

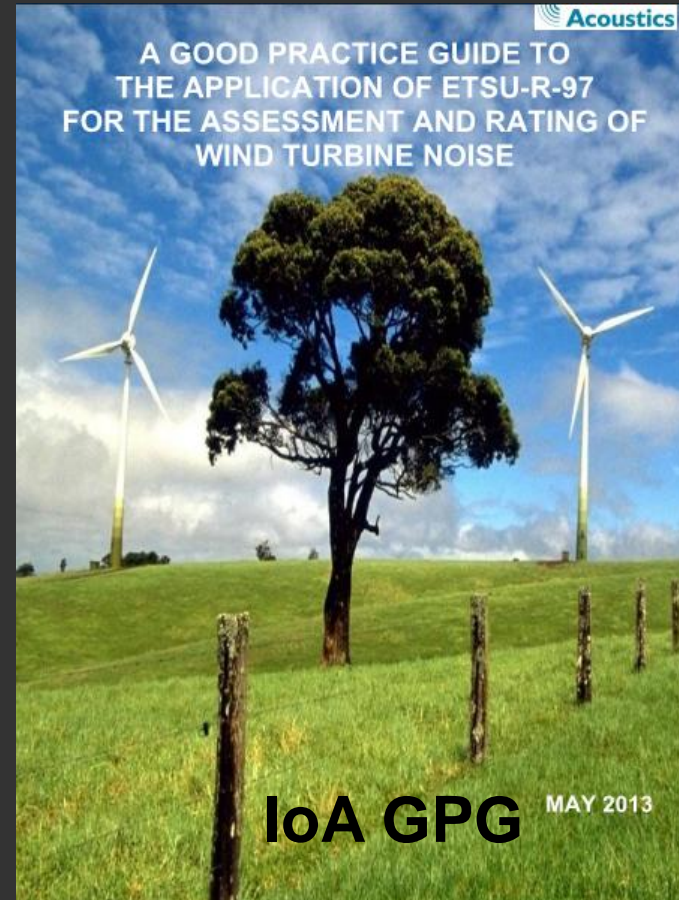
# Wind Farm Noise Impact Assessment

## WHAT COULD AN ALTERNATIVE TO ETSU-R-97 LOOK LIKE?



Andy McKenzie & Andrew Bullmore

# ETSU-R-97



- advice to be reviewed after two years of implementation
- now almost two decades on (but with IoA GPG in 2013)



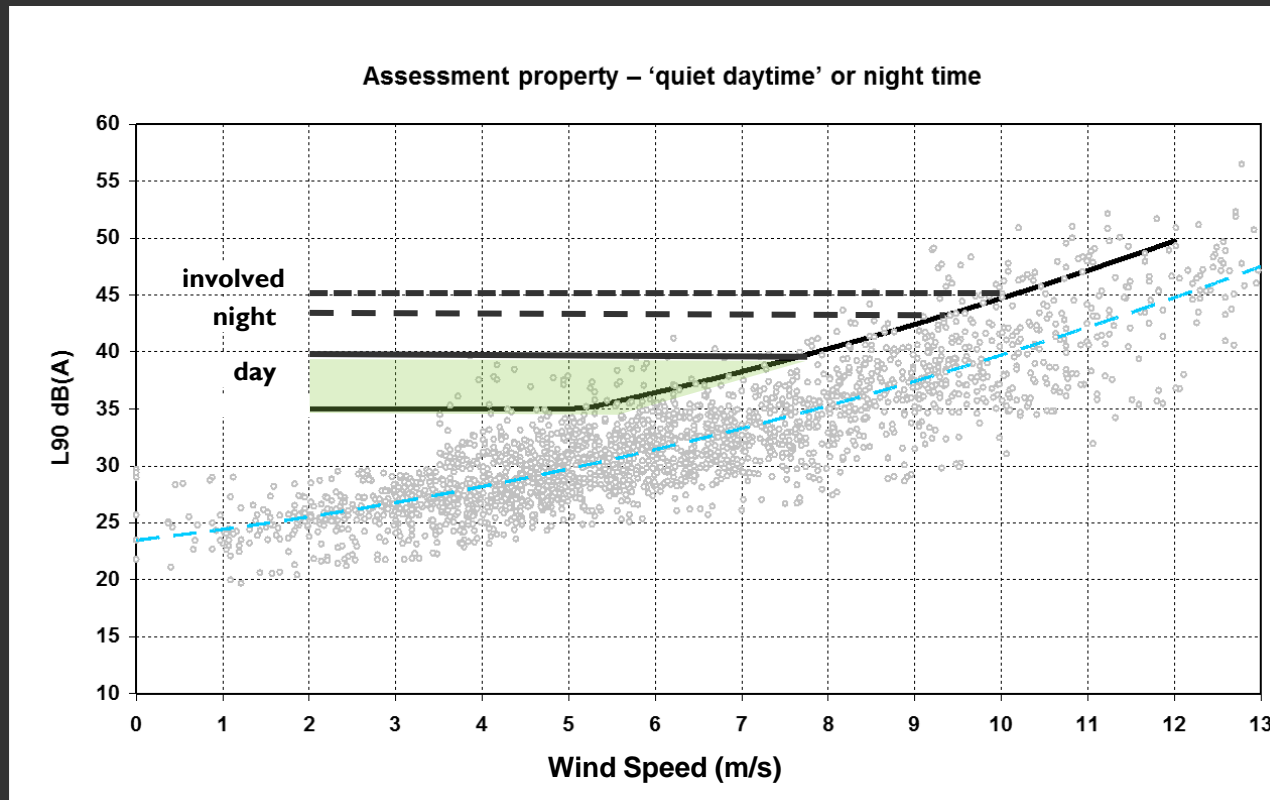
# Time for change ... ?



- do we need an ETSU-R-XX in the light of current guidance ?
- if we do, then what should ETSU-R-2015 look like ?
- what has changed since the mid 90s ?
- how should the setting of noise limits be addressed ?
- what character corrections should be included ?
- should the noise limits include matters of planning balance ?
- how should the concept of effect levels be dealt with ?
- is further research required to establish 'true' noise effects ?

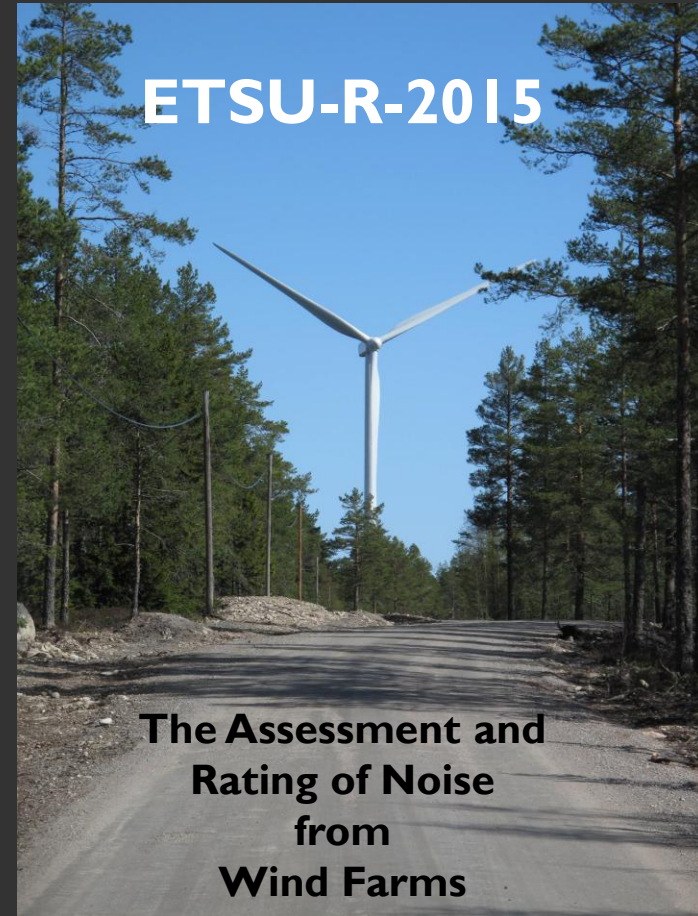
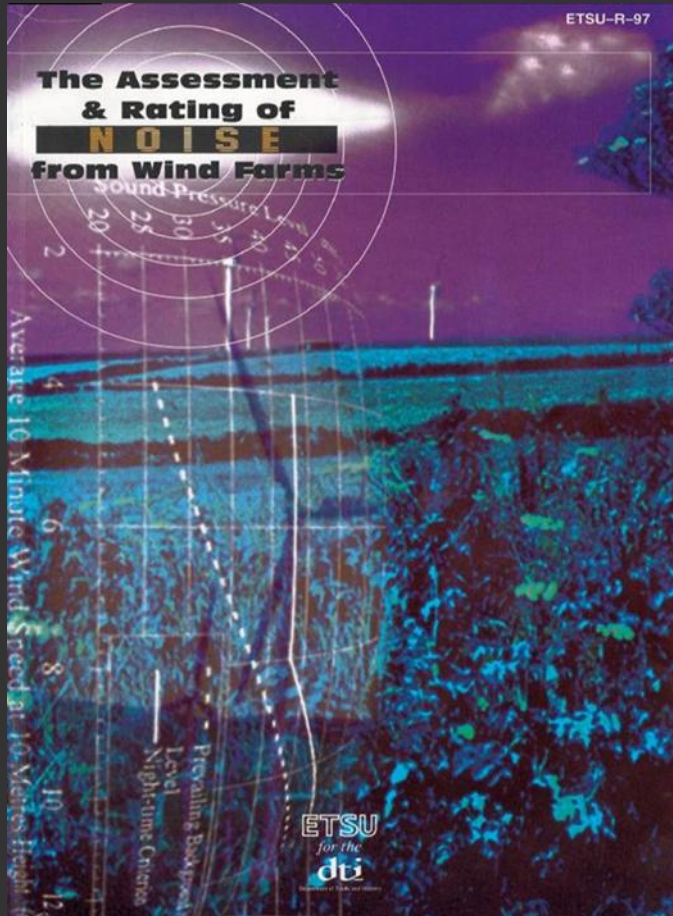
# ETSU-R-97

BS4142:1990 basis - set the ETSU-R-97 noise limit at 5dB(A) above the (average) background noise curve but with an absolute lower limit



- noise limits in part justified on the basis of an assumed planning balance
- accounting for extant advice contained in policy, standards and other guidance

# Option for ETSU-R-2015 ?



- overview of some possible options in principle
- setting of appropriate limit values would need to be addressed

