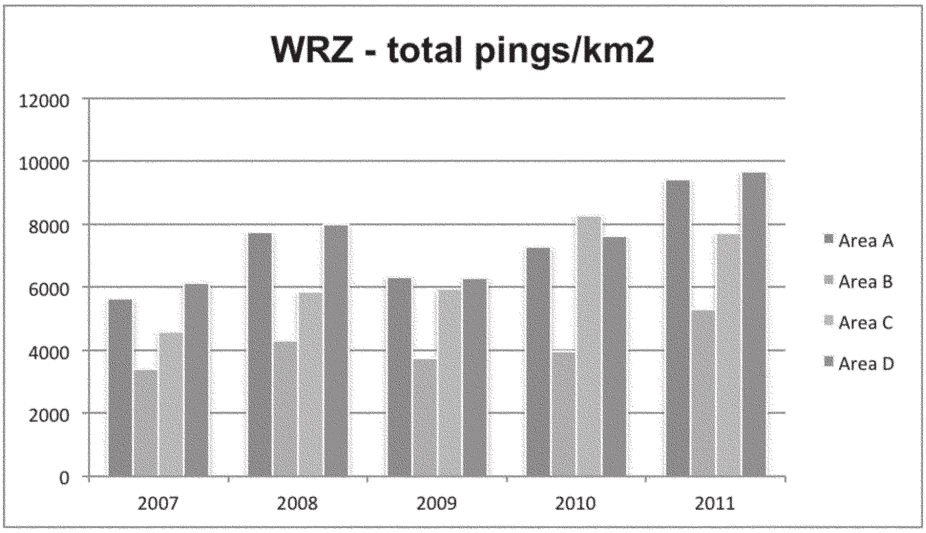


Figure 9 total sum of pings/km2 in each area per year (2007-2011)

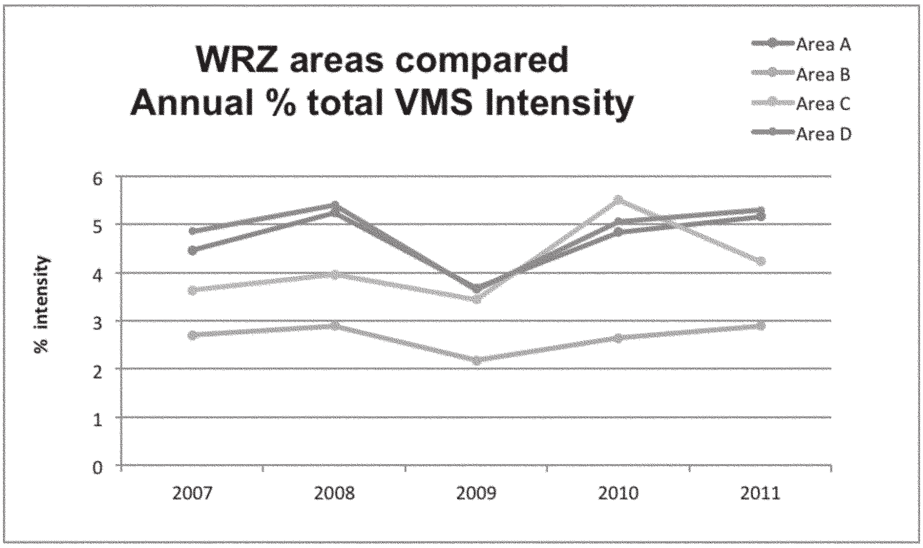


Figure 10 % of total annual fishing intensity within each area per year (2007-2011)

% of VMS grids in each area:

The % reflects amount of each area that has fishing activity – 100% means the entire area (120km^2) has some amount of fishing activity (at 0.25km^2 grid resolution).

Area\ Year	2007	2008	2009	2010	2011
Area A	100	100	99	100	100
Area B	91	97	97	89	93
Area C	99	97	99	98	99
Area D	100	100	100	100	100

The *Area B* scenario has the least amount of fishing activity and, as illustrated in figure 10, the area with the least intense fishing activity for boats over 15 metres.

SECTION 2 CONCLUSIONS

This report has focussed on the utility of VMS data for assessing fishing effort and certain assumptions have been made with regard to the processing. Although recommendations have been made recently for the adoption of a vessel monitoring system for the <10m fleet no decision has yet been made on this. http://www.afbini.gov.uk/sustainable_development_strategy_for_ni_inshore_fisheries__fin_.pdf.

Trial developments have proven useful but without universal adoption have limited value. Consequently further work is required to quantify scallop dredging and potting effort.

It is anticipated that the forthcoming FishRAMP project will provided an assessment of the potential economic and environmental consequences arising from displacement of fishing activity due offshore development and other regulatory developments.

Seafish
18 Logie Mill, Logie Green Road, Edinburgh EH7 4HS
E: lynn.gilmore@seafish.co.uk
W: www.seafish.org

Follow up letter from the Chartered Institute of Environmental Health

Chartered
Institute of
Environmental
Health

FAO: NI ASSEMBLY ENVIRONMENT COMMITTEE

Contact: G. McFarlane, Director CIEH NI
Email: g.mcfarlane@cieh.org
Tel: 02890243884

RE: Inquiry into Wind energy 2014; Information requested further to oral evidence session on 5th June 2014.

INTERIM FOLLOW ON REPORT

A number of additional queries/requests for further information arose during our evidence session deliberations on 5th June.

We have set out the responses to these below

1: Electronic copies of maps provided at the meeting
We tabled 2 documents during the course of the discussion.

The first showed current applications in N Ireland for single wind turbines. This is updated on a monthly basis by DOE Planning NI and is available at
http://www.doeni.gov.uk/index/information/asb/statistics/planning_statistics.htm

The second map contained UK wide statistics to illustrate the concentration of activity in N Ireland compared with other parts of the UK. This was taken from a dynamic mapping feature published by Renewable UK (the industry body) and is available at:

http://www.renewableuk.com/en/renewable-energy/wind-energy/uk-wind-energy-database/index.cfm/maplarge/1

Members should note that this map is interactive and can be viewed using 3 different criteria namely operational, under construction and consented. These can be selected at the top right hand corner of the map. Additionally, the map can be zoomed to give greater definition and detail.

2: Data relating to Applications received in NI

During the course of the discussion we undertook to provide the committee with data illustrating the trends in Ni with regards to applications for wind turbines. This data is available by way of a spreadsheet at the following link

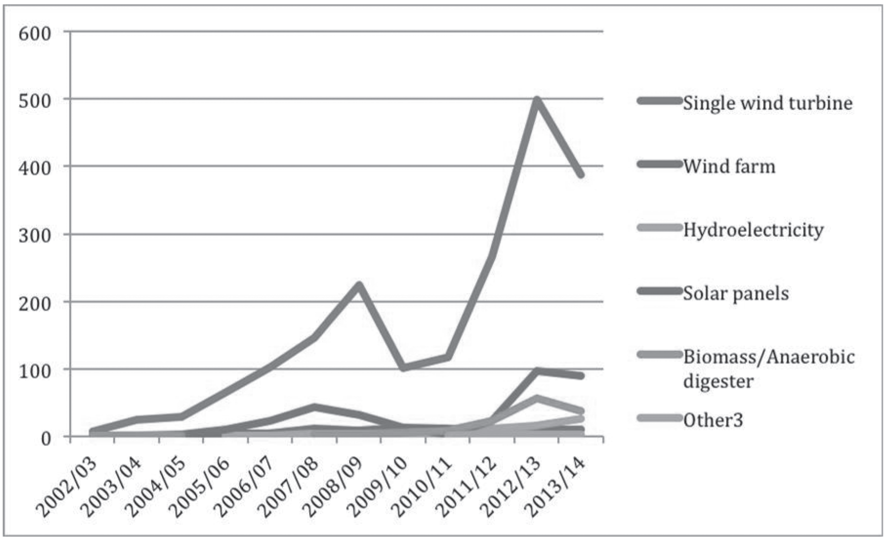
123 York Street, Belfast BT15 1AB
Telephone 02890 243884
Fax 02890 233328
www.cieh-nireland.org

http://www.doeni.gov.uk/index/information/asb/statistics/planning_statistics.htm

From this page the spreadsheet can be downloaded by clicking on "renewable energy applications"
(Please note that the dataset is updated monthly usually on the last Thursday of each month)

For the purposes of illustration and ease of reference some of the key data from the data up to the end of June 2014 is represented in the charts below

FIGURE 1: Applications approved in NI from 2002 – 2014 by renewable energy type.



As can be seen from the above data, Approvals (and therefore by definition applications) for single wind turbines far exceeds approvals/application for any other kind of renewable energy, including wind farms. It should be noted that these figures represent applications/approvals – not actual installations constructed/operational. (See Section 3 below)

FIGURE 2: Applications for single turbines by District Council from 2002 – 2014

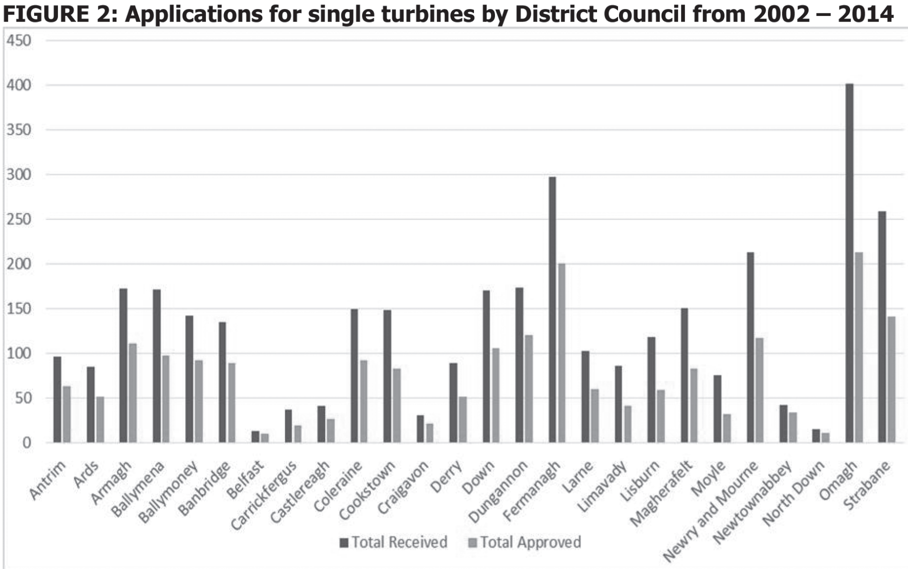
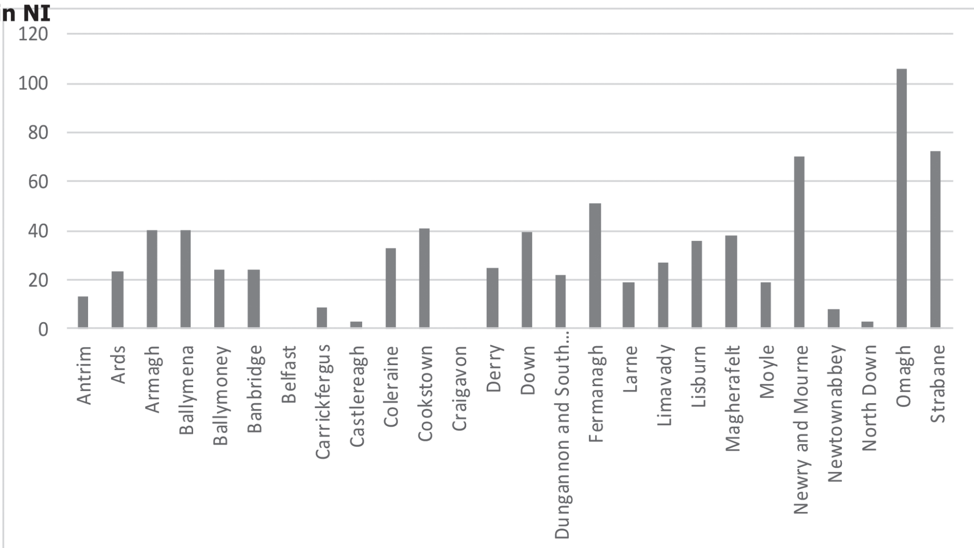


FIGURE 3: Pending applications for single wind turbines in each district Council in NI



3: Data relating to number of single wind turbines actually built/operational

It must be noted that the statistical data represented in the previous section and available through the Planning NI Website does not represent the number of sites for which planning permission has been sought and permission granted that have actually been built and are operational.

We did undertake to attempt to provide further information on this to the Committee. From our enquiries to date we can confirm that this information can only currently be obtained through a reporting tool on the OFGEM website. (None of the NI Agencies/departments ie Planning (NI) ; DETI, or Action Renewables (Industry) hold such data).

Based on the information obtained through this tool, the total number of installed single wind turbines in Northern Ireland with a generation capacity of greater than 50kW as of April 2014, claiming renewable obligation certificates = 83

(NOTE: This doesn't include any wind turbines associated with wind farms (2 or more turbines) or single wind turbines less than 50kW). There is no available data for these.

Hence our original estimate of approximately 200 for all installed single wind turbines (including less and greater than 50kW) would be consistent with this data as we believe, based on anectdotal evidence, that there are a significant number of operational single turbines less than 50kW.

4: Data relating to Complaints received concerning single wind turbines

We are currently still in the process of compiling this data from across all 26 district Councils and will provide this as soon as is possible. However, based on data collated so far, the number of actual complaints yet received remains relatively low. However what needs to be borne in mind is that complaints can only arise from turbines that are actually operational. Bearing in mind the previous section, this is as yet unclear.

5: Recent Single Wind Turbine Planning Appeal Decision – 2012/A0312

A recent planning appeal decision with respect to a single wind turbine has been published subsequent to our presentation to the Committee. This is attached as Appendix 2. It confirms that the Planning Appeals Commission NI agree with Environmental Health's position that a complaint investigation condition is necessary and enforceable. Consequently, Planning (NI) is the only planning authority in the whole of the United Kingdom that do not routinely apply a complaint investigation condition for single wind turbine applications.

6: Key issues

As we highlighted during our discussion it is our view that the key issues at present are as follows

- The current ETSU-R-97 guidance is no longer fit for purpose and requires review on a UK wide basis as a matter of urgency.
- Current planning conditions applied to single turbine applications we do not believe has the confidence of the public. This needs review.

In relation to the second point, we attach a letter (APPENDIX 1) recently sent on behalf of the Chief Environmental Health Officers Group for your information.

APPENDIX 1

Fiona McCandless
Chief Planning Officer
Planning Group
Causeway Exchange
1–7 Bedford Street
Belfast
BT2 7EG

Dear Fiona,

Re: Noise conditions for individual wind turbine proposals

I refer to and thank you for your detailed reply dated 5th December 2013 on this complex and ever-changing subject. The Chief Environmental Health Officers Group technical sub-group dealing with environmental protection issues is tasked with keeping abreast of wind turbine noise issues relevant to the Environmental Health Service in Northern Ireland. We hope that we can continue to engage and debate on this matter to ensure that development control applications can be dealt with in the best manner possible.

In your response you have highlighted the Department's concern that the Courts would expect the Department to make its own assessment and present evidence of a breach of noise condition. We appreciate these concerns but believe that noise from wind turbines is a unique case due to the complexity and duration in establishing such a breach. It is true to say that a 'complaint' condition is routinely attached to permissions for the development of wind farms and would wish to highlight that the effect of the breach, that is - noise levels in excess of the ETSU-R-97 limits causing an unreasonable loss of amenity or sleep disturbance - is precisely the same to affected residents irrespective if it is due to a single development of six wind turbines or one or more turbines all in different ownerships. It therefore appears inconsistent that one Section of Planning (NI) routinely utilises a condition that another believes to be legally unsound. This is all the more pertinent given the pending transfer of Planning powers to Local Councils, where consistency will be a key performance benchmark.

A further matter of equity arises from the concerns about the Department's ability to take action for an alleged breach of noise conditions. Again due to the complexity and duration of establishing such a breach, the Environmental Health Service in Councils is unlikely to be in a position to be able to assist Planning (NI) in obtaining evidence of a breach, unlike all other noise conditions where we have for years worked in partnership with Planning (NI) in gathering evidence including "out-of-hours" work. It must be remembered that wind energy noise limits are stated relevant to wind speed, with turbine wind speed data only available to the turbine operator i.e. both wind speed and noise level data is needed to demonstrate compliance with ETSU-R-97 noise limits. It would be unreasonable to assume that the resourcing of enforcement should in future be determined by local Councils as the Planning Authority in the absence of 'complaint' conditions given the number of turbine permissions being granted by the Planning (NI) (currently in excess of 2000) could result in grossly excessive enforcement costs being borne by rural upland districts where turbines are more commonly situated.

We would also wish to draw your attention to a number of planning appeals in other UK jurisdictions for similar sized single wind turbines, the recent RenewablesUK (the industry body representing the wind energy industry) Template planning conditions and a case heard before the High Court in England that was reported subsequent to your letter. The accompanying paper to this letter was submitted to the Northern Ireland Assembly Environment Committee Inquiry into Wind Energy, with Committee members highlighting their concerns with respect to the disparity of Northern Ireland and the rest of the United Kingdom.

One of the key strategic objectives of the Sustainable Development Strategy for Northern Ireland 2006 was to, *'establish Northern Ireland as world class exemplar in the development and use of renewable energy'.* In this regard, it would appear that we are lagging behind the rest of the United Kingdom in ensuring the inclusion of robust and fair planning conditions. Accordingly, we would ask for further consideration of this matter by the Department.

We are, as always, willing to discuss this matter further or provide any further information that may assist you deliberations. We look forward to hearing from you in due course.

Yours sincerely,

Martina McNulty
CEHOG Chair

pac
Planning Appeals
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The Department of the Environment
Southern Area Planning Office
County Hall
182 Galgorm Road
BALLYMENA
BT42 1QF

Your Reference: T/2012/0419/F

Our Reference: 2012/A0312

Date: 7th July 2014

Dear Sir/Madam

THE PLANNING (NORTHERN IRELAND) ORDER 1991
APPEAL: Mr Alan Rea
Installation of a wind turbine on a tubular tower height up to 32.5m with blade tip height up to 47.5m with associated switch room (up to 250 KW)

I enclose a copy of the Commission's decision.

Yours faithfully

Area Planning Office
RECEIVED
- 8 JUL 2014
File No...............
Ballymena 1

I GARRETT

Enc.

2012/A0312 - Mr Alan Rea

pac Planning Appeals Commission

Appeal Decision

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Appeal Reference: 2012/A0312
Appeal by: Mr Alan Rea in default of a decision on an application for full planning permission
Development: Installation of a wind turbine on a tubular tower, height up to 32.5m with blade tip height up to 47.5m with associated switch room (up to 250 kW)
Location:
Application Reference: T/2012/0419/F
Procedure: Informal Hearing on 10th April 2014
Decision by: Commissioner A. McCooey, dated 7th July 2014

Area Planning Office
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- 8 JUL 2014
File No ....
Ballymena 1

Decision

1. The appeal is allowed and full planning permission is granted, subject to the conditions set out below.

Reasons

2. Commissioner Spiers issued a decision on this appeal on 30th July 2013. However, following an application for judicial review, the Commission agreed to that decision being quashed and remitted. I have considered the appeal afresh, taking account of the written evidence previously submitted, as well as the new evidence submitted in advance of and at the Hearing.

3. The main issue in the appeal is whether or not the proposal would have an adverse impact on aviation safety.

4. The site lies within the countryside and policy within Planning Policy Statement 21: 'Sustainable Development in the Countryside' (PPS21) applies to the proposal. Policy CTY1 thereof sets out the types of development that are considered to be acceptable in principle in the countryside. One of these is renewable energy projects in accordance with Planning Policy Statement 18: 'Renewable Energy' (PPS18). It follows that if the proposal meets the requirements of PPS18, it will comply with Policy CTY1 of PPS21.

5. Policy RE1 of PPS18 indicates that a proposal for renewable energy development will be permitted provided it will not result in an unacceptable adverse impact on five listed criteria. These include public safety, human health, or residential amenity. It goes on to indicate that compliance with an additional seven criteria must be demonstrated. Criterion (ii) requires that the development has taken into consideration the cumulative impact of existing wind turbines, those which have permissions and those that are currently the subject of valid but

undetermined applications. Criterion (v) indicates that no part of the development should have an unacceptable impact on roads, rail, or aviation safety. The policy states that the wider environmental, economic and social benefits of all proposals for renewable energy projects are material considerations that will be given significant weight in determining whether planning consent should be granted.

6. PPS18 is supported by a Best Practice Guide: 'Renewable Energy' (BPG). With regard to aviation interests, paragraph 1.3.65 of the BPG states that wind turbines may have an adverse effect on air traffic movement and safety. Pertinent to this case, it states that, they may represent a risk of collision with low-flying aircraft. Paragraph 1.3.66 indicates that risk of collision is likely to occur close to civilian and military airfields, and in military low flying zones. An applicant should take account of the airfield management's requirements, which will depend on local topography and the preferred flight paths at the site. The aim of PPS18 is to facilitate the siting of renewable energy generating facilities in appropriate locations within the built and natural environment in order to achieve Northern Ireland's renewable energy targets and realise the benefits of renewable energy.

7. Policy PSU 3 of 'A Planning Strategy for Rural Northern Ireland' (PSRNI) is entitled 'Transport Facilities'. The policy states that careful consideration will be given to proposals for development in the vicinity of regional airports and ports. With regard to aircraft safety the policy states that the Department will consult with the Civil Aviation Authority (CAA) or the airport operators about proposals for developments, the heights of which would exceed the various specified limits within the safeguarded area (defined by the CAA) around the airport. This is to ensure that precision instrument approaches are not adversely affected and that flights are not endangered.

8. The main concern at the previous appeal hearing was the impact of the proposal on radar operations at Belfast International Airport (BIA). BIA were consulted by the Department and took an active role in both hearings. It was confirmed at the new hearing that the effect on radar could be mitigated within a reasonable timeframe. BIA representatives and the Department were content that the details of the proposed mitigation could be controlled by a suitably worded condition. The Department's remaining reason for refusal indicates that the proposal would be contrary to Policy PSU 3 of the PSRNI and Policy RE1 of PPS 18 as it would breach the Outer Horizontal Surface (OHS) of BIA and, taken together with other turbines in the area, may cause a major safety issue for aircraft taking off and landing at BIA.

9. The CAA has produced a series of documents that provide guidance for Aerodrome operators, aviation stakeholders and in some instances Local Planning Authorities and the general public. The relevant documents that were referred to in this appeal are:

- CAP 168 Licensing of Aerodromes. Its stated purpose is to give guidance to applicants and licence holders on the procedure for the issue of an aerodrome licence and to indicate the licensing requirements relating to such an application and operational management of an aerodrome.

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- CAP 738 Safeguarding of Aerodromes. Its stated purpose is to offer guidance to those responsible for the safe operation of an aerodrome.
- CAP 764 CAA Policy and Guidelines on Wind Turbines. It is primarily aimed at providing assistance to aviation stakeholders to help understand and address wind energy related issues, thereby ensuring greater consistency in the consideration of the potential impact of wind turbine developments. It provides CAA policy and guidance on a range of issues associated with wind turbines and their effect on aviation that will need to be considered by aviation stakeholders, wind energy developers and Local Planning Authorities.

10. CAP 168 states that the OHS is a specified portion of a horizontal plane around an aerodrome that may extend 10 or 15 Km from the aerodrome depending on the length of the runway. It also indicates that the OHS represents the level above which consideration needs to be given to the control of new obstacles in order to facilitate practicable and efficient instrument approach procedures to ensure safe visual manoeuvring in the vicinity of an aerodrome. The minimum dimensions for the OHS are established by the CAA. Chapter 4 of CAP 168 relates specifically to the assessment and treatment of obstacles. Paragraph 9.2 thereof states that new obstacles or additions to existing objects should not extend above an OHS, except when in the opinion of the CAA the object would be shielded by an existing immovable object or it is determined that the object would not adversely affect the safety or significantly affect the regularity of aircraft operations. Paragraph 10.1 provides guidance on shielding and states that: the principle of shielding is employed when a substantial and permanent object or natural terrain already penetrates an obstacle limitation surface. When it is considered that such an obstacle is permanent, objects of equal or lesser height around it may, at the CAA's discretion, be permitted to penetrate the surface.

11. The subject turbine would be sited approximately 10 km from the starting point or threshold of runway 25 of the BIA. All parties were in agreement that the turbine would be located within and would penetrate the OHS of BIA and that this is a safeguarding issue. Parties were also in agreement that paragraph 9.2 of CAP 168 defines the test to be applied when assessing proposals such as this. Pursuant to this test, CAP 764 advises that the CAA can be consulted where there is an impasse as they can provide objective comment. CAP 738 advises that before objecting to a proposal or before seeking advice from the CAA it might be reasonable to consider whether there are mitigating circumstances. For example, the development may be in an area where it is surrounded or shielded by higher topography or the infringement could be mitigated by the installation of obstacle lighting and/or notification in Aeronautical Information Service Publications. Paragraph 5.13 of this document further advises aerodrome licensees to seek the advice of the CAA if a proposal infringes the OHS or is deemed unacceptable.

12. The appellants argued that there were higher obstacles in the area, in the form of terrain, television and communications masts and electricity pylons. They argued that the terrain to the south east would shield the proposal. The land rises to an elevation of 304.5m AOD in this area and is 1.7km away from the proposed turbine (the proposal would be at 298m AOD at its highest point). They also stated that the other obstacles represent greater hazards to aircraft. In response,

the BIA indicated that a 1 km radius had been adopted by the airport for assessing OHS shielding and the other objects cited on behalf of the appellants were outside this 1 km radius. It was submitted that the proposed turbine would be the tallest obstacle within a 1 km radius. The nearby Bog Hill rises to 283m AOD and the proposal would be 15m taller than that terrain. Being the tallest object, BIA considered that the turbine would be likely to increase the risk of collision and danger during visual flight approaches.

13. BIA advised that their 1 km radius shielding policy was implemented as a result of an increase in the number of wind turbine applications within a heavily trafficked airspace. They had previously trialled a radius of 2km pre 2013 but this was found to be unsafe with respect to rotary and fixed aircraft manoeuvres due to the quantum of turbine proposals. No detailed explanation of the safety implications of a 2km rather than a 1km shielding distance was provided. From the evidence presented, it appears that the 1km distance was chosen on the basis of convenience and ease of dealing with a large number of consultations for the Airport operator. It was not chosen on the basis of the CAA guidance.

14. Paragraph 2.8 of CAP 764 states that in all cases, regardless of the status of the aerodrome, any development that causes pilots to experience, or simply perceive an increase in difficulty when using an aerodrome may lead to a loss in utility. The CAA considers that if the Aerodrome Manager advises that the aerodrome's established amenity would be affected by a development, their advice can generally be considered as expert testimony. However, it goes on to say that such comment requires robust evidence and may be subjected to scrutiny by the CAA (or any other party with equivalent expertise), should disagreement between the aviation operator and the wind energy developer arise.

15. The test to be applied is as outlined in paragraph 10 above. If a proposal would be shielded by an existing immovable object, then it would satisfy the test. In this case the proposal would be shielded by terrain some 1.7km away to the south east. A 1 km radius is not advocated or specified in any CAA document. The only guidance on the shielding of obstacles is in paragraph 10.1 of CAP 168 referred to above. The CAA was not formally consulted in this case as advocated and no documentary evidence from the CAA in respect of this proposal was presented. Furthermore, the BIA have not presented the required 'robust evidence' in the form of survey and trial results (a) to justify their 1km shielding policy and (b) to demonstrate why an immoveable object some 1.7km away would not offer adequate shielding.

16. It was clarified that the main safeguarding concern was in relation to visual flight approaches to the BIA and low flying military and police helicopters. My attention was drawn to the Rules of Air Regulation (ROAR) and low flying rules that must be adhered to by all pilots. These rules prohibit flying less than 500 feet above known obstacles and there are also standard procedures to be followed in the event of poor weather conditions. The minimum clearances are about to be increased by the European Commission. This left low flying military and police aircraft. The appellant's expert witness had considerable experience of commenting on safeguarding issues in relation to wind turbine proposals affecting RAF operations. His unchallenged evidence was that the proposal would not give rise to any concern in this regard and that infra-red lighting would

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be sufficient to identify the obstacle. There were no objections from the Ministry of Defence or the Police Service of Northern Ireland drawn to my attention. The two examples of aircraft collisions cited by the BIA are not relevant to this appeal as they do not directly compare nor do they demonstrate how this proposal would unacceptably impact upon aviation safety. I therefore conclude that the proposal would not have an adverse impact on air traffic movement and safety. The reason for refusal is not sustained.

17. A letter of objection from the resident at No. 104 Boghill Road, received by the Department during the processing of the planning application was forwarded to the Commission. The letter raised concern about (a) potential noise impact from the proposed turbine, (b) the distance of the proposal from the property and (c) the absence of written consent from residential premises in the area. No further submission was made by the resident in respect of the planning appeal and no explanation of the concerns was forthcoming. With regard to noise, there was no objection in principle to the proposal from the Environmental Health Officer and I am not persuaded that an objection based on noise generation is therefore sustained. Paragraph 1.3.43 of the BPG refers to a separation distance from occupied property of 10 times the rotor diameter in respect of wind farms. However, this proposal is for an individual turbine and the relevance of the guidance is therefore questionable. Even if it were applied, the separation distance of the proposal from No. 104 would exceed the relevant multiple. There is no planning policy requirement, in the case of a turbine proposal, for the developer to seek the written consent of all residential premises in the area. These concerns are not sustained.

18. A BIA witnesses referred to an operational effect on the use of runways at the airport as a result of the proposal. This effect was not quantified and its significance to air traffic operations at the airport was not explained. As discussed at paragraph 8 above, I was told that a radar mitigation solution could be found and implemented within the lifetime of this permission and all parties agreed that this was the case. I am therefore satisfied that the negatively worded condition agreed by the parties would be appropriate and necessary and in line with the provisions of paragraph 58 of Planning Policy Statement 1 'General Principles' (PPS1). This would address the Department's objection regarding cumulative impact, which was related to the combined effect of this proposal with other proposals for wind turbines in the area on radar systems. This objection cannot be sustained. It is also necessary that the condition requires the submission and approval of the radar mitigation scheme before development commences. The alternative could be that the turbine is erected without the scheme having been secured, which would defeat the object of the condition. This would not be in the developer's interest either. Planning conditions need to meet the legal tests including clarity and enforceability. The wording I am adopting meets those tests. No evidence was provided to substantiate the claim that the proposal would have an adverse effect on the economic success and future expansion of the BIA.

19. The Environmental Health Department (EHD) of the local council had no objections to the proposal on noise impact grounds. However, at the Hearing they submitted a number of suggested conditions along with detailed background information including guidance notes to be attached to said conditions. The

provision of this information so late in the day was unhelpful. The Commission does not attach guidance notes or informatives as conditions should be self-contained, clear and precise in order to satisfy the legal tests.

20. The predicted noise levels from the proposed turbine would be below ETSU-R-97 standards. The appellants suggested a condition stating that noise levels should not exceed the ETSU-R-97 standard of 40dBA during daytime and 43dBA during night-time as used in appeal decision 2011/A0243. However, in that appeal such a condition was not a matter of dispute. In this appeal the Department contended that such a condition could leave insufficient capacity in terms of noise generation for further turbine development in the area. While I note the appellants' arguments in favour of their suggested condition, the general thrust of policy is towards meeting renewable energy targets. While these targets may be aimed at Northern Ireland in general, individual localities will have a role in meeting them. In this context, and while they will be considered on their own merits, the door should not be unnecessarily closed on future turbine proposals. There are other approved turbines in the area that have yet to be constructed where this condition was imposed at appeal. As the Department's suggested conditions reflect the findings of the appellants' own noise assessment for predicted noise impacts at specified properties I am not persuaded that the appellants would be penalised by their imposition. However, I do accept the appellant's point that the noise impact should be limited to wind speeds up to 10 m/s as this is reflective of the ETSU-R-97 standards. I also consider that the condition should be re-worded to refer to ETSU-R-97 procedures and that the reference to the guidance notes be removed for the reason outlined above. This is a full planning application and the noise impact of the turbine proposed has fed into the noise impact assessment which has formed part of the overall consideration of the appeal. Even if a new make or model is proposed under this planning permission, it must not exceed the stated values or it will be in breach of the conditions.

21. The Department also suggested the imposition of a complaint investigation condition that puts the onus on the appellant to assess the noise levels associated with the proposal if a complaint is made. In support of this approach, the EHD referred to a model condition contained in a Renewables UK document and 4 appeal decisions from England (including a decision of the Secretary of State), Scotland and Wales where such conditions have been used. Renewables UK is the body representing the wind energy industry. Several of the appeal decisions relate to single wind turbines.

22. I note that the measurement of wind turbine noise and the interpretation of the gathered data can be lengthy and therefore resource intensive. The EHD points out that the measurement requires many readings at different wind speeds and relies on information being supplied by the operator. They question whether the operator can be compelled to provide this information in the absence of a condition. The specialist nature of the equipment and personnel required means that councils would require the services of consultants, it was claimed. I also acknowledge that the public purse is providing subsidies through the Renewables Obligation Certification Scheme and the Department's position that it would be unreasonable for rate payers to foot the bill to determine whether a development is compliant with predicted noise levels. The appellant provided

little rebuttal to this suggested condition. His argument was that it was unnecessary given the Department's enforcement powers and would undermine his ability to attract finance for the proposal. This position appears to be contradicted by the High Court decision in R (John Lancashire) v Northumberland CC and R Tait where the judge ruled that such a condition was lawful. Whether a condition is necessary is one of the legal tests in assessing its lawfulness. It is necessary: as an example, should there be a mechanical failure resulting in increased noise output that leads to complaints from nearby residential properties. The appellant did not address the fact that it appears to be the type of condition endorsed by Renewables UK and in widespread use in Britain, without any apparent effect on the ability to attract finance. The appellant asserted that problems would arise, but did not provide any evidence of the reasons or basis for the concern. If the turbine is operated properly and its noise impacts are in line with the appellant's noise impact assessment then there should be little cause for concern.

23. The appellant rightly points out that the Commission has rejected the use of this type of condition in the past. However, the evidential context of this appeal is different given the examples of its use in other jurisdictions, the support from the industry body for it and the detailed evidence of problems in gathering the data necessary to establish the validity of a complaint. I cannot see how a breach of condition notice could be served with no evidence of an actual breach having first been obtained. I consider that it is timely for the Commission's approach to this issue to be re-appraised. I am persuaded in the circumstances of this case that such a condition is necessary and reasonable.

24. Given the proximity of Belfast International Airport and in the interests of aviation safety, it would be necessary to attach a condition requiring a red light and/or infrared lighting to be attached to the turbine. Whilst not specifically raised paragraph 4.17 of PPS 18 states that the duration of a planning permission should be linked to the operational lifespan of the turbine, which is normally taken to equate to 25 years. On this basis I consider that a condition limiting the duration of this planning permission to 25 years is necessary. In the interests of visual amenity, the turbine should be removed and the land restored within 12 months of the cessation of electricity generation.

Conditions

1. No development shall take place until a Radar Mitigation Scheme (RMS) for the wind turbine has been submitted to and approved in writing by the Department.

   This scheme shall:

   (i). Set out the appropriate measures to mitigate the impact of the development upon the operation of the Belfast International Airport (BIA) Air Traffic Control (ATC) radar (the radar) and the ATC operations which are reliant on the radar.

   (ii) Set out the appropriate performance criteria to be satisfied to mitigate the impact of the development on the radar.

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(iii) Set out a requirement that if the RMS for whatever reason ceases to operate, then the turbine must cease operation following a request from BIA.

The wind turbine shall not become operational until all the measures and timescales in the RMS have been implemented and met. The development shall thereafter operate in accordance with the RMS which will be in place for the period during which the radar remains in operation.

2. The level of noise immissions from the wind turbine (including the application of any tonal penalty) when determined in accordance with the procedures described in pages 104-109 of ETSU-R-97, shall not exceed the values set out in the table below. Noise limits for dwellings which lawfully exist or have planning permission for construction at the date of this consent but are not listed in the table shall be those of the physically closest location listed in the table, unless otherwise agreed by the Department.

Noise levels dBL_{A90} 10 minute

Property	**Standardised wind speed at 10m height (m/s) within the site averaged over 10-minute periods**								
	4	5	6	7	8	9	10		
70 Boghill Road	23.3	23.7	24.1	24.5	24.9	25.3	25.7		
99 Boghill Road	33.6	34	34.4	34.8	35.2	35.6	36		
105 Boghill Road	36.2	36.6	37	37.4	37.8	38.2	38.6		
104 Boghill Road	35.3	35.7	36.1	36.5	36.9	37.3	37.7		
106 Boghill Road	35.6	36	36.4	36.8	37.2	37.6	38		
44 Aughnabrack Road	22.5	22.9	23.3	23.7	24.1	24.5	24.9		
40 Aughnabrack Road	23.4	23.8	24.2	24.6	25	25.4	25.8		
36 Aughnabrack Road	22.9	23.3	23.7	24.1	24.5	24.9	25.3		

3. Within 28 days of the receipt of a written request from the Department following a complaint from an occupant of a dwelling relating to noise from the turbine, the turbine operator shall, at their expense, employ a suitably qualified and competent person to undertake a noise test at the complainant's property to assess the level of noise immissions from the wind turbine and submit the results of the test and the data on which it was based to the Department. The test results shall be submitted to the Department within 3

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months of the date of the written request, unless otherwise agreed in writing with the Department.

4. The turbine hereby approved shall not be erected without upward-facing red obstruction lights on the top of the turbine hub (and infra-red lighting if required) to specifications agreed in writing with the Department. These lights shall be displayed through the hours of darkness and maintained in a serviceable condition throughout the lifetime of the turbine.

5. The planning permission hereby granted shall be for a limited period expiring 25 years after the turbine is first connected to the electricity grid. Within 12 months of the cessation of electricity generation at the site or the expiration of this permission, whichever is sooner, all above ground structures shall be removed and the land restored in accordance with a scheme submitted to and approved by the Department before the commencement of development.

6. The development shall be begun before the expiration of five years from the date of this permission.

The decision relates to the following drawings:-
Drawings:- 01 at scale 1:5000 showing site location, 02 at scale 1:500 showing the proposed block, 03 showing the turbine details, 04 showing further turbine details, and 05 showing switch room details. All drawings stamped received by the Department on 20th December 2012.

COMMISSIONER AIDAN McCOOEY

2012/A0286 A0312 A0314

Report from Specialist Advisor Ursula Walsh

Overview – keypoints

LAeq,T is the 'average' of the total sound.

LA90,T is the background sound when the loudest elements are ignored

LAeqT and L90 do not take account of the type of the sound.

Sound reduces with increasing distance from the source and is affected by weather and the landscape. At a distance of 1km you mainly only hear the low pitch (frequency) sounds.

Mechanical noise from wind turbines is generally the result of faults or wear and tear. Most wind turbine noise is not mechanical, it is aerodynamic noise ie 'swish'. The sound from turbine blades is not steady, it fluctuates, this is called amplitude modulation (AM).

Wind turbine noise can also contain noticeable tones. Generally, sounds containing tones are more annoying. Wind turbine noise is more annoying than transport noise or noise from other industries.

Reasons for recommendation that ETSU-R-97 is updated

Modern wind turbines are considerably larger now than those that were in place in 1997, this can result in more lower frequency noise and an increased risk of AM due to high level wind fluctuations.

ETSU - R - 97 The Assessment and Rating of Noise from Wind Farms' is influenced by BS4142 Method for rating industrial noise affecting mixed residential and industrial areas. BS4142 is currently being updated. The draft revised BS4142 includes further emphasis on the annoyance from tones and fluctuations. The draft proposes that when both characteristics are present the two should individually be taken into account.

The WHO guidance for indoor noise levels at night was 35dB when ETSU-R-97 was published in 1997, it has now been revised to 30dB

ETSU-R-97 advises using the LA90,10min noise index for both turbine and background noise. Most other relevant standards use LAeq for source noise. LA90 was adopted by ETSU-R-97 as it was assumed at the time of drafting that wind turbine noise was relatively steady and characterless. Evidence and knowledge since 1997 has highlighted that certain wind farms/ single wind turbines produce AM and hence the original assumption within ETSU-R-97 that wind turbine noise was relatively steady and characterless no longer holds true. ETSU-R-97 needs to be updated to take account of much greater understanding of the acoustics of large wind turbines and the annoyance/health effects of wind turbine noise.

In particular, consideration of the following content of ETSU-R-97 is recommended:

- The statement that it is not necessary to use a margin above background approach in low-noise environments
- The use of LA90 for both the background noise and the wind farm noise
- Night time limit of 43dBA bearing in mind the revised WHO guidelines
- The assumption that background noise rises with increasing wind speed
- The consideration of fluctuations and tones.

Specific issues

More recent designs of wind turbines are much quieter than older designs. Many industries are required to apply Best Available Techniques (BAT) to prevent noise disturbances. The enquiry may wish to consider the age and type of turbines being proposed for installation in Northern Ireland. Anecdotally, many “new” wind turbines installed in Northern Ireland (NI) are in fact reconditioned turbines.

On-going, long term monitoring by the developer would enable the continuing noise exposure of the nearby residents to be determined and increases in noise, beyond the predicted and permitted levels, to be identified and remedied.

It is common practice for local planning authorities to set planning conditions to control or reduce noise levels, or to mitigate the impact of noise. Examples relating to wind turbine noise are provided in the IOA Good practice guide to the application of ETSU-R-97.

There is a great deal of expertise within the Environmental Health profession in Northern Ireland’s district councils. There is a considerable burden, on individual councils, associated with contributing to planning applications regarding wind turbines.

It is suggested that a more strategic approach to both single turbine and wind farm applications would be beneficial, as opposed to the ad hoc approach currently employed in Northern Ireland.

Danish policy

The Danish policy includes

- a replacement Scheme for Wind turbines on land
- a recent emphasis on a planned and coordinated development of offshore wind farms
- a loss of value scheme for dwellings
- the option to purchase scheme. Erectors of large wind turbines shall offer for sale at least 20% of the wind turbine project to the local population.

Committee for the Environment

Wind Energy Inquiry

SPECIALIST ADVISOR Report

Contents

Appendix 2 - Glossary of acoustic terminology

Appendix 3 – BS4142 definitions and further detail

Appendix 4 - Traffic noise

Appendix 4   Traffic noise comparisons

Executive summary

Noise management is a complex issue. Unlike air quality, there are currently no European or national noise limits which have to be met.

PART A - Acoustic terms and theory

To accommodate the very large range of pressures that the human ear can detect, the loudness of noise levels is measured using the decibel (dB) scale. A change of 3 dB is noticeable, 6 dB obvious and a change of 10 dB is significant and corresponds approximately to halving or doubling the loudness of a sound.

In addition to loudness, frequency (or pitch) is also important. One aspect of the frequency content of sound, is the presence or otherwise of recognisable notes or tones. Generally, sounds containing distinguishable tones are more noticeable, and potentially more annoying than sound without such features. BS4142 suggests that this should be penalised in assessments of noise impact, usually by adding 5 dB to the measured level.

A Weighting L_A*. The human ear has a relatively poor response to low frequencies. To give a sound reading that better reflects how the human ear responds, a frequency weighting is applied to most environmental noise measurements. The most commonly used one is the 'A' weighting. 'A' filter takes off up to 26 dB off in the lower frequencies.*

L_{AeqT}*, (Equivalent continuous sound pressure level) is 'an average' of the total sound energy level over a specified time period. It is the most widely used parameter for assessing environmental noise.*

$L_{A90,T.}$ *The LA90,T, is the level that is almost always there in between intermittent noisy events.*

L_{Aeq} *has been found to be around 2dB higher than the* L_{90}*.*

The L_{AeqT} and $L_{A90,T}$ do not take account of the frequency character of the sound. Even for steady sounds, a wide range of character can result from differing frequency content: for example, sounds with predominantly low frequency content might be described as 'rumbling' or 'booming'.

Low frequency noise has been recognised by the World Health Organization as meriting special attention, requiring lower environmental limits than those of other noises, as it presents particular problems to those people who are sensitive to its effects The effects of low frequency noise on health follow from the stress and frustration which sufferers experience in attempting to find a solution to their problem, which is often worse at night and affects sleep.

Low–frequency noise and A weighting. The 1995 Guidelines for Community Noise state that the A-weighted sound pressure level does not reflect the true impact of the noise load, "When prominent low frequency components are present, noise measures based on A-weighting are inappropriate"

Sound levels reduce with increasing distance from the source. Generally, doubling the distance from a point source produces a reduction in sound level of 6dB. However atmospheric absorption, ground effect, reflections and screening also affect how sound travels. Higher frequencies are absorbed in air much more significantly than lower frequencies. At a distance of 1km there is little air absorption of low frequency sound and a substantial absorption of the high frequency components.

Meteorological (weather) conditions fluctuate and can influence sound propagation. Night time, or cloudy conditions, can result in sound carrying over distance. Over large distances this can give rise to variations in sound level up to 20dB At high altitude, downwind of a source, wind causes sound waves to bend downwards towards the ground leading to higher noise levels in that direction. Topography also is of importance when predicting how sound will travel over distances, convex and concave ground contours must be taken into consideration.

PART B - Noise generation from wind turbines

Mechanical noise issues may arise if there is a fault. In the absence of mechanical fault, noise emission from modern wind turbines tends to be dominated by aerodynamic noise.

Aerodynamic noise accounts for the majority of the noise from wind turbines. Aerodynamic noise generation is very sensitive to the speed of the blade. To limit its generation, modern, large wind turbines restrict the rotor speeds.

A condition known as stall may occur and indeed is used to regulate rotational speed and power generation for some designs. This can generate noise up to 10 dB higher than without stall; however, manufacturers are increasingly moving away from stall-regulated machines.

Another possible cause of noise is flow over imperfections in the blade surface. For example, damage due to holes in blades has been known to cause strongly noticeable tones.

Other means of reducing aerodynamic noise are associated with the design of the blade which has become more efficient in recent designs, causing a greater proportion of the wind energy to be converted into rotational energy and less into acoustic noise.

Many of the noise issues mentioned above are more associated with older turbines. Anecdotally, "new" wind turbines installed in Northern Ireland are in fact often reconditioned turbines. Therefore NI may not be benefitting from more modern lower noise emitting design. Furthermore the blades may have signs of wear (such as blade surface irregularities, holes or slits) also increasing noise levels beyond those expected of new turbines. The enquiry may wish to consider age and type of turbines being proposed for installation in Northern Ireland.

The sound level from turbine blades is often not completely steady, but is modulated (fluctuates) in a cycle of increased and then reduced level, sometimes called —blade *swish. It was thought that in the majority of installations the modulation depth may be up to 2-3 dB_A, which was regarded as being acceptable by the ETSU-R-97 working group. In some situations, however, the modulation depth increases to the point where it can become more pronounced and potentially give rise to increased annoyance. This phenomenon is known as amplitude modulation (AM). Findings of several authors concluded that:*

- *Amplitude variations can occur downwind from single wind turbines and wind farms, and can be observed at distances up to approximately one km and perhaps more.*
- *The low-frequency character of wind turbine sound is a possible cause of increased annoyance. Research shows significant variations in the lower frequencies of approximately 8 dB*

Low frequency wind turbine noise

As wind turbines get larger, the turbine noise moves down in frequency and that the low-frequency noise would cause annoyance for the neighbours. The relative amount of low-frequency noise is larger for large turbines (2.3–3.6 MW) than for small turbines (≤ 2 MW).

At long distances higher frequencies are reduced compared to low frequencies. Due to the air absorption, the low-frequency content becomes even more pronounced. One researcher concluded that "it is beyond any doubt that the low-frequency part of the spectrum plays an important role in the noise at the neighbours."

PART C – Noise and health

Annoyance is probably the most widespread adverse effect of noise. There is a wide range of how people respond to noise due to variations in individual sensitivity to noise and/or susceptibility to annoyance. These variations are not well understood in physiological or psychological terms.

Adverse feelings aroused by the wind turbine noise have been found to be influenced by feelings of lacking control, being subjected to injustice, lacking *influence, and not being believed. The risk of annoyance from wind turbine noise is increased in quiet areas. The general trends show that:*

- *annoyance increases with noise level,*
- *sleep disturbance was associated with annoyance*
- *Descriptors of the turbine noise characteristics including swishing, whistling, pulsating/throbbing and resounding were highly correlated with noise annoyance*

Several studies suggest that wind turbine noise is more disturbing than transportation and industrial noise sources.

PART D - Relevant standards, policy and guidance

In the absence of a Northern Ireland Noise policy, it is useful to refer to Noise Policy Statement for England, 2010 (NPSE). The second aim of this Noise Policy is to "Mitigate and minimise adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development." It requires that all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development. This does not mean that such adverse effects cannot occur.

World Health Organization (WHO) Guidelines. The WHO (1999) Guidelines recommends noise limits for both the inside and outside of dwellings during day and night time periods. During the daytime levels should be at or lower than 35 dB L_{Aeq}*,16h inside dwellings and 50 dB* L_{Aeq}*,16h outside. In 2009, the WHO (2009) revised the guidance for night time noise to a guideline limit for bedroom* L_{Aeq}*,8h (Lnight) with the window open of 30 dB, stating "It is particularly important if the background level is low".*

The NI Environment Agency Integrated Pollution Prevention and Control (IPPC) requires installations to be operated in such a way that all appropriate preventative measures are taken against pollution, in particular through the application of Best Available Techniques (BAT). This guidance refers to the application of BS4142.

Statutory nuisance. The Environmental Health departments, within district councils, have a duty to investigate complaints of statutory nuisance including noise. The law recognises that a defendant should not be held liable for the existence of a nuisance due to the fact that he has taken "the best practicable means" to either prevent the nuisance or counteract its effects.

BS4142 (1997) provides a method for assessing whether noise from sources of an industrial nature is likely to give rise to complaints. The standard depends on the margin by which the industrial noise level of interest exceeds the background noise level after making an appropriate allowance for acoustic features of the noise (i.e. a 5 dB penalty for noise that has specific characteristics such as tones or fluctuations). The standard warns that the guidance may not apply where background noise levels are very low (below 30 dB) and rating levels very low (below about 35dB).

A draft revised BS4142 was published for comment in February 2014. This draft specifies that the standard is not applicable to the measurement and rating of sound levels from the several sources including wind farms. In addition, this standard is not applicable to situations where the background and rating sound levels are both very low. It is noteworthy that draft revised BS4142 includes potentially much greater consideration of tonality and impulsive corrections.

Planning Policy Guidance PPG24 Planning and Noise. PPG24 (now withdrawn following the NPPF however still referred to in the absence of subsequent detailed guidance) suggests that BS 4142:1997 should be used to assess the likelihood of complaints from industrial sources. PPG 24 states that noise need not be considered as determining factor in granting planning permission for new dwellings where the external night time noise from road, rail and mixed industrial sources is <45dB although at the high end of the category (near 45dB) should not be considered desirable.

ETSU - R – 97. The ETSU-R-97 guidance states that:
· The guidance advises using the $L_{A90,10min}$ *noise index for both turbine and background noise;*

· Noise limits set relative to the background noise are more appropriate in the majority of cases;

· It is not necessary to use a margin above background noise levels in particularly quiet areas. This would unduly restrict developments which are recognised as having wider national and global benefits.

