WICO – Wind of the Coast

Seawork 2010
17 June 2010

Small Wind Turbines: Opportunities for Marine Businesses

Simon Powell

Marine South East Ltd, Southampton, UK

What is a Small Wind System?

Definitions of small wind systems.

In the UK:

– Micro	0 - 1.5 kW	
– Small	1.5 – 15kW	<25m height
– Small/Medium	15 -100kW	< 45m height
(Utility scale	6MW	200m height)

WICO
Project Background

- Province of Ravenna identified need for better guidance for exploiting local sea breezes.
- WICO project developed with Spanish and UK partners.
- Duration: July 2009 – September 2011
- Main output: Functional Guidelines to facilitate the development of policies to enable faster and wider deployment of small-scale renewable energy systems.
-

WICO Partners

1. Provincia di Ravenna - Italy
   - Simona Melchiorri
   - Marco Bacchini
   - Francesco Matteucci (Tozzi Nord)
2. Provincial de Heulva - Spain
   - Larry Parker
   - Patricia García
3. Marine South East -UK
   - Simon Powell
   - Brendan Webster

POWER Interregional Programme

- Low Carbon Economies programme in 7 European regions.
- 5 areas for co-operation and pilot initiatives:
    1. Energy Efficiency
    2. Renewable Energies
    3. Eco-innovation and environmental technologies
    4. Sustainable transport
    5. Behaviour Change

POWER Low Carbon Economies

European Union

INTERREG IVC

Programme

Registration and networking		1400-1430
Simon Powell Marine South East	Welcome and Introduction	1430-1440
Francesco Matteucci Tozzi Renewable Energy	Wind resource evaluation and measurement	1440-1500
Brendan Webster Marine South East	Policies and Practices	1500-1520
Stephen Crosher Quiet Revolution	Practical considerations for the sighting of small wind installations	1520-1540
Alan Banks Envirobusiness	Feed-in Tariffs: A Money making Opportunity?	1540-1600
Simon Powell Marine South East	Open discussion	1600-1630

Feedback & News

- Feedback forms in packs
- WICO information and newsletter subscription at: www.marinesoutheast.co.uk/WICO

WiCo

WIND RESOURCE ASSESSMENT

FOR WIND FARMS

Francesco Matteucci PhD
General Manager
Tozzi Nord Trentino Wind Turbines
Francesco.matteucci@tozziholding.com
Mobile: +39-3471528121

INDEX

TOZZI RENEWABLE ENERGY

TOZZI RENEWABLE ENERGY

RENEWABLES ACTIVITIES

TRE renewable energy portfolio is composed by a wide number of **power plants** in **operation**, **under construction** and **under development**:

- **Hydropower Plants:** **8 operating hydropower plants** for a total installed capacity equal to **32,91 MW** and **3 hydropower plants under construction** for a total installed capacity equal to **21,84 MW**.
  Hydropower plants **under development**, in **Italy** and **Serbia**, for a total expected installed capacity roughly equal to **250,0 MW**;
- **Wind Farms:** **5 operating wind farms** for a total installed capacity equal to **171,0 MW** and **3 wind farms under construction** for a total installed capacity equal to **182,0 MW**.
  Wind farms **under development** for a total installed capacity roughly equal to **3.000,0 MW** in **Italy** and **Romania**;
- **Photovoltaic Plants:** TRE owns and **operates 2** integrated photovoltaic plants installed at the Tozzi Group factories of Foggia and Ravenna for a total installed capacity of **0,7 MW**.
  Photovoltaic plants **under development** for a total expected installed capacity equal to **45,0 MW**.
- **Biomass Plants:** **Solid biomass** power plants **under development** for a total expected installed capacity of **25,0 MW**
  Liquid biomass power plants **under development** for a total expected installed capacity of **200,0 MW**.
- **Off Shore Wind Farm:** **Off-Shore wind farm** projects **under development** for a total expected installed capacity equal to **825,0 MW**.

HYDRO

WIND

SOLAR

BIOMASS

OFFSHORE

PLANTS IN OPERATION

T.R.E. - IMPIANTI

Tozzi Renewable Energy S.p.A.

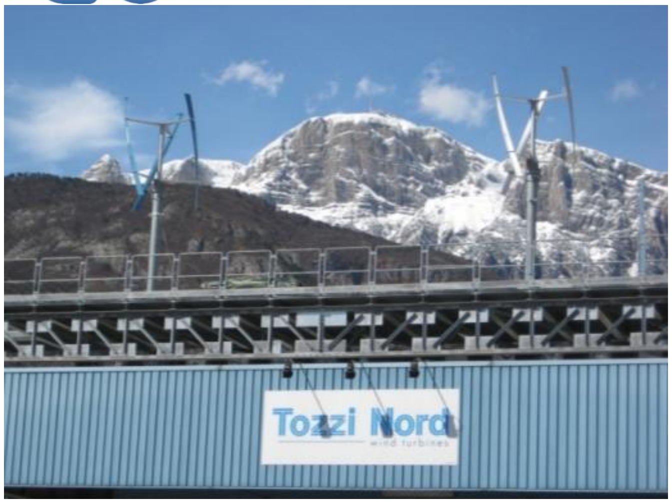
OTHER RENEWABLE ACTIVITIES

Small wind turbines (SWTs)
for low wind sites and for urban environment

TN 420 - HAWT

Tozzi Nord
wind turbines

TN 1.5 - VAWT



Stabilimento di Trento Nord (TN)

Torbole (VR) – Lago di Garda

CNR-ITAE di Messina (ME)

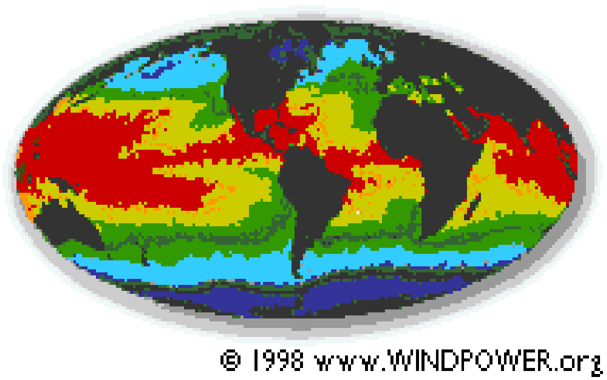
Trento (TN)

Eolica Expo 2008 (Roma)

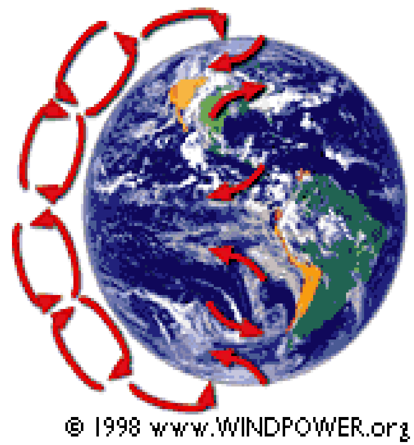
WIND BASICS

WIND

The source of all energies (execpt tidal and geothermic) is the sun that irradiates the earth with a power of **1.74 x 10^{17} W**. Approximately **1 - 2 %** of the energy coming from the sun is converted in wind energy with an efficiency that is up to 100 times higher than the energy converted in biomass.

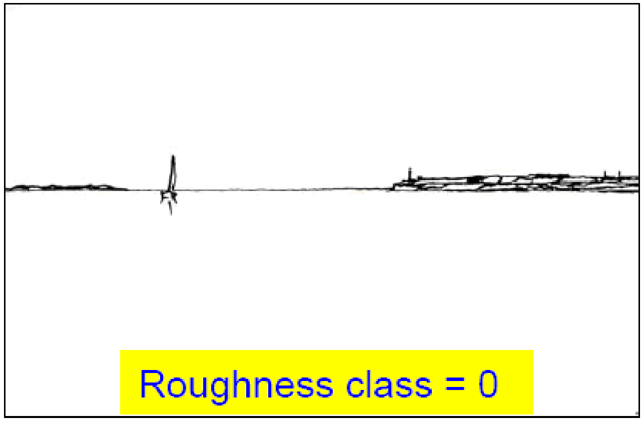


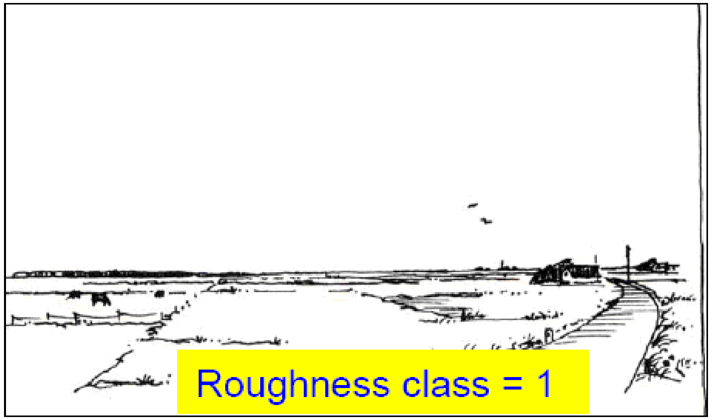
Geostrophic winds

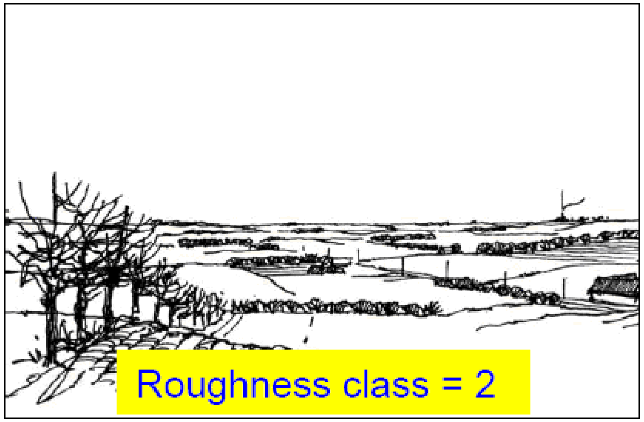


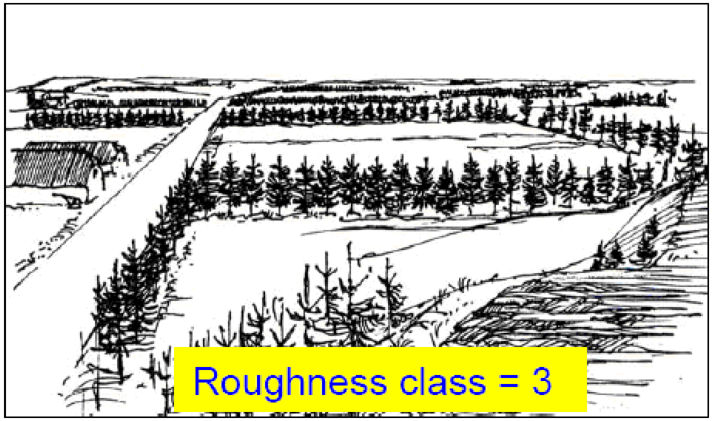
Geostrophic winds are at high heights but winds that are attractive for wind engineering happens in the Surface Layer therefore they are mainly affected by surface roughness.

WIND


Roughness class = 0


Roughness class = 1

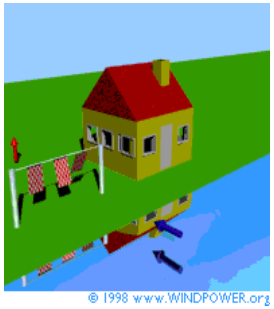

Roughness class = 2


Roughness class = 3

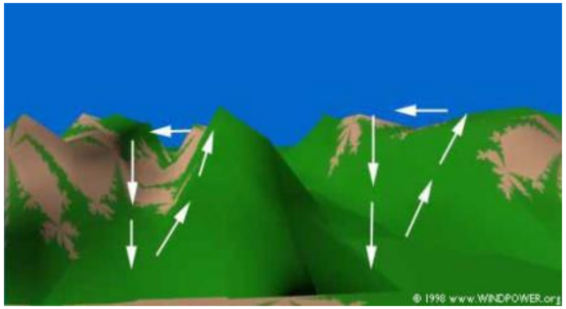
WIND

Therefore local wind are mainly affected by local geography:

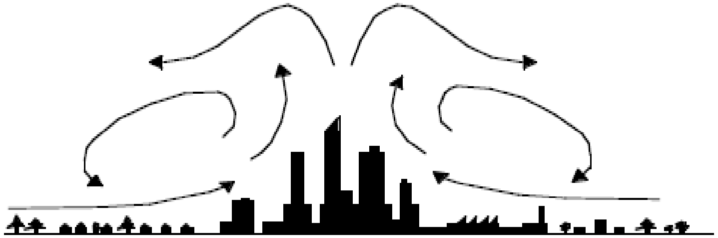
→Sea winds



→Thermic winds



→Obstacles in urban areas

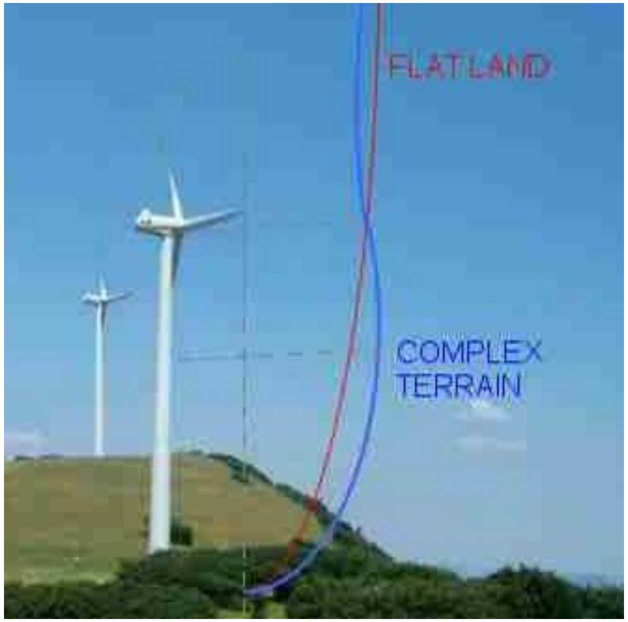


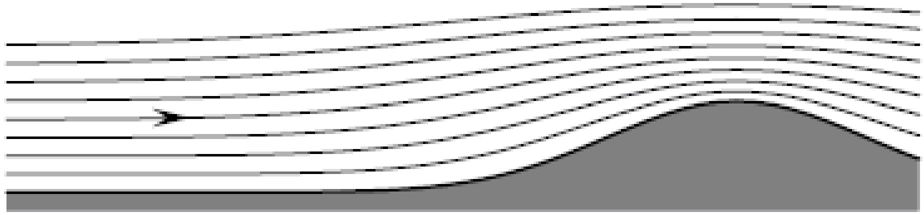
WIND

❖Wind speed almost increase with the height,

❖Wind speed almost increase at the top of the hills,

❖At a certain height wind speed decrease due to surface roughness.





WIND CLASSES BASED ON IEC NORM

Vref - represents wind speed highest value within a 10min mean, measured at hub height, within a period of 50 years

Table 1 – Basic parameters for wind turbine classes[1]

Wind turbine class		I	II	III	S
V_{ref}	(m/s)	50	42,5	37,5	Values specified by the designer
A	I_{ref} (-)	0,16			
B	I_{ref} (-)	0,14			
C	I_{ref} (-)	0,12			

In Table 1, the parameter values apply at hub height and

V_{ref} is the reference wind speed average over 10 min,

A designates the category for higher turbulence characteristics,

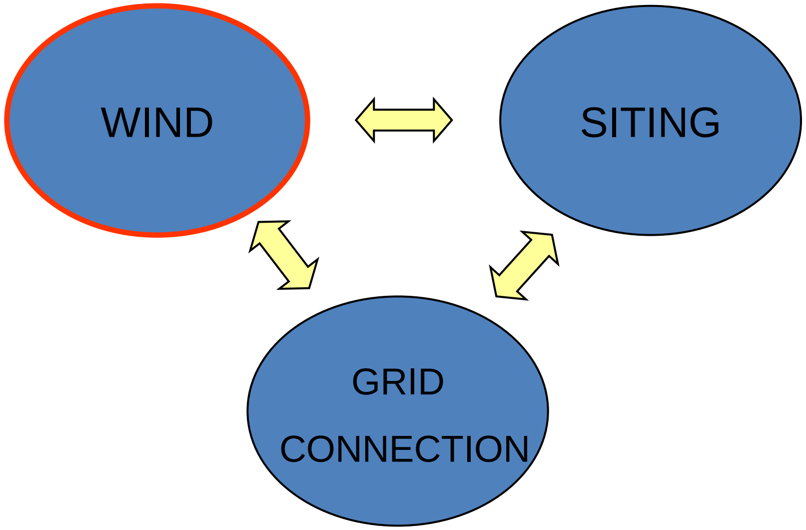
B designates the category for medium turbulence characteristics,

C designates the category for lower turbulence characteristics and

I_{ref} is the expected value of the turbulence intensity[2] at 15 m/s.

WIND RESOURCE ASSESSMENT BASICS

DEVELOPMENT OF A WIND FARM



The design of a wind farm requirements are:

- **Wind Resource Assessment**
- **Estimation of AEO (annual energy output).**

The most important step when developing a wind farm is to make accurate wind measurements because as a rule of thumb in a site with an annual mean wind speed of 6 m/s a 5% mistake in the wind measurements means your standard deviation on the AEO is approximately of 15% (f(power curve)).