# Maximum noise level approach



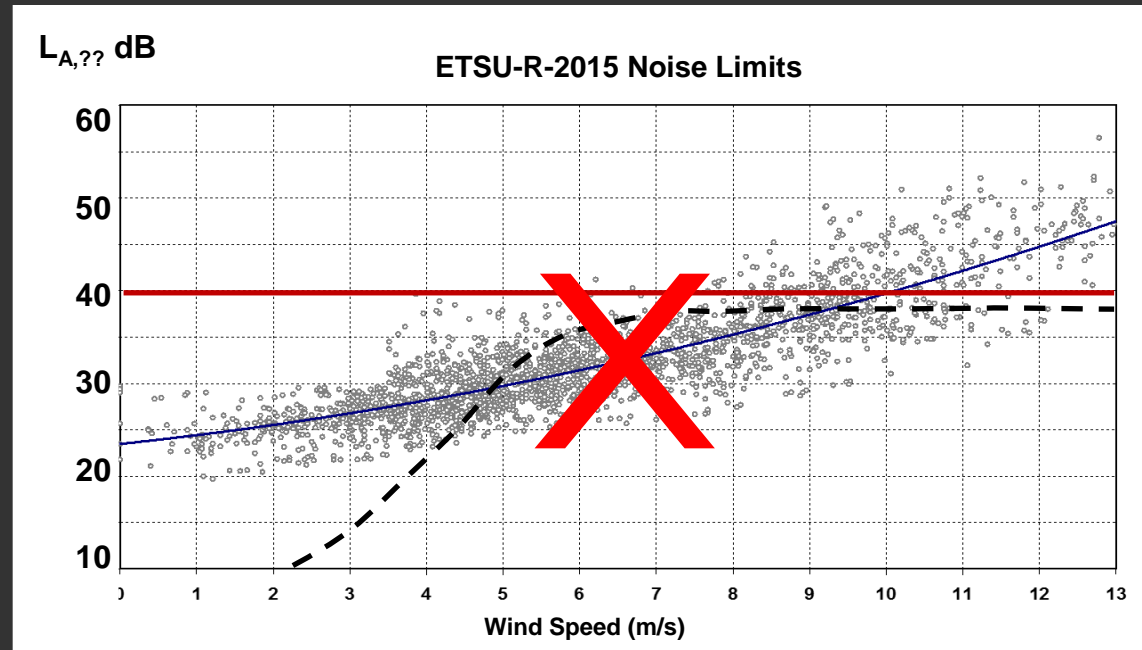
## Option 1 –

Fixed noise limit(s)  
regardless of  
background level

Possible due to  
changing characteristics  
of turbine noise outputs

No baseline noise measurements required

Variable limit(s) depending on time of day and other  
relevant factors (prescriptive method)



# Maximum noise level approach

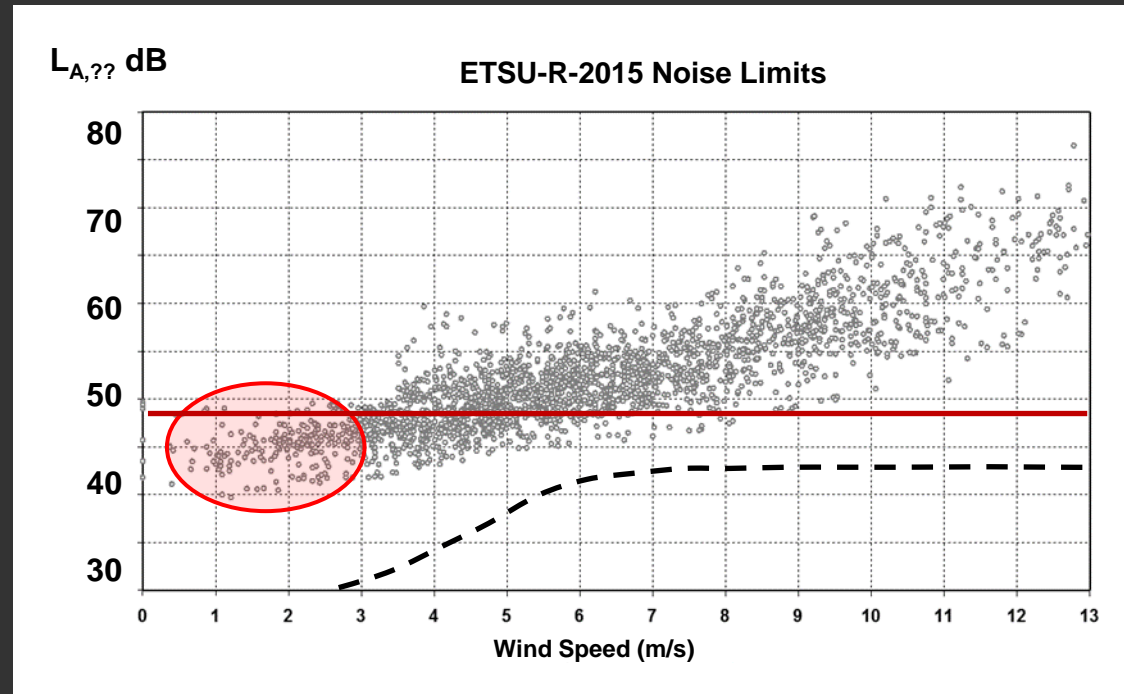
## Option 2 –

As per Option 1 but limits account for non-wind related background noise

BS4142 type baseline noise measurements only required (no wind speed measurements)

need to account for the variability of the background (e.g. BS4142:2014)

suitable for transport corridors or industrial areas





# Noise Dose Approach

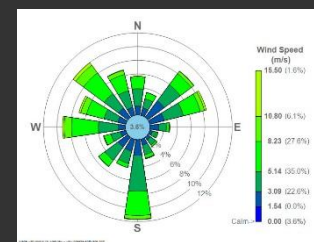
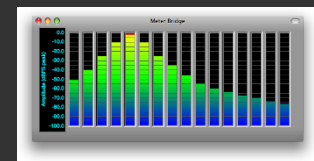
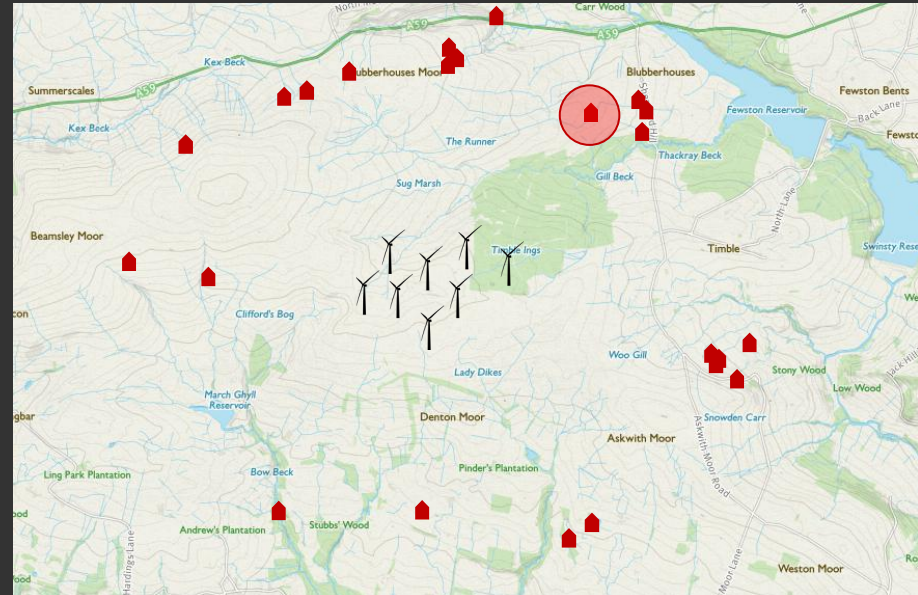
## Option 1 –

Total noise dose approach follows WHO, END, etc

No background noise measurements necessary

Requires ‘acceptable’ noise dose to be set (possibly with absolute maximum levels)

Demonstration of compliance at receptor locations not measurable – possible adoption of calculated compliance methodology based on measured turbine SWLs and agreed propagation model with full account being taken of wind effects over the dose period (annual?)





# Noise Dose Approach

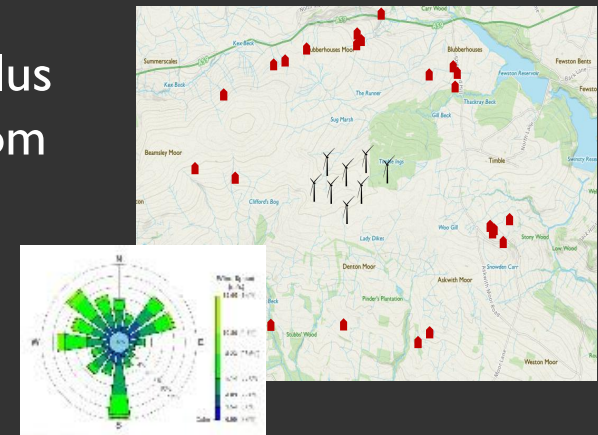
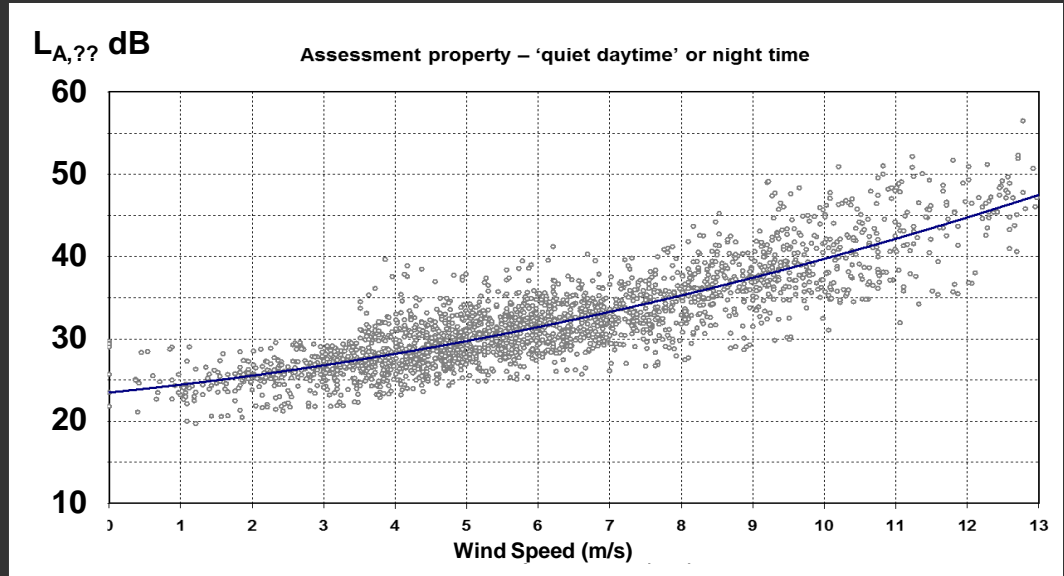
## Option 2 –

