Assessing the Costs of Intermittent Power Generation

Stakeholder Workshop - Invited Presentation

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Main Themes

- Many factors impact on our view of costs, including:
  - Our perception and understanding of “intermittent” resources
  - The development scenario
  - The analysis methods used

- Calculating costs requires an understanding of the:
  - Additional backup requirement
  - Modified reserve operation
  - Transmission requirements

- Costs may be exaggerated if the benefits renewables bring are not included.

- **Ultimately, informed energy policy decisions will only result from clear, accurate information.**

Clear Terminology

- Different perspectives on what constitutes “intermittent” energy sources
  - Just wind
  - All except biomass and to some extent hydro
  - All renewable sources
  - All generation technologies
- Oxford English Dictionary Definitions
  - Intermittent: That intermits or ceases for a time = Conventional Generation
  - Variable: Liable or apt to vary or change = Wind / Wave Generation
- Most debate focuses on wind resources, rarely acknowledging that:
  - All generators are intermittent or variable
  - Demand is variable
  - Both supply and demand variability is reduced through diversification

Accurate Information

Energy policy decisions need require accurate information

"The average availability for wind turbines across Europe is about 15%. Even if we assume a more charitable 25% for the windier UK, we would need to build wind capacity equivalent to our entire current conventional capacity, around 60,000 megawatts, to provide 25% of our electricity from a source available only 25% of the time. But over 20 years, demand will grow. Assuming a conservative 20% total growth to 72,000 MW would imply constructing 48,000 new 1.5 MW turbines…"

Tony Cooper, The Climate for Nuclear Power. Ingenia (Royal Academy of Engineering), Issue 23, June 2005.

The reality is…

Measured onshore capacity factor for UK wind over the last 12 years is **27%** (DUKES).

60GW wind would generate **40%** of UK electricity demand (assuming 25% capacity factor).

Wind resource is available **100%** of the time (ie capacity factor is not the same as availability).

Perspectives on UK Renewables

"…we must not lose sight of the fact that the wind only blows a third of the time…"

Tom Foulkes (Director-General of the Institute of Civil Engineers)
Press Release, 2003

"There are several periods during a year when the UK is covered by an anticyclone and there is no wind and consequently no waves."

Prof Ian Fells (Fells & Associates)
Submission to House of Lords Enquiry into Renewable Energy, 2003

"Large high-pressure systems with little wind pass over the country or parts of the country throughout the year. Those occurring in the winter are invariably accompanied by low temperatures, frost and fog, the occasions when heating and lighting loads can also be at maximum…"