WIND MEASUREMENTS QUALITY

Source of uncertainty	Uncertainties *	
	Min. [%]	Max [%]
Quality of sensor calibration	1,0	5,0
Changes in sensor calibration	0,2	3,0
Uncertainty caused by sloping wind on the anemometre	0,2	1,5
Measurement of too high wind speed as a result of sensor dynamic	0,2	1,0
Flow distortion caused by mast	0,5	2,0
Flow distortion caused by boom	0,5	2,0
Flow distortion caused by mountings and other protruding objects	0,1	2,0
Unsymmetrical horizontal flow at the anemometre	0,2	2,0
Sensor and data logging uncertainty	0,2	1,0
Total uncertainty	**1,3**	**7,4**

*)

WIND MEASUREMENTS MUST BE DONE PROPERLY, THAT MEANS:

PROPER PLANNING OF THE SITING

USE OF CORRECT DEVICES (SENSORS, DATA-LOGGERS, ETC…)

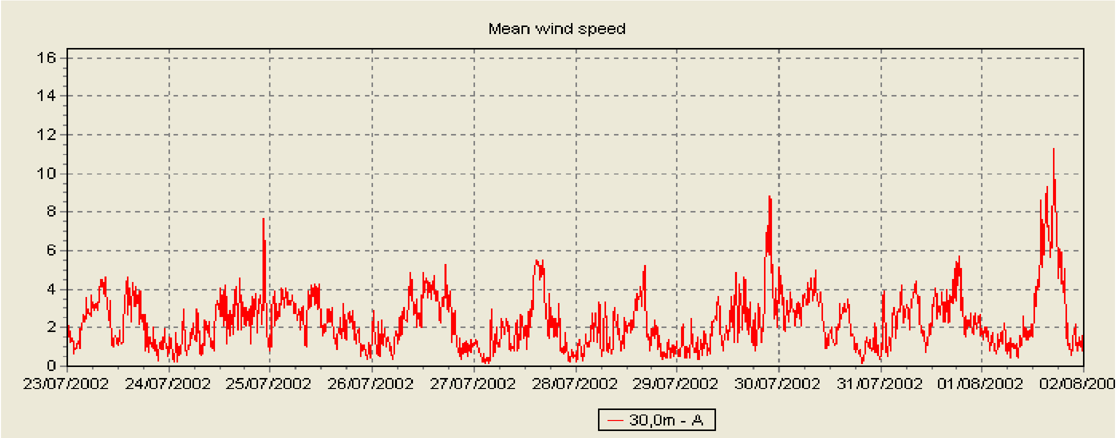
PROPER DATA EXTRACTION/VALIDATION

WIND RESOURCE CHARACTERIZATION OF SITES

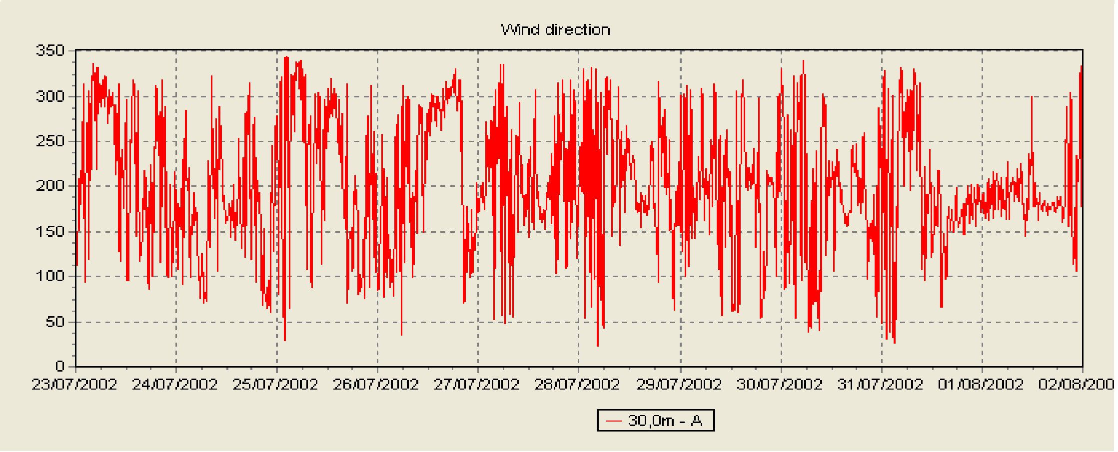
TIME SERIES

Data loggers generally records data in a period T with a lenght of time of 10 minutes

V of the wind



D of the wind

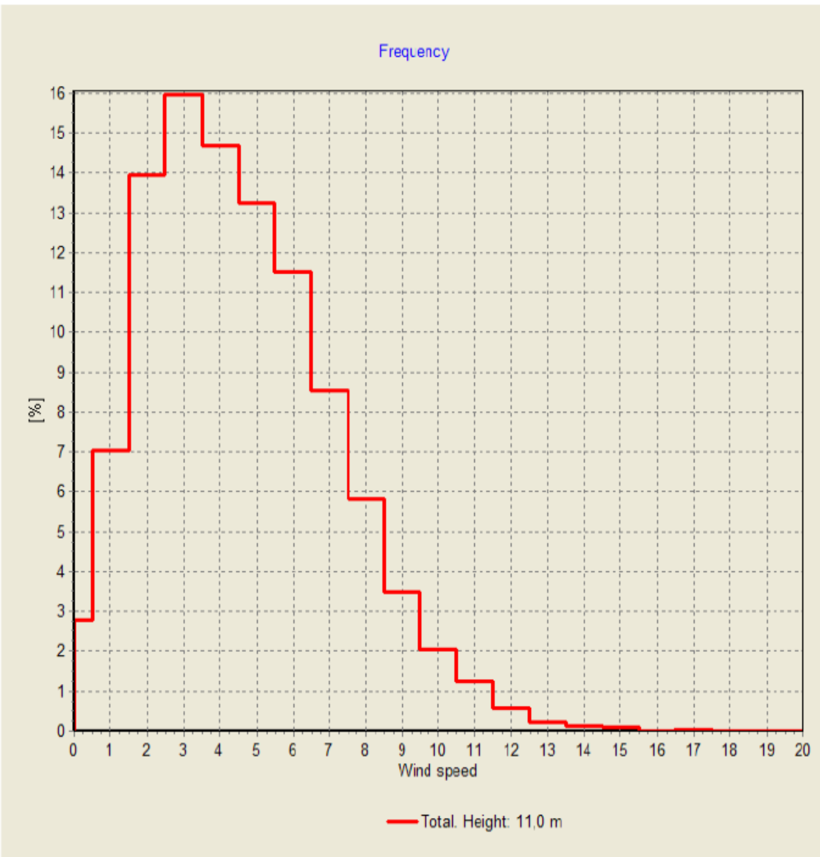


Frequency table

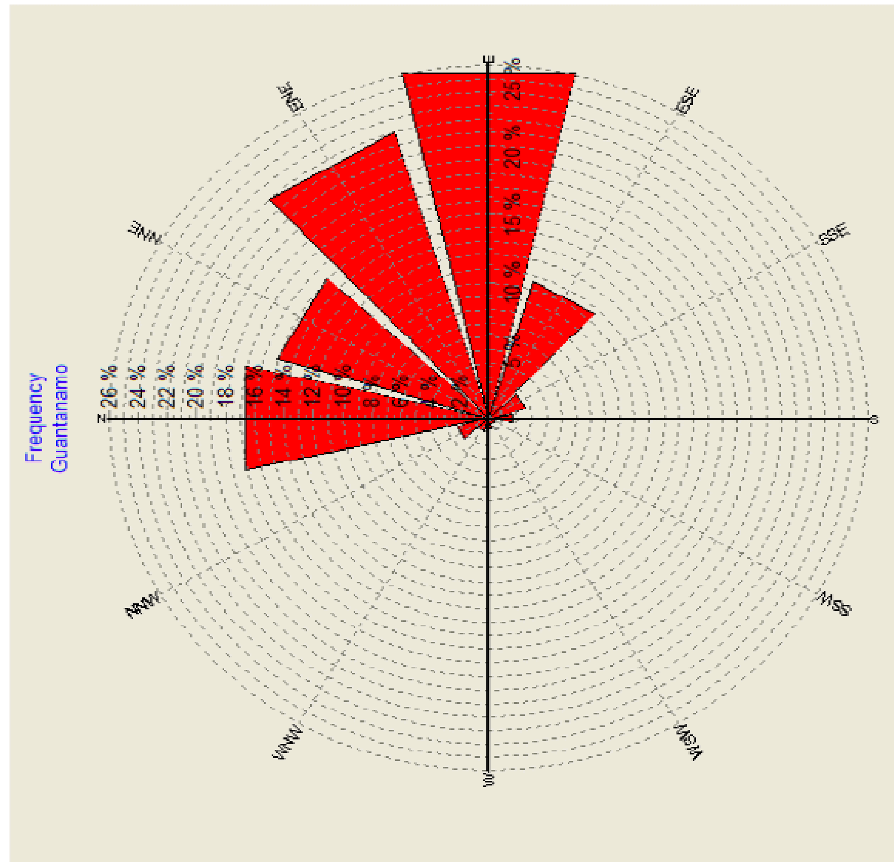
Bin	Start	End	Sum	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW
Mean			1,68	1,88	1,67	0,67	0,54	1,13	1,50	3,46	1,98	0,92	0,79	0,85	1,66
0		0,49	14454	1279	2390	2747	2077	1315	993	796	585	517	560	565	630
1	0,50	1,49	18446	2979	3204	2297	1323	988	1036	1280	896	717	803	971	1952
2	1,50	2,49	6689	2075	959	207	97	142	390	819	358	147	118	186	1191
3	2,50	3,49	4264	946	1053	159	41	99	418	892	298	68	41	30	219
4	3,50	4,49	3135	476	752	102	21	103	241	988	264	36	12	22	118
5	4,50	5,49	2351	297	318	32	17	95	95	1139	194	5	4	5	150
6	5,50	6,49	1702	184	114	10	9	64	50	1032	119	2	2	1	115
7	6,50	7,49	917	107	89	0	3	32	9	578	37	1	0	1	60
8	7,50	8,49	334	59	65	0	0	14	3	158	6	0	0	0	29
9	8,50	9,49	102	30	36	0	0	5	0	25	0	0	0	0	6
10	9,50	10,49	49	21	21	0	0	2	0	4	0	0	0	0	1
11	10,50	11,49	13	4	6	0	0	1	0	1	0	0	0	0	1
12	11,50	12,49	15	6	8	0	0	0	0	0	0	0	0	0	1
13	12,50	13,49	0	0	0	0	0	0	0	0	0	0	0	0	0
14	13,50	14,49	0	0	0	0	0	0	0	0	0	0	0	0	0
15	14,50	15,49	0	0	0	0	0	0	0	0	0	0	0	0	0
16	15,50	16,49	0	0	0	0	0	0	0	0	0	0	0	0	0
17	16,50	17,49	0	0	0	0	0	0	0	0	0	0	0	0	0
18	17,50	18,49	0	0	0	0	0	0	0	0	0	0	0	0	0
19	18,50	19,49	0	0	0	0	0	0	0	0	0	0	0	0	0
20	19,50	20,49	0	0	0	0	0	0	0	0	0	0	0	0	0
21	20,50	21,49	0	0	0	0	0	0	0	0	0	0	0	0	0
22	21,50	22,49	0	0	0	0	0	0	0	0	0	0	0	0	0
23	22,50	23,49	0	0	0	0	0	0	0	0	0	0	0	0	0
24	23,50	24,49	0	0	0	0	0	0	0	0	0	0	0	0	0
25	24,50	25,49	0	0	0	0	0	0	0	0	0	0	0	0	0
26	25,50	26,49	0	0	0	0	0	0	0	0	0	0	0	0	0
27	26,50	27,49	0	0	0	0	0	0	0	0	0	0	0	0	0
28	27,50	28,49	0	0	0	0	0	0	0	0	0	0	0	0	0
29	28,50	29,49	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum			52471	8463	9015	5554	3588	2860	3235	7712	2757	1493	1540	1781	4473

WIND RESOURCE CHARACTERIZATION OF SITES

FREQUENCY DISTRIBUTION



WIND DIRECTION DISTRIBUTION

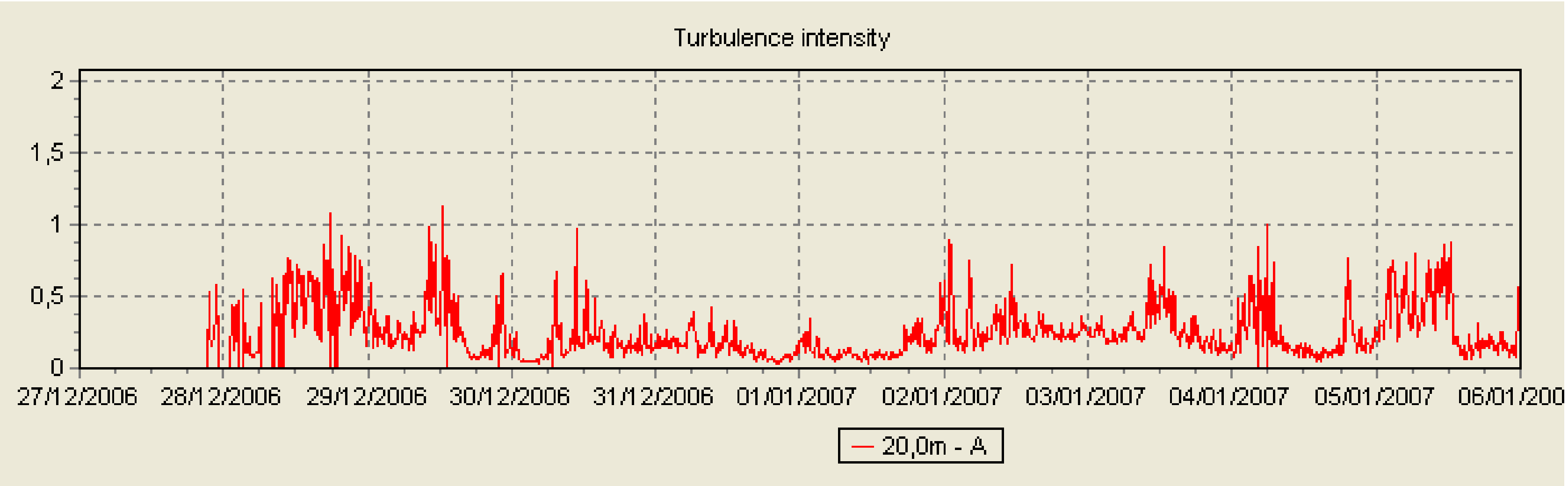


WIND RESOURCE CHARACTERIZATION OF SITES

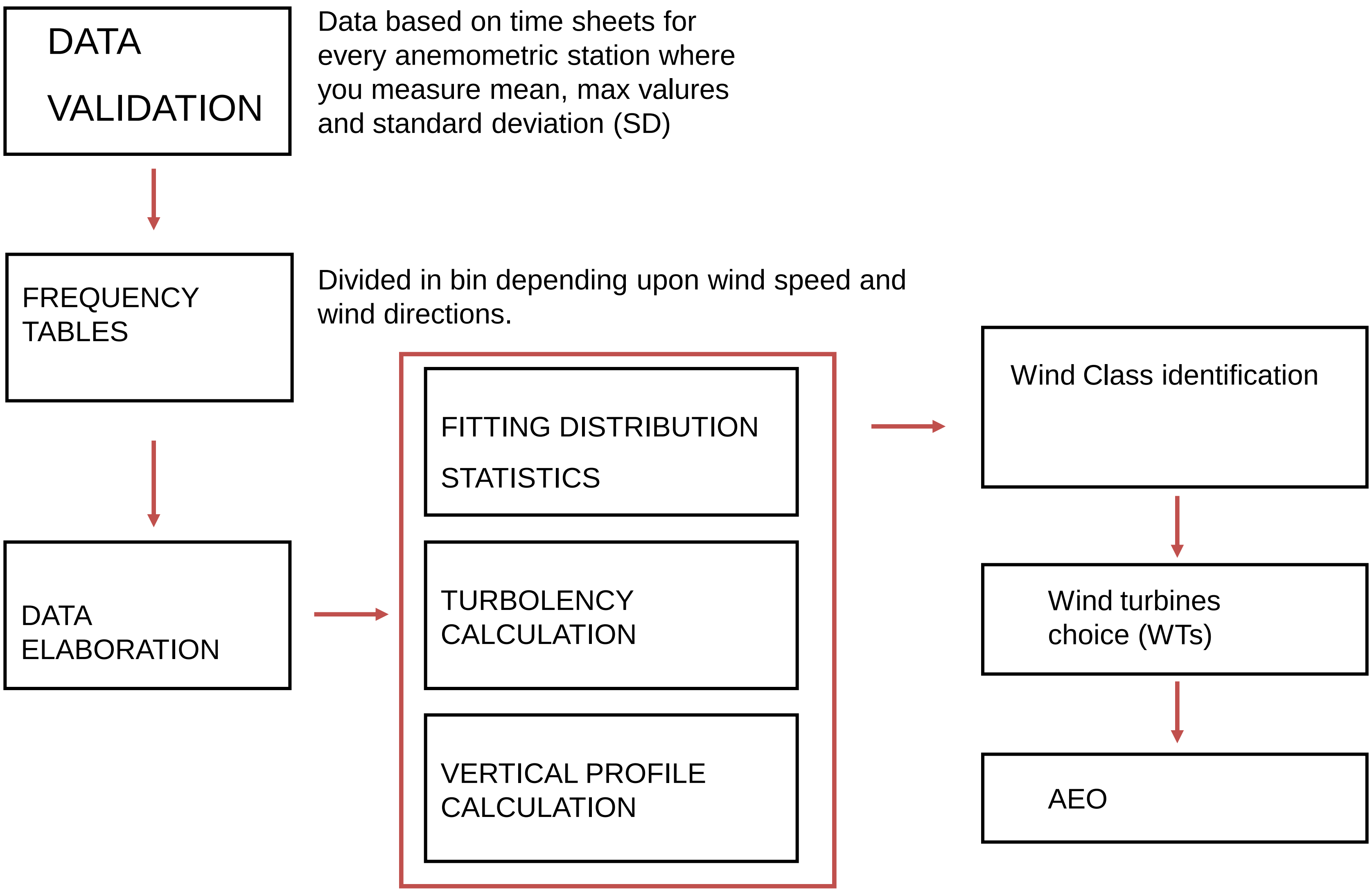
TURBOLENCY INTENSITY

These variable is very important because is directly connected to the wind turbine loads. Through the analysis of this variable it is possible to define the class of the site based on norm IEC 61400

$$I = \frac{SD}{v_{av}}$$



WIND RESOURCE CHARACTERIZATION OF SITES



Basics of AEO evaluation

Wind turbine power at a certain wind speed is

$$P = \frac{1}{2} \cdot \rho \cdot v^3 \cdot A \cdot Ce$$

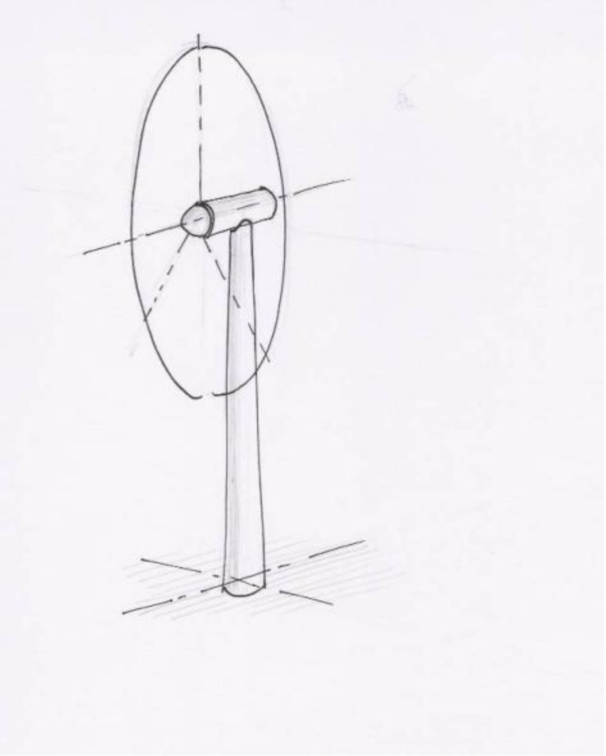
where:

ρ is air densisty

V is wind speed;

A is swept area

Ce is the wind turbine efficiency f(v)



Output power increase with

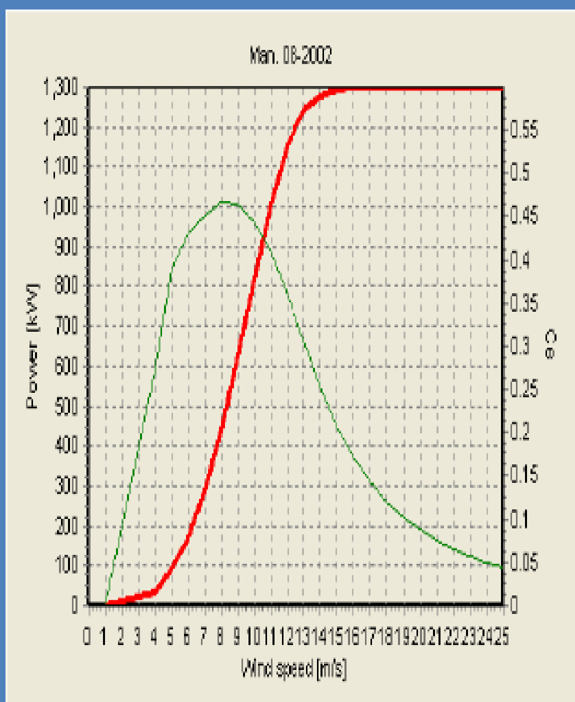
Power 2 of the ray of the wind turbine

Power 3 of the wind speed

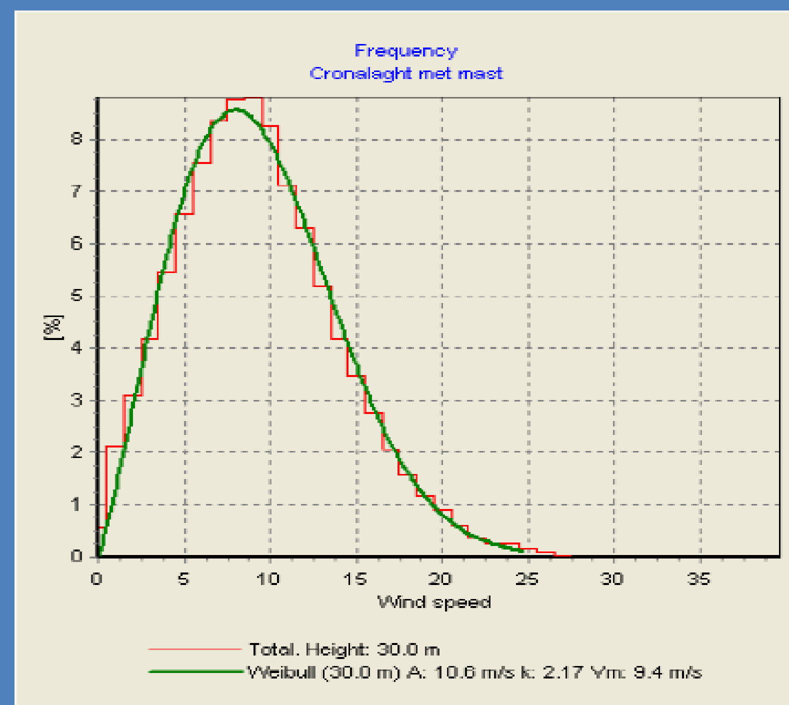
Rule of thumb: 5% more speed → 10% more

AEO – (annual energy output)

Multiplying each value of wind speed (from vaiours bins or from the wind distribution) with the correspondant output power of the turbine WT from the wind turbine power curve and adding such values you will get the AEO



X



= AEO

METHODS FOR WIND RESOURCE ASSESSMENT

METHODS

Traditional Systems

- Cup anemometer
- Wind vane
- Propeller
- Sonic anemometer
- Hot wire anemometer

Remote Sensing Systems

- SODAR
- RASS
- Windprofiler
- Lidar

Studies at high height

- Pilot balloon
- Radiowave
- Still balloon

TRADITIONAL SYSTEMS

EQUIPMENTS

SUPPORT STRUCTURE	TYPE SIZE INSTALLATION ELECTRICAL CONNECTION SAFETY HEIGHT LIGHT
SENSORS	WIND SPEED DIRECTION AIR TEMPERATURE ATMOSPHERIC PRESSURE
CABLES DATA LOGGERS CABINET DATA TRANSMISSION SYSTEM POWER SUPPLY	

TRADITIONAL SYSTEMS

SUPPORT STRUCTURE

TILT-UP TOWER

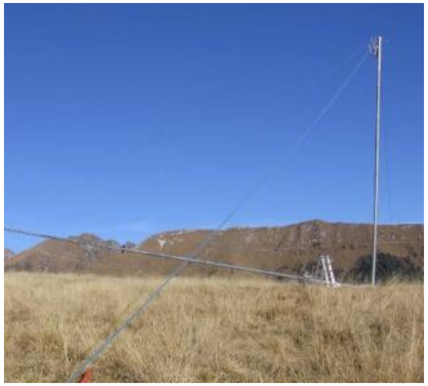
LATTICE TOWER

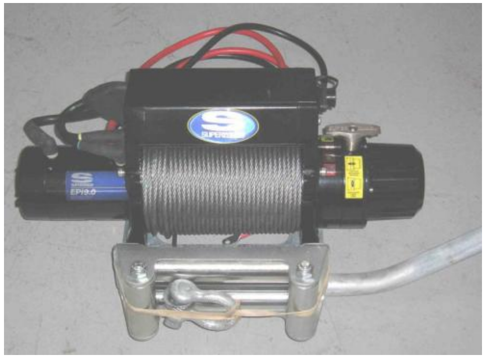
TUBULAR TOWER

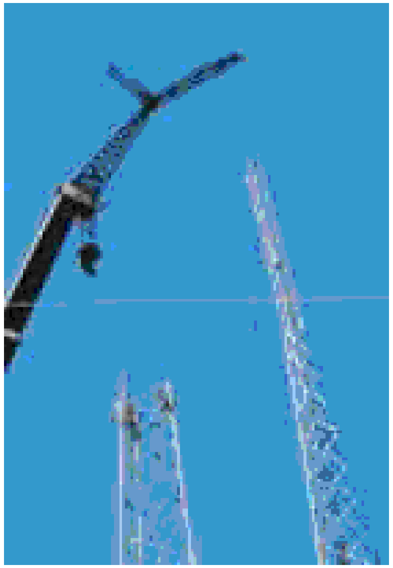
TRADITIONAL SYSTEMS

INSTALLING EQUIPMENTS

Winch or Trefor or Crane

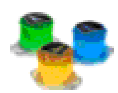
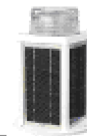






TRADITIONAL SYSTEMS

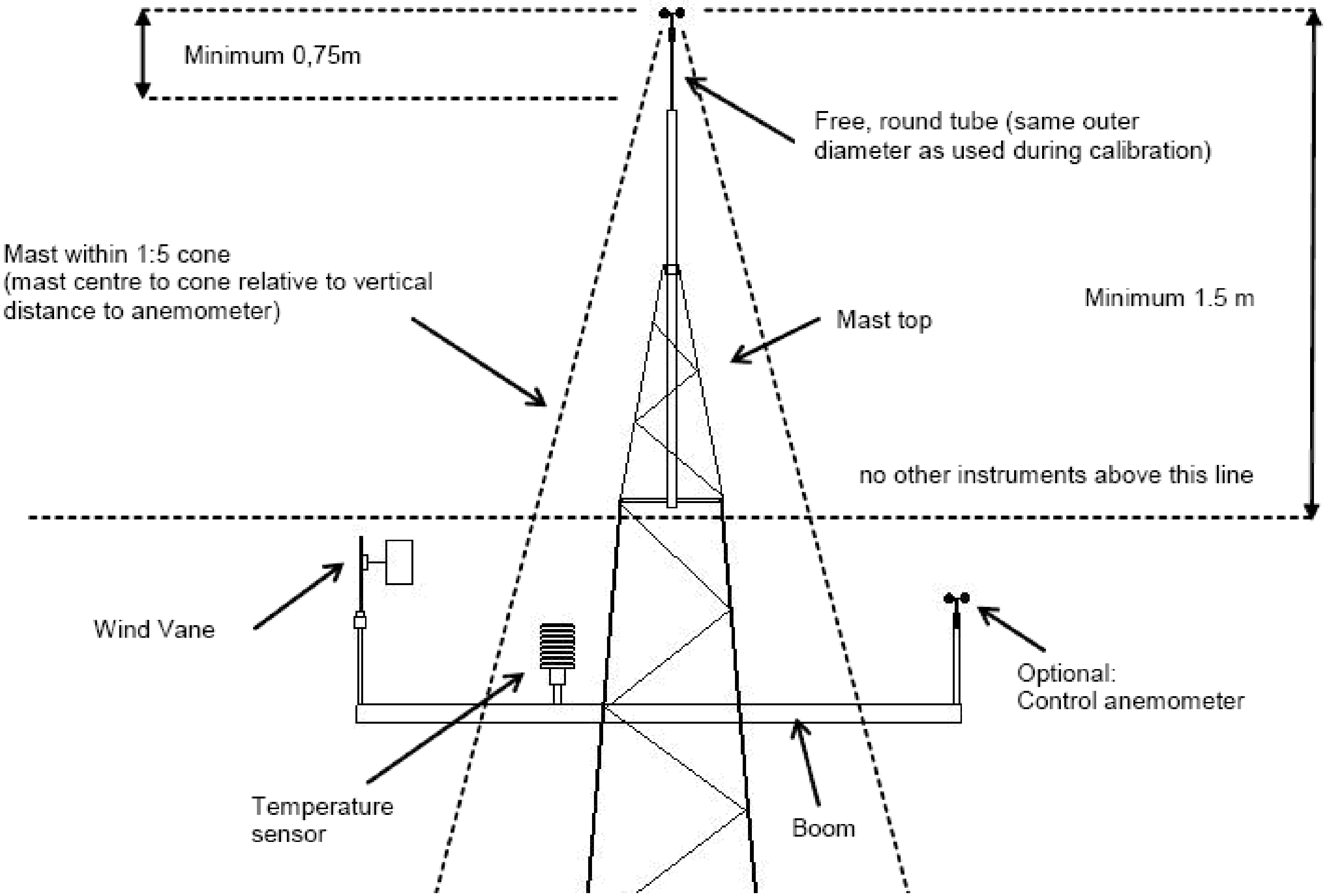
SAFETY HEIGHT LIGHT

MODELS	201	501	601	701-5	702	702-5	
LED Technology ISO 9001 Manufacturer							 IR – Programmer for - Flash rates - Intensity and Autonomy - Lux levels, Battery Check ...
Visibility (km)	1.6	1.6	2.4 - 4.7	3.2 - 5.9	3.2 - 5.9	3.2 - 5.9	Features and Benefits
On / Off Level (Lux)	350 / 250	350 / 250	350 / 250	70 / 100	70 / 100	70 / 100	
Light Output	Flashing / Steady On						
Effective Intensity (Candela) Green Red, White, Amber, Blue	-- ~ 1.5 / 0.8	~ 3.1 / 0.5 ~ 1.2 / 0.2	~ 11 / 4.0 ~ 6 / 2	~ 29 / 10 ~ 18 / 6	~ 29 / 10 ~ 18 / 6	~ 29 / 10 ~ 18 / 6	
Nominal Night Range	Km						
Green Red, White, Amber, Blue	-- ~2.2 / 1.8	~ 3.0 / 1.4 ~ 2.1 / 1.0	~ 4.7 / 3.2 ~ 3.7 / 2.4	~ 5.9 / 4.2 ~ 5.1 / 3.5	~ 5.9 / 4.2 ~ 5.1 / 3.5	~ 5.9 / 4.2 ~ 5.1 / 3.5	
Vertical Divergence at 50% intensity	10 %	± 3.5 %	6.5 %	7 %	7 %	± 3.5 %	
Solar Panels Maximum Power (Watts)	0.4	0.3	1.4	7.0	11.2	12.6	
Battery Capacity (Amp-hr)	2.5	2.5	5.0	15	24	24	
Min. Autonomy hours (Flashing/Steady) With Peak sun hours	300 1.5	300 1.5	300 / 150 1.5 / 3	150 / 75 2.5 / 5	300 / 150 1.5 / 3	300 / 150 1.5 / 3	
Dimensions (Diameter x Height, mm)	139 x 165	128 x 113	177 x 140	230 x 244	235 x 330	235 x 330	
Weight (kg)	1.1	1.1	2.2	5.4	7.75	7.75	

- Improve safety
- Completely self contained and water tight (IP 67)
- Compact and lightweight
- No need for external power
- No cables or wiring
- Installation takes minutes, no technical expertise needed
- Significantly reduced infrastructure costs
- Available in blue, red, amber, white and green
- Up to 208 different flash patterns
- 501 & 601 are totally maintenance free
- Expected life span of LEDs 100'000 hours
- 700 series only require change of battery pack every 5 years
- Suitable for latitudes 55°S to 55°N
- Operating temperature range –40° to +80°C

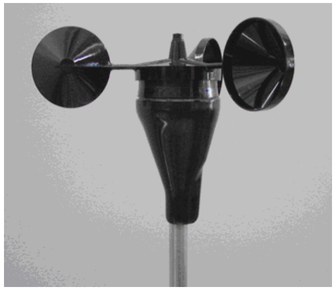
TRADITIONAL SYSTEMS

SENSORS



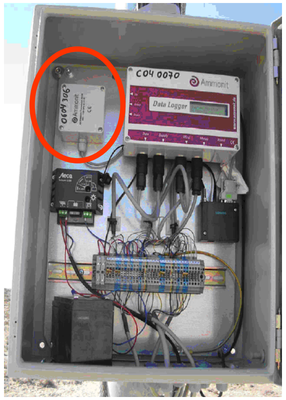
TRADITIONAL SYSTEMS

SENSORS FOR MEASURING WIND SPEED


SENSORS FOR MEASURING WIND DIRECTION AND TEMPERATURE AND ATMOSPHERIC PRESSURE





EMERGING TECHNOLOGIES

SONIC ANEMOMETERS

They can be 2D or 3D. They measure the conponent of the wind vector.

Advantages:

- Vertical component;

-High frequency of the data acquisition

-No dynamic overspeed thanks to inertia.

-Disadvantages

- low accuracy due to the presence of the suppotrt structure;

- lower long time reliaibility compared to the traditional cup anemometer;

-Higher costs;

- high energy consumption (approximately 0,6W);

- high quality data loggers due to the need of getting many data for very high frequency

- not reliability in case of storm.

EMERGING TECHNOLOGIES

SODAR ANEMOMETER

It is the acronym of Sound Detection And Ranging.

Its working principle is based on eco-doppler (sonic anemometers).