Noise dose change  
approach

Ideal from EIA perspective  
as it identifies change

Requires extensive baseline  
noise measurements correlated with wind speed plus  
the calculation of the corresponding noise dose from  
the wind farm accounting for wind conditions

Potential issues with creeping baseline and  
demonstration of compliance



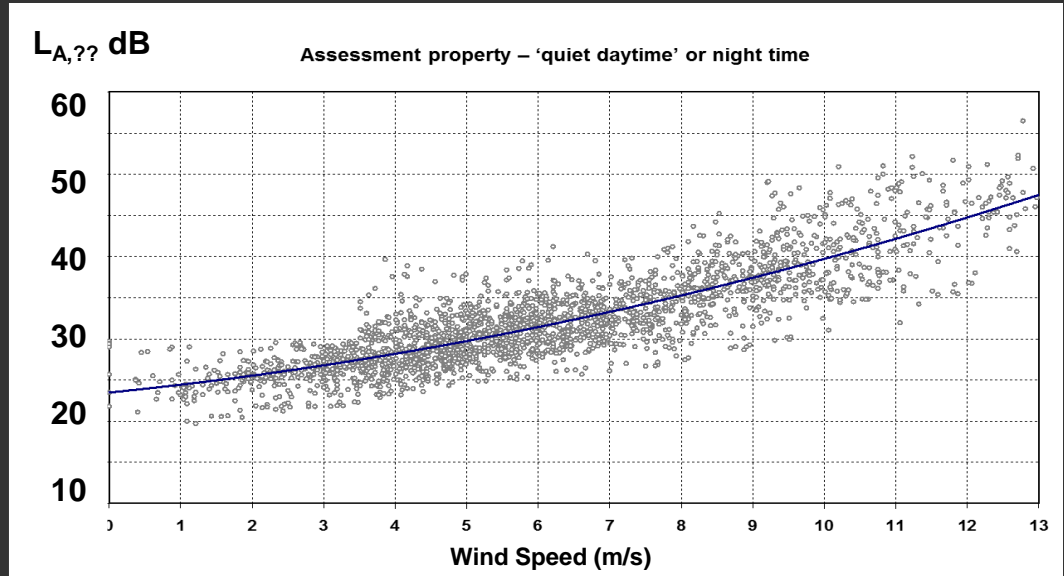
# Variable noise limit with wind speed



## Option 1 –

Assumed background noise curve

No background noise measurements required



Could adopt standard baselines for specific situations (similar to original BS4142) but would require wind speed dependent noise curves including factors such as remoteness and topography

# Variable noise limit with wind speed

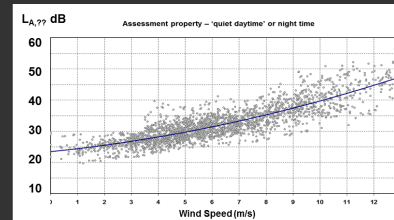


## Option 2 –

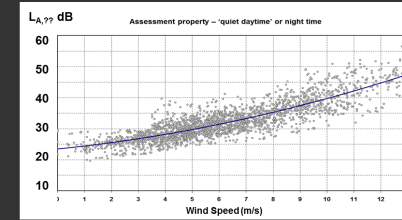
Derive noise curve from some combination of the noise curves measured across the site (possibly average or minimum at any given wind speed)

Extensive background noise measurements required

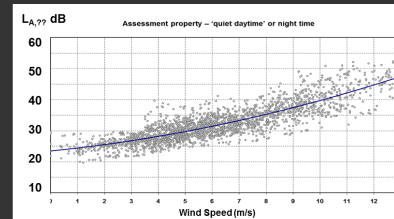
Location 1



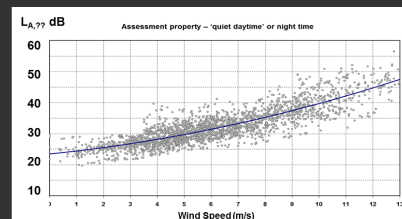
Location 2



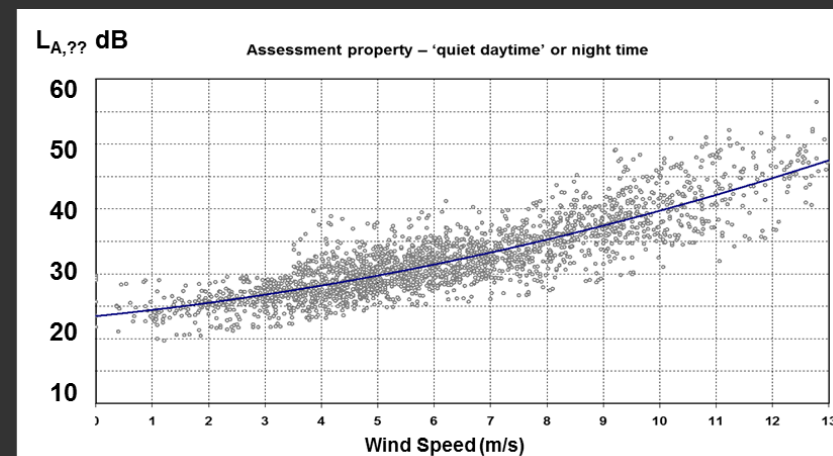
Location 3



Location 4



Limits at all locations = Avg/Min (1:2:3:4)





## **ETSU-R-97**

**what has changed since  
the mid-90s ?**

# Policy background



Department of the Environment  
Welsh Office

PPG22  
February 1993

## PLANNING POLICY GUIDANCE NOTE:

### RENEWABLE ENERGY

Planning Policy Guidance notes set out the Government's policies on different aspects of planning. They are to be taken into account by local authorities as they prepare their development plans, and they may be material to decisions on individual planning applications and appeals.

This PPG describes the various renewable forms of energy; explains renewable energy's potential role in tackling greenhouse gas emissions; sets out the relevant instruments of policy, including the Non-Fossil Fuel Obligation; outlines relevant environmental protection legislation; gives a statement of general planning aims; explains how local planning authorities should include renewable energy policies in their plans, and advises them to consider what contribution their plans should make; notes the considerations which should apply when it is intended to locate renewable energy installations in designated areas; explains when environmental assessment is required; sets out the environmental implications of renewable energy; and refers to planning conditions, temporary permissions and other consents/permissions.

The Annex on Wind Energy has two main sections: *the technology*, encompassing wind turbine characteristics; wind speed and connection; siting; and degree of disturbance; and *planning implications*, covering safeguarding; precedent; standards; safety; icing; proximity to power lines; airports, roads and railways; shadow flicker; noise; electromagnetic interference; and the landscape; ecology; archaeology and listed buildings; construction disturbance; and conditions.

## INTRODUCTION

1. Renewable energy is the term used to cover those energy flows that occur naturally and repeatedly in the environment - energy from the sun, the wind and the oceans, and the fall of water. The heat from within the earth itself, geothermal energy, is usually regarded as renewable, although locally it cannot always sustain continuous extraction. Plant material is an important source of renewable energy. Combustible or digestible industrial, agricultural and domestic waste materials are also regarded as renewable sources of energy.

2. In industrialised countries there has been a tendency for energy to be supplied from increasingly large and centralised fossil-fuel and nuclear generating sources via transmission and distribution systems to homes, offices, industrial and other premises. Planning procedures have evolved to deal with these centralised systems: in the case of electricity generating stations and overhead lines in England and Wales they are explained in DOE Circular 14/90 (Welsh Office 20/90, Department of Energy 1/90).

## Planning Policy Guidance 24: Planning and noise

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superceded by the Control of Noise at Work 2007, which has since been revoked

# Standards background



**BS 4142: 1990:** Method for rating industrial noise affecting mixed residential and industrial areas **superseded by BS4142:2014**

**BS 5228: Part 1: 1984** Noise Control on construction and open sites. Part 1: Code of Practice for basic information and procedures for noise control **superseded by BS 5228:2009,**

**BS 7445: Parts 1-3: 1991:** Description and measurement of environmental noise **superseded by BS 7445, Part 1: 2003, Parts 2 and 3 still extant**

**BS 7135: Part 1: 1989:** Noise emitted by computer and business equipment Part 1. Method of measurement of airborne noise **superseded by BS 7779: 2001 then BS 7779: 2010**



# International Guidance



CEC Report EUR 5398 e: Environment and Quality of Life: Damage and Annoyance Caused by Noise: 1975 **1975 - superseded?**

OECD Report: Reducing Noise in OECD Countries **1978 - superseded?**

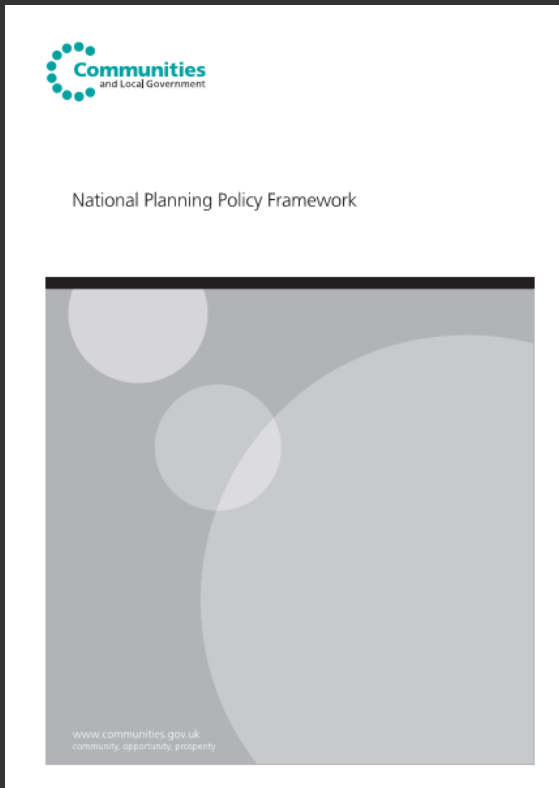
WHO Environmental Health Criteria 12 - Noise: 1980 **superseded by**

