

Energy From Fresh Air 2003
Renewable Energy Information Evening

Irish National Onshore Wind Energy Resource Study

Presented By:
Pat McCullen, ESB International

Sligo Park Hotel, Sligo
13th November 2003

1. Wind – A Complex Resource

- Geographically dependent
- Non linear and intermittent over time
- Non linear relation between speed and power
- Non linear relation with height

2. Altener 1996-7 Study Irish Wind Resource Distribution @ 45m above ground

- Based on 1km square grid
- Nine Met Eireann Stations as used in European Wind Atlas
- Average wind rose for country
- Directionality, slopes
- Resource Calculations
- Theoretical Resource: Whole land area
- Feasible Resource: Theoretical less areas physically occupied by constraints [Particular land cover, buffer zones, slopes $> 10^\circ$]
- Accessible Resource: Feasible less environmentally sensitive areas, Threshold commercial wind speed 7m/sec.

3. Dept. of Public Enterprise

- Green Paper on Sustainable Energy (1999)
- Strategy for Intensifying Wind Energy Development (2000)
- Emphasis on need for county based wind resource mapping for planning purposes

4.1 Brief (Sept. 2001)

- Determine onshore commercially accessible wind energy resource – national and county basis.
- Unconstrained theoretical resource.
- Feasible commercial resource constrained by physical limitations.

4.2 Input

- Hourly field wind data values from available sources for at least 10 years from 1990 (incl. NI data).
- Orographic elements.
- Surface roughness.
- Temperature/Atmosphere stability.
- Ordnance Survey Mapping

4.3 Constraints

- Use meso scale atmospheric model with measured wind energy parameters and verifiable field data
- 500m buffer around settlements
- 100m buffer along main roads, railways, HV lines
- Delete rivers, lakes, canals, reservoirs
- Delete areas with mean wind speed < 7.0m/sec.
- Secure best reliable fit between meso scale model and field data
- Commercial resource maps to identify transmission network
- To be compatible with 1 : 50,000 scale OSI mapping
- To be compatible with common Geographic Information Systems
- Allow for addition of other restrictions by Planning Authorities

4.4 Output

- Digital coloured map of each county
- Resolution on grid of at least 1km x 1km
- Annual mean wind speed distribution at 0.25m/sec intervals
- Wind power density distribution (W/m^2)
- Wind power class and direction distribution
- Typical Diurnal/Seasonal wind patterns
- Roughness classes
- Description of analysis method for resource prediction

5.1 Mesoscale Atmospheric Simulation System (MASS) Model

- Involves iterative solution of set of differential equations based on principles of conservation of
 - Energy
 - Momentum
 - Mass
- Ideal gas law

5.2 Prognostic Variables for the Mass Model

- Velocity components in x, y, z, co-ordinate directions
- Pressure perturbation relative to reference atmosphere
- Temperature
- Mass mixing ratio of water vapour
- Mass mixing ratio of cloud waterdrops
- Mass mixing ratio of rain drops
- Mass mixing ratio of cloud ice crystals
- Mass mixing ratio of snow particles
- Mass mixing ratio of hail
- Turbulent kinetic energy
- Mixing ratio of plume constituents

5.3 Computation Methods

- Equations solved over a limited area domain via finite difference methods on a Cartesian grid.
- Short time step used to integrate certain terms to maintain computational stability.
- Longer time step used for remaining terms to improve computational efficiency and reduce required computing power.

