

DEL Quarterly Seminar

Energy Resource Group, DIT

Wind Urchin: An Innovative Approach
to
Wind Resource Measurement

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Introduction

- **Energy Resource Group (ERG)**
- **The problem with Wind Resource Assessment**
- **Wind Measurement – Urchin**
- **Application of Urchin to Wind Forecasting and Power Prediction**
- **Overview of Research**

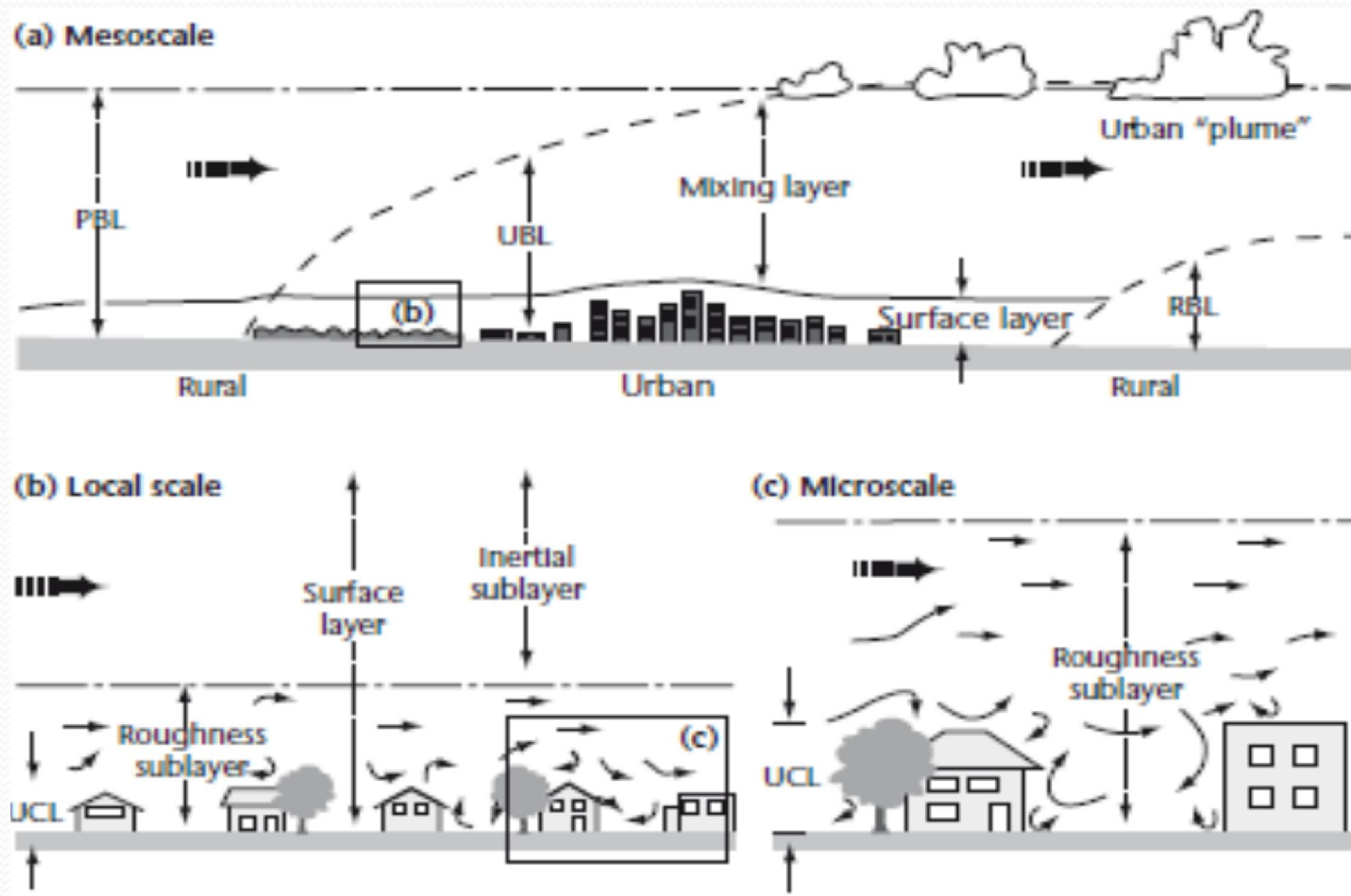
**Horns Rev Wind Farm,
Eastern North Sea**