**WHO Guidelines for Community Noise 2000**

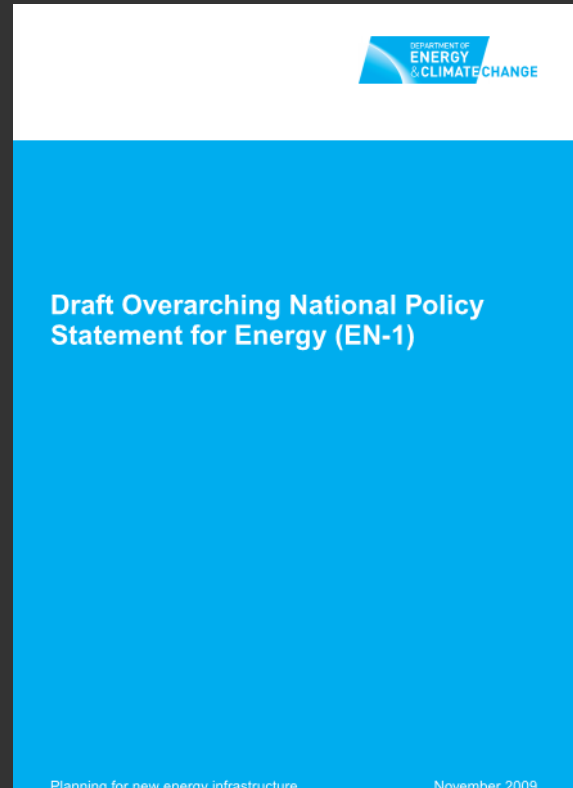
**WHO Night Noise Guidelines for Europe 2009**

WHO Environmental Health Criteria Document on Community Noise, External Review Draft, 1999 **(WHO Guidelines 2015 update imminent)**

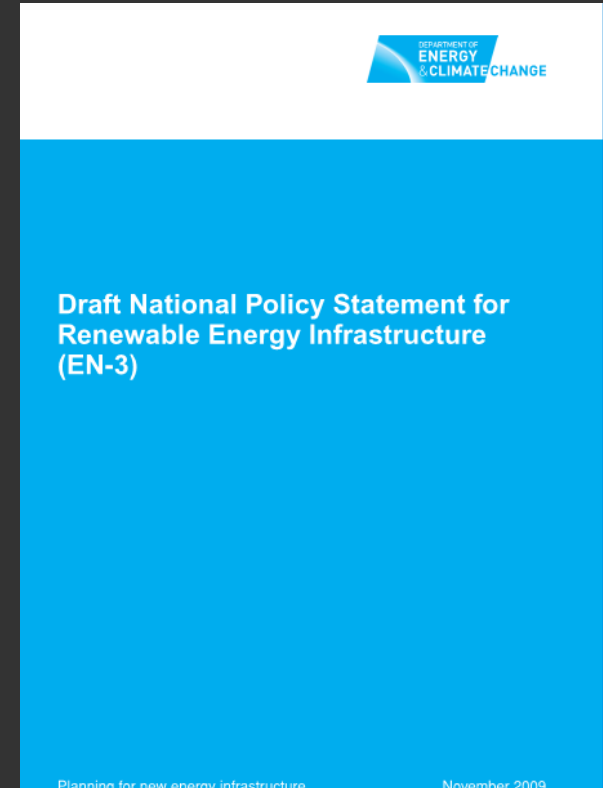
# Current Policy



**NPPF**



**EN-1**



**EN-3**

# Current Policy

A screenshot of the Planning Practice Guidance website. The page title is 'Noise'. It contains three paragraphs of guidance. Paragraph 001 discusses when noise is relevant to planning. Paragraph 002 discusses whether noise can override other planning concerns. Paragraph 003 discusses how to determine noise impact. A 'Related policy' section points to Paragraph 123 of the National Planning Policy Framework.

Planning Practice Guidance

National Planning Policy Framework Planning Practice Guidance About

Planning Practice Guidance > Guidance > Noise > Noise

Guidance

## Noise

Print

### Noise

Paragraph 001 Reference ID: 30-001-20140306

#### When is noise relevant to planning?

Noise needs to be considered when new developments may create additional noise and when new developments would be sensitive to the prevailing acoustic environment. When preparing local or neighbourhood plans, or taking decisions about new development, there may also be opportunities to consider improvements to the acoustic environment.

Revision date: 06 03 2014

#### Can noise override other planning concerns?

It can, but neither the [Noise Policy Statement for England](#) nor the National Planning Policy Framework (which reflects the Noise Policy Statement) expects noise to be considered in isolation, separately from the economic, social and other environmental dimensions of proposed development.

Revision date: 06 03 2014

#### How to determine the noise impact?

Local planning authorities' plan-making and decision taking should take account of the acoustic environment and in doing so consider:

- whether or not a significant adverse effect is

Related policy

National Planning Policy Framework

- Paragraph 123

PPG (noise)

The cover of the Noise Policy Statement for England (NPSE). It has a green header with the URL 'www.defra.gov.uk'. The main title is 'Noise Policy Statement for England (NPSE)' and the date is 'March 2010'. The Defra logo is in the bottom right corner.

www.defra.gov.uk

## Noise Policy Statement for England (NPSE)

March 2010

defra  
Department for Environment, Food and Rural Affairs

NPSE



# NPSE/PPG Noise Effect Levels



Perception	Examples of Outcomes	Increasing Effect Level	Action
<b>Not Noticeable</b>	No Effect	No Observed Effect	No specific measures required
<b>Noticeable and not intrusive</b>	Noise can be heard, but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect	No specific measures required
		Lowest Observed Adverse Effect Level	
<b>Noticeable and intrusive</b>	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
		Significant Observed Adverse Effect Level	
<b>Noticeable and disruptive</b>	The noise causes a material change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
<b>Noticeable and very disruptive</b>	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory	Unacceptable Adverse Effect	Prevent

- effect levels allow the likely impact of noise to be considered in the planning balance alongside all other impacts (negative and positive)
- planning balance presently stated as being considered in the ETSU-R-97 limits

# NPSE/PPG Noise Effect Levels



No Observed Effect Level (NOEL)



No Observed Adverse Effect



Lowest Observed Adverse Effect Level (LOAEL)



Observed Adverse Effect



Significant Observed Adverse Effect Level (SOAEL)



Significant Observed Adverse Effect



Unacceptable Adverse Effect

Perception	Examples of Outcomes	Increasing Effect Level	Action
Not Noticeable	No Effect	No Observed Effect	No specific measures required
Noticeable and not intrusive	Noise can be heard, but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect	No specific measures required
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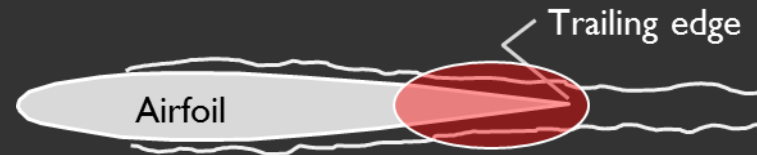




# Turbine size and SWL evolution

**500 kW**

35 rpm @ 17 m blade length = ~60 m/s tip speed



**2300 kW**

18 rpm @ 45 m blade length = ~85 m/s tip speed

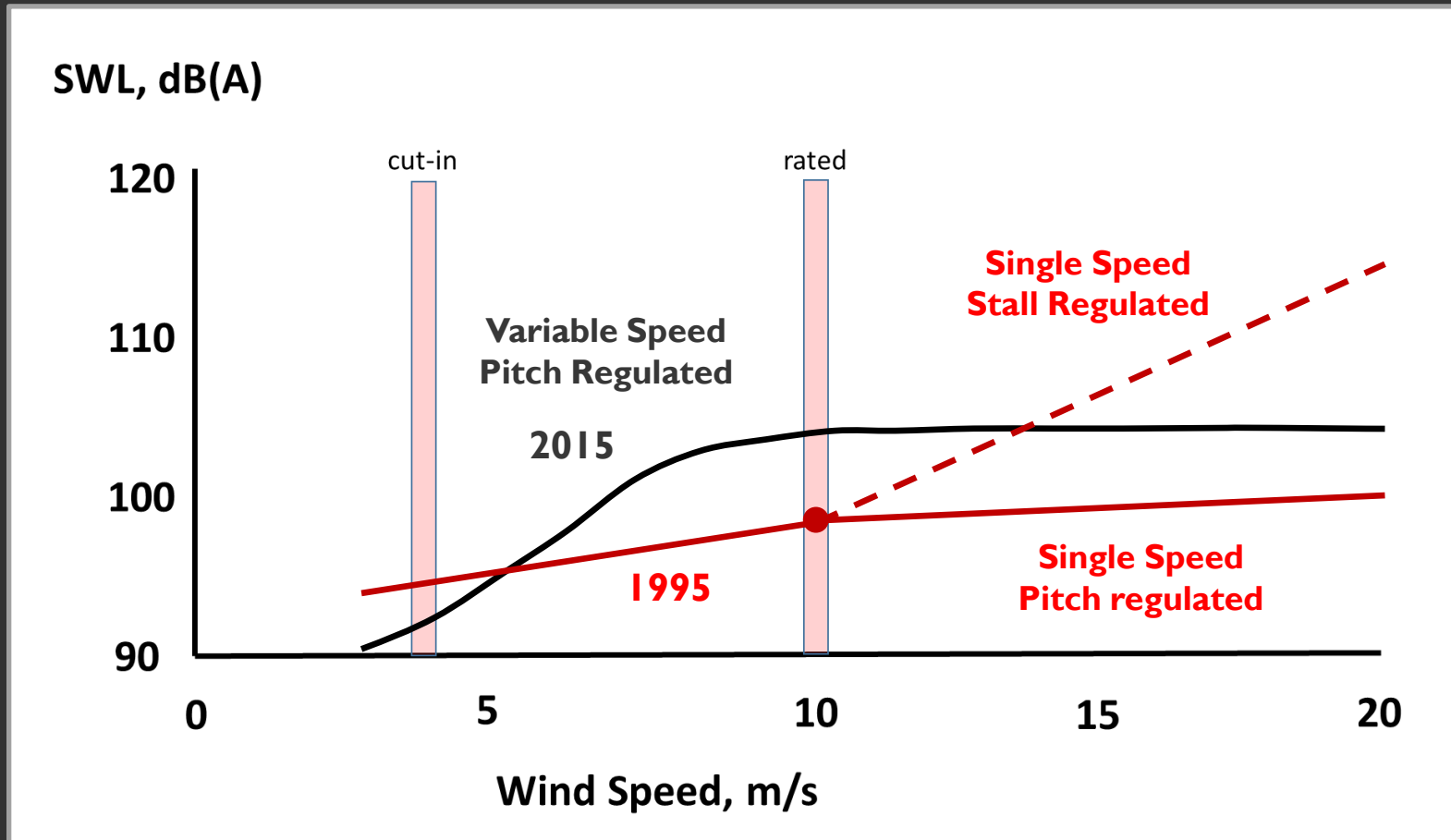
## **Approximations to noise outputs**

Increased tip speed equates to an approximate 6 dB increase

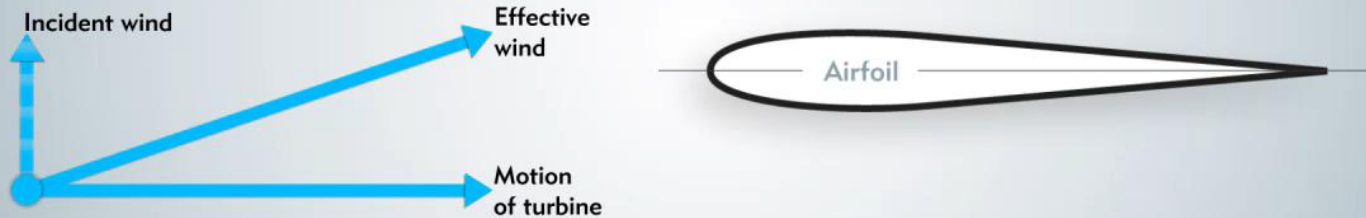
Increased power also scales to an approximate 6 dB increase