5.4 Wide array of geographical & meteorological inputs

- Geographical
 - Ocean/Land elevation (Topo & 50m grid DTM)
 - Land Cover (CORINE)
 - Vegetation (Forestry)
 - Surface roughness
- Meteorological
 - Global reanalysis database of gridded historical weather data (US Nat. Cent. For Atmospheric Research) 200km global grid
 - Radiosonde data
 - Land/Sea surface temperatures
 - Field Measurements

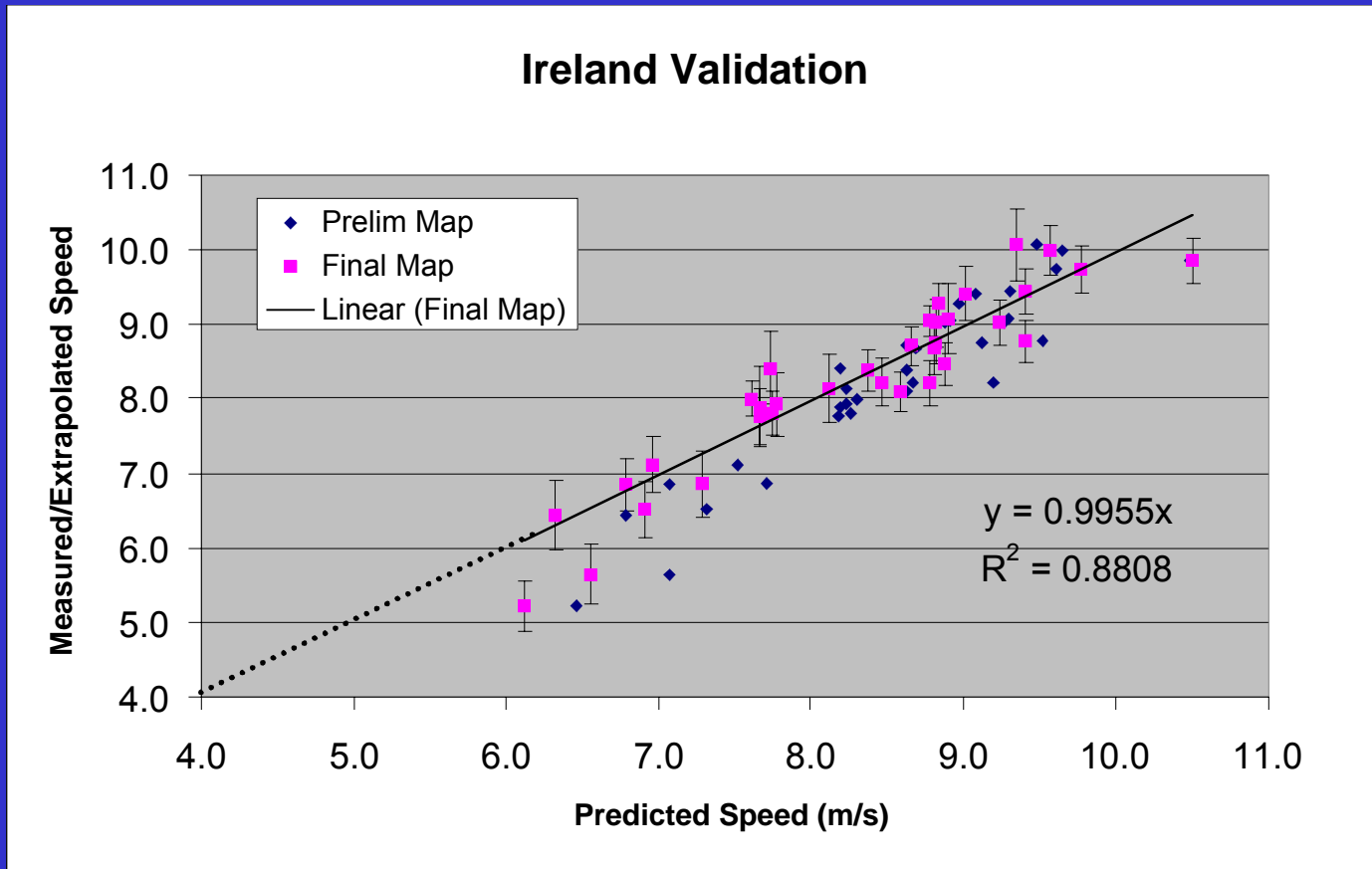
5.5 Calibration Sequence

- Simulate and store hourly weather data for 366 days randomly sampled from 15 year period on a grid scale of 2km.
 - Wind speed/direction
 - Temperature
 - Pressure
 - Precipitation
 - Cloud cover etc.
- Compare:
 - Kinetic energy
 - Heat flux
 - Predicted long-term mean annual wind speeds with surface and near surface wind speeds from field measurements (34 sites)
 - Sea surface wind measurements from Special Sensor Microwave Imager (US D Met. Sat. Prog.)
 - Adjust