ENERGY RESOURCE GROUP

- Recently formed research group in DEL
- The Capabilities of the group include:
 - Lab-to-Market
 - Proof of concept
 - Product design
 - Prototyping
 - Data analysis
 - Wind forecasting
 - Development of Intellectual Property
- Two Enterprise Ireland funded commercialisation projects currently running with more in the pipeline:
 - Urchin (Metometer) – A Three-Dimensional Anemometer
<http://dit.technologypublisher.com/files/sites/metometer-information-sheet.pdf>
 - Wind Predictor – A Wind Power Prediction Software:
<http://dit.technologypublisher.com/files/sites/wind-predictor-technology.pdf>

Field of Interest

- Wind measurement
- Wind energy resource prediction



Problem Statement

Wind is a three-dimensional complex phenomenon.

Traditional instrumentation provides inadequate data on wind characteristics, because it measures accurately only in two dimensions.

Accurate wind speed data is vitally important for wind-industry players.

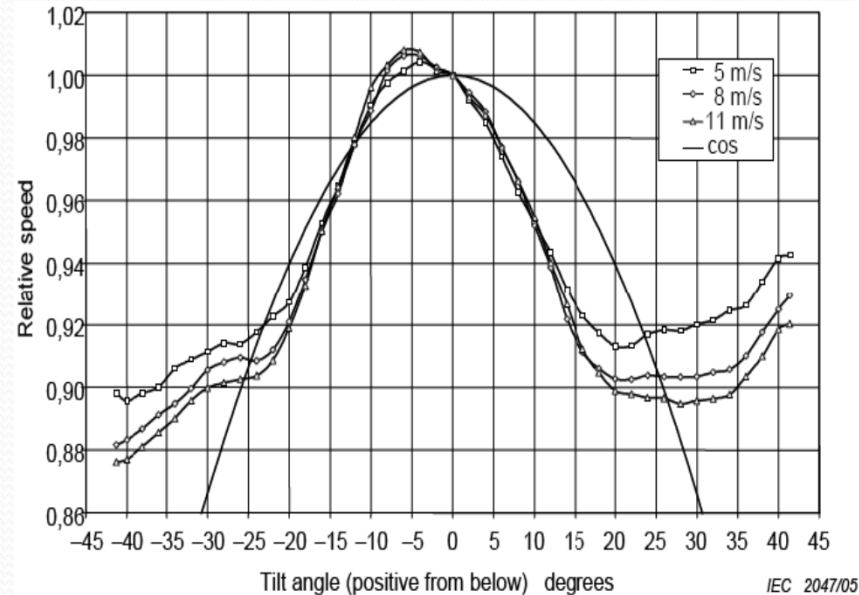
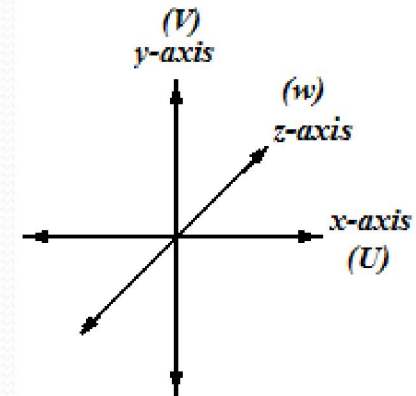
Generation forecasts frequently underestimate and overestimate the power potential of wind projects with serious commercial implications

IEC 61400-12-1: 2005 quotation

[wind] ... flow variables affect power yield ... identical wind turbines will yield different power at different sites even if the hub height wind speed and air density are the same. ... Presently, analytical tools offer little help in identification of the impact of these variables and experimental methods encounter equally serious difficulties.