Michael Laughton
Platts Power in Europe, Issue 383, 9 September 2002, pp 9-11

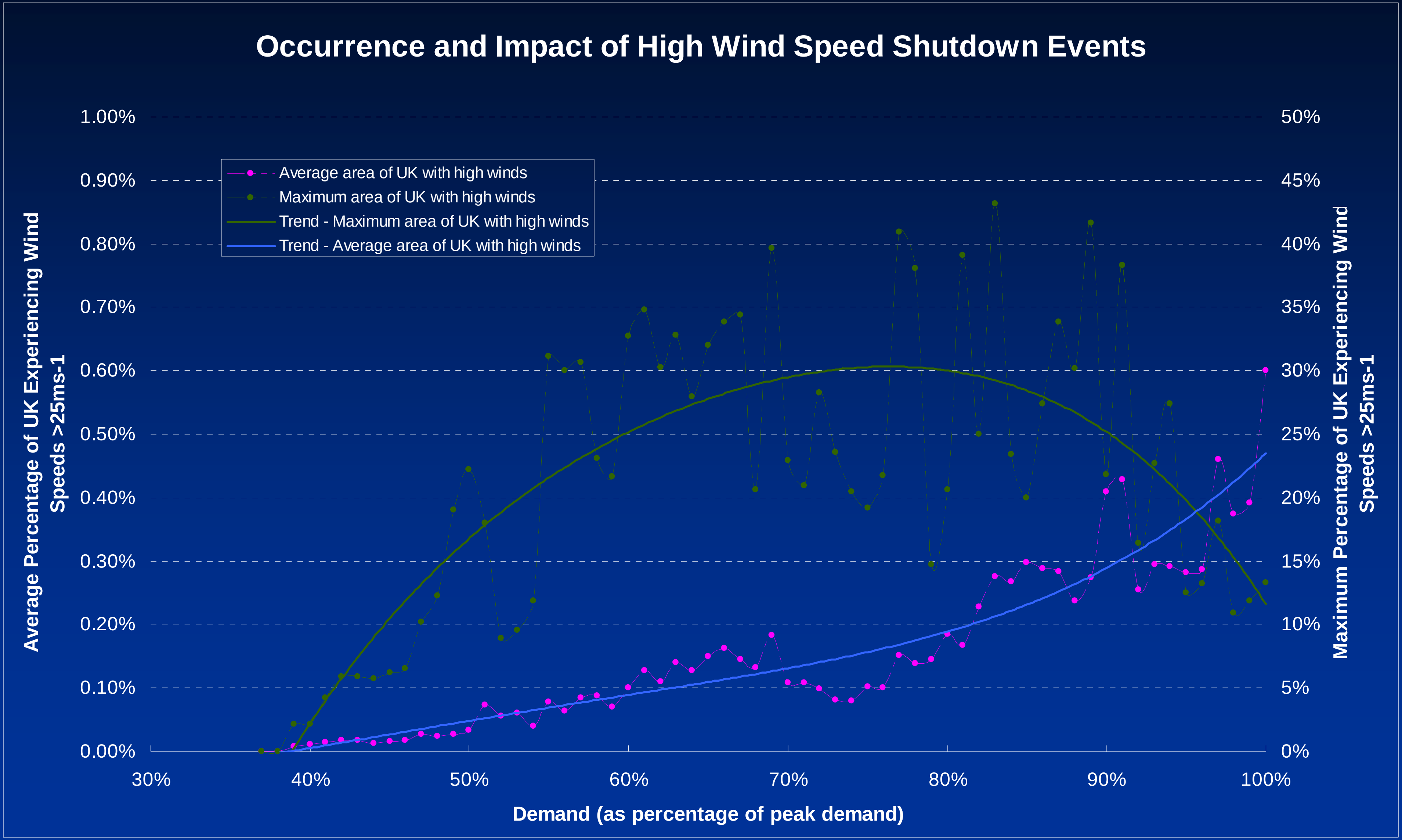
"Windfarms only manage to generate about quarter of their nominal capacity spread in random bursts over the year as the wind varies."