Advantages:

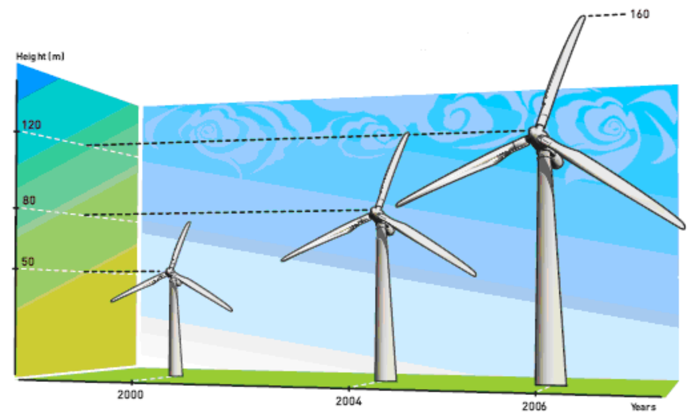
- 3D measurements;
- no met masts;
- portable device;
- wind shear up to 200m;
- cost of approximately € 40.000

-Disadvantages

-Not reliable results in presence of high noise

-Not possible to make it work during rains

-Data need a lot of filtering



Tozzi Nord wind turbines

EMERGING TECHNOLOGIES

LIDAR ANEMOMETER

It is the acronym of LIght Detection And Ranging.

Its working principle is based on Mie-scattering and Rayleigh diffusion (laser anemometers).

Advantages:

- 3D measurements;
- no met masts;
- portable device;
- wind shear up to 200m;
- sufficient accuracy also below 40m (not below 25m)

-appliable in all weather conditions;

- data do not need to be filtered

-Disadvantages

-Not reliable results in presence of “pure” sky

-High cost

-Stand-alone application

WIND RESOURCE ASSESSMENT FROM METEREOLOGICAL DATA

Starting from satellite data or metereological data and merging them with the surface topography you can get reliable data of wind resource at different hub height.

There are several mathematical modelling methods to do such evaluation but the best improvements has been recently given by the use of "powerful" hardware that allows you to perform such analysis in few weeks instead of many months.

Nowadays such methods are gaining much interest but their actual limit is its acceptance by the bank as a reliable and "bankable" way of evaluating wind resource and therefore calculate the AEO (business plan).

APPLICATION IN OFFSHORE PLATFORM

EMERGING TECHNOLOGIES







TRADITIONAL TECHNOLOGIES



CONCLUSIONS

Wind resource assessment is mandatory when you design a wind farms.

Design, choice of equipments and quality of data exctration/validation has to be done in the proper way by expertised person.

Choice of the lenght of time of the wind resource campaign depends from many factors but mainly is related to the site complexity.

Choice of the type of technologies for the wind resource campaign depends from many factors but mainly is related to the Bank request.

Wind resource assessment based upon satellite data is promising but still needs to get the final “bankability”.

When installing a small wind turbine wind resource assessment is important but it depends upon budget and time availability because it might sufficient to look for wind resource data already available close to the site.

THANK FOR YOUR KIND ATTENTION

Francesco Matteucci PhD
General Manager
Tozzi Nord Trentino Wind Turbines
Francesco.matteucci@tozziholding.com
Mobile: +39-3471528121

WiCo

WICO – Wind of the Coast

Seawork 2010
17 June 2010

Policies and Practices

Dr Brendan Webster

Marine South East Ltd, Southampton, UK

Renewable Energy Policies (1/4)

- No Specific Law for Wind Energy but …
- ‘*Planning Policy Statement 22*’ requires *Regional Spatial Plans* to include Renewable Energy Targets
- *Regional Spatial Plans* identify possibilities for Wind Turbine Power across the Region
- Local Authorities provide *Local Development Frameworks* which guide development planning

“As a commitment to the environment it comes with its own wind turbine.”

Renewable Energy Policies (2/4)

- Regional planning bodies and Local Planning Authorities work together to agree a credible spatial plan
- District, Borough or other sub region authority reviews its area to identify land assets suited to various forms of development
- *Regional Spatial Plans* thus created are sympathetic to Environmental, Economic and Social impacts when setting Regional Targets

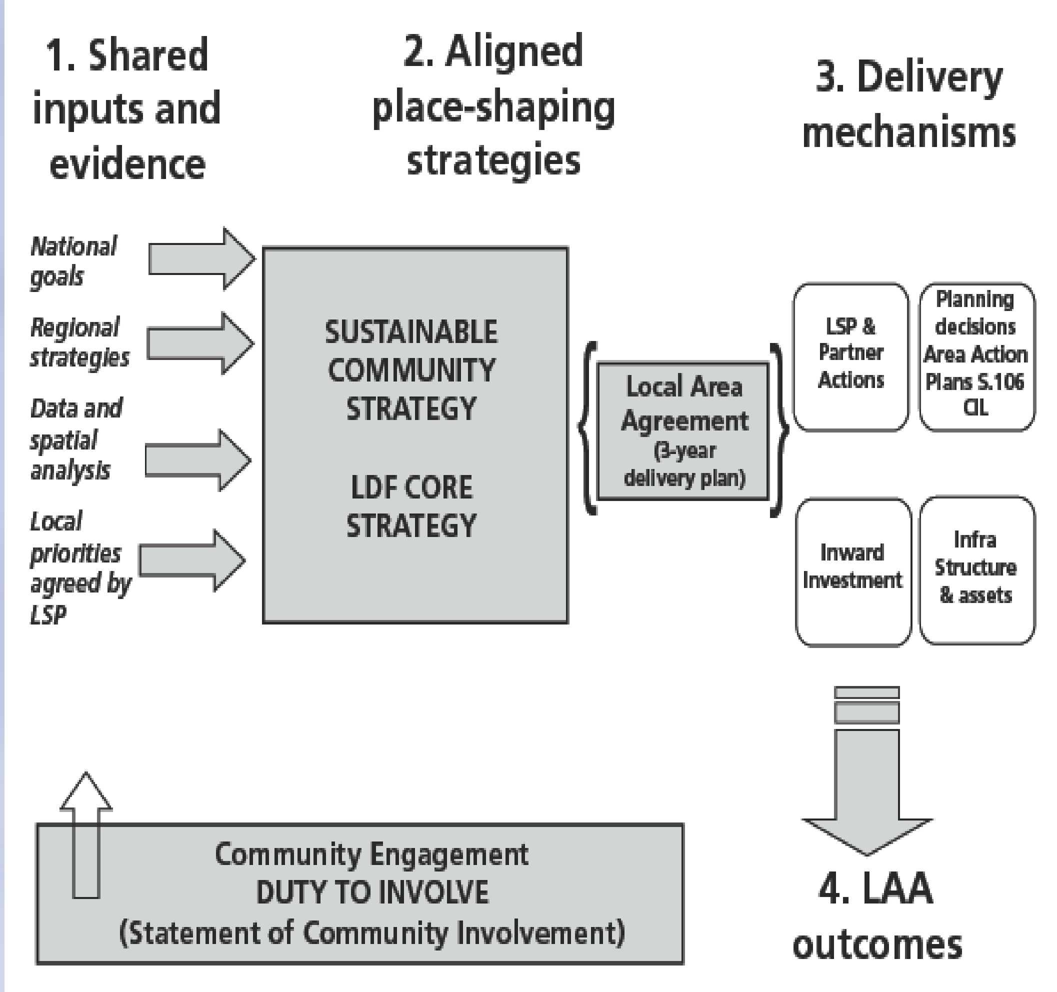
Making it Happen

- Investors
- Local Area Agreements
- Local Development Framework
- Sub-Regional Planning

All tie-in with

- Higher Level Policies
- Local Democracy

(This process is not fully realised across England as yet)



Official Partner

POWER Low Carbon Economies

European Union

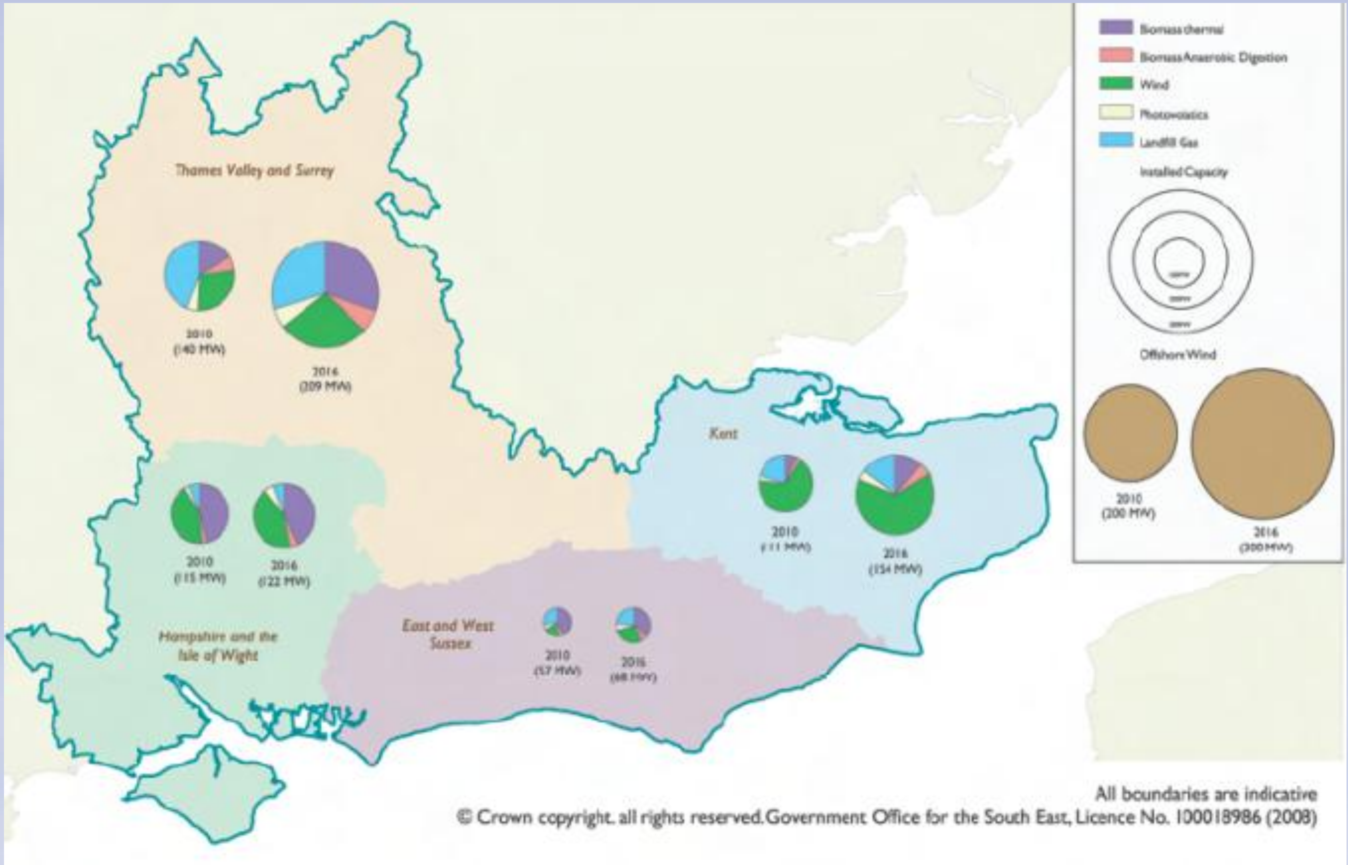
INTERREG IVC

Renewable Energy Policies (3/4)

Extracted from

“The South East Plan”

Regional Spatial Strategy for the South East of England (May 2009)



POWER Low Carbon Economies

European Union
European Regional Development Fund

INTERREG IVC
INNOVATION & ENVIRONMENT REGIONS OF EUROPE SHARING SOLUTIONS

Renewable Energy Policies (4 / 4)

- Small Wind Turbines must Comply with General Principles for Development Planning
- A “General Permitted Development Order” may soon be introduced for some SWTs <15m height and < 28m^2 swept area for freestanding or ridge line + 3m & 5m^2 on buildings

(Consultation closed 9 Feb 2010)

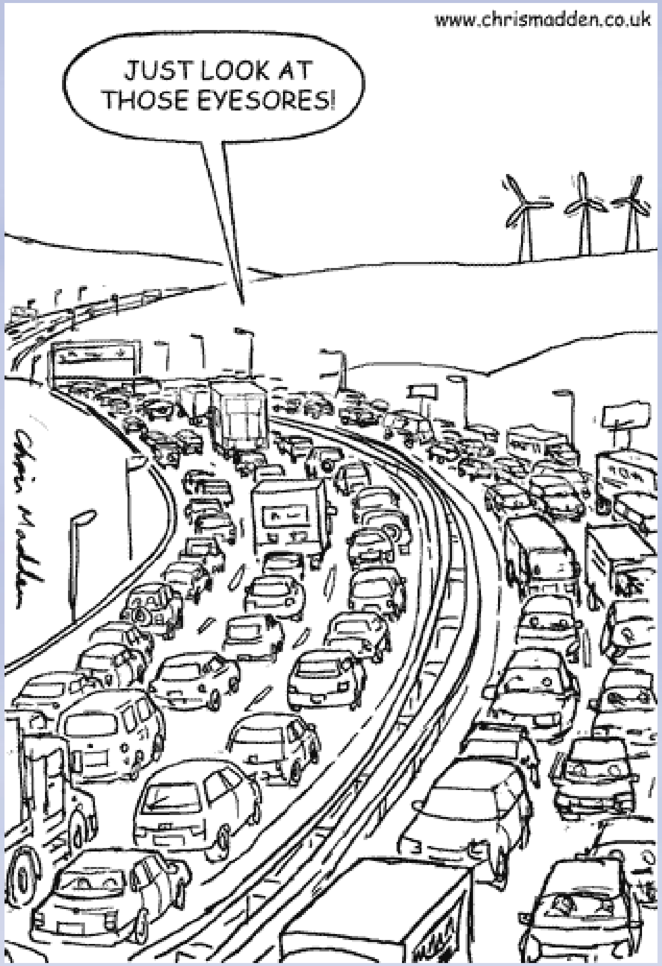
Authorisation Procedures (1/4)

- **Pre-Application Consultation**

(Developer Works with Local Planning Authority)
Identify key issues & compliance with Local Development Framework, Material Considerations and Relevant Stakeholders, such as:

- Aviation, (Civil & Military)
- SSSIs
- Highways Agency
- Neighbouring properties, etc.

- Identify Consultation Needs
- Identify Conditions



Environmental Considerations

- **Topics Include**
  Noise
  Wildlife Habitats
  AONB
  SSSI
  Radar (if >11m tall incl. blades)
  Radio/TV
  Flicker
  etc.
- **Just Acceptable Limits**
  Location dependent and generally not defined but open to “democratic” judgement

POWER Low Carbon Economies
European Union
INTERREG IVC

Pre Application Studies

- **Developer Produces, or Engages Competent Consultants to Produce, a sufficient for Purpose Environmental Impact Assessment and Report, etc.**

Statutory Consultees

- **Natural England**
  Statutory Consultee
  EIA Regulations
  Habitats Regulations
    AONB
    SSSI
    Wildlife

- **Other Consultees could amongst others Include:**
  Environment Agency
  Health & Safety Executive
  Highways Agency
  Adjoining LPA
  Commission for Rural Communities
  Commission for Architecture & Built Environment

Authorisation Procedure

- **Developer Submits Application**
- **Statutory Bodies**
  Natural England, Environment Agency, etc. Examine application and Reports
- **Public Written Comments Received**
- **Local Planning Authority Officers Make Recommendation**

  No, Yes, Temporary Yes, Conditions, (Small developments may be automatically delegated to local planning officers and not require committee)
- **Planning Committee of Local Authority**
  8 week standard (13 for significant impact)
  Reviews recommendation and decides "No", "Yes", perhaps "Temporary Yes" and Imposes Conditions. Often the committee will not agree with officer recommendations – local democracy
- **Conditions Imposed**
  Standard Conditions
  Archaeology
  Electrical Connection, Etc.

Planning Committee

- Planning Committee consists of local **Elected Persons**, assisted and guided by Professional **Local Authority Planning Officers**

  Members of the public can make representations in person at planning committee meeting

  Conditions may be imposed

  Committee can delegate negotiation of detail to local planning officers

Grant of Approval Concerns

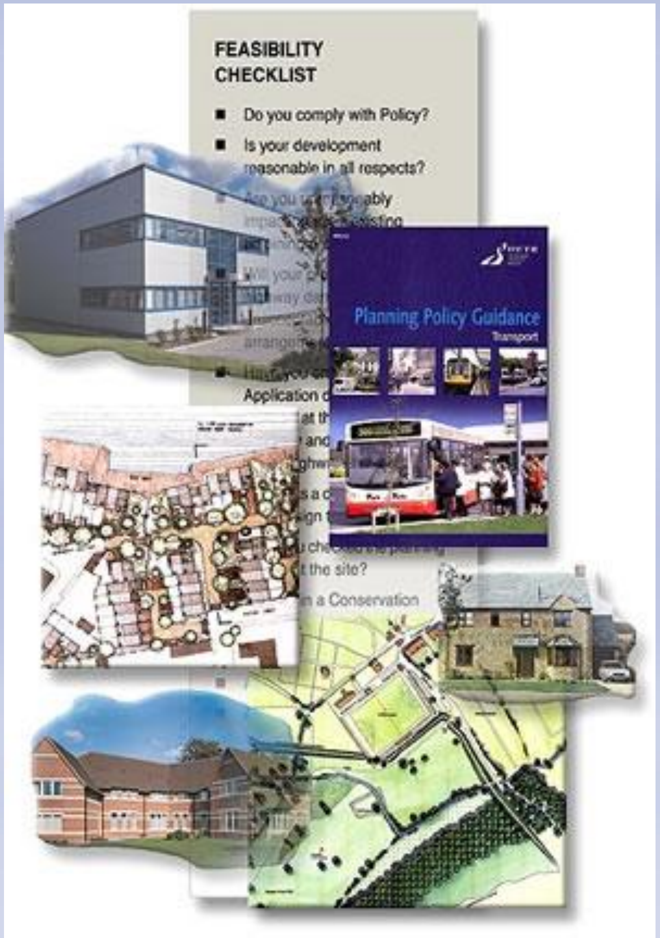
- **Local Planning Authority May Grant "Temporary Planning Consent"**

  This would require the developer to reapply for planning consent after three or five years, say. Concerns might be that the initial performance of the turbine in terms of (bearing?) noise and vibration could decline over time and then cause a nuisance.
  This underlines the need for certification for lifespan and maintenance requirements especially in respect of location.