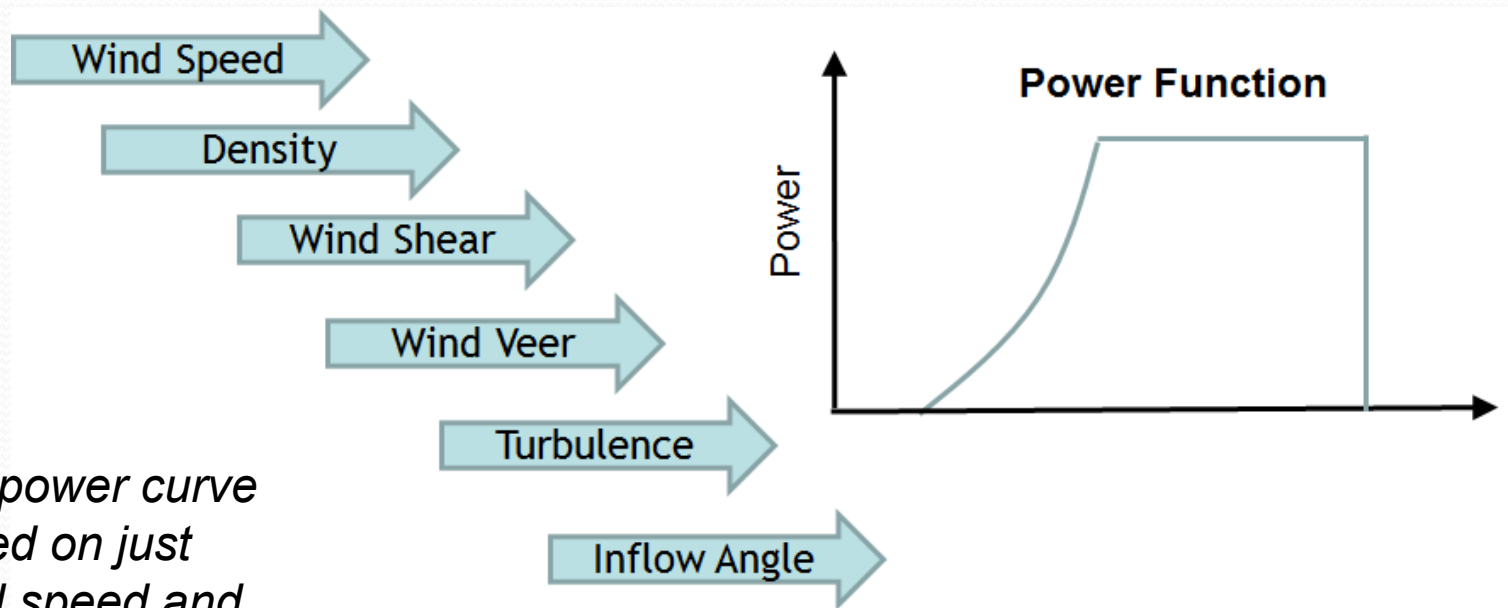
Performance Characteristics of a Cup Anemometer

- Cup anemometers measure horizontal wind speed only - it produces a single *scalar quantity* only.
- The characteristic curve for a cup anemometers show that the relative speed of a cup anemometer will vary with the angle of the wind.
- IEC 61400:12-1 Standard estimate the uncertainty associated with wind speed as 1.1 to 9.6%.
- This leads to an Uncertainty Annual Energy Production (AEP) 3.0 to 25.0%
- How this is currently handled in the industry at the moment is that they model it and de-rate it but we are going to measure it.



Power Curve for Wind Turbines – PCWG Overview

What power will a wind turbine generate in the full range of atmospheric conditions seen in the 'real world'?



Is a power curve based on just wind speed and density the 'whole truth'?