· Noise from the wind farm should be limited to 5dB$_A$ above background for both day- and night-time, remembering that the background level of each period may be different, subject to a lower limit of 35 to 40 dB$_A$ during the day and 43 dB$_A$ at night.

· The $L_{A90,10min}$ index should be used for both the background noise and the wind farm noise, and that when setting limits it should be borne in mind that the $L_{A90,10min}$ of the wind farm is likely to be about 1.5-2.5dBA less than the L_{Aeq} measured over the same period.

· A fixed limit of 43dBA is recommended for night-time. This is based on a sleep disturbance criterion of 35dBA with an allowance of 10dBA for attenuation through an open window (free field to internal) and 2dBA subtracted to account for the use of $L_{A90,10min}$ rather than $L_{Aeq,10min}$

· In low noise environments the day-time level of the $L_{A90,10min}$ of the wind farm noise should be limited to an absolute level within the range of 35-40dB$_A$.

PART E International perspective

> *Separation distances (or sometimes referred to as setback) between turbines and residential areas vary greatly between countries in term of the distances, the reason for their establishment and the weight that is given to them i.e. whether they are recommendations or more of a statutory requirement.*
>
> *Danish policy includes a move towards off-shore wind turbines, a turbine replacement scheme and a loss of value scheme.*

PART F Specific Issues

Noise monitoring by the developer

On-going, long term monitoring would enable the public, developers, planners and the LA to determine the continuing noise exposure of the nearby noise sensitive receptors. In addition, this would identify where WT noise has increased beyond the predicted and permitted levels. This would also enable action to be taken to reduce noise where it is deemed necessary.

Planning consent conditions

Local planning authorities should consider whether it is practicable to control or reduce noise levels, or to mitigate the impact of noise, through the use of conditions or planning obligations. An Example Planning Condition is provided in the IOA Good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise (2003).

Expertise of council environmental health officers

There is a great deal of expertise with the Local Authority employed Environmental Health profession in Northern Ireland with numerous having post graduate qualifications in Acoustics and Noise Control. In addition Environmental Health Officers within LA are routinely consulted regarding planning applications in relation to industrial developments including wind farms. There is a considerable burden associated with contributing to planning applications regarding wind turbines.

The cumulative impact of wind developments

It is suggested that a more strategic approach to both single and wind farm applications would be beneficial, as opposed to the ad hoc approach currently employed in Northern Ireland.

Adequacy of ETSU-R-97

Some of the members of the original Noise Working Group on wind farm noise, which drafted ETSU-R-97, gathered in order to build on experience and knowledge gained during the period since the adoption of ETSU-R-97. Their thoughts can be summarised as follows:

- *Under specific wind shear conditions the hub height wind speed may be underestimated, and as a result the wind turbine source noise levels may also be underestimated at any given 10m height wind speed.*
- *The background noise levels should be correlated with derived (not measured) 10 m height wind speeds. One method for doing this (described in the IoA article) effectively adjusts the background noise level at the receptor downwards to reflect the influence of wind shear on the turbine noise propagation.*

Work more recent than ETSU-R-97 suggests that amplitude modulation (AM) of 3 dB to 5 dB from multiple turbines has been detected, and postulates that AM of potentially 6 to 10 dB is possible from multiple turbines in very stable atmospheric conditions

ETSU-R-97 recognises a potential for AM of up to 3 dBA (i.e. the noise level goes up and down by 3 dBA in each blade rotation) and states that it takes such a degree of blade swish into account in the noise limits it recommends However the document does not include a specific penalty for AM, beyond a 2 dBA adjustment in setting the fixed noise limit for low wind speeds.

ETSU-R-97 advises using the $L_{A90,10min}$ noise index for both turbine and background noise; and that the $L_{A90,10min}$ of turbine noise is typically 2 dBA less than the equivalent L_{Aeq},t value. ETSU-R-97 measures wind turbine noise and background noise differently from most other guidance regarding industrial noise sources.

ETSU is unique in its use of $L_{A90,10min}$ for both wind turbine noise and background noise. This may have the effect of recording a lower noise level than if L_{AeqT} were used. Most other standards refer to the equivalent continuous A-weighted sound pressure level as a basic quantity.

The BS4142 assessment procedure compares the source noise level (L_{Aeq}) to the background level ($L_{A90,T}$) measured in the area in the absence of the source of interest.

Whilst in the UK ETSU-R-97 advises use of the statistical method (L_{A90}) for the measurement of noise from wind farms, most other countries use the Equivalent Continuous method (L_{Aeq}). Additionally most other EU countries have fixed limits, the lowest being Sweden and Ireland (40 $L_{Aeq,t}$) and the highest being Spain (65 $L_{Aeq,t}$)

Further consideration of some parts of ETSU-R-97 would be useful as there is some ambiguity regarding the rationale of some recommendations. The evidence base has expanded significantly since 1997 with much greater understanding of the acoustics of large wind turbines and the annoyance/health effects of wind turbine noise, AM and reaction to the low frequency content. There has also been further research on the propagation of wind turbine noise.

It is recommended that further consideration of the following content of ETSU-R-97 would be desirable:

- *It is not necessary to use a margin above background approach in such low-noise environments*
- *The LA90 used for both the background noise and the wind farm noise*
- *Night time limit of 43dBA in view of the revised WHO guidelines*
- *The statement that background noise rises with increasing wind speed*
- *The penalties regarding the character of noise and tones.*

The WHO guidance for indoor noise levels at night was 35dB when ETSU-R-97 was published in 1997, it has now been revised to 30dB

Modern wind turbines are considerably larger now than in 1997, this can result in more significant lower frequency noise and an increased risk of AM due to wind shear and other high level wind fluctuations.

ETSU-R-97 is influenced by BS4142. BS4142 is currently being updated to bear in mind the advances made in current knowledge of industrial noise and annoyance (although it will most likely exclude wind turbine noise and areas with very low background noise levels). The proposed revisions to BS4142 should be borne in mind when considering whether ETSU-R-97 should be updated.

The appliance of L_{90} rather than L_{Aeq} in ETSU-R-97 requires further consideration as L_{90} is usually a few decibels lower than L_{Aeq}.

As noted above, L_{90} was adopted by ETSU-R-97 to aid post completion measurements as it was assumed at the time of drafting ETSU-R97 that wind turbine noise was relatively steady and characterless i.e. the L_{90} was used as a proxy for the L_{Aeq}. Evidence and knowledge since 1997 has highlighted that certain wind farms/single wind turbines produce amplitude modulation and hence the original assumption within ETSU-R-97 that wind turbine noise was relatively steady and characterless no longer holds true.

Excessive wind turbine noise can be the result of mechanical fault, wear and tear and older designs. Anecdotally it is common for refurbished turbines to be installed in Northern Ireland. This may be an issue with regard to annoyance and complaints in relation to wind turbine from noise. The law relating to industrial permits requires 'Best available technology' and the statutory nuisance legislation refers to best 'available techniques'. The committee may wish to consider these principles in relation to wind turbine noise.

The acoustic impact on neighbouring properties cannot be adequately gauged as a desk exercise, in advance of the installation and operation of a wind turbine. A desk top exercise can predict the likelihood of ETSU-R-97 limits being complied with, it cannot predict amplitude modulation.

Set-back distances

From a noise perspective, separation distances are irrelevant, noise levels are the relevant parameter. Whilst a set-back distance is easier to measure, it provides no substitute for a robust noise impact assessment. For example a single wind turbine 500m from a resident will produce significantly less noise that a 20 turbine wind farm scheme at a similar distance.

Local topography can provide barrier effects (e.g. turbine on one side of a hill and the resident on the other) but these are limited to only 2dB, whilst valleys can increase the noise impact (e.g. wind farm on one side of the valley and the resident *on the other side). Set back distances are more appropriately applied to visual impacts than noise impact.*

1. Specialist acoustician remit

This report is in response to the Committee's request that a specialist acoustician be engaged to review all evidence already provided to members in the course of the inquiry and, taking into account the Terms of Reference, to use his or her specialist knowledge to assist the Committee in its understanding of the issues before it.
In particular the following emerging Issues in relation to *Wind Turbine Noise were highlighted:*

- Many residents living close to turbines feel that the level and type of noise emanating from turbines is having a detrimental impact on their day to day lives and their longer-term health.
- The ETSU-97 regulations which set out acceptable levels of day- and night-time noise are deemed to be in need of revision. Representatives of the industry, however, believe that the existing regulations are still sufficiently robust to deal with the latest technology.
- Complaints regarding noise may be investigated by local Environmental Health Officers, but such investigations place a considerable strain on existing resources.

The following specific issues were raised as requiring clarification:
It would be beneficial for the Committee to receive specialist advice in order to properly assess their significance and meaning:
The type of noise generated by wind turbines.

- The units of measurement used for noise:
- Comparative measurements of noise
- The cumulative impact of wind developments.
- The current guidelines (ETSU-R-97) have been deemed outdated by many stakeholders and described as '*vague, open to interpretation and unenforceable*' immeasurable, and inadequate to deal with modern and

emerging technology. Developers have defended the guidelines as being robust and appropriate

- The measurement of appropriate set-back distances to minimise noise disturbance has given rise to a great deal of concern.

As far as possible this report was written in straightforward clear non-technical style however many of the issues are technical in nature and also at times the evidence is regarding certain issues is not conclusive.

See full specification in appendix 1

2. Introduction

Noise management is a complex issue and at times requires complex solutions. Unlike air quality, there are currently no European or national noise limits which have to be met. Furthermore, sound only becomes noise (often defined as "unwanted sound□) when it exists in the wrong place or at the wrong time such that it causes or contributes to some harmful or otherwise unwanted effect, like annoyance or sleep disturbance. Unlike many other pollutants, noise pollution depends not just on the physical aspects of the sound itself, but also the human reaction to it.

This report provides explanations regarding sound, wind turbine noise and Northern Ireland and UK policy and guidance in light of the evidence base. It also provides some international comparisons. This report contains extracts from the sources listed in the references section.

3. PART A - Acoustic terms and theory

4.1 Units of measurement used for noise

The human ear is a very sensitive system with an extensive dynamic range. To accommodate this very large range, noise levels are measured using the decibel (dB) scale. This is a logarithmic scale rather than a linear scale

It is commonly accepted that for the average person a change of 1 dB is just perceptible under controlled conditions. A change of 3 dB is noticeable, 6 dB obvious and a change of 10 dB is significant and corresponds approximately to halving or doubling the loudness of a sound.

Combining decibels

Since the decibel system is based on logarithms, when more than one noise source is operating at once the combined decibel level (sound pressure level SPL also written as Lp or just L)) is not simply the sum of the SPLs of the individual sources. The addition of decibels requires the use of a formula. However a useful approximate is that the doubling of sound energy, power or intensity corresponds to an increase of 3dB so if two wind turbines each individually produce a SPL of 50dB at a certain point then when both are operating together the combined SPL is expected to be 53dB and four such wind turbines can be expected to produce a SPL of 56dB. However it is important to also consider the type of noise (character), its frequency, the time of day, the duration of the noise and nature of the area (background noise levels) as explained below.

4.2 Frequency

Noise is usually made up of a wide range of different frequencies. Bass notes are low frequency and high pitched sounds are high frequency. The spread of noise energy across the human audible frequency “spectrum” (about 20Hz – 20kHz) is one factor that helps to make it identifiable to the human ear. Often the sound energy will be spread over a wide band of frequencies (“broad-band” noise).

Sounds like distant thunder with a predominantly low frequency content might be described as ‘rumbling’ or ‘booming’, whereas sounds with high frequency content, might be described as ‘screeching’, ‘squealing’, ‘hissing’ etc.

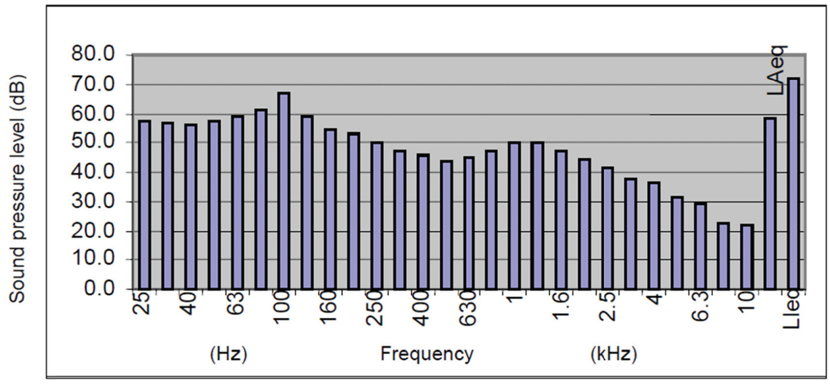
4.3 Tones

Another aspect of the frequency content of sound that has a pronounced effect on character is the presence or otherwise of recognisable notes or tones. Notes or tones at low frequencies would often be described as 'humming', whereas high frequency tones might elicit descriptions such as 'whistling', 'singing' or 'screeching'. Generally, sounds containing distinguishable tones are more noticeable, and potentially more annoying than sound without such features

Sometimes a noise source will emit noise that is concentrated in a "narrow band" of the spectrum or contains a high proportion of energy at a single frequency (a "pure tone"). This is referred to as "tonal noise".

This can be achieved through *octave band, 1/3rd octave band or by narrow – band analysis.* BS 7445:1991 Part 2 - *Description and measurement of environmental noise*, suggests that if the level in one 1/3rd octave band is 5dB or more higher than the level in the two adjacent bands, then tonal character may be present and an audible tone is likely to be perceived.

Environmental Agency's Horizontal Guidance for Noise (HGN) 2004 provides an illustration of tonal noise shown below



In the example shown above, a distinct peak of 67dB can be seen in the 100Hz band. This would be judged as tonal, since the levels either side are 61dB at 80Hz and 59 dB at 125Hz.

Tonal noise is generally more noticeable and both HGN and BS4142 suggest that is should be penalised in assessments of noise impact, usually by adding 5 dB to the measured level.

4.4 A Weighting L_A

Explanation of the term dBA. The upper case ‘A’ (appears in most measurements of environmental sound) indicates that the measurement has been ‘A’-weighted. The ‘A’-weighting is applied to mimic the frequency response of the human ear, so that the contribution of sounds at frequencies (pitches) to which we have lower sensitivity are reduced and those to which we are most sensitive are emphasised.

The human ear has a relatively poor response to low frequencies, whilst it is more responsive in the range 1– 5kHz, with a peak response at 2 – 3kHz. Put simply, our hearing of low pitch sounds is relatively poor, we hear relatively high pitched sounds better. In descriptive terms, sound at 100Hz has to be around 20 dB louder than a sound at 1kHz before it can be heard. Hearing deteriorates with age, the higher frequencies being most affected. In assessing the subjective impact of noise on individuals, both the sound pressure level and the frequency need to be taken into account, so weighting networks are used.

To provide a figure that better reflects how the human ear perceives sound, a frequency weighting is applied to most environmental noise measurements. The most commonly used one is the ‘A’ weighting. The ‘C’ weighting is sometimes used to assess high decibel sound (very high noise levels) with low–frequency content, such as fan noise, and for peak noise. All weightings have a flat response at 1000Hz, that is, no correction is applied, since the ear’s response can be regarded as equal to that of the sound level meter at that frequency. However, in the 63Hz centre–frequency band, for example, the ear’s response is down by around 26 dB, so the ‘A’ filter takes off 26 dB in that centre–frequency band. Although each frequency is considered independently in terms of its weighting, the levels can be logarithmically added to give an overall ‘A’-weighted figure that best represents the response of the ear. This concept is widely used in environmental measurement and acoustic engineering.

4.5 L_{AeqT}, *(Equivalent continuous sound pressure level)*

$L_{Aeq,T}$ is the average of the total sound energy measured over a specified time period. It is the level of a steady continuous noise which has the same total energy as the real fluctuating noise over the same time period.

L_{AeqT}, is the equivalent continuous sound pressure level and is an average energy level of all the sampled levels. To take account of the logarithmic nature of the decibel scale of sound, however, it is the logarithmic average and not the more familiar arithmetic average. The ambient sound level is usually measured as an L_{AeqT} and is made up of all the sound in an area from sources near and far.

L_{AeqT}, is the sound level, that, if generated continuously, would give the same energy content over a specified time period T as the fluctuating sound being measured. It is the most widely used parameter for assessing environmental noise.

The L_{AeqT}, can be heavily influenced by the short duration loud incidents, selecting an appropriate duration for 'T' will depend on a number of factors including the nature of the source being measured, the time of day and the purpose of the measurement.

It can be helpful to think of it as an average level (although strictly speaking this is not quite correct). The measurement period, *T*, must be stated, so for example we have L_{Aeq},16h(07.00-23.00)

Sounds with identical L_{AeqT}, may differ considerably in their capacity to cause annoyance or disturbance because of the character of the sounds. Two of the main elements contributing to the character of a sound are its time structure and frequency content. For example, a series of short impact sounds has a very different time structure to a continuous sound, such as that from a fan, and in most cases would be more disturbing for the same $L_{Aeq,T}$.

The L_{AeqT} does not take account of the frequency character of the sound.

Clearly, only part of the noise climate is being quantified when using L_{Aeq} as this parameter does not provide a description of the content or character of the sound.

(LeqT is defined in BS7445-1:2003 (British Standard Institution, 2003)

4.6 $L_{A90,T}$

The most commonly used percentile level is the LA90,T , is the level exceeded for 90 per cent of the time, T. It has been adopted as a good indicator of the "background" noise level. It is specified in BS 4142:1997 as the parameter to assess background noise levels. Whilst it is not the absolute lowest level measured in any of the short samples, it gives a clear indication of the underlying noise level, or the level that is almost always there in between intermittent noisy events. BS 4142:1997 advises that the measurement period should be long enough to obtain a representative sample of the background level.

The L_{AeqT} and Ln,T s (for example, LA90,T, LA10,T) do not take account of the frequency character of the sound.

4.7 Distance attenuation

The sound level falls with increasing distance from the source. The principal reason is the wave front spreading and for a point source the "inverse square law" applies — doubling the distance from a point source produces a reduction in sound level of 6dB.

ISO 9613:1996 Acoustics – *Attenuation of sound during propagation outdoors*, offers detailed advice on distance attenuation and provides algorithms for the effects of atmospheric absorption, ground effect, reflections and screening, as well as the geometric divergence or wave–front spreading.

Higher frequencies are absorbed in air much more significantly than lower frequencies, as shown in the example below (ISO 9613:1996).
At a temperature of 20^0C and a relative humidity of 50% the predicted attenuation is:

- 0.5dB/km at 500Hz
- 1.5dB/km at 1KHz
- 6dB/km at 4kHz

Note The inverse square law as described above is the principle measurement of how sound decreases with distance. Atmospheric absorption must be considered after the inverse square law is applied.

It is clearly that at a distance of 1km there is little air absorption of low frequency sound and a substantial absorption of the high frequency components.
Meteorological (weather) conditions fluctuate and can influence sound propagation. Wind and air temperature have a noticeable effect over large distances. These conditions are difficult to predict. As temperature increases sound velocity also increases. During inversion conditions, where the air at higher level is warmer than that at ground level (as occurs at night or in cloudy conditions) sound waves tend to bend towards low temperature areas. In an inversion, wavefronts return to earth some distance from the source giving the effect of sound carrying over distance. Over large distances this can give rise to variations in sound level up to 20dB (Peters et al, 2011).

Wind speed is higher at high altitude than at ground level. This causes a distortion of the wavefront where downwind of the source sound waves tend to bend downwards towards the ground leading to higher noise levels in that direction

Topography is of importance when predicting how sound will travel over distances, convex and concave ground contours must be taken into consideration.

Topographical conditions at sites also have importance for the degree to which the noises from wind turbines are masked by the wind. Dwellings that are positioned within deep valleys or are sheltered from the wind in other ways may be exposed to low levels of background noise, even though the wind is strong at the position of the wind turbine (Hayes MacKenzie 1996). The noise from the turbine may on these conditions be perceived at lower sound pressure levels than expected. (Pedersen 2003)

PART B - Noise generation from wind turbines

5.1 Mechanical and aerodynamic noise

The following relates mainly to modern large wind turbines and the main source is DEFRA 2011.

Mechanical noise issues may arise if there is a mechanical fault, such as worn bearings within the gear box/generator, worn teeth within the gear box, or misalignment of the generator drive shaft. In the absence of mechanical fault, noise emission from modern wind turbines tends to be dominated by aerodynamic noise.

Aerodynamic noise, which is typically the dominant component of noise from modern wind turbines, originates from the flow of air around the blades and is generally broadband in character. It is directly linked to the production of power and therefore its generation is, to some extent, inevitable - even though it may be minimised by altering the design of the blades. More recent designs of wind turbines have improved performance regarding aerodynamic noise with improved design of the blade – such as lower angles of attack and the use of modified trailing edges - causing a greater proportion of the wind energy to be converted into rotational energy and less into acoustic noise.

Aerodynamic noise generation is very sensitive to speed of translation at the tip of the blade. To limit its generation, modern, large wind turbines restrict the rotor speeds to ensure that the tip speed remains below 65 m/sec or thereabouts. Large, variable speed wind turbines often rotate at slower speeds in low winds, increasing in higher winds until the limiting rotor speed is reached. This results in much quieter operation in low winds than a comparable constant speed wind turbine.

The principal mechanisms for the generation of aerodynamic noise are divided into three groups:
i. Low Frequency Noise - This type of noise is generated when the rotating blade encounters localized flow deficiencies due to the flow around a tower for downwind turbines, wind speed changes, or wakes shed from other turbines.
ii. Inflow Turbulence Noise - Atmospheric turbulence results in local pressure fluctuations which enter into the blade region and generate inflow turbulence noise as the blades chop through them.

iii. Airfoil Self Noise - As air flows over the surface of the blades, turbulence is generated close to the surface at the boundary layer. This boundary layer turbulence generates noise, particularly when it interacts with the trailing edge of the blade, which is therefore known as trailing edge noise - this is often the principal noise generating mechanism on wind turbines.

Other types of turbulence are the vortices shed from the tip which generate 'tip noise' or from the trailing edge of the blade. Trailing edge vortices are stronger for blunt trailing edges and the associated noise is therefore called blunt trailing edge noise. These noise sources are typically broadband in nature, although tonal components may occur due to blunt trailing edges, or flow over slits and holes.

Of the above mechanisms, inflow turbulence, trailing edge noise, tip noise and blunt trailing edge noise, account for the majority of the noise from wind turbines, although on modern design blunt trailing edge noise is not a significant effect.

Other types of turbulence may also generate noise, but can be avoided. A condition known as stall may occur and indeed is used to regulate rotational speed and power generation for some designs. This can generate noise up to 10 dB higher than without stall; however, manufacturers are increasingly moving away from stall-regulated machines, particularly for those of higher power - one of the main reasons for this trend being the higher noise levels they generate.

Another possible cause of noise is flow over imperfections in the blade surface. For example, damage due to holes in blades has been known to cause strongly noticeable tones. There have even been cases of materials (nuts and bolts) being left in the blade to rattle around and of —whistling from openings in the blades being left exposed (screw fixing holes). For large wind turbines with good manufacturing quality control, such imperfections would be considered a fault condition.

The frequency of the noise generated depends on the size of the turbulent eddies; broadly speaking large eddies produce low frequency noise and small eddies generate higher frequencies. Aerodynamic noise is generally both broadband i.e. it does not contain a distinguishable note or tone, and is of random character, such as exhibited in white noise. The dominant character of the combined aerodynamic noise as described above is therefore ‘swish‘, which is familiar to most people who have stood near to a large wind turbine.

The enquiry may wish to consider age and type of turbines being proposed for installation in Northern Ireland. Many of the noise issues mentioned above are more associated with older turbines. Anecdotally, “new” wind turbines installed in Northern Ireland are in fact often reconditioned turbines. Therefore NI may not be benefitting from more modern lower noise emitting design. Furthermore the blades may have signs of wear (such as blade surface irregularities, holes or slits) also increasing noise levels beyond those expected of new turbines.

5.2 Amplitude Modulation of Aerodynamic Noise (AM)

The sound level from turbine blades is often not completely steady, but is modulated (fluctuates) in a cycle of increased and then reduced level, sometimes called *—blade swish* , typically occurring at a rate of around once or twice per second. It was thought that in the majority of installations the modulation depth may be up to 2-3 dBA, which was regarded as being acceptable by the ETSU-R-97 working group. In some situations, however, the modulation depth increases to the point where it can become more pronounced and potentially give rise to increased annoyance. This phenomenon is known as amplitude modulation of aerodynamic noise or more succinctly by the acronym AM. However work more recent than ETSU-R-97 suggests that AM of 3 dB to 5 dB from multiple turbines has been detected, and postulates that AM of potentially 6 to 10 dB is possible from multiple turbines in very stable atmospheric conditions - Van Den Berg, *2005 and Pedersen and Persson-Waye, 2004*

It has been suggested that the effect of the passage of the blade past the tower is relatively small in comparison to that attributable to the downward sweep of the blade as it approaches the observer, according to the data on which the study was based (Oerlemans and Lopez, 2005) indicating that the latter can give rise to a modulation of some 12 dB in certain one-third octave bands.

Salford University 2007 study focused specifically on the issue of AM of wind farm noise and concluded that this was an infrequently occurring phenomenon tending to arise under very specific meteorological conditions. This research found that out of 133 operational wind farms investigated, 27 were associated with complaints; but AM was considered to be a factor in noise complaints at only four sites and a possible factor in a further eight locations.

Amplitude modulation and frequency

However, Van Den Berg (2009) in commenting on the findings of other authors concluded that:

· *Amplitude variations can occur downwind from single wind turbines and wind farms, and can be observed at distances up to approximately one km and perhaps more.*

· *Spectral analysis of the variations in the sound level at dwellings due to a single or to multiple wind turbines show that the variations occur in frequency bands from 100 to 2000 Hz, but are strongest at 500 to 1000 Hz. (Van Den Berg F 2006)*

· *The dominant source at these frequencies is turbulence at the trailing edge of the blades. Di Napoli 2009 found similar variations at a position 530 m downwind from a single wind turbine.*

Hayes MacKenzie (2006) investigated the low-frequency character of wind turbine sound as a possible cause of increased annoyance at three wind farms, but concluded that the regular variations of the sound level were a more likely cause. He showed that the variations in broad-band A-weighted sound level (approximately 2 dB) were less pronounced than the variations in the 250, 315 and 400 Hz 1/3 octave band level (approximately 8 dB), with a modulation frequency equal to the blade passing frequency. Variations in other 1/3 octave bands were less strong. This means that when the sound is measured overall, the frequencies adjusting it for human ear there is not a great deal of fluctuation however there are large fluctuations at certain lower frequencies.

The Salford University AM study (Moorhouse et al 2007) reports with regard to 4 sites where AM was identified as a factor in complaints that they found modulation in noise levels as follows:

—Measurements of the internal noise levels during these periods of wind farm operation indicate that A-weighted noise levels are subject to amplitude modulation

levels of between 3 – 5 dB(A). Analysis of these periods using third octave band analysis indicates that between 200 – 800 Hz, noise levels in specific frequency bands may change between 8 – 10 dB. External measurements indicate that, for external A-weighted changes in level of 3 – 4 dB(A), third octave band levels may change by between 7 – 9 dB. Measurements indicated that third octave band levels when complaints were received before the implementation of wind turbine control features, indicated level changes of 12–15dB. (All the above figures are ranges from peak to trough).

Useful information on which frequency bands it might be helpful to concentrate investigation of possible AM is provided by the DTI report into low frequency noise and wind turbines (Hayes Mackenzie, 2006), which indicates that —*the dominant audible noise associated with wind turbine operation is acoustic energy within the 250-800 Hz frequency region which originates from the aerodynamic modulation of the wind turbine noise*. Whilst the Salford AM study advises that —*The finding that this modulation is concentrated between the frequency bands of 200 – 800 Hz is significant in that this is generally generated by the trailing edge of a wind turbine blade.*

ETSU-R-97 recognises a potential for AM of up to 3 dBA (i.e. the noise level goes up and down by 3 dBA in each blade rotation) and ETSU-R-97 states that it takes such a degree of blade swish into account in the noise limits it recommends (recommendation 27 in the ETSU-R-97 summary). However the document does not include a specific penalty for AM, beyond a 2 dBA adjustment in setting the fixed noise limit for low wind speeds.

The Hayes MacKenzie 2006 report concludes that —*some wind farms clearly result in modulation at night which is greater than that assumed within the ETSU-R-97 guidelines*. i.e. excess AM. The report then goes on to suggest that in conditions of high aerodynamic modulation it may therefore be appropriate for a correction for the character of the noise to be applied.

Amplitude Modulation & Meteorology

A case study carried out in the Netherlands (Van den Berg, 2004) showed that aerodynamic modulation can be stronger under certain meteorological conditions and that periodic swishes are louder in a stable atmosphere associated with night time than in daytime, and residents can use words like —*clapping, beating or thumping* to describe the character or the sound. In the case of the Rhede wind park, the beating could be heard clearly at distances up to 1 km, and at night the beat of the noise could be used to determine the rotational speed of the turbine. When the atmosphere becomes more stable, which is usual during the night when there is a partial clear sky and a light to moderate wind (at ground level), there is an important change in the wind profile affecting the performance of modern, tall wind turbines. The airflow around the blade then changes to less than optimal, resulting in added induced turbulence. It was suggested that this effect is strongest when the blades pass the tower, causing short lasting higher sound levels at the rate of the blade passing frequency. The synchronisation of these pulses from multiple turbines can give rises to additive effects at a distance and the repetitive pulses may be expected to cause added annoyance.

5.3 Low frequency wind turbine noise

Moller 2011 investigated whether, as wind turbines get larger, the turbine noise would move down in frequency and that the low-frequency noise would cause annoyance for the neighbors. The noise emission from 48 wind turbines with nominal electric power up to 3.6 MW was analyzed and discussed. The relative amount of low-frequency noise was found to be larger for large turbines (2.3–3.6 MW) than for small turbines (≤ 2 MW), and the difference was statistically significant. The difference can also be expressed as a downward shift of the spectrum of approximately one-third of an octave. A further shift of similar size was suggested for future turbines in the 10-MW range.

Modern up-wind wind turbines tend to produce broad band (rather than infrasound or low frequency dominated noise) however at long distances higher frequencies are reduced compared to low frequencies due to differential attenuation from air and ground absorption etc. In addition higher frequencies can be less readily masked by ambient noise. It is therefore conceivable that lower frequencies may become the distinguishing feature of turbine noise under some circumstances. Such a phenomenon has been found with sound from some outdoor pop concerts, as noted in guideline 3.4 of the noise council code of practice on environmental noise from outdoor pop concerts and its underpinning research. Here differential attenuation of different frequencies sound caused a frequency imbalance at 2 Km distance from the venue which led to complaints of low frequency noise; whereas there was less of a problem with low frequency dominance closer to the venue, although overall noise levels were higher, as the frequency balance was less skewed towards low frequency sound.

Due to the air absorption, the low-frequency content becomes even more pronounced, when sound pressure levels in relevant neighbour distances are considered. Even when A-weighted levels are considered, a substantial part of the noise is at low frequencies, and for several of the investigated large turbines, the one-third-octave band with the highest level is at or below 250 Hz. Moller (2011) concluded that it is beyond any doubt that the low-frequency part of the spectrum plays an important role in the noise at the neighbors.

5.4 Suitability of A weighting for wind turbine noise

A number of studies (Persson et al 1990) have established that conventional methods of assessing noise impact, typically based on A-weighted equivalent level, can be inadequate for characterising noise with a strong low frequency component and lead to incorrect conclusions by regulatory authorities.

There have been a large number of laboratory measurements of annoyance by low frequency noise, each with different spectra and levels, making comparisons difficult, but the main conclusions are that annoyance of low frequencies increases rapidly with level. Additionally these studies confirm that the A-weighted level underestimates the effects of low frequency noises. However, validation of those criteria that have been developed has been for a limited range of noises and subjects.

Professor Geoff Leventhall produced a comprehensive review of Infrasound and low frequency noise for DEFRA in 2003 (Contract ref: EPG 1/2/50) 24, extracts of which he used in a paper published in 200425, and which are reproduced below

"*There have been a large number of laboratory determinations of annoyance of low frequency sounds. Whilst they are adequate studies, and have shown some general factors in low frequency noise annoyance, they are limited in that their results apply only to the particular noises investigated, often with a small number of subjects. It is unlikely that continued studies of this kind will result in step changes in our understanding of low frequency noise annoyance."*

The criteria have been compared under laboratory conditions for some specific noises (Poulsen, 2002; Poulsen and Mortensen, 2002). The noises were judged by 18 ontologically normal young listeners and by four older people (41-57 years) who had made complaints of annoyance by low frequency noise. Judgements were made under assumed listening circumstances of day, evening and night. The complaint group rated the noises to be more annoying than the other group did. Overall, the Danish method gave highest correlation between objective and subjective assessments, but only when a 5dB penalty for impulsive sounds was included.

2005 DEFRA released the report and findings from a study into low frequency noise by Salford University Contract NANR 4526 which developed:

- Proposed criteria for the assessment of low frequency noise disturbance;
- Procedure for the assessment of low frequency noise complaints, and;
- Field trials of proposed procedure for the assessment of low frequency noise complaints.

The enquiry may wish to consider or refer to this procedure (Salford University Contract NANR 45 procedure) for the assessment of low frequency noise into assessments of wind turbine noise.

PART C – Noise and health

6.1 Annoyance – Environmental Noise

Annoyance is probably the most widespread adverse effect of noise. In general terms the likelihood of, and strength of, annoyance can be related to indicators of sound exposure. This observation has led to the development of dose-response curves that express the relationship graphically: mathematical descriptions of the relationships are also available. It is important to note that around the average response of a group of people there is a wide scatter of responses due to variations in individual sensitivity to noise and/or susceptibility to annoyance. These variations are not well understood in physiological or psychological terms.

That sleep can be affected by noise is common knowledge. Defining an exposure-response curve that describes the relationship between exposure to noise and sleep disturbance has, however, proved surprisingly difficult. Laboratory studies and field studies have generated different results. In part this is due to habituation to noise which, in the field, is common in many people.

Exposure to noise has been shown to be associated with increased levels of stress hormones in the blood. These include the adrenal cortico-steroids and also adrenaline and noradrenaline which reflect activity of the sympathetic system. Whether such increases in concentrations are harmful is uncertain but some authors have linked such changes with the possibility of long-term effects on blood pressure and on cardiovascular disease.

It has been suggested that exposure to environmental noise is associated with an increased likelihood of development of mental illness. This assertion has attracted some attention but the evidence is by no means clear cut. In our view it has not been established that exposure to environmental noise is linked to the likelihood of developing mental illness, although further research is recommended.

Exposure to environmental noise has been shown to be linked with impairment of cognitive performance amongst children exposed to raised sound levels. A number of well-conducted studies have confirmed this. Less clear are the long-term implications of this finding.

6.2 Low frequency noise and health

Low frequency sound (10 Hz to 200 Hz), from sources such as transport or building ventilators, has been linked to changes in the respiratory rate and heart and gastrointestinal functions (Maschke, 2004).

The evidence on health effects of low frequency noise is ambiguous; there are suggestions that some people are more susceptible to this type of noise and there may be learned aversive responses to low frequency noise (Leventhall, 2004) and possibly sleep disturbance (Persson-Waye, 2004).

Low frequency noise covers the range from about 10 Hz to 200 Hz, although the limit frequencies are not rigidly fixed (Leventhall *et al*, 2003). Low frequency noise has been recognised by the World Health Organization as meriting special attention, requiring lower environmental limits than those of other noises, as it presents particular problems to those people who are sensitive to its effects (WHO, 1999). For example:
'If the noise includes a large proportion of low frequency components, values even lower than the guideline values will be needed, because low frequency components in noise may increase the adverse effects considerably. When prominent low frequency components are present, measures based on A-weighting are inappropriate.' (WHO, 1999)

Often low frequency noise complained of is a very low decibel level and, perhaps, cannot be measured separately from general environmental low frequency noise, which is always present. It then becomes difficult to distinguish between an external low frequency noise and low frequency tinnitus, so that tinnitus is often used as an explanation of last resort, after noise measurements have failed to detect a source (*HPA 2010).*

The effects of low frequency noise on health follow from the stress and frustration which sufferers experience in attempting to find a solution to their problem, which is often worse at night and affects sleep. Claims that their lives 'have been ruined' by their persistent low frequency noise, which cannot be traced to a source, are valid. Increasing exposure to the low frequency sound may lead to development of a general decrease in tolerance to all sounds.

Many sufferers are, understandably, resentful of the noise and of whoever might be responsible for the source. They become tremendously stressed and aggrieved by their situation (Leventhall *et al,* 2008).

Infrasound

Infra Sound is generally regarded as sound with a frequency of <20 Hz. Normally sound of frequency less than 20 Hz is considered not audible to most people, as the average human hearing threshold is typically substantially above ordinary environmental noise levels at these frequencies. However, should sound levels at frequencies below 20 Hz be abnormally high, then especially sensitive persons can perceive the sound, and as levels at these frequencies increase then persons with normal hearing may be able to detect the sound. However, *—there is no reliable evidence that infrasounds below the hearing threshold produce physiological or psychological effects*. However in certain circumstances, low frequency noise, typically defined as sound in the frequency range from about 20 Hz to 200Hz, has been recognised as a special environmental noise problem (WHO 1995)

There are four main subjective factors in response to high levels of infrasound and low frequency noise: auditory perception, pressure on the eardrum, perception through vibration of the chest and more general feeling of vibration. Analysis of these responses shows that auditory perception was the controlling factor. That is, although high levels of low frequency noise may produce other sensations, the ear is the most sensitive receptor.

At high levels infrasound and low frequency noise can have similar effects as higher frequency sound e.g. sleep and activity disturbance, annoyance and other health effects. Among the more consistent findings in humans of the effects of infrasound and low frequency noise are changes in blood pressure, cardiac and respiratory rate, endocrine (hormone) response and balance.

Low–frequency noise and A weighting

The ‘A’-weighting frequency network applies the highest attenuation to low frequencies (for example, 39 dB in 31.5Hz centre–frequency band) ie the A weighting makes the lower frequency sounds worth less than the higher frequency sounds, the actual dB measurement at low frequencies is higher when the A weighting is not applied. When measuring noise with a high content of low–frequency energy, ‘A’-weighting can give non-representative results. In other words, it may not give sufficient emphasis to the "annoyance" value of the low frequencies. Consequently there is a growing trend to use "linear" noise levels (that is, with no frequency weighting at all) when quantifying a low–frequency noise source. This is a valid technique, but generally requires specialist advice.

The 1995 Guidelines for Community Noise edited by Berglund & Lindval and advise that —*The general use of the A-weighting filter attenuates the low frequencies so that the A-weighted sound pressure level does not reflect the true impact of the noise load*.; Whilst the WHO guidelines for Community Noise from 2000 advise that " *When prominent low frequency components are present, noise measures based on A-weighting are inappropriate*"

6.3 Annoyance and wind turbine noise

Several studies suggest that it may be the case where wind turbines are regarded as an unwelcome, dangerous or avoidable intrusion that the response of some people to the noise may be more than in circumstances where such factors do not apply.

Pedersen (2007) suggests that negatively appraising the impact of the wind turbines on the landscape scenery was highly associated with noise annoyance. The risk of noise annoyance increased when the wind turbines were visible i.e. residents who could see at least one turbine from their home were more negative of the impact of wind turbines on the landscape.

Adverse feelings aroused by the wind turbine noise were influenced by feelings of lacking control, being subjected to injustice, lacking influence, and not being believed. Appraising an exposure to noise as an unfair social situation has, in experimental studies, been shown to increase the risk of noise annoyance (Maris et al 2007). Surprisingly, noise sensitivity was only correlated to response to wind turbine noise to a low degree.

Type of Area

An increased risk of perception of wind turbine noise was found (Pedersen, 2007) in those areas that were rated as quiet compared with non-quiet areas. Also, the risk of annoyance was increased in quiet areas, indicating that the contrast between the wind turbine noise and the background noise could make the turbine noise more easily detectable and subsequently more annoying; although confounding factors such as expectation of peace and quiet, effects of visual impact and attitude to wind turbines could have an influence on annoyance response, and be more marked in quiet compared with non-quiet areas.

Pedersen 2007 found dose-response relationships for perception of noise and for noise annoyance in relation to A-weighted sound levels derived in accordance with the Swedish Environmental Protection Agency (2001) Guidelines. *This report suggests that the reported dose responses are formulated for the LAeq,T noise index.* Whilst in the UK ETSU-R-97 advises *use of the statistical method (LA90) for the measurement of noise from wind farms, most other countries use the Equivalent Continuous method (LAeq). Additionally most other EU countries have fixed limits, the lowest being Sweden and Ireland (40 dB(A) LAeq,t and the highest being Spain (65 dB(A) LAeq,t – although care should be taken when comparing advice from different countries as noise index, time period and definition of night and day periods can vary substantially.*

However, several notes of caution are given in regard to the above study as several assumptions, uncertainties and other limitations have been identified.

The Pedersen 2007 study indicates that mere audibility of wind turbine noise is not sufficient to provoke annoyance in most of the respondents; as there is a significant difference in the percentage perceiving the wind farm noise and those who are annoyed, with a smaller differential at lower noise levels compared to higher values. This study shows clear differences in the degree of response, which suggests that the response rate is influenced by location specific factors.

However the general trends show that:
· annoyance increases with noise level,

· sleep disturbance was associated with annoyance (although only phase 1 showed an association between noise level and sleep disturbance),

· Descriptors of the turbine noise characteristics including *swishing, whistling, pulsating/throbbing and resounding* were highly correlated with noise annoyance

More recent (Janssen et al 2009), work from two surveys in Sweden (n=341, n=754) and one survey in the Netherlands (N=725) published wind farm noise dose response compared to industrial noise, concluding that:

· *At outdoor exposure levels higher than 40 dBA, the expected percentage of annoyed persons indoors due to wind turbine noise is higher than due to industrial noise from stationary sources at the same exposure level.*

· *Besides noise exposure, various individual and situational characteristics were found to influence the level of annoyance.*

· *Having economic benefit from the use of wind turbines, or being able to see one or more wind turbines from within the home are two particularly influential situational factors [with positive and negative effects respectively]*

· *The economic benefit factor is reminiscent of earlier findings that being employed at the noise source (e.g. airport or industry) attenuates the annoyance reported.*

· *Also, visibility from the home (e.g. living room, bedroom) has been reported earlier to affect annoyance from stationary sources.*

· *In addition, noise sensitivity and age had similar effects on [increasing] annoyance to those found in research on annoyance by other noise sources.*

The conclusion from these studies is that wind turbine noise appears to have a higher annoyance rate than industrial noise.

Annoyance and characteristics of wind turbine noise

In 2006 DTI (now BERR) published a study which investigated claims that infrasound or low frequency noise emitted by wind turbine generators was causing health effects (Hayes MacKenzie 2006). This report concluded that there was no evidence of health effects arising from infrasound or low frequency noise generated by wind turbines. The report went on to note that Aerodynamic Modulation (AM) was in some isolated circumstances occurring in ways not anticipated by ETSU-R-972, which is the DTI's definitive report on wind turbine noise. DTI took the view that more work was required to determine whether or not AM is an issue requiring attention for noise assessment and rating advice.

The Pedersen 2009 field study referred to earlier found that the sound characteristics of wind turbine noise, generated by the rotation of the blades, were found to be especially annoying. Noise from rotor blades was noticed more than noise from machinery. Descriptors of sound characteristics relating to sound from the rotor blades were highly correlated with noise annoyance. Sound characteristics describing the aerodynamic modulation were appraised as the most annoying (swishing, whistling and pulsating/throbbing).

6.4 Health effects of wind turbine noise

Eja Pedersen carried out a review of health effects from wind turbine noise in 2003. She found that there is no scientific evidence that noise at levels emitted by wind turbines could cause health problems other than annoyance. However, she suggests that sleep disturbance should be further investigated. As noise from wind turbines can have special characteristics (amplitude / aerodynamic modulation and *swishing* sounds). As with any noise that has temporal and spectral characteristics different from the prevailing soundscape it may be detected when near to or even below background noise levels and this may increase the probability of annoyance and sleep disturbance. Pedersen commented that the combination of different environmental impacts e.g. intrusive sounds, visual disturbance and the inability to avoid the source in the living environment, could lead to a low-level stress-reaction, which should be further studied.

These findings were confirmed in the 2007 study conducted by Pedersen. In phase I of the study, the A-weighted sound pressure level was correlated with sleep disturbance; however this result was not replicated in the phase III survey. In the first survey 16% of the respondents exposed to noise levels above 35 dBA stated in an open question that they were disturbed in their sleep by wind turbine noise. Only a few respondents reported impaired health and social well-being and no association between wind turbine noise and health was found.

The absence of strong evidence on the existence of health effects from wind turbine noise should not be taken as proof that such effects do not occur. However, it would appear that the self-reported health effects associated with wind turbine noise are significantly weaker compared with other types of noise, for example the findings reported for domestic noise (Van den Berg 2004).

Pedersen has updated her work with a 2009 published paper and reports that:

· Based on data from two Swedish studies and one Dutch study in which self-reported health and well-being were related to calculated wind farm A-weighted sound pressure levels outside the dwelling of each respondent. The main adverse effect was annoyance due to the sound, and the prevalence of noise annoyance increased with increasing sound pressure levels.

· Disturbance of sleep was related to wind turbine noise; the proportion of residents reporting sleep disturbance in one of the Swedish studies due to noise increased significantly at sound levels close to those recommended as the highest acceptable levels in Sweden (Maximum recommended external level for houses, educational establishments, nursing homes/hospitals = 40 dBA Leq,t - Swedish EPA report 78.5 – As amended) while the Dutch study showed this at a higher level (45dBA).

· No other clear associations between sound levels and self reported health symptoms have been found.

· However, a statistically significant association between annoyance and symptoms of stress was found.

Nissenbaum (2012) compared sleep and general health outcomes between participants living close to industrial wind turbines (IWTs) and those living further away from them, participants living between 375 and 1400 m (n = 38) and 3.3 and 6.6 km (n = 41) from IWTs The results showed that participants living within 1.4 km of an IWT had worse sleep, were sleepier during the day, and had worse SF36 Mental Component Scores compared to those living further than 1.4 km away. Significant dose-response relationships between sleep and Mental Component Score, and log-distance to the nearest IWT were identified after controlling for gender, age, and household clustering. The adverse event reports of sleep disturbance and ill health by those living close to IWTs are supported

None of the above effects are unique to wind turbine noise, although it is unclear whether the dose-response for wind turbine noise is the same as for other noise sources; as several of the studies referenced above suggest that wind turbine noise is more disturbing than transportation and industrial noise sources.

6.5 Wind Turbine Syndrome (WTS) & Vibro-acoustic Disease (VAD) DEFRA

Some campaign groups and activists have raised the issue of a wind turbine syndrome and vibro-acoustic disease in regard to wind farm schemes in the UK. These alleged health effects are largely rebutted in a review by the American Wind Energy Association and the Canadian Wind Energy Association which highlights the poor science and weak methodologies used by the researchers making claims in regard to these effects., although it must be borne in mind that the AWAEA review was not a systematic literature or robust epidemiological study; and that it recognised that noise can have both direct and indirect effects on health. Additionally; the National Health Service has commented on the study alleging wind turbine as follows:

—No firm conclusions can be drawn from this study as the design was weak and included only 38 people. Participants were asked about their symptoms before they were exposed to wind turbines to provide a control for their symptoms after exposure. This was not a sufficient control as many of the participants were reportedly already convinced that wind turbines caused their symptoms and were actively trying to move out of their homes or had already moved.

The DEFRA 2011 report considers that the evidence currently put forward for WTS and VAD in regard to wind turbines is not sufficiently robust to support its use in regard to Statutory Nuisance. Instead this study advises that some of the direct and indirect health effects of noise from many sources are already well established and that knowledge in these areas continues to grow. The current evidence base of the health effects of noise in general is significantly better established and more widely accepted and reported than for wind turbine and VAD specifically in regard to wind turbines; and attempting to bring a case based on such unproven hypotheses as wind turbine and VAD is considered unlikely to succeed.

PART D – Relevant standards, policy and guidance

7.1 IEC 61400-11:2012(E)

IEC 61400-11:2012(E) Wind turbines: Acoustic noise measurement techniques presents measurement procedures that enable noise emissions of a wind turbine to be characterised. This involves using measurement methods appropriate to noise emission assessment at locations close to the machine, in order to avoid errors due to sound propagation, but far away enough to allow for the finite source size. The procedures described are different in some respects from those that would be adopted for noise assessment in community noise studies. They are intended to facilitate characterisation of wind turbine noise with respect to a range of wind speeds and directions. Standardisation of measurement procedures will also facilitate comparisons between different wind turbines. This standard is based on L_{Aeq}.

7.2 BS 7445-1:2003 Description and measurement of environmental noise. Guide to quantities and procedures measurement of environmental noise

This guidance defines the basic quantities to be used for the description of noise in community environments and describes basic procedures for the determination of these quantities. The methods and procedures described in this British Standard are intended to be applicable to sounds from all sources, individually and in combination, which contribute to the total noise at a site. At the present stage of technology this requirement is best met by adopting the equivalent continuous A-weighted sound pressure level as a basic quantity. Based on the principles described in this British Standard, acceptable limits of noise can be specified and compliance with these limits can be controlled. This British Standard does not specify limits for environmental noise

7.3 ISO 9613-1:1993 Acoustics -- Attenuation of sound during propagation outdoors -- Part 1: Calculation of the absorption of sound by the atmosphere

This standard specifies an analytical method of calculating the attenuation of sound as a result of atmospheric absorption for a variety of meteorological conditions. For pure-tone sounds, attenuation due to atmospheric absorption is specified in terms of an attenuation coefficient as a function of the frequency of the sound (50 Hz to 10 kHz), the temperature (- 20 °C to + 50 °C), the relative humidity (10 % to 100 %) and pressure (101,325 kPa) of the air. Formulae are also given for wider ranges (e.g. ultrasonic frequencies, lower pressure) and for other than pure tones.

7.4 ISO 9613-2:1996 Acoustics -- Attenuation of sound during propagation outdoors -- Part 2: General method of calculation

Describes a method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level (as described in ISO 1996) under meteorological conditions.

7.5 Noise Policy Statement for England, 2010 (NPSE).

In the absence of a NI Noise policy, it is useful to refer to Noise Policy Statement for England, 2010 (NPSE). The vision of this policy is to promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development.

The first aim of the Noise Policy Statement for England is to "*Avoid significant adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.*"

The second aim of the Noise Policy Statement for England
Mitigate and minimise adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

This aim of the NPSE refers to the situation where the impact lies somewhere between Lowest Observed Adverse Effect Level (LOAEL) and Significant Observed Adverse Effect Level (SOAEL).*

*A single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations is not possible. Consequently, the SOAEL is likely to be different for different noise sources, for different receptors and at different times.

It requires that all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development. This does not mean that such adverse effects cannot occur.

The phrase, "*Within the context of Government policy on sustainable development" is explained as follows: "*Sustainable development is a core principle underpinning all government policy. For the UK Government the goal of sustainable development is being pursued in an integrated way through a sustainable, innovative and productive economy that delivers high levels of employment and a just society that promotes social inclusion, sustainable communities and personal wellbeing. The goal is pursued in ways that protect and enhance the physical and natural environment, and that use resources and energy as efficiently as possible. There is a need to integrate consideration of the economic and social benefit of the activity or policy under examination with proper consideration of the adverse environmental effects, including the impact of noise on health and quality of life. This should avoid noise being treated in isolation in any particular situation, i.e. not focussing solely on the noise impact without taking into account other related factors."