5.6 Calibration Sequence

- Generate local high resolution database on 200m grid
 - MASS Model run over three nested grids 30km/8km/2km
 - WINDMAP at 200m grid

5.7 Projected/Measured Mean Wind Speed (m/s)



6. Project Schedule

- 836 Activity Prima Vera Critical Path Schedule
- Updated at Inception Report Stage
- May 02 – March 03 : 11 months
- Key milestones for deliverables

7. Problems

- Meteorological Records: changes in locations and instrumentation, calibration, reporting conventions
- Consistency of locally measured Developer data
- Availability on schedule
- Ordnance Survey data
 - Incomplete digital terrain model (particularly near border)
 - Data on individual 20 x 20km tiles (234)
 - OSNI digital terrain coding system
 - Incomplete digital county boundaries and high water line
- Utility Data
 - Electrical networks not fully digitised or digitised off paper maps. Future developments sensitive due to planning issues.
 - Unavailability of comprehensive digital data on communications facilities
 - Ground roughness and land cover, Forestry status, (Forest Service)

8.1 Unconstrained Theoretical Wind Resource:

- Projected naturally occurring mean wind speed distribution and its derivatives at heights of 50, 75, 100m over each county, unconstrained by deductions for areas where wind farm development would be unrealistic for physical or other reasons and contoured in intervals of 0.25m/sec.

8.2 Constrained Commercially Feasible Wind Resource

- Theoretical Wind Resource (8.1) reduced by deletion of unbuffered lakes and settlement areas and areas where mean wind speed is less than 7.5m/sec. Include electrical network infrastructure at 38kV and above.

8.3 Accessible Commercial Wind Resource

- Feasible wind resource 8.2 reduced by manmade selective restrictions imposed in respect of designated areas, transport, infrastructure, communications by individual competent central and local authorities. (To be added by these authorities through the planning or foreshore liscencing process).

9. Digital Data Base

- Contains 2.6 Million Data points
- 37 times more than Altener Study

10. Pilot County – Theoretical Resource

	Height
10.1 Mean Wind Speed Distribution (Theoretical)	50m
10.2 “ “	75m
10.3 “ “	100m
10.4 County Power Distribution (Theoretical)	50m
10.5 “ “	75m
10.6 “ “	100m
10.7 County Mean Wind Rose (Wind Speed)	50m
10.8 “ “	75m
10.9 “ “	100m
10.10 County Power Rose	50m
10.11 “	75m
10.12 “	100m
10.13 County Diurnal & Seasonal Variation	50m
10.14 “ “	75m
10.15 “ “	100m

11. Pilot County: Commercially Feasible Resource

- Mean Wind Speed Distribution $\geq 7.5\text{m/sec.}$ 50m
- “ “ 75m
- “ “ 100m
- Power Distribution $\leq 3000\text{W/m}^2$ 50m
- “ 75m
- “ 100m
- Indicative A0 Paper Map Scale 1:150,000 (11.1)

12. Marine Dimension

- Extends circa 15km offshore

13. Future Development

- Addition of specific county planning constraints
- Computation of resource monetary value/county
- Ranking/reporting of county resource utilisation
- Addition of new wind data for revision/update