In coastal areas salt and dust in atmosphere can lead to "concretion" of blades and this might be a contributing factor for wear and tear.

Beyond "Planning"

- *Regulations* must be followed, ex. "Building Regulations" and Health and Safety relating to the installation, etc.
- Grid Connection is permitted up to a certain maximum (currently 16 Amps per phase) above this, Utility company agreement is needed
- A Generation Meter is Required to claim Feed In Tariff payments
- An Export Meter (or "Smart Meter where/when available) is required to claim payment from utility company for systems >30kW rated
- At this time, systems <30kW can be *deemed* to export 50% of electricity generated (awaiting roll-out of Smart Meters)



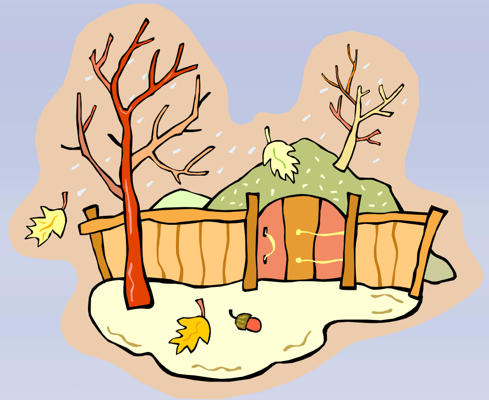
Other Issues for SWT Specification and Prediction

- Standards of site assessment, system specification and installation are critical for individual success. Examples of over optimistic income prediction bring SWT into disrepute. FITs were set for a typical 8% return on capital in “Good” locations
- SWTs must not only be calibrated for wind and rotation speed and generator frequency matched with their power control and grid connection electronics, but must be selected for wind variability – choice range from HAWT to VAWT plus design responsiveness to swirl and direction changes etc.

“Good” Locations (1)

Poor Wind Assessment

Wind charts indicate statistical wind speeds at say 25m in unobstructed locations. Local topography may create highly significant reduction. Problem in urban areas especially but also in rural and industrial settings where immediate landscape, and nearby building or vegetation impact



Wind sampling is statistically limited by duration and errors may be large or biased

“Good” Locations (2)

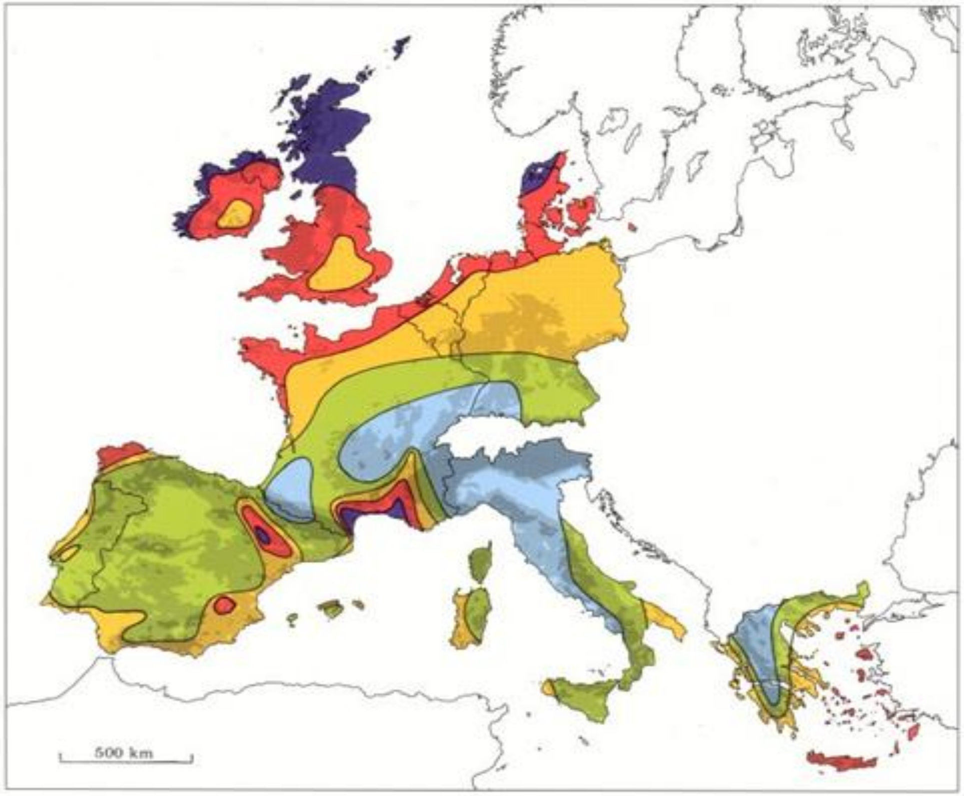
Small Wind – “Good” Wind, non-sensitive (civilly acceptable) location, **Likely Users**:- Anybody with open space or tall building.

In reality, wind is unlikely to be “Good” in urban settings and acceptability by neighbours is precarious. GDPO review recommends turbines very limited in height and to be sited at least 100m from residential windows of buildings outside the curtilage of the development site.

Other Issues for SWT

- Certification of Turbines is demanding and costly:-
  Large Wind and Small Wind have different hazard profiles recognised by two IEC standards IEC 61400-1 and a reduced stress version IEC 61400-2 applicable for rotors of <200m^2. Community scale turbines may be larger this but small compared to the 1500m^2 of "large" wind Turbines.
- Wind test profiles require significant periods of high wind speed restricting practicable test sites to regions such as Scotland
- Turbines must be calibrated to allow effective power electronics matching

UK Wind Resource 1



Wind resources[1] at 50 metres above ground level for five different topographic conditions										
	Sheltered terrain[2]		Open plain[3]		At a sea coast[4]		Open sea[5]		Hills and ridges[6]	
	$m s^{-1}$	Wm^{-2}	$m s^{-1}$	Wm^{-2}	$m s^{-1}$	Wm^{-2}	$m s^{-1}$	Wm^{-2}	$m s^{-1}$	Wm^{-2}
	> 6.0	> 250	> 7.5	> 500	> 8.5	> 700	> 9.0	> 800	> 11.5	> 1800
	5.0-6.0	150-250	6.5-7.5	300-500	7.0-8.5	400-700	8.0-9.0	600-800	10.0-11.5	1200-1800
	4.5-5.0	100-150	5.5-6.5	200-300	6.0-7.0	250-400	7.0-8.0	400-600	8.5-10.0	700-1200
	3.5-4.5	50-100	4.5-5.5	100-200	5.0-6.0	150-250	5.5-7.0	200-400	7.0- 8.5	400- 700
	< 3.5	< 50	< 4.5	< 100	< 5.0	< 150	< 5.5	< 200	< 7.0	< 400

Policy Non Financial Drivers

Promotes SWT

- **Microgeneration**
  All Renewable Microgeneration Contributes to National Targets for Renewable Energy (There is “Permitted Development” for some technologies already and this may be extended to SWTs)
  Niche solutions for off-grid situations
  Regional Planning Solution for RE
  Low Carbon Developments mandated for future (Could SWT count toward Code 6 if installed outside housing development curtilage?)

Hinders SWT

- **Local Authority Planning Approval**
  NIMBY
  AONB Environmental Pressure Groups
- **Utilities**
  Grid Connection for Larger SWTs

END

Dr Brendan Webster

Marine South East Ltd, Southampton, UK

WICO – Wind of the Coast

Seawork 2010
17 June 2010

Policies and Practices
Additional Slides – *GPDOs for SWT*

Dr Brendan Webster

Marine South East Ltd, Southampton, UK

General Permitted Development Orders (GPDO) 1

GPDO introduced 6 April 2008 gave permitted development status to some microgeneration schemes such as PV, solar thermal ground/water heat pumps, biomass and CHP

GPDO not yet granted to SWT but consultation has taken place as is likely lead to GPDO for wind.

GPDOs have location limits – typically exclude AONB, Conservation Areas, Listed Buildings, other sensitive areas

General Permitted Development Orders (GPDO) 2

UKAS approved standards will be mandated to moderate objections to the GPDO. These may include MCS and MIS. Noise levels in particular have not been agreed and attitudes to noise vary widely throughout UK Local Authorities.

Department for Communities and Local Government has issued recommendations for a staged introduction of GPDO for wind. RenewableUK believe this will accelerate deployment of qualifying installations and help realise market potential

General Permitted Development Orders (GPDO) 3

Likely key limiting features:
Free Standing:15m hub HAWT/15m total VAWT, max 6m blade HAWT or 28m^2 other, 200m from next turbine. **Roof Mounted**: total height max 3m above roof high point, 2,5m blade dia or 5m^2. **Both Types**: UKAS Scheme

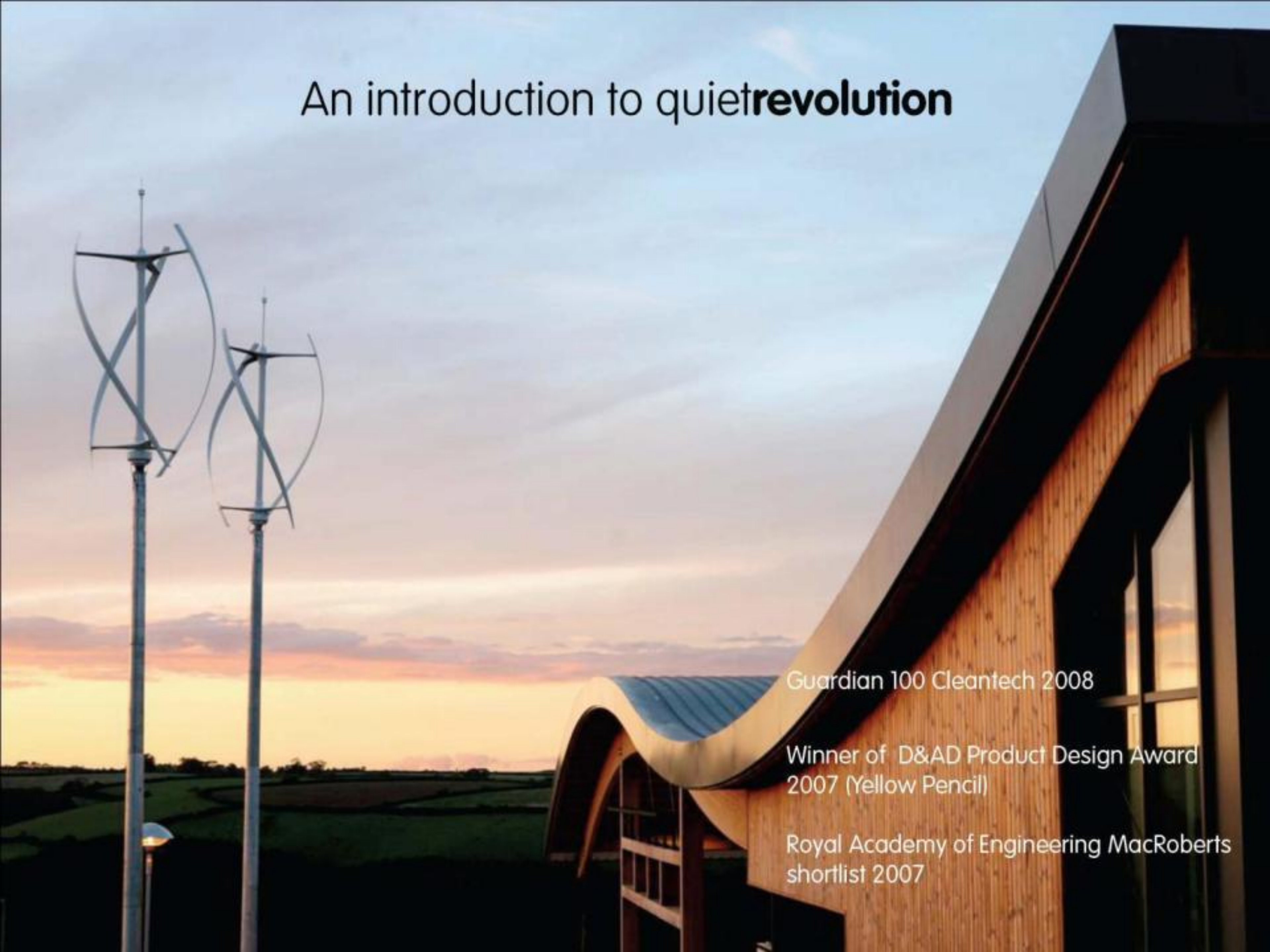
Interim GPDO awaiting UKAS scheme: + 100m separation from neighbour windows, max ref Sound Level 40dB(A), no overhang to public space, radar clearance (>11m), 3 Hz max

Source Iskra

WiCo

Stephen Crosher

quietrevolution


An introduction to quiet**revolution**
Guardian 100 Cleantech 2008
Winner of D&AD Product Design Award 2007 (Yellow Pencil)
Royal Academy of Engineering MacRoberts shortlist 2007

quietrevolution

Wind turbines for the
'developed' environment

Developed :

- **Areas where man has already had impact**
- **High turbulence intensity**

The qr5 turbine is a recognised, iconic design with strong aerodynamic performance


More than 100 turbines have been installed in the UK, The Netherlands, Germany and Australia


Clean design, low noise & vibration are key advantages over HAWTS for use near people or buildings


Unlike traditional horizontal axis wind turbines, the qr5 will maintain its power curve in turbulent winds


The aerodynamic power
curve has been audited by
the NRC in Canada


The qr5 turbine is tried and tested and will be certified by Q4 2010

quietrevolution qr5

unlocks the opportunity for small scale wind energy at or near point of use

- harvests turbulent wind
- very quiet
- low vibration
- complements architecture
- safe

The turbines are grid connected and energy can either be used on site or exported as appropriate to maximise energy value

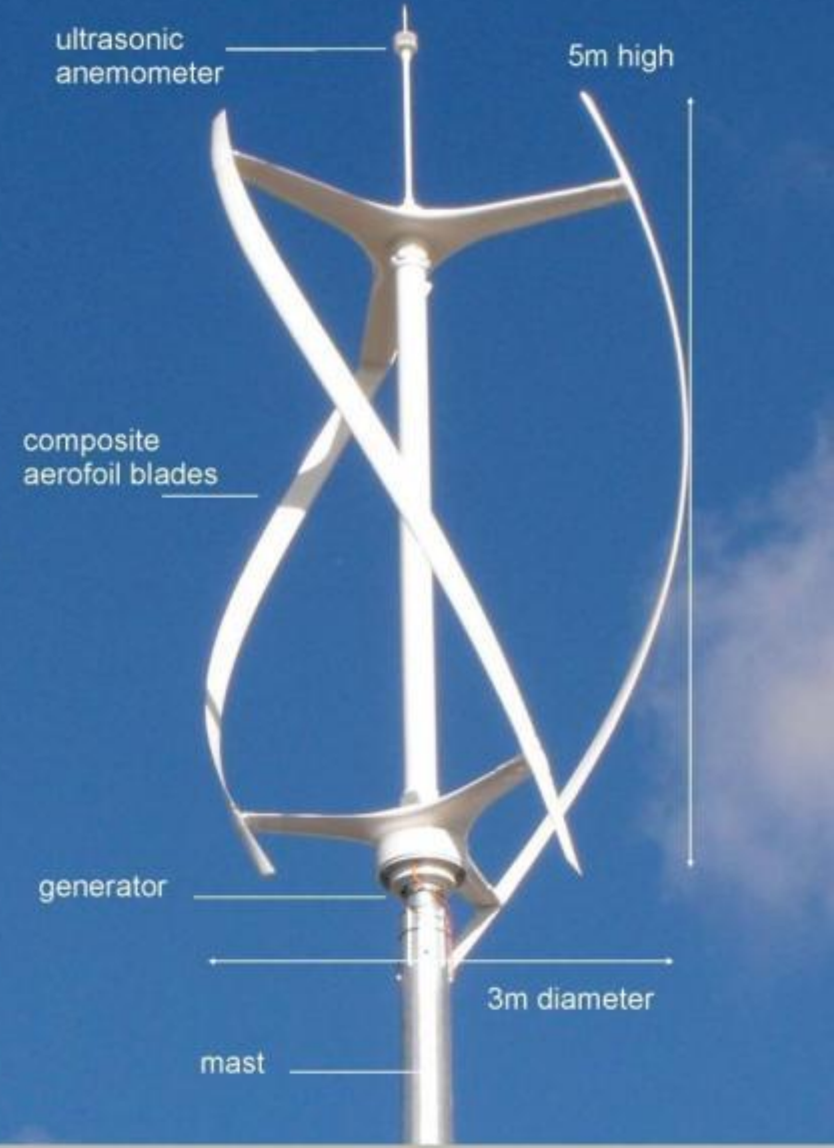
Rated power: (at 11m/s)	4.2kW Aero/3.1kW DC/2.5kW grid
Rotor size:	5m high x 3.1m diameter
Mounting:	6m mast for roof 15m mast for ground
Construction:	Carbon and glass composite blades and spokes
Class:	IEC 61400-2 III (suitable for AMWS 5.0 – 7.5m/s)
Cut out:	19 m/s
Generator:	Direct drive, permanent magnet