7.6 WHO guidelines

The WHO (1999) Guidelines are the outcome of a meeting of an expert task force in London in 1999 based on a report 'Community Noise' produced in 1995 by authors at Stockholm University and the Karolinska Institute. The WHO (1999) document offers guidelines that relate to health effects from overall long term exposure to noise including noise from road traffic, aircraft and neighbourhood sources. It does not consider site-specific industrial noise and, in particular, noise with identifiable characteristics. The document recommends noise limits for both the inside and outside of dwellings during day and night time periods. During the daytime (defined as 07:00 to 23:00) noise levels should be at or lower than 35 dB $L_{Aeq},16h$ inside dwellings and 50 dB $L_{Aeq},16h$ outside. If the source is not continuous, sleep disturbance correlates best with *LAmax*. During night time (the 8 hours between 23.00 – 7.00), it was recommended that the levels should be below 35 dB $L_{Aeq},8h$ inside and 50 dB $L_{Aeq},8h$ outside, with recommended values of *LAmax* of 45dB inside and 60dB outside.

However in 1999 the WHO (2009) revised the 1999 conclusions about night time sleep disturbance by noise on the basis of more evidence concerning the health effects of noise-induced sleep deprivation. If the intruding noise is continuous then the recommended guideline limit for bedroom $L_{Aeq},8h$ (*Lnight*) with the window open is 30 dB. It is particularly important if the background level is low. Moreover the guideline limits for internal *LAmax* proposed in 1999 were reduced from 45 dB to 42 dB.

7.7 The Northern Ireland Environment Agency Integrated Pollution Prevention and Control (IPPC) Horizontal Guidance for Noise

This guidance was produced in 2004 by the Environment Agency for England and Wales in collaboration with the Scottish Environment Protection Agency (SEPA) and the Northern Ireland Environment and Heritage Service (EHS).

Integrated Pollution Prevention and Control (IPPC) is a regulatory system that employs an integrated approach to control the environmental impacts of certain industrial activities. It involves determining the appropriate controls for industry to protect the environment through a single Permitting process. To gain a Permit, Operators will have to show that they have systematically developed proposals to apply the Best Available Techniques (BATs) and meet certain other requirements, taking account of relevant local factors.

IPPC requires installations to be operated in such a way that all appropriate preventative measures are taken against pollution, in particular through the application of Best Available Techniques (BAT). BAT includes both the technology used and the way in which the installation is designed, built and operated. In deciding what level of control constitutes BAT for a given installation, a number of factors need to be considered and balanced. These include:

• costs and benefits

• the technical characteristics of the installation concerned
• geographical location
• local environmental conditions

The EA guidance states that application of BS4142 should be applied.

7.8 Statutory nuisance

Under the Clean Neighbourhoods and Environment Act (NI) 2011, Environmental Health departments have a duty to investigate complaints of statutory nuisance including noise emitted from any premises so as to be prejudicial to health or a nuisance. A premises includes land. In the case of machinery, equipment, trade or business, it is a defence to prove 'Best Practicable Means'. The law recognises that a defendant should not be held liable for the existence of a nuisance due to the fact that he has taken "the best practicable means" to either prevent the nuisance or counteract its effects.

"Best Practicable Means" Defence
The defence that best practicable means (bpm) were used to prevent or counteract the effects of a nuisance is available for prosecutions involving a breach of an abatement notice for certain types of nuisance including industrial premises
The term can be summarised as:-

(a) reasonably practicable having regard to local conditions and circumstances, the current state of technical knowledge and to the financial implications;

(b) the means to be employed include the design, installation, maintenance and operation of plant and machinery, and the design, construction and maintenance of buildings and structures;
(c) the test is to apply only so far as compatible with any duty imposed by law and safe working conditions, and with the exigencies of any emergency or unforeseeable circumstances.

The means to be used are the best available not only those currently accepted in the business concerned. The costs of compliance are an important but not over-ruling principle. The lack of finance available to the person served with the notice is not to only factor in cost assessment nor is the increased cost and impact on profitability. The location of a nuisance is also of importance as it has been held that the test should be applied to the existing location of an activity and cannot require the relocation to another site as this was too onerous.
The key issue when determining BPM usually relates to the interpretation of “practicable”. It should be noted that definition of “practicable” is not exhaustive as the legislation details issues that “among other things” should be taken into account. The definition includes cost consideration but clearly cost is not necessarily the decisive factor.”

This guidance regarding refers to PPG24 and the principles described in BS4142

7.9 British Standard 4142: 1997 - Method for rating industrial noise affecting mixed residential and industrial areas

BS4142 (1997) provides a method for assessing whether noise from factories or industrial premises or fixed installations or sources of an industrial nature in commercial premises, whether measured or predicted outside a building, is likely to give rise to complaints from people living within that building. It is not based on substantive research but rather on accumulated experience. The outcome of applying the standard depends on the margin by which the industrial noise level of interest exceeds the background noise level after making an appropriate allowance for acoustic features of the noise (i.e. a 5 dB penalty for noise that has specific characteristics such as an irregular noise). The assessment procedure compares the source noise level (L_{Aeq}) averaged over an hour during the day and 5 minutes at night to the background level (*LA90,T*) measured in the area in the absence of the source of interest. Methods for measuring the source noise level and the background level are detailed in the standard. According to BS4142 paragraph in the case of a new source, the background noise should be measured "on days of the week and at times of the day when the new source is likely to be operating." The standard suggests that:

(i) complaints are likely if the specific (i.e. character corrected) noise level is 10 dB or more above the background level.

(ii) complaints are unlikely if this the source level is 10 dB or more below background level

(iii) the likelihood of complaints is marginal if the difference is around + 5dB but increases with increasing (positive) difference.

The standard warns that the guidance may not apply where background noise levels are very low (below 30 dB) and rating levels very low (below about 35dB).

More detail on this method, including definitions, is given in Appendix 3

7.10 Updates on BS4142

A study by the National Physical Laboratory in 1995 showed that the rating method of BS 4142:1990 generally gives a good indication of the likelihood of complaint (in 80 per cent of the cases reported), However, this implies that the method was wrong in the remaining one in five cases. Also the study showed that under–prediction of complaints occurred in some cases including low–frequency noise, impulsive noise and tonal new noise. Adopting the +5 dB "marginal" case as acceptable may be inappropriate if there is a likelihood of other future developments adding to ambient noise levels.

Draft revised BS4142

A draft revised BS4142 was published for comment in February 2014. This standard specifies methods for rating and assessing industrial and/or commercial sound. It is applicable to the determination of the following sound levels at outdoor locations:
a) sound levels from industrial and/or commercial sources; and

b) background sound levels and residual sound levels, for the purposes of:

1) investigating industrial and/or commercial noise complaints at existing private and commercial premises used for residential purposes;

2) planning for new, modified or additional industrial or commercial developments that can affect people at existing private and commercial premises used for residential purposes;

3) planning for new premises used for existing private and commercial residential purposes that can be affected by existing industrial and/or commercial sources.

The methods specified in this British Standard use outdoor sound levels to assess the likely effects of the sound on people who might be outdoors or within a building where sound is incident.

This draft specifies that the standard is not applicable to the measurement and rating of sound levels from the several sources including wind farms. In addition, this standard is not applicable to situations where the background and rating sound levels are both very low.

*NOTE: Background sound levels below approximately 25 dB and rating levels below approximately 30 dB are considered to be very low. H*owever the proposed revisions should be borne in mind when considering whether ETSU-R-97 should be updated.

The draft revised BS4142 includes new methods to assess tonal and impulsive characteristics. It also includes further detail on tonality and impulsive corrections. The draft proposes that when both characteristics are present the two should both be taken into account and added linearly.

The IOA responded to this draft revised BS4142 stating

“In general some of the additional detail in the standard is welcomed e.g. clarification of its scope and the reinforcement of use of the typical background, because it will help ensure practitioners carry out thorough noise investigations that yield sensible results. However, in a some areas we feel that the standard has become too prescriptive e.g. reproducing rather than referencing the advice of other standards, and some of the areas of good practice that have been described may not be relevant in all cases and would be better included in the annexes. This IOA is concerned that, when planning a new industrial noise source it is rarely possible to predict tonality or impulsiveness to the degree expected by the requirements of the draft standard. Furthermore, applying a worst case scenario by giving a 16 dB cumulative rating penalty to a predicted level would very often result in an unnecessarily restrictive outcome for new development." The IOA response also included concerns regarding the potential for large penalties when both tonal and impulsive noise are present, possible. In addition, the IOA stated that it was not clear why it is proposed to change the meaning of "very low" noise levels in the Scope of the standard.

7.11 Planning Policy Guidance PPG24 Planning and Noise

PPG24 (now withdrawn in England following the NPPF however still referred to) suggests that BS 4142:1997 should be used to assess the likelihood of complaints from industrial sources. BS4142: 1997 describes a method for determining industrial and background noise levels outside residential properties and for assessing whether the industrial noise is likely to give rise to complaints from residents.

PPG24 outlined the Government's view on noise and planning and *focuses on the planning of new noise-sensitive development in already noisy environments.* It establishes Noise Exposure Categories (NECs) that are applicable when planning new residential developments affected by transport noise or by mixed noise sources in which industrial noise does not dominate. However, these NECs cannot be used for assessing noise impacts of new or existing noise sources on existing housing. In the case of proposed noise-producing development affecting existing noise sensitive premises, PPG24 advises that BS 4142:1997 can be used, within its own terms of reference, to predict the likelihood of complaints, and hence assist in the assessment. However, many planning authorities adopt more stringent standards than are implied in PPG24, which really only discusses the likelihood of complaints.

PPG24 does not offer a single set of criteria, but introduces the concept of *Noise Exposure Categories* (NECs) that provide flexibility to take account of local conditions and the needs of the local community and economy.

There are four NECs:

A. Noise need not be considered as a determining factor in granting planning permission, although the noise level at the high end of the category should not be considered as desirable.
B. Noise should be taken into account when determining planning applications and, where appropriate, conditions imposed to ensure an adequate level of protection against noise.
C. Planning permission should not normally be granted. Where it is considered that permission should be given, for example, because there are no alternative quieter sites available, conditions should be imposed to ensure a commensurate level of protection against noise.
D – low background. Planning permission should generally be refused.

Categories For New Dwellings $L_{Aeq,T}$ dB				
	Noise Exposure Category			
Noise Source	**A**	**B**	**C**	**D**
road traffic				
07.00 - 23.00	<55	55 - 63	63 - 72	>72
23.00 - 07.00[1]	<45	45 - 57	57 - 66	>66
rail traffic				
07.00 - 23.00	<55	55 - 66	66 - 74	>74
23.00 - 07.00[1]	<45	45 - 59	59 - 66	>66
air traffic[2]				
07.00 - 23.00	<57	57 - 66	66 - 72	>72
23.00 - 07.00[1]	<48	48 - 57	57 - 66	>66
mixed sources[3]				
07.00 - 23.00	<55	55 - 63	63 - 72	>72
23.00 - 07.00[1]	<45	45 - 57	57 - 66	>66

7.12 ETSU - R - 97 The Assessment and Rating of Noise from Wind Farms

The technical detail of ETSU-R-97 is important, but can be summarised as follows:
· The guidance requires the predicted noise levels from the wind turbine under a range of wind speeds to be compared with the background noise level at noise sensitive premises under similar wind conditions;
· The guidance advises using the LA90,10 min noise index for both turbine and background noise; and that the LA90,10 min of turbine noise is typically 2 dBA less than the equivalent L_{Aeq},T value.
· Noise limits should be applied to external locations and should apply only to those areas frequently used for relaxation or activities for which a quiet environment is highly desirable;

· Noise limits set relative to the background noise are more appropriate in the majority of cases;

· Generally, the noise limits should be set relative to the existing background noise at the nearest noise-sensitive properties and that the limits should reflect the variation in both turbine source noise and background noise with wind speed;

· It is not necessary to use a margin above background noise levels in particularly quiet areas. This would unduly restrict developments which are recognised as having wider national and global benefits. Such low limits are, in any event, not necessary in order to offer a reasonable degree of protection to wind farm neighbours.

· Separate noise limits should apply for day-time and for night-time as during the night the protection of external amenity becomes less important and the emphasis should be on preventing sleep disturbance.

· Absolute noise limits and margins above background should relate to the cumulative effect of all wind turbines in the area contributing to the noise received at the properties in question. Any existing turbines should not be considered as part of the prevailing background noise. (DEFRA 2011)

· Noise from the wind farm should be limited to 5dBA above background for both day- and night-time, remembering that the background level of each period may be different, subject to a lower limit of 35 to 40 dBA during the day and 43 dBA at night.

· The LA90,10min index should be used for both the background noise and the wind farm noise, and that when setting limits it should be borne in mind that the LA90,10min of the wind farm is likely to be about 1.5-2.5dBA less than the L_{Aeq} measured over the same period. The use of the LA90,10min index for wind farm noise allows reliable measurements to be made without corruption from relatively loud, transitory noise events from other sources.

· A fixed limit of 43dBA is recommended for night-time. This is based on a sleep disturbance criterion of 35dBA with an allowance of 10dBA for attenuation through an open window (free field to internal) and 2dBA subtracted to account for the use of LA90,10min rather than L_{Aeq},10min.

· Both day-and night-time lower fixed limits can be increased to 45dBA to increase the permissible margin above background where the occupier of the property has some financial interest in the wind farm.

· In low noise environments the day-time level of the LA90,10min of the wind farm noise should be limited to an absolute level within the range of 35-40dBA. The actual value chosen within this range should depend upon: the number of dwellings in the neighbourhood of the wind farm; the effect of noise limits on the number of kWh generated; and the duration of the level of exposure.

· For single turbines or wind farms with very large separation distances between the turbines and the nearest properties, a simplified noise condition may be suitable. If the noise is limited to an LA90,10min of 35dBA up to wind speeds of 10m/s at 10m height, then this condition alone would offer sufficient protection of amenity, and background noise surveys would be unnecessary.

7.13 The IOA Good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise (2003)

This guide has been approved by the IOA Council for use by IOA Members and others involved in the assessment and rating of wind turbine noise using ETSU-R-97. It describes methods for Background Data Collection, Data Analysis & Noise

Limit Derivation and Noise Predictions. The references list at the end of this publication also provides sources of further information on the on:

- Analysis of how Noise Impacts are considered in the Determination of Wind Farm Planning Applications
- Farm Noise Predictions and Comparison with Measurements
- Comparison of predicted and measured wind farm noise levels and implications for assessments of new wind farms,
- Comparison of compliance results obtained from the various wind farm standards
- Development of a Wind farm Noise Propagation Prediction Model
- Measurement and Evaluation of Environmental Noise From Wind Energy

ETSU-R-97 was originally published in 1996 and has been used extensively since then. The Working Group suggested that the report and its recommendations be reviewed 2 years after publication. A formal review did not occur but it is understood that ETSU-R-97 is kept under consideration by the government. The Government accepted the document when PPS 22 was adopted in England; and equivalent policy and advice has been adopted in the devolved administrations.

PART E International perspective

8.1 Separation distances (Set back distances)

Separation distances (or sometimes referred to as setback) between turbines and residential areas vary greatly between countries in term of the distances, the reason for their establishment and the weight that is given to them i.e. whether they are recommendations or more of a statutory requirement.

Current situation in Northern Ireland

In Northern Ireland, there is no statutory separation distances stipulated in legislation. Recommendations or suggestions for separation are made through planning policy and guidance. Planning policy and guidance influence and inform decisions made on applications, therefore it is good practice for a developer to adhere to the recommendations made, however, they are not obligated.

Planning Policy Statement 18 (PPS18) suggests that turbines are a safe technology and that even in the rare event of structural damage occurring incidents of blade throw are most unlikely. Distances are calculated on the basis of noise levels so as to reduce nuisance: *The minimum desirable distance between wind turbines and occupied buildings calculated on the basis of expected noise levels and visual impact will usually be greater than that necessary to meet safety requirements. Fall over distance (i.e. the height of the turbine to the tip of the blade) plus 10% is often used as a safe separation distance.*

The Department of the Environment for Northern Ireland's best practice guidance on PPS18 goes on to state that: *As a matter of best practice for wind farm development, the Department will generally apply a separation distance of 10 times rotor diameter to occupied property (with a minimum distance of not less than 500m).*

Haugen's (2011) report on the *International Review of Policies and Recommendations for Wind Turbine Setbacks from Residences: Setbacks, Noise, Shadow Flicker, and Other Concerns*, examined separation distances in over 14 countries and about 25 local planning jurisdictions, excluding the USA. The report attempted to identify and clarify existing governmental requirements and recommendations regarding wind turbine setbacks from residences. This included identifying the rationale for setbacks and analysing whether or not they were based on public opinion or research findings. Haugen's (2011) report found that:
Setbacks are claimed to be developed out of public concern for possible impacts to the landscape, health and quality of life, historical and cultural areas, the environment, and tourism.

However, the evidence trail to support these setback distances is often lacking or unclear, with no statements of justification provided. There is no worldwide agreement on appropriate setback distances from homes. There was limited awareness of wind turbine setbacks in many countries, or why a particular setback distance was chosen. Frequently, separation distances were set not based on visual impacts, but on noise limits, health and shadow flicker concerns.

From the same report, it is clear that the leading on-shore wind generating countries such as Denmark and Germany do not have a standardised approach to setting separation distances. In Denmark, which has the highest wind energy capacity per capita, per land area, and per GDP in the world, a new regulation related to low frequency noise recommends a measured setback of 4 times the total height of the turbine (see also Mills and Manwell, 2012). In Germany, there is no national requirement or recommendation for wind turbine setback distances from residences; although the German states and local governments are responsible for guidelines determining setbacks. Five states in Germany use 1,000m, whilst the others used between 300 and 500m. However, state policies cannot be overly restrictive and must allow 20% of areas favourable to wind energy to remain open for wind facility development. In Germany, the average lower setback distance is approximately 450m and the average upper setback distance is approximately 700 meters. However, the turbine heights associated with the separation distances are not provided anywhere in the report.

In 2013, a report was commissioned by the Madison Wind Advisory Committee, USA, to review the siting of wind power facilities in relation to negative impacts. The report concluded that the larger the setback from residences and other structures, the less the negative impacts. Accordingly, they advised that a setback requirement for a large turbine is 3,560 feet (1,078m) from the property line of any non-participating owner, and 2.5 times the turbine height from any other turbine or house of a participating member. The rationale provided is that this is the minimum distance that would be safe in the event of potential equipment failure, ice throw and similar dangers. The review report was based on a relatively small sample of policy and empirical studies, mainly focusing on socio-economic factors. The turbine heights are not mentioned and, as in other reports, visual impact is not mentioned in the rationale.

In Canada, setbacks are decided at the provincial rather than federal level. The Canadian Wind Energy Association developed some guidelines regarding setback distances (Canadian Wind Energy Association, CanWEA, 2007) for Ontario province. The aim was to provide guidelines for setbacks for various stakeholders in the wind energy industry, based on broad input from the industry technical experts and international research. CanWEA (2007) concluded that comprehensive setback guidelines for large-scale wind turbines should address a series of objectives including ensuring public safety, minimizing on and off-site impacts, and promoting good land use planning and practices while balancing the economics and viability of the wind project. It also stated that the definition of appropriate setbacks, at least for Ontario for which the report was commissioned, revolved around four main issues: public safety, noise levels, impact on radio, radar and telecommunications, and ensuring minimal impact on sensitive environments. However, the report also admitted to the challenges of setting fixed separation distances and recommended that setbacks be defined on a case by case basis through a site-specific study. The report also offered some definitions and tried to clarify the issue of rationale for separation distances. For example, it defined “the minimum distance requirement” to mean the necessary distance between the wind turbine generator and residential premises. Furthermore, in a wind farm, the minimum distance requirement would apply to each wind turbine individually. It also defined “setback” as: the shortest horizontal distance measured at grade between a residential building, lot line, public roadway, or other identified feature and the nearest part of the wind turbine structure.

In England, North Yorkshire County Council commissioned a study to review setbacks in the UK and come up with evidence-based recommendations for policy options on separation distances in their planning jurisdiction (Bryant, 2012). The study was motivated by the existence of an earlier consensus seeking to secure a 2 kilometre minimum separation distance within North Yorkshire, a figure that was based on the Scottish national policy (Scottish Government, 2010). Further evidence-based research into the 2 km criterion was therefore requested. The published report in 2012, *Renewable Energy Policy – Proximity of Homes to Wind Turbines*, summarised approaches to minimum separation distances throughout the UK. Only three English authorities, i.e. Cherwell and Torridge District Councils and Milton Keynes Council, had introduced specified minimum separation distances to protect residential amenity. These minimum separation distances do not hold any formal planning status and are “encouraged rather than enforced”.
The report states that “…the most reasonable updated evidence-based recommendations at this point in time can be summarised thus: at least 400m for visual amenity”. It is however not shown how the 400m is arrived at, neither is a further narrative or rationale provided. In the end, the report’s recommendation on

the separation distance was not adopted at least in part due to the absence of robust evidence for setting separation distances.

UK Position

Planning practice guidance for renewable and low carbon energy policy on siting of wind turbines differs across the UK (Department for Communities and Local Government 2013) states that: 'The assessment and rating of noise from wind farms' (ETSU-R-97) should be used by local planning authorities when assessing and rating noise from wind energy developments. Good practice guidance on noise assessments of wind farms has been prepared by the Institute Of Acoustics. The Department of Energy and Climate Change accept that it represents current industry good practice and endorses it as a supplement to ETSU-R-97.

The Scottish Planning Policy states:
A separation distance of up to 2km between areas of search and the edge of cities, towns and villages is recommended to guide developments to the most appropriate sites and to reduce visual impact, but decisions on individual developments should take into account specific local circumstances and geography. Development plans should recognise that the existence of these constraints on wind farm development does not impose a blanket restriction on development, and should be clear on the extent of constraints and the factors that should be satisfactorily addressed to enable development to take place. Planning authorities should not impose additional zones of protection around areas designated for their landscape or natural heritage value.

Welsh Planning Policy on separation distance is set out in Technical Advice Notice (TAN) 8: Planning for Renewable Energy. This states that:
500m is currently considered a typical separation distance between a wind turbine and residential property to avoid unacceptable noise impacts, however when applied in a rigid manner it can lead to conservative results and so some flexibility is advised.

Republic of Ireland

Irish Planning guidelines are similar to ETSU. They consider a number of issues around the siting of wind turbines but noise is the primary consideration. Planning the separation distance was not adopted at least in part due to the absence of robust evidence for setting separation distances.

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Erectors of wind turbines with a total height of at least 25 metres, including offshore wind turbines erected without a governmental tender, shall offer for sale at least 20% of the wind turbine project to the local population.

Noise limits

In accordance with the Danish Ministry of the Environment's Order, the noise in the open land immediately outside the neighbour's house and in open spaces up to 15 metres from the house may not exceed 44 dB(A) at a wind speed of 8 metres per second. This corresponds roughly to the noise of soft speech. In more densely builtup areas, summer home areas and noise-sensitive recreational areas, the noise may not exceed 39 dB(A). The limits are lower for lower wind speeds see further detail below.

Statutory Order on Noise from Wind Turbines (Translation of Statutory Order no. 1284 of 15 December 2011)
The total noise impact from wind turbines may not exceed the following limit values:
1) At the most noise-exposed point in outdoor living area no more than 15 metres from dwellings in open countryside:
(a) 44 dB(A) at a wind speed of 8 m/s.
(b) 42 dB(A) at a wind speed of 6 m/s.
2) At the most noise-exposed point in areas with noise-sensitive land use:
(a) 39 dB(A) at a wind speed of 8 m/s.
(b) 37 dB(A) at a wind speed of 6 m/s.

It should be borne in mind that the topography of Denmark differs significantly from that of Northern Ireland ie Denmark is mainly flat topography with rolling plains.

PART F - Specific issues requiring clarification:

9.1 Monitoring of noise by the developer

Bearing in mind the issues discussed above in relation to the noise associated with wear and tear on wind turbine mechanics and blades, on-going, long term monitoring would enable the public, developers, planners and the LA to determine the continuing noise exposure of the nearby noise sensitive receptors. In addition, this would identify where wind turbine noise has increased beyond the predicted and permitted levels. This would also enable action to be taken to reduce noise where it is deemed necessary and follows the 'polluter pays' principle.

The Danish model places a duty on wind turbine developers to monitor noise.

9.2 Conditions of planning consent

It is common practice for local planning authorities to set planning conditions to control or reduce noise levels, or to mitigate the impact of noise.

Examples provided in (the now withdrawn) PPG24 include:

"The level of noise emitted from the site shall not exceed [A] dB between [T] and [T] Monday to Friday and [A] dB at any other time, as measured on the [specified boundary/boundaries] of the site at [location(s) of monitoring point(s)].

Specify: A - noise level expressed as L_{Aeq},T over a time period X (eg 1 hour)
T - time of day

The rating level of the noise emitted from the site shall [not exceed] [be lower than] the existing background noise level [determined to be [A] dB] by [more than] [at least] [B] dB between [T] and [T] Monday to Friday and [B] dB at any other time. The noise levels shall be determined at [the nearest noise-sensitive premises] [specified locations)]. The measurements and assessment shall be made according to BS 4142:1990."

An Example Planning Condition is also provided in the IOA Good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise (2003). This includes: "The assessment of the rating level of noise emissions shall be undertaken in accordance with an assessment protocol that shall previously have been submitted to and approved in writing by the Local Planning Authority."

9.3 Local councils expertise and resources

There is a great deal of expertise with the LA employed Environmental Health profession in Northern Ireland with numerous having the IOA post graduate qualification, the Diploma in Acoustics and Noise Control. In addition Environmental Health Officers within Local authorities are routinely consulted regarding planning applications in relation to industrial developments including wind farms. They review planning applications and provide comments to regarding noise impact assessments against Planning Policy Statement 18 (i.e. compare predictions against ETSU-R-97 limits and IOA GPG). Their expertise is shared within a CEHOG sub-group pollution group. Several members of this group are members of the IOA and one of the group contributed to the IOA Good Practice Guide to the application of ETSU-R-97. However, although new councils within Northern Ireland from 2015 onwards will be larger, there is still a considerable burden associated with contributing to planning applications regarding wind turbines. This process is resource intensive and has the potential to result in a considerable impact on smaller councils.

9.4 The cumulative impact of wind developments.

Planning Policy guidelines including ETSU-R-97 are applied for both wind farms and single wind turbines. Smaller singer turbines are typically sited closer to residential dwellings that larger turbines. For example, a 250kW single wind turbine is typically sited 300m from a neighbouring dwelling. At this distance, it will effectively use up the full ETSU-R-97 limits. If at a later stage a developer wished to install a 10MW wind farm on the hill 1km from the same dwelling, it would be refused due to cumulative impacts, as the single wind turbine has used up all of the limit.

A large wind farm produces more noise that a single wind turbine, but single wind turbines under planning policy are allowed to be sited a lot closer to dwellings. It would appear that a more strategic approach to both single and wind farm applications, as opposed to the ad hoc 'build where you like' approach currently employed in Northern Ireland.

9.5 Is ETSU-R-97 in need of revision?

Some of the members of the original Noise Working Group on wind farm noise, which drafted ETSU-R-97, and others who have often advised on opposing sides during public inquiries, gathered in order to build on experience and knowledge gained during the period since the adoption of ETSU-R-97. They also aimed to settle a number of disputes about the factors that should be taken into account when assessing wind farm noise. Their thoughts were published in an article in the Institute of Acoustics Bulletin, Vol 34 No 2, March/April 2009; which can be summarised as follows:

Wind naturally exhibits a shear effect. That is, wind speeds increase with increasing height above the ground. Thus the wind speed at a typical wind turbine hub height of more than 50m can be higher than that at 10m. This height is used here as an example because the various standards used to assess wind farm noise and wind turbine sound outputs, including ETSU-R-97, tend to relate all results to the wind speed at 10m height. Typically this is done by assuming a standardised wind shear to convert between turbine hub height wind speeds and the wind speed at 10m height. Consequently, under specific wind shear conditions the hub height wind speed may be underestimated, and as a result the wind turbine source noise levels may also be underestimated at any given 10m height wind speed. However, the actual wind shear seen on any specific site may deviate from the assumed 'standardised' shear. The actual shear will depend both on the roughness of the ground (influenced by, for example, vegetation or topography) and also the 'stability' of the atmosphere (influenced by the cooling/heating effect of the ground on the air above it).

Due to potential difference in wind speed at different heights above the ground, the background noise levels should be correlated with derived (not measured) 10 m height wind speeds. One method for doing this is described in the IoA article. Effectively, the result of adopting this procedure is to reference all noise levels (both background and turbine) to the wind speed at turbine hub-height. The effect of such a procedure is to move the derived background noise regression curve to the left i.e. for any given wind speed, the correlated turbine noise level will be higher than the equivalent value for wind speed measured at 10m height. It should be noted that the scatter of data is often greater compared to the ETSU-R-97 method of referencing background noise levels at the receptor to 10 m height wind speeds at the scheme site; because wind speed at hub height will have less influence on background noise levels at the receptor compared to wind speeds at a height of 10 m or lower. This method effectively adjusts the background noise level at the receptor downwards to reflect the influence of wind shear on the turbine noise propagation. However, the method detailed in the IOA article relies on wind shear data gathered during the background noise survey; the duration of which may be appropriate to establish prevailing background noise levels, but may not be long enough to gather representative data about wind shear. It is important to note that whilst the article only describes one method for dealing with wind shear in detail, it specifically allows for other methods to be used to account for wind shear, provided they are fully explained and justified by the user. One alternative that has been accepted by planning inspectors is to use historical data regarding wind shear from any long term i.e. 6 to 18 months, wind resource survey at the site, typically utilising a 60m mast and multiple anemometers. This data is then used to correct the noise output of the turbine to account for typical wind shear at the site.

Work more recent than ETSU-R-97 suggests that AM of 3 dB to 5 dB from multiple turbines has been detected, and postulates that AM of potentially 6 to 10 dB is possible from multiple turbines in very stable atmospheric conditions - Van Den Berg, *2005 & Pedersen and K. Persson-Waye, 2004*

It should be borne in mind that wind turbine noise has been found to be more annoying that traffic noise.

ETSU-R-97 advises using the $L_{A90,10min}$ noise index for both turbine and background noise; and that the LA90,10 min of turbine noise is typically 2 dBA less than the equivalent $L_{Aeq,t}$ value. It is interesting that ETSU-R-97 measures wind turbine noise and background noise differently from all other guidance regarding industrial noise sources.

Further consideration of some parts of ETSU-R-97 would be useful as the evidence base has expanded regarding wind turbine noise considerable since 1997 and there is some ambiguity regarding the rationale of some recommendations. It is recommended that further consideration of the following content of ETSU-R-97 would be desirable:

- It is not necessary to use a margin above background approach in such low-noise environments
- The L_{A90} used for both the background noise and the wind farm noise
- Night time limit of 43dBA
- The statement that background noise rises with increasing wind speed
- The penalties regarding the character of noise and tones.

In summary, ETSU-R-97 is in need of revision for the following reasons.
The WHO guidance for indoor noise levels at night was 35dB when ETSU-R-97 was published in 1997, it has now been revised to 30dB

Modern wind turbines are considerably larger now than in 1997, this can result in more significant lower frequency noise and an increased risk of AM due to wind shear and other high level wind fluctuations.

The evidence base has expanded significantly since 1997 with much greater understanding of the acoustics of large wind turbines and the annoyance/health effects of wind turbine noise, AM and reaction to the low frequency content. There has also been further research on the propagation of wind turbine noise.

PPG24 has now been withdrawn; the enquiry may wish to bear in mind the principles outlined in NPSE.

ETSU-R-97 is influenced by BS4142. BS4142 is currently being updated to bear in mind the advances made in current knowledge of industrial noise and annoyance (although it will most likely exclude wind turbine noise and areas with very low background noise levels).

The appliance of L_{90} rather than L_{Aeq} in ETSU-R-97 requires further consideration as L_{90} is usually a few decibels lower than L_{Aeq}. The L_{90} measurement was used in order to discount any infrequent louder noise events such as aircraft however in absence of significant short duration louder noise events L_{90} will simply result in a lower dB reading the L_{Aeq}.

As noted above, L_{90} was adopted by ETSU-R-97 to aid post completion measurements as it was assumed at the time of drafting ETSU-R97 that wind turbine noise was relatively steady and characterless i.e. the L_{90} was used as a proxy for the L_{Aeq}. Evidence and knowledge since 1997 has highlighted that certain wind farms/single wind turbines produce AM and hence the original assumption within ETSU-R-97 that wind turbine noise was relatively steady and characterless no longer holds true.

A desk top exercise can predict the likelihood of ETSU-R-97 limits being complied with, it cannot adequately predict AM.

9.6 Appropriate set-back distances

From a noise perspective, separation distances are irrelevant, noise levels are the relevant parameter. Whilst a set-back distance is easier to measure, it provides no substitute for a robust noise impact assessment. For example a single wind turbine 500m from a resident will produce significantly less noise that a 20 turbine wind farm scheme at a similar distance.

Local topography can provide barrier effects (e.g. turbine on one side of a hill and the resident on the other) but these are limited to only 2dB, whilst valleys can increase the noise impact (e.g. wind farm on one side of the valley and the resident on the other side).

Set back distances are more appropriately applied to visual impacts than noise impacts.

10 Conclusions and recommendations

It is important to also consider the type of noise (character), its frequency, the time of day, the duration of the noise and nature of the area (background noise levels).

Sounds with a predominantly low frequency content might be described as ‘rumbling’ or ‘booming’.

Generally, sounds containing distinguishable tones are more noticeable, and potentially more annoying than sound without such features. Notes or tones at low frequencies would often be described as ‘humming’,

Tonal noise is generally more noticeable and BS4142 suggests that is should be penalised in assessments of noise impact, usually by adding 5 dB to the measured level.

‘A’-weighting is applied to mimic the frequency response of the human ear, so that the contribution of sounds at frequencies (pitches) to which we have lower sensitivity are reduced and those to which we are most sensitive are emphasised. In the 63Hz centre–frequency band, for example, the ear’s response is down by around 26 dB, so the ‘A’ filter takes off 26 dB in that centre–frequency band..

$L_{Aeq,T}$ is the ‘average’ of the total sound. Sounds with identical L_{AeqT}, may differ considerably in their capacity to cause annoyance or disturbance because of the character of the sounds.

The most commonly used percentile level is the $L_{A90,T}$ is the level exceeded for 90% of the time, T. It has been adopted as a good indicator of the “background” noise level. It is specified in BS 4142:1997 as the parameter to assess background noise levels.

The L_{AeqT} and L_{90} do not take account of the frequency character of the sound.

Sound reduces with increasing distance from the source and is affected by atmospheric absorption, ground effect, reflections and screening, as well as the geometric divergence or wave–front spreading.

Higher frequencies are absorbed in air much more significantly than lower frequencies. At a distance of 1km there is little air absorption of low frequency sound and a substantial absorption of the high frequency components.

Meteorological (weather) conditions fluctuate and can influence sound propagation. Wind and air temperature have a noticeable effect over large distances.

Topography is of importance when predicting how sound will travel over distances, convex and concave ground contours must be taken into consideration.

Wind turbine mechanical noise issues may arise if there is a mechanical fault. In the absence of mechanical fault, noise emission from modern wind turbines tends to be dominated by aerodynamic noise. The dominant character of the combined aerodynamic noise as described above is therefore 'swish', which is familiar to most people who have stood near to a large wind turbine.

More recent designs of wind turbines have improved performance regarding aerodynamic noise with improved design of the blade.

Modern large wind turbines restrict the rotor speeds. This results in much quieter operation in low winds than a comparable constant speed wind turbine.

Tonal noise may occur due to blunt trailing edges, or flow over slits and holes.

A condition known as stall may occur, this can generate noise up to 10 dB higher than without stall; however, manufacturers are increasingly moving away from stall-regulated machines.

Another possible cause of noise is flow over imperfections in the blade surface.

The enquiry may wish to consider age and type of turbines being proposed for installation in Northern Ireland. Many of the noise issues mentioned above are more associated with older turbines. Anecdotally, "new" wind turbines installed in Northern Ireland are in fact often reconditioned turbines. Therefore NI may not be benefitting from more modern lower noise emitting design. Furthermore the blades may have signs of wear (such as blade surface irregularities, holes or slits) also increasing noise levels beyond those expected of new turbines.

The sound level from turbine blades is often not completely steady, but is modulated (fluctuates) in a cycle of increased and then reduced level, sometimes called —*blade swish*. It was thought that in the majority of installations the modulation depth may be up to 2-3 dBA, which was regarded as being acceptable by the ETSU-R-97 working group. In some situations, however, the modulation depth increases to the point where it can become more pronounced and potentially give rise to increased annoyance. This phenomenon is known as amplitude modulation of aerodynamic noise or more succinctly by the acronym AM. Work more recent than ETSU-R-97 suggests that AM of 3 dB to 5 dB from multiple turbines has been detected, and postulates that AM of potentially 6 to 10 dB is possible from multiple turbines in very stable atmospheric conditions.

Amplitude variations can occur downwind from single wind turbines and wind farms, and can be observed at distances up to approximately one km and perhaps more.

Aerodynamic modulation of the wind turbine noise has been found to be significant in the lower frequencies.

ETSU-R-97 recognises a potential for AM of up to 3 dBA (i.e. the noise level goes up and down by 3 dBA in each blade rotation) and ETSU-R-97 states that it takes such a degree of blade swish into account in the noise limits it recommends (recommendation 27 in the ETSU-R-97 summary). However the document does not include a specific penalty for AM, beyond a 2 dBA adjustment in setting the fixed noise limit for low wind speeds.

The Hayes MacKenzie 2006 report concludes that —*some wind farms clearly result in modulation at night which is greater than that assumed within the ETSU-R-97 guidelines*. i.e. excess AM. The report then goes on to suggest that in conditions of high aerodynamic modulation it may therefore be appropriate for a correction for the character of the noise to be applied.

As wind turbines get larger, the turbine noise moves down in frequency and that the low-frequency noise would cause annoyance for the neighbors.

At long distances higher frequencies are reduced compared to low frequencies due to differential attenuation from air and ground absorption etc. In addition higher frequencies can be less readily masked by ambient noise. It is therefore conceivable that lower frequencies may become the distinguishing feature of turbine noise under some circumstances.

Suitability of A weighting for wind turbine noise

A large number of studies confirm that the A-weighted level underestimates the effects of low frequency noises.

In 2005 DEFRA released a report from a study by Salford University Contract which developed:
• Proposed criteria for the assessment of low frequency noise disturbance;
• Procedure for the assessment of low frequency noise complaints.

The enquiry may wish to consider or refer to this procedure (Salford University Contract NANR 45 procedure) for the assessment of low frequency noise into assessments of wind turbine noise.

Low frequency noise has been recognised by the World Health Organization as meriting special attention, requiring lower environmental limits than those of other noises, as it presents particular problems to those people who are sensitive to its effects (WHO, 1999). For example:
'If the noise includes a large proportion of low frequency components, values even lower than the guideline values will be needed, because low frequency components in noise may increase the adverse effects considerably. When prominent low frequency components are present, measures based on A-weighting are inappropriate.' (WHO, 1999)

The general trends show that:

- annoyance increases with wind turbine noise level,
- sleep disturbance was associated with annoyance

- descriptors of the turbine noise characteristics including *swishing, whistling, pulsating/throbbing and resounding* were highly correlated with noise annoyance

Wind turbine noise appears to have a higher annoyance rate than industrial noise.

Disturbance of sleep has been found to be related to wind turbine noise;

In 2009 the WHO revised its night time noise guidelines. If the intruding noise is continuous then the recommended guideline limit for bedroom L_{Aeq},*8h* (*Lnight*) with the window open is 30 dB. It is particularly important if the background level is low. As wind turbine noise is not continuous then a lower limit may be suitable

On the question of whether older models and/or refurbished wind turbines should be permitted in Northern Ireland, it may be useful to refer to the IPPC guidance regarding Best Available Technology and the statutory nuisance defence of Best Practicable Means.

- Integrated Pollution Prevention and Control (IPPC) is a regulatory system that employs an integrated approach to control the environmental impacts of certain industrial activities. IPPC requires the application of Best Available Techniques (BAT). BAT includes both the technology used and the way in which the installation is designed, built and operated including: costs and benefits; the technical characteristics of the installation concerned; geographical location; local environmental conditions.
- It is a statutory nuisance defence to prove ‘Best Practicable Means’. The term can be summarised as:- (a) reasonably practicable having regard to local conditions and circumstances, the current state of technical knowledge and to the financial implications; (b) the means to be employed include the design, installation, maintenance and operation of plant and machinery

A study by the National Physical Laboratory showed that under–prediction of complaints occurred in some cases including low–frequency noise, impulsive noise and tonal new noise.

A draft revised BS4142 was published in February 2014. This draft specifies that the standard is not applicable to the measurement and rating of sound levels from the several sources including wind farms. In addition, this standard is not applicable to situations where the background and rating sound levels are both very low. *H*owever the proposed revisions should be borne in mind when considering whether ETSU-R-97 should be updated. The draft revised BS4142 includes new methods to assess tonal and impulsive characteristics. It also includes further detail on tonality and impulsive corrections. The draft proposes that when both characteristics are present the two should both be taken into account and added linearly.

ETSU - R - 97 The Assessment and Rating of Noise from Wind Farms

- advises using the $L_{A90,10min}$ noise index for both turbine and background noise; and that the $L_{A90,10min}$ of turbine noise is typically 2 dBA less than the equivalent $L_{Aeq,T}$ value.
- Noise from the wind farm should be limited to 5dBA above background for both day- and night-time, remembering that the background level of each period may be different, subject to a lower limit of 35 to 40 dBA during the day and 43 dBA at night.
- A fixed limit of 43dBA is recommended for night-time. This is based on a sleep disturbance criterion of 35dBA with an allowance of 10dBA for attenuation through an open window (free field to internal) and 2dBA subtracted to account for the use of $L_{A90,10min}$ rather than $L_{Aeq,\ 10min}$.

ETSU-R-97 was originally published in 1996 and has been used extensively since then. The Working Group suggested that the report and its recommendations be reviewed 2 years after publication. A formal review did not occur but it is understood that ETSU-R-97 is kept under consideration by the government.

The use of L_{A90} of is interesting bearing in mind that the following standards are based on L_{Aeq}

- IEC 61400-11:2012(E) Wind turbines: Acoustic noise measurement techniques presents measurement procedures that enable noise emissions of a wind turbine to be characterised.
- ISO 9613-2:1996 Acoustics -- Attenuation of sound during propagation outdoors.

- BS 7445-1:2003 Description and measurement of environmental noise. Guide to quantities and procedures measurement of environmental

In addition, BS 4142: 1997, Method for rating industrial noise affecting mixed residential and industrial areas, compares the source noise level (L_{Aeq}) to the background level ($L_{A90,T}$). This standard also makes an appropriate allowance for acoustic features of the noise (i.e. a 5 dB penalty for noise that has specific characteristics such as an irregular noise).

Some of the members of the original Noise Working Group on wind farm noise, which drafted ETSU-R-97, published in an article which can be summarised as follows:

- ETSU-R-97, tend to relate all results to the wind speed at 10m height. Consequently, under specific wind shear conditions the hub height wind speed may be underestimated, and as a result the wind turbine source noise levels may also be underestimated at any given 10m height wind speed.
- Work more recent than ETSU-R-97 suggests that AM of 3 dB to 5 dB from multiple turbines has been detected, and postulates that AM of potentially 6 to 10 dB is possible from multiple turbines in very stable atmospheric conditions

It should also be borne in mind that wind turbine noise has been found to more annoying that traffic noise.

Further consideration of some parts of ETSU-R-97 would be useful as the evidence base has expanded regarding wind turbine noise considerable since 1997 and there is some ambiguity regarding the rationale of some recommendations. It is recommended that further consideration of the following content of ETSU-R-97 would be desirable:

- It is not necessary to use a margin above background approach in such low-noise environments
- The L_{A90} used for both the background noise and the wind farm noise
- Night time limit of 43dBA bearing in mind the revised WHO guidelines
- The statement that background noise rises with increasing wind speed
- The penalties regarding the character of noise and tones.

In summary, ETSU-R-97 is in need of revision for the following reasons

The WHO guidance for indoor noise levels at night was 35dB when ETSU-R-97 was published in 1997, it has now been revised to 30dB

Modern wind turbines are considerably larger now than in 1997, this can result in more significant lower frequency noise and an increased risk of AM due to wind shear and other high level wind fluctuations.

The evidence base has expanded significantly since 1997 with much greater understanding of the acoustics of large wind turbines and the annoyance/health effects of wind turbine noise. There has also been further research on the propagation of wind turbine noise.

The enquiry may wish to bear in mind the principles outlined in NPSE.

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The appliance of L90 rather than L_{Aeq} in ETSU-R-97 requires further consideration as L90 is usually a few decibels lower than L_{Aeq}.

As noted above, L_{90} was adopted by ETSU-R-97 to aid post completion measurements as it was assumed at the time of drafting ETSU-R97 that wind turbine noise was relatively steady and characterless i.e. the L90 was used as a proxy for the L_{Aeq}. Evidence and knowledge since 1997 has highlighted that certain wind farms/single wind turbines produce AM and hence the original assumption within ETSU-R-97 that wind turbine noise was relatively steady and characterless no longer holds true.

The enquiry may wish to consider some aspects of Danish policy, including:

- In 2004 a replacement Scheme for Wind turbines on land was introduced.

- The cross-ministry committee work has placed its emphasis on a planned and coordinated development of offshore wind farms
- A loss of value scheme for dwellings. Any party erecting new wind turbines with a height of 25 metres or more, including offshore wind turbines erected without a government tender procedure, must pay for any loss of value on real property if the erection of the wind turbines results in a loss of at least 1% of the property value.
- The option to purchase scheme. Erectors of wind turbines with a total height of at least 25 metres, including offshore wind turbines erected without a governmental tender, shall offer for sale at least 20% of the wind turbine project to the local population.

Monitoring of noise by the developer

Bearing in mind the issues discussed above in relation to the noise associated with wear and tear on wind turbine mechanics and blades, on-going, long term monitoring would enable the public, developers, planners and the LA to determine the continuing noise exposure of the nearby noise sensitive receptors. In addition, this would identify where wind turbine noise has increased beyond the predicted and permitted levels. This would also enable action to be taken to reduce noise where it is deemed necessary and follows the ‘polluter pays’ principle.

Conditions of planning consent

It is common practice for local planning authorities to set planning conditions to control or reduce noise levels, or to mitigate the impact of noise. Examples are provided in the IOA Good practice guide to the application of ETSU-R-97.”

Local councils expertise and resources

There is a great deal of expertise with the LA employed Environmental Health profession in Northern Ireland. There is still a considerable burden associated with contributing to planning applications regarding wind turbines. This process is resource intensive and has the potential to result in a considerable impact on smaller councils.

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Appendix 1

Northern Ireland
Assembly

Committee for the Environment

Wind Energy Inquiry

SPECIALIST ADVISOR BRIEFING PAPER

Background

- The Committee for the Environment received correspondence from Windwatch NI, an umbrella group which opposes the siting of wind turbines in populated rural areas, and had a formal briefing in June 2013 both from representatives of this group and from the Strabane/ Omagh Councils Working Group on Wind Energy. In September 2013 the Committee invited representatives from the Northern Ireland Renewables Industry Group (NIRIG) to respond on behalf of wind energy suppliers and developers. The evidence presented at these two meetings led the Committee to agree to carry out a short focussed Review, to take place over four weeks in October and November 2013.
- In the course of this Review the Committee commissioned a number of research papers from the Assembly in-house facility (RaISe) on issues which members believed required further clarification, especially in relation to separation distances of wind turbines from dwellings. The Committee also heard formal evidence from Professor Geraint Ellis, School of Planning, Architecture and Civil Engineering**,** Queen's University, Belfast, who outlined the key issues in strategic planning for renewable energy.
- After making an initial consideration of the evidence before it at that point, the Committee agreed that the Review should be replaced by a formal Inquiry and that evidence already received in connection with the Review would also be accepted. The Committee agreed a formal Terms of Reference which were to reflect the issues directly within its remit; other relevant issues, such as the

higher cost to the consumer of renewable energy, were not included as these related more closely to the area of scrutiny of other Assembly committees.

Terms of Reference

- The agreed **Terms of Reference** were as follows:
- To assess the adequacy of PPS18 and related supplementary guidance in regulating proposals for wind turbines on a consistent and strategic basis, with due regard for emerging technologies and independent environmental impact assessment;
- To compare the perceived impact of wind turbine noise and separation distances with other jurisdictions and other forms of renewable energy development; and
- To review the extent of engagement by wind energy providers with local communities and to ascertain how this engagement may best be promoted.

Written Submissions

- A Call for Evidence for the Inquiry closed on 28 February 2014, and 98 submissions were received. These submissions have been published on the Assembly website.
- The breakdown of submissions received was as follows:

Energy companies/ developers/planning consultants	21
Local councils	8
Professional representative bodies	7
Statutory agencies/ public bodies	9
Voluntary/ charitable	4
Community groups	9
Individuals	40
Total	**98**

Further evidence

- At its meeting on 6 May 2014 the Committee agreed a plan for its inquiry. This included taking evidence from the Chartered Institute for Environmental Health, the Northern Ireland Authority for Utility Regulation, Northern Ireland Electricity and DOE Planning Division. The plan also included a stakeholder event to consider the community engagement aspect of the inquiry – all these briefing sessions were recorded by Hansard.

- In addition, the Committee agreed to carry out a fact-finding visit to wind farms; this took place on 26 June 2014 at Crighshane and Church Hill near Castlederg in West Tyrone, and Committee members also met with local residents both opposed to, and in favour of, wind turbine developments in the area.

- The final element of the inquiry plan was to secure the services of a specialist acoustician to provide further information and clarification on the issue of the types and level of noise generated by wind turbines. Noise disturbance is one of the key issues emerging from the inquiry and, in particular, the relationship between turbine noise and separation distance. It is an area which is both contentious and complex, and one where the Committee believes that appropriate specialist advice would be invaluable in informing its scrutiny.

Emerging Issues

Regulation of Wind Turbine Noise

- A number of submissions highlighted the noise generated by wind turbines. As anticipated, many residents living close to turbines feel that the level and type of noise emanating from turbines – particularly the newer, more powerful turbines – is having a detrimental impact on their day to day lives and their longer-term health.
- The ETSU-97 regulations which set out acceptable levels of day- and night-time noise are deemed to be in need of revision by many of those who made submissions, including a number of local councils, so that the noise output from more modern and more powerful turbines can be appropriately regulated. Representatives of the industry, however, believe that the existing regulations are still sufficiently robust to deal with the latest technology.
- Complaints regarding noise may be investigated by local Environmental Health Officers, but such investigations place a considerable strain on existing resources – a number of local councils have highlighted this in their submissions.