Power Curve Working Group Overview – Peter Stuart

<http://www.pcwg.org/>

Wind Urchin

- Proposed solution to the difficulty in measuring wind.
- A three-dimensional wind instrument



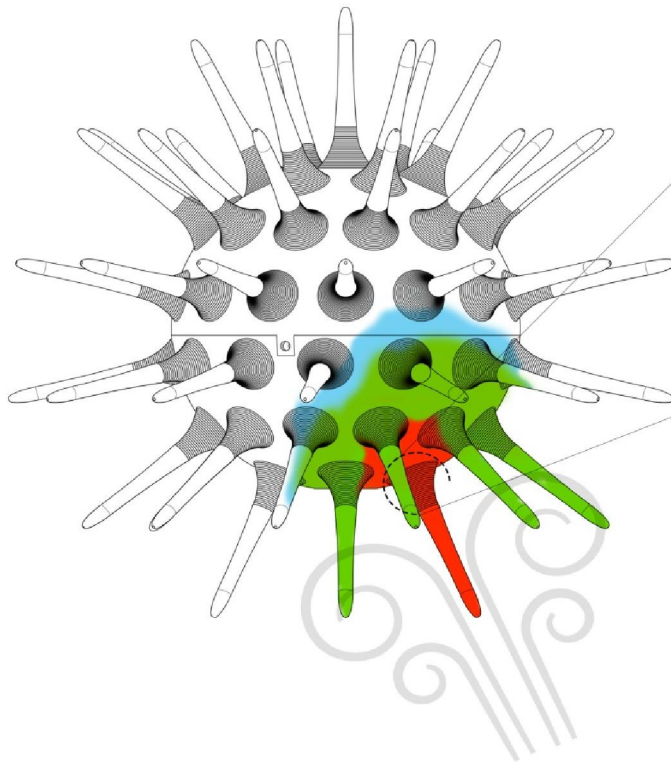
‘Don’t model it,
measure it’

Urchin – Operating Principles

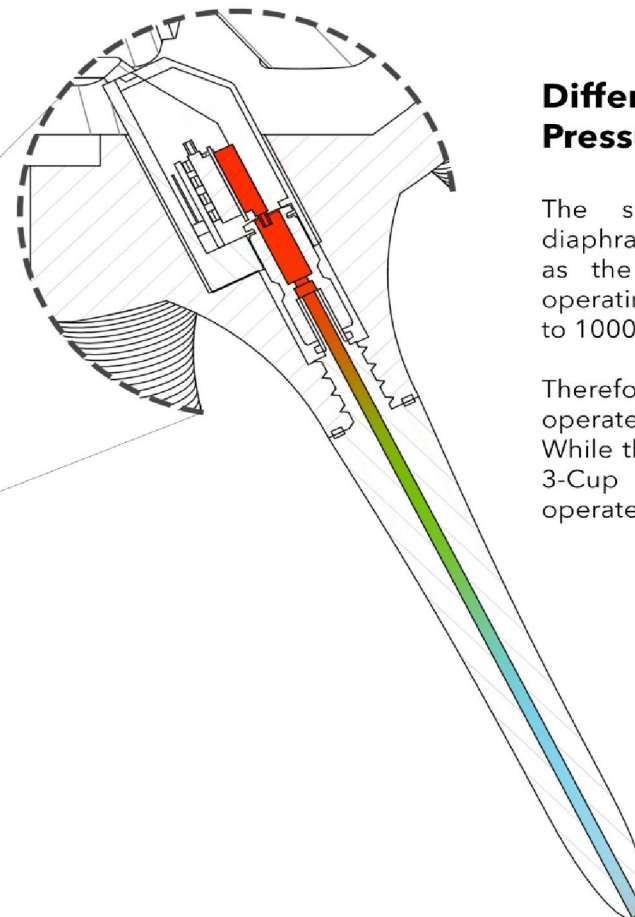
How it Works

The Wind Urchin measures wind in 3D using 64 Pitot Tubes spread equally around its body with a sensor attached to each one.