....but noise outputs now have different wind speed relationships  
and are controllable

# Wind speed and SWL



# Pitch regulation



Fixed rpm, increasing pitch and inflow wind speed

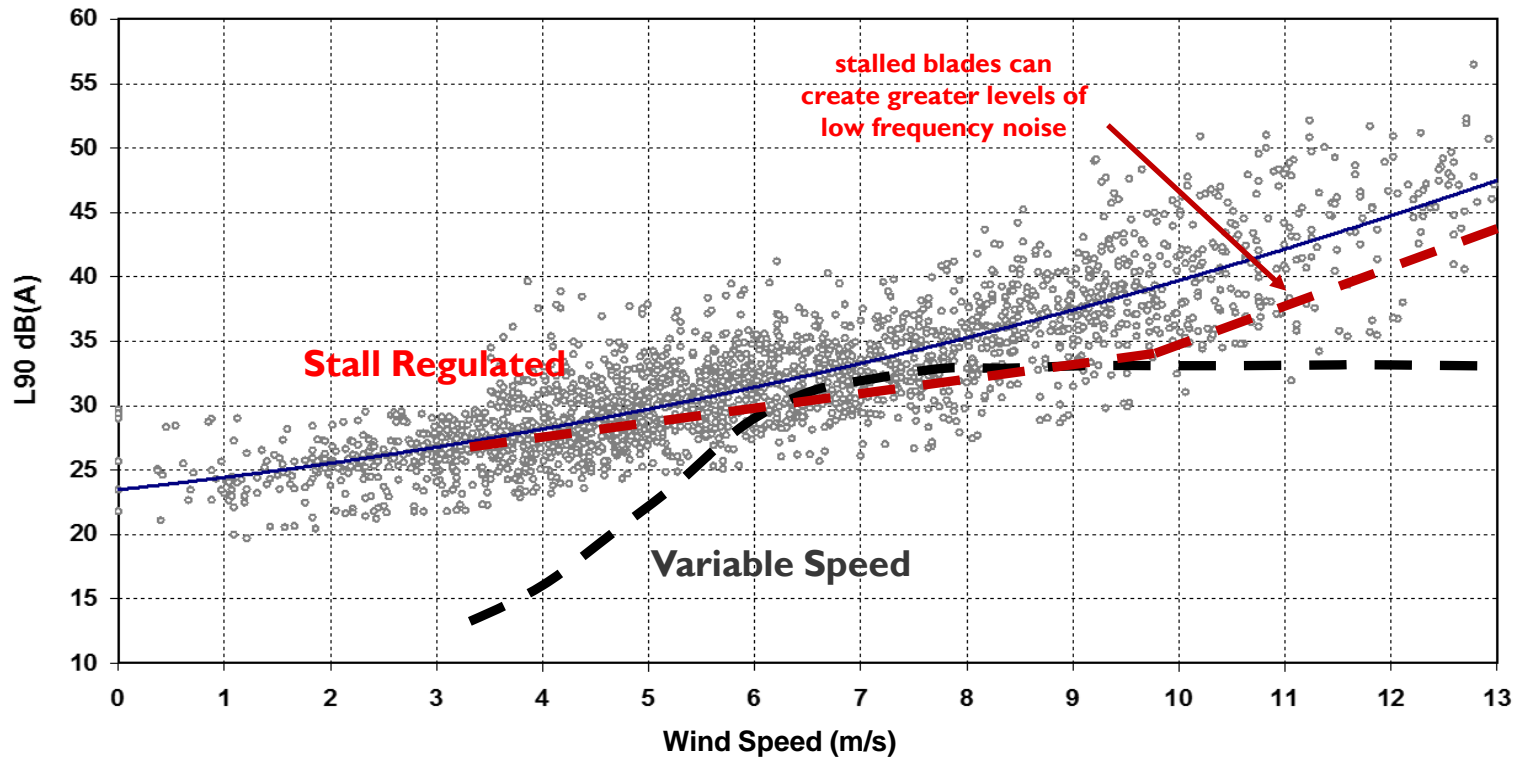
# Stall regulation



Fixed pitch and rpm, different inflow wind speed

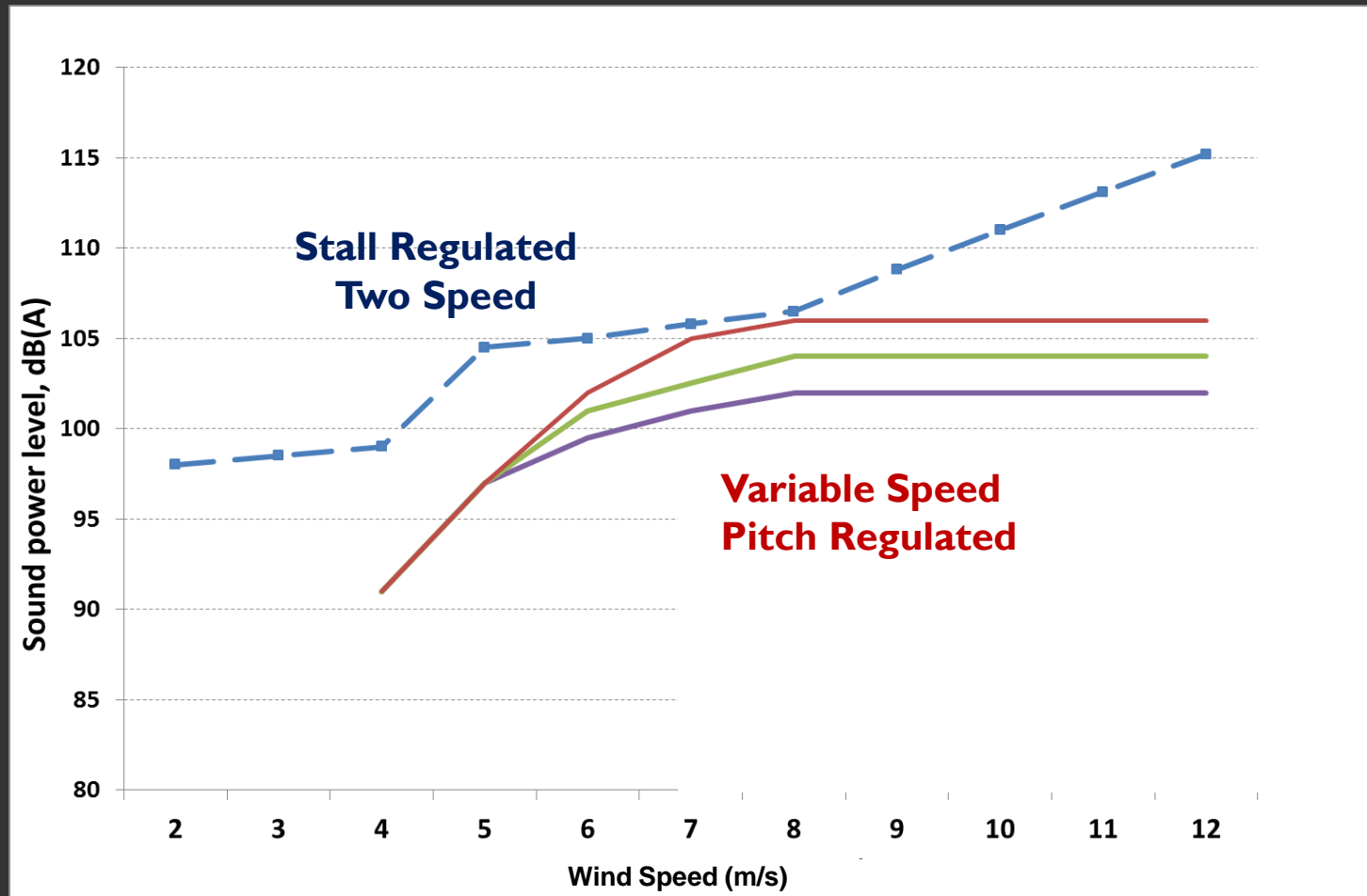
# Wind speed and SWL

Assessment property – ‘quiet daytime’ or night time



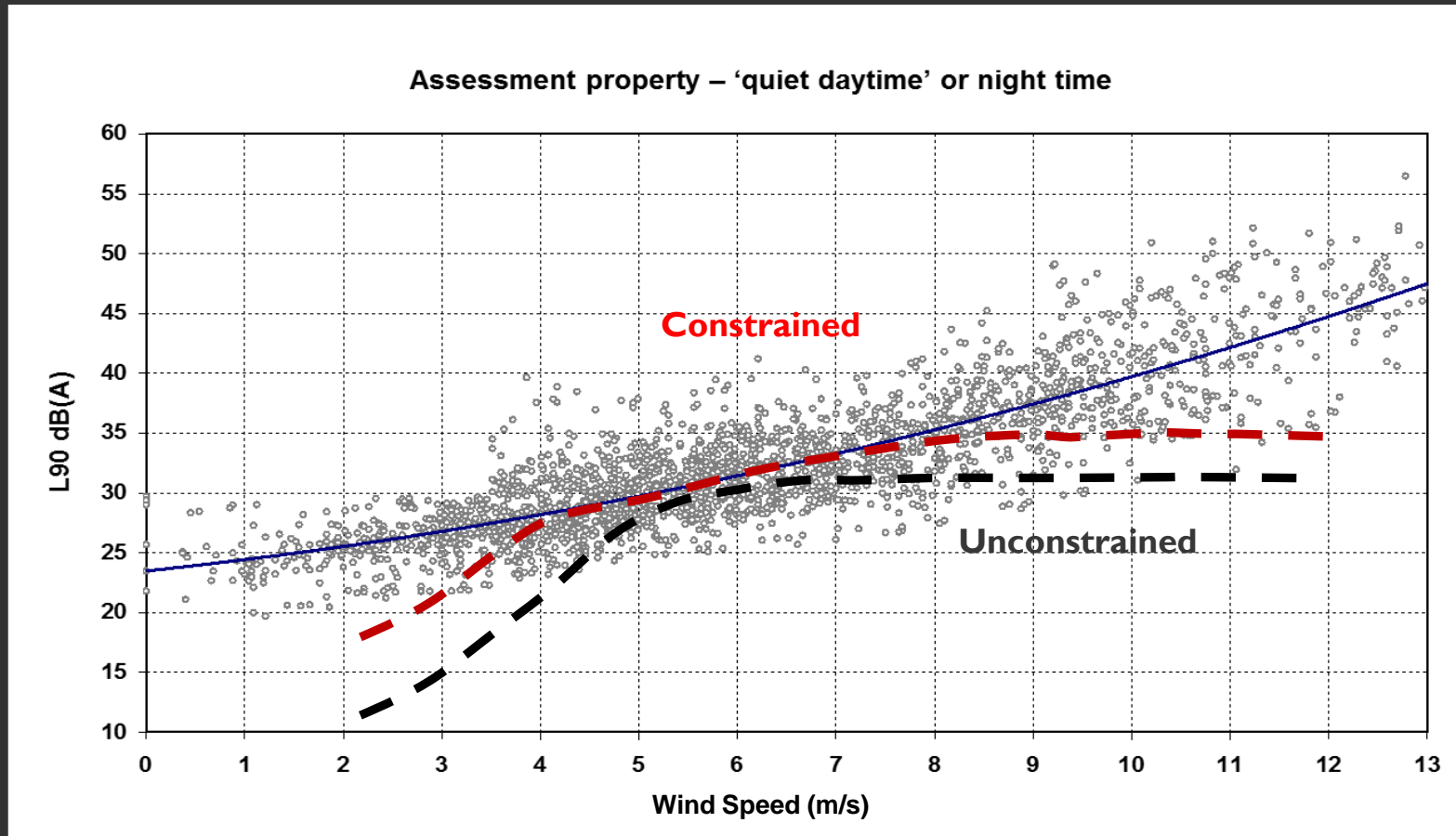