Specific issues requiring clarification:

- The following issues have arisen and are of such a technical nature that it would be beneficial for the Committee to receive specialist advice in order to properly assess their significance and meaning:
  - The **type of noise** generated by wind turbines. This has been variously described as '*low frequency* noise'; '*vibrational pulsating*' noise; '*amplitude modulation* (a loud beating or slapping noise)'; '*infrasound'*; noise '*of a different character'* produced by taller and more powerful wind turbines; noise of an '*impulsive, intrusive and incessant'* nature; '*blade swish*'; 'noise created and *magnified by the interaction of varying air velocities'*; noise 'enhanced by *excessive wind shear* and *varying upland topography*'; 'noise *resonating within the building*

structure'. What type of noise has been objectively recorded as being produced by wind turbines? Does the type of noise vary with the size or number of turbines? Does the type of noise emitted relate to the topography?

- The **units of measurement** used for noise: '$L_{A90\ 10min}$ dB'; 'L_{Aeq}'. What do these mean in layman's terms? What is the significance of the use of different measures?
- **Comparative measurements** of noise: for example, how does the volume of noise permitted by ETSU-R-97 compare with traffic noise or aircraft noise? How does the ambient environmental noise impact on the measurement?
- The **practical measurement** of wind turbine noise seems problematic. How should this be carried out? Is there a sufficient level of expertise available to local councils? Are council environmental health officers adequately experienced/ resourced for this type of monitoring? Should there be on-going/ long-term monitoring of noise by the developer to build up a complete record of the noise levels? Is it practical to suggest that this is introduced as an enforceable condition of planning consent?
- The **cumulative impact** of wind developments. The Committee has heard some evidence that a single turbine can produce almost as much noise as a cluster of turbines, thereby 'using up' the available noise limit: how is the cumulative noise produced measured? How does this differ from the noise produced by a single turbine?
- The current guidelines (**ETSU-R-97**) have been deemed outdated by many stakeholders and described as '*vague, open to interpretation and unenforceable*' immeasurable, and inadequate to deal with modern and emerging technology. Developers have defended the guidelines as being robust and appropriate; the Minister has also endorsed the use of this guidance in his submission to the Committee. In layman's terms, what do these guidelines say? Is ETSU-R-97 in need of revision? Can the higher noise limits for night-time be justified? Can the acoustic impact on neighbouring properties be adequately gauged as a desk exercise, in advance of the installation and operation of a wind turbine?
- The measurement of **appropriate set-back distances** to minimise noise disturbance has given rise to a great deal of concern. Should a minimum linear separation distance be specified (current guidance recommends 500m)? How does the local topography impact on the set-back distance? Should a more appropriate measurement be specified in terms of 10 or 12 times the rotor blade diameter?

Duties of the Specialist Advisor

- The Committee would require the advisor to review all evidence already provided to members in the course of the inquiry – all of this information has been published and is available on the Assembly website – and, taking into account the Terms of Reference, to use his or her specialist knowledge to assist the Committee in its understanding of the issues before it. The Committee Clerk will provide further clarification as required.
- The advisor will produce a written report for the Committee based on the issues outlined above. This should be completed and made available to the Committee by **1 September 2014**, for oral presentation at its meeting on **11 September 2014.** The Committee may also require the advisor to provide further information in response to any issues arising from the oral presentation.
- It is envisaged that this will require up to **five days**, i.e. 5 x 8 hours, 40 hours' work as follows:
    - 3 to 4 days to provide a written brief; and
    - 1 day to attend the Committee meeting and to provide follow-up information.

The specialist advisor will, as far as possible, avoid the use of technical terms and will draft the report in a clear and structured way to maximise the Committee's understanding of the issues outlined

Appendix 2 — Glossary of acoustic terminology

1/3 octave band analysis:
Frequency analysis of sound such that the frequency spectrum is subdivided into bands of one–third of an octave each. An octave is taken to be a frequency interval, the upper limit of which is twice the lower limit (in Hertz).

Ambient noise *
The totally encompassing sound in a given situation at a given time, usually composed of sound from many sources near and far. Unlike the *residual noise*, the ambient noise includes the contribution from the specific noise.

Background Noise Level, LA90,T *
The 'A'-weighted sound pressure level of the residual noise in decibels exceeded for 90 per cent of a given time and is the LA90,T.

dB (decibel)

The scale in which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and the reference pressure (0.00002 N/m2).

0 dB is the threshold of hearing, 140 dB is the threshold of pain. A change of 1 dB is detectable only under laboratory conditions. A change of 10 dB corresponds approximately to halving or doubling the loudness of sound.

dBA

A measure of the overall noise level of sound across the audible frequency range (20Hz - 20,000Hz) with a frequency weighting (i.e. 'A' –weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies. The background noise level in a living room may be about 40 dBA, normal conversation about 60 dBA, heavy road traffic at 60mph about 80 dBA, the level near a pneumatic drill about 100 dBA.

dB(C)

A measure of the overall level of sound across the audible frequency range with the 'C' frequency which is virtually linear between 50Hz and around 5kHz.

Façade Level

Noise levels at locations 1m from the façade of a building are described by the term *Façade Levels* and are subject to higher noise levels than those in open areas (free-field conditions) due to reflection effects.

Hz (Hertz)

The unit of sound frequency in cycles per second

Impulsive noise

A noise that is of short duration (typically less than one second), the sound pressure level of which is significantly higher than the background.

L_{Aeq}, *T* *

The equivalent steady sound level in dB containing the same acoustic energy as the actual fluctuating sound level over the given period, T. T may be as short as 1 second when used to describe a single event, or as long as 24 hours when used to describe the noise climate at a specified location. L_{Aeq} T can be measured directly with an integrating sound level meter.

Noise

Unwanted sound. Any sound, that has the potential to cause disturbance, discomfort or psychological stress to a subject exposed to it, or any sound, that could to cause actual physiological harm to a subject exposed to it, or physical damage to any structure exposed to it, is known as noise.

NR

Noise Rating curves, similar to Noise Criteria (NC) curves, form a set of noise criteria given in octave bands.

GLOSSARY OF TERMS

Noise–sensitive location

Any dwelling, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other facility or area of high amenity, which for its proper enjoyment requires the absence of noise at nuisance levels.

Rating level LAr T *

The equivalent continuous 'A' –weighted sound pressure level of an industrial noise during a specified time interval, plus specified adjustments for tonal character and impulsiveness of the sound.

Residual noise *

The noise level in the area in the absence of the noise source under investigation.

Sound power level and sound pressure level

Any source of noise has a characteristic s*ound power*, a basic measure of its acoustic output, but the s*ound pressure levels* it gives rise to depend on many external factors. These include the distance and orientation of the receiver, the temperature and velocity gradients in the medium, and the environment.
Sound power, on the other hand, is a fundamental physical property of the source alone, and is therefore an important absolute parameter, which is widely used for rating and comparing sound sources.

Specific noise level *

The equivalent continuous 'A' –weighted noise level produced by the source under investigation (that is, the specific noise source *) over a period (T) as measured at the assessment point (usually a noise–sensitive receptor) $L_{A\ eq,T.}$

Peak particle velocity

The rate of change of displacement of the particles in a solid medium. It is the term usually used to describe vibration in relation to activities involving blasting. Velocity will vary from zero to a maximum value — the peak particle velocity, and the units used are millimetres per second (mm/sec).

Pure tone

A sound in which the sound pressure varies regularly, at a single frequency, over time.

Vibration Regularly repeated movement about a fixed point.

VDV

Vibration Dose Value — vibration measurement parameter that combines the magnitude of vibration and the time for which it occurs. The measurement is based on a form of acceleration that is frequency weighted to reflect human sensitivity to various frequencies (see BS6472).

*Note: More information on the definitions above marked with an asterisk can be found in BS4142: 1997.

Appendix 3

BS 4142:1997

Ambient noise
Totally encompassing sound in a given situation at a given time usually composed of sound from many sources near and far.

Background noise level $L_{Aeq,T}$. The 'A'-weighted sound pressure of the residual noise at the assessment position that is exceeded for 90 per cent of a given time interval, T, measured using the time weighting, F, and quoted to the nearest whole number of decibels.

Measurement time interval, Tm
The total time over which measurements are taken.

Rating level LAr,Tr
The specific noise level plus any adjustment for characteristic features of the noise.

Reference time interval Tr
The specified interval over which an equivalent continuous 'A'-weighted sound pressure level is
determined.

Residual noise
The ambient noise remaining at a given position in a given situation when the specific noise source is suppressed to a degree such that it does not contribute to the ambient noise.

Residual noise level, $L_{Aeq,T}$
The equivalent continuous 'A' –weighted sound pressure level of the residual noise.

Specific noise level, L_{Aeq},*Tr*

The equivalent continuous 'A'-weighted sound pressure level at the assessment position produced by the specific noise source over a given reference time interval.

Specific noise source
The noise source under investigation for assessing the likelihood of complaints.

Relationship between different BS 4142 parameters
The BS4142: 1997 assessment methodology involves the following procedure:

- measure the background (LA90,T) sound level, in the absence of the new noise source, at the noise sensitive receptors
- measure the noise levels attributable to the source of interest to the sensitive receptor as an L_{Aeq},T (using the procedures set out in the standard)
- correct the noise levels for duration and character, to produce the rating level (LAar,T). (The correction for tonal, impulsive or any distinctive character in the noise source is +5dB)
- assess the likelihood of complaints by subtracting the measured background noise level from the rating level.

The interpretation of the difference between the *rating level* and the *background noise level* is shown in but can only be done after carrying out the steps detailed in Section 10 of the standard. The greater the positive difference, the greater the likelihood of complaints.

Difference in noise level (dB) Significance

- Around +10 Complaints are likely
- Around +5 Marginal
- 10 Positive indication that complaints are unlikely

Appendix 4

Comparisons with traffic noise

Information from Roads: traffic noise - Parliament

Wind turbine noise management (ETSU) is broadly related to the management of industrial noise, Road traffic, however, is managed in the UK using a different framework than industrial noise i.e. surface noise reduction, sound insulation of dwellings and mapping followed by action plans.

Roads, railways and airports are the main sources of ambient noise, which can affect the quality of people's lives. Around half the UK's population may be exposed to levels above the World Health Organization (WHO) guideline of 50-55 decibels which aims to protect the majority of people from serious annoyance during the daytime. However, the UK does not have national limits on ambient noise, although there are limits on individual aircraft and road vehicles. Local authorities can also impose local limits.1 RCEP, *The urban environment* (twenty-sixth report), Cm 7009, March 2007, para 2.34

Noise mapping and action plans

The EU Environmental Noise Directive (2002/49/EC) requires noise levels to be assessed from road traffic, railways, major airports and industry. The Directive was implemented in the UK by the *Environmental Noise (England) Regulations 2006* (SI 2006/2238). Regulation 7 requires the Secretary of State to make strategic noise maps for agglomerations, major roads, major railways and major airports.
In March 2010 Defra published noise action plans; there was a specific plan for road traffic noise outside agglomerations (i.e. specific urban areas). This explains how Defra has identified 'important areas' and 'first priority locations', where it will work with the relevant highways authorities to investigate how best to deal with noise impacts at those locations. Noise mitigation measures
The March 2010 Noise Action Plan for road traffic noise outside agglomerations sets out the measures available to highway authorities to alleviate road traffic noise impacts:

Control of Noise at Source

Noise from individual vehicles is controlled under mandatory EU noise emission standards which apply to all new road vehicles. These have been implemented in regulations made under the Road Traffic Acts. These requirements must be met by all models, or in the case of heavier vehicles, by engine types, before vehicles are permitted to enter into service. In addition, once in service, silencers and exhaust systems are required to be maintained in good condition and not altered so as to increase noise. Noise made by the contact of tyres with road surfaces when in motion is also controlled through an EU directive which since 2005 has mandated noise limits that all tyres fitted to newly manufactured vehicles have to meet. This directive has also been implemented in regulations made under the Road Traffic Acts. By 2011 through a phased introduction, all replacement tyres will have to meet the same noise limits as tyres fitted to newly manufactured vehicles. Further reductions in tyre noise limits will take effect from 2016 under new legislation.

Planning controls

When proposing the construction of a new road, or an additional carriageway to an existing road, a noise impact assessment must be carried out. For large scale projects, an Environmental Impact Assessment is required by law, which would include a noise impact assessment. In addition, the Highways Agency requires a noise impact assessment to be undertaken if there is an expected increase of 1 dB LA10,18h as a result of any works it carries out on its network, including maintenance. The process which tends to be followed is set out in the Design Manual for Roads and Bridges. Mitigation such as optimising the route alignment and the use of noise barriers, either through landscaping or purpose built walls or fences, is included in the design to minimise any adverse noise impact. This process also has regard to the protection of tranquil areas in general through consideration of the impact on landscape. Once the basic data regarding the potential impact of the proposals has been obtained (including predicting the noise from the new network), an estimate of the likely numbers of people to be affected is made. In addition, through the Transport Appraisal Guidance, the noise impact is monetised as a means of evaluating the overall merits of the proposal.

Through the operation of the land use planning system, a noise assessment would normally be carried out for any proposed residential development that may be affected by road traffic noise. Planning Policy Guidance 24 provides guidance regarding the suitability or otherwise of the site for such development. Guidance is also given about the type of mitigation that might be needed in order to achieve appropriate internal noise levels within homes. The approaches used to achieve these levels include designing appropriate façade insulation or optimising the proposed layout of the buildings.

Compensation and insulation

For new or improved highways, the Land Compensation Act 1973 allowed regulations to be promulgated to provide compensation for dwellings affected by increased noise. These regulations are the Noise Insulation Regulations 1975, as amended 1988. If certain criteria are met, the highway authority must offer secondary glazing and alternative ventilation for habitable rooms of dwellings so affected.

In addition, Part 1 of the Land Compensation Act provides for monetary compensation to those home owners affected by the new or improved highway recognising any loss in value of the home that has occurred by the opening of the new or improved highway. This assessment is purely subjective, carried out by surveyors, and claims have to be made within a certain time period.

Maintenance

It is the Highways Agency's current policy that when a length of highway requires a replacement road surface (due to wear and tear) the opportunity is often taken to lay a low noise road surface, one that assists in reducing the noise generated by the tyre/road interface. Other highway authorities adopt a similar policy to varying extents.

Specific Initiatives

From time to time a highway authority will undertake a specific noise abatement initiative. Arguably the most notable example is the work being carried out by the Highways Agency, where it is addressing sites on the motorway and trunk road network that have been identified as having the most pressing noise problems. Around 60 sites across that network have benefited from additional noise mitigation either through the application of low noise road surfaces or by the use of noise barriers since around 1999/2000. Additional sites are already under consideration for noise abatement works during the next few years.

Limit values

There are no relevant formal noise limit values in force in England with regard to environmental noise levels from major roads. However, the Noise Insulation Regulations 1975 (as amended in 1988) define a threshold level as part of the eligibility criteria. Furthermore, there are guideline levels to be found in Planning Policy

Under the respective legislation, occupiers of property within 300m of a new road are entitled to be offered appropriate insulation if the noise from traffic on it reaches a specified level at the property. The entitlement to insulation is governed by the Noise Insulation Regulations which refer to the method of noise prediction to be used

The occupier of a property may also claim monetary compensation for any loss in value of the property caused by the presence of the road. Compensation may be payable even where the noise at a property does not reach the qualifying level and whether or not it is situated within 300m of the road. Careful consideration of road alignment options and mitigation measures can avoid noise and visual intrusion on properties, with consequential savings in compensation costs.
Highway authorities are empowered to carry out "works for mitigating any adverse effect which the construction, existence or use of a highway has or will have on its surroundings". They are also given the power to acquire land additional to that needed for construction of the road itself to permit landscaping or the creation of earth mounds. The interpretation of "works" in this context is fairly broad and includes amenity treatment such as grassing and planting of trees and shrubs on landscape areas. In this context both noise and visual intrusion are adverse effects which can properly be mitigated by the use of earth mounds, barriers and planting.

Properties affected by new roads may in extreme cases be acquired at the discretion of the highway authority where mitigation cannot prevent living conditions becoming intolerable either during construction or after the road is opened. In certain circumstances affected properties (within 100m of the centre line) may be acquired in advance of construction.18

Compensation

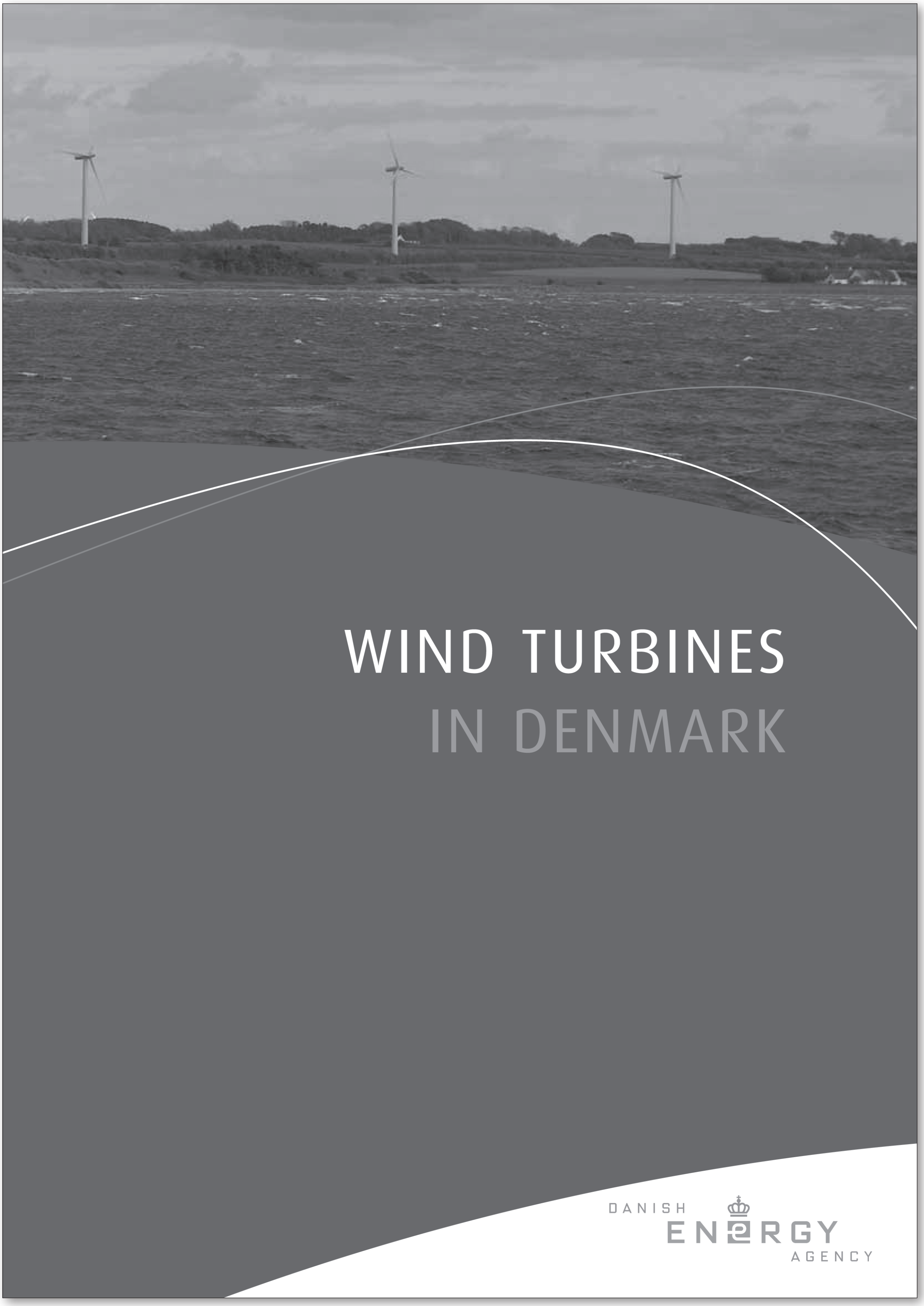
The *Land Compensation Act 1973*, as amended, specifically excludes the claiming of compensation where there has been intensification of use of an existing road although it can provide for compensation to be paid where the value of a property is adversely affected by physical factors, such as noise, vibration, smell, fumes, smoke and artificial lighting. There is no statutory requirement for compensation to be paid to those who live next to public works, such as roads and railways, purely because traffic has increased. The view is taken that those who purchase property near existing roads or railways do so in the knowledge that traffic can change in composition or volume, and that it would not be right to require the relevant authorities to pay compensation solely because traffic patterns have altered in this way.

When a new road is built a calculation is made of future noise levels. The highway authority then offers those eligible help with insulation. It may also install sound barriers to help avoid reaching the projected levels and these may be used in conjunction with earth mounding to hide traffic as it is recognised that continuous passing traffic can be stressful. The rules state that a dwelling within 300 metres of road works would be eligible for help if it is calculated that within 15 years from the opening of the new or altered road:

- the traffic noise level at one or more facades will increase by at least 1dB(A) and will be not less than the specified level of 68 dB(A) L10 (18 hour);21 and
- noise caused or expected to be caused by traffic using the new or altered section of road will contribute at least 1dB(A) to the noise level.

The Highways Agency's general view is that if a property was eligible for compensation under the 1973 Act then noise levels would have been taken into account and any further noise mitigation once compensation has been settled would be double counting. For this reason it will not install acoustic fencing on motorways that have already been completed. However, in exceptional circumstances help may be given to those suffering from noise under section 282 of the 1980 Act, usually by the construction of noise barriers on the highway as opposed to insulating an individual's property.

Report: ‘Wind Turbines in Denmark’



CONTENTS

FOREWORD


Photo: Wind Turbine Secretariat

This booklet, *Wind Turbines in Denmark*, aims to provide a general introduction to wind turbines in Denmark. It is directed at municipalities, wind turbine players and other interested parties, who will gain insight into relevant topics relating to wind turbines. The descriptions of the individual topics are intended to answer and elaborate on questions that are frequently asked about wind turbines.

In 2007 the Danish Government's Planning Committee for Onshore Wind Turbines published a report containing, among other things, a recommendation that there should be an increase in government information and advice on wind power for the municipalities and the public in general. This booklet is a response to that recommendation.

Further information on wind turbines can be found on the websites of the Danish Energy Agency (**www.ens.dk**), the Agency for Spatial and Environmental Planning (**www.blst.dk**), the Danish Environmental Protection Agency (**www.mst.dk**), and CAA-Denmark (**www.slv.dk**). References to other relevant websites can be found elsewhere in the booklet.

Section 1 ("Wind power – one of the solutions to the challenges of energy policy") gives an introduction to the evolution of renewable energy, the goals of energy policy, and the challenges presented by wind power. Section 2 ("The history of Danish wind power") provides facts about wind turbines and their development up to the present day. Section 3 ("Wind turbines and their surroundings") describes the environmental features of wind turbines, highlighting shadow and noise as local challenges of wind turbines.

Section 4 ("Onshore wind turbines") covers the general regulations for erecting onshore turbines and the special regulations that apply for household wind turbines and small wind turbines. Section 5 ("Offshore wind turbines") describes offshore wind turbines and the administrative 'one-stop shop' set-up.

Section 6 ("New schemes in the Danish Promotion of Renewable Energy Act") discusses the four schemes that were agreed politically in the *Energy Policy Agreement of 21 February 2008* and incorporated into the *Danish Promotion of Renewable Energy Act*: namely, the loss-of-value scheme, the option-to-purchase scheme, the green scheme, and the guarantee scheme. Section 7 ("Tariffs for electricity produced by wind turbines") presents the price supplements that are paid for wind turbine electricity. Finally, Section 8 ("Incorporation of wind power into the electricity system") examines wind power production in the context of the overall European electricity system.

Sections 3, 4 and 6 are aimed in particular at the municipalities and the planning that they undertake with regard to the erection of onshore wind turbines.

This booklet has also been published in Danish.

1. WIND POWER – ONE OF THE SOLUTIONS TO THE CHALLENGES OF ENERGY POLICY

Factbox

WIND TURBINES IN THE *ENERGY POLICY AGREEMENT*

As part of the efforts to secure the target of a 20% wind power share in 2011, the *Energy Policy Agreement of 21 February 2008* introduces a number of improvements in the conditions for erecting wind turbines:

- The supplement to the market price for new onshore wind turbines is increased to DKK 0.25 per kWh for 22,000 full-load hours. DKK 0.023 per kWh as compensation for balancing costs, etc., is retained
- The scrapping scheme is amended to give an additional price supplement of DKK 0.08 per kWh for 12,000 full-load hours. The deadlines for connecting new wind turbines to the grid under the scrapping scheme are extended
- The municipalities are required to plan for 75 MW wind turbines in each of the years 2010 and 2011
- A number of schemes are introduced to promote local acceptance of new onshore wind turbines: 1) a loss-of-value scheme gives neighbours the right to claim compensation for loss of value on their property if the loss is assessed to be at least 1% of the property's value; 2) an option-to-purchase scheme gives the local population the right to purchase at least 20% of new projects involving wind turbines with a total height of more than 25 metres; 3) a guarantee fund of DKK 10 million helps local wind turbine owners' associations to finance preliminary investigations, etc.; 4) a green scheme offers subsidies for municipal projects that enhance scenic values in local areas where new wind turbines are erected
- A total of 400 MW offshore wind turbine capacity is being tendered out and is expected to be put into operation in 2012 (the Anholt project)
- The *Offshore Wind Turbine Action Plan of September 2008* is being updated, and earlier site development is being considered. Clearer guidelines are being set out for the establishment of new offshore wind turbine projects via an "open-door" procedure

1.A. THE CHALLENGES OF ENERGY AND CLIMATE POLICY

Since the first oil crisis in 1973 Denmark has transformed its energy supply and developed its own production of oil, natural gas and renewable energy. At the same time, energy has been greatly optimised so that, in spite of considerable economic growth during this period, there has only been a marginal increase in energy consumption. Denmark is therefore better prepared for international energy crises than most other countries, regardless of whether the challenges relate to supply or price. Furthermore, Danish emissions of the greenhouse gases covered by the Kyoto Protocol were reduced by around 8% in the period 1990-2008.

In spite of these results, Danish society is still facing major challenges in its energy and climate policies. Denmark is expected, with its existing fields and finds, to be a net exporter of oil and natural gas for about 10 more years, although technological advances and any new finds may bring further production and extend this period. But there is a need to build up alternative sustainable energy production while there is still time. In *A visionary Danish energy policy 2025* the Danish Government presented a vision for the long-term phasing-out of fossil fuels such as coal, oil and gas, and appointed the Climate Commission to set out specific directions for how this can be done. A phasing-out of fossil fuels will strengthen long-term supply reliability and contribute to a reduction in CO_2 emissions.

1.B. ENERGY POLICY OBJECTIVES

A visionary Danish energy policy 2025 was published in January 2007. It was followed by the *Energy Policy Agreement of 21 February 2008* between the Danish Government and all of the parliamentary parties with the exception of the Red-Green Alliance. This Agreement sets out ambitious goals for the development of renewable energy and for energy savings. A specific goal is that, compared to 2006, gross energy consumption should be reduced by 2% by 2011 and by 4% by 2020. Furthermore, renewable energy should cover at least 20% of Denmark's gross energy consumption in 2011.

In order to achieve these goals, the *Energy Policy Agreement of 21 February 2008* contains a number of resolutions on, among other things, improving the feed-in tariff for electricity from new wind turbines, biomass incineration, biomass gasification, and biogas. Funding was allocated to promote the introduction to the market of newly developed renewable energy technologies such as solar cells, thermal gasification of biomass, and wave power, and government support for the research, development and demonstration of energy technologies will be increased to DKK 1 billion in 2010.

The Agreement also contains a range of initiatives aimed at promoting local acceptance of and commitment to new onshore wind turbine projects. Neighbours will be entitled to seek compensation for loss of property value due to the erection of wind turbines. A local option to purchase has been introduced for new wind turbine projects. Local wind turbine owners' associations can apply for a guarantee covering their financing of essential preliminary investigations. And municipalities where new wind turbine projects are established will have access to subsidies from a green scheme for new wind turbine projects.

The *agreement of 21 February 2008* also includes initiatives to further promote the development of wind power. A follow-up to the 2004 scrapping scheme for old wind turbines was agreed. And it was also decided that the Danish Minister for the Environment should conclude an agreement on behalf of the Danish Government with Local Government Denmark with a view to facilitating local wind turbine planning. In April 2008 the Minister duly signed just such an agreement with Local Government Denmark setting out the goals for local planning of onshore wind turbines. In connection with this, the Danish Ministry of the Environment's Wind Turbine Secretariat was established to assist the municipalities with their planning.

Finally, the supporting parliamentary parties agreed that 400 MW of new offshore wind turbine capacity should be established and operational by the end of 2012.

1.C. EU ENERGY AND CLIMATE POLICY

The aims of the EU as a whole are for emissions of greenhouse gases to be reduced by 20% compared to the 1990 level, for renewable energy to constitute at least 20% of energy consumption (and at least 10% in the transport sector), and for energy efficiency to be improved by at least 20%, all by 2020: the so-called "20-20-20 in 2020".

The obligations to develop renewable energy are spread throughout the 27 Member States according to a range of criteria. Denmark must improve its development of renewable energy so that it can cover 30% of energy consumption in 2020. It is a matter for the Member States themselves to choose the renewable energy technologies that best suit their local energy resources and energy systems. In Denmark, biomass (including waste) and wind power are expected to be the chief renewable energy sources leading up to 2020.

1.D. WIND POWER – A CHALLENGING SOLUTION

The Danish climate makes wind power one of the most obvious renewable energy sources because the wind conditions are more favourable for electricity production than in most other European countries. Added to this, since the end of the 1970s Denmark has been building up a strong technological and research competence within wind power, and wind turbines have undergone such considerable technological advances that wind has become one of the most competitive renewable energy sources. In 2008 the combined global market share of the two largest Danish wind turbine manufacturers was just over 27%.

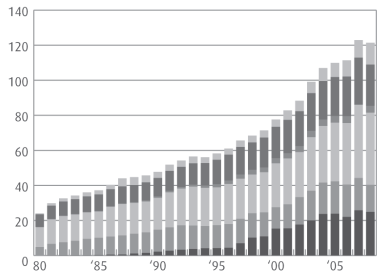
However, although wind turbines can thus be regarded as an important part of the solution to Denmark's obligations, wind power is also a technology that presents certain social challenges. Even though wind turbines have undergone considerable technological advances, it is still more costly to produce electricity with wind turbines than with conventional thermal power plants, especially all the while that the external environmental costs of conventional electricity production are not fully incorporated into the market price. In accordance with the applicable regulations, the additional costs of producing electricity with wind turbines are paid for by the electricity consumers as a public service obligation (PSO) that is collected through their electricity bills.

In comparison with fuel-fired power plants, electricity production from wind turbines is also more unstable because wind turbines do not produce electricity at low wind speeds (less than 4 metres per second) or high wind speeds (more than 25 metres per second). Under average wind conditions, an onshore wind turbine can produce electricity for 6,000-7,000 hours a year, corresponding to 70-80% of the total hours in the year. But the production fluctuates with the wind speed. This presents special challenges for the electricity system in incorporating the varying electricity production, and it is necessary for the system to operate with a reserve capacity in the form of power plants or cross-border connections in order to be able to cover the Danish electricity requirement in periods when the wind turbines are idle. Furthermore, work is being carried out to improve the incorporation of wind power, among other forms, by making the individual turbines easier to regulate. And the possibilities of using intelligent electricity meters, electric cars and heat pumps are being investigated.

Wind turbines erected onshore are often highly visible in the landscape. This is particularly true of the latest MW wind turbines, which have rotating blades that reach more than 125 metres high. Although new wind turbines have been designed to minimise noise nuisance, the turbines can still be both seen and heard in the immediate surroundings, which means that restrictions on distance to neighbours are imposed and the municipalities are obliged to consider the landscape in the planning that underpins the siting of new wind turbines. As a result of the ambitious objective for renewable energy, the Danish Government is seeking to promote the erection of new, more efficient wind turbines both offshore and onshore.

Photo: Wind Turbine Secretariat

FIGURE 1.1. PRODUCTION OF RENEWABLE ENERGY



Source: Danish Energy Agency

The production of renewable energy in 2008 was calculated at 121.5 PJ, which was 1.4 PJ less than the year before. In 2008, the production of wind power fell by 0.9 PJ to 24.9 PJ due to poor wind conditions. Under the Energy Policy Agreement of 2008, renewable energy should cover at least 20% of gross energy consumption in 2011.

2. THE HISTORY OF DANISH WIND POWER

FIGURE 2.1
TECHNICAL SPECIFICATIONS OF A V90 NACELLE

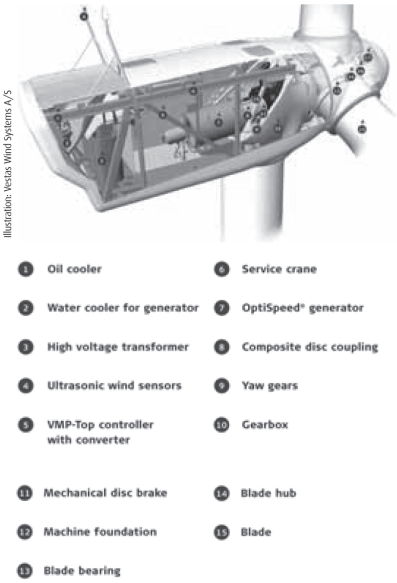


Illustration: Vestas Wind Systems A/S

2.A. HOW A WIND TURBINE IS CONSTRUCTED

A wind turbine is a machine that converts the kinetic energy of wind into electricity. The idea of taking energy from wind has been known and exploited for centuries in many countries. In Denmark, wind power has historically been used to produce mechanical energy for, among other things, grinding corn.

The size of a wind turbine can be stated in several ways. It can be the wind turbine's maximum electrical output, its height from the ground to the top of the blade tip, the blade's diameter, or the area that the rotor's three blades cover in one revolution. By way of example, we might have a wind turbine of 1 MW (1,000 kW), a total height of 77 metres, a swept area (rotor diameter) of 54 metres, and a rotor area of 2,300 square metres.

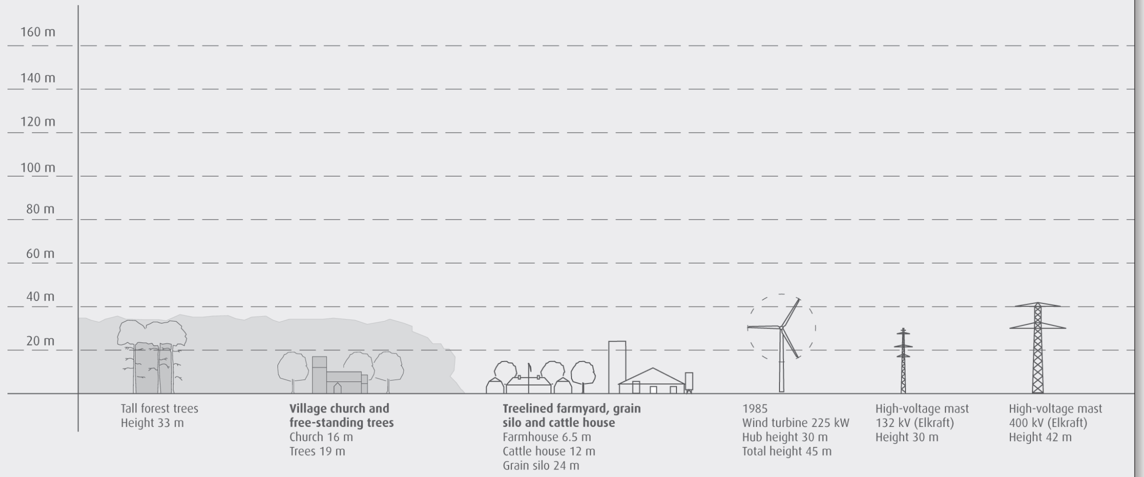
A modern wind turbine consists of a rotor (the Danish design has three blades) that drives a generator that produces electricity. The rotor and generator are installed at the top of a tower, which stands on a foundation in the ground or in the seabed. The turbine cap (nacelle) and the blades are controlled based on measurements of the wind direction and speed. In order to ensure the best possible incorporation of the wind turbine's production into the electricity system, new wind turbines are fitted with advanced control electronics, and a modern wind turbine consists of up to 10,000 different components.

2.B. WIND TURBINE ELECTRICITY PRODUCTION

In simple terms, a wind turbine not only utilises the wind's pressure on an obliquely positioned blade, but also utilises the fact that the air current around the blade creates a negative pressure on the rear of the blade in relation to the wind. The force from this negative pressure produces a draught that causes the blades to rotate.

The electricity production of a wind turbine depends on wind conditions. Obviously the wind does not blow constantly, and wind speed varies greatly from place to place and over time. On average, the wind blows more at sea than on land. In Denmark, it blows most along the western and southern facing coasts and least inland. A turbine on the west coast of Jutland generally therefore produces twice as

WIND TURBINE SIZES



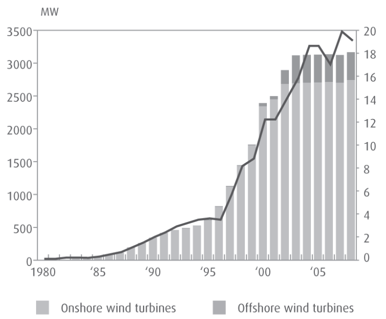
much as a turbine of the same size located on an unwindy point inland. Future wind turbines will generally be of megawatt scale. And as future turbines will be far more efficient, significantly fewer turbines will be needed for electricity production.

The electrical output of a wind turbine is measured in kW or MW (1,000 kW), while the production volume is measured in kWh or MWh. The maximum output that a wind turbine can produce is referred to as the rated output or, in popular terms, the turbine size. A wind turbine of 2 MW can thus produce a maximum output of 2 MW, typically at wind speeds of 15-25 metres per second. At maximum production, the turbine produces 2 MWh (2,000 kWh) in one hour, equivalent to half of an average Danish family's annual electricity consumption. Or, to put it another way, a 2 MW wind turbine can produce electricity for around 1,000 electric kettles with an output of 2 kW switched on at the same time.

The majority of wind turbines are designed so that they start producing electricity at a wind speed of 4 metres per second and reach their maximum production volume at wind speeds of 12-15 metres per second. For safety reasons, the wind turbines stop running if the wind speed exceeds 25 metres per second. The wind meter on the individual turbine informs the turbine's control system when the wind speed is sufficient to make electricity production worthwhile (4 metres per second) or when the wind becomes too strong. In the latter case, when the wind drops so that it is safe to start producing again, the control system is informed so that the turbine can be restarted. For safety reasons, a wind turbine is fitted with two independent braking systems, at least one of which must be aerodynamic.

A new large onshore wind turbine sited where there are good wind conditions will typically produce at maximum output for around 2,500 hours a year. In an average wind year, this type of wind turbine will be able to produce around 5,000 MWh, equivalent to the annual electricity consumption of 1,250 single-family homes with an electricity consumption of 4,000 kWh. An offshore wind turbine will typically be able to produce 3,000-4,000 hours a year at maximum output; most for locations in the North Sea, less in the Baltic region and internal Danish waters.

FIGURE 2.2
WIND CAPACITY AND SHARE OF ELECTRICITY SUPPLY



Source: Danish Energy Agency

The use of wind power increased greatly in the second half of the 1990s, reaching around 15% of the overall electricity supply in 2000. Since then, the share of wind power has further increased to around 19%. The total wind power output, which exceeds 3,000 MW, is produced by just over 5,000 wind turbines.

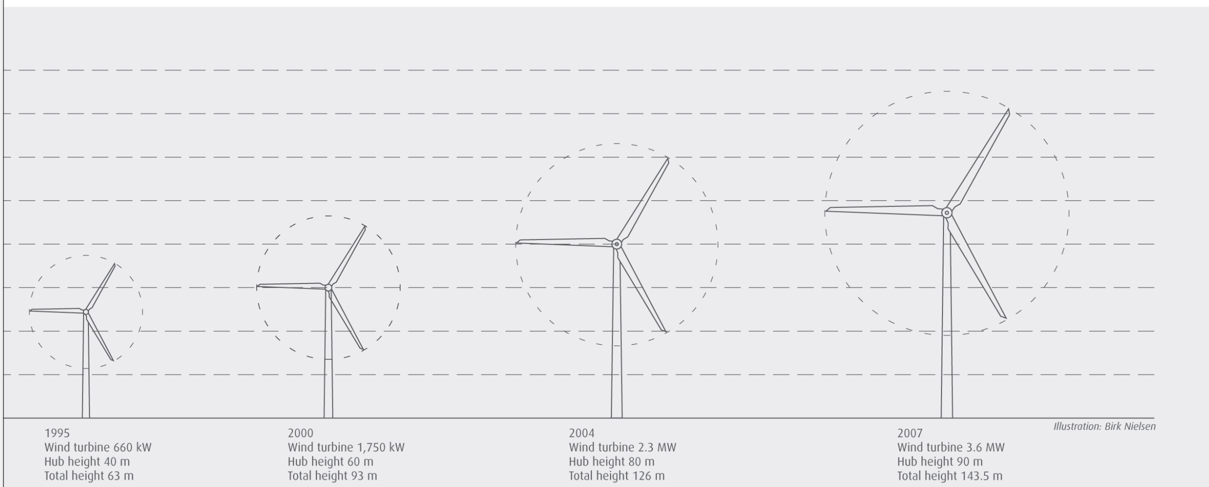
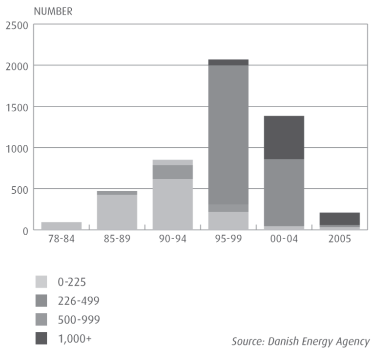


FIGURE 2.3 BREAKDOWN OF EXISTING TURBINES BY OUTPUT AND INSTALLATION YEAR					
Period	0-225 kW	226-499 kW	500-999 kW	1,000+ kW	Total
78-84	91	1	0	0	92
85-89	425	43	6	0	474
90-94	616	169	65	0	850
95-99	218	91	1687	73	2069
00-04	44	2	812	526	1384
05-09	33	0	26	150	209
Total	**1427**	**306**	**2596**	**749**	**5078**

Source: Danish Energy Agency

FIGURE 2.3 BREAKDOWN OF EXISTING TURBINES BY OUTPUT AND INSTALLATION YEAR



Source: Danish Energy Agency

Danish wind turbines have undergone considerable upscaling. Up to the mid-1990s, the majority of wind turbines that were erected had an output of 225 kW or less, and a large proportion of these have since been replaced by fewer, larger wind turbines under the "scrapping schemes". Most of the wind turbines erected in the last decade have had an output above 500 kW. The largest new Danish wind turbines have an output of 3.0-3.6 MW.

2.C. THE DEVELOPMENT OF DANISH WIND TURBINES

The first batch-produced Danish wind turbines from the late-1970s had an output of 22 kW, and the wind turbines were gradually scaled up to 55, 75 and 95 kW through the course of the 1980s. Alongside this commercial production, a government-funded development programme was undertaken by the electricity companies to test considerably larger pilot wind turbines. Since the 1980s, the wind turbine industry's commercial products have become increasingly larger-scale, and the largest commercial wind turbines produced by Danish manufacturers today are 3 MW (Vestas) and 3.6 MW (Siemens Wind Power) respectively.

The 3.6 MW wind turbine has a rotor diameter of 107 metres, a swept area of 9,000 square metres, and a hub height of 80-100 metres depending on the conditions at the erection site. The 3.6 MW wind turbine can thus reach a total height of more than 150 metres and a weight of around 465 tons.

The number of wind turbines in Denmark peaked in 2000 at more than 6,200, of which more than half were older wind turbines with an electrical output of less than 500 kW. Since then, the number of wind turbines has decreased by around 1,000, while the total installed output has grown from just under 2,400 MW in 2000 to just under 3,400 MW end of 2009. In the same year, smaller wind turbines with an output of less than 500 kW accounted for around 11% of the total installed output.

The wind power share of the domestic electricity supply has been growing steadily since 1980. In 1990, the share was 1.9%, and since then it has increased sharply. In 1999 the figure topped 10%, and in 2008 it reached 19.1% of the electricity supply. In *A visionary Danish energy policy 2025* from 2007 the Danish Government formulated an objective of more wind power through strategic planning of wind turbine development. This includes a good framework for Danish wind capacity and the promotion of onshore and offshore demonstration and pilot sites as well as the drafting of an infrastructure plan for offshore wind turbines.

In 2008, the wind turbine industry's Danish production sites had a gross turnover of DKK 53 billion, and overall exports reached DKK 42 billion, equivalent to 7.2% of total Danish exports. The wind turbine sector had 28,400 employees at the end of 2008.

2.D. PUBLIC INVOLVEMENT

The development of wind power in Denmark has been characterised by strong public involvement. It was small machinery manufacturers that created the established wind turbine industry, and only after the consolidation of the industry through the 1990s did it become dominated by large, partly internationally owned and listed companies. Similarly, on the customer side numerous joint-owned wind turbines were established in the period 1984-94. Around two thousand of the 5,200 Danish wind turbines are still owned by local wind turbine owners' associations. These are mostly older, smaller wind turbines because the majority of wind turbines erected since 1995 are owned by individuals, energy companies and other commercial wind power companies.

The progression towards fewer joint-owned and relatively large wind turbines has made it difficult to maintain local support for new wind power projects. But to ensure continued development of wind power, it is essential to have backing in the local community. The *Energy Policy Agreement of 21 February 2008* therefore stipulated that a range of new initiatives should be undertaken to promote local acceptance and option to purchase wind turbines shares of new wind power projects. The regulations are examined in more detail in section 6. ●

3. WIND TURBINES AND THEIR SURROUNDINGS

3.A. ENVIRONMENTAL FEATURES OF WIND TURBINES

CLIMATE AND AIR POLLUTION

Wind power is regarded as an environmentally renewable energy source because producing electricity with wind turbines does not entail the use of fossil fuels such as oil, natural gas and coal. In terms of energy supply, wind power is advantageous because the source of the electricity production, i.e. wind, is renewable and the electricity from wind turbines is not therefore conditional on the import of fuels or the use of limited resources. In terms of the environment and climate, wind power has major benefits because it is not associated with atmospheric emissions of CO_2, SO_2, NO_x and particles, as is the case to a greater or lesser extent with power plants that use fossil fuels.

Emissions of SO_2, NO_x and particles pollute the regional and local environment around the power plants, while emissions of CO_2 from electricity production are regarded as the largest global contributor to the greenhouse effect, which is considered by the UN's Intergovermental Panel on Climate Change (IPCC) to be a serious threat to the climate. "Greenhouse effect" is a term that denotes the changed balance between incoming solar radiation and heat radiated out into space, which arises due to human-created discharges of greenhouse gases such as CO_2, methane and nitrous oxide.

ENERGY BALANCE

The energy balance of wind turbines over their lifetime is analysed using a life cycle assessment (LCA) that covers energy consumption and other effects of production, erection, ongoing operation, and scrapping when the wind turbine no longer can or needs to produce electricity. In this assessment, raw materials for the wind turbine's components as well as energy consumption for production, transport, operation and disposal are incorporated as a negative impact on the environment. The positive side includes the wind turbine's overall electricity production and any recyclable materials. Assessed over the wind turbine's normal lifetime of 20-25 years, the negative environmental impact is minimal compared with the average European electricity production. Over 20-25 years the wind turbine will typically produce more than 35 times the energy production involved in its manufacture, operation, etc. A modern MW wind turbine will take around seven months to produce the amount of energy used in its manufacture, erection, operation and disposal.

3.B. IMPACT ON THE IMMEDIATE SURROUNDINGS

The planning and environmental legislation sets out requirements to ensure that a wind turbine project will not cause major damage or nuisance to its surroundings, including noise and spacing requirements. It is also assumed that as a rule an environmental impact assessment (EIA) will be carried out as part of the detailed planning for specific projects. As well as describing the environmental impacts, this ensures, among other things, that the legislative requirements are observed. The overall impact of wind turbines on their immediate environment includes visual impact, noise, shadow, the effects of lighting, impacts on nature, etc. The nature of these impacts depends on how the wind turbine is positioned in the landscape, the type of landscape, the wind turbine's size, and proximity to the wind turbine. In order to minimise the overall impact, when planning the siting of wind turbines the municipalities should seek to limit these nuisances, including ensuring that noise and spacing requirements are observed. Similarly, wind turbine manufacturers are continuously working to optimise turbine design so that they not only produce optimally but also reduce the impact on their surroundings as much as possible.

SHADOW

A wind turbine casts shadows when the sun is shining. In windy, sunny weather, an area of the turbine's surroundings will be affected by rotating shadows from the blades. In Denmark the area lying to the south of the wind turbine will never be affected by shadow from the blades. Nuisance from shadow, which takes the form of a rapid change between direct light and short "flickers" of shadow, depends on

Photo: Wind Turbine Secretariat

IllIllustration: Odense Environment Centre, based on calculations from CUBE Engineering

FIGURE 3.1.
SHADOW CHART IN THE EIA

In new wind turbine projects, the project developer must provide information in an Environmental Impact Assessment (EIA) on the shadow cast by wind turbines. The chart shows the area of calculated shadow for "real case" (weather-dependent) in relation to Danish neighbours in an alternative project involving 5 x 3 MW wind turbines at Rens Hovedgaard Plantage in Aabenraa Municipality. Number of hours per year.

Photo: Wind Turbine Secretariat

Photo: Wind Turbine Secretariat

Factbox

SHADOW

Shadows cast by rotating turbine blades are experienced by neighbours as a nuisance, with the shadows passing across their homes for a short duration but at a high frequency. The applicable spacing requirements ensure that neighbours are mainly subjected to shadows in the early morning and late evening. Shadow is normally calculated as "real case", i.e. taking into consideration the normal distribution of sunshine hours and wind. Possible remedial measures include switching off the wind turbines at critical times.

where the wind turbine is standing from the perspective of the neighbour, the distance between the wind turbine and the neighbour, the wind turbine's hub height, and the length of the blades.

The critical times for shadow occur mainly in the early morning and late evening, with long shadows at a greater distance from the wind turbines than the neighbour distance requirement of four times the total height of the wind turbine. The impact of shadow is calculated as the total number of hours annually that a neighbour is subjected to shadow and will vary with seasonal changes in the weather. The assessment of the anticipated number of annual hours of shadow is therefore calculated based on the anticipated normal distribution of operating hours and sunshine hours during the course of the year.

It is recommended that the calculated normal distribution of shadow hours for neighbours not exceeds 10 hours a year. By taking these issues into consideration in the planning of wind turbine sitings, the periods during which shadow actually occurs can be limited. If a full assessment shows that the most suitable siting entails that the recommended maximum of 10 hours' shadow cannot be observed, the owner of the wind turbine may alternatively be required to shut down the wind turbine in critical periods. The wind turbines can be fitted with meters so that the operation can be halted if the sun shines during critical periods; this can reduce operating losses.

REFLECTION

As wind turbine blades must have a smooth surface to be able to produce optimally and repel dirt, the blades can produce reflective flashes. As part of the type-approval of wind turbines, the reflective qualities of the blades are stated. Typically, the reflective effect of the blades will be halved during the wind turbine's first year of operation, and in their planning the municipalities can set requirements for anti-reflective treatment of the blades. Normally, the blades from the manufacturer will be surface-coated to obtain a low gloss. Usually the gloss value will be less than 30, which is regarded as sufficiently low for reflections from the wind turbine not to be a problem.