14.1

14.2

14.3

15.1 County Cork Unconstrained Wind Resource

Annual Mean Power Density (watts/sq. metre) 100m above ground

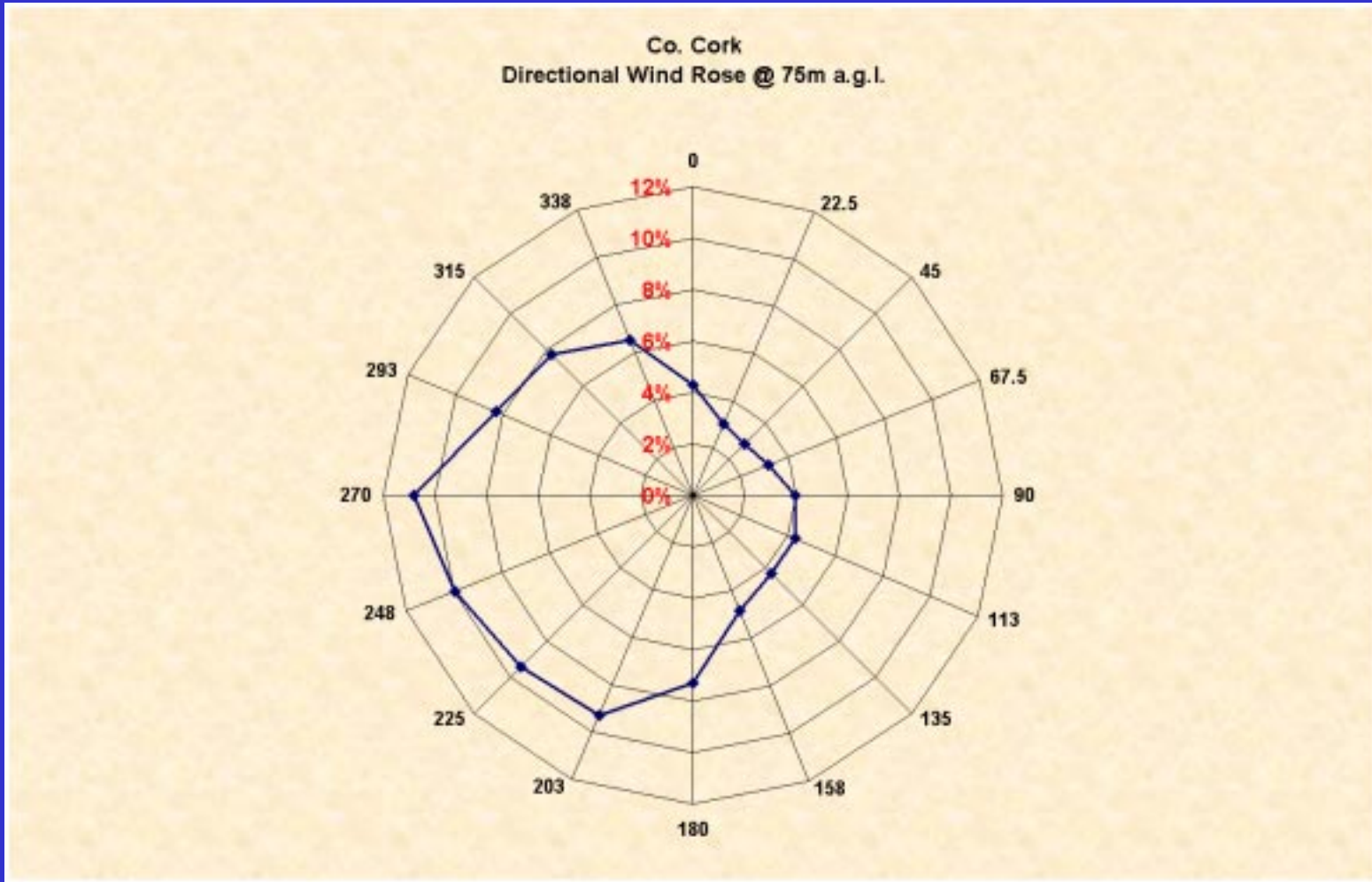
15.2 County Cork Constrained Wind Resource