# Evolution of a particular model



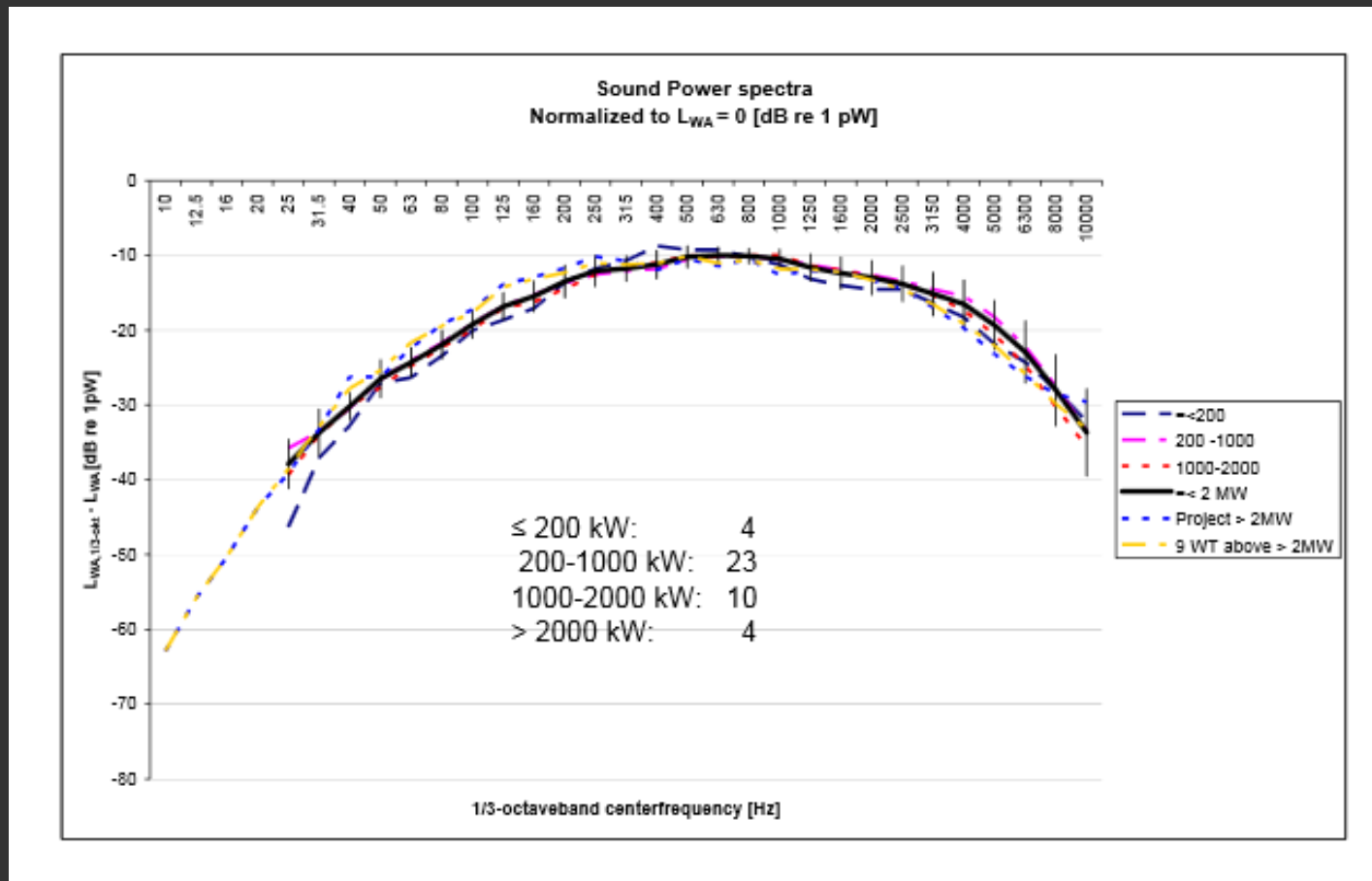
- potential for increased noise dose by controlling noise to follow limits

# Controllable SWL



- potential for controlling noise to follow limits
- potential for upwind/downwind and day/night fine tuning

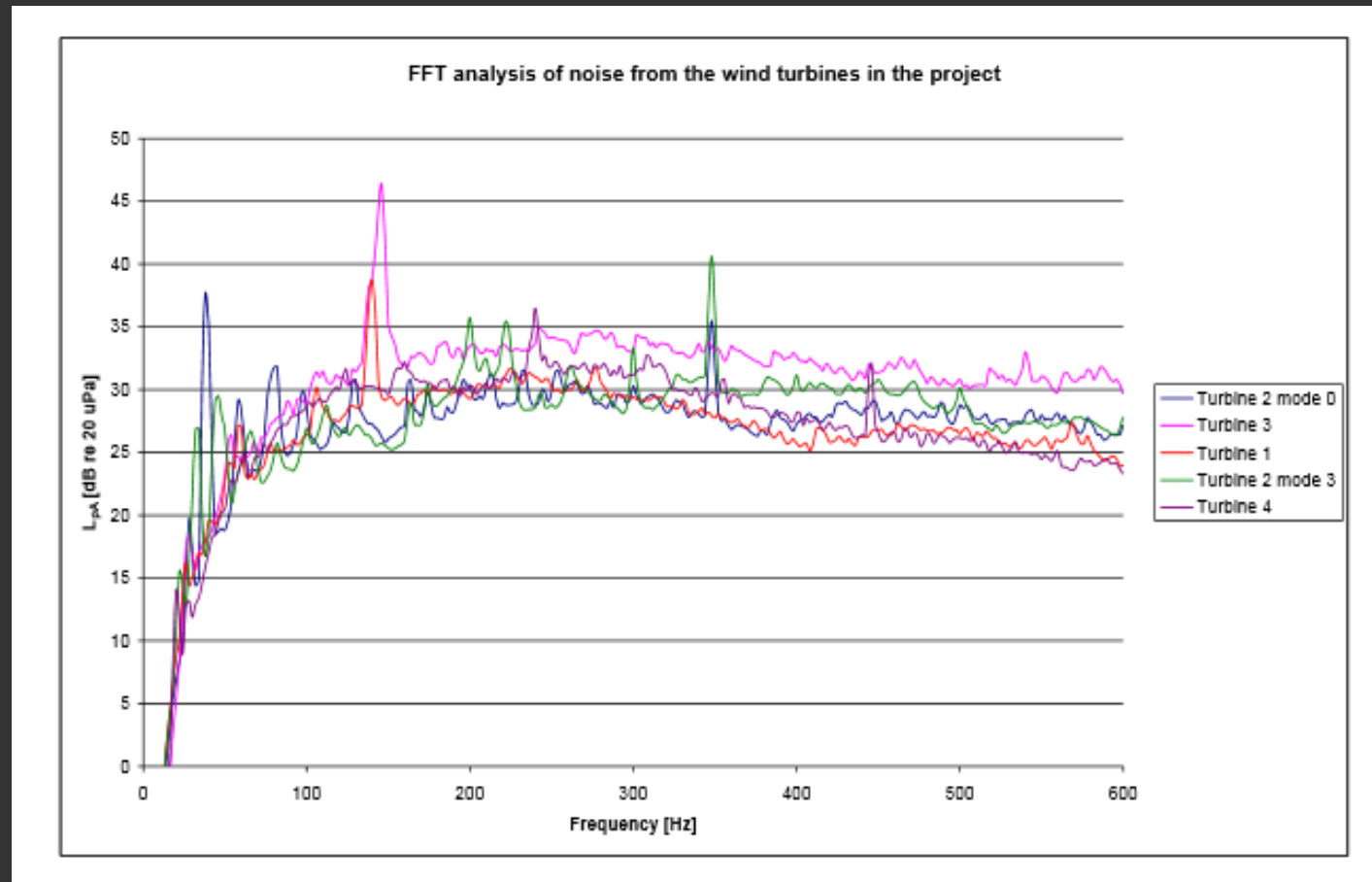
# Spectral content



Delta Report

- no significant difference between smaller and larger ( $> 2$  MW) turbines but ...