MARKING OF WIND TURBINES IN RELATION TO AIR TRAFFIC

In order that installations should not compromise the safety of air traffic, any obstacles – including wind turbines – with a total height of more than 100 metres must be approved by Civil Aviation Administration-Denmark (CAA-Denmark). Around state-approved airports and airfields, aircraft are protected against obstructions using the approved obstacle limitation surfaces. The approach plan's height restrictions are registered with easements or notified in the municipal plans.

All wind turbines with a total height of minimum 150 metres must be provided with high-intensity, white flashing lights. The exact regulations are set out in the *BL 3-10 Regulations for Civil Aviation* based on applicable international standards and recommendations. The basis for the regulations is a desire for obstructions to air traffic to be visible at a suitable distance so that the pilot can take the necessary operational actions in time. In the case of wind turbines of 100-150 metres in height, which will typically be pertinent in connection with projects under the scrapping scheme and new onshore wind turbines, CAA-Denmark will carry out a specific assessment of the need for marking, including taking into consideration Danish Defence's assessments of military flights in the area. Under normal circumstances, the marking of the wind turbines with low-intensity fixed red obstruction lights on the nacelle plus painting the wind turbine white will be sufficient. Where special air safety factors apply, marking with medium-intensity flashing obstruction lights will be necessary in addition to painting the wind turbine white. It would be appropriate for requirements for air traffic marking to be clarified with CAA-Denmark before an EIA, where one is required, is drawn up.

Previous attempts to counteract light nuisance from TV-station transmitting masts have shown that it is not possible to effectively shield surrounding houses against obstruction lights. Any shielding must be carried out taking into consideration that obstruction lights must be observable by the pilot from all directions in the horizontal plane.

3.C. NOISE

Wind turbines emit a relatively weak but characteristic noise. The noise emanates from the operation of the turbine's gear and generator as well as from the movement of the blades through the air. In relation to generated output, modern wind turbines emit considerably less noise than the earliest wind turbines from the 1970s and 1980s. In particular, the mechanical noise from the turbine's gear and generator are significantly reduced in comparison with earlier models. In modern wind turbines, the machine house is soundproofed, the generator and gear are suspended in rubber elements, and the nacelle's cabin is tight-closing and fitted with sound locks that dampen airborne noise. Blade design has developed so that the noise from the movement of the blades through the air is minimised.

In order for a wind turbine to be certified for erection in Denmark, it must satisfy a number of requirements set out in the *Danish Ministry of the Environment Order on noise from wind turbines* (no. 1518 of 14 December 2006). Among other things, a noise survey must be carried out and the noise level calculated at the premises of immediate neighbours.

Sound is measured in decibels (dB). The human ear can just detect a change in sound intensity of 1-2 dB. If the sound intensity increases by 6-10 dB, it will be heard as a doubling of the sound intensity. Similarly, a reduction of 6-10 dB will be heard as a halving of the sound intensity. The intensity of the sound is generally measured using a method that mimics the ear's sensitivity and is stated by the measuring unit decibel-A, dB(A).

In accordance with the Danish Ministry of the Environment's Order, the noise in the open land immediately outside the neighbour's house and in open spaces up to 15 metres from the house may not exceed 44 dB(A) at a wind speed of 8 metres per second. This corresponds roughly to the noise of soft speech. In more densely built-up areas, summer home areas and noise-sensitive recreational areas, the noise may not exceed 39 dB(A). The limits are lower for lower wind speeds. The municipalities monitor compliance with these noise limits.

The relatively weak noise from wind turbines also includes some low-frequency noise, i.e. deep sound with a low frequency. Low-frequency noise is where a significant proportion of the sound energy is found in the frequency range below around 160 Hertz (Hz). Hertz is a designation for the number of oscillations per second. None of the noise surveys that have been carried out suggest that there are special problems with low-frequency noise from wind turbines. In the assessment of the Danish Environmental Protection Agency, wind turbines that observe the limits for ordinary noise do not give low-frequency noise higher than the recommended limit. In order to shed further light on the issues of low-frequency noise, thereby giving municipalities and players in the wind power industry a more reliable basis for evaluating new wind turbine projects, DELTA – Danish Electronics, Light and Acoustics – has headed up a research project that has been mapping the issues of low-frequency noise from modern wind turbines since 2006. The project is expected to be completed in spring 2010.

Infrasound is sound with a frequency lower than 20 Hz and thus constitutes the "deepest" part of the low-frequency range. Previously it was thought that infrasound could not be detected by the human ear, but infrasound can actually be heard if it is strong enough, and even weak infrasound is regarded as a nuisance. The threshold for hearing infrasound has been well researched, and the Danish Environmental Protection Agency recommends a limit that is 10 dB lower than the hearing threshold. The infrasound emitted by modern wind turbines is of no consequence for the surroundings and is much weaker than the Danish Environmental Protection Agency's recommended limit.

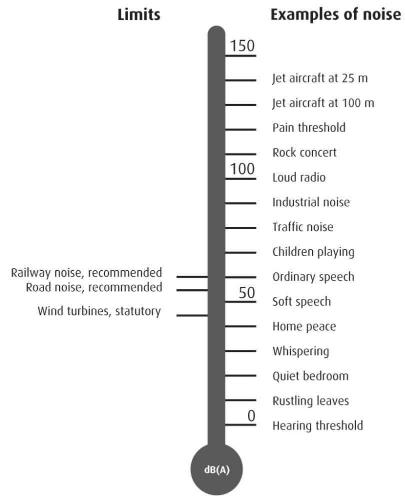


Illustration: Factsheet from the Danish Wind Turbine Owners' Association

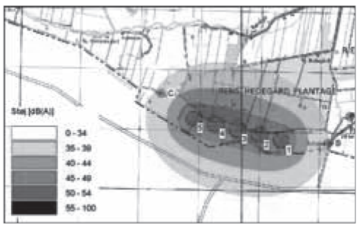


Illustration: Odense Environment Centre, based on calculations from EMD International

FIGURE 3.2
CHART OF CALCULATED NOISE ZONES IN THE ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
The two charts from the EIA for the wind turbine project at Rens Hovedgaard Plantage show the calculated noise zones for Danish neighbours from 5 x 1.8 MW wind turbines. The chart on the left shows noise zones at a wind speed of 6 metres per second, while the chart on the right shows the same noise zones for a wind speed of 8 metres per second. The noise level is stated in dB(A). The colours indicate the noise level: the darker the colour, the higher the noise level.

4. ONSHORE WIND TURBINES

Factbox

WIND TURBINE PLANNING PHASES

A typical planning process passes through the following steps:

Designation of wind turbine areas
- Consideration of potential areas, process and political aims in the municipality

- Idea phase and scoping
  - Invitation to submit ideas and proposals
  - Consultation with relevant authorities
  - Citizen meeting, where required
- Processing of any comments and consultation responses received
- Drafting of proposed municipal plan, including acceptance and rejection of alternatives, based among other things on a general environmental assessment of the plan and political aims
- Drafting of an environmental report summarising the general environmental assessment of the plan

- Public phase
  - Announcement of proposed municipal plan and environmental report
  - Citizen meeting, where required
- Processing of objections and comments received
- Any necessary revision, plus consultation period and any new public phase
- Final adoption of the plan
- Period for complaints

Planning for a specific wind turbine project
- Application for a specific project by a project sponsor in the designated wind turbine area
- Decision on whether an EIA is required

- Idea phase and scoping
  - Invitation to submit ideas and proposals
  - Consultation with relevant authorities
- Citizen meeting, where required

Photo: Birk Nielsen

The perception of order is a basic aesthetic precondition. It is therefore recommended that wind turbines should be erected in geometric (usually linear) formations that create a contrast with the landscape. The photo shows the visualisation for Lønborg Hede.

4.A. POLITICAL FRAMEWORK CONDITIONS FOR THE DEVELOPMENT OF WIND TURBINES

The political framework conditions for the erection of onshore wind turbines have been agreed in part in the *Energy Policy Agreement of 21 February 2008* and subsequently implemented in the *Danish Promotion of Renewable Energy Act,* which was adopted by the Danish Parliament in December 2008 and entered into force on 1 January 2009. The municipalities are responsible for securing the necessary planning basis for wind turbines with a total height of up to 150 metres in the form of designated wind turbine areas with associated guidelines in the municipal plan as well as supplements to the municipal plans with associated EIAs and local plans for the specific wind turbine projects under application. In the case of wind turbines over 150 metres, the Environment Centres within the Danish Ministry of the Environment are the planning authority. The Environment Centres are also tasked with monitoring that the municipalities plan for wind turbines in accordance with government interests.

As part of the objective for renewable energy to constitute 20% of gross energy consumption in 2011, the Danish Government entered into an agreement with Local Government Denmark that the municipalities, through their planning, should reserve areas that can accommodate onshore wind turbines with a total output of 150 MW; 75 MW in each of the years 2010 and 2011.

It was also agreed that the Danish Ministry of the Environment should strengthen its follow-up on the municipalities' work of implementing the scrapping scheme adopted as part of the *Energy Policy Agreement of 29 March 2004 on wind energy and decentralised combined heat and power.*

4.B. MUNICIPAL PLANNING AND REGULATIONS ON EIAS

Following the Local Government Reform, the planning authority for onshore wind turbines up to 150 metres has passed to the municipalities. The regulations for municipal planning ensure that citizens, associations, authorities and other stakeholders are continuously involved in the process. In order to be able to assist the municipalities in this work, the Danish Ministry of the Environment has set up the Wind Turbine Secretariat under the Agency for Spatial and Environmental Planning.

In order to allow enough time for drafting various materials, citizen involvement, etc., both the municipal designation of wind turbine areas and the municipality's subsequent processing of a specific project normally take at least a year.

Apart from household and small turbines, wind turbines may only be erected in areas designated through reservations and guidelines in the municipal plan. The municipality must therefore assess which areas are suitable for erecting wind turbines.

The local council must ensure in its planning that it gives full consideration to neighbouring residences, nature, the landscape, culturo-historical values, agricultural interests, and the possibility of exploiting the wind resource.

The municipal plan must include guidelines and a framework, and must be accompanied by a statement on the assumptions underlying the local council's proposed plan. The guidelines for designated wind turbine areas must include regulations on the anticipated maximum number and size of the turbines as well as the spacing between the turbines.

The further planning of specific projects then awaits the initiative of a project sponsor, a wind turbine owners' association or others wishing to use the designated area to erect wind turbines.

A project sponsor wishing to establish a wind turbine project must notify the project to the municipality. The planning process for projects requiring an EIA begins with an idea phase in which the municipality drafts a discussion paper inviting proposals from citizens on the content of the EIA and the supplement to the municipal plan. This idea phase, which is also called the pre-public phase, must last at least two weeks.

The planning must also satisfy the requirements for environmental assessment of plans and programmes, which include consultation with the relevant authorities, including neighbouring municipalities, the region and national bodies that have to grant environmental approvals to allow implementation of the physical planning, as well as any local and regional supply companies whose installations may be affected by the project.

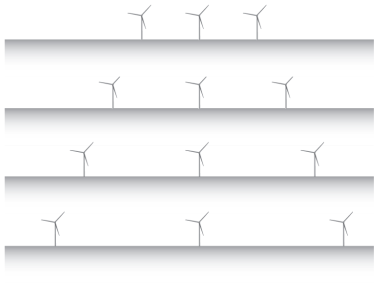
Taking into consideration the feedback that it receives, the municipality draws up guidelines on the further local planning in a supplement to the municipal plan and determines the scope of the EIA, which the project owner and the municipality often prepare jointly. This material is sent for public consultation lasting at least eight weeks. In this public phase, property owners, neighbours, associations, authorities, etc., may submit objections, comments and alternative proposals.

After this, the municipality can finally adopt the wind turbine project and give the project sponsor an EIA approval. If a local plan also has to be drawn up for the project, the local council draws this up in parallel. The local plan for a wind turbine area must include regulations on the turbines' exact siting, number, minimum and maximum total height, and appearance.

In accordance with the *Danish Planning Act*, a supplement to the municipal plan for a wind turbine project involving turbines with a total height of more than 80 metres or a group of more than three turbines must be accompanied by an EIA assessing the consequences of the project for the environment. Other projects are screened by the local council, which decides whether a project has such major consequences for the environment that an EIA should be drawn up or whether only a rural zone permit should be issued. *Order no. 1335 of 6 December 2006 on the assessment of certain public and private installations' impact on the environment* contains regulations on EIAs.

The EIA must assess how the wind turbine project will affect neighbouring residences in terms of, among other things, noise and shadow, nature, the landscape, culturo-historical values, and agricultural interests, as well as giving information on local wind conditions. This normally requires the project owner to draw up a visualisation of the project so that citizens can more easily form a realistic impression of the implications of the wind turbine project.

FIGURE 4.1
EXAMPLES OF SPACING IN A WIND TURBINE PROJECT



Illustrations: Birk Nielsen

With regard to both turbulence and aesthetics, it is recommended that in projects involving multiple wind turbines their spacing should be three to four times the rotor diameter. The illustrations from Birk Nielsen show examples of wind turbines spaced at intervals of two times the rotor diameter (top), three times the rotor diameter, four times the rotor diameter, and five times the rotor diameter (bottom) respectively.

- Processing of any comments and consultation responses received
- Drafting of supplement to municipal plan and local plan, including adjustment of the project based on a general environmental assessment of the plan
- Drafting of an EIA for the project

- Public phase
  - Announcement of the proposed plans, incl. EIA for the project
  - Citizen meeting, where required
- Processing of any objections and comments received
- Any revision, plus consultation period and any new public phase
- Final adoption of the plans and issuing of EIA approval
- Period for complaints

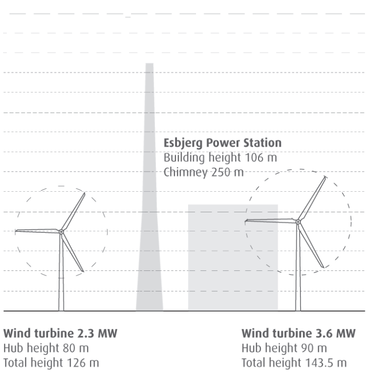


FIGURE 4.2 WIND TURBINE IN A TECHNICAL LANDSCAPE
Birk Nielsen's sketch shows the siting of MW wind turbines at Esbjerg Power Station.

Factbox

All EIAs, including those for wind turbine projects, must include:

- A description of the project.
- A summary of major alternatives to the execution of the proposed project that the project sponsor has investigated (minimum the zero alternative, i.e. the situation if the project is not implemented).
- A description of the impact of the project on people, fauna, flora, soil, water, air, climate, landscape, tangible property, and the Danish cultural heritage.
- A description of the project's short-term and long-term, direct and indirect, derived and cumulative impacts on the environment.
- A description of environment-improving measures, including preventive measures.
- A non-technical summary of the assessment.

In the case of wind turbine projects that do not require an EIA, the rural zone regulations of the *Danish Planning Act* set out requirements for informing neighbours about the project. Generally, there is no requirement for the information to include a visualisation, but Energinet.dk (the Danish transmission system operator) may require this if it would be a precondition for neighbours being able to realistically assess whether the project will entail a loss of value on their properties, cf. 6.b.

Decisions of the local council concerning wind turbine projects may be contested with the Nature Protection Board of Appeal.

The Danish Ministry of the Environment's Wind Turbine Secretariat is a type of "flying squad" that provides the municipalities with guidance and practical help in wind turbine planning – such as identifying the sites that are most suitable in respect of neighbours and nature protection interests, formulating idea proposals, decision-making documentation and proposals for wind turbine plans, or arranging citizen meetings, etc.

Most of Denmark's municipalities are in dialogue with the Wind Turbine Secretariat, either to get answers to specific questions or to obtain formal assistance with the planning process. The Wind Turbine Secretariat has a Danish website, **www.vind.mim.dk**, via the Agency for Spatial and Environmental Planning. Here you can find answers to frequently asked questions as well as tools for use in municipal wind turbine planning, including:

- A summary of essential siting considerations.
- A process line with a model of the planning process and a timeframe.
- Links, including to applicable regulations and the Agency for Spatial and Environmental Planning's spacing map.

4.C. REGULATIONS FOR SITING ONSHORE WIND TURBINES

The siting of new wind turbines is carried out on the basis of an overall balancing of various factors such as wind speed, distance to nearest neighbours, noise and shadow, other technical installations, and regard for the landscape and nature. This balancing is brought about through the municipal wind turbine planning, which directly involves affected citizens, organisations, authorities, etc. The key principles for erecting wind turbines are wind conditions, distance to neighbours, and regard for specific affected interests, e.g. nature protection areas and areas of culturo-historical interest.

The regulations for siting are set out in the *Danish Planning Act* and implemented in *Wind Turbine Circular no. 9295 of 22 May 2009*. The aim of the Circular is to ensure regard for landscape, neighbours, etc. Generally, new wind turbines must as a minimum be sited at a distance from the nearest neighbours of at least four times the wind turbine's total height.

Special consideration must be given to the coastal zone, which is defined in the *Danish Planning Act* as a three-kilometre zone along the coast throughout the country that is generally to be kept free of buildings and installations. If a municipality wants to erect wind turbines in the coastal zone, this requires special planning or functional justification, for example that there are especially favourable wind conditions along the municipality's coasts, as is the case in the West Jutland municipalities. Visualisation is an excellent method for illustrating the implications of new wind turbines for landscape and nature. Landscapes that in the past have been dominated by large technical installations will often be suitable for erecting large wind turbines because the turbines will not significantly increase the impact on the landscape. These technical installations might be CHP plants, waste incineration plants, high-voltage masts, industrial activities with tall chimneys, harbour areas with large cranes, etc. These installations are already highly visible in the landscape.

Large and uniform landscapes will also usually be suitable for erecting large wind turbines. The reason for this is that the landscape matches the large dimensions because it is often characterised by flat or evenly sloping terrain with large units of area and "landscape space".

Small-scale landscapes will often be less suitable for erecting large wind turbines. These landscapes are characterised by small hills or gentle slopes with less "landscape space", where large wind turbines would contrast starkly with the nature of the landscape.

A more exhaustive description of the impact of large wind turbines on different types of landscape can be found in the report *Store vindmøller i det åbne land – en vurdering af de landskabelige konsekvenser* (*Large wind turbines in the open countryside – an assessment of implications for the landscape*), which can be downloaded (in Danish only) from **www.blst.dk**.

The oldest wind turbines were often erected spread out in the landscape, which meant that they impacted a very large area in relation to their installed electrical output. As a starting point, the aim is to site new wind turbines in groups wherever possible so as to achieve a high installed electrical output with impact on a relatively small area. Furthermore, the municipality can require wind turbines in a group to be uniform and arranged in a simple geometric pattern, for example in a single row, so that the wind turbines create a calmer impression.
It is also important that wind turbines erected as a group should appear harmonious and uniform in design. A wind turbine is regarded as harmonious if there is a balance between tower height and rotor diameter. Generally, experience suggests that the most harmonious rotor/tower ratio for larger wind turbines is 0.9–1.35, depending on the total height. As an example, a wind turbine with a tower height of 80 metres and a rotor diameter of 100 metres, giving a total height of 130 metres, has a rotor/tower ratio of 1.25.

4.D. TECHNICAL CERTIFICATION OF WIND TURBINES

In order to help ensure that new wind turbines are safe and can be incorporated into the electricity system, a Secretariat for the Danish Wind Turbine Certification Scheme has been set up and located at Risø DTU (National Laboratory for Sustainable Energy at the Technical University of Denmark). The specific regulations are described in *Danish Energy Agency's Order no. 651 of 26 June 2008 on the technical certification scheme for the design, manufacture, installation, maintenance and servicing of wind turbines*. The secretariat has a website at **www.vindmoellegodkendelse.dk**. The technical prescriptions for the connection of wind turbines to the electricity grid can be found at **www.energinet.dk**.

4.E. HOUSEHOLD WIND TURBINES AND SMALL WIND TURBINES

A household wind turbine is normally understood to be a smaller, stand-alone turbine with a total height of less than 25 metres that is erected directly connected to existing housing in the open countryside, usually in a rural zone. Small wind turbines are normally understood to be stand-alone turbines with a rotor area of up to 1 m^2 ("micro turbines") or 1-5 m^2 ("mini turbines"). The turbine may be installed on a building.

For all turbine types the *Danish Ministry of the Environment Order on noise from wind turbines* must be respected when erecting and operating the turbines. Turbine types with a rotor area in excess of 1 m^2 are subject to the *Danish Energy Agency's Order no. 651 of 26 June 2008 on the technical certification scheme for the design, manufacture, installation, maintenance and servicing of wind turbines*. In the case of turbines with rotor area 1-5 m^2, however, only a registration notification is required.

Wind turbine projects must as a minimum be screened in accordance with the regulations of the *EIA Order*. Household and small turbines will not normally require an EIA, supplement to the municipal plan and EIA.

ERECTION OF WIND TURBINES IN RURAL ZONES

It is the task of the municipalities, as the rural zone authority, to issue rural zone permits. In this regard, the municipality must carry out

Illustrations: Birk Nielsen

FIGURE 4.3
TOWER/BLADE RATIOS

The ratio between a wind turbine's tower and blades (the "harmony ratio") is important for the turbine's own aesthetics. New types of large turbine have a more slender design than older models, and the tower can therefore better support long blades with a large rotor area and production capacity. The recommended harmony ratio thus depends on the size of the wind turbine. For wind turbines with a total height of less than 100 metres, the recommended rotor diameter is -/+ 10% in relation to the tower height, while for larger wind turbines with a total height of up to 150 metres, the recommended rotor diameter is between +10% and +35% in relation to the tower height.

Photo: Wind Turbine Secretariat

planning appraisals in respect of ongoing planning. Furthermore, landscape considerations and any building lines as per the *Danish Nature Protection Act* as well as any supplementary considerations regarding neighbours (view, reflection, etc.) must also be taken care of.

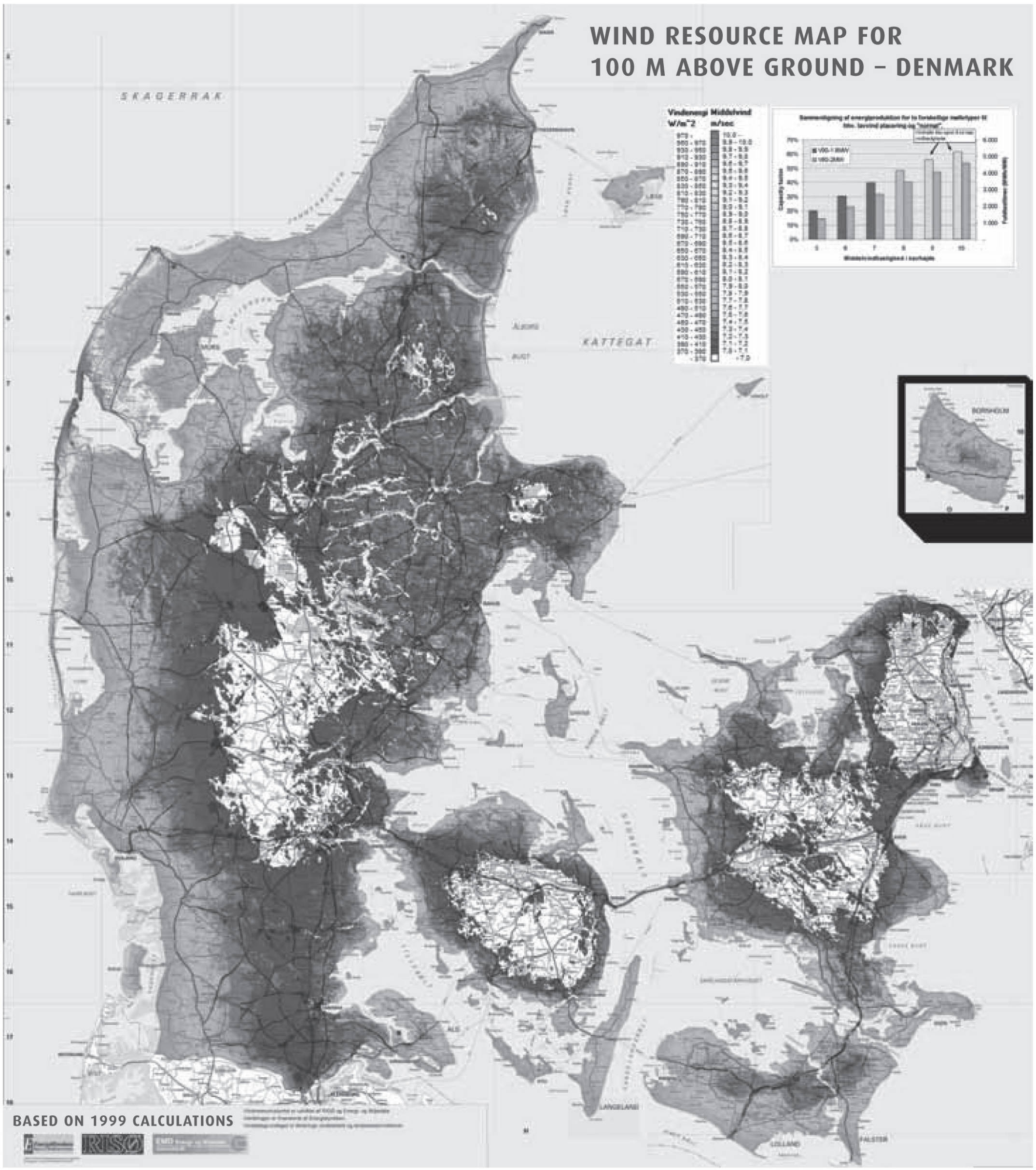
In the case of household and small turbines, the *Wind Turbine Circular* does not set out fixed requirements for the distance to neighbouring homes, etc., in relation to the turbine's total height.

The municipalities must carry out individual assessments of cases/applications. However, the fact that the decision must always be taken on the basis of a specific assessment does not preclude the municipality from clarifying in its municipal planning guidelines other protection interests and considerations that receive particular attention in its case-handling, including of course any guidelines for erecting smaller wind turbines.

WIND RESOURCE ATLAS FOR DENMARK: In 1998, with funding from the Danish Energy Agency, Risø DTU's Wind Energy Division teamed up with the Danish software and consultancy firm EMD International to compile the Wind Resource Atlas for Denmark, which can be seen on page 17. Areas with the highest average wind speeds are shown in red and yellow, while areas with less wind are shown in green and blue.

In addition to large wind turbines, the Samsø Renewable Energy Island project has also established household wind turbines, one of which (shown below) can be seen in front of the solar-panelled roof of Samsø Energy Academy.

Photo: Samsø Energy Academy


WIND RESOURCE MAP FOR
100 M ABOVE GROUND – DENMARK
SKAGERRAK
KATTEGAT
BORNHOLM
LANGELAND
LOLLAND
FALSTER
BASED ON 1999 CALCULATIONS

5. OFFSHORE WIND TURBINES

Photo: DONG Energy

With 209 MW produced by 91 wind turbines, the Horns Rev II offshore wind farm, which was opened in September 2009, is the largest offshore wind farm in the world to date. The turbines are located 30 km from the coast and can produce electricity to cover the consumption of 200,000 households.

Photo: Samsø Energy Academy

The offshore wind farm at Paludans Flak 4 km south of Samsø comprises 10 wind turbines with a combined output of 23 MW that produce approximately 77,500 MWh a year. The offshore wind farm was commissioned in 2002, and in the long term its production will make it possible to cover electricity consumption for the operation of electric cars and hydrogen for transportation on the island. Half of the wind turbines are owned by the municipality, while the inhabitants of Samsø own most of the rest.

5.A. OFFSHORE WIND TURBINES IN DENMARK

In 1991 Denmark became the first country in the world to take wind turbines out to sea with 11 x 450 kW turbines in the Vindeby offshore wind farm. This was followed by a number of smaller demonstration projects, leading to the first two large offshore wind farms Horns Rev I and Nysted (Rødsand I) with outputs of 160 and 165 MW respectively. Some offshore wind farms have been built because power companies were given political orders to do so or via tenders, while others are wholly or partly owned by local wind turbine owners' associations such as Middelgrunden and Samsø.

With 660 MW offshore wind turbines connected to the electricity grid in 2009, Denmark is still one of the largest developers of offshore wind farms. Only the United Kingdom has a larger capacity.

In 2010 the offshore wind turbines at Rødsand II will be erected with an output of just over 200 MW. The Danish Energy Agency has tendered out another offshore wind turbine project at Anholt/Djursland with an output of around 400 MW. These projects are the result of the *Energy Policy Agreement of 29 March 2004* and the *Energy Policy Agreement of 21 February 2008* respectively.

It is considerably more expensive to build and operate offshore wind turbines than onshore wind turbines. On the other hand, the production conditions are better at sea with higher wind speeds and more stable wind conditions.

The increased costs are reflected in the feed-in tariff that the project developers for the latest offshore wind farms have obtained through the Danish Energy Agency's tender. DONG Energy, which is the project sponsor for Horns Rev II, receives DKK 0.518 per kWh for 10 TWh, corresponding to around 50,000 full-load hours, after which the electricity produced has to be sold under market conditions. E.ON AB from Sweden, which won the tender for Rødsand II, receives DKK 0.629 per kWh for 10 TWh, corresponding to around 50,000 full-load hours.

5.B. THE DANISH ENERGY AGENCY AS A ONE-STOP SHOP

The Danish Energy Agency is the authority responsible for the planning and erection of offshore wind turbines. In order to make preparation of new offshore wind turbine projects as simple as possible for project developers, the Danish Energy Agency has organised the overall official handling as a "one-stop shop", which means that a project owner wishing to establish an offshore wind turbine project only has to deal with one body – namely the Danish Energy Agency – to obtain all the necessary approvals and licences.

As a one-stop shop, the Danish Energy Agency involves other relevant authorities such as the Agency for Spatial and Environmental Planning, the Danish Maritime Authority, the Danish Maritime Safety Administration, CAA-Denmark, the Heritage Agency of Denmark, Danish Defence, etc. The Danish Energy Agency also arranges consultation with the relevant stakeholders and issues all the necessary approvals and licences. Energinet.dk is responsible for transmitting the electricity production from offshore wind turbines to the electricity grid and owns both the transformer station and the underwater cables that carry the electricity production of offshore wind farms to land.

In comparison with the official administration of offshore wind farms in other countries, the Danish model has provided a quick, cost-effective process to the benefit of operating economy in the individual projects and the development of offshore wind turbines as a whole.

5.C. MAPPING OF FUTURE SITES FOR OFFSHORE WIND FARMS

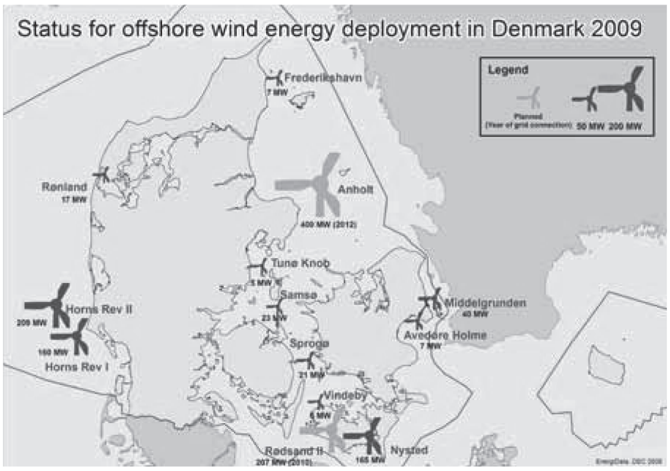
In order to ensure that the future development of offshore wind turbines does not clash with other major public interests and that the development is carried out with the most appropriate socio-economic prioritisation, the Danish Energy Agency, in conjunction with the other relevant authorities, has mapped the most suitable sites for future offshore wind farms. This mapping is a dynamic process because the framework conditions for developing offshore wind farms are continually changing. In 2007 the Danish Energy Agency published a technical mapping report designating 23 suitable sites, each with space for around 200 MW.

These possible offshore wind farms could achieve a total installed output of 4,600 MW, and with average wind speeds of around 10 metres per second they could produce around 18 TWh annually, equivalent to more than half of current Danish electricity consumption. The sites are prioritised according to public interests such as regard for grid transmission, navigation, nature, landscape, raw material extraction, and the anticipated cost of establishing and operating the offshore wind farms. The cross-ministry committee work has placed its emphasis on a planned and coordinated development of offshore wind farms and the transmission grid, and the chosen sites have been submitted to a strategic environmental assessment in order to prevent any future conflicts with environmental and natural interests.

Through its *Offshore Wind Turbine Action Plan of September 2008* the Danish Energy Agency updated the mapping in light of the *Energy Policy Agreement of 21 February 2008*. The good wind conditions at the chosen sites allow the offshore wind farms to produce for around 4,000 full-load hours a year. With sea depths of 10-35 metres and a distance to the coast of 22-45 kilometres, a balance has been struck between economic considerations and the visual impact on land.

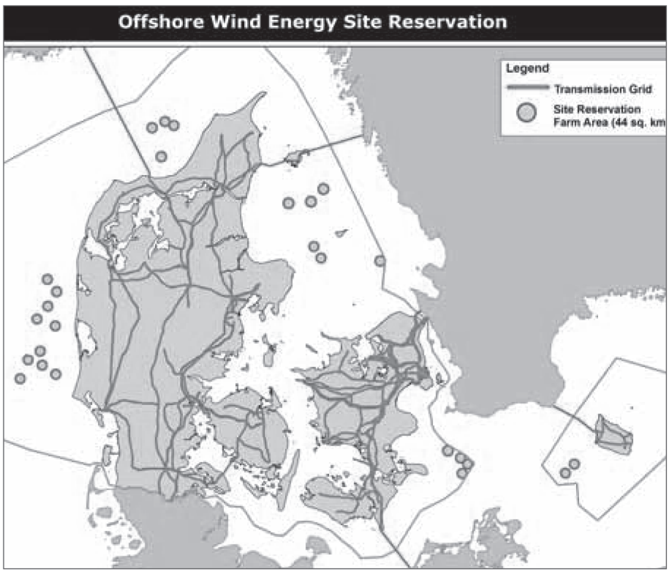
5.D. TENDERING OUT OF OFFSHORE WIND FARMS

The establishment of offshore wind turbines can follow two different procedures: a government tender procedure run by the Danish Energy Agency; or an open-door procedure. For



Map: Danish Energy Agency

The map of Denmark shows the locations of existing and planned offshore wind farms. Up to now offshore wind farms have been located with a considerable geographical spread, which has made it easier for Energinet.dk to incorporate the varying electricity production into the electricity system. Following a government tender initiated in 2009, a 400 MW offshore wind farm is to be established between Anholt and Djursland.



Map: Danish Energy Agency

The Committee for Future Offshore Wind Power Sites updated its mapping of potential locations in September 2008. The purple colour on the map indicates 26 potential sites, each of which can be developed with 200 MW, giving a total of 5,200 MW, while the existing large offshore wind farms are indicated in blue.

Photo: DONG Energy

Horns Rev II will predominantly be serviced by operating and maintenance personnel who will live for one week at a time on a habitation platform linked to the offshore wind farm. This will help reduce transport time and costs, thereby optimising operating economy.

Factbox

Two types of procedure for establishing offshore wind farms

In Denmark, new offshore wind farm projects can be established according to two different procedures: a government tender or an open-door procedure.

A government tender is carried out to realise a political decision to establish the project as part of the Danish development of renewable energy. The Danish Energy Agency tenders out the project in an open competition to obtain the lowest possible costs. Energinet.dk may be responsible for preparing the Environmental Impact Assessment (EIA) and the electricity link to land.

In an open-door procedure, the project developer applies to the Danish Energy Agency for a licence to carry out preliminary investigations and establish an offshore wind farm in the given area. The Danish Energy Agency clarifies whether there are any competing public interests and, where possible, issues the required licence. The project developer receives the same price supplement as for new onshore wind turbines and has to finance the connection of the project to the electricity grid on land.

both procedures, the project developer must obtain a licence to carry out preliminary investigations, a licence to finally establish the offshore wind turbines, a licence to exploit wind power for a given number of years, and – in the case of wind farms of more than 25 MW – an approval for electricity production.

In the government tender procedure, the Danish Energy Agency announces a tender for an offshore wind turbine project of a specific size, e.g. 200 MW, within a specifically defined geographical area. A government tender is carried out to realise a political decision to establish a new offshore wind farm at the lowest possible cost.

Depending on the nature of the project, the Danish Energy Agency invites applicants to submit a quotation for the price at which the bidders are willing to produce electricity in the form of a fixed feed-in tariff for a certain amount of produced electricity, calculated as number of full-load hours.

The winning price will differ from project to project because the result of a tender depends on the project location, the wind conditions at the site, the competitive situation in the market at the time, etc. In the two tenders so far the winning price has been higher than the feed-in tariff that is paid for an open-door project which corresponds to the feed-in tariff for new onshore wind turbines. As well as the lowest feed-in tariff, the technical and financial capacity of the bidding companies or consortia to implement the project are assessed.

Based on the experiences of the Rødsand II offshore wind farm, where the winner of the first tender ultimately chose not to implement the project due to changed market conditions, the Danish Energy Agency has tightened the conditions in the latest tenders so that the project developer has to pay a fine if the project is not implemented as planned or is delayed.

In projects covered by a government tender, Energinet.dk owns both the transformer station and the underwater cable that carries the electricity to land from the offshore wind farm. In the tender for the Anholt offshore wind farm, which is being implemented in 2009-2010, Energinet.dk will also undertake the EIA and preliminary geotechnical and geophysical surveys of the seabed. The winner of the tender will pay Energinet.dk's costs for these preliminary surveys.

In the open-door procedure, the project developer takes the initiative in establishing an offshore wind farm in a specific area. This is done by submitting an unsolicited application for a licence to carry out preliminary investigations in the given area. The application must as a minimum include a description of the project, the anticipated scope of the preliminary investigations, the size and number of turbines, and the limits of the project's geographical siting.

In an open-door project, the developer pays for the transmission of the produced electricity to land. An open-door project cannot expect to obtain approval in the areas that are designated for offshore wind farms in the report *Future Offshore Wind Power Sites – 2025* from April 2007 and the follow-up to this from September 2008.

Before the Danish Energy Agency actually begins processing an application, as part of the one-stop shop concept it initiates a hearing of other government bodies to clarify whether there are other major public interests that could block the implementation of the project. On this basis, the Danish Energy Agency decides whether the area in the application can be developed, and in the event of a positive decision it issues an approval for the applicant to carry out preliminary investigations, including an EIA.

The Danish Energy Agency has approved applications within the open-door procedure for the following offshore wind turbine projects: Avedøre Holme, involving three demonstration wind turbines (DONG Energy); Frederikshavn, involving six demonstration wind turbines (NearshoreLAB); and Sprogø, involving seven offshore wind turbines (Sund & Bælt).

5.E. IMPLEMENTATION OF AN OFFSHORE WIND TURBINE PROJECT

Once the Danish Energy Agency has granted the project developer a licence to carry out preliminary investigations, all projects follow the same procedure. The preliminary investigations include as a minimum an EIA as well as geophysical and geotechnical surveys of the seabed to clarify what type of foundation should be used.

Photo: Samsø Energy Academy

The EIA must assess the offshore wind farm's impacts on the environment. On the basis of responses from the initial consultation of authorities and other stakeholders, the Danish Energy Agency determines what the EIA should include. The EIA must demonstrate, describe and assess the environmental consequences of implementing the project in respect of:

a) people, fauna and flora
b) seabed, water, air, climate and landscape
c) tangible property and Danish cultural heritage
d) interaction between these factors.

Furthermore, the EIA must describe proposals for alternative siting and proposals for how demonstrated environmental nuisances can be prevented or reduced. *Order no. 815 of 28 August 2000 on assessments of impacts on the environment of offshore electricity-producing installations* sets out the detailed conditions for this type of EIA.

The project developer's application to establish the offshore wind farm must include a full description of the project's expected scope, size, geographical location, coordinates for turbines, grid connection plans and cable trace, etc., as well as the results of the preliminary investigations.

Once the Danish Energy Agency has received the EIA together with a final application to establish the offshore wind farm, it sends both for public consultation with a deadline for reply of at least eight weeks. The consultation is announced on the Danish Energy Agency's website and in national and local newspapers. This gives other authorities, interested organisations and citizens the opportunity to voice objections and other comments, which the Danish Energy Agency includes in its processing of the application and the EIA.

If the Danish Energy Agency does not receive any objections with weighty arguments for cancelling the project, it grants a licence to establish the offshore wind farm. In this regard, the Danish Energy Agency will generally require the project developer to document, prior to starting the construction work, a detailed project description.

The project developer must apply for a licence to exploit wind power from the offshore wind farm and, in the case of wind farms of more than 25 MW, for an authorisation to produce electricity. This must be done after the installation work has begun and at the latest two months before the first wind turbine is ready to begin operating. The offshore wind farm must not supply electricity to the grid until the licence and, where required, the approval have been granted.

Significantly and individually affected parties as well as relevant environmental organisations may appeal the Danish Energy Agency's decisions to the Energy Board of Appeal. Any appeals must be submitted in writing within four weeks of the publication of the decision.

Factbox

The environmental impact of offshore wind farms

As an integral part of the projects for the first two large demonstration offshore wind farms, Horns Rev I and Nysted, from 1996 to 2006 an Environmental Monitoring Programme was carried out to document the impact of the projects on the marine environment. On completion of the programme, at the recommendation of an international expert panel a small follow-up programme was launched focusing on the long-term effects for porpoises, water birds (common scoters, divers, long-tailed ducks, etc.) and fish.

The results show that the foundations of the offshore wind farms have created new artificial habitats, thereby contributing to increased biodiversity and better living conditions for the local fish communities. Seals were only affected in the short term during the construction work, while porpoises, which disappeared from the area while the wind farm was being built, have to some extent returned. Birds have been able to avoid the offshore wind farms.

The results of the Environmental Monitoring Programme are quality-assured by the international expert panel and regularly published on the English pages of the Danish Energy Agency's website, **www.ens.dk**.

6. NEW SCHEMES IN THE *DANISH PROMOTION OF RENEWABLE ENERGY ACT*

Photo: Visualisation by Birk Nielsen

Factbox

Claims for payment for loss of value on real property

The *Energy Policy Agreement of February 2008* introduced a scheme giving neighbours of new wind turbine projects the right to have loss of value on their property covered if the loss is assessed to be at least 1% of the property's value. The scheme was introduced to create greater local acceptance of and involvement in the erection of new onshore wind turbines.

In order for their claims to be processed, neighbours living within a distance of six times the wind turbine's total height must notify their claims for payment for loss of value within four weeks after the wind turbine project developer has conducted the prescribed information meeting. Neighbours living further away must pay a fee of DKK 4,000. If the claim for payment for loss of value is upheld, the fee is repaid.

The loss of value is assessed by an impartial valuation authority appointed by the Minister for Climate and Energy. In all there are five valuation authorities covering the whole country, each consisting of a lawyer and an expert in assessing real property value in the local area. Decisions of the valuation authority cannot be contested with another administrative authority, but they may be taken before the courts.

Energinet.dk's Front Office administers the loss-of-value scheme and has placed forms and other material for use in the case-handling on its website, **www.energinet.dk**, where it also provides regular updates on new decisions.

6.A. A COMPREHENSIVE ACT ON RENEWABLE ENERGY

The Danish Promotion of Renewable Energy Act (L 1392 of 27 December 2008), which entered into force on 1 January 2009, covers, among other things, price supplements for installations producing electricity with renewable energy, technical and safety-related requirements for wind turbines, and special regulations for offshore wind turbines. The *Energy Policy Agreement of 21 February 2008* required that these regulations should be combined into one act on renewable energy.

Further to this agreement, the *Danish Promotion of Renewable Energy Act* also contains four new schemes aimed at promoting the local population's acceptance of and involvement in the development of onshore wind turbines: a loss-of-value scheme for neighbours of new wind turbines; an option-to-purchase scheme with preference given to the local population; a green scheme so that municipalities can improve the scenery and recreational values in areas where wind turbines are erected; and a guarantee scheme to support local initiative groups with preliminary investigations. All the schemes are administered by Energinet.dk.

6.B. THE LOSS-OF-VALUE SCHEME

Any party erecting new wind turbines with a height of 25 metres or more, including offshore wind turbines erected without a government tender procedure, must pay for any loss of value on real property if the erection of the wind turbines results in a loss of at least 1% of the property value. In order to give neighbours the opportunity to assess the consequences of the wind turbine project, the erector must draw up information material on the project and invite the neighbours to a public information meeting. The material must include a list of the properties lying within a distance of up to six times the wind turbine's total height. Energinet.dk, which must approve the information material, can require that the material should also include a visualisation of the project. The meeting must be convened with a reasonable period of notice by means of an announcement in local newspapers and must take place at the latest four weeks before the municipal planning process ends.

Property owners who believe, based on the information material and the information meeting, that the erection of the wind turbines will reduce the value of their property must notify the loss of value to Energinet.dk within four weeks of the meeting. If a property owner lives further away than six times the wind turbine's total height, the owner must pay a fee to Energinet.dk of DKK 4,000. Neighbours who live closer to the wind turbine project are not required to pay this fee. The fee is repaid if the property owner is granted the right to compensation for loss of value.

The wind turbine erector may enter into a voluntary agreement concerning compensation for loss of value with property owners who have notified their claims to Energinet.dk. If this is not done within four weeks, Energinet.dk will submit the owners' claims to a valuation authority. The Danish Minister for Climate and Energy has appointed five valuation authorities consisting of a lawyer and an expert in assessing real property value. The valuation authority will decide, on the basis of a specific assessment, the extent to which property owners' claims can be accommodated.

If the property owner's claim for compensation is upheld, the wind turbine erector will pay the valuation authority's costs. If the property owner's claim is rejected, Energinet.dk pays the case costs not covered by any fee of DKK 4,000. This cost is recouped from the electricity consumers as a PSO contribution.

Decisions of the valuation authority cannot be contested with another administrative body but may be brought before the courts as civil proceedings by the owner of the property against the wind turbine erector.

6.C. THE OPTION-TO-PURCHASE SCHEME

Erectors of wind turbines with a total height of at least 25 metres, including offshore wind turbines erected without a governmental tender, shall offer for sale at least 20% of the wind turbine project to the local population. Anyone over 18 years of age with his/her permanent residence according to the National Register of Persons at a distance of maximum 4.5 kilometres from the site of installation or in the municipality where the wind turbine is erected has the option to purchase. If there is local interest in purchasing more than 20%, people who live closer than 4.5 kilometres from the project have first priority on a share of ownership, but the distribution of shares should ensure the broadest possible ownership base.

In order to give local citizens an adequate decision-making platform, wind turbine erectors must provide information on the nature and financial conditions of the project. This must be done through sales material containing as a minimum the articles of association of the company that will be erecting the wind turbine, a detailed construction and operating budget, including the financing for the project, the liability per share, and the price of the shares on offer. The sales material must be quality-assured by a state-authorised public accountant. Energinet.dk must approve the sales material as a condition for the wind turbine erector obtaining the price supplement provided for in the *Danish Promotion of Renewable Energy Act*.

The wind turbine erector must run through the sales material at an information meeting convened with a reasonable period of notice by announcement in a local newspaper. Following the information meeting, local citizens have a period of four weeks to make a purchase offer. In the case of both the loss-of-value and option-to-purchase schemes, transitional regulations exempting wind turbines where the municipality has published a supplement to the municipal plan with an associated EIA or announced that the project does not require an EIA apply until 1 March 2009. The wind turbine project must also be connected to the grid before 1 September 2010.

6.D. THE GREEN SCHEME

In order to further promote the local council's commitment to wind turbine planning and local acceptance of new wind turbine projects, the *Danish Promotion of Renewable Energy Act* has introduced a green scheme for the financing of projects that enhance the scenery and recreational opportunities in the municipality. Energinet.dk, which administers the scheme, pays DKK 0.004 per kWh for the first 22,000 full-load hours from wind turbine projects that are connected to the grid on 21 February 2008 or later. The money for the green scheme is recouped from electricity consumers as a PSO contribution.

The money is lodged in a special account for the given municipality; the amount of money depends on how many wind turbines and of what size are connected to the grid in the municipality. A wind turbine of 2 MW generates a total sum of DKK 176,000. In order to

Photos: Visualisations by Birk Nielsen

Visualisations are an important element of an Environmental Impact Assessment (EIA) for new onshore wind turbine projects, and the method has been described in the report Store vindmøller i det åbne land – en vurdering af de landskabelige konsekvenser (Large wind turbines in the open countryside – an assessment of implications for the landscape). This example from the project in Gisselbæk illustrates the difference between a project with 3 x 1.75 MW wind turbines, each with a total height of 93 metres (top), and a layout of 3 x 3.6 MW wind turbines, each with a total height of 150 metres. The distance from the observer to the nearest wind turbine is 1.6 kilometres.

The visualisations were produced using a wind turbine model taken from the list in the WindPro software program: Siemens Wind Power's 3.6 MW wind turbine. The report's visualisation examples assume that the turbines have a standard grey anti-reflective coating. The spacing is three times the rotor diameter, which is recommended in respect of the wind turbine project's own aesthetics and to avoid problems with turbulence. For 3.6 MW wind turbines, this means a distance between the wind turbines of 321 metres.

Photo: Samsø Energy Academy

SAMSØ RENEWABLE ENERGY ISLAND: These three wind turbines, each 1 MW with a total height of 77 metres, are owned by local farmers and a wind turbine owners' association with around 450 members. The wind turbines, which were erected in 2000 as part of the Samsø Renewable Energy Island project, are an example of how it really is possible to create strong public support for the erection of large onshore wind turbines by financially involving the local population in new projects.

In addition to these three wind turbines near the village of Permelille, a further eight 1 MW wind turbines have been erected at two other sites on Samsø. The total construction cost for the 11 onshore wind turbines was around DKK 66 million, and in a normal year the turbines produce around 25,300 MWh, equivalent to the electricity consumption of some 6,500 households. Samsø Municipality has approximately 4,000 inhabitants.

promote local involvement in new wind turbine projects, during processing of the project the municipality may apply to Energinet.dk for a subsidy for certain development works or activities that draw on the full amount so that citizens become aware of the benefits that are obtained from the wind turbine erection.

However, the subsidy can only be paid once the wind turbine project is connected to the grid. If several wind turbine projects are implemented in a municipality, the subsidies can be used for one combined project. In order for the money to be paid, the municipality must demonstrate to Energinet.dk that the money will be used in accordance with the application.

The green scheme may wholly or partly finance development works for enhancing scenic or recreational values in the municipality. A subsidy may also be granted for municipal cultural activities and informational activities in local associations, etc., aimed at promoting acceptance of the use of renewable energy sources in the municipality. The municipalities may not raise complaints about Energinet.dk's handling of subsidies within the green scheme, but they can refer Energinet.dk's calculation of the municipality's share of the green scheme to the Energy Board of Appeal.

6.E. THE GUARANTEE SCHEME

In order to give local wind turbine owners' associations and other initiative groups the opportunity to initiate preliminary investigations, etc., for wind turbine projects, Energinet.dk has set up a guarantee fund of DKK 10 million that will make it easier for local initiatives to obtain commercial loans for financing preliminary investigations and keep the initiative-takers financially indemnified if the project cannot be realised. The money for the guarantee fund is recouped from electricity consumers as a PSO contribution.

A local initiative may apply to Energinet.dk for a guarantee to take out a loan of maximum DKK 500,000. There are conditions that the wind turbine owners' association or initiative group must have at least 10 members, the majority of whom have a permanent residence in the municipality, and that the project prepared involves onshore wind turbines with a total height of at least 25 metres or offshore wind turbines that are established without a government tender.