Dr John Etherington, This is the Lakes District, 24 June 2005

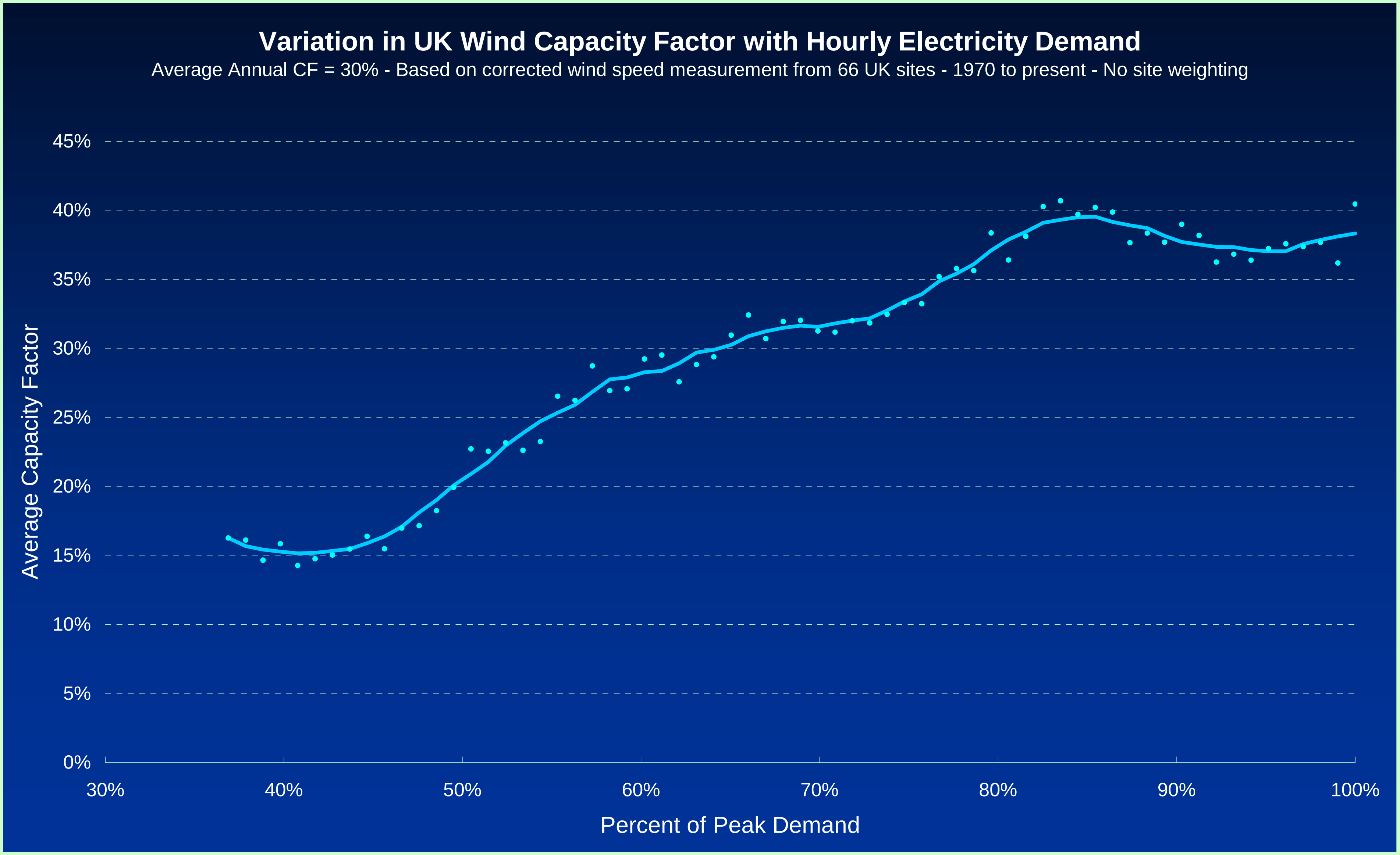
UK Wind Characteristics

- Duration of operation:
  - Wind power sites typically generate electricity for around 85% of all hours
  - a diversified UK wind power system would generate electricity for 100% of all hours.
- Occurrence of no-wind events:
  - Between 1970 and 2003 there was not an hour, let alone a day or week, with no wind across the UK .
- Correlation between wind and waves:
  - Waves may be present or absent during windy conditions, and during low wind conditions.