Energy yield estimate

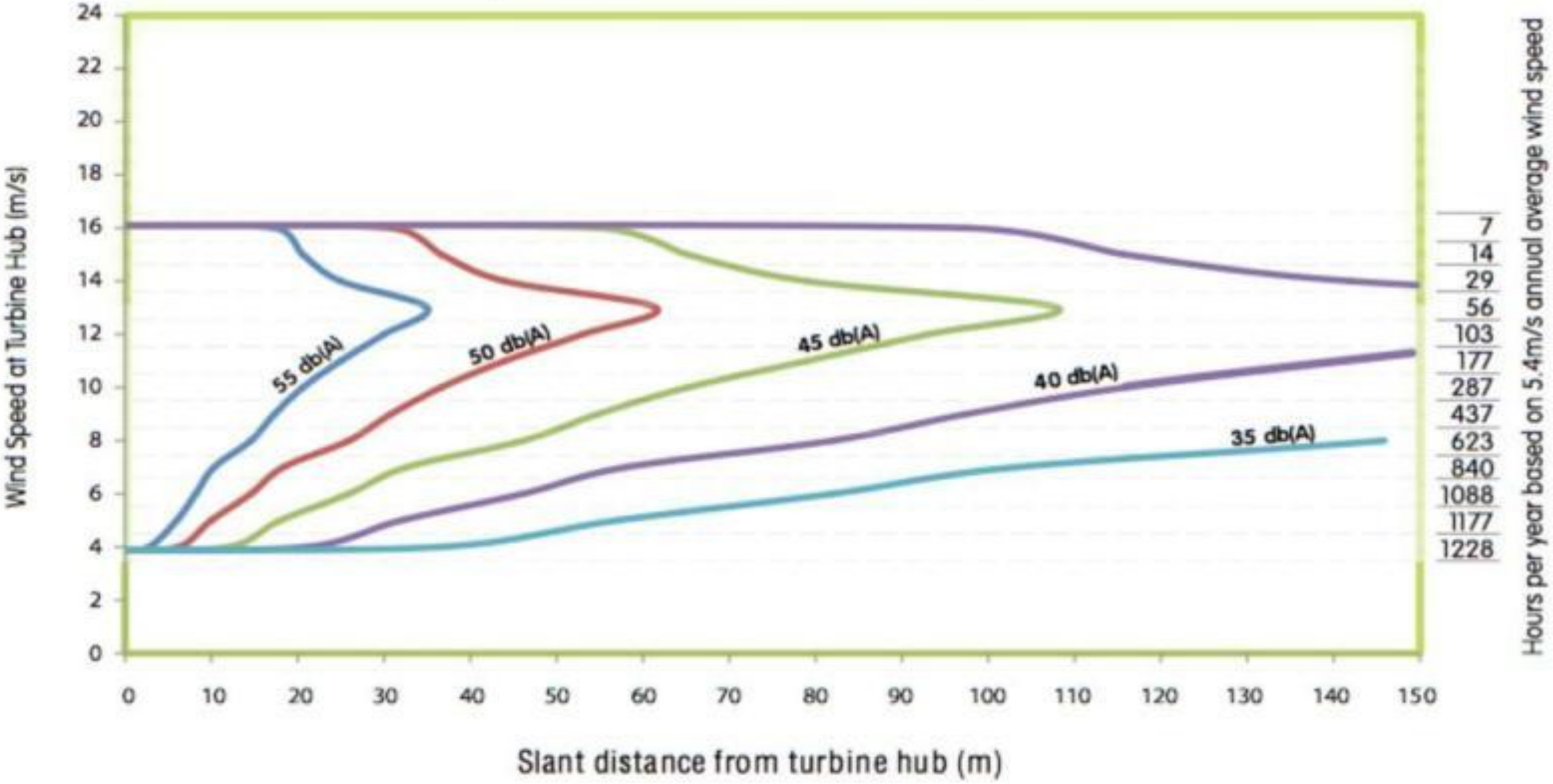
High:	7,500-8,000kWhrs grid out p.a.(>7.0m/s)
Typical:	4,500-5,000kWhrs grid out p.a.(≥6.0m/s)
Low:	2,000-2,500kWhrs grid out p.a.(5.0m/s)

GPRS connection for remote monitoring

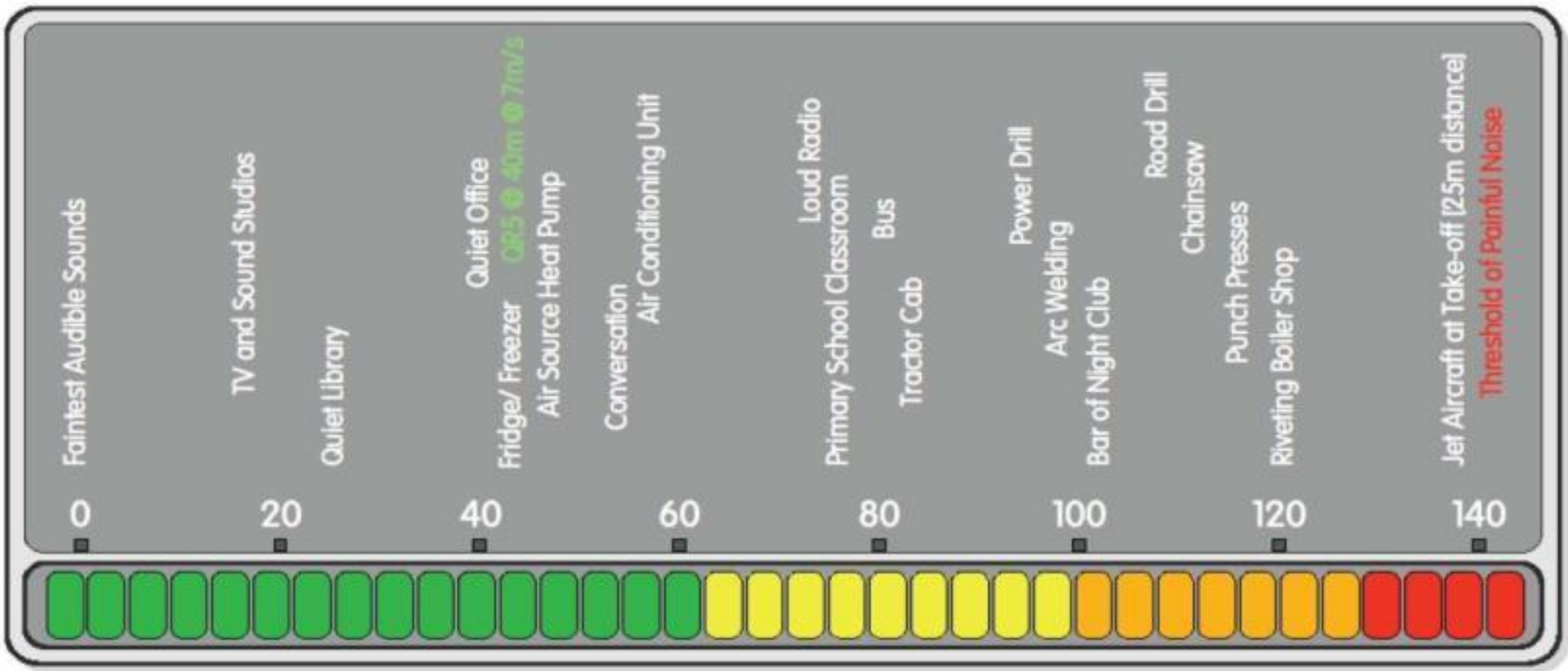
Integrated anemometer and safety systems



qr5 Immission Noise Map



Comparative noise levels



quietrevolution

Select Baseplates:

cleveleys-cafe-1
cleveleys-cafe-2
cleveleys-cafe-3

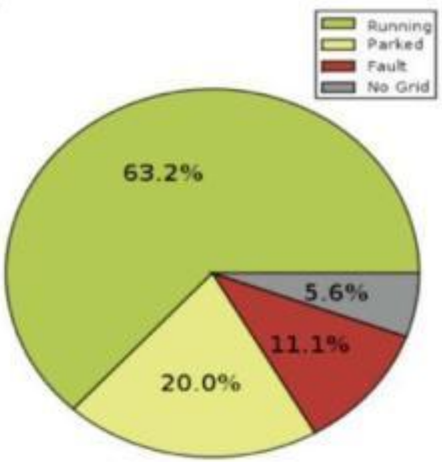
Submit

Change Reporting Period:

From: 01-06-2009 To: 31-07-2009

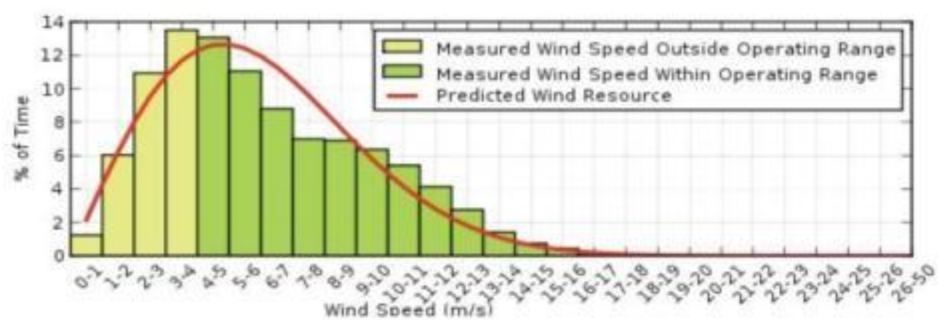
Logout

Operational State: 01-06-2009 to 31-07-2009*



Mean Windspeed (m/s)	6.1
Operational Hours*	1,199
Energy Generated (kWh)	781
Availability %*	83.3
Generating wind conditions %	68.3

Wind Resource

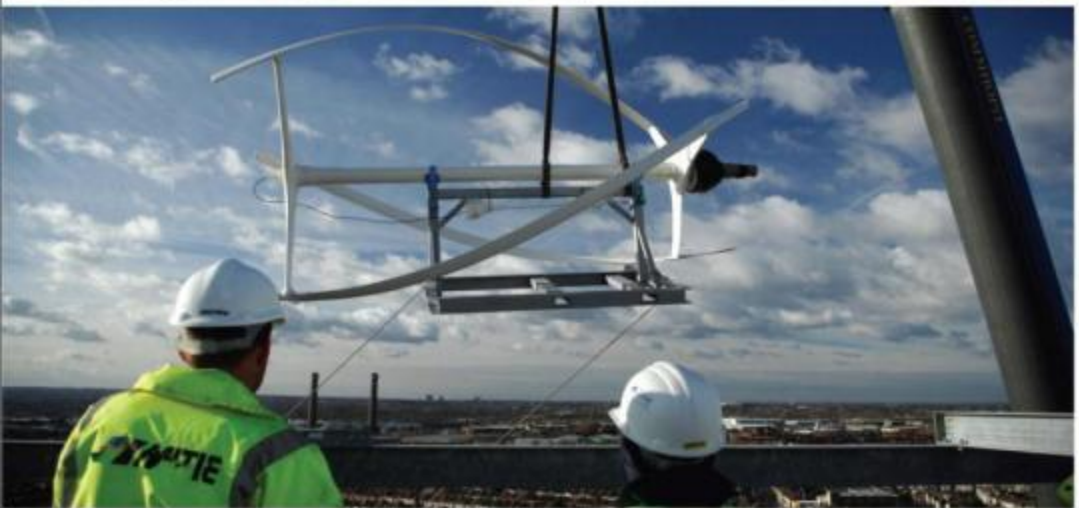


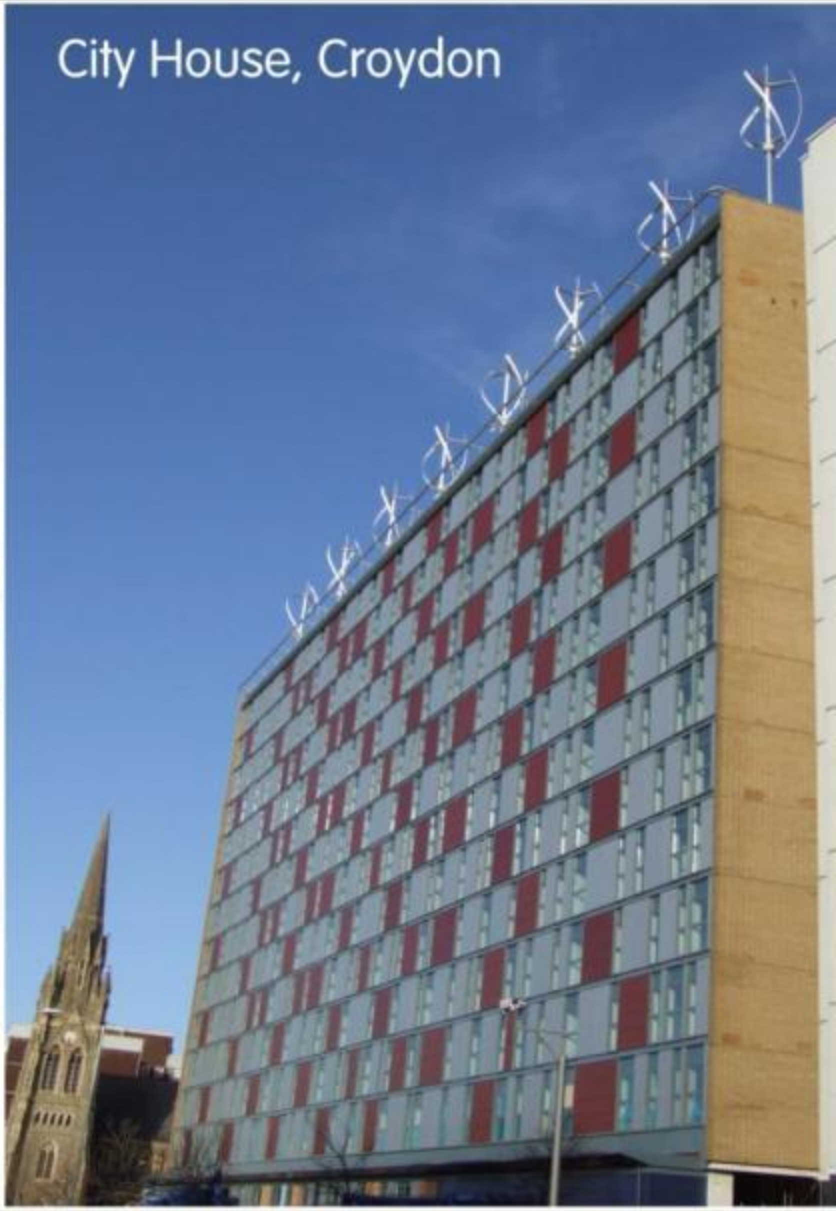
Each turbine has an integrated anemometer

Wind speed & direction, yield and uptime data are accessed via GPRS

Clients can access performance data via a microsite

Service engineers can monitor performance and upload software upgrades remotely 24/24



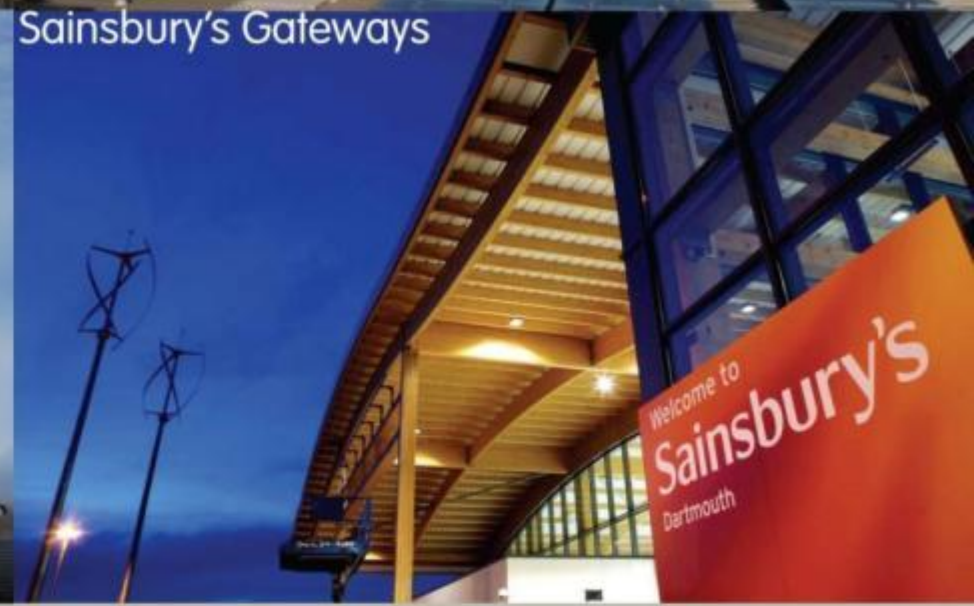


quietrevolution


Network Rail sites – no planning req'd


ANZ Melbourne


Ports and promenades



Sainsbury's Gateways

quietrevolution

qr5 installations 2009

quiet**revolution**

Understanding Wind Resource

It takes time and costs money to physically measure wind speeds on site, as a result many customers don't do it

Wind resource is frequently over estimated in databases – leading to inaccurate business cases and ultimately disappointed customers

Windspeed is by far the most critical factor in calculating cost per kWhr and payback

$$\textbf{Power} = 0.5 \times \rho \times C_p \times \text{Swept area} \times \text{windspeed}^3$$

qr has therefore developed a desktop tool to help qualify sites for turbines at the start of the process