As wind hits the device it maps out the direction by averaging the data from each sensor. Showing speed and direction but also wind shear and wind veer



✱ **By using Pitot tubes the Urchin is compact with no moving parts, not effected by inclement weather, provides high density data while remaining cost effective**



Differential Pressure Sensor

The sensor contains a diaphragm which fluctuates as the pressure changes operating at a frequency up to 1000Hz.

Therefore the Urchin can operate at up to 64,000Hz. While the industry standard 3-Cup anemometer operates at only 1 Hz

Application of Urchin to Future Wind Industry

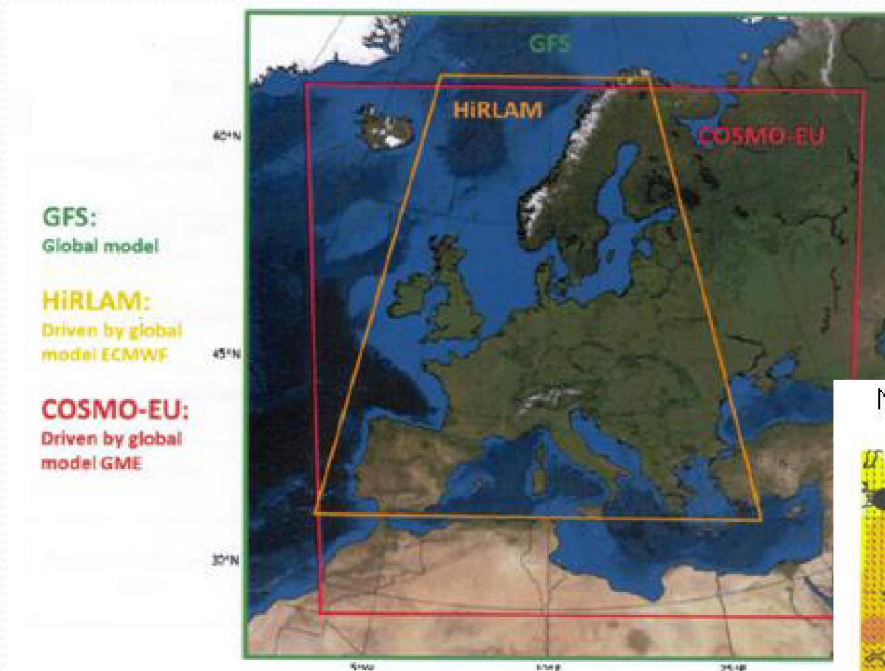
- Transition of SEM to I-SEM due in 2017
 - Concentration on *ex ante* or day-ahead markets
 - Financial implications for inaccurate forecasting of wind power

“Market participants will be financially responsible for ensuring that their physical generation and demand is in balance with their contracted position traded in the day-ahead and intra-day markets”

(SEM Committee, September 2014)

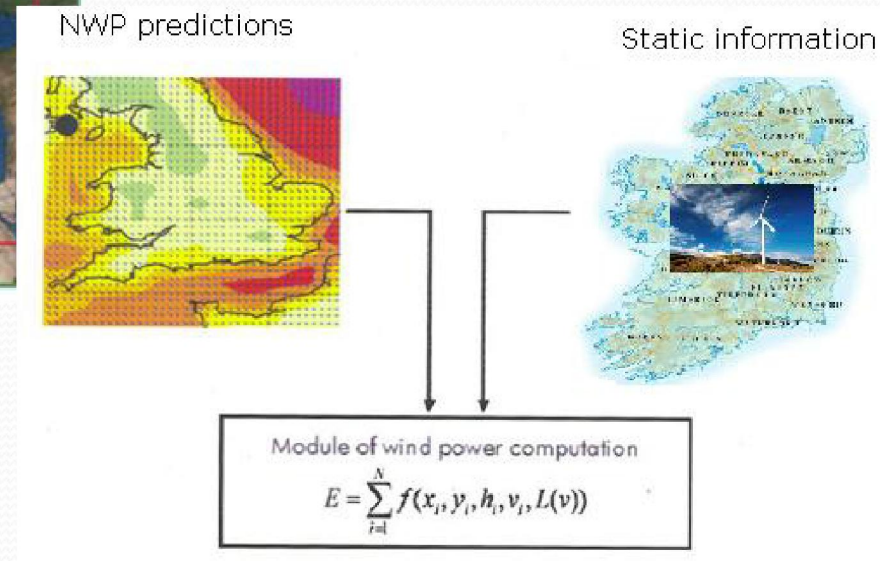
- In other words, energy producers in the new I-SEM will become “balance responsible”