Annual Mean Power Density (watts/sq. metre) 100m above ground

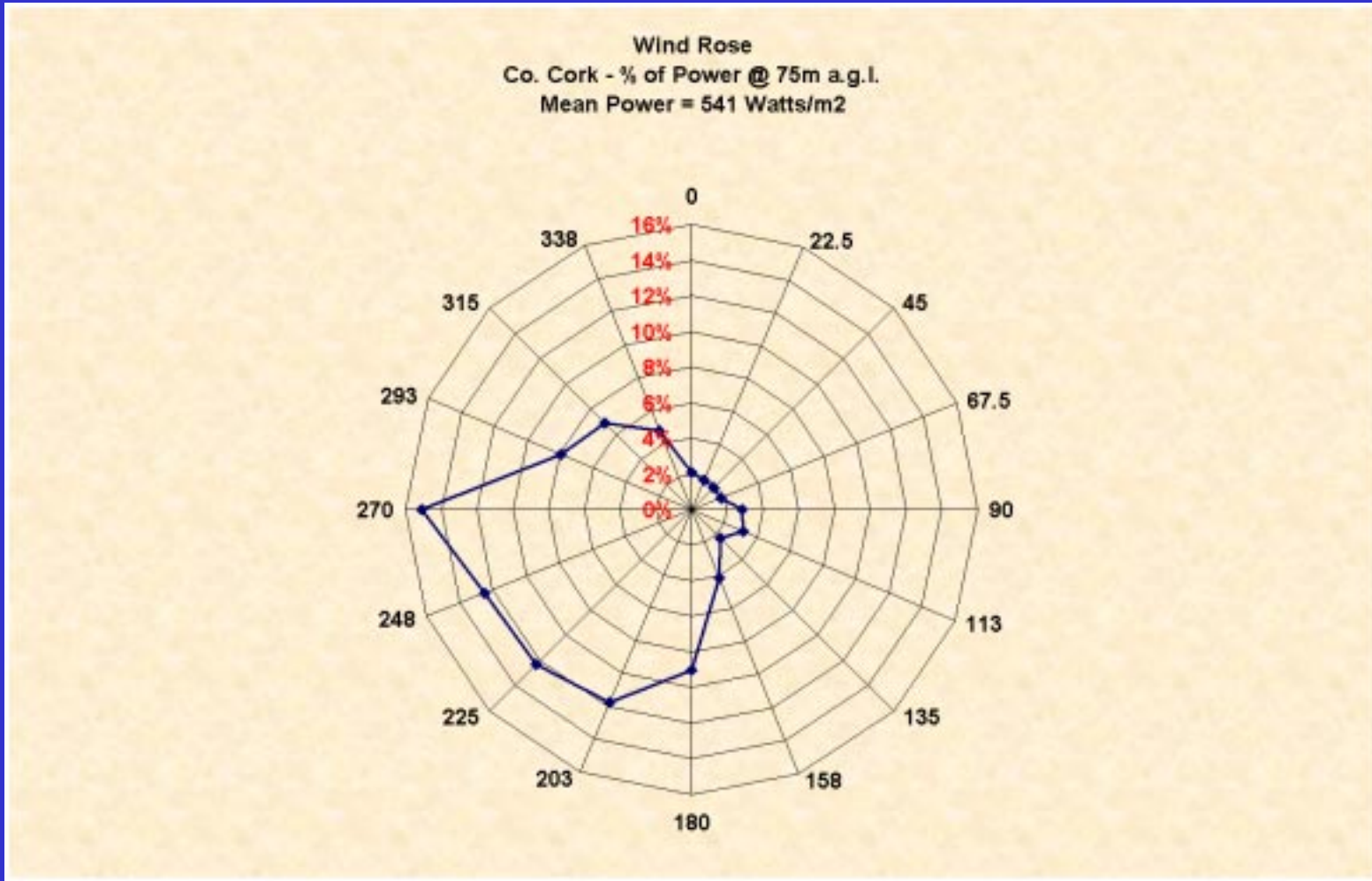
15.3 County Cork Constrained Wind Resource