This is based on data from 100 sites over two years, and is constantly evolving

quietrevolution

Coastal Opportunities for wind turbines

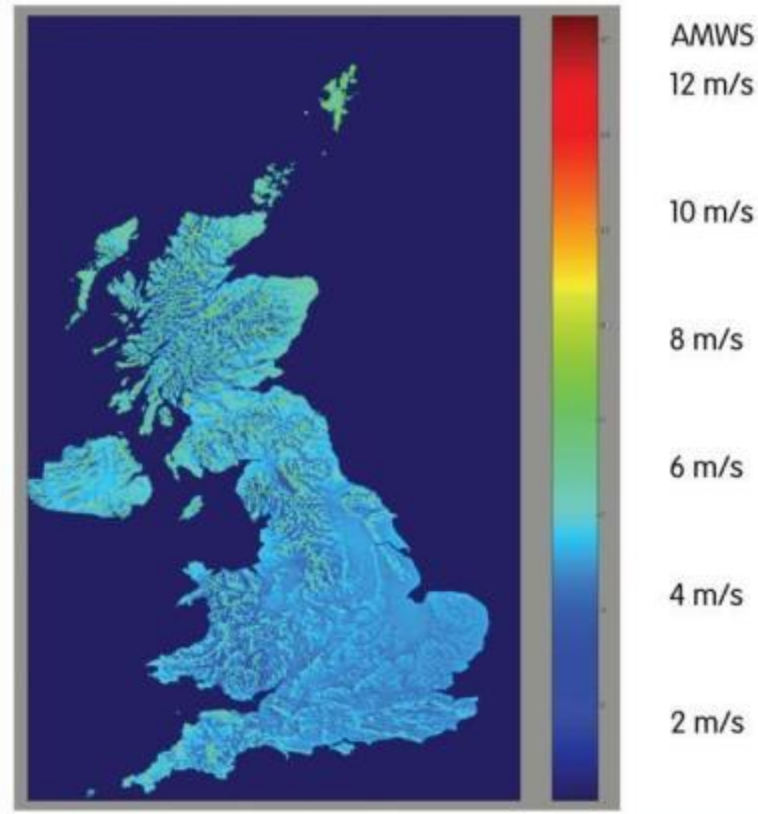
quietrevolution

Case study of qr wind estimation tool

Starting point is NOABL: a widely used database of windspeeds at 10/25/45m agl

The key limitations are:

1. This is an Air flow model that estimates the effect of elevation on wind speed
2. 1km square resolution and takes no account of topography on a small scale
3. No allowance for the effect of local thermally driven winds such as sea breezes or mountain/ valley breezes
4. No allowance for the effect of local surface roughness
5. No allowance for shadowing and acceleration effects due to topography



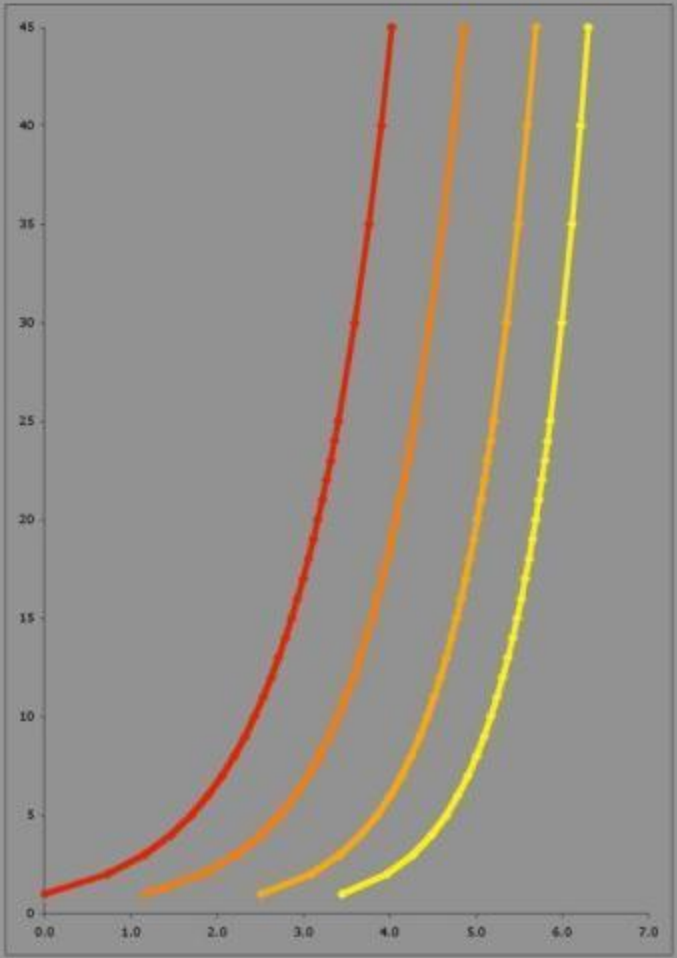
Adjust for surface roughness

Coastal

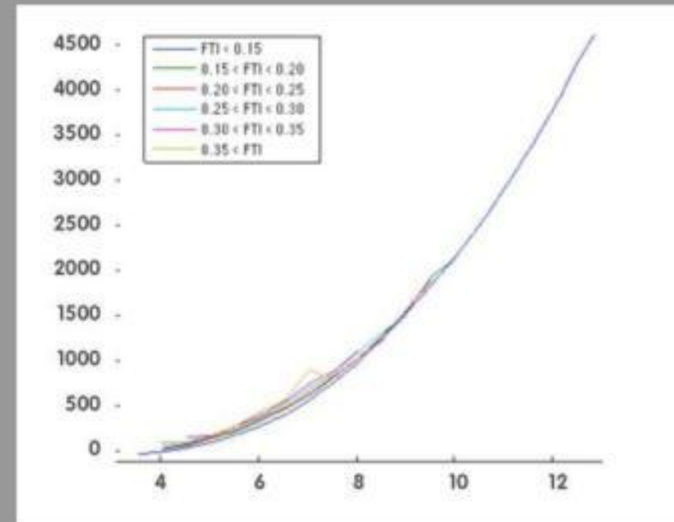
Rural

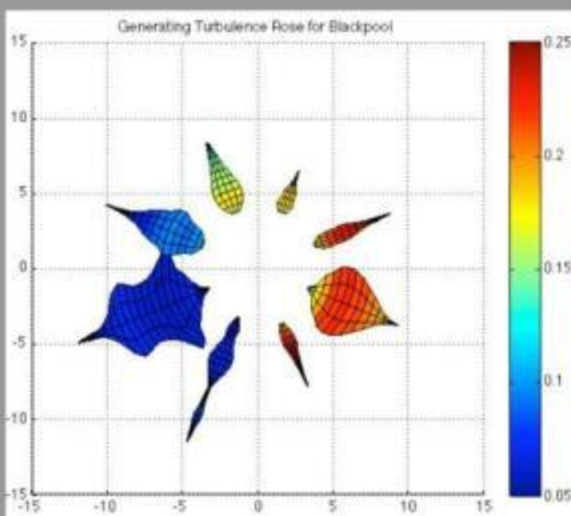
Suburban

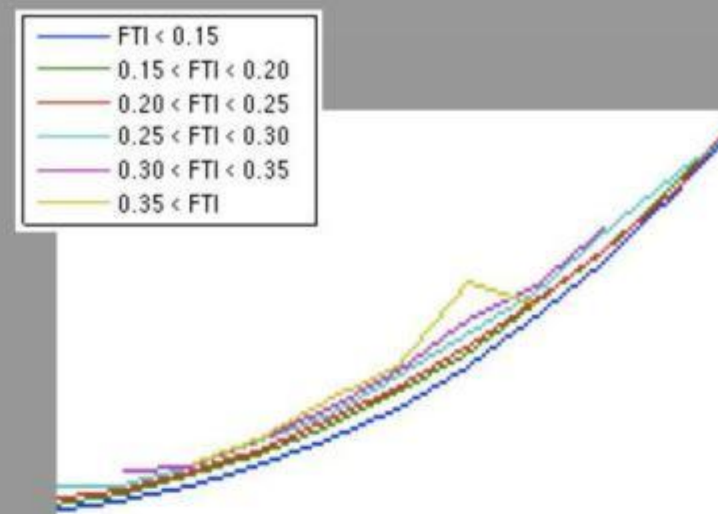
Urban

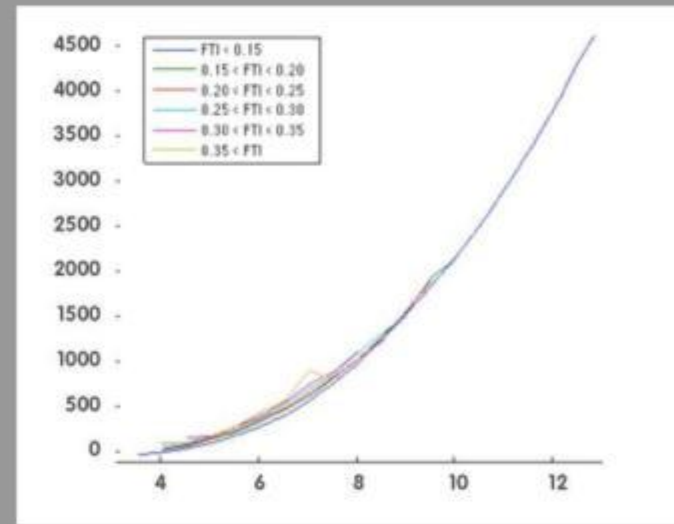


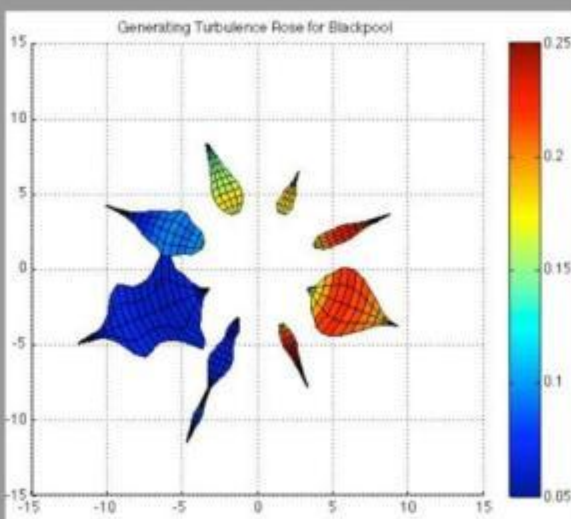
Higher wind resource →

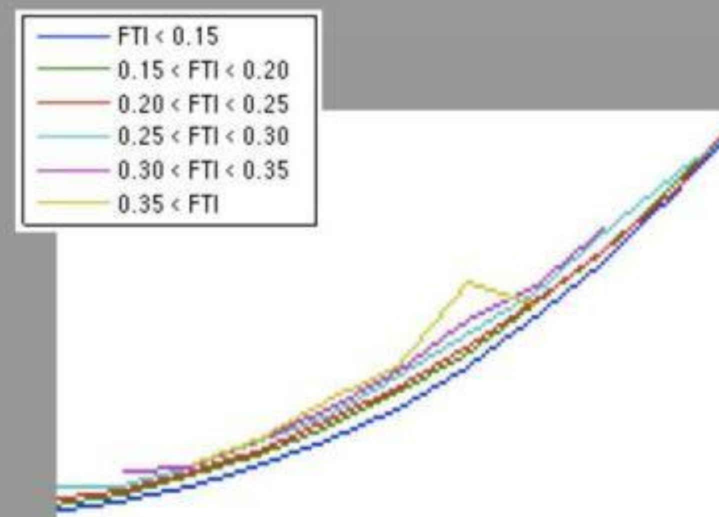

FTI < 0.15
0.15 < FTI < 0.20
0.20 < FTI < 0.25
0.25 < FTI < 0.30
0.30 < FTI < 0.35
0.35 < FTI
4500
4000
3500
3000
2500
2000
1500
1000
500
0
4
6
8
10
12


Generating Turbulence Rose for Blackpool
15
10
5
0
-5
-10
-15
-15
-10
-5
0
5
10
15
0.25
0.2
0.15
0.1
0.05


FTI < 0.15
0.15 < FTI < 0.20
0.20 < FTI < 0.25
0.25 < FTI < 0.30
0.30 < FTI < 0.35
0.35 < FTI


4500
4000
3500
3000
2500
2000
1500
1000
500
0
4
6
8
10
12
FTI < 0.15
0.15 < FTI < 0.20
0.20 < FTI < 0.25
0.25 < FTI < 0.30
0.30 < FTI < 0.35
0.35 < FTI


Generating Turbulence Rose for Blackpool
15
10
5
0
-5
-10
-15
-15
-10
-5
0
5
10
15
0.25
0.2
0.15
0.1
0.05


FTI < 0.15
0.15 < FTI < 0.20
0.20 < FTI < 0.25
0.25 < FTI < 0.30
0.30 < FTI < 0.35
0.35 < FTI

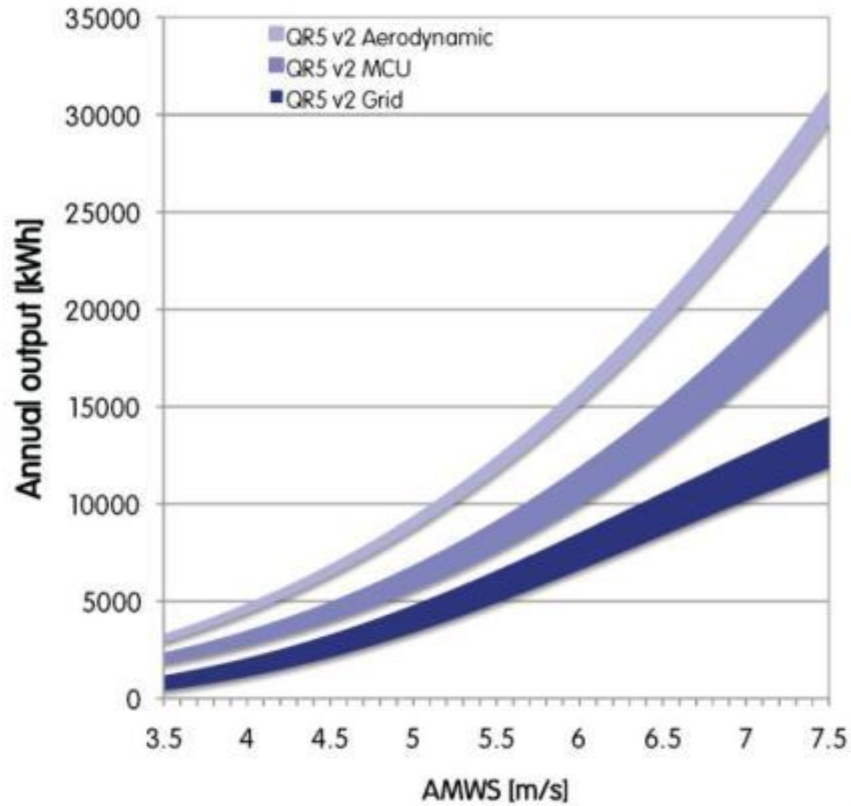
qr5 version 2.0 performance

Released 2012

DESKTOP DESIGN DATA

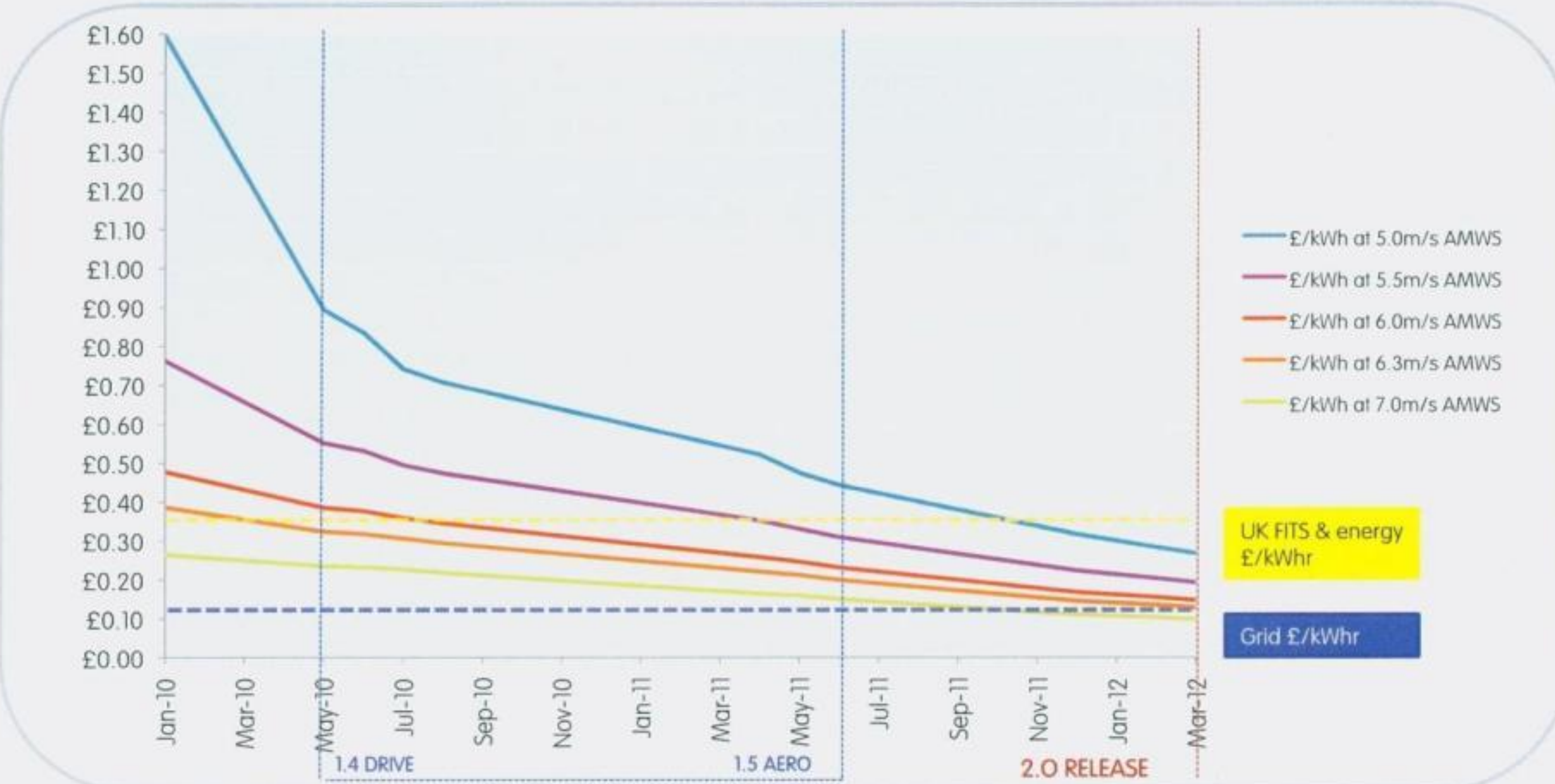
qr5 v1.5	Design data
Energy yield at 5.0m/s AMWS	4,500 kWhrs
Energy yield at 5.5m/s AMWS	6,400 kWhrs
Energy yield at 6.0m/s AMWS	**8,300 kWhrs**
Energy yield at 6.3m/s AMWS	9,600 kWhrs
Energy yield at 7.0m/s AMWS	12,500 kWhrs
Est. installed price	£27,000 (£22,000 with volumes)
Cost per kWhr (on 6.0m/s AMWS site)	£0.13
Payback (on 6.0m/s AMWS site)	10 years
Grid delivered energy as % of aerodynamic	48%

Yields are shown in ranges prior to certification, and because grid output in particular will vary according to configuration on site



quietrevolution

Cost per kWhr will reduce significantly over 18 months as electrical losses are reduced and higher manufacturing volumes lead to lower costs



quietrevolution

quietrevolution

quietrevolution

quietrevolution

Wind turbines for the 'developed' environment


Hackney Wick
quietrevolution

WiCo

Enviro Business

Feed in Tariffs:
A Money Making Opportunity?