The guarantee can be given for activities that may be regarded as a natural and necessary part of a preliminary investigation into establishing one or more wind turbines. This might be an investigation of the siting of wind turbines, including technical and financial assessments of alternative sitings, technical assistance with applications to authorities, etc. However, it is a condition that at the time of application the project is financially viable in the opinion of Energinet.dk. Guarantees can be awarded for a maximum total sum of DKK 10 million. If this limit has been reached, new applications are placed on a waiting list. The guarantee shall lapse when the wind turbines are connected to the grid or if the local group sells its project to another party.

Energinet.dk's decisions concerning the guarantee fund may be contested with the Energy Board of Appeal.

6.F. ENERGINET.DK'S FRONT OFFICE

In order to ensure smooth, efficient administration of the four new schemes, Energinet.dk has set up a Front Office to take care of all direct contact with users of the schemes, while Energinet.dk's technical experts (back offices) undertake the actual legal and financial case-handling. In order to make the work easier for wind turbine erectors, neighbours and municipalities, there is a link (in Danish only) on the Energinet.dk website to a small library where all relevant application forms and other documents can be downloaded via the menu item "Nye vindmøller – hjælp til ejere, naboer og kommuner m.fl." (New wind turbines – help for owners, neighbours and municipalities, etc.).

The website also gives access to information (in Danish only) on the new schemes: the menu item "Kunder" (Customers) gives access to information and material on the loss-of-value scheme and the option-to-purchase scheme, while the menu item "Klima og miljø" (Climate and the environment) gives access to information on all four schemes via the sub-menu *"Danish Promotion of Renewable Energy Act"*. The Front Office staff can be contacted during business hours (9:00 am to 3:00 pm) by telephone on +45 70 20 13 53, or by e-mailing **fo@energinet.dk**.

The majority of initial inquiries have been about the loss-of-value scheme. In the first project to pass through the scheme's procedures, around half of the neighbours who made a claim for compensation obtained a voluntary settlement with the wind turbine erector, while the valuation authority has been involved in the other claims. Compensation was paid in two cases, while two claims were rejected. The valuation authority's specific decisions, which are published in anonymous form, can be monitored via the website **www.taksationsmyndigheden.dk** (in Danish only).

The website **www.energinet.dk** also contains a summary of the individual municipalities' accounts in the green scheme so that you can see whether a municipality currently has funds available for projects and activities.

Photos: Mogens Holmgaard/Vattenfall Wind Power

The Vattenfall electricity company, which is the largest owner of Danish onshore wind turbines, was also responsible for the largest project under the scrapping scheme at Nørrekær Enge, where 77 older wind turbines were replaced with 13 x 2.3 MW turbines. In the photo, the installers are setting up one of the new wind turbines, which were connected to the grid in 2009.

Factbox

The scrapping scheme

Part of the current projects involving new onshore wind turbines is being carried out under the scrapping scheme, which was agreed in the *Energy Policy Agreement of 2004*. Older and less efficient wind turbines with an output of maximum 450 kW can be dismantled in return for a scrapping certificate giving an erector the right to an extra supplement of DKK 0.08 per kWh for 12,000 full-load hours for new wind turbines with a total output up to twice as high as that of the dismantled turbines.

The scrapping scheme covers wind turbines totalling 175 MW, equivalent to the erection of new wind turbines with scrapping certificates for a total of 350 MW.

The scheme for earning scrapping certificates and redeeming them for new projects is administered by Energinet.dk, which also pays the price supplements connected with the scrapping scheme as a PSO-financed contribution.

7. TARIFFS FOR ELECTRICITY PRODUCED BY WIND TURBINES

Factbox

Tariffs for electricity produced by wind turbines

The development of wind power in Denmark has been promoted since the late 1970s by paying wind turbine owners a supplement to the electricity production price. Even though the electricity market in Denmark was liberalised in 1999 so that the market price could fluctuate according to supply and demand, the wind turbine owners were guaranteed a fixed feed-in tariff.

In the *Energy Policy Agreement of 2004* the wind turbine owners' production subsidy was established as a supplement to the market price of DKK 0.10 for 20 years. In the Energy Policy Agreement of February 2008 it was decided to increase the production subsidy to make it more attractive to erect onshore wind turbines.

As the 4,700 or so onshore wind turbines were erected at different times, the production subsidy varies depending on the date of grid connection and the size of the wind turbines. The detailed conditions are set out in the *Danish Promotion of Renewable Energy Act*, which contains all the tariffs for electricity produced by wind turbines. New onshore wind turbines connected to the grid after the *Energy Policy Agreement of 21 February 2008* receive a supplement to the market price of DKK 0.25 per kWh. This supplement applies for the first 22,000 full-load hours, after which the wind turbine owner only receives the market price. Furthermore, a supplement of DKK 0.023 per kWh is paid to cover balancing costs for the full lifetime of the wind turbine. New wind turbines established with a scrapping certificate receive an extra supplement of DKK 0.08 per kWh for 12,000 full-load hours.

Offshore wind turbines established under an open-door procedure receive the same supplement as new onshore wind turbines, i.e. DKK 0.25 per kWh plus DKK 0.023 per kWh. In the case of offshore wind turbines established as part of a government tender, the supplement depends on the price at which the tendering party is prepared to produce electricity. This price will usually depend on the estimated construction costs, the local wind conditions, and the project developer's financing terms.

7.A. THE NEED FOR FINANCIAL SUPPORT FOR WIND TURBINE ELECTRICITY

Right from the late 1970s, there has been financial support for electricity produced by wind turbines. In the early years, this support took the form of both installation grants and electricity production subsidies. Since the beginning of the 1990s, the support has taken the form of a guaranteed feed-in tariff or a supplement to the market price. The support is offered as compensation for wind turbine owners because electricity production from wind turbines still cannot compete financially with conventional production at power plants using coal, natural gas or oil.

The current supplement to the market price is paid by Energinet.dk, which recoups the sum as a public service obligation (PSO). The amount is indicated on electricity bills. In recent years, when the average market price in the Nordic spot market has been fluctuating between DKK 0.20 and 0.35 per kWh, the PSO tariff has been around DKK 0.10 per kWh. As well as wind turbines, which receive around half of these PSO contributions for environmentally friendly electricity production, the contributions are also spent on supporting decentralised CHP plants, electricity production from biomass, solar power, etc.

7.B. PRICE SUPPLEMENTS FOR ONSHORE WIND TURBINES

The price supplement for electricity produced by wind turbines is regulated in the *Danish Promotion of Renewable Energy Act* in accordance with the *Energy Policy Agreement of 21 February 2008*. Here, a broad political majority in the Danish Parliament agreed to increase the supplement to make it more attractive to erect onshore wind turbines. The electricity produced is supplied to the electricity supply grid, and the turbine owner sells the actual electricity on the market under market conditions. A DKK 0.25 supplement to the market price is paid for electricity produced by wind turbines connected to the grid on or after 21 February 2008. The price supplement applies for the first 22,000 full-load hours. Furthermore, a supplement of DKK 0.023 per kWh is paid to cover balancing costs throughout the turbine's lifetime.

In the case of wind turbines that were connected to the grid before 21 February 2008, there are special regulations that depend on the date of connection and the size.

Household wind turbines and small turbines, i.e. wind turbines with an output of less than 25 kW, that are connected in a household's own consumption installation, receive a price supplement which, together with the current market price, amounts to DKK 0.60 per kWh.

If a wind turbine erector has earned or purchased scrapping certificates from older wind turbines with an output of 450 kW or less and dismantles the turbines in the period 15 December 2004 to 15 December 2010, the erector may receive a scrapping price supplement of DKK 0.08 per kWh, which is added to the general price supplement of DKK 0.25 per kWh. The scrapping price supplement is paid for the first 12,000 full-load hours at double the dismantled wind turbine's output. The supplement is conditional on the wind turbine being connected to the grid by 31 December 2010.

7.C. PRICE SUPPLEMENTS FOR OFFSHORE WIND TURBINES

The price supplement for electricity produced by offshore wind farms established as part of a government tender is determined as part of the given tender. The winners of the tenders to date have been the bidders that could offer the lowest feed-in tariff. In the two government tenders carried out so far, the feed-in tariff for Horns Rev II, which is owned by DONG Energy, was set at DKK 0.518 per kWh for 10 TWh, corresponding to around 50,000 full-load hours, and the feed-in tariff for Rødsand II, which is owned by E.ON AB, was set at DKK 0.629 per kWh for 10 TWh, corresponding to around 50,000 full-load hours. Wind turbines established under an open-door procedure receive the same price supplement as new onshore wind turbines, i.e. DKK 0.25 per kWh for 22,000 full-load hours plus DKK 0.023 per kWh for the full lifetime of the turbine.

8. INCORPORATION OF WIND POWER INTO THE ELECTRICITY SYSTEM

8.A. VARYING ELECTRICITY PRODUCTION OF WIND TURBINES

Over the decades Denmark has built up a well-functioning electricity system that gives consumers technical supply reliability that is among the best in the world. The electricity system has traditionally been based on a limited number of large thermal power stations whose heat surplus is used to feed the district heating supply of the largest towns. In the last 15-20 years this set-up has changed significantly, with the predominant proportion of new capacity being established as decentralised CHP plants, waste-based CHP plants, and wind turbines. This decentralised electricity production set-up has required the development of new methods for controlling and regulating the electricity system.

With a total installed capacity of around 3,200 MW, wind turbines today can annually cover around 20% of domestic electricity supply. By way of example, to cover around half of the electricity consumption with wind power in 2025 would require an increase to around 6,700 MW.

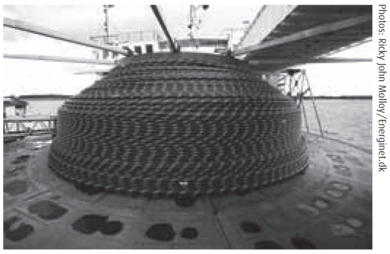
With the current wind turbine capacity there are already periods of the year when the electricity production of the wind turbines exceeds the total Danish consumption. This occurs in particular at night, when the wind blows strongly.

In a European context, Denmark is located between Norwegian and Swedish systems dominated by hydroelectric power and a continental system dominated by thermal power stations south of the border. In Germany, the Netherlands and Belgium, as well as in Norway and Sweden, there are currently plans for a major development of wind power, and the Danish electricity system will therefore assume an important role in linking areas with hydroelectric power, wind power and thermal electricity production respectively. The cross-border connections from Denmark to Norway, Sweden and Germany currently play a key role in optimum utilisation of the fluctuating electricity production of the wind turbines. When it is windy in Denmark and electricity consumption is relatively low, Denmark exports electricity to Norway and Sweden, which turn down their hydroelectric power stations' turbines accordingly. In this way the hydroelectric power stations' water reservoirs function as an indirect store for wind-power-produced electricity because the hydroelectric power stations can quickly increase their production when the wind turbines can no longer cover such a large proportion of electricity consumption.

As the electricity system also has to be able to supply Danish consumers in periods when Danish wind turbines are not producing due to a lack of wind or storms, the system can either be fed by thermal power stations or via cross-border connections. In this way, the development of strong cross-border connections acts as an alternative to Danish back-up capacity with thermal power stations.

An anticipated major development of Danish wind power capacity increases the need to develop methods and means to make electricity consumption more flexible so that electricity consumers are encouraged to reduce consumption in periods of low production capacity in return for increasing consumption when production is high. Practical trials have demonstrated various forms of flexible electricity consumption: electric heat consumers can be switched off for a few hours without inconvenience; cold stores can switch off the electricity supply without the temperature increasing to a critical level; washing machines and dishwashers in private homes can be switched on when electricity prices are low; and so on.

However, a greater effect on the electricity system's overall flexibility can be achieved by integrating electric car batteries and heat pumps into a flexible electricity consumption. This will help reduce Denmark's greenhouse gas emissions from the sectors of society that are not covered by the European CO_2 quota regulation. (The European quota regulation regulates CO_2 emissions for large dischargers such as electricity and heating plants and energy-intensive industry.) Given that from 2013 Denmark will have a special climate emission



Photos: Ricky John Molloy/Energinet.dk

GREAT BELT ELECTRICITY LINK: In order to be able to connect up the two separate parts of Denmark into one electricity system, work has been carried out in recent years on an electricity link under the Great Belt. The link is expected to begin operating in 2010 with a transmission capacity of 600 MW, equivalent to about one tenth of the total Danish electricity consumption on a cold winter's day.

The Great Belt link has a construction budget of approximately DKK 1.2 billion and estimated annual operating costs of just over DKK 100 million. This is regarded as a good investment for Danish society because the link will make it possible to exploit Danish wind turbine power more efficiently within Denmark.

The link will also reduce the need for reserve production capacity in the electricity system and increase competition in the electricity market.

The electricity link consists of a 32 km underwater cable and two land cables of 16 km on Funen and 10 km on Zealand. The link will run from Fraude on Funen to Herslev on Zealand.

The above photos show the underwater cable being laid in summer 2009.

target duty for the sectors that are not covered by the quota system, the reduction of emissions in these sectors will be of particular value. At the same time, the transport sector is still completely dominated by oil, from which Denmark has a long-term goal to free itself. There are therefore environmental, supply-related and economic benefits associated with converting energy consumption from the sectors that are not quota-regulated into electricity and district heating. At the same time, an increase in electricity consumption's share of total Danish energy consumption makes it possible to use a relatively larger proportion of the electricity production from the wind turbines in Denmark, especially if this can be done with a more flexible electricity consumption.

8.B. RESEARCH INTO AN INTELLIGENT ENERGY SYSTEM

Converting the Danish energy system requires the introduction of more intelligent and self-regulating methods for controlling the system. In order to maintain a high technical level of supply reliability there must be a constant balance between production/supply and consumption in the Danish electricity system. As the electricity production from wind turbines can be changed at very short notice, there is a need for advanced communication between production installations, the system operator and consumers. The quicker and more efficiently the system operator can regulate both production and consumption, the lower the energy system's economic costs become.
In order to ensure this development of the electricity system, for several years intensive research has been carried out into advanced methods for regulating the electricity system, and Danish research environments are among the most competent in the world. Furthermore, research is being undertaken into components that make individual wind turbines easier to regulate by the system operator. By combining new advanced regulation methods with intelligent electric meters installed in the premises of consumers, the operation of the electricity system can be optimised and it will be technically possible to incorporate ever greater amounts of fluctuating electricity production from wind turbines, wave power installations, solar cells, etc. ●

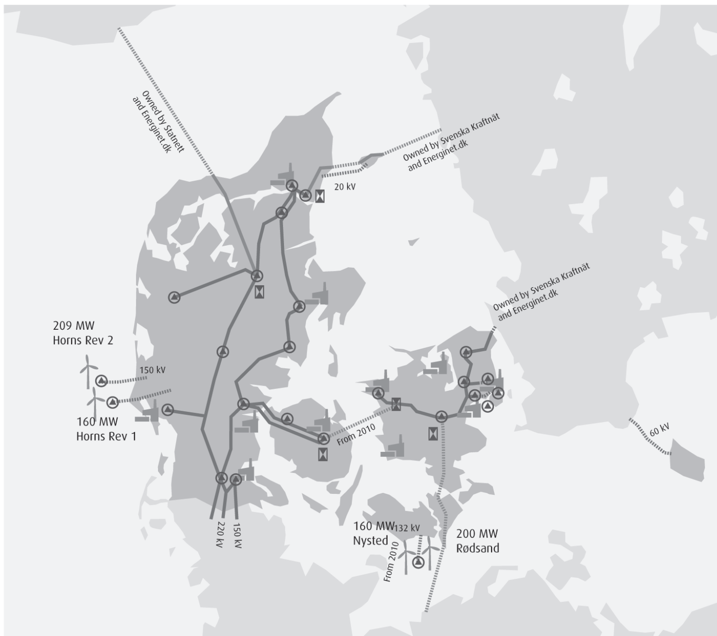


Illustration: Energinet.dk

Key

- 400 kV overhead line, a/c
- 400 kV cable, a/c
- Overhead line, d/c
- Cable, d/c
- Transformer station
- Converter station

The map of Denmark from Energinet.dk shows the Danish high-voltage grid and associated cross-border connections to Norway, Sweden and Germany. Strong cross-border connections are regarded as a vital precondition for efficient utilisation of the varying Danish electricity production from wind turbines.

Currently there are plans to expand the connections between Denmark and Norway (Skagerak IV) and between Denmark and Germany. Furthermore, it is possible to expand the connections between Denmark, Sweden and Germany by connecting a large offshore wind farm on Kriegers Flak to the grid. A possible offshore wind farm south of Læsø could also pave the way for a stronger connection between Jutland and Sweden. And finally, work is being carried out on plans for an underwater cable connection between Denmark and the Netherlands (Cobra), which in the long term would make it possible to carry electricity production from Denmark and Danish offshore wind farms in the North Sea to continental Europe.

FURTHER INFORMATION

The legal provisions on wind power can be found in the *Danish Promotion of Renewable Energy Act* (L 1392, adopted by the Danish Parliament on 27 December 2008), bill no. 55 of 5 November 2008 with explanatory notes. Both can be downloaded (in Danish) from **www.retsinformation.dk**.

More detailed regulations on onshore wind turbines can be found in *Circular no. 9295 of 22 May 2009* on planning and rural zone permits for the erection of wind turbines. The Circular and the associated guideline (no. 9296) can be downloaded (in Danish) from **www.blst.dk/Landsplan/Vindmoeller**.

The Birk Nielsen visualisation report entitled *Store vindmøller i det åbne land – en vurdering af de landskabelige konsekvenser (Large wind turbines in the open countryside – an assessment of implications for the landscape)* can be downloaded (in Danish) from **www.skovognatur/Udgivelser/2007/Storevindmoller.htm**.

The report of the Danish Government's Planning Committee for Onshore Wind Turbines, published in 2007, can be downloaded in Danish from **www.blst.dk/Landsplan/Vindmoeller/Vindmoelleudvalg**. An interactive map for assistance with wind turbine planning can be accessed via **www.blst.dk/Landsplan/Vindmoeller/afstandskort**.

An English summary of the report of the Danish Government's Committee for Future Offshore Wind Power Sites entitled *Future Offshore Wind Power Sites – 2025*, published in April 2007, can be downloaded from **www.ens.dk/en-US/supply/Renewable-energy/WindPower/offshore-Wind-Power/Future-offshore-wind-parks/Sider/Forside.aspx** and the updated *Offshore Wind Turbine Action Plan 2008*, published in April 2008, can be downloaded (in Danish) from **www.ens.dk/da-DK/UndergrundOgForsyning/VedvarendeEnergi/Vindkraft/Sider/Forside.aspx**.

The Danish Ministry of the Environment's Wind Turbine Secretariat has a website at **www.vind.mim.dk** and can be contacted during business hours (09:00 am to 4:00 pm) by telephone on +45 72 54 05 00, or by e-mailing **vind@mim.dk.**

Energinet.dk's Front Office can be contacted during business hours (09:00 am to 3:00 pm) by telephone on +45 70 20 13 53, or by e-mailing **fo@energinet.dk.**

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DANISH ENERGY AGENCY

NIRIG briefing paper 23rd October 2014

NIRIG
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NIRIG Paper to the Environment Committee – Wind Energy Inquiry 2014

23 October 2014

The Northern Ireland Renewables Industry Group (NIRIG) is a joint collaboration between the Irish Wind Energy Association and RenewableUK. NIRIG represents the views of the large and small scale renewable electricity industry in Northern Ireland, providing a conduit for knowledge exchange, policy development support and consensus on best practice between all stakeholders in renewable electricity.

The Strategic Energy Framework 2010, the Sustainable Development Strategy for Northern Ireland and the Regional Development Strategy – Building a Better Future 2035 all need renewables projects in order to achieve their aims and objectives.

Below we provide statistics that represent an overview of some of the successes and challenges that Northern Ireland is experiencing as it moves towards a low-carbon future. With political will and coordinated effort we believe the challenges can be overcome.

We have absolute confidence that with the vision and commitment of all government bodies, and a joined-up strategy to deliver this we will not only reach our 2020 targets but in doing so will create jobs, investment, reduce carbon emissions and future-proof our energy system.

We ask for the Committee's support in achieving this vision.

Renewables in numbers

- **531MW** - operational wind farms producing clean electricity for Northern Ireland
- **70MW** – operational small-scale renewable generation (wind, solar, biomass etc.)
- **35MW** – operational micro-generation (including wind, solar and other)[1]
- **19.5%** - the proportion of electricity from renewables in NI April 2013-March 2014[2]

[1] NIE – figures as of end August 2014

IWEA Irish Wind Energy Association | renewableUK | NIRIG is a collaboration between the Irish Wind Energy Association and RenewableUK

- **93.6%** - the percentage of this figure that came from onshore wind
- **345,375** – the number of homes powered by this renewable generation
- **20%** - the Programme for Government target for electricity consumption from renewables by 2015

Grid connection

- **172.3MW** – large-scale renewable energy expected to connect during 2014
- **41MW** - large-scale renewable energy generation connected to date in 2014
- **178MW** –approximate amount of renewable generation that needs to be connected each year from 2015-2020 in order to reach our renewables targets

Economics

- **£36 million** – money spent with **75** local suppliers involved in the engineering, construction and services sectors for one recent wind farm development in NI
- **£100m** - the estimated benefit to the NI economy (2011-20) of reaching our 2020 targets[3]
- **11.5%** - the predicted reduction in wholesale electricity prices that will be achieved in the Single Electricity Market through delivering 45% of the overall generation mix from wind by 2020 (representing all-island €39 per household)[4]
- **€1 billion** -savings on fossil fuel imports in the last five years in Ireland through renewables[5]

Planning and Resourcing

- **19** – number of wind farm planning applications submitted since 1st April 2013
- **£1,493,790** – application fees paid in respect of those 19 wind farms
- **17** – number of the 19 applications that are still awaiting decisions
- **7** – number of wind farm applications awaiting planning decision **>5 years**

Environment

- **35%** - Programme for Government target to reduce greenhouse gas emissions in 2025 from 1990 levels
- **628,054** – tonnes of CO_2 savings in 2013-14 from wind energy in Northern Ireland

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[2] http://www.detini.gov.uk/electricity_consumption_and_renewable_generation_in_northern_ireland_april_2013_to_march_2014_-_2.pdf?rev=0

[3] This is likely to provide a conservative estimate, as it does not take account of the higher income achievable in wind sector employment relative to that provided by welfare payments.

[4] http://www.iwea.com/viewnews&id=73

[5] http://www.seai.ie/News_Events/Press_Releases/2014/Renewable-energy-has-saved-Ireland-over-%E2%82%AC1-billion-in-fossil-fuel-imports-in-past-five-years.html

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Key policy concerns

Strategic Energy Framework
The Strategic Energy Framework 2010-2020 framework has facilitated major successes: almost one fifth of Northern Ireland's electricity (April 2013-March 2014) came from renewable sources.

The SEF will be reviewed in 2015 and represents the opportunity to recommit to our renewables targets of 40% electricity from renewables, make these legally binding and indeed begin to look further ahead to our 2030 targets.

We ask this Committee to take an active interest in the SEF review to ensure that the long-term future of our environment remains a government priority

Strategic Planning Policy Statement (SPPS)
The draft SPPS clearly emphasises **sustainable development** as a core principle, and recognises the role of renewable energy in this. However, the 'golden thread' of sustainability appears to have been cut in the policy relating to renewable energy.

We believe that the SPPS' overarching emphasis on sustainable development is not reflected in the policies specifically relating to Renewable Energy and we urge that this be rectified.

We believe that it is vital to ensure that there is a presumption in favour of renewable energy resources as this one of the key forms of development that will actively contribute to a sustainable future.

Local Councils will shortly be producing **development plans**, based on the policy framework of the SPPS. We have major concerns that there is **no** mention of our key energy policy – the SEF - within the SPPS. The current wording would allow Councils to develop policy within their LDPs which conflicts with regional policy.

We believe that the SPPS must require local plans and policies to unambiguously align with national policies, frameworks and strategies, including specific mention of the SEF.

We believe that the renewables industry has been a leader in **community engagement and community benefit**: as the Committee will be aware we published a best practice guidance in June of this year. We are concerned that the draft SPPS only singles out wind energy developments as needing to provide community benefit.

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We do not accept this discriminatory treatment of one particular technology within one particular sector

Local Government Reform

We believe it to be crucial that projects in the planning system at the time of transition to local Councils do not suffer long delays. Based on potential timeframes on the transition period we have estimated that further delays of up to 4 years in determining planning applications could be possible

We therefore believe that any live wind farm applications at the time of transition should be concluded by the Strategic Projects Team at DOE Headquarters.

Development Management Regulations

Wind farms and associated grid infrastructure are complex and regionally important development projects. The DOE Strategic Projects Team has the experience and expertise to assess these complex applications. We believe that renewable energy developments greater than 5MW and associated grid infrastructure should continue to be determined by the Strategic Projects Team at Headquarters.

Appropriate call-in facilities need to be developed to safeguard in case of non-determination of planning applications, or decision-making that does not reflect Executive policy as laid out in the SEF.

Planning and Resourcing

We understand that NIEA is working with reduced resources and we appreciate the challenges being faced in this regard. However, the current situation is now severely affecting the progress of both planning applications and wind farm build-out, which in turn is impacting upon Programme for Government planning targets, progress towards our Strategic Energy Framework targets and investment and job creation in our economy.

Serious delays in substantive responses from NIEA are in large part the cause of wind farm applications not being turned around within 6 months as per PfG targets.

Within the last 18 months developers have paid almost £1.5million in planning application fees. Of the 19 applications submitted in this time period, 2 have received decisions. We do not believe that this represents value for money or indeed fair treatment for renewables projects.

The obvious solution to this situation is an increase in the resources available, particularly within the NIEA, and as soon as possible. Furthermore, the ability to prioritise planning

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applications already exists. We believe that it would be of considerable benefit to Northern Ireland's economy to do so for wind farm developments.

Contributing to DOE and international targets in carbon emissions
Low-carbon electricity production is one of the most cost-effective methods of reducing greenhouse gases across the Agri-Food, Transport and Energy sectors in Northern Ireland; especially important as the DOE has committed in its 2014-15 business plan to secure a lower-carbon approach to these sectors.

We ask the Committee to continue to promote the contribution of renewable energy as a key method of ensuring success in carbon and greenhouse gas emission reduction targets.

Conclusion

As the Committee will be aware, outside of planning and local government reforms, a significant number of policies are being developed, replaced or amended for the renewable energy sector in the period 2014 - 2017. These include two fundamental changes in our energy markets which will be applied by 2017 and this now means a sustained effort on the part of developers to make sure projects are operational by this date. The urgency of an efficient planning system is therefore compounded.

The renewables industry has delivered lower-carbon electricity, hundreds of jobs and millions of pounds of investment in Northern Ireland. This has been a direct success of a clear government vision and strategy and political will. Targets work but they need full political commitment.

One recent wind farm development in Northern Ireland equated £125million of investment, including £36million during the construction phase with local supply chain companies. This development supported jobs and enterprise with over 75 local businesses.

Northern Ireland **cannot** afford to jeopardise this investment and these jobs.

We ask this Committee to take an active interest in the SEF review and all other renewables-related policy to ensure that the long-term future of our environment remains a government priority.

NIRIG
NORTHERN IRELAND
RENEWABLES INDUSTRY GROUP

Windwatch – Comments on UU survey 'Living with wind turbines'

This response by a member of Windwatch NI to the University of Ulster survey 'Living with Wind Turbines', June 2012, has been anonymised to protect the identity of the respondent who is employed in the energy industry.

It should be noted that the organisers of the survey refused to reveal the locations involved. The actual and proposed wind farms were discovered to be Garves at Dunloy and the proposed one is at Loughguile. It was discovered that most of the people who had indicated opposition to the proposed wind farm were not invited to participate in the survey or even knew of its existence. Those that did participate were not made aware of the purpose of the survey.

It is remarkable that there were over 90 objections against the proposed wind farm and a further Petition against signed by over 200 residents, while only three letters supported the proposal, two with a financial involvement, and the third a person unknown. That the survey should attempt to represent such a positive attitude to the proposal by the same community at the same time, is simply not credible.

My comments on the "Living with Wind Turbines Survey":

1. I took part in the survey and do not remember being told that it was being funded by the NIEA, and I do not remember the Chartered Institute of Environmental Health being mentioned.. Neither do I remember being advised that the NIEA Challenge Fund was set up to facilitate study of:

   - the sustainable use and protection of our natural resources,
   - improved conservation and management of our natural heritage,
   - improved conservation and protection of our built heritage,
   - better public awareness and understanding of the environment.

   In the interests of a fair assessment of the community's views, perhaps the other highlighted elements above should also have been assessed by the NIEA with respect to Wind Farm Development, and perhaps the Chartered Institute of Environmental Health should carry out a more detailed and objective study of the environmental health of those living closest to wind farms, instead of a generalised and diluted study such as this one which draws very broad conclusions from a very small information base.

2. I believe the greatest flaw in the survey is the conclusion that has been drawn; ref the Executive Summary: "The research findings indicate that the presence of wind turbines had little impact on the resident's perception of their neighbourhood as both sites rated their area as 'good' or 'very good'.

   I think it is ludicrous to come to this conclusion, as it assumes that the residents at the Proposed site would, in the case of development, be affected in exactly the same way as the residents of the operational site had been. It should be obvious that this would only be the case if the turbines were exactly the same size, the same distances from occupied dwellings, with the same predominant wind directions and capacity factors in relation to the residents who took part in the survey, and furthermore, if they were located in such a way that the impact on the character of the local landscape was also the same.

3. There is almost no detail provided in the survey results. We have no idea whether the respondents lived on the outer edge of the 3km limit or within 1 km of the Site. Those living towards the outer boundaries would probably not be subject to any noise impact, while those living within 1km could – literally – have their quality of life destroyed by noise from the wind

turbines. Those living towards the outer boundaries may not even have direct line of sight to the turbines, in which case they would hardly be expected to complain strongly against visual impact, while those living within 1km usually cannot escape the visual impact. Those living towards the outer boundaries may not foresee of suffer ay devaluation in their property values, while those living on the edge of the wind farm sites could find that their properties are unsalable. Surely it is obvious that such a survey does not truly represent the views of a local community, since it covers such a relatively large area and provides absolutely no indication of where the respondents are located within that area. These flaws are inherent in the reports (Warren et al (2005) and Braunholtz et al 2003) to which this survey refers;

The question of how representative the survey was is also highlighted by the statement that: " In total, 241 questionnaires were completed over the course of the 3 days – 131 from Site 2 (operational) and 110 from Site 1 (proposed). The approximate response rate from Site 2 was 19.9% and from Site 1, 43.8%, taking into consideration the number of properties within 3km of the wind farm or proposed site". Can a survey of 19.9% of potential respondents, with no knowledge of where those respondents live in relation to the wind farm, be considered representative?

4. The survey interpretations are not at all objective and the authors draw and/or imply conclusions in a very dismissive way; e.g. "Although the respondents from Site 1 were generally positive towards wind farms and wind power generation, a substantial proportion of people thought that their area would be less satisfactory to live in due to the proposed wind farm, which is suggestive of a NIMBY attitude". As one of the respondents, I take strong issue with this statement. In general, if someone was supportive of wind power but believed for example that wind turbines should not be installed within 2 km of any residential homes or located in areas where they will change the landscape character of the area, those views would pertain to any wind farm development in the country, not just those in that persons own back yard. In the case of the proposed site

   a. There are numerous residents within 1 km of the proposed wind farm. Having seen the devastating impact of other wind farm developments so close to dwellings (where people have had to leave their homes), why is it unreasonable to have a view that nobody – whether in the respondents back yard or not – should be subject to that treatment?

      Even local councils and Ministers in other jurisdictions have accepted that those living in the immediate vicinity have a right to be listened to, without being dismissed as 'NIMBY's'. For example, in rejecting plans for the Newburgh Wind Farm in Fife, Scotland, Fife Council stated that the wind farm: "would create an overbearing effect on the virtually undeveloped surrounding rural landscape, and would detrimentally affect the visual amenity of the occupiers of properties within the immediate locality"; similarly, in rejecting the Spittal Wind Farm near Greenock Scottish Ministers had "considered the residential receptor assessment, included in the application, which identified 89 existing or nearly completed properties within 2 kilometres of the nearest turbine, 16 of these within 1 kilometre and the remaining 72 properties lie between 1 and 2 kilometres. The Reporter examines these effects in paragraphs 9.58 to 9.68 of the report and found that overall at least 5 non-stakeholder properties would become unpleasant places to live in and that a number of others would suffer from adverse visual impacts.

   b. the NIEA themselves (Chief Landscape Architect) had stated repeatedly that they have concerns "Landscape Architects Branch has significant concerns regarding the potentially adverse impacts which this wind farm would have on both the visual amenity and landscape character of this area. The proposed development will impact on key views of the AONB from the lowland landscapes to the west and will be seen in the context of the distinctive skyline of Slieveanorra. Landscape Architects Branch also has concern at the cumulative impact of the proposed development which will extend the influence of wind farm development further to the north and will undermine the integrity of the landscape". Again, I would have thought it reasonable for any right minded person to support a view that no wind farm should be developed anywhere in the country where the applicable Environment Agency has formed such an opinion.

I strongly resent the fact the survey has drawn or implied potentially false conclusions from answers provided by respondents.

5. In Chapter 2 "Introduction and Policy Background", some very broad and subjective statements are made in relation to energy policy and no mention is given to the fact that there are numerous opposing views, in most cases from professional and industry sources whose opinions should not be dismissed so casually, for example:

- "A shift to renewable energy for electricity generation will also contribute significantly towards reducing NI's greenhouse gas emissions". This may not be the case; Dr. Fred Udo, a graduate of the Technical University of Delft, has carried out a study of the Irish Grid using real-time, ¼ hr data published by Eirgrid. (i.e. not a theoretical simulation). His study revealed that the supposition that 1 MW of wind energy can displace 1 MW of fossil fuel energy and its associated CO2 (i.e. a 1:1 ratio) is false. In fact, the ratio in 2010-2011 was 0.6, and he further found that the greater the wind energy percent on the grid, the lower the ratio, i.e., adding still more wind energy becomes less and less effective for CO2 emissions reduction. - at very high wind energy percent on the grid, the ratio will ultimately go to zero and then become negative, i.e., adding still more wind energy to the grid will actually INCREASE CO2 emissions.
- Graph 1 included in this section also highlights one of the fallacies of the renewable energy approach. This survey follows the now standard approach of suggesting that renewable energy is the only way of meeting greenhouse gas emissions targets (which are of course, the primary concern). In fact, a growing number of experts are concluding that wind energy is neither the quickest or the least cost way of reducing greenhouse gas emissions. For example, AF-Mercados, a global energy consultancy reported that, in relation to UK Renewable Energy Targets "Our modelling indicates that in order to meet our 2050 target for carbon reduction emissions for power we need to spend around 25% more than we would if we had no such target. To achieve exactly the same amount of carbon reduction – but with the renewable targets as well – would add around another 15%, or about 40% extra overall costs compared to no targets ….. If our only policy driver is to reduce carbon emissions, then the lowest cost way of meeting our emissions targets requires a mixture of gas and nuclear new build". It's interesting that Graph 1 shows that in Northern Ireland, a large proportion of electrical power is generated in low efficiency and high emission coal and oil fired plants. Moving these generations sources to modern CCGT would have saved more CO2 than all the wind farms installed on the island of Ireland.
- This Section also ignores scientific concern about the release of CO2 from peat bogs when they are disturbed. In 2006, New Scientist reported that 'Mike Hall from the Cumbria Wildlife Trust had developed assessment methods for estimating CO2 release from degrading peat. The first is a baseline figure calculated simply from the amount of peat excavated in construction. The second "minimal scenario" includes emissions from degraded peat up to 50 metres around areas of disturbance such as foundations and service roads. This figure was being used by wind farm developer AMEC in Scotland. A third "high scenario" extends that range to 100 metres. Hall believes this is closest to the actual level of disruption, citing Lindsay's research, which indicates that damage to peat can extend for as much as 250 metres on either side of tracks or drainage ditches, as water drains from the affected area.

To calculate carbon savings, Hall uses the developers' own predictions, which generally give figures for overall electricity generation of about 30 per cent of the maximum rated capacity of a turbine. The average achieved output for existing wind farms is actually lower than this

- 25.6 per cent according to industry figures. Using the conservative “minimal scenario”, Hall calculates that a 2-megawatt turbine built on peat moorland 1 metre deep will take 8.2 years to pay back its CO2 cost. The figure for the “high scenario” is a whopping 16 years. Even the minimal figure is a substantial portion of a turbine’s normal lifespan of 25 years, and considerably higher than the industry’s own figures, which range between three and 18 months.’

For the “Living with Wind Turbines” survey to be taken seriously, it should either refrain from making subjective statements or at least point out to the reader that other views and opinions exist.

6. In Chapter 2.2 “Introduction and Policy Background –Potential Health Impacts of Wind Turbines”, the survey again makes a series of sweeping and subjective statements which I don’t believe provide an objective view. Even the references to source material are selective; for example, the Knopper et al study referred to in this Section actually states that: “A number of governmental health agencies agree that while noise from wind turbines is not loud enough to cause hearing impairment and are not causally related to adverse effects, wind turbines can be a source of annoyance for some people. Ultimately it is up to governments to decide the level of acceptable annoyance in a population that justifies the use of wind power as an alternative energy source” and also states: “Assessing the effects of wind turbines on human health is an emerging field, as demonstrated by the limited number of peer-reviewed articles published since 2003. Conducting further research into the effects of wind turbines (and environmental change) on human health, emotional and physical, as well as the effect of public consultation with community groups in reducing preconstruction anxiety, is warranted”. So not quite as dismissive as the survey might suggest.

The Living with Wind Turbines survey and the sources it references would have us believe that any symptoms of ill health derive solely from the “stressed condition induced in some of those living near wind farms”. Yet in an article published in February 2012, Renewable Energy World, a publication which is advertised as being :” The World’s #1 Renewable Energy Network for News & Information”, Jim Cummings from the Acoustic Ecology Institute stated that “there have been some reliable reports from non-residents (i.e., not coping with stress or annoyance from living near turbines) who experienced physical and mental effects shortly after arriving in the vicinity of operating turbines. Among these are two acousticians who recently experienced a dramatic loss of concentration and focus within a half hour of arriving to do measurements of a turbine in Massachusetts, something that had never before occurred in decades of field work

Rare Earths and Other Chemicals Damaging the Environmental Value of Renewables

The old adage about how you don't want to see how laws or sausage is made applies to so-called renewable energy. Specifically, you don't want to know the environmental cost of all those rare earth minerals that the technology requires.

The wind power industry produces a great deal of toxic waste because mining rare earth minerals, which are essential for wind turbines, is a dirty business.

Is it worth the cost?

Wind Energy: About Those Rare Earths…

Wind energy seems so clean – gentle breezes quietly spinning sleek blades, generating energy. What could be dirty about that? According to The Data Center Journal, for one, the answer is, "Plenty." Why? To get those supposedly clean and green turbines, one needs a rather large quantity of rare earth minerals (which, despite their name, are not so rare). Mining and processing these rare earths generates a tremendous amount of "hazardous and radioactive byproducts," the DCJ reports, which "can cause tremendous harm to both people and the environment."

In fact, the environmental effects of rare earth mining can be literally sickening. In the Mongolian town of Baotou, the epicenter of Chinese rare earths production, the mining has literally killed off the local farming, The Guardian reports: "The soil and groundwater are saturated with toxic substances. Five years ago (local farmer) Li had to get rid of his sick pigs, the last survivors of a collection of cows, horses, chickens, and goats, killed off by the toxins."

The irony is rather hard to miss – proponents of wind power demand stringent environmental standards on our domestic coal and nuclear industry, but seem strangely unconcerned at the appalling environmental conditions necessary to supply their rare earths habit.

In fact, it's rare earths which account for a great deal of the overall carbon footprint of wind energy, but this carbon debt is not calculated as part of the assessment of the value of a wind energy application. It's an almost-ironic situation where carbon-intensive production and mining methods are used to manufacture products claimed to lower the overall carbon footprint. Danish wind turbine producer Vestas writes on its website, "The rare earth elements are used in the magnets found in the tower and in the permanent-magnet generators in some of the newer models… to improve the performance of turbines by making the generators more efficient and more grid-compatible…"

At the Hong Kong conference on rare earths JLMag projected that global demand for rare earth permanent magnets from wind would increase from 4500 tonnes in 2012 to 8000 tonnes in 2014 assuming stable neodymium, praseodymium and dysprosium pricing. Traditional wind generators are less efficient at low wind speeds, while direct drive wind turbines which use neodymium-iron-boron magnets can operate at low wind speeds and improve wind farm economics. A 3 MW wind turbine can use up to 2,700 kg of NdFeB magnets. While the increase in demand from rare earth turbines is still dependent on government subsidies, they will be increasingly favoured over their less efficient counterparts if rare earth prices are low.

Rare Earths Not So Eco-Friendly, Either.

A major concern surrounding China's practice of mining rare earth elements is the negative impact it has to the environment due to lax mining practices. There are a number of potential environmental implications to mining rare earth elements if not done properly. Unfortunately, because of the revenue potential, many rare earth mines have been operating illegally, with no regulation, causing severe environmental hazards, which exacerbates the problem.

According to an article published by the Chinese Society of Rare Earths, "Every ton of rare earth produced, generates approximately 8.5 kilograms (18.7 lbs) of fluorine and

13 kilograms (28.7 lbs) of dust; and using concentrated sulfuric acid high temperature calcination techniques to produce approximately one ton of calcined rare earth ore generates 9,600 to 12,000 cubic meters (339,021 to 423,776 cubic feet) of waste gas containing dust concentrate, hydrofluoric acid, sulfur dioxide, and sulfuric acid, approximately 75 cubic meters (2,649 cubic feet) of acidic wastewater, and about one ton of radioactive waste residue (containing water)." Furthermore, according to statistics conducted within Baotou, where China's primary rare earth production occurs, "all the rare earth enterprises in the Baotou region produce approximately ten million tons of all varieties of wastewater every year" and most of that waste water is "discharged without being effectively treated, which not only contaminates potable water for daily living, but also contaminates the surrounding water environment and irrigated farmlands."

The disposal of tailings also contributes to the problem. Tailings are the ground up materials left behind once the rare earth has been extracted. Often, these tailings contain thorium, which is radioactive. Generally, tailings are placed into a large land impoundment and stored. In the U.S. strict controls are put into place and permits are required to store tailings. According to Wang Caifeng, China's Deputy Director-General of the Materials Department of the Ministry of Industry and Information Technology, producing one ton of rare earth elements creates 2,000 tons of mine tailings. Wang said that China has sacrificed greatly in its extraction of rare earths. However, according to a study on behalf of the United States Army by Cindy Hurst of The Institute for the Analysis of Global Security, the people of China are still being made to pay a terrible price so that wind turbines can have permanent magnets.

For example, the ore mined in Bayan Obo is transported to Baotou via open railway carts, where it is then processed. Unfortunately, the waste finds its way into the Yellow River, which passes by the south side of Baotou and travels about another 1,300 miles, through mountainous terrain as well as through heavily populated areas before finally dumping into the Yellow Sea.

In 2005, Xu Guangxian wrote that thorium was a source of radioactive contamination in the Baotou area and the Yellow River. According to a local source, "In the Yellow River, in Baotou, the fish all died. They dump the waste – the chemicals into the river. You cannot eat the fish because they are polluted." Some 150 million people depend on the river as their primary source of water.

Under traditional technology means, refining rare earth elements requires such chemicals as ammonium bicarbonate and oxalic acid. The potential health hazards of ammonium bicarbonate include: Irritation to the respiratory tract if inhaled, irritation to the gastrointestinal tract if ingested, redness and pain if it comes in contact with the eyes, and redness, itching, and pain if it comes in contact with the skin. Oxalic acid is poisonous and potentially fatal if swallowed. It is also corrosive and causes severe irritation and burns to the skin, eyes, and respiratory tract, is harmful if inhaled or absorbed through the skin, and can cause kidney damage. These and other chemicals often find their way into the Yellow River.

The grim trade-off between obtaining power from wind and the methods required to make that happen leave those within the industry uncomfortable. "Executives in the $1.3 billion rare-earths mining industry say that less environmentally damaging mining is needed, given the importance of their product for green energy technologies," The New York Times wrote back in 2009, adding that Nicholas Curtis, the executive chairman of the Lynas Corporation of Australia, in a speech to an industry gathering in Hong Kong said, "This industry wants to save the world. We can't do it and leave a product that is glowing in the dark somewhere else, killing people."

So, in short, it is best not to talk about it – and that is exactly what the industry has done!

DRK 16 October 2014

1990sOne tonne of CO_2 claimed per MWh of electricity generated (see PowerGen CRR);

Mid-1990s. Reduced to reflect displacement of coal to 0.86 tonnesCO_2/MWh. But the DTI (now BERR) stated that grid-average mix should be used rather than the coal displacement figure (Wind Energy Fact Sheet 14). At that time this was 0.654 tCO_2/MWh based on a 1993 blend of power stations. Since then many dirty coal plants have been replaced by cleaner gas power stations.1

2004. DEFRA use grid average mix of 0.43 tCO_2/MWh 2. Also used by the Carbon Trust3 and Ofgem for converting ROCs into Emissions Trading Scheme Credits 4;

December 2005 onwards. The use of 0.43t/MWh was confirmed by the Advertising Standards Authority (ASA) in several rulings against Renewable Energy Systems Ltd and NPower Renewables for calculating the lifetime savings of a wind farm.

mid-2007. BWEA negotiating with ASA to try to agree a figure acceptable to the industry.

May 2005. Sustainable Development Commission refers to a figure of 0.36t/MWh by 2020. 5

Autumn 2007.Press release from BERR, Malcolm Wicks, the Energy Minister, used a figure of 0.37t/MWh for savings expected from the Fullabrook Down wind farm (Devon). This became the norm for BERR as confirmed in replies to parliamentary questions January 15th 2008.6

2005. In its Climate Change Review, DEFRA 7 used a figure of 0.27 tCO_2/MWh for the year 2010, confirmed in a written answer by the Energy Minister8.

November 2008. BWEA agreed with ASA, figure of 0.43t/MWh should be used for CO_2 emissions saving calculations.

March 2013. Analysis of Irish grid based on Eirgrid data by Dr Joe Wheatley, identifies savings from wind of 0.28 tonne CO_2/MWh,

These figures make no allowance for electricity consumed by the wind turbines for functions such as:

- Yaw control (maintaining the direction of the blades into the wind) and pitch control (the angle of the blades)
- Lighting
- Heating and de-icing
- Lubricating pumps
- Controls
- Exciting the stator
- Blade and shaft turning in light wind to prevent warping.

Unless measurements are made of electricity consumed by wind turbines, it is not possible to determine what the net electricity production is and therefore what the CO_2 emissions savings are. It is my understanding that the electricity produced is sold and metered for calculating and claiming ROCs whereas the electricity used to operate the turbines is bought back. Thus gross electrical output rather than net electrical output is used to claim ROCs, which are used in official calculations of achieved capacity factors.

Need for an independent assessment of the effect of wind turbines on the CO_2 emissions of conventional power stations and a realistic calculation of the pay back time for CO_2 emissions during fabrication, transport, erection and maintenance of the turbines and infrastructure.

Erroneous aassumption that wind output would allow conventional plant to be shut down, whereas certain transmission constraints exist. For example, the "Transmission Constraint

Groups” published by Eirgird and SONI and effective from 17th May 2012 includes the following SONI TCG:

“Coolkeeragh CCGT must remain on load when the N/system demand is above 1000 MW to ensure system security in the North West”. This TCG will apply at the moment regardless of whether any further wind farms are built.

The Intergovernmental Panel on Climate Change gives figures for natural fluxes between the biosphere and the atmosphere of 120GtC/yr and between the oceans and atmosphere of 70GtC/yr. Thus the total fluxes are 190GtC/yr. This equates to 697Gt CO2/year. Burning of fossil fuels accounts for an additional 6.4GtC/yr (23.5Gt CO2/yr), i.e. about 3.4% of the total flux.

The recently rejected Drumadarragh wind farm application would therefore reduce the world’s fossil fuel derived CO2 emissions by 2,649/ (23.5 x 109) = 0.00000011 or 0.000011%. To put this into context, it would require the construction of more than 90,000 wind farms of the size of Drumadarragh to reduce the world CO2 emissions from fossil fuels by 1%.

Drumadarragh would reduce the world’s total CO2 emissions by 2,649/ (720 x 1 09) = 0.0000000035 or 0.00000035%. To put this into context, it would require the construction of more than 2,760,000 wind farms of the size of Drumadarragh to reduce the world’s total CO2 emissions by 1%.

Windwatch – 20 questions for the wind industry

20 Questions for the Wind Industry

Q1. What effect do wind turbines have on electricity prices in Northern Ireland?

The Industry view:

“There is a misconception that the construction of wind farms and the electricity that they produce is somehow leading to a significant increase in the electricity bill. In reality, the increase that consumers face in electricity bills is coming because of gas price increases. As an industry, we are very clear that the contribution that the 15% — 14% at the minute — is making to the electricity market is actually helping to reduce the price of electricity.”

N.I.Renewable Industries Group to Environment Committee, 12 September 2013.

The reality:

The cost of domestic electricity increased by 36% between January and October 2008. The cost of domestic natural gas increased by 19% in the same period.

The Consumer Council for Northern Ireland.

Cost of a unit of electricity from Power NI (formerly NIE):

October 2003	9.38 pence per unit
October 2004	9.64 pence per unit
October 2005	9.95 pence per unit
October 2006	11.02 pence per unit
October 2007	10.69 pence per unit
October 2008	12.66 pence per unit
October 2009	15.06 pence per unit
October 2010	14.31 pence per unit
October 2011	14.31 pence per unit
October 2012	17.18 pence per unit

Q2. Has Fuel Poverty in Northern Ireland increased?

"With 42% of households in Northern Ireland spending more than a tenth of their income on energy, compared to 15% in England, we have the highest level of fuel poverty in Western Europe.” Pat Austin, Chair of the NIFPC.

More than seven out of ten people have been deprived of basic essentials such as food due to rising energy bills.

Eight out of ten struggle to adequately heat their homes.

Households in Fuel Poverty	Northern Ireland	42% - 23% in 2004
	Wales	29%
	Scotland	25%
	England	15%

Fuel Poverty Statistics Report 2013

2

Q3. How much of Northern Ireland's electricity comes from Renewables?

Fuel Mix Information for Northern Ireland

Year	Coal	Natural Gas	Nuclear	Renewable	Peat	Oil	Other
2008	19.00%	66.05%	0.00%	3.54%	7.06%	3.84%	0.51%
2009	15.80%	68.70%	0.00%	4.80%	7.40%	2.80%	0.50%
2010	17.6%	70.4%	0.00%	3.4%	6.4%	1.7%	0.5%
2011	14.7%	71.3%	2.5%	1.6%	6.0%	0.7%	3.2%
2012	31.6%	52.8%	0.0%	2.0%	10.9%	0.0%	2.7%

from Power NI electricity bills, including supplies through interconnectors

As can be seen, only 2% of electricity came from renewable sources in 2012 and there was a reduction of over a quarter in the amount from natural gas between 2011 and 2012, yet this is blamed by NIRIG (above) for the increase in electricity prices. Note the amount from coal more than doubled in the same period and there was also an increase in CO_2 emissions during the year.