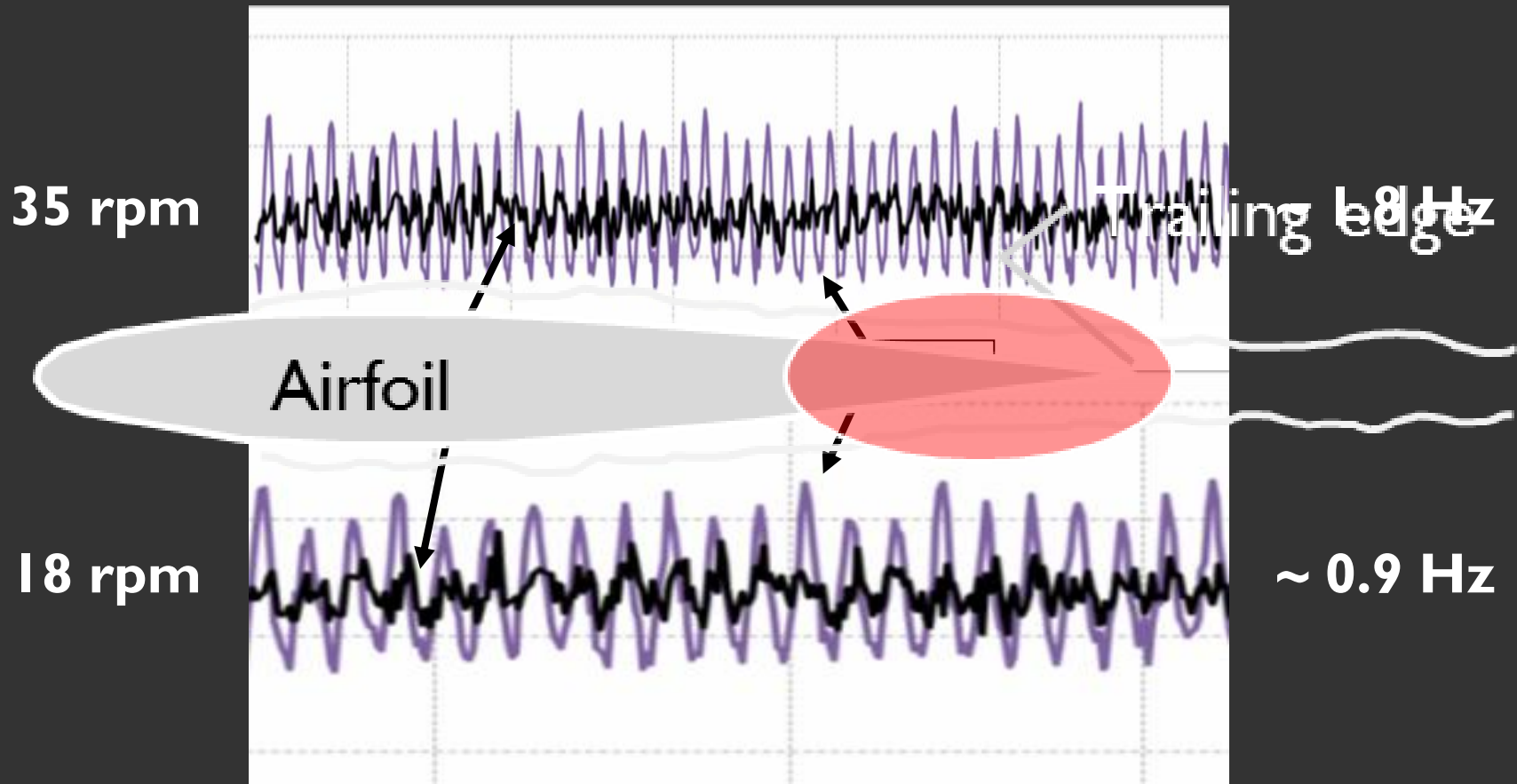
# Spectral content



Delta Report

- evidence of lower frequency (<200 Hz) tones on >2 MW turbines

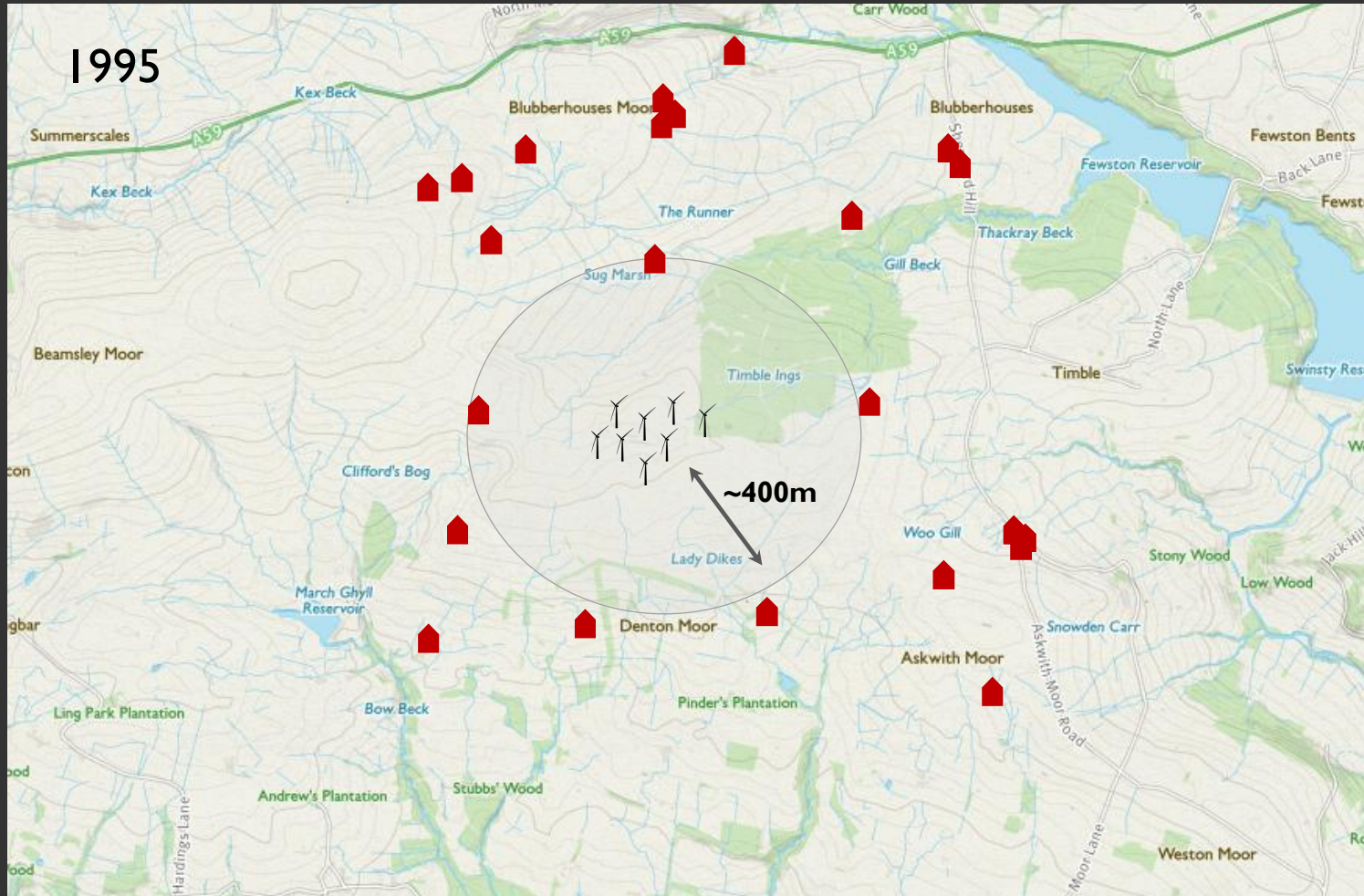
# Blade Swish and other AM



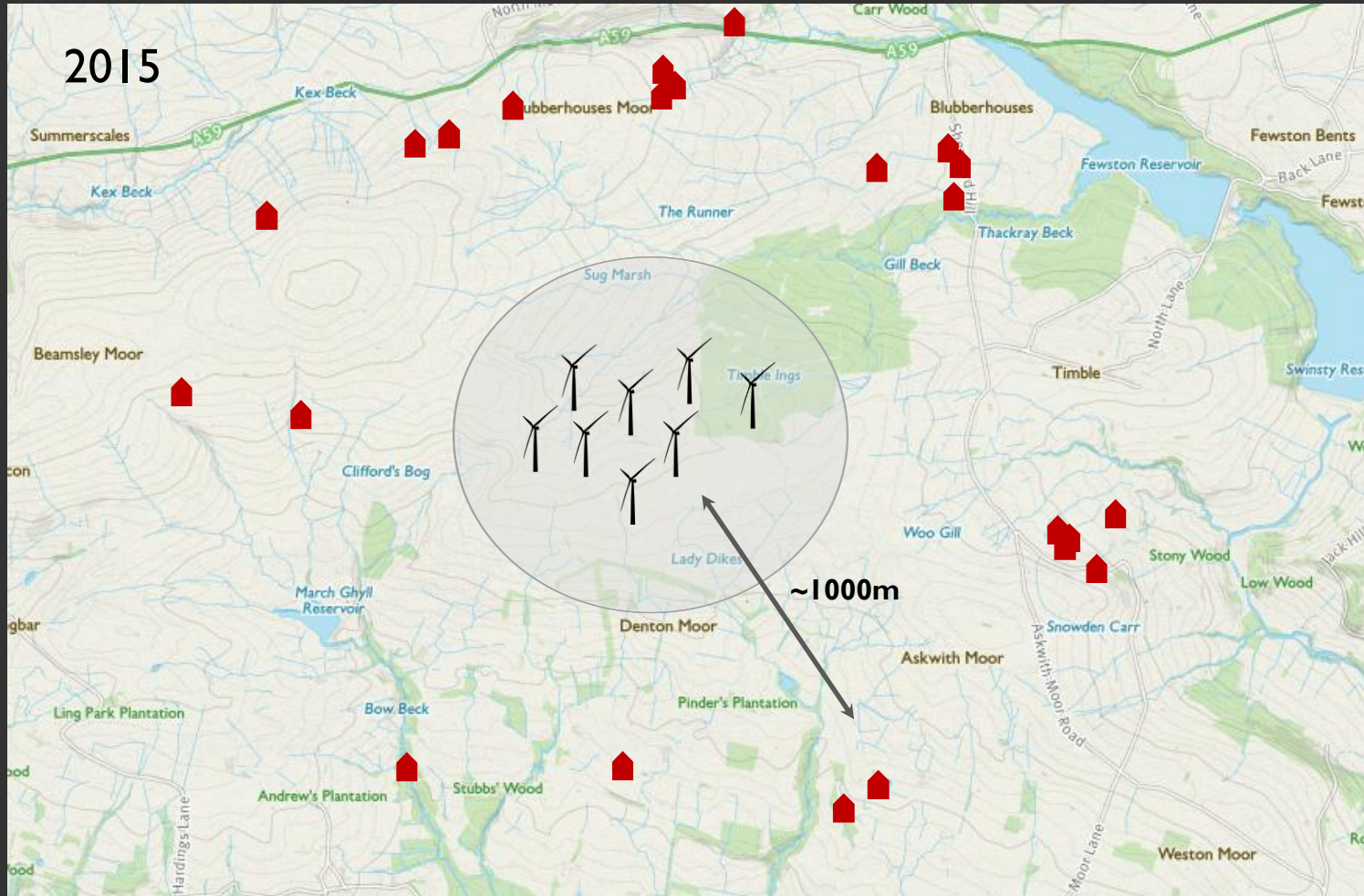
+ identified occurrence of transient stall noise in the far field