Current Approaches to Wind Power Prediction



Physical models employing meso-scale (2-5km) off-the-shelf numerical weather prediction (NWP) models

Complemented by on-site SCADA readings from nacelle-mounted anemometers and/or met-masts.



(ref: EirGrid, Amanda Kelly)

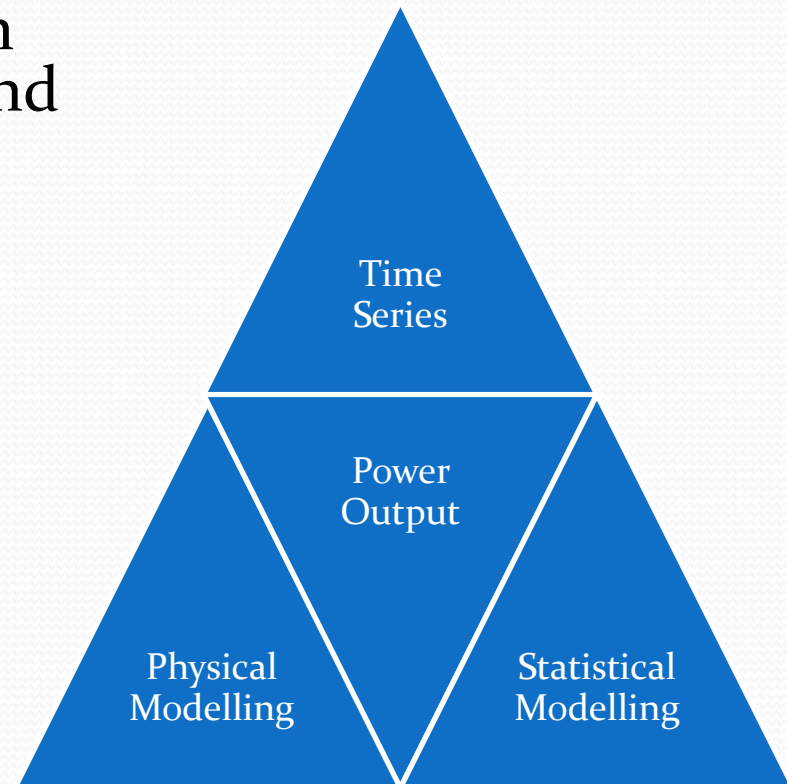
Power Output Modelling Platform (ERG)

A site-specific energy management and forecasting platform.

- Based on a combination of three approaches:
 - **Time-Series Modelling** uses the current and most recent wind speeds at the location to determine trends in the data.
 - Machine learning algorithms generate forecasts and associated uncertainties for different forecast horizons.
 - Aim: more accurate forecasts and accurate uncertainties.
 - Patterns in wind and electrical power output
 - Possibilities with NGF
 - **Physical Modelling** / NWP
 - Meso-Scale data available from Hirlim, IBM Blue Thunder
 - On-site measurement with Urchin
 - **Statistical modelling**
 - Unique data from Urchin is better correlated to power output than conventional approaches.

Power Output Modelling Platform (ERG)

- Install an Urchin near a wind farm and measure the quality of the wind i.e.
 - wind speed
 - density
 - vertical wind shear
 - vertical wind veer
 - turbulence intensity
 - directional variation
 - inflow angle
- Initial data from trials in DIT promising.
- Next stage of development is field trials with an operational wind farm and the Urchin installed on site



Future Development

- Development work continuing
- Field deployment of Urchin to a wind farm due in June 2015
- Two partners for the project identified
- Actively seeking more industry partners



Thank You

Any Questions?