Alan Banks

CEO, Envirobusiness

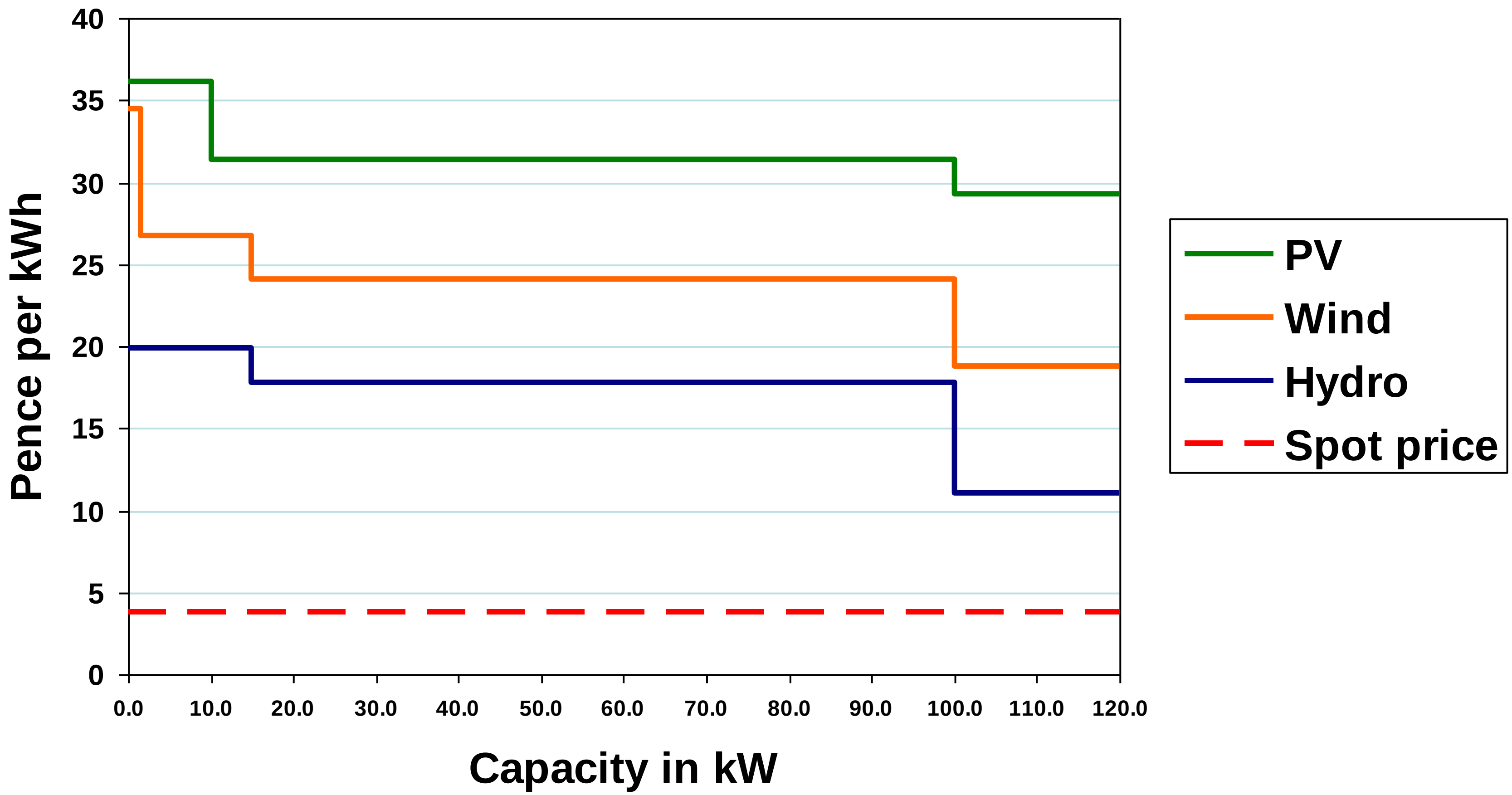
alan.banks@envirobusiness.co.uk

2 Mers Seas Zeeën
INTERREG IV A

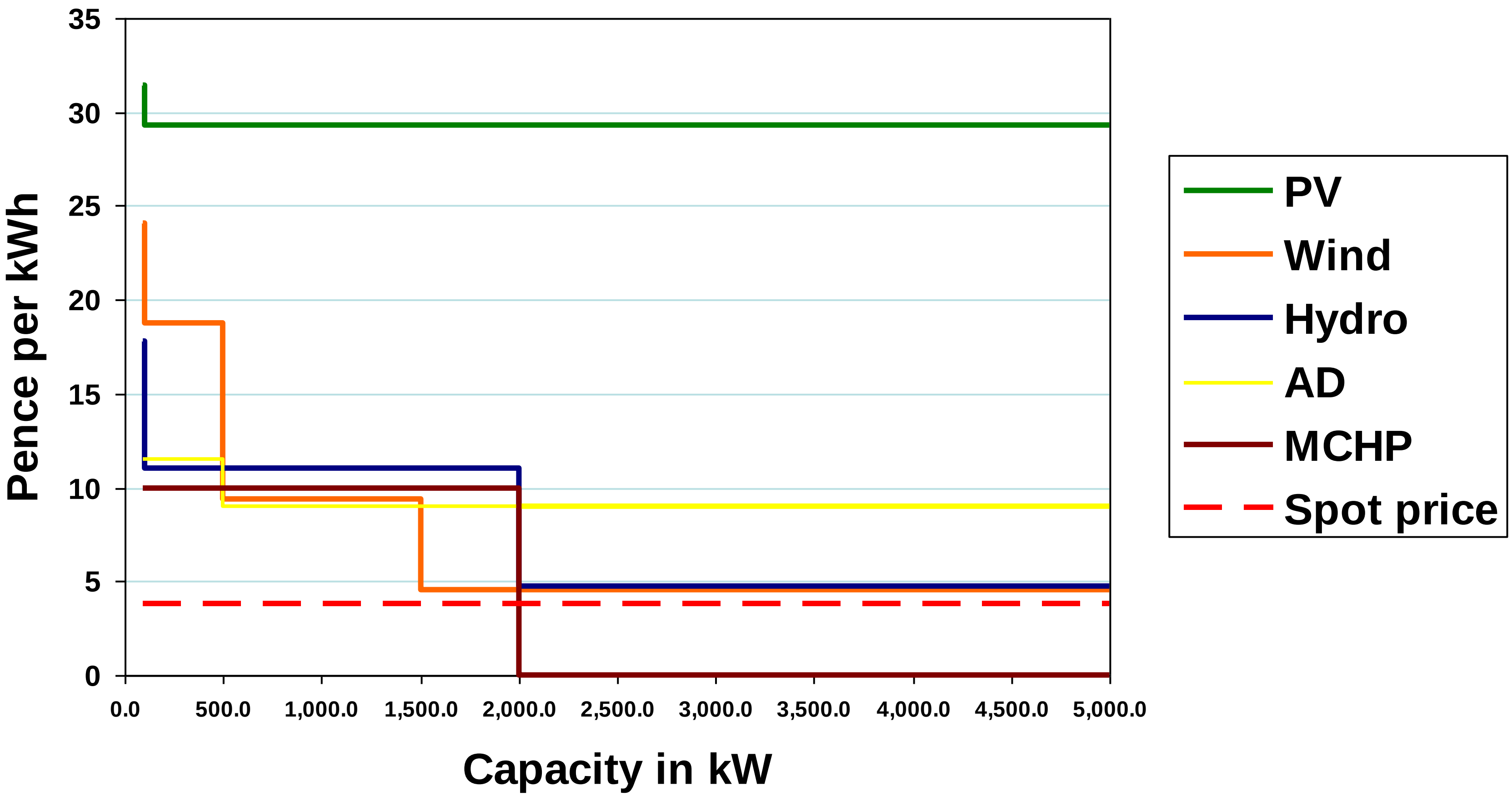
Feed in Tariffs

- Started from April 2010
- Purpose is to guarantee the price that small renewable electricity installations will get for the power they generate
- Small generation plants also no longer need a power purchase agreement – just a two way meter and route into the grid
- Many different technologies qualify:
  - Anaerobic digestion
  - Hydro turbines
  - Micro combined heat and power systems
  - Photovoltaic's (solar power)
  - Wind turbines
- Covers systems from the very small up to 5 MW

Structure of FITs: Small Generators (up to 100 kW)



Structure of FITs: Large Generators (up to 5 MW)

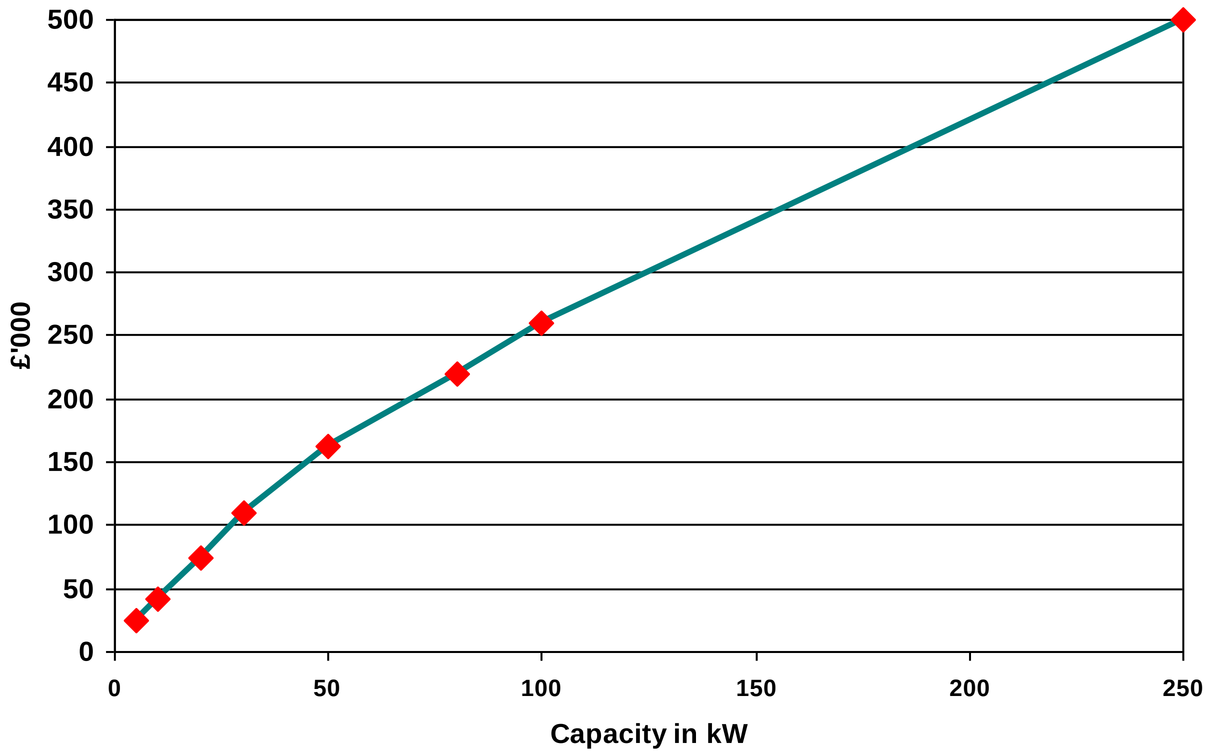


Further Tariff Information

Of course it's not that simple!

- For PV and Wind, tariffs decline from 2012/13 by around 5% - 8%
- There is a separate tariff for stand alone PV arrays (same as that for 100kW – 5,000 kW installations)
- Micro generation plants currently receiving support under the Renewables Obligation transfer to the FIT scheme with a tariff of 9 pence/kW
- There is an additional 'export' tariff of 3 pence/kWh for electricity exported to the grid
- The tariffs last for different periods:
  - 10 years for Micro CHP
  - 20 years for AD, Hydro and Wind
  - 25 years for PV

Typical Installed Price Curve



Above 50 kW some slight economies of scale

Above 100 kW, FIT drops off significantly

Implies a 'sweet spot' of up to 100 kW

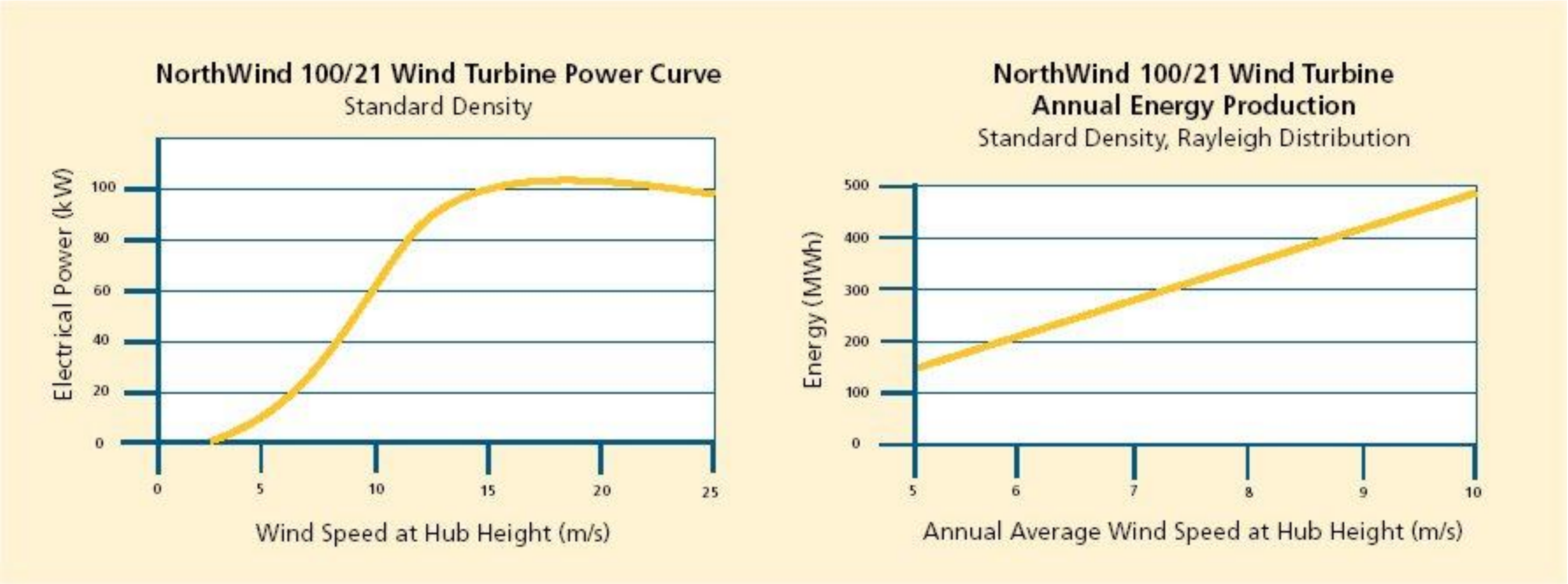
Enviro Business

Typical 100 kW Wind Turbine Parameters

- 21 m diameter rotor
- 35 m high tower
- 100 kW maximum rated power (at 14 m/s; 32 mph)
- No power produced below 3 m/s
- Produces 220,000 kWh electricity (at AMWS of 6 m/s; 13.5 mph)
- Electricity generation worth £53,000/year at FIT of 24.1p/kWh + export tariff of 3p/kWh
- Must be installed by an MCS certified installer
- Installed cost of £260,000 = 5 year payback

2 Mers Seas Zeeën
INTERREG IV A

Average Wind Speed Critical to Value



- Power generation is proportional to cube of wind speed
- At 5m/s = 10.5 kW vs. at 10m/s = 66.8 kW
- Marine estate typically has higher average wind speeds, and less interference from built environment
- Reduces payback period

Wind Power is Economically Viable for the Marine Estate

- 100 kW turbine produces enough electricity for the equivalent of 120 homes
- Can power significant amount of port and associated activities
- Payback of around 5 years is reasonable, if not spectacular
- Siting is critical to economics
- As FIT is primarily a generation tariff, can improve economics by using electricity locally to replace grid power and grid prices:
  - (e.g. electricity is worth around 9p/kW if used but only 3p/kw if exported to the grid)

Enviro Business

How can Envirobusiness and Marine South East Help?

- If you have marine estate, we can help you to evaluate micro-generation opportunities
- If you have already developed a micro-generation plan, we can help you to understand better the available technologies
- If you are a manufacturer/installer, we can help you identify opportunities in the marine estate
- If you need capital, we can help you access public and private sources of funds

WiCo

Questions?