Q4. Is electricity from wind cheaper?

As is now widely known, wind farms' biggest problem is that for about three-quarters of the time, the wind does not blow at the right speed to turn the turbines.

Electricity cannot be stored – you have to generate it at the moment you need it – and the wind might not oblige when 10 million viewers want to switch the kettle on at the end of Coronation Street. So, at the same time as building new wind farms, you must build new conventional power stations as backup.

The Government does not include the costs of building these backup stations in its figures for wind. Nor does it include the cost of the thousands of miles of extra powerlines needed to collect electricity from wind farms, much more widely scattered than conventional power plants.

The Renewable Energy Foundation (REF) and The Sunday Telegraph asked Colin Gibson, former power network director at the National Grid, for an estimate that takes into account these production costs.

His figures suggest that across its whole life, onshore wind will cost as much as £178 per megawatt hour of electricity generated, three times nuclear (£60). Offshore wind, with its much higher construction cost, is more than four times dearer, at £254 per megawatt hour.

Mr Gibson stresses that, though most of his calculations are based on official data, some have to be based on his best judgment, and aren't definitive. But the broad picture is clear. "If you take the costs of a mixture of on and offshore wind, it is very roughly £140 per megawatt hour higher than a mixture of nuclear and gas turbines," he says.

3

"Multiply that by the number of megawatt hours we use, and you get a figure in the order of maybe £11 billion a year, which is about £550 per customer per annum [extra] for wind power. That is quite frightening."

Until now, the main controversy about electricity prices has been to do with consumers. Last week, new figures showed that rising bills have driven another 700,000 people into "fuel poverty". But the impact on manufacturing could deliver a double whammy: not only costing you money, but also costing you your job.

The Telegraph, 13 June 2010

Shelving expensive wind farms in favour of cheaper nuclear and gas-fired power stations would save every Briton almost £550, it is claimed.

Government plans to cut pollution by a third by 2020 rely heavily on wind power and will cost £108billion to implement, an accountancy firm has calculated. But shifting the emphasis away from turbines and towards nuclear and gas-fired power stations would slash the bill by £34billion, according to KPMG. This equates to around £550 for every person in the country.

Mail Online, 7 November 2011

Q5. What is the Life Expectancy of a Wind Turbine?

Britain's wind farms are wearing out far more rapidly than previously thought, making them more expensive as a result, according to an authoritative new study.

Analysis of almost 3,000 onshore wind turbines — the biggest study of its kind —warns that they will continue to generate electricity effectively for just 12 to 15 years.
The wind energy industry and the Government base all their calculations on turbines enjoying a lifespan of 20 to 25 years.
The study estimates that routine wear and tear will more than double the cost of electricity being produced by wind farms in the next decade…

The report concludes that a wind turbine will typically generate more than twice as much electricity in its first year than when it is 15 years old.
The report's author, Prof Gordon Hughes, an economist at Edinburgh University and a former energy adviser to the World Bank, discovered that the "load factor" — the efficiency rating of a turbine based on the percentage of electricity it actually produces compared with its theoretical maximum — is reduced from 24 per cent in the first 12 months of operation to just 11 per cent after 15 years.
The decline in the output of offshore wind farms, based on a study of Danish wind farms, appears even more dramatic. The load factor for turbines built on platforms in the sea is reduced from 39 per cent to 15 per cent after 10 years.
Prof Hughes said in his conclusion: "Adjusted for age and wind availability, the overall performance of wind farms in the UK has deteriorated markedly since the beginning of the century….In addition, larger wind farms have systematically worse performance than smaller wind farms."

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He said: "I strongly believe the bigger turbines are proving more difficult to manage and more likely to interfere with one another. British turbines have got bigger and wind farms have got bigger and they are creating turbulence which puts more stress on them. It is this stress that causes the breakdowns and maintenance requirements that is underlying the problem in performance that I have been seeing."

Prof Hughes examined the output of 282 wind farms —about 3,000 turbines in total — in the UK and a further 823 onshore wind farms and 30 offshore wind farms in Denmark.

Dr John Constable, the director of REF, said: "This study confirms suspicions that decades of generous subsidies to the wind industry have failed to encourage the innovation needed to make the sector competitive. Bluntly, wind turbines onshore and offshore still cost too much and wear out far too quickly to offer the developing world a realistic alternative to coal."

Prof Hughes said his analysis had uncovered a "hidden" truth that was not even known to the industry. His report was sent to an independent statistician at University College London who confirmed its findings.

Daily Telegraph, 30 December 2012

Q6. What is the UK target for renewables and when will it be met?

Chris Heaton-Harris MP

"Firstly, the European targets. There are two. They are known as the 20:2020 and the 15:2020. The first is a target to reduce our carbon emissions by 20% by 2020 and the second is to have 15% of our energy requirements produced by renewable energy sources by 2020…the Directive concerned did not state which method you could/should use to hit these targets. You could do it with no wind energy element at all should you wish.

Exchange on targets between Chris Heaton-Harris MP and the Rt Hon Ed Davey MP, the Secretary of State in the Department of Energy and Climate Change, in the House of Commons on Thursday 8th March, 2012:

Mr Davey: I thank my hon. Friend for his question. He and I may disagree about the significance of onshore wind, but I appreciate the measured way in which he has engaged with me and the Prime Minister on this issue. I can tell him that 5 GW of onshore wind power generation has already been built, that there is planning consent for a further 6 GW and that planning permission is being sought for 7 GW-worth of projects, only some of which will be approved. Given that the ambition was for 13 GW, most of the development that the country needs is indeed already on the table.

Based on the Department for Energy and Climate Change's own figures, we'll be hitting our onshore wind target for turbines constructed and approved awaiting construction by mid-summer 2012.

This proves two things: Firstly, that the subsidy level is too high. Secondly, that we can afford to be choosy as to where these things are sited now. We don't have to put them

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within 500 metres of dwellings, or motorways, or historic buildings, or in the middle of beautiful countryside or in places where there is little wind."

Q7. How much employment will wind farms provide?

Please note that the number of wind turbines operational and under construction in Scotland is 2666 and 348 in Northern Ireland – a ratio of 7.66 to 1. To work out the employment wind farms will create in NI, just divide the figures in the articles below by 7.66. Note that on 31 January 2013, the wind industry in Northern Ireland claimed 4,000 jobs. However, when the N.I. Renewable Industries Group met the Environment Committee on 12 September 2013, they stated, "We estimate that some 1,300 people across Northern Ireland are working specifically in wind." Using the ratio above, employment is unlikely to exceed 300!

Barely 2,000 onshore wind farm jobs in Scotland

Fergus Ewing, the SNP Energy Minister, published figures showing there are 2,235 posts "connected directly to onshore wind", less than a fifth of the total for all forms of green power.

Mr Salmond last year told MSPs that 18,000 Scots were employed in renewable energy before downgrading that total to 11,000 by requesting the Scottish Parliament written record of proceedings be secretly changed…

The First Minister has claimed his target of generating the equivalent of all Scotland's electricity from renewable sources by 2020 would lead to the country's re-industrialisation and thousands of jobs. However, most of the target is expected to be met using thousands of onshore wind turbines as this is by far the most mature of the renewable technologies.

John Lamont, Scottish Tory Chief Whip, said: "The rhetoric from the Scottish Government over recent years has given the clear impression that wind farms are worth the visual sacrifice because they are such a major source of employment. "Yet now we learn that far from the misleading 11,000 figure, which includes all renewable sources, there are only 2,000 employed thanks to wind farm developments. This is deliberate manipulation by the SNP – and they can't even say where these jobs are."

Mr Lamont received the real jobs total after asking the Scottish Government how many people have jobs "directly connected to wind farm developments".

Mr Ewing replied initially using an oft-quoted estimate by Scottish Renewables, the trade body representing wind farm companies, that there were 11,136 full-time posts in green energy in 2011/12.

However, he then admitted that only 18 per cent of these jobs were in onshore wind. But the minister added: "The success of the onshore wind industry has contributed towards the wider success of the renewable energy sector and, in particular, provided a rationale for major grid upgrade projects."

The Scottish Government has claimed offshore wind alone will generate up to 28,000 jobs but critics have claimed the majority of posts will be filled by foreign turbine manufacturers and installation teams…

Daily Telegraph 15 March 2013

Scottish green energy drive 'may create only 300 jobs'

Richard Marsh, a renewable power economist, said the First Minister and green energy companies are "greatly exaggerating" the supposed benefits of their plan for a new swathe of wind and wave farms.

While they insist that 48,600 jobs will be created by the end of the decade, he said the real number of long-term posts is more likely to be 1,100 but could be as low as 300.

The large difference is because the higher figure includes temporary construction jobs created while green energy projects are being installed.

However, these will disappear after the building work has been completed. Mr Marsh concluded that the large taxpayer subsidy paid to green power companies means the industry is actually harming the Scottish economy.

He said diverting public funding into the industry instead of projects where it would have more economic impact in effect means that every renewable power job costs 3.7 posts that would have arisen elsewhere.

The Telegraph, 13 March 2012

Q8. What effect will wind farms in an area have on tourism?

Key findings

• 40 per cent want governments to prioritise protecting scenic wild land over large wind farms, while 28 per cent want governments to prioritise large wind farms over scenic wild land
• 43 per cent would be less likely to visit a scenic area with a large concentration of turbines, while just 2 per cent would be more likely to visit a scenic area with a large concentration of turbines.

John Muir Trust/YouGov poll results, October 2012

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While the Board accepts the rationale behind the Government's Non-Fossil Fuel Obligation (N FFO) and the 'Energy - A Strategic Framework for Northern Ireland June 2004 a balance must be achieved between pursuing renewable energy and ensuring the protection of Northern Ireland's countryside.

Wind Farms

As a general comment, the Board has concerns regarding the development of wind farms, relating primarily to their visual impact and noise generation and in turn the potential impact on tourism, particularly in scenic areas. Although many of the constraints on wind farm development such as noise and safety issues can be addressed by appropriate action, the visual impact of the wind farm is largely unavoidable, Wind farms present a difficult challenge to all those involved in landscape protection and, depending on the scale of development, they can be regarded as a potential major threat to the natural beauty of the countryside, which is often the main resource of the area.

In terms of tourism. NITB places great emphasis on the retention of a clean, green environment and would consider the variety and uniqueness of our countryside and coast as the foundation of a high quality, world class visitor experience. While we welcome the Department's (EHS) intention to assess 130 areas of landscape character and their suitability or otherwise for wind energy development, we would continue to have major concerns about PPS 18 and its ability to limit the visual impact of wind farms and., therefore, the potential to cause long term detriment to the tourist amenity of the Northern Ireland countryside. Our current policy states that we oppose the development of commercial onshore and off shore wind turbines within areas of primary designation (AONB. National Nature Reserve, National Park) and on adjacent sites that are clearly visible from the primary designated areas. We consider that proposals elsewhere should clearly demonstrate that there will be no detrimental effect on tourism.

Draft PPS 18 quotes 'Attitudes Towards the Development of Wind Farms in Ireland' (Sustainable Energy Ireland 2003) which indicates that wind energy and tourism can 'co-exist happily', While this assessment might be valid from a 2003 perspective, there has been an acceleration in wind energy developments in both parts of the island in the intervening five years, with further applications either in the system or pending. Our primary concern is not with wind farms themselves, but the qualitative impactors the destination of wind farm proliferation, particularly in highly visible upland areas.

The additional educational benefits of wind energy development is overstated (at A113 p.3) and, while a few sites might be suitable for this purpose e.g. existing facilities at Altahullion outside Dungiven, this should not be used as justification for a wind farm development.

Q9. Do most people support the construction of wind farms?

"In attempting to convince others that there is a large silent majority in favour of wind farms, companies often rely on opinion polls. These are methodologically-weak and unreliable methods of assessing attitudes because they rely on instant responses to the questions posed. Opinion polls require instant responses passing through at best superficial parts of the thinking process..."

For example, they are not usually…" asked the following simple questions;,

(1). Which would you prefer, a landscape with turbines or a landscape without?
(2). Would you buy a house a kilometre from a wind farm given the uncertainty of the effects of very low frequency sound on its inhabitants?
(3). If it was shown that wildlife was damaged by the presence of a wind farm would you still support its construction.
(4) Do you think that consultation with the public should be properly initiated before any company starts on proposals?
(5). Would you be more supportive of wind farms if the local community owned them totally and thus received all the profit?
(6) The respondent should then be shown two pictures of the same house, one with and one without turbines in the background. Then asked which they prefer and to give a valuation of both.

…in rebuttal, this short article has relied on seven detailed (and peer reviewed) investigations by environmental economists and sociologists that have provided assessments of real public attitudes to wind energy. These investigations did not require instant responses but thoughtful discussion over days and weeks and thus are more reliable.

The real public attitude to wind farms.
Wind power needs to be distinguished from wind farms; the two are entirely different in the public mind. When asked about the use of wind power in the abstract, the public is usually strongly in favour. Wind as a source of power is free at source (although not in exploitation) and supposedly green so is supported on that basis. But explicit (and local) proposals for wind farms in defined environments now remove it from the abstract and crystallise and focus attention on the reality of what wind power in the form of a farm actually means to the landscape and to peoples lives."

Perceptions of Wind Farms by Prof Anthony Trewavas Edinburgh university

Key Findings

Poor communication of issues

> Opinion polls undertaken by the wind industry tend to be shallow and over simplified. Their results do not reflect the complexity of opinions.

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> Rhetorical devices are commonly used to persuade the public in literature that purports to provide information about wind power. These include exploiting the language of war, the objectivity of science and invoking invisible threats, such as climate change.

Queen's University Belfast survey on attitudes to wind energy.

Q10. How safe is wind energy?

The wind energy industry has admitted that 1,500 accidents and other incidents have taken place on wind farms over the past five years.

The figures – released by RenewableUK, the industry's trade body – include four deaths and a further 300 injuries to workers.

The scale of incidents – equivalent to almost one a day – emerges following the publication of dramatic photographs showing one turbine which had crashed to the ground in a field near a road and another exploding into flames, caused by 150mph winds which buffeted Scotland and northern England last week.

Charles Anglin, RenewableUK's director of communications, stressed that last week's incidents were caused by "freak weather". The organisation said that no member of the public had ever been hurt as a result of a wind turbine accident.

A dossier of incidents, compiled by a campaign group opposed to wind farms, includes cases where blades, each weighing as much as 14 tonnes, have sheared off and crashed to the ground.

Residents living near a wind farm have reported sheltering in their homes when lumps of ice were thrown from blades from a 410-ft high turbine near Peterborough, Cambridgeshire.

The Health and Safety Executive (HSE) said last week it was "extremely difficult" to assemble a "complete picture of reported incidents at wind farms" because accidents are not recorded by industry type.

An HSE spokesman said wind turbines were classed as machines rather than buildings or structures and that there was no obligation to report mechanical failures.

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The Telegraph, 11 December 2011

Data below reports only 142 UK accidents from 2006-2010 and so the figures below, when compared to The Telegraph finding 1,500 accidents above, may only represent 9% of actual accidents.

Of 144 fatalities known to 30 September 2013:

- 87 were wind industry and direct support workers (divers, construction, maintenance, engineers, etc), or small turbine owner/operators.
- 57 were public fatalities, including workers not directly dependent on the wind industry (e.g. transport workers). 17 bus passengers were killed in one single incident in Brazil in March 2012.

123 accidents regarding human injury are documented.

99 accidents involved wind industry or construction/maintenance workers, and a further 23 involved members of the public or workers not directly dependent on the wind industry (e.g. fire fighters, transport workers). Six of these injuries to members of the public were in the UK.

Q11. How frequently do turbine blades fail and how far are the pieces thrown?

By far the biggest number of incidents found was due to blade failure. "Blade failure" can arise from a number of possible sources, and results in either whole blades or pieces of blade being thrown from the turbine. A total of 272 separate incidences were found to 30 September 2013:

Pieces of blade are documented as travelling up to one mile. In Germany, blade pieces have gone through the roofs and walls of nearby buildings. This is why we believe that there should be a minimum distance of at least 2km between turbines and occupied housing or work places - in order to adequately address public safety and other issues including noise and shadow flicker.

The government's own 2007 report by the Health & Safety Laboratory, 'Numerical Modelling of Wind Turbine Blade Throw', Demonstrated that blade fragments were being thrown distances of up to 1,462 meters.

Blade failure is particularly dangerous for neighbours of wind farms because detached blades can 'plane' for long distances and fragments are cast using the velocity of the spinning blades to travel significantly further. As can be seen in Figures 5 and 6 below,

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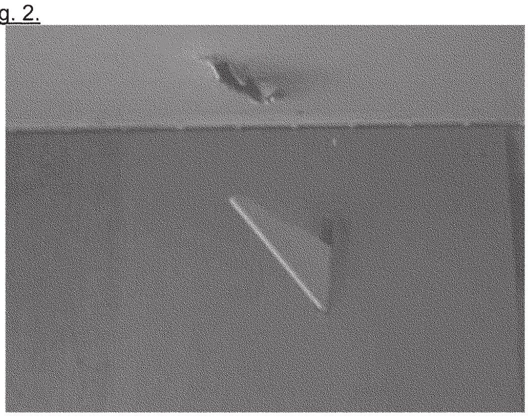
the blade fragments in this case went through the roof of an office building and lodged in the door of one of the offices.

Fig. 1.

Fig. 2.



As an example of the potential damage, a one centimetre slice through a standard 40 m. long turbine blade weighs 2¼ kg. Or 5 lbs. But how likely is this to occur?

In one year in Germany, 36% of turbines suffered component failure. As can be seen in Fig. 3, below, this is a common problem.

Fig. 3.

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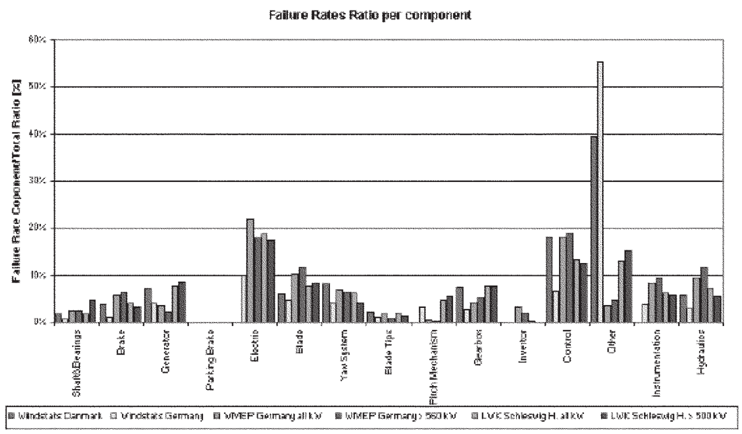
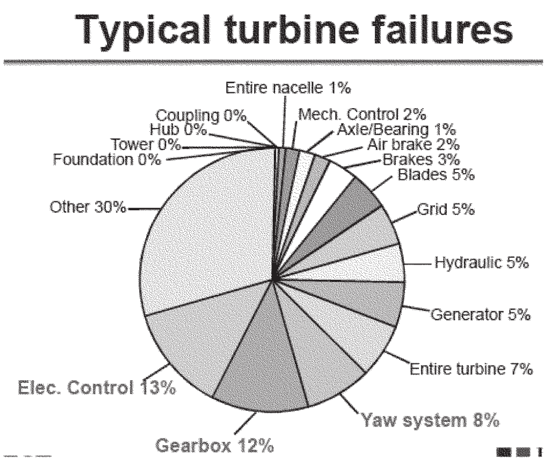


The recent piece of EC - funded research in Fig. 4, below is UK based and has been undertaken by Loughborough University with the aim of identifying the problems of component failure and offering support to address it.

<u>Fig. 4.</u>



It has been estimated that from 8 to 10% of wind turbine blades will fail in some manner, the brakes controlling the speed of the blades will fail in another 7% of turbines, and the structure of 3% of turbines (which obviously support the blades) will fail. It is also the case that turbines above 0.5MW are significantly more prone to failures than those below.

<u>Q12. Are wind turbines a fire risk?</u>

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Fire is the second most common accident cause in incidents found. Fire can arise from a number of sources - and some turbine types seem more prone to fire than others. A total of 211 fire incidents were found.

The biggest problem with turbine fires is that, because of the turbine height, the fire brigade can do little but watch it burn itself out. While this may be acceptable in reasonably still conditions, in a storm it means burning debris being scattered over a wide area, with obvious consequences. In dry weather there is obviously a wider-area fire risk, especially for those constructed in or close to forest areas and/or close to housing or work places. Three fire accidents have badly burned wind industry workers.

Q13. Do Wind Farms Reduce Global Warming?

The report, "Wind farms 'cause greater pollution'"(January 9), cites a Dutch study showing that the use of wind turbines increases overall CO_2 emissions. A more extensive study by Dr Fred Udo, using Irish National Grid data, makes the point even more strongly.

The Irish National Grid publishes real-time data on wind energy and CO_2 emissions every quarter of an hour. Dr Udo's analysis of these data shows that as wind penetration increases, overall CO_2 emissions also increase because coal-fired power stations have to operate on stand-by in case the wind drops. Where back-up is provided by gas-fired power stations, the reduction in emissions is at most a few per cent, even when wind energy is providing 30 per cent of National Grid usage.

Dr Udo's study confirms that wind energy contributes little to the reduction of CO_2 emissions…

Professor J. C. Dearden, Helsby, Cheshire

Daily Telegraph letters, 12 January 2012

It is claimed that windfarms help reduce global warming. This is based on the claim by developers and the British Wind Energy Association that for every megawatt hour of electricity generated by a wind turbine, 0.86 tonnes of CO_2 is saved. DEFRA, the DTI, Ofgem, the Carbon Trust, and the House of Commons do not accept this figure. Instead they use a figure of 0.43 t/MWh and are suggesting an even lower figure by 2010 of about 0.31t/MWh. Hence developers greatly exaggerate the climate-related benefits of wind farms. The use of the figure 0.43t/MWh was recently supported by the Advertising Standards Authority when they upheld a complaint against Renewable Energy Systems Ltd (a wind farm company) for using the higher value of 0.86t/MWh.

Sceptics issue challenge to 'green' claims of wind-farm developers

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The Scottish Government has no way of verifying claims by wind-farm developers on the carbon footprint of their turbines, a leading wildlife charity has revealed.
Now the John Muir Trust claims no large wind farms should be approved by planners until developers' environmental claims can be independently confirmed by government scientists.

Both the Scottish Environmental Protection Agency (SEPA) and Scottish Natural Heritage (SNH) say verifying claims of "carbon payback" by wind-farm companies is not part of their remit.

The carbon payback period - the length of time it will take for the wind farm to compensate for carbon emissions resulting from its development - is often highlighted by firms to promote their green credentials.

The Scotsman, 16 November 2010

Q14. Are wind turbines noisy?

Wind Farm forced to close after complaints over the noise!

The £55 million turbines at Athany in the Scottish Highlands ground to a halt after complaints from residents that their lives are being made a misery by the constant whirring of the blades.

People living close to the wind farm complained to the council that their complaints were being ignored.

Highland Council imposed the ban, saying the company breached planning controls by failing to deal with excessive noise from the development which came on stream in July last year and generates 40MW of power.

The Telegraph, 16 June 2011

Officials cover up wind farm noise report

Civil servants have suppressed warnings that wind turbines can generate noise damaging people's health for several square miles around.

The guidance from consultants indicated that the sound level permitted from spinning blades and gearboxes had been set so high — 43 decibels — that local people could be disturbed whenever the wind blew hard. The noise was also thought likely to disrupt sleep.

The report said the best way to protect locals was to cut the maximum permitted noise to 38 decibels, or 33 decibels if the machines created discernible “beating” noises as they spun.

It has now emerged that officials removed the warnings from the draft report in 2006 by Hayes McKenzie Partnership (HMP), the consultants. The final version made no mention of them.

It means that hundreds of turbines at wind farms in Britain have been allowed to generate much higher levels of noise, sparking protests from people living near them.

The HMP report was commissioned by the business department whose responsibilities for wind power have since been taken over by Ed Miliband's Department of Energy and Climate Change (DECC).

In 2007 Mike Hulme of the Den Brook Judicial Review Group, a band of residents opposing a wind turbine development close to their houses in Devon, submitted a Freedom of Information request asking to see all draft versions of the study. Officials refused the request, claiming it was not in the public interest for them to be released. Hulme appealed to the information commissioner's office, which has ordered Miliband's department to release the documents. The drafts show the HMP originally recommended that the night-time wind turbine noise limit should be reduced from 43 decibels to 38, or 33 if they made any kind of swishing or beating noise — known as "aerodynamic modulation".

The HMP researchers had based their recommendations on evidence. They took noise measurements at houses close to three wind farms: Askam in Cumbria, Bears Down in Cornwall and Blaen Bowi in Carmarthenshire.

They found that the swish-swish signature noise of turbines was significantly greater around most wind farms than had been foreseen by the authors of the existing government guidelines, which date from 1996. They also found that the beating sound is particularly disruptive at night, when other background noise levels are lower, as it can penetrate walls.

In their draft report the HMP researchers recommended that "Consideration be given to a revision of the night-time absolute noise criterion", noting that this would fit with World Health Organisation recommendations on sleep disturbance.

However, an anonymous government official then inserted remarks attacking this idea because it would impede wind farm development. He, or she, wrote: "What will the impact of this be? Are we saying that this is the situation for all wind farms ... I think we need a sense of the scale of this and the impact."

The final report removed any suggestion of cutting the noise limits or adding any further penalty if turbines generated a beating noise — and recommended local authorities to stick to the 1996 guidelines.

Hulme said: "This demonstrates the conflict of interests in DECC, because it has the responsibility for promoting wind farm development while also having responsibility for the wind farm noise guidance policy ... meant to protect local residents."

Sunday Times, 13 December 2009

Why are there noise complaints about more than one in six wind farms in the UK?

New figures reveal that at least one in six wind farms have had complaints about noise causing a lack of sleep or just been "dreadfully irritating".

The statistics show the growing concern around the health impacts of wind turbines as the Government plans to spend billions of pounds encouraging developers to erect around 1,000 new onshore turbines over the next ten years.

The Telegraph, 6 March 2010

Q15. *Do Wind Turbines cause Low Frequency Noise?*

In fact, current recommendations for noise evaluation near wind turbine sites completely exclude the measurement of low frequency sound. The wind turbine companies state that the wind turbines at 350m will only produce noise which is equivalent to that in a quiet room, (35-45dB).

However, the sound measurement scale which they are using (A weighting) completely ignores the low frequency components. A preferred method of noise measurement would take the whole range of frequencies into consideration by using, for example, a C weighting scale.

Low frequency sound is often beyond the audible range - i.e. you can't hear it, but you can feel it as a resonance, typically in the chest or through the feet etc.
This problem has been recognised by the World Health Organisation, which has said that special attention should be given to noises in an environment with low background sound levels, where there are combinations of noise and vibrations; and where there are noises with low frequency components.

It recognises that low frequency noise can disturb rest and sleep even at low sound levels. More importantly, the WHO states that in noises where a large proportion is in the low frequency range, the adverse effects on health may be considerably increased.

As a result of these findings WHO feels the evidence available on low frequency noise is sufficiently strong to warrant concern.

It goes further and suggests that for noise with a large proportion of low frequency sounds lower acceptable levels should be accepted (i.e. lower than 30dB).

Sadly, the UK is lagging behind the rest of Europe in taking these factors into consideration. But there is no getting away from the fact that low frequency noise causes extreme distress to a number of people who are sensitive to its effects.

Western Morning News, 6 January 2004

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Q16. Do wind turbines cause amplitude modulation?

UK Court OK's Amplitude Modulation limit, Wind Industry scrambles to comply

The UK wind industry is scrambling to respond to a High Court ruling that affirmed the legality of conditions placed on the Den Brook wind farm near Devon, limiting amplitude modulation of wind turbine noise to a level that could be very hard to comply with. After years of pooh-poohing the reports of neighbours who said that the pulsing quality of the turbine noise made it especially hard to live with, including a much-criticized study a few years back that found nearly no AM at UK wind farms, Renewable UK (formerly the British Wind Energy Association) is fast-tracking a far-reaching study of AM, which they hope to complete in just seven months.

After years of claiming there is no need to assess or regulate AM, it appears that the industry has now found itself suffering the consequences of denying the problem. Instead of working to create regulations that take the issue seriously (whether or not it is common), the industry is now vulnerable to being out of compliance when AM does occur.

The recent ruling unfolded along just these lines. The wind developer claimed noise would be inaudible or at least not problematic, while local resident Mike Hulme was unconvinced and wanted to be sure that if AM did occur, there would be consequences for the wind farm. His acoustical consultant Mike Stigwood told the Noise Bulletin: "I devised an excess amplitude modulation condition based on my findings and measurements at other wind farms that was worded simply and made an exceedence a breach. It was a simple stand-alone condition."

It's likely that this High Court ruling will provide precedent and justification for the development of ordinances that do address Amplitude Modulation as a particular quality of wind turbine sound, and that future ordinances will be developed with a penalty scheme to minimize the negative effects of this pulsing quality of wind turbines, by requiring them to be quieter when AM is present; in practice, this is likely to mean that wind farms will need to be built a bit farther from homes, so that their noise is quieter all the time, leaving room for AM factor to be added without breaking the noise limits.

Noise Bulletin, 25 July 2011

Q17. Is wind energy sustainable energy?

Report Questions Wind Power's Ability to Deliver Electricity When Most Needed

The report, Analysis of UK Wind Power Generation November 2008 to December 2010, is the result of detailed analysis of windfarm output in Scotland over a 26-month period between November 2008 to December 2010 using data from the BMRS (Balancing Mechanism Reporting System). It's the first report of its kind and draws on data freely available to the public. This data challenges five common assertions made regularly by wind industry and the Scottish Government that:

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- Wind turbines will generate on average 30% of their rated capacity over a year
- The wind is always blowing somewhere
- Periods of widespread low wind are infrequent
- The probability of very low wind output coinciding with peak electricity demand is slight
- Pumped storage hydro can fill the generation gap during prolonged low wind periods

In fact, the report finds that:

- On 124 separate occasions from November 2008 to December 2010, the total generation from the windfarms metered by National Grid was less than 20MW (a fraction of the 450MW expected from a capacity in excess of 1600MW+). These periods of low wind lasted an average of 4.5 hours.
- Actually, low wind occurred every six days throughout the 26-month study period. The report finds that the average frequency and duration of a low wind event of 20MW or less between November 2008 and December 2010 was once every 6.38 days for a period of 4.93 hours.
- At each of the four highest peak demand points of 2010, wind output was extremely low at 4.72%, 5.51%, 2.59% and 2.51% of capacity at peak demand.
- In fact, the average output from wind was 27.18% of metered capacity in 2009, 21.14% in 2010, and 24.08% between November 2008 and December 2010 inclusive.
- The entire pumped storage hydro capacity in the UK can provide up to 2788MW for only 5 hours then it drops to 1060MW, and finally runs out of water after 22 hours.

The report also found that during the study period, wind generation was:

- below 20% of capacity more than half the time
- below 10% of capacity over one third of the time
- below 2.5% capacity for the equivalent of one day in twelve
- below 1.25% capacity for the equivalent of just under one day a month

John Muir Trust, 6 April 2011

Q18. Do wind turbines affect house prices?

Wind farms DO hit house prices: Government agency finally admits that thousands can be wiped off value of homes

Wind farms can wipe tens of thousands of pounds off the value of homes, a government agency has admitted for the first time. The Valuation Office Agency has been forced to re-band homes into lower council tax categories, confirming what most residents who live near the giant turbines already know: they are detrimental to property prices.

The move will make it harder for the wind farm industry to dismiss public concerns over the impact of their turbines.

At least five homeowners have seen their properties officially downgraded by the VOA because of their proximity to windfarms.

But only cases that go to appeal are made public by the agency, suggesting many more applications have been received for council tax. In one case, a couple saw the value of their home near the Fullabrook wind farm site near Braunton, Devon, fall from £400,000 to £300,000 when they asked estate agents to value it.

The home is 650 yards from three of the turbines and the couple feared that the noise and visual dominance of the turbines would not only de-value their home, but make it impossible to sell.

The VOA agreed to put the home from council tax F to band E, saving the couple £400 a year in council tax.

Families living in the seaside Suffolk village of Kessingland have also applied to be put into a lower council tax band as many of their homes are near 400ft turbines.

When one resident, Sue Price, put her home up for sale last year for £460,000, she found a buyer. But they pulled out when local papers reported that the wind farms were about to be erected and estate agents told her to drop her price, she told the Sunday Times.

'We went down to £360,000 and still could not sell so now we have taken it off the market,' she said.

Waveney Council which covers the area has admitted that the constant swooshing noise does constitute a 'statutory nuisance', and is working on a technical solution with the wind farm operators, Triodos Renewables.

Recent council-tax rebandings by the Valulation Office are the first admission by an arms-length government body that house prices can be dented by wind farms.

This is despite other studies pointing to their detrimental effects, including the Royal Institute of Chartered Surveyors who pointed out in a 2007 report that homes within one mile of wind farms would lose value.

One in five prospective buyers rate peace and quiet as their number one priority when looking at a house, according to an Alliance and Leicester survey.

Val Weedon, the honorary president of the UK Noise Association, said wind farms would have an impact on people's quality of life and therefore house prices.

She said: 'These re-valuations will set a precedent which the wind farm industry does not want. Wind farm noise is like road and airport noise, it has an impact on property prices.'

'Noise is also associated with headaches and nausea as it is a form of stress, so it can also have a detrimental effect on your health.'

A VOA spokesman said: 'The Valuation Office Agency (VOA) is responsible for keeping council tax bands up to date in England and Wales. We do not record the number of occasions where a band challenge is made by a taxpayer due to the proximity of a wind turbine/farm.

'If a taxpayer believes that the value of their home has been reduced by a substantial physical change to their locality, then they may be entitled to make a proposal to alter their band.

'The proposal will be considered by the VOA, which may or may not result in a band change. If the taxpayer disagrees with the decision of the VOA, there is a right of appeal to an independent Valuation Tribunal.'

Mail Online, 24 July 2012.

Q19. Do wind turbines have an effect on animals?

Between 2000 and 2006, 13 healthy thoroughbred Lusitanian horses were born and raised on Mr. R's property. All horses (N=4) born or raised after 2007 developed asymmetric flexural limb deformities. WT began operations in November 2006. No other changes (constructions, industries, etc) were introduced into the area during this time.

Tissue analyses of the defected tendons were performed and revealed the classical features of LFN-induced biological responses: thickening of blood vessel walls due to proliferation of collagen in the absence of an inflammatory process.

The results presented herein strongly suggest that the presence of LFN-generating WT in the vicinity of this horse breeding farm can play a significant role in the triggering and onset of equine flexural limb deformities.

Castelo-Branco-follow-up-WT near-home 2010

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Q20. Do wind turbines cause adverse health effects to humans?

The impact of road, rail, and aircraft noise on sleep and daytime functioning (sleepiness and cognitive function) is well established. Shortly after wind turbines began to be erected close to housing, complaints emerged of adverse effects on health. Sleep disturbance was the main complaint. Such reports have been dismissed as being subjective and anecdotal, but experts contend that the quantity, consistency, and ubiquity of the complaints constitute epidemiological evidence of a strong link between wind turbine noise, ill health, and disruption of sleep.

The aerodynamic noise generated by wind turbines has a large low frequency and infrasound component that is attenuated less with distance than higher frequency noise. Current noise measurement techniques and metrics tend to obscure the contribution of impulsive low frequency noise and infrasound. A laboratory study has shown that low frequency noise is considerably more annoying than higher frequency noise and is harmful to health—it can cause nausea, headaches, disturbed sleep, and cognitive and psychological impairment.

A large body of evidence now exists to suggest that wind turbines disturb sleep and impair health at distances and external noise levels that are permitted in most jurisdictions, including the United Kingdom. Sleep disturbance may be a particular problem in children,and it may have important implications for public health.

British Medical Journal, 8 March 2012

Windwatch – briefing paper by Prof. Alun Evans

WIND TURBINE NOISE

Report for meeting of Environment Committee
Prof. Alun Evans

Due to time constraints, it has not been possible to update this paper since it was originally written in May 2014. However, the amount of peer-reviewed material that is identifying the physiological impact of noise and vibration from all scales of wind energy installations on humans and animals, and is clarifying the mechanisms through which this occurs, has now become such a torrent, that it is difficult to keep such a paper current. Some of the most recent additional research has been listed at the foot of this document to illustrate this trend.

My Qualifications are provided in the appendix to this report.

According to the World Health Organisation's recent report, 'Night Noise Guidelines for Europe,'[1] environmental noise is emerging as one of the major public health concerns of the twenty-first century. It observes that, "Many people have to adapt their lives to cope with the noise at night," and the young and the old are particularly vulnerable. This is because hearing in young people is more acute and, in older people, a loss of hearing of higher sound frequencies renders them more susceptible to the effects of low frequency noise. It is a particularly troublesome feature of the noise generated by wind turbines due to its impulsive, intrusive and incessant nature. A recent case-control study conducted around two wind farms in New England has shown [2] that subjects living within 1.4 km of an IWT had worse sleep, were sleepier during the day, and had poorer SF36 Mental Component Scores compared to those living further than 1.4 km away. The study demonstrated a strongly significant association between reported sleep disturbance and ill health in those residing close to industrial wind turbines.

The major adverse health effects caused seem to be due to sleep disturbance and deprivation with the main culprits identified as loud noise in the auditory range, and low frequency noise, particularly infrasound. This is inaudible in the conventional sense, and is propagated over large distances and penetrates the fabric of dwellings, where it may be amplified. It is a particular problem at night, in the quiet rural settings most favoured for wind farms, because infrasound persists long after the higher frequencies have been dissipated.

Sleep is a physiological necessity and the sleep-deprived are vulnerable to a variety of health problems.[2,3] particularly Cardiovascular Disease in which nocturnal noise is an important factor.[4] Sleep deprivation in children is associated with increased bodyweight, [3,] which is known to 'track' into later life, and predisposes to adult disease. That is why "Encouraging more sleep" is a sensible target in the Public health Agency's current campaign to prevent obesity in children. It also causes memory impairment because memories are normally reinforced in the later, Rapid Eye Movement, phase of sleep; again, it is the young and the old who are most affected.

Sleep deprivation is associated with an increased likelihood of developing a range of chronic diseases including Type II Diabetes, cancer (eg breast with shift work[6]), Coronary Heart Disease[7,8] and Heart Failure.[9] Although the quality of the data are mixed, those on Heart Failure reported recently from the HUNT Study[9] are quite robust as they are based on 54,279 Norwegians free of disease at baseline (men and women aged 20-89 years). A total of 1412 cases of Heart Failure developed over a mean follow-up of 11.3 years. A dose-dependent relationship was observed between the risk of disease and the number of reported insomnia symptoms: i) Difficulty in initiating sleep; ii) Difficulty in maintaining sleep; and, iii) Lack of restorative sleep. The Hazard Ratios were '0' for none of these; '0.96' for one; '1.35' for two; and, '4.53' for three; this achieved significance at the 2% level. This means that such a result could occur once by chance if the study were to be repeated 50 times, Significance is conventionally accepted at the 5% level.

Another important, recent study is MORGEN which followed nearly 18,000 Dutch men and women, free of Cardiovascular Disease at baseline, over 10-14 years.[8] In this period there were 607 events: fatal CVD, non-fatal Myocardial Infarction and Stroke. Adequate sleep, defined as at least seven hours, was a protective factor which augmented the benefits conferred by the absence of four traditional cardiovascular risk factors. For example, the benefit of adequate sleep equalled the protective contribution of not smoking cigarettes. Given that cigarette smoking is such a potent risk factor for Cardiovascular Disease, this result is striking. The findings built on earlier ones from the MORGEN study.[7] It seems that adequate sleep is important in protecting against a range of Cardiovascular Diseases which

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result when arteries of different sizes are compromised: large (coronary, cerebral) arteries in heart attacks and stroke, small arteries (arterioles) in heart failure.

All of these studies share the weakness that they are 'observational' as opposed to 'experimental' and, as such, their results do not constitute 'proof.' We now have the evidence of an experimental study carried out in human volunteers which shows that the expression of a large range of genes is affected by sleep deprivation of fairly short duration.[10] This might be the key to understanding why the health effects of sleep deprivation are so diverse. It could also shed light on the 'Wind Turbine Syndrome (WFS),' a cluster of symptoms which include sleep disturbance, fatigue, headaches, dizziness, nausea, changes in mood and inability to concentrate.[11] In this condition infrasound is a likely causal agent. Another report from HUNT has examined insomnia in almost 25,000 persons and has demonstrated it to a robust risk factor for incident physical and mental disease, including several features of WFS.[12]

This group has now shown in another small intervention study that mistimed sleep desynchronized from the central circadian clock has a much larger effect on the circadian regulation of the human transcriptome (i.e., a reduction in the number of circadian transcripts from 6.4% to 1% and changes in the overall time course of expression of 34% of transcripts).[13] This may elucidate the reasons for the large excess of cardiovascular events associated with shift work found in a meta-analysis of over 2 million subjects in 34 studies.[14] The results demonstrate that any interference in normal sleeping patterns is inimical to cardiovascular health.

The old admonition that 'What you can't hear won't harm you,' sadly isn't true. It is now known that organ of Corti in the cochlea (inner ear) contains two types of sensory cells: one row of inner hair cells which are responsible for hearing; and, three rows of outer hair cells which are more responsive to low frequency sound.[15] The infrasound produced by wind turbines is transduced by the outer hair cells and transmitted to the brain by Type II afferent fibres. The purpose is unclear as it results in sleep disturbance. Perhaps it served some vital function in our evolutionary past which has persisted to our detriment today? In fact, many animals use infrasound for communication and navigation. This could well have a genetic basis as it is only a minority, albeit a sizable one, which is affected. This may well be the group which is also liable to travel sickness. Schomer et al have now advanced the theory that as wind turbines increase in size they increasingly emit infrasound with a frequency below 1Hz (CPS).[16] Below this frequency the otoliths in the inner ear respond in an exaggerated way in a susceptible minority who will suffer symptoms of the Wind Farm Syndrome. Previously it was thought that the brain was only under the control of electrical and biochemical stimuli but there is new evidence that it is sensitive, in addition, to mechanical stimuli.[17]

The problem of infrasound and low frequency noise was well-recognised in a report by Casella Stanger,[18] commissioned by DEFRA in 2001, and since ignored: “For people inside buildings with windows closed, this effect is exacerbated by the sound insulation properties of the building envelope. Again mid and high frequencies are attenuated to a much greater extent than low frequencies.” It continued: “As the A-weighting network attenuates low frequencies by a large amount, any measurements made of the noise should be with the instrumentation set to linear.” It drew heavily upon the DOE’s Batho Report of 1990.[19] In fact, these problems had already been elucidated and the measurement issues addressed in a trio of papers by Kelley (et al) in the 1980s.[20-22] This research again has been ignored or forgotten so the problem continues to be seriously underestimated. When measured using a tool which can detect it, levels of infrasound and low frequency noise are disturbingly high, with ‘sound pressure levels’ greater than previously thought possible.[23]

There are a number of other adverse effects associated with sleep deprivation. Tired individuals are more likely to have road traffic accidents and injure themselves while operating machinery. In addition, wind turbines can, and do, cause accidents by collapsing, blade snap, ice throw, and even going on fire. They induce stress and psychological disorder from blade flicker, which also has implications for certain types of epilepsy and autism. Even the current planning process, with its virtual absence of consultation, is stress inducing, as is the confrontation between land owners, who wish to profit from erecting turbines, and their neighbours who dread the effects. Finally, wind turbines considerably reduce the value of dwellings nearby and this has a negative long term effect on their owners’ and their families’ health.[24] On top of this, increasing numbers of families will be driven into fuel poverty by spiralling electricity costs which are subsidising wind energy. It is galling that

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SSE's current, seductive advertising campaign is being supported from these sources.

'Wind Turbine Noise' was reviewed in an editorial in the British Medical Journal in 2012.[25] The authors concluded that "A large body of evidence now exists to suggest that wind turbines disturb sleep and impair health at distances and noise levels that are permitted in most jurisdictions... " This remains the case today. The Public Health Agency has dismissed this editorial as falling short of a 'systematic review,' which is fair enough, given the constraints of the format, yet ignores at least one, excellent, recent systematic review.[24] Interestingly, that review records the fact that in 1978 the British Government was found guilty in a case taken to Europe by the Irish Government of applying five techniques, including subjection to noise and deprivation of sleep. These were used in Ulster to 'encourage' admissions and to elicit information from prisoners and detainees. They amounted to humiliating and degrading treatment, ie torture.[24]

The Public Health Agencies in the UK are now relying on a document published in April 2013.[26] It was written by a group of acousticians at the University of Salford, which begs the question as to why such a group was selected to give advice on health issues. Since acousticians derive a significant proportion of their income from the wind industry, their scientific objectivity might be open to question. Similarly, if a profession, which worked closely with the tobacco industry, was asked to report on health, questions would be asked.

The wind industry has at times acted in a way that is reminiscent of the tobacco industry in the past. Recently a Vestas Powerpoint presentation from 2004 has surfaced[27] demonstrating that Vestas knew a decade ago that safer buffers were required to protect neighbours from wind turbine noise. They knew their pre-construction noise models were inaccurate and that "...we know that noise from wind turbines sometimes annoys people even if the noise is below noise limits." Some of this is due to the methods they use to measure noise. Presenting mean amplitude data means that 50% of the peak noise is disguised. In 2011 the CEO of Vestas wrote to the Danish Minister of Environment admitting that it was not technically possible to produce wind turbines which produced less noise. Similarly, we are repeatedly told that modern turbines are quieter and produce less ILFN which in reality is the reverse of the case.[28]

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The Salford Report concludes[26] that there is "…some evidence for sleep disturbance which has found fairly wide, though not universal, acceptance." The increasing weight of evidence of sleep deprivation's association with several chronic diseases is totally ignored. The authors of the report are at pains to deny any 'direct' health effects. In terms of prevention any differentiation between 'direct' and 'indirect' is irrelevant: the introduction of iodine supplementation in milking cattle to improve their "reproductive performance" during the 1960s indirectly led to a reduction in endemic goitre in humans. This was thanks to the unforeseen spillover of iodine into milk and dairy products.[29]

In 2008 the distinguished American acoustic engineers, George Kamperman, and Richard James posed the question,[30] "What are the technical options for reducing wind turbine noise emission at residences?" They observed that there were only two options: i) Increase the distance between source and receiver; or, ii) reduce the source sound power emission. They added[30] that neither solution is compatible with the objective of the wind farm developer to maximise the wind power electrical generation within the land available.

Although the associations between noise pollution and ill health can be argued against, and there are gaps in our knowledge, there is sufficient evidence to cause grave misgivings about its safety. Further research, supported by adequate funding, remains necessary. Good and caring Government should entail acting with greater caution when its policies could jeopardise the health and human rights of its people. It is essential that the 'Primum non nocere,' or 'Precautionary' principle should be applied. Another recent review on the 'Cardiovascular effects of environmental noise exposure' quotes the Nobel Prize winning microbiologist, Robert Koch. As early as 1910, Koch predicted,[31] "One day man will have to fight noise as fiercely as cholera and plague."

In conclusion, there are serious adverse health effects associated with noise pollution generated by wind turbines. It is essential that separation distances between human habitation and wind turbines are increased. There is an international consensus emerging for a separation distance of 2 km, indeed some countries are opting for 3 km. The current guideline on separation distance is based on ETSU-R-

97 and is manifestly out of date. It is only relevant to the small turbines of that era. The vastly increased scale of today's turbines means that the current recommendation on turbine separation is grossly inadequate.

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Appendix

Alun Evans

Current Position

Professor Emeritus, Senior Visiting Research Fellow, Centre for Public Health, The Queen's University of Belfast, Institute of Clinical Science B, Grosvenor Road, Belfast BT12 6BJ, UK

Qualifications

1968 MB, BCh (IInd Class Hons)

1971 MRCP (London)

1973 Dip Soc Med (Edinburgh)

1974 MFCM (London)

1984 MD (QUB)

1987 FRCP (London)

1989 FFPHMI (Dublin)

Medals

1967, Houston, 1968, Thompson, Sinclair, 1995 Hickey, 2005 Campbell

Previous Position

1990–2009 Professor of Epidemiology (Personal Chair), Department Of Epidemiology and Public Health, QUB

Teaching Experience

I have lectured to societies and in universities in this country and in many countries across the world. I have acted as a WHO Consultant on numerous occasions and this has also involved lecturing. I have acted as External Examiner to UCD, TCD and the University of Aberdeen.

Research Interests

My main interest for the past 35 years has been the Epidemiology of CVDs. I initially trained as a physician with an interest in Cardiology. I subsequently did some Family Medicine in Western Canada and in Co Donegal. In the late 1970s I was involved in clinical trials and community studies of coronary heart disease. In 1982, I became the Principal Investigator of the WHO MONICA Project in Belfast. I was elected to the Steering Committee of MONICA in 1990 and chaired it from 1994-97. At the time, MONICA was the largest epidemiological study in the world, comprising 38 centres in 26 countries. I have been in receipt of numerous grants, and I have coordinated two major EU funded projects, and have been a partner in 17 others. I have taken part in an extensive research program with France, through the ECTIM and PRIME Studies. I have published several hundred papers, and many book chapters. I established and coordinated a large European pooling project of CVD cohorts. This study, which is called MORGAM (MOnica Risk Genetics Archiving and Monograph) formed part of ENGAGE (European Network for Genomics and Genetic Epidemiology) and is currently part of CHANCES and BiomarCaRE. A present main focus is on Medical History with an emphasis on Social and Public Health. I became concerned over the adverse health effects of wind turbines, particularly in relation to CVD, around five years ago.

Publications

I have published around 700 papers and several book chapters. I am a

co-author of the World Health Organization Monograph: Cardiovascular Survey Methods, WHO Monograph (IIIrd Edition) Geneva, 2004.

I co-wrote the Editorial 'Wind Turbine Noise' in the British Medical Journal in 2012.

Illustrative additional research papers not included above:

Guang Yang et al, Sleep promotes branch-specific formation of dendritic spines after learning, Science 344, 1173, 2014.

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Claire E. Sexton, Andreas B. Storsve, Kristine B. Walhovd, Heidi Johansen-Berg, Anders M. Fjell, Poor sleep quality is associated with increased cortical atrophy in community-dwelling adults, Neurology 83, 9 September 2014.

Windwatch – briefing paper Pat Swords

By Pat Swords BE CEng FIChemE CEnv MIEMA

October 2014

Biography: Pat Swords is a Fellow of the Institution of Chemical Engineers and a Chartered Environmentalist, who graduated from University College Dublin in 1986. Pat has been active in the design and development of industrial projects in the chemical, pharmaceutical, food and energy sectors both in Ireland and abroad. For over a decade he helped implement the EU's environmental legislation concerning environmental assessment, industrial pollution control and major accident hazards into the then accession states of Central and Eastern Europe. As such he was responsible for training regulators, industry and, in later years, members of the public and NGOs in the implementation of the Environmental Acquis, the EU legislative framework in the environmental sector.