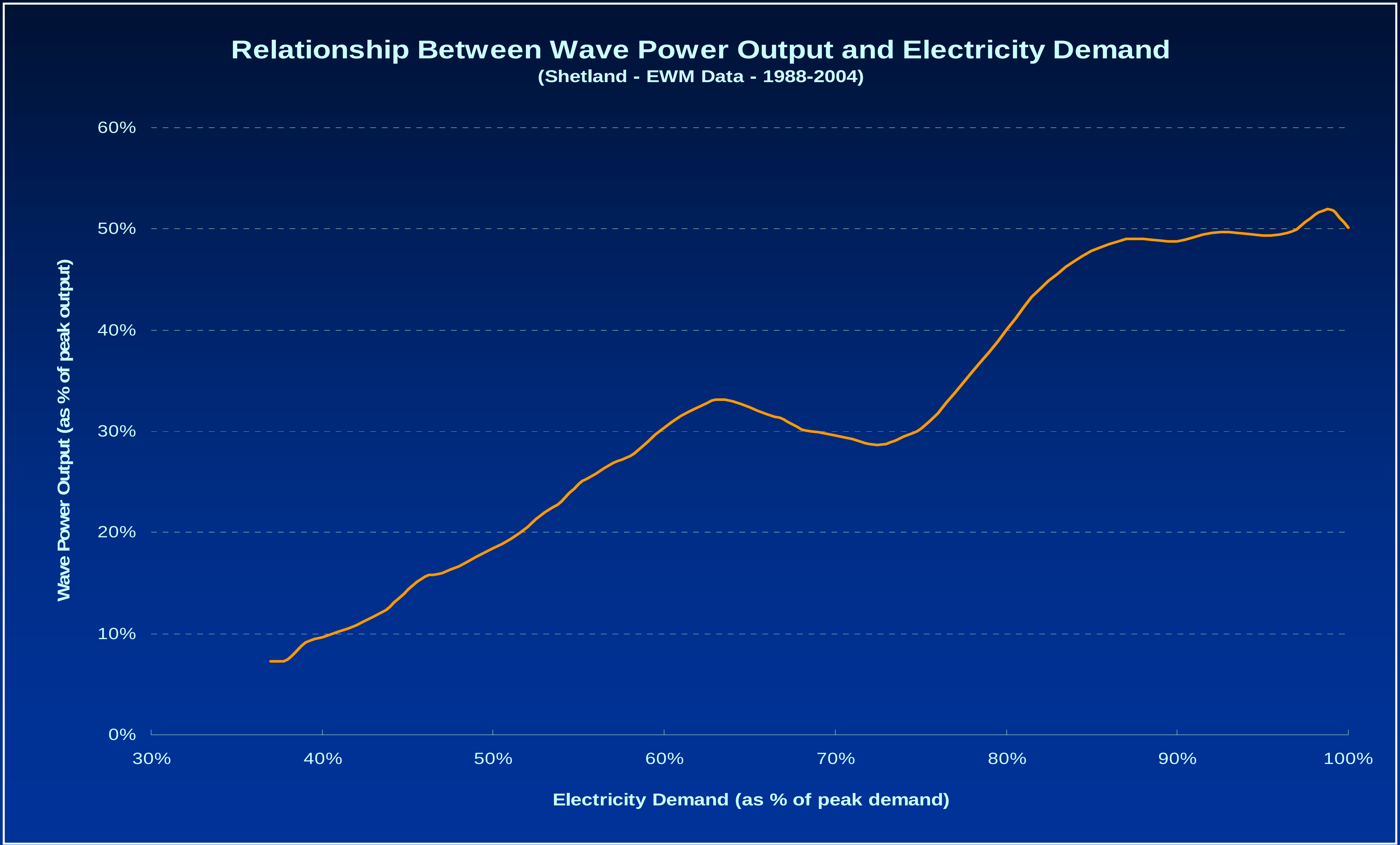
UK Wind Power – High Wind Speed



UK Wind Power & Electricity Demand

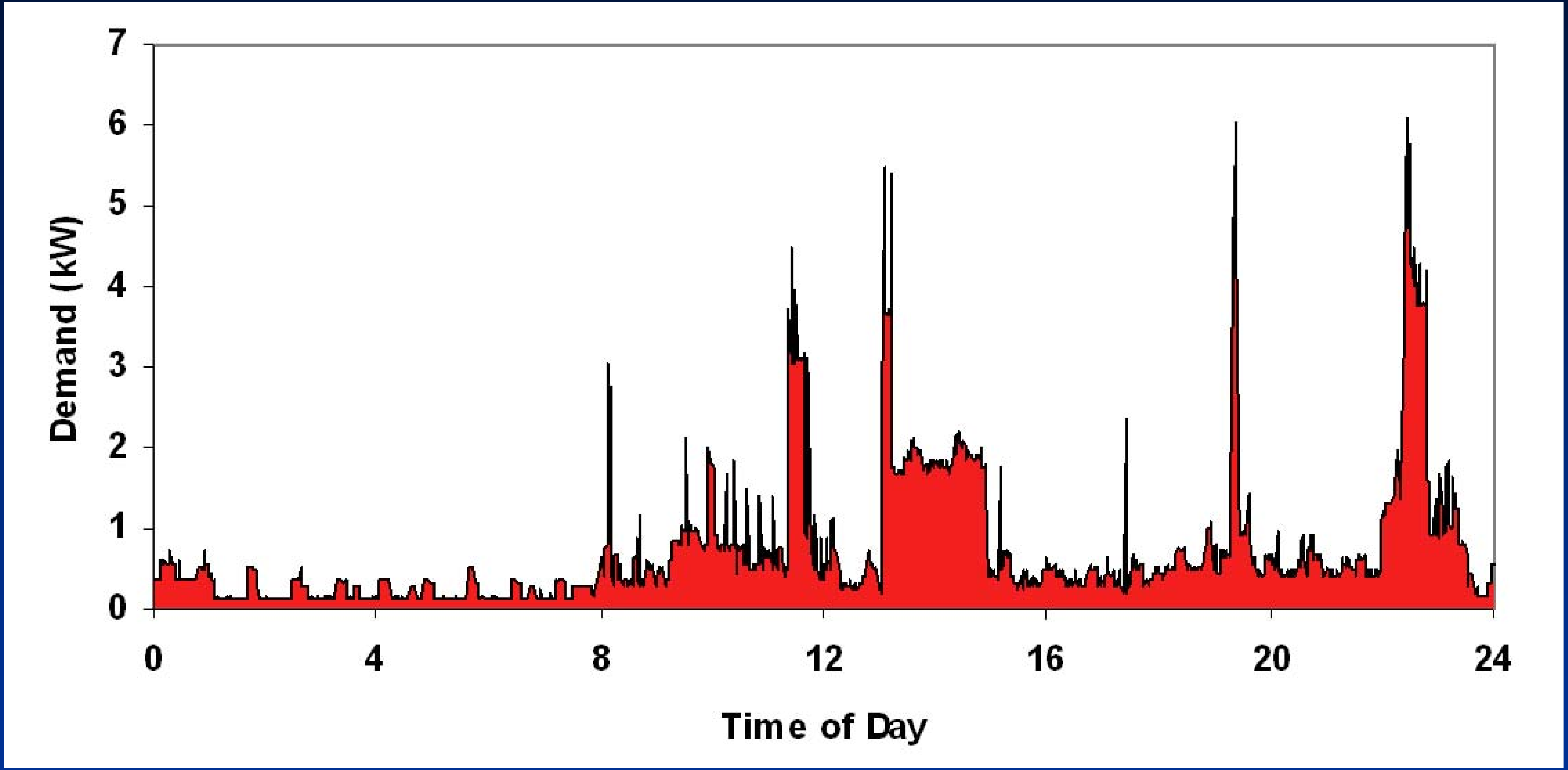


UK Wave Power & Electricity Demand