Annual Mean Power Density (watts/sq. metre) 50m above ground

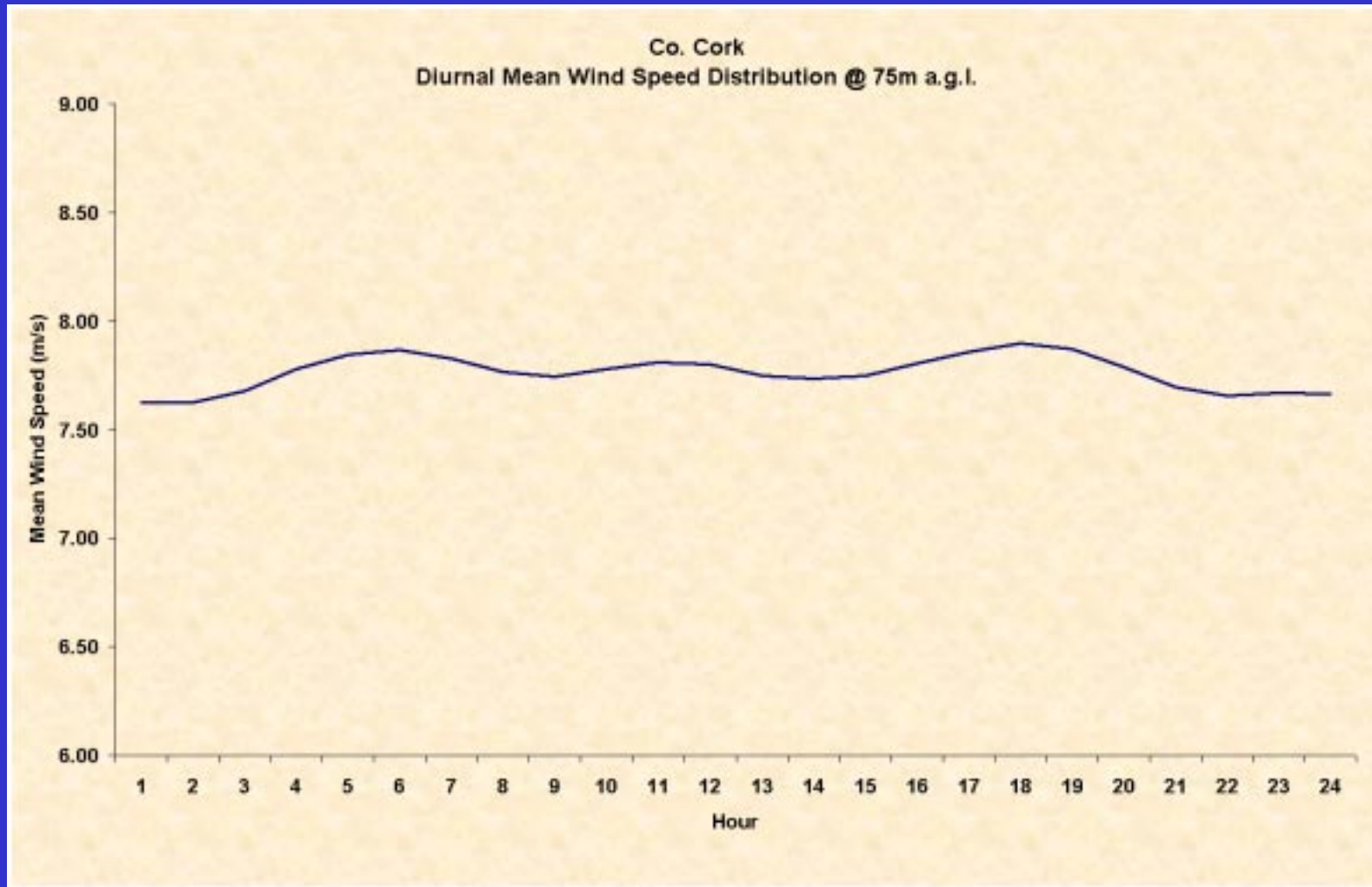
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