It was these skills he applied to the EU's and Ireland's renewable programme to fund and install several thousand wind turbines and thousands of kilometres of new high voltage lines into the Irish rural landscape. This lead to a legal case with the legal tribunal at the United Nations Economic Commission for Europe's (UNECE) Aarhus Convention in Geneva, the Compliance Committee ruling that the implementation of the EU's National Renewable Energy Action Plans (NREAPs), particularly in Ireland, was in non-compliance with the requirements of the Convention. The NREAPs having by-passed the mandatory steps in relation to assessment and public participation in decision-making. These findings and recommendations have since been endorsed by the UNECE Meeting of the Parties in July 2014[1], which is the formal Governing Body of the 47 Parties (countries) to the Convention, and are as such a declaration in International Law and binding on Community Law. UNECE are now engaged in formal compliance proceedings with the EU in relation to their recommendation that the NREAPs should be completed in a compliant manner with the active public participation before their adoption, while the matter is also subject to on-going proceedings in the High Court[2].

Pat also helped prepare and present a second case at the Compliance Committee taken by a Community Council in Western Scotland. This lead to the findings by the Compliance Committee in that the UK had failed to comply with the Convention in the manner in which it had adopted its NREAP. These findings were also endorsed by the Meeting of the Parties in July 2014 and currently are part of a Judicial Review, which is on-going in Scotland.

"The state exists for man, not man for the state. The same may be said of science. These are old phrases, coined by people who saw in human individuality the highest human value. I would hesitate to repeat them, were it not for the ever recurring danger that they may be forgotten, especially in these days of organisation and stereotypes." Albert Einstein

1 As formally adopted by ECE/MP.PP/2014/CRP.9/Rev.1 on the 2 July 2014: http://www.unece.org/fileadmin/DAM/env/pp/mop5/Documents/Category_I_documents/ECE_MP.PP_2014_L.16_ENG.pdf

2 http://irishplanningnews.ie/high-court-challenge-to-national-renewable-energy-action-plan/ Proceedings to recommence on the 11th November 2014

Contents

1.1 Why Public Participation

Elections are only a 'roll call' to select public representatives and not put 'rulers' into place with unlimited powers by diktat. The environment of N. Ireland does not belong to administrators of the UK or of the EU to do what they want with it, such as filling it with wind turbines and pylons. Instead, the environment of Ireland belongs to its people and they have defined rights in law, which must be respected. History teaches us that populist trends and fashions come and go; as a result that is why a defined legal structure and associated rights have been put in place. This legal structure and associated rights are there for a reason, as part of the necessary checks and balances.

So let's look at those rights and the legal structure, which was put in place to control such matters. Principle 10 of the United Nations Rio Declaration of 1992 spelt it out[3]:

- Environmental issues are best handled with participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided.

Information has to be generated and provided, public participation in decision-making has to occur and proper access to justice provided.

In the region of the United Nations Economic Commission for Europe (UNECE), this became the Aarhus Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters[4], in many respects influenced by the unfortunate environmental legacy, which was left behind by the planned economies of Eastern Europe and Central Asia. The EU ratified the Convention in February 2005 in Decision 2005/370 and it became a binding part of Community Law[5]. As the EU clarified in their first National Implementation Report to UNECE[6]:

- International agreements concluded by the European Community are binding on the institutions of the Community and on Member States. In accordance with the European Court of Justice's case-law, those agreements prevail over provisions of secondary Community legislation. The primacy of international agreements concluded by the

3 http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=78&ArticleID=1163

4 http://www.unece.org/env/pp/welcome.html

5 http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32005D0370

6 http://ec.europa.eu/environment/aarhus/pdf/sec_2008_556_en.pdf

Community over provisions of secondary Community legislation also means that such provisions must, so far as is possible, be interpreted and applied in a manner that is consistent with those agreements.

- Such provisions constitute rules of Community law directly applicable in the internal legal order of the Member States, which can be relied on by individuals before national courts against public authorities.

However, the principles behind this are nothing new or radical.

"I not only use all the brains that I have, but all that I can borrow" - Woodrow Wilson, US President, 1913-1921.

Gathering opinions and information from interested parties is an essential part of the policy-development process, enhancing its transparency and ensuring that proposed policy is practically workable and legitimate from the point of view of stakeholders. Furthermore, civil society is not without considerably talented people. It is not by any means uncommon that members of the public may be more competent and knowledgeable in the subject matter than designated public officials, in particular where it concerns matters in their locality. A modern democracy is about being inclusive and bringing out the talents of the public, not suppressing them in the manner which George Orwell so aptly described in Animal Farm, where the pigs decide and the animals have to toil building windmills:

- No one believes more firmly than Comrade Napoleon that all animals are equal. He would be only too happy to let you make your decisions for yourselves. But sometimes you might make the wrong decisions, comrades, and then where should we be?

1.2 The Principles of Public Participation

As the 'Aarhus Convention: An Implementation Guide'[7] points out in relation to the first pillar on access to information:

- Under the Convention, access to environmental information ensures that members of the public are able to know and understand what is happening in the environment around them. It also ensures that the public is able to participate in an informed manner.

Obligations are placed on public authorities not only in relation to providing access to environmental information on request, but also to possessing and updating environmental information which is relevant to their function, ensuring that it is transparent and effectively accessible. The latter relates to the general obligation of the Convention of:

- Recognizing the importance of fully integrating environmental considerations in governmental decision-making and the consequent need for public authorities to be in possession of accurate, comprehensive and up-to-date environmental information.

These measures were adopted through Directive 2003/4/EC on public access to environmental information and the N. Ireland Environmental Information Regulations.

As regards the principles of public participation the Implementation Guide further clarifies:

- Public participation in decision-making is the second "pillar" of the Convention. Public participation cannot be effective without access to information, as provided under the first pillar, nor without the possibility of enforcement, through access to justice under the third pillar.
- In its ideal form, public participation involves the activity of members of the public in partnership with public authorities to reach an optimal result in decision-making and policymaking. There is no set formula for public participation, but at a minimum it requires effective notice, adequate information, proper procedures and appropriately taking account of the outcome of the public participation. The level of involvement of the public in a

7 http://www.unece.org/fileadmin/DAM/env/pp/Publications/Aarhus_Implementation_Guide_interactive_eng.pdf

particular process depends on a number of factors, including the expected outcome, its scope, who and how many will be affected, whether the result settles matters on a national, region or local level, and so on. In addition, different persons may have different status in connection with participation on a particular matter.

- Those who are most affected by the outcome of the decision-making or policymaking should have a greater chance to influence the outcome. This is behind the distinction between "public" and "public concerned".

The Convention differentiates between the public participation requirements for permit approvals, such as planning or pollution control, which is Article 6 of the Convention and public participation for plans, programme or policies related to the environment, which is Article 7 of the Convention. At the EU level Article 6 was transposed by updating the Directives on Environmental Impact Assessment (EIA) and Integrated Pollution Prevention and Control (IPPC) legislation. However, Article 7 was never properly transposed. The EU has a 2001 Directive on Strategic Environmental Assessment, which is applicable in certain cases, such as programmes related to energy. While this is more specific in content than Article 7 of the Convention, the UK Parliament's January 2006 briefing paper[8] on the implementation of the Convention was accurate when it pointed out:

- Implementing the second pillar has been problematic. Given the many discrete policy areas involved and the need to meet EU time limits, the competence for public participation has been split between different legal instruments and thus different government departments. *With public participation legislation mainly focusing on EIA, IPPC and planning, it provides insufficient coverage for other areas affected.*
- Problems have to be highlighted early "*when all options are open and effective participation can take place*". At the moment, however, consultations, which do not have to take account of the opinions given, remain the key instrument used by decision makers.

This needs some further explanation, if a project is an isolated entity, such as a 'one off' new power station to replace an aging one, it will be assessed at the project level through Article 6 of the convention and the EIA Directive. If instead it is power generation connected to an overall programme, such as a plan related to renewables, then tiered decision making applies and prior assessment of the plan or programme should have also occurred to Article 7 of the Convention and the interlinked Directive on Strategic Environmental Assessment.

At the UNECE Meeting of the Parties in July 2014, the Maastricht Recommendations on Public Participation were adopted, which are both highly informative and readable[9]. As regards the 'step by step' procedures in relation to 'when all options are open' and 'taking due account of the public participation', these were clarified in the Maastricht recommendations with respect to the 'case law' of the Convention, in particular:

- 2(b). The "zero option" means the option of not proceeding with the proposed activity, plan or programme at all nor with any of its alternatives.
- 16. In line with the Convention's requirement for the public to have an opportunity to participate when all options are open,[10] *the public should have a possibility to provide comments and to have due account taken of them, together with other valid considerations required by law to be taken into account, at an early stage of decision-making when all options are open, on whether the proposed activity should go ahead at all (the so-called "zero option").[11] This recommendation has special significance if the proposed activity concerns a technology not previously applied in the country and which is considered to be*

8 Parliamentary Office of Science and Technology- Postnote January 2006 Number 256 (available on internet)

9 http://www.unece.org/fileadmin/DAM/env/pp/mop5/HLS/ece.mp.pp.2014.crp.7_ece.mp.prtr.2014.crp.1_e_.pdf

10 Article 6, paragraph 4 of the Convention.

11 Compliance with regard to Lithuania, ECE/MP.PP/2008/5/Add.6, para. 74; Compliance with regard to the European Commission, ECE/MP.PP/2008/5/Add.10, para. 51; Compliance with regard to Slovakia, ECE/MP.PP/2011/11/Add.3, ECE/MP.PP/2011/11/Add.3, para. 61 and 63.

of high risk and/or to have an unknown potential environmental impact. The opportunity for the public to provide input into the decision-making on whether to commence use of such a technology should not be provided only at a stage when there is no realistic possibility not to proceed.[12]

- 19. Irrespective of how the framework for decision-making is structured, the public should have a possibility to discuss the nature of and need for the proposed activity at all (the zero option, see para.16 above). In order to satisfy the requirements of the Convention and to meet the legitimate expectations of the developer, this possibility should be provided at the earliest stage of the entire decision-making, when it is genuinely still open for the project not to proceed.
- 78(c) Information about the decision-making in the earlier tiers should be available in order for the public to understand the justification of those earlier decisions – including the rejection of the zero option and other alternatives.

Article 6(8) of the Convention requires that:

- Each Party shall ensure that in the decision due account is taken of the outcome of the public participation.

As the ‘Implementation Guide’ clarifies: *In its findings on communication ACCC/C/2008/24 (Spain), the Committee found that:*

- It is quite clear to the Committee that the obligation to take due account in the decision of the outcome of the public participation cannot be considered as a requirement to accept all comments, reservations or opinions submitted. However, while it is impossible to accept in substance all the comments submitted, which may often be conflicting, the relevant authority must still seriously consider all the comments received. The Committee recalls that the obligation to take “due account” under article 6, paragraph 8, should be seen in the light of the obligation of article 6, paragraph 9, to “make accessible to the public the text of the decision along with the reasons and considerations on which the decision is based”. Therefore the obligation to take due account of the outcome of the public participation should be interpreted as the obligation that the written reasoned decision includes a discussion of how the public participation was taken into account. ... The Committee notes that a system where, as a routine, comments of the public were disregarded or not accepted on their merits, without any explanation, would not comply with the Convention.

In a similar fashion the EU’s Directive on Environmental Impact Assessment, requires that the following information shall be made available to the public:

- Having examined the concerns and opinions expressed by the public concerned, the main reasons and considerations on which the decision is based, including information about the public participation process.

As the case law of the European Court confirms with regard to the Environmental Impact Assessment Directive[13] in that it:

- Prescribes an assessment of the environmental impact of a public or private project, but does not lay down the substantive rules in relation to the balancing of the environmental effects with other factors or prohibit the completion of projects which are liable to have negative effects on the environment.

It therefore informs the final decision on a project, rather than directs it, but it must be completed in a ‘transparent and fair’ manner in accordance with the public participation requirements of the Convention including proper ‘reasons and considerations’ on which the decision is based.

12 Compliance with regard to Lithuania, ECE/MP.PP/2008/5/Add.6, para 74

13 http://ec.europa.eu/environment/eia/pdf/eia_case_law.pdf

1.3 The UK and Northern Ireland's Failure to Transpose the Environmental Impact Assessment Directive

The DOE and NIEA's own website on Environmental Impact Assessment state:

- Environmental Impact Assessment (EIA) is a process undertaken by developers when it is considered that a development proposal may have a significant environmental impact.

This is not correct; the Environmental Impact Assessment is the responsibility of the competent authority for the planning decision, which he must make available to the public on request as part of the decision-making process. This requirement on the competent authority has been defined in Article 3 of the Environmental Impact Assessment Directive since 1985. To explain, the below taken from the same website is accurate:

- An Environmental *Statement* (ES) is a developer's assessment of the environmental impact of a project. It will contain suggestions for mitigation (taking protective measures to reduce or remove this impact).

In addition members of the public through the public participation process can submit their assessments of environmental impact and other observations. This can also be supplemented by other relevant documentation produced public authorities, such as a Strategic Environmental Assessment.

The March 2011 European Court ruling against the Republic of Ireland in case C-50/09 for failure to properly transpose Article 3 of the Environmental Impact Assessment Directive[14], states in Points, 37, 38 and 40:

- 37. "In order to satisfy the obligation imposed on it by Article 3, *the competent environmental authority may not confine itself to identifying and describing a project's direct and indirect effects on certain factors, but must also assess them in an appropriate manner, in the light of each individual case".*
- 38. "That assessment obligation is distinct from the obligations laid down in Articles 4 to 7, 10 and 11 of Directive 85/337, which are, essentially, *obligations to collect and exchange information, consult, publicise and guarantee the possibility of challenge before the courts. They are procedural provisions which do not concern the implementation of the substantial obligation laid down in Article 3 of that directive*".
- 40. "However, that obligation to take into consideration, at the conclusion of the decision-making process, information gathered by the competent environmental authority must not be confused with the assessment obligation laid down in Article 3 of Directive 85/337. *Indeed, that assessment, which must be carried out before the decision-making process* (Case C-508/03 Commission v United Kingdom [2006] ECR I-*3969, paragraph 103), involves an examination of the substance of the information gathered as well as a consideration of the expediency of supplementing it, if appropriate, with additional data. That competent environmental authority must thus undertake both an investigation and an analysis to reach as complete an assessment as possible of the direct and indirect effects of the project concerned on the factors set out in the first three indents of Article 3 and the interaction between those factors".*

This legal requirement is for *"as complete an assessment as possible of the direct and indirect effects of the project concerned on the facts set out in the first three indents of Article 3 and the interaction between those factors",* where the factors comprise:

(a) human beings, flora and fauna,

(b) soil, water, air, climate and the landscape,

(c) material assets and the cultural heritage, and;

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14 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:62009CJ0050:EN:NOT

(d) the interaction between the factors mentioned in paragraphs (a), (b)

and (c).

However, if we consider the Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 2012[15], which is similar to other UK regulations, there is a requirement in Section 4 that:

- The Department or the Commission, as the case may require, shall not grant planning permission or subsequent consent pursuant to an application to which this regulation applies unless they have first taken the environmental information into consideration, and they shall state in their decision that they have done so.

This is important, Northern Ireland planning decisions are based solely on a very weak obligation to take environmental information into consideration. The more stringent obligation on the decision maker to properly assess the impacts of the development on human beings, as to what the climate change impacts are, what the landscape impacts are, etc. and to take ownership and responsibility for them in justifying the decision to the public is simply by-passed.

1.4 The Systematic Failures of Northern Ireland Planning to comply with the legal framework when approving wind farms

In the Planning Appeals Commission decision on Case 2013/A0169 on the Drumadarragh Windfarm in Point 14 it is stated:

- Performance of Wind Turbines: General criticisms of wind power in general were raised by objectors. However, such criticisms are inappropriate for consideration in the context of this individual appeal. For example, the question of whether wind turbines are more or less efficient or cost effective relative to other power sources is a matter of national and regional policy review. General concerns about wind farms; 'green credentials' and carbon release impacts are similarly beyond the scope of this appeal. The economic viability of the proposal is a matter of the developer.

This has to be considered quite remarkable given the legal context previously outlined '*of effective public participation when all options are open'* and the requirement of the competent authority for the planning decision to actually produce an assessment of the impact on climate, i.e. what the alleged benefits of the development were. Naturally the public should be entitled to see a demonstration that those alleged benefits actually outweigh the considerable known and documented negative impacts of the wind farm.

If we go back to the origin of this, the EU failed to evaluate what exactly was to be built in each Member State, where it was to be built, what its costs and benefits would be, what were the alternatives to the programme, etc. It therefore reached the position that its 20% renewable energy by 2020 target had to be implemented in the following manner, as described in Recital 15 of the 2009/28/EC Directive[16]:

- The starting point, the renewable energy potential and the energy mix of each Member State vary. It is therefore necessary to translate the Community 20 % target into individual targets for each Member State, with due regard to a fair and adequate allocation taking account of Member States' different starting points and potentials, including the existing level of energy from renewable sources and the energy mix. It is appropriate to do this by sharing the required total increase in the use of energy from renewable sources between Member States on the basis of an equal increase in each Member State's share weighted by their GDP, modulated to reflect their starting points, and by accounting in terms of gross final consumption of energy, with account being taken of Member States' past efforts with regard to the use of energy from renewable sources.

15 http://www.legislation.gov.uk/nisr/2012/59/contents/made

16 http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32009L0028

In other words, the 20% renewable energy target was 'dished out' to the Member States based on what level of renewable energy resources they already had, some like Sweden having considerable existing hydro sources, and a 'fudge factor' based on GDP. Neither were the proper public participation procedures followed in the development of this Directive, as not only was there an absence of environmental information on what was to be built, why it was to be built and where it was to be built, but also the public concerned were not contacted and provided with an opportunity to participate in this decision-making.

This completely dysfunctional and legally non-compliant approach, evident in the development of the 20% renewable energy programme and the associated Directive 2009/8/EC, continued throughout its implementation. Member States were given little more than a year to adopt a National Renewable Energy Action Plan (NREAP) defining how their allocated National Target would be met. However, EU legislation which implements Article 7 of the Aarhus Convention[17] requires that such plans or programmes related to Energy, which lead to future development consent of projects regulated by the Environmental Impact Assessment Directive, must undergo a Strategic Environmental Assessment before adoption.

This did not happen, not only in the UK and Ireland, but also in the other Member States. The NREAPs were adopted by by-passing the Strategic Environmental Assessment and associated public participation. As a result the assessment of the objectives of the plan, the alternatives to reach those objectives, the likely state of the environment without implementation of the plan, the significant environmental impacts of the plan, the necessary mitigation measures, the monitoring for unforeseen adverse environmental impacts, all of this was bypassed and ignored.

Really it's not in the least bit surprising that UNECE has issued two rulings against both the EU and the UK for the implementation of the NREAPs being non-compliant with Article 7 of the Convention.

The same renewables Directive provides at Recital 44 that:

- "The coherence between the objectives of this Directive and the Community's other environmental legislation should be ensured. In particular, during the assessment, planning or licensing procedures for renewable energy installations, Member States should take account of all Community environmental legislation and the contribution made by renewable energy sources towards meeting environmental and climate change objectives, in particular when compared to non-renewable energy installations."

In further provides at Recital 90 that:

- "The implementation of this Directive should reflect, where relevant, the provisions of the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters, in particular as implemented through Directive 2003/4/EC of the European Parliament and of the Council of 28 January 2003 on public access to environmental information."

As regards to Northern Ireland, the planning decision referred to previously provides in Point 7 reference to the UK's renewable energy target of 15% and the document "First Steps Towards Sustainability – a Sustainable Development Strategy for Northern Ireland (SDS)"[18]. The latter set in 2006 a 40% target beyond 2025 of all electricity consumed in Northern Ireland being obtained from indigenous renewable energy resources.

So here we had a classic example in 2006 of what the UK Parliamentary was 'calling foul' about, namely rushing in plans and programmes without the necessary public participation. Article 7 of the Convention is clear in that the 'necessary information' has to be provided

17 See Section on Article 7 in EU Implementation Report to UNECE: http://www.unece.org/fileadmin/DAM/env/documents/2008/pp/mop3/ece_mp_pp_ir_2008_EC_e.pdf

18 http://www.doeni.gov.uk/index/epd_about_us.htm

to the public, in which 'necessary' is understood within the context of effective public participation. Yet when at a 'downstream' project approval stage, i.e. the next tier in the tiered decision making, when members of the public appealing a decision raise fundamental questions that there is an absence of critical environmental information to support the basis of the project, they are told to essentially 'feck off'. We have our plan and if you don't like it take us to Court.

However, as any environmental lawyer will point out, the clear intent of Recitals 44 and 90 of the Renewables Directive, taken together, is that implementation of the Directive (including preparation of the NREAP) should allow for public participation in the process of preparing the NREAP, and for the NREAP itself to be based on information which is up to date and accurate, and which considers the contribution made by renewable energy sources towards meeting environmental and climate change objectives, in particular when compared to non-renewable energy installations. Such contribution cannot be assessed in the absence of reliable environmental data verifying the expected CO2 reductions from wind power as compared with fossil fuels. In failing to subject the NREAP to proper public consultation the United Kingdom denied interested parties the opportunity to comment on or query such matters as the extent to which claimed savings in CO2 emissions associated with wind power were substantiated by the available "up to date and accurate" information relating to claimed CO2 savings. It follows that planning decisions taken to assist the achievement of renewables targets should be taken in pursuance of planning policies, which have themselves been promulgated pursuant to the NREAP, and pursuant to public consultation based upon up to date and accurate environmental information.

Furthermore, in accordance with established case law in the European Court, the fact that Northern Ireland has allocated considerable resources to its 40% electricity target from 2006 above, means that it engaged the legal requirement in the 2001 Strategic Environmental Impact Assessment Directive, which required a detailed environmental report and public participation before that programme could be adopted. However, all of this was by-passed. So not only is there no information on the justification of this programme in terms of CO2 savings, but there was also no proper consideration of alternatives, assessment of impact on human beings, monitoring for unforeseen adverse environmental impacts, etc.

In the planning appeal mentioned, on the basis of considerable scientific evidence presented by the appellant in relation to the adverse impacts of noise, the development in question was refused. However, the appellant shouldn't have had to go to that level of detail; it is not his responsibility to prove a negative, but the authorities to prove a positive. This they had failed to do, they had never assessed the 40% Northern Ireland renewable programme in terms of impact on population and human health, plus once the programme was adopted completed the monitoring for unforeseen adverse environmental impacts.

Take your pick; 'don't know',' don't care', 'an entitlement to act ultra vires'; but either way from a legal perspective, it is a god awful mess.

1.5 How the EU's Renewable Targets won't be met, particularly by the UK

Not only are there serious legal issues related to the validity of the EU's renewable Directive, but because it was conceived in such a dysfunctional manner, is it no wonder it is going completely off the rails, as can be seen below:

The EU Commission published a "Renewable energy progress report COM(2013) 175 final" in March 2013[19]. It also published a Staff Working Document accompanying this report, entitled SWD(2013) 102 final[20]. As the latter pointed out:

- These findings are based on data from the period 2008-2010. Since then, as set out in the Report mentioned above, the economic climate has changed significantly and, as a

19 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013DC0175&from=EN

20 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013SC0102&from=EN

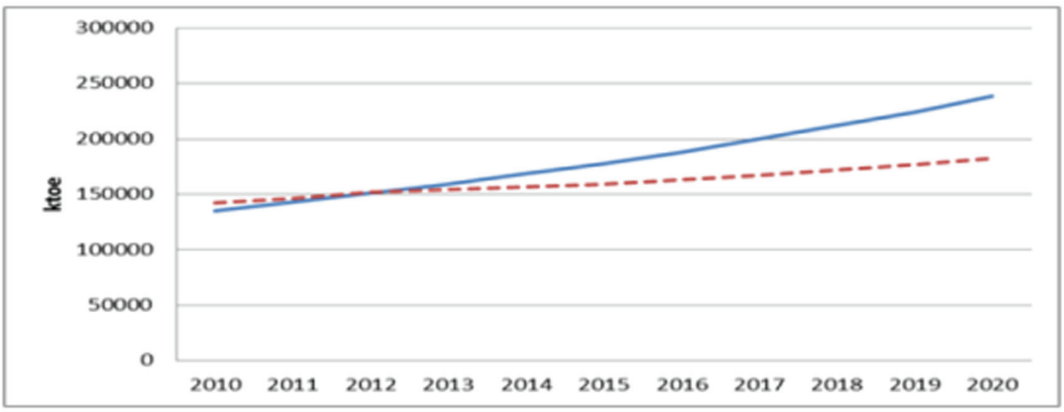
result, the overall prospects of Member States meeting their targets for 2020 are less evident.

It then further pointed out:

- *In the electricity sector, 12 Member States (Belgium, Bulgaria, the Czech Republic, Estonia, Finland, Germany, Hungary, Italy, the Netherlands, Romania, Spain and Sweden) exceeded their planned targets for renewable energy electricity in 2010, whilst the remaining 15 missed their targets. The "planned" targets for 2010 were also the indicative targets for the share of renewable energy in the electricity mix as submitted by Member States under Directive 2001/77/EC. Thus 15 Member States failed to meet their legally agreed indicative 2010 targets.*
- *The Commission has also undertaken a qualitative assessment of Member States' policies and measures described in their progress reports of 2011 and made a comparison with the commitments contained in the national renewable energy action plans ("Plans"). This assessment indicates that few Member States have vigorously implemented their planned short term measures and many have not honoured their commitments.*
- *In addition, modelling-based analysis was undertaken for the Commission, considering the current and planned policy initiatives of Member States, their current implementation rates and the various barriers to renewable energy development. This conservative analysis points to the possibility of an even less optimistic outlook for 2020.*
- *In the majority of countries, currently implemented renewable energy policies appear insufficient to trigger the required renewable energy deployment, at least under such conservative assumption. Generally this reflects the inadequacy of both the current, existing measures necessary to mitigate the non-economic barriers that hinder renewable energy growth and support. The financial crisis also affects these developments more than was anticipated by Member States in their national renewable energy action plans; EU countries face a different financial risk rating today and that has had a further negative impact on investments in renewable energy.*

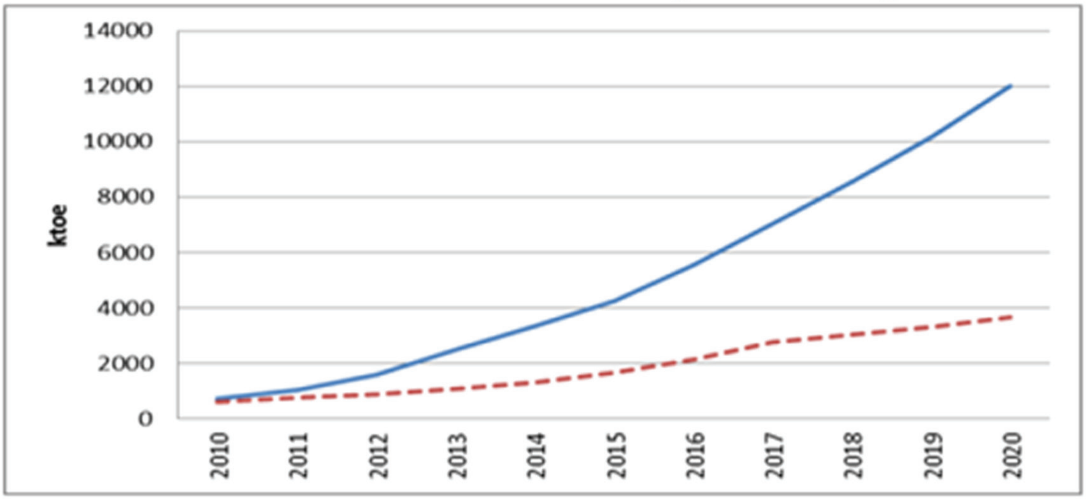
If we consider the main "Renewable energy progress report" itself, the same issues are to be seen. Indeed as presented in the following graphs

Planned (blue) versus estimated (red/dotted) trend in EU renewable energy



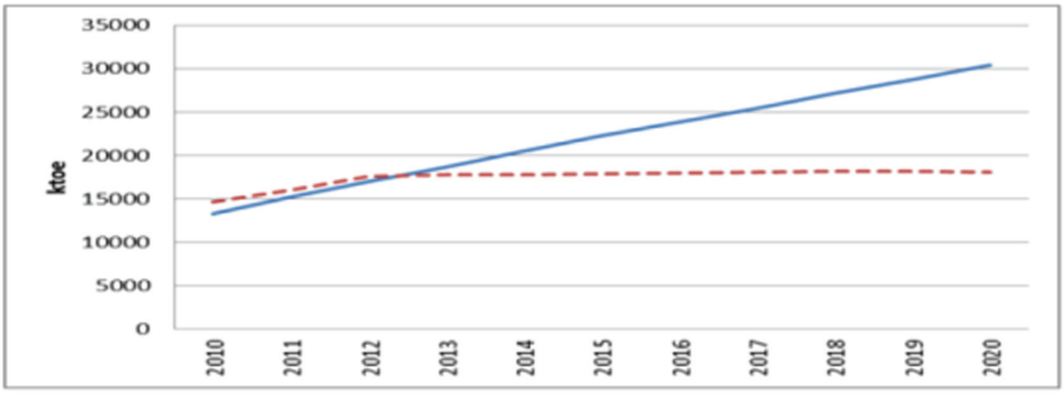
- *The failure to comply with national plans is most evident in the wind sector. According to Member State plans, wind capacity is expected to reach 213 GW in 2020 (169 GW onshore and 44 GW offshore). Electricity generation from offshore capacity is planned to reach 140 TWh (roughly 12 Mtoe). However, according to the Commission's analysis, it may only reach 43 TWh (3.7 Mtoe) due to reduced national efforts and infrastructure difficulties.*

Planned (blue) versus estimated (red/dotted) trend in EU offshore wind energy



- Despite the recent strong growth in the onshore wind industry of recent years, Member States' plans for onshore wind production 354 TWh may fall short. Further efforts will be needed to reinforce measures and improve infrastructure, or only an estimated 210 TWh might be achieved.

Planned (blue) versus estimated (red/dotted) trend in EU onshore wind energy



- Total wind generation may therefore fall short of expectations. Whereas Member State plans foresee wind generation of almost 500 TWh, current trends point to the risk of achieving only half of it, i.e. 253 TWh.

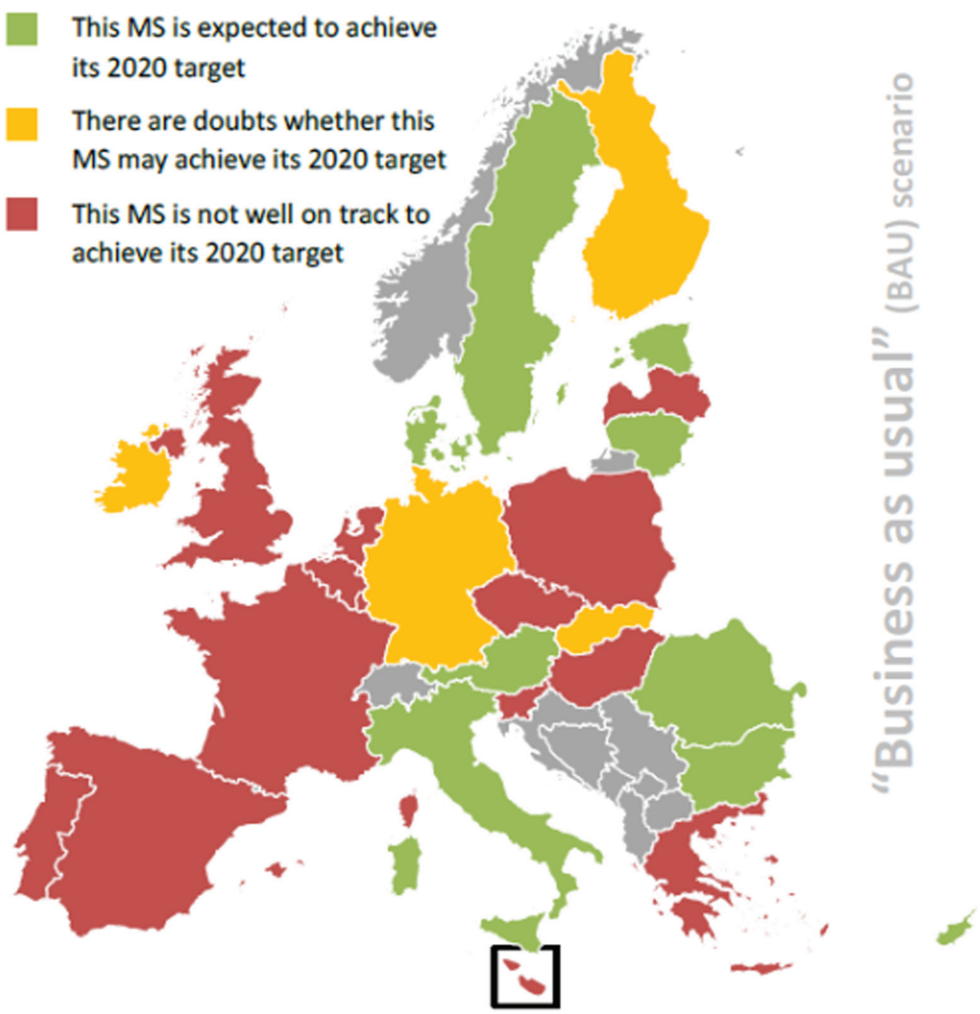
There is a website funded by the EU's Intelligent Energy Europe Programme 'Keep on Track[21]', whose function is to track the progress towards the EU's 20% renewable energy by 2020 programme, namely the implementation of Directive 2009/28/EC. It is therefore considerably more up to date than the latest EU Commission's documentation of March 2013 above. Indeed, the website's press release of 6th October 2014 couldn't be clearer: "*14 EU Member States will fail to meet their 20% renewables target by 2020, as progress stands today*[22]".

- According to the 2020 RES (Renewable Energy Sources) Scenarios for Europe Report, as it stands today, 14 Member States will fail to meet their 2020 RES targets and there are doubts about 4 other Member States reaching their target.

21 http://www.keepontrack.eu/

22 http://www.keepontrack.eu/contents/mediapressreleases/scenario-2020-press-release.pdf

Consideration of this report[23] shows the results in the figure below of the quantitative analysis of a Member State's ability to meet its 2020 target given the current 'business as usual' scenario:



Note: The traffic light colours of the figure on the left hand-side show an achievement or shortfall of 2020 RES targets by Member State after possible adjustments through RES cooperation.

An examination Member State by Member State then follows in the report, some points to note being:

France is not well on track with respect to its 2020 RES target.

For Germany it can be expected that the given 2020 RES target (18%) can be achieved under baseline conditions, i.e. if currently implemented RES policy measures are kept in place and framework conditions may not change to the worse in forthcoming years. Note: Not included in this report was the reform of Germany's renewable supports (EEG) in August 2014, which reduced significantly the previous generous renewable subsidies, given soaring electricity prices amounting to a doubling of electricity rates, since these renewable supports were introduced in 2000.

Poland is a Member State where the achievement of its 2020 RES target cannot be expected under baseline conditions. Note the report predicts a renewable energy share of 12.1% under the business as usual case versus a target of 15% set in the EU Directive. 90% of Poland's

23 http://www.keepontrack.eu/contents/publicationsscenarioreport/kot–2020-res-scenarios-for-europe.pdf

electricity comes from coal and the Polish Prime Minister Donald Tusk has it made it clear that the Polish economy will continue to be based on coal[24]. Poland has never implemented generous support schemes for renewables.

In terms of stagnating RES deployment in previous years Spain is expected to fail in achieving its 2020 RES target under baseline conditions. Note the report predicts a renewable energy share of 15.6% under the business as usual case versus a target of 20% set in the EU Directive. Generous renewable energy subsidies in Spain had to be slashed due to soaring electricity costs and worsening economic conditions.

For the UK it is not expected that its 2020 RES target can be achieved under baseline conditions. Note the report predicts a renewable energy share of 7.8% under the business as usual case versus a target of 15% set in the EU Directive.

It is also necessary to point out that the 20% renewable energy by 2020 Directive (2009/28/EC) contained a target that at least 10 % of the final consumption of energy in transport in a Member State had to come from renewable sources. As a consequence, this lead to a massive roll out of biofuels with associated seriously adverse impacts in relation to global food prices and biodiversity. As a result, the situation was reached in summer 2014, where the EU Energy Ministers have had to agree the 10% renewable target in transportation should now be capped[25]. As Oxfam are quite rightly putting it, such biofuels are a:

- "Brazen assault on common sense. In a starving world, phasing out the use of food for fuel is the only sensible thing to do".

The European Environment Agency has also had to call a 'spade a spade'[26]:

- "The overambitious 10 % biofuel target is an experiment, whose unintended effects are difficult to predict and difficult to control. Therefore the Scientific Committee recommends suspending the 10 % goal; carrying out a new, comprehensive scientific study on the environmental risks and benefits of biofuels; and setting a new and more moderate long-term target, if sustainability cannot be guaranteed".

1.6 The Lawyers move in

Currently in the High Court in Dublin there are seven Judicial Reviews in relation to approvals of renewable projects, plus one case in relation to the validity of the Irish NREAP. The Access to Justice Pillar of the Convention, Article (9), bestows the right of "access to administrative or judicial procedures to challenge acts and omissions of private persons and public authorities, which contravene provisions of its national law related to the environment". These procedures must be fair, equitable, timely and not prohibitively expensive. In addition, the Charter of Fundamental Rights of the Lisbon Treaty make binding the Right to Good Administration and the Right to have damages made good. In areas of Community legal order, such as failures of a Member State or an institution of the EU, there is legal liability.

This is an established part of case law of the European Court since 1991, when Senor Francovich won his case, in relation to Italy failing to implement EU legislation for the protection of employees in the event of insolvency of the employer. The European Court found the Italian State liable to financially compensating the workers for the breach in legislation. This principle of Member State liability has been well established in further cases since taken. Indeed, the EU Commission has seen it as an effective mechanism for the public to themselves enforce Community law in the Member States. They have published a specific guidance document on the case law concerning damages in relation to breaches of EU law by Member States[27].

24 http://www.thenews.pl/1/12/Artykul/146850,-Poland-will-stick-with-coal-PM-pledges

25 http://www.reuters.com/article/2014/06/13/us-eu-biofuels-idUSKBN0EO14L20140613

26 http://www.eea.europa.eu/highlights/suspend-10-percent-biofuels-target-says-eeas-scientific-advisory-body

27 http://ec.europa.eu/eu_law/infringements/infringements_dommages_en.htm

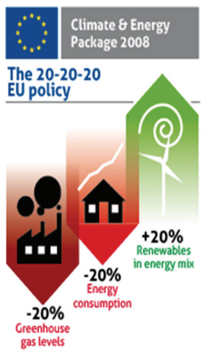
The current legal cases in relation to validity of planning decisions, will undoubtedly be followed in time by claims for damages, owing to a breach in rights and a causal relationship between those rights and the damage caused, such as in relation to unacceptable noise impacts and loss of residential amenity.

Presentation on Aarhus Convention and Irish Renewable Energy Programme

- **Biography:** Pat Swords is a Fellow of the Institution of Chemical Engineers and a Chartered Environmentalist. Since graduation from University College Dublin in 1986, Pat has worked in developing the high technology manufacturing industry in Ireland.
- His work experience has also included projects in over a dozen other countries throughout Europe and North America. Since 1999 he has worked extensively on EU Technical Aid Projects in Central and Eastern Europe helping to implement EU Industrial Pollution Control and Control of Major Accident Hazards legislation.

20% Renewable Energy EU Target – through Directive 2009/28/EC

- Never worked out; what was to be built, where it was to be built, what were the impacts, etc.
- 20% overall target 'shared out' to Member States based on existing level of renewables and factor based on GDP.
  - Ireland 16%, UK 15%, Austria 34%, Sweden 49%, etc
- National Renewable Energy Action Plans (NREAPs) to be adopted by June 2010
- Legally binding environmental assessments and public participation by-passed.



Principle 10 of UN Rio Declaration of 1992

- ***Environmental issues are best handled with participation of all concerned citizens, at the relevant level.***
- ***At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities****, including information on hazardous materials and activities in their communities,* ***and the opportunity to participate in decision-making processes.***
- *States shall facilitate and encourage public awareness and participation by making information widely available.* ***Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided.***

UNECE – Aarhus Convention (~ 1998)

- The Aarhus Convention grants the public rights and imposes on Parties and public authorities obligations regarding **Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters.**
- The subject of the Convention goes to the heart of the relationship between people and governments. The Convention is not only an environmental agreement, it is also a Convention about government accountability, transparency and responsiveness.

Findings and Recommendations of Aarhus Convention Compliance Committee

- **ACCC/C/2010/54** 16th August 2012:
  - EU did not comply with the provisions of the Convention in connection with its 20% renewable energy by 2020 programme (Directive 2009/28/EC) and its implementation throughout the 27 Member States by the National Renewable Energy Action Plans (NREAPs).

Aarhus Convention – Compliance Mechanisms

- Meeting of the Parties (MoP) approx. every 3 years – 47 Countries met in July 2014.
- Findings and recommendations of Compliance Committee endorsed by the MoP.
- *Express its concern …"a proper regulatory framework and/or clear instructions for implementing article 7 of the Convention with respect to the adoption of NREAPs" and that it remains unclear how the Party concerned will "adapt the manner in which it evaluates NREAPs" in accordance with the recommendations of the Committee.*
- EU to report to Geneva this December and at regular intervals – NREAPs have to be redone!

Scottish Communication in Geneva – ACCC/C/2012/68 Oct 2013

- The UK NREAP for its national renewable energy programme did not comply with the public participation requirements of Article 7 of the Convention**.**
- Article 7 requires the '**necessary information**' to be provided to the public and effective public participation **when all options are open**.

Aarhus Convention and EU Law

- The Convention is an integral part of Community legal order since 2005:
- Under European Community law, an international agreement concluded by the Community is binding on the Community institutions and the Member States, and takes precedence over legal acts adopted by the Community.
- A failure to comply with an International Treaty, such as compliance with the Aarhus Convention, is a breach of EU law.
- Current legal case in Irish High Court and forthcoming Judicial Review in Scotland.

Irish Renewable Energy Programme Proportionate / Reasonable?

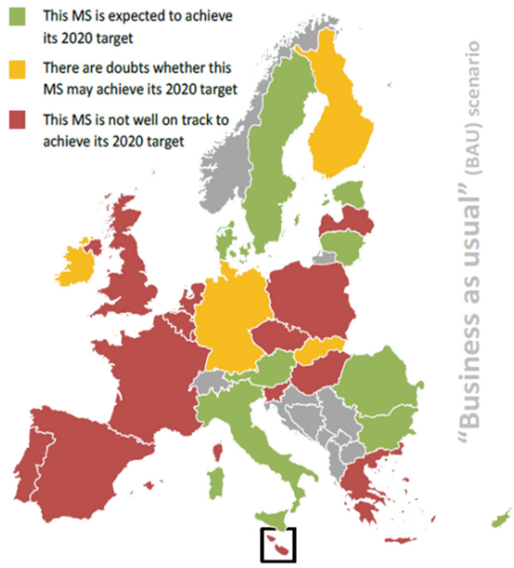
- The only reason why we have got so far with it is that buzz words have sufficed and legal assessments by-passed – public authorities don't have the information they are required to posses by law.
- Once assessed it is nothing but completely disproportionate and dysfunctional.
- UNECE Compliance Committee in Geneva Dec 2012 – Position of Jean-Francois Brakeland of the EU:
- *"If we were to take instead of a 110 m high wind turbine a 110 m high metal statue of Mickey Mouse, you would not be expected to do a detailed carbon assessment on that, so why do you expect a detailed carbon assessment for the wind turbine?"*

PAC Appeal on Drumadarragh Windfarm - so much for 'when all options are open'

- *Performance of Wind Turbines: General criticisms of wind power in general were raised by objectors. However, such criticisms are inappropriate for consideration in the context of this individual appeal.*
- *For example, the question of whether wind turbines are more or less efficient or cost effective relative to other power sources is a matter of national and regional policy review. General concerns about wind farms; 'green credentials' and carbon release impacts are similarly beyond the scope of this appeal.*

Even EU's own documentation recognises these targets won't be met

- *For the UK it is not expected that its 2020 target can be achieved under baseline conditions.*
- Predicts a renewable energy share of 7.8% versus a target of 15% set in the EU Directive.



NIRIG follow up letter from briefing on 23rd October 2014

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27th October 2014

Dear Anna,

Many thanks for the opportunity to present to the Committee last Thursday morning. We appreciated the time taken by the Committee to take further evidence from the renewables sector and hope that the session was both useful and informative.

We made reference to a number of policy areas in our briefing, some of which fall within the remit of the Committee. In particular, we raised our concerns about the renewable energy policies contained within the draft SPPS. The draft SPPS emphasises sustainable development as a core principle and low-carbon electricity production is one of the most cost-effective methods of reducing greenhouse gases. It is therefore vital that the presumption in favour of renewable development is retained within the SPPS.

Furthermore, we have major concerns that there is no mention of our key energy policy - Strategic Energy Framework - within the SPPS. It raises concerns that local Councils could produce development plans that do not align with national energy policy. We believe that the SPPS must require local plans and policies to unambiguously align with national policies and frameworks, including the SEF.

The SEF will be reviewed in 2015 and it is vital that we recommit to our 2020 targets of 40% electricity from renewables and indeed begin to look further ahead to our 2030 targets, in particular as on the 23rd and 24th of October, the EU Heads of State and government agreed a Climate and Energy package for 2030 setting binding targets for greenhouse gas emissions savings of at least 40% as compared to 1990 levels and a binding renewable

IWEA Irish Wind Energy Association | renewableUK | NIRIG is a collaboration between the Irish Wind Energy Association and RenewableUK energy target of at least 27%. We again ask this Committee to take an active interest in the SEF review to ensure that the long-term future of our environment remains a government priority.

The Committee had also requested further information on the calculation of carbon savings from wind. Please find the calculation and all relevant references below.

As always, NIRIG is happy to meet with the Committee and provide information on an aspect of the wind, wave or tidal renewable energy sectors at any time.

Yours,

____

Meabh Cormacain
NIRIG

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How does the wind industry calculate the amount of carbon saved?

Assuming an average load factor for Northern Ireland of 31.5%, the reduction in CO_2 emission reduction is calculated as:

Installed capacity in megawatts (MW),
multiplied by load factor expressed as a fractional percentage of 1 (e.g. ***0.315****),*
multiplied by number of hours in the year,
multiplied by the number of grams of CO_2 *saved per kilowatt hour (NIRIG uses DECC's standard figure of* ***430g/kWh***[1]***)***
divided by 1,000 (to align the units, as grams of CO_2 *is expressed in kWh).*

Therefore, as Northern Ireland currently has 531MW of installed large-scale wind energy:

531MW x 0.315 load factor x 8760 hours x 430g / 1,000
= **630,054 tonnes of CO_2 per year**.

Load factor/capacity factor for wind:

For wind power systems, the load or capacity factor provides a measure of the amount of electricity generated by the turbines compared to the theoretical maximum output of the turbines under ideal wind conditions. Capacity factor is sometimes confused with being a measure of the amount of time a generator runs – this is not the case. For example, a wind turbine could operate at maximum capacity for 30% of the year, at 30% capacity for the entire year, or some combination in-between – in each case the capacity factor would be 30%, however the number of hours of operation is different.

In the UK, a typical wind turbine will generate some electricity for 80-85% of all hours in the year. Capacity factor is sometimes confused with the efficiency of a generator – they are not the same thing.[2]

NIRIG uses an average capacity factor from SONI/EirGrid of **31.5%.**[3]

For onshore wind in Ireland the historical figures are:
2012: 28%
2011: 33%
2010: 24%
2009: 31%
2008: 32%

(Updated July 2014)

1 http://webarchive.nationalarchives.gov.uk/20120403171904/http://www.decc.gov.uk/assets/decc/what%20we%20do/supporting%20consumers/saving_energy/analysis/fes-appendix.pdf
2 http://www.eci.ox.ac.uk/publications/downloads/sinden05-dtiwindreport.pdf
3 http://www.eirgrid.com/media/Generation%20Capacity%20Statement%202014.pdf p32

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Northern Ireland Assembly

Appendix 8

List of Witnesses

List of Witnesses

Ms Joy Hargie	Department of the Environment
Ms Deidre McSorley	Department of the Environment
Mr Scott Symington	Department of the Environment
Mr Simon Kirk	Department of the Environment
Fiona McGrady	Department of the Environment
John Murphy	Department of the Environment
Dr. Chris Jordan	Chartered Institute of Environmental Health
Mr Paul McCullough	Chartered Institute of Environmental Health
Mr Gary McFarlane	Chartered Institute of Environmental Health
Mr Raymond Smith	Chief Environmental Health Officers Group NI
Mr Sean Clarke	Cookstown District Council
Mr Michael Harris	Department of Enterprise, Trade and Investment
Ms Mary Lavery	Department of Enterprise, Trade and Investment
Ms Lynda Hutton	Fermanagh District Council
Mr Desmond Reid	Fermanagh District Council
Mr Graeme Dunwoody	Fermanagh Trust
Mr Lauri McCusker	Fermanagh Trust
Ms Victoria McCabe	First Flight Wind Ltd
Ms Sacha Workman	First Flight Wind Ltd
Ms Helen Harrison	Juno Planning
Ms Oralith Kirk	Juno Planning
Ms Shanti McCallister	Landscape Institute Northern Ireland
Mr Pete Mullin	Landscape Institute Northern Ireland
Mr Jason Devine	Lisnaharney Area Residents Group
Ms Shauna Ward	Lisnaharney Area Residents Group
Ms Tanya Hedley	Northern Ireland Authority for Utility Regulation
Mr Michael Atkinson	Northern Ireland Electricity
Mr Denis Kelly	Northern Ireland Electricity
Mr Jonathan Bell	Northern Ireland Environment Link
Mr Gary Connolly	Northern Ireland Renewables Group
Ms Meabh Cormacain	Northern Ireland Renewables Group

Ms Lucy Whitford	Northern Ireland Renewables Group
Dr Matthew Cassidy	Northern Ireland Renewables Group
Mr Michael Gordon	Northern Ireland Renewables Group
Mr Patrick McClughan	Northern Ireland Renewables Group
Councillor Charles Chittick	Omagh District Council
Councillor Sean Clarke	Omagh District Council
Prof. Geraint Ellis	Queen's University Belfast
Ms Suzie Cave	RaISe
Ms Lucy Whitford	RES
Mr Fergal O'Donnell	Rural Community Network
Ms Gail Hitchins	SKM Enviros
Ms Vicky Boden	SSE Renewables Ireland
Mr David Manning	SSE Renewables Ireland
Councillor Daniel Kelly	Strabane District Council
Councillor Kieran McGuire	Strabane District Council
Mr Patsy Kelly	Strabane and Omagh District Council Wind Farm Working Group
Ms Ann McAleer	Strabane and Omagh District Council Wind Farm Working Group
Mr Adam Larkin	Strategic Planning
Mr Ryan McBirney	Strategic Palnning
Ms Aine Coyle	TCI Renewables
Mr Peter Craig	TCI Renewables
Mr Gary Preston	TCI Renewables
Mrs Ursula Walsh	University of Ulster
Prof. Alun Evans	Windwatch
Dr. Dan Kane	Windwatch
Mr John Peacocke	Windwatch
Mr Peter Sweetman	Windwatch
Mr Owen McMullan	Windwatch
Mr Pat Swords	Windwatch
Mr Mervyn Keys	Windwatch
Mr Keith Graham	Windwatch
Ms Pauline Graham	Windwatch

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