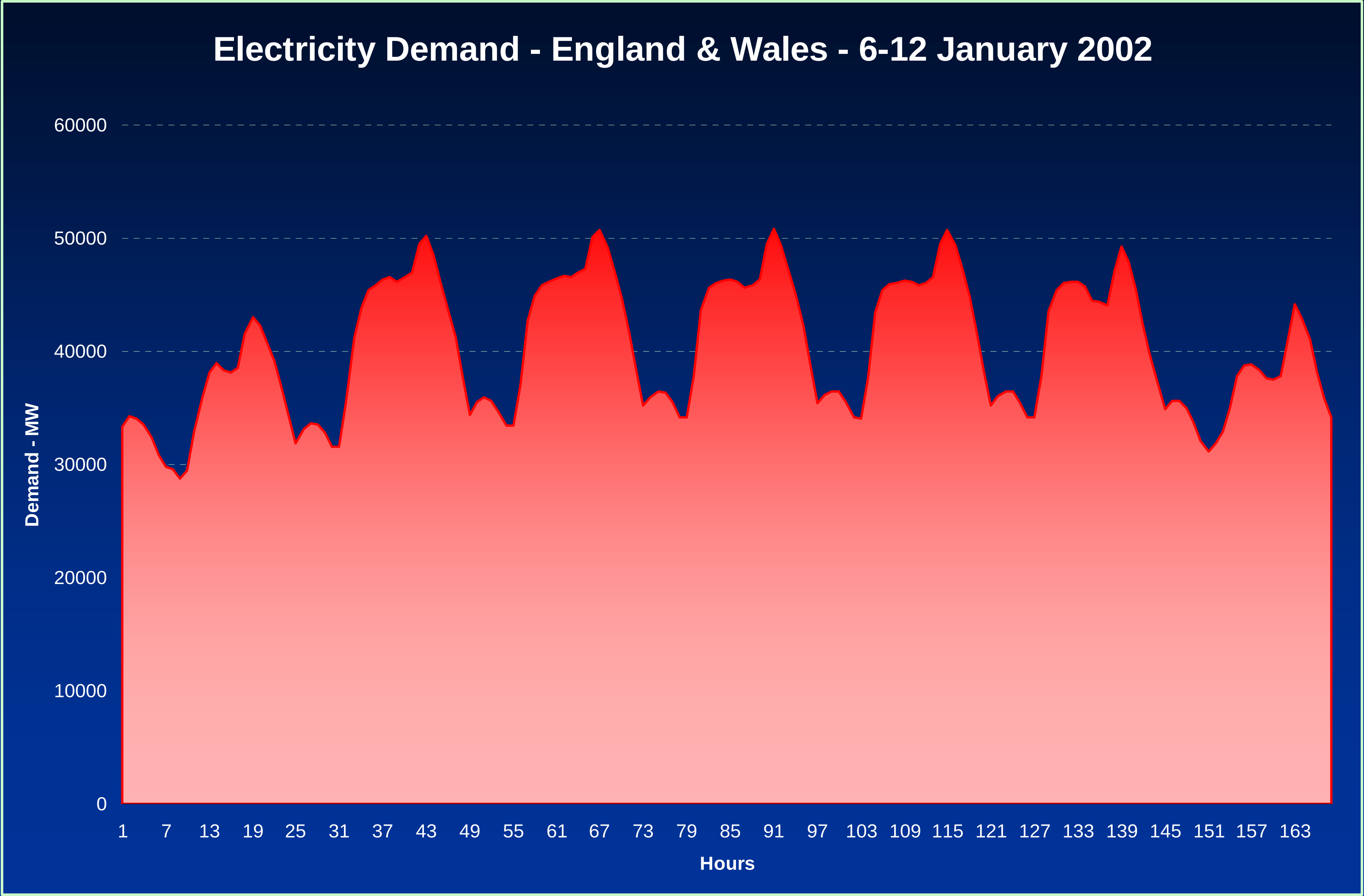
Individual Demand Variability

Electricity demand profile of an individual dwelling – 2 min resolution

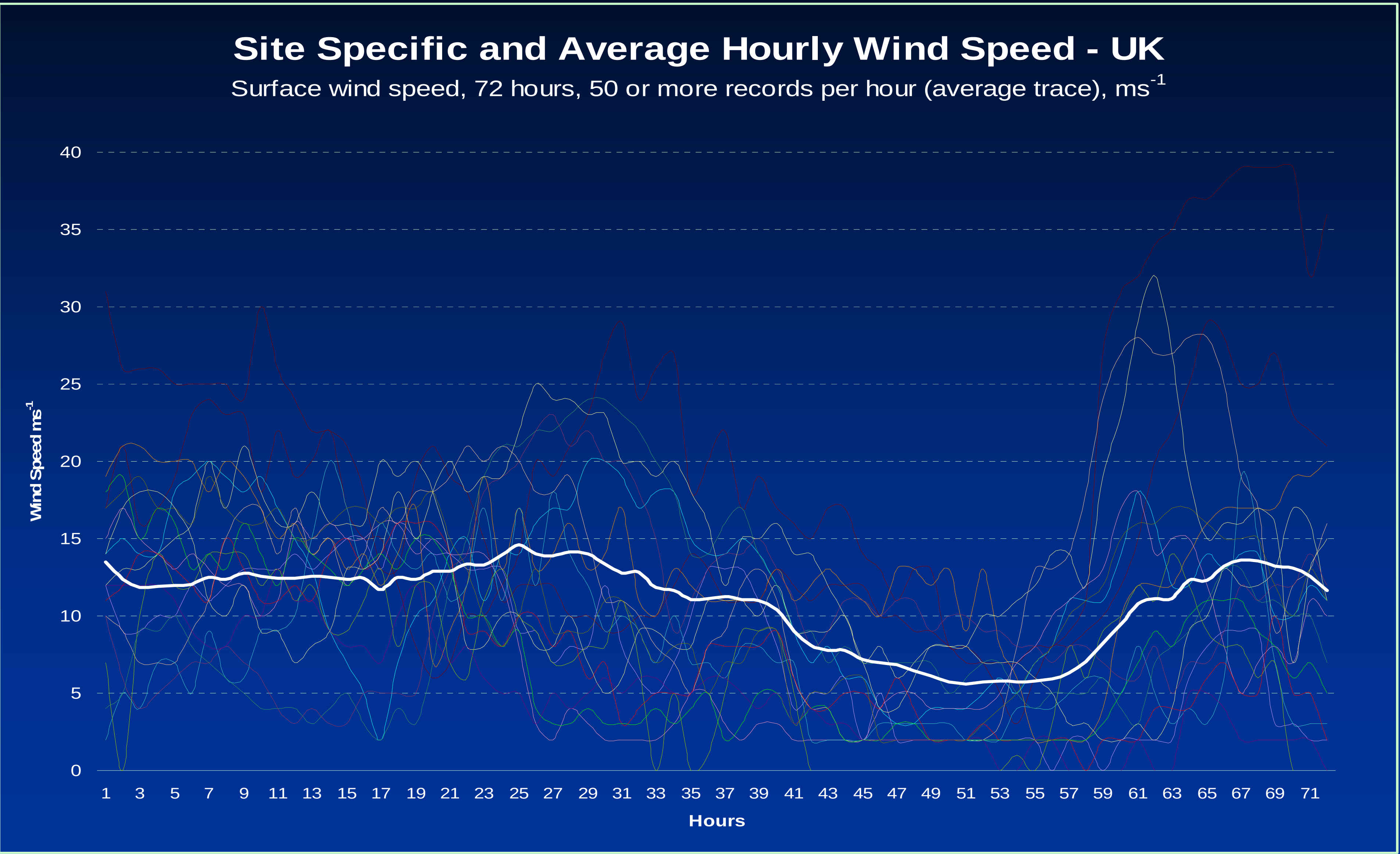


Matching this demand pattern to an electricity generator is almost impossible. However, the electricity network smooths demand by relying on the diversity of different demand patterns…