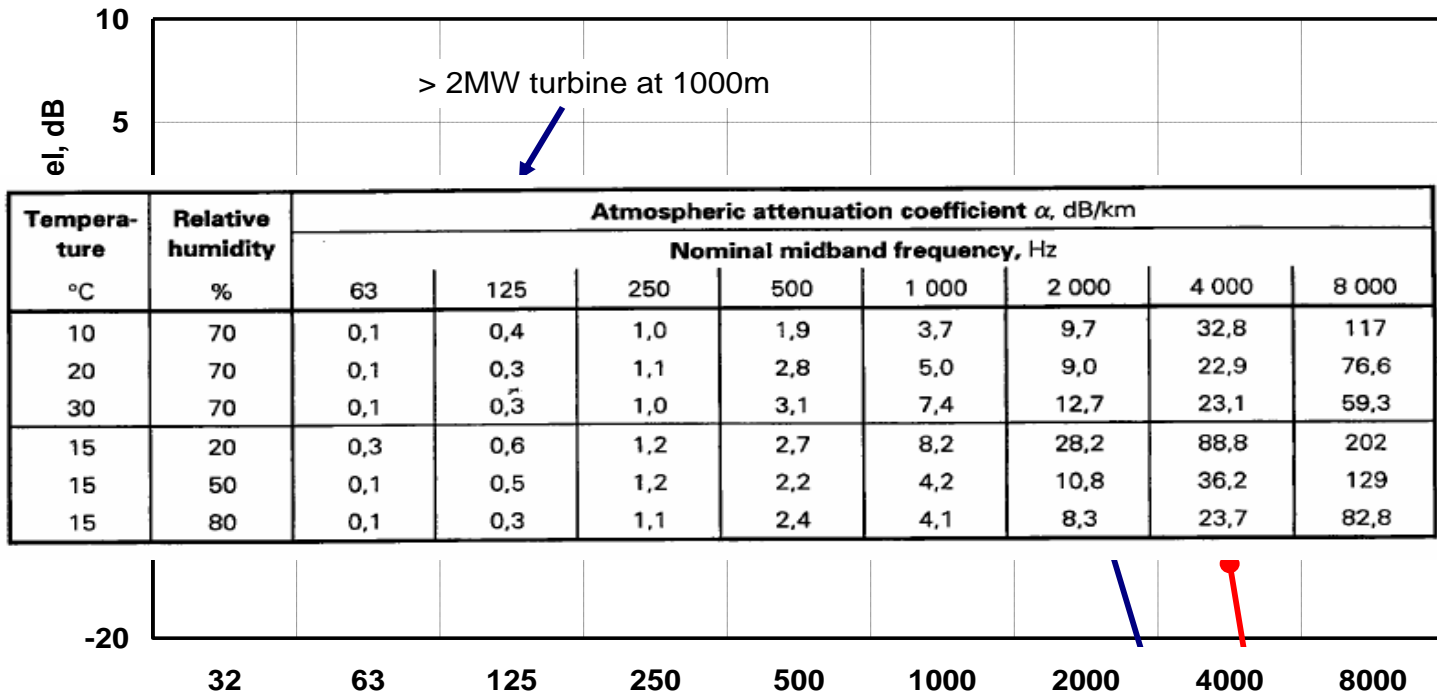
# Wind Farm Layout



# Wind Farm Layout

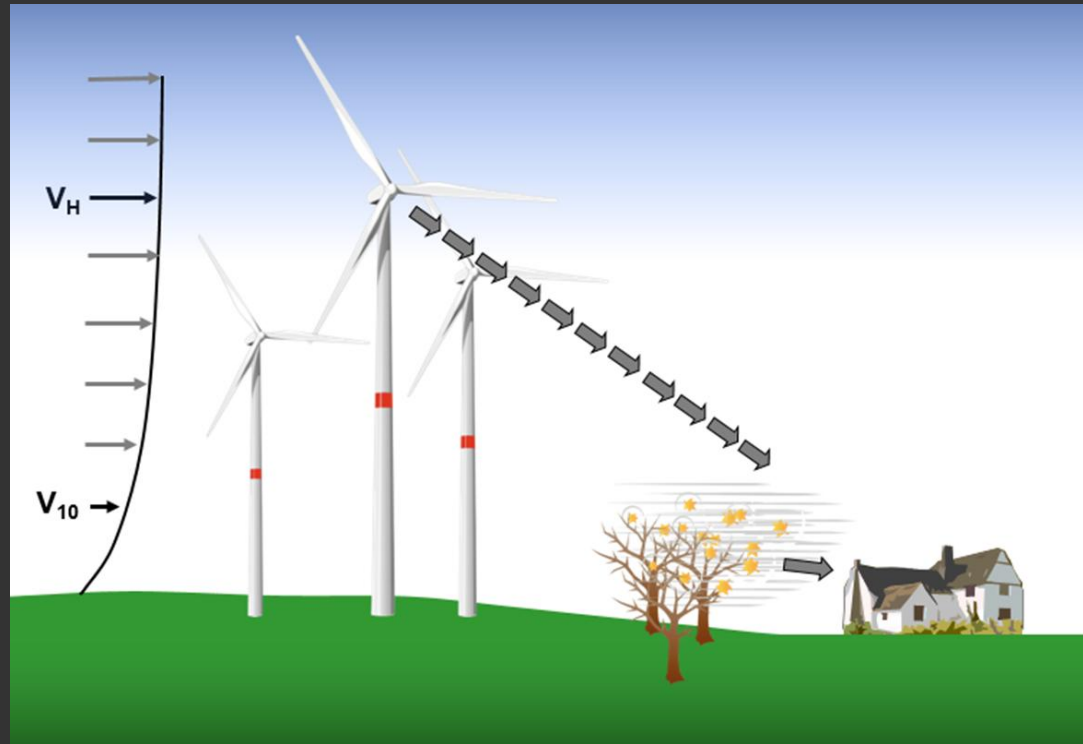


# Far field spectral content – lower frequency bias



- effectiveness of assumed background noise masking ?

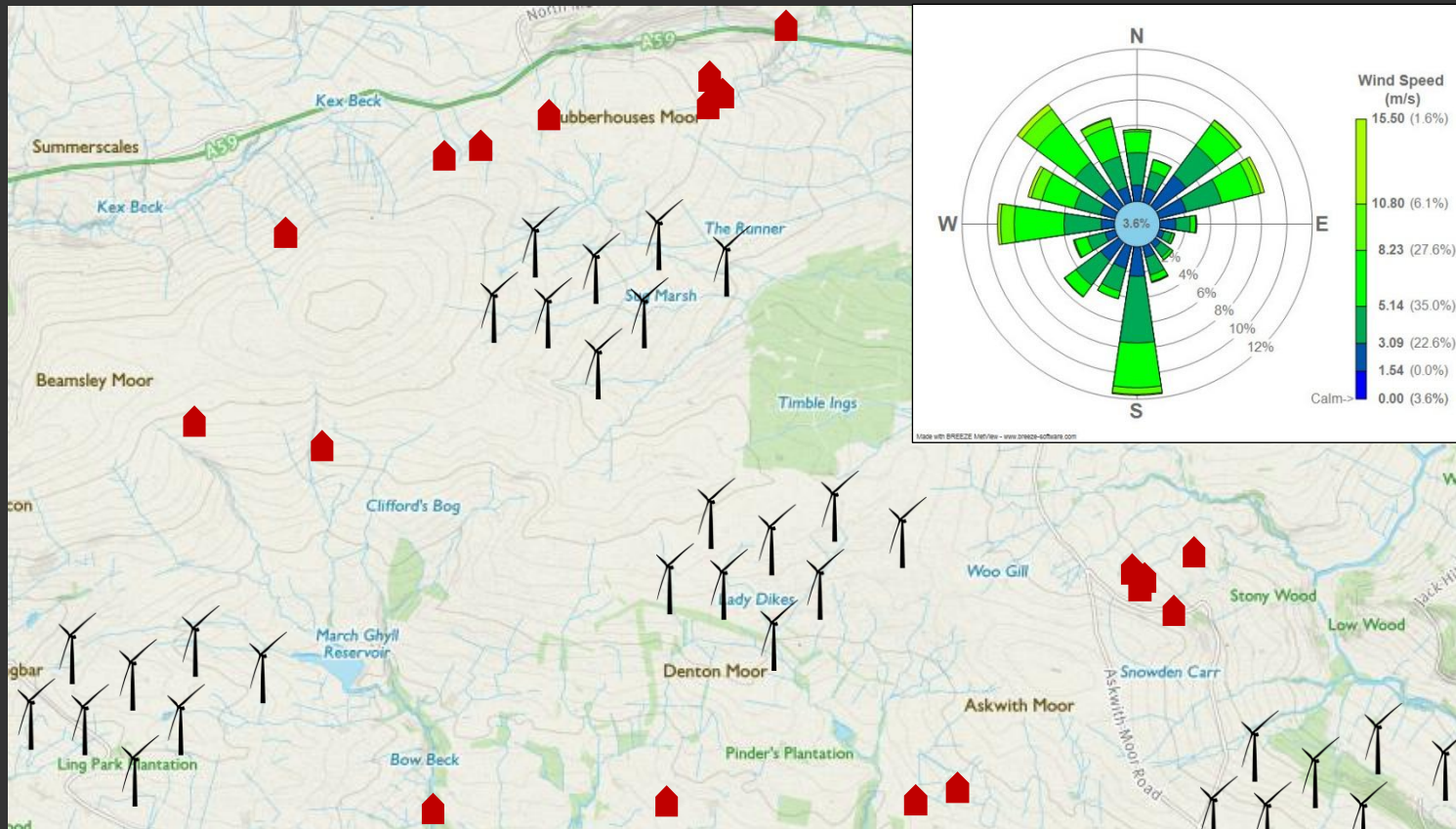
# Wind shear effects



- use of hub height as a common wind speed reference
- effect of wind shear on background levels – increased scatter
- higher hub heights and higher wind shear can cause increased durations of exposure across a wider ground level wind speed range



# Cumulative effects



- need to apportion ETSU-R-97 derived limits between schemes
- appropriate wind speed reference
- increased importance of directivity effects in modelling

# Wind Farm Locations



industrial areas / transport corridors  
possible differences in effective masking noise ?



# Time for change ... ?



- things have changed since the mid 90s .....
- do we need an ETSU-R-XX in the light of current guidance ?
- but if we do, then what should ETSU-R-2015 look like ?
- how should the setting of noise limits be addressed ?
- what character corrections should be included ?
- should the noise limits include matters of planning balance ?
- how should the concept of effect levels be dealt with ?
- is further research required to establish 'true' noise effects ?

**THANK YOU**