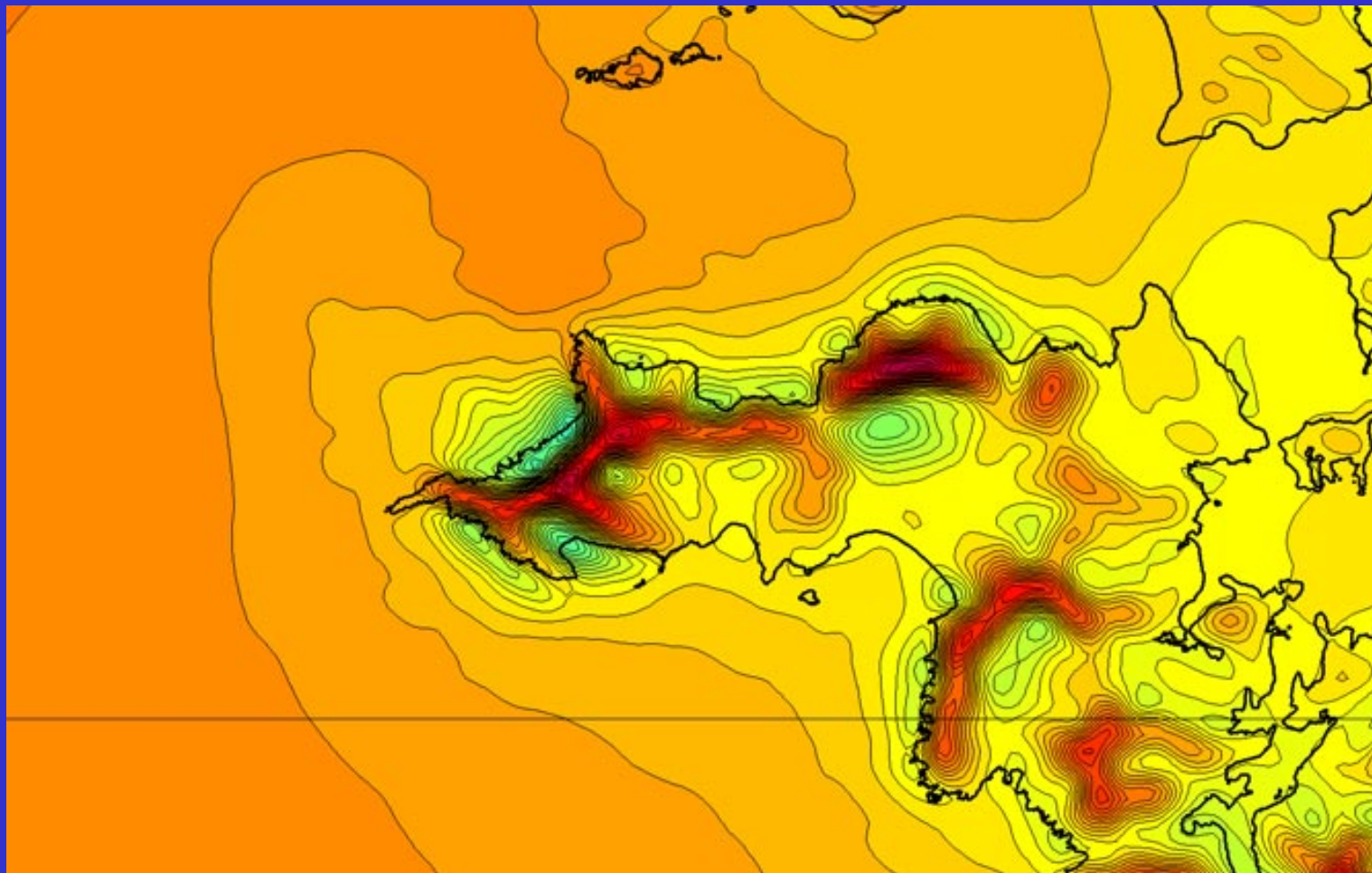
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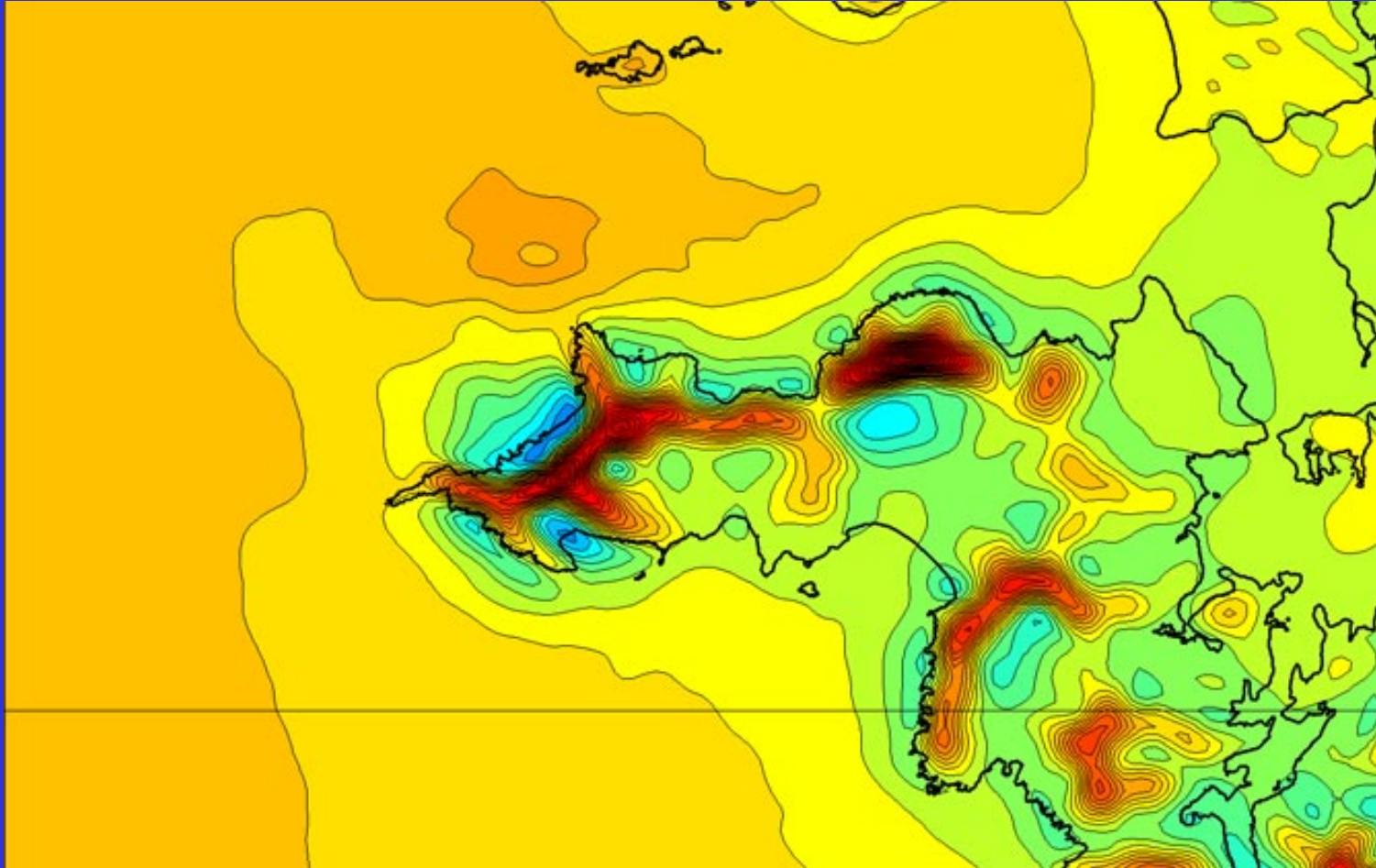
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20.2 Croghaun Achill MWS 75



20.3 Croghaun Achill Power Density 75



County Louth