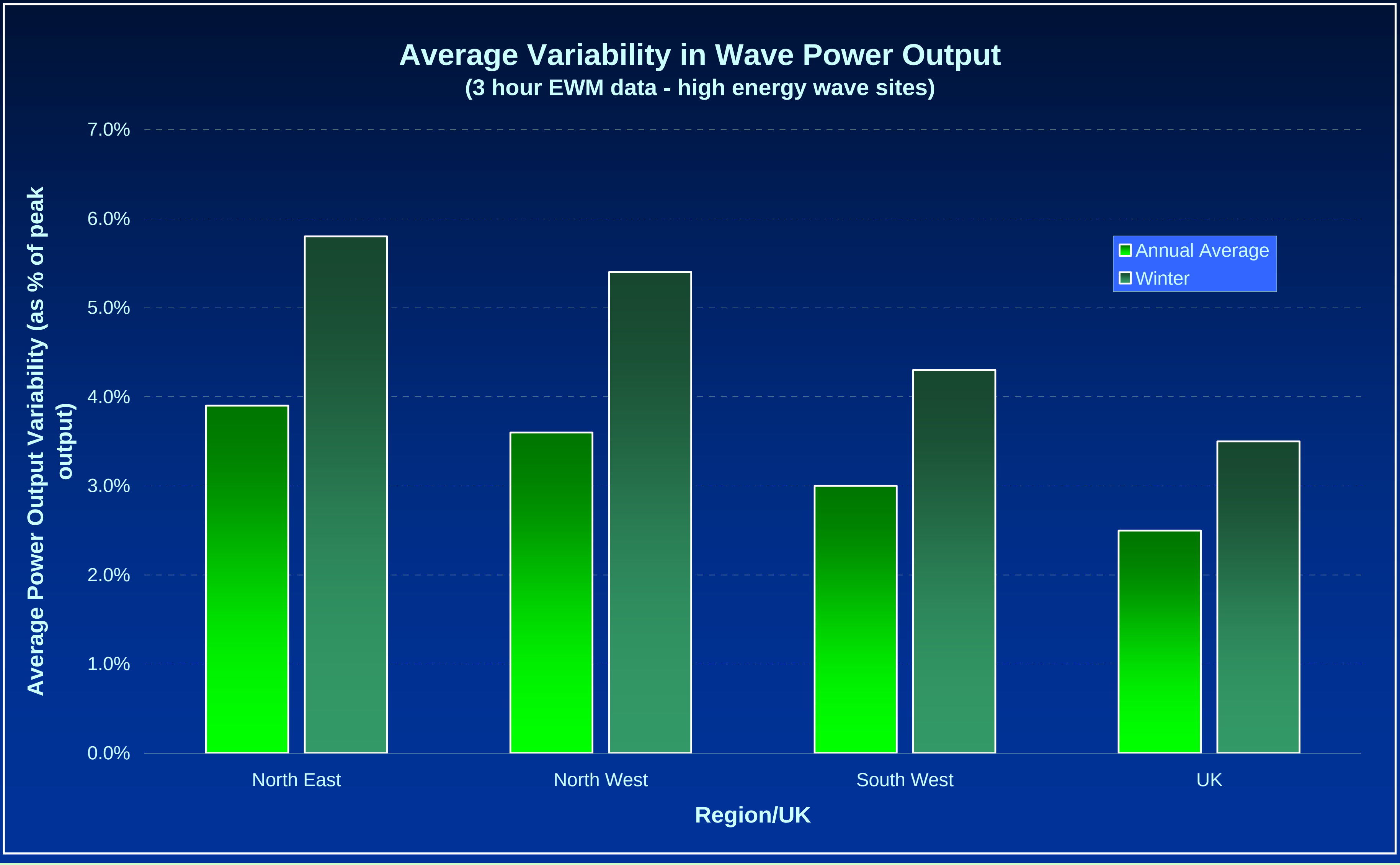
Network Demand Variability



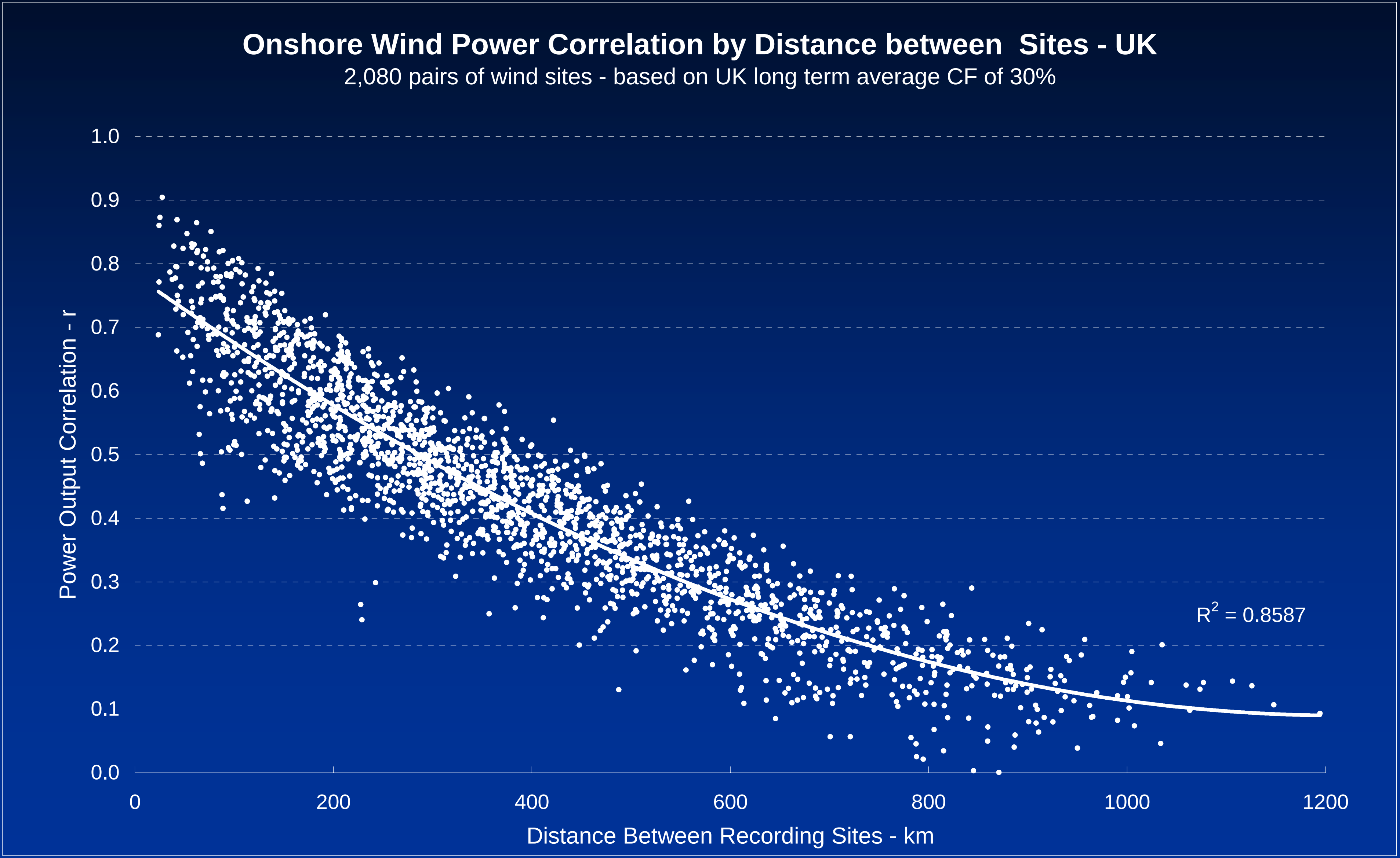
UK Wind Variability



UK Wave Power Variability



UK Wind Power Correlation



International Comparisons

- International experience may be relevant to UK policy, but it is very important to understand the limitations of such comparisons.

- For example, comparing UK and Danish wind characteristics…
  - **The wind resource characteristics of the two countries are different**
    - Denmark experiences country-wide calm periods and country-wide overspeed wind events – these never occur in the UK.
  - The UK is over 5½ times the land area of Denmark
    - Scotland alone is 2.4 times larger than Jutland & Fyn combined.
    - This smaller size will accentuate variability in Danish wind output.
  - Wind generates ~20% of annual Danish electricity demand, but 0.49% of UK demand (2004).
  - Predictability – the UK's different wind resource and shorter gate closure requirement prevents direct comparison of forecast errors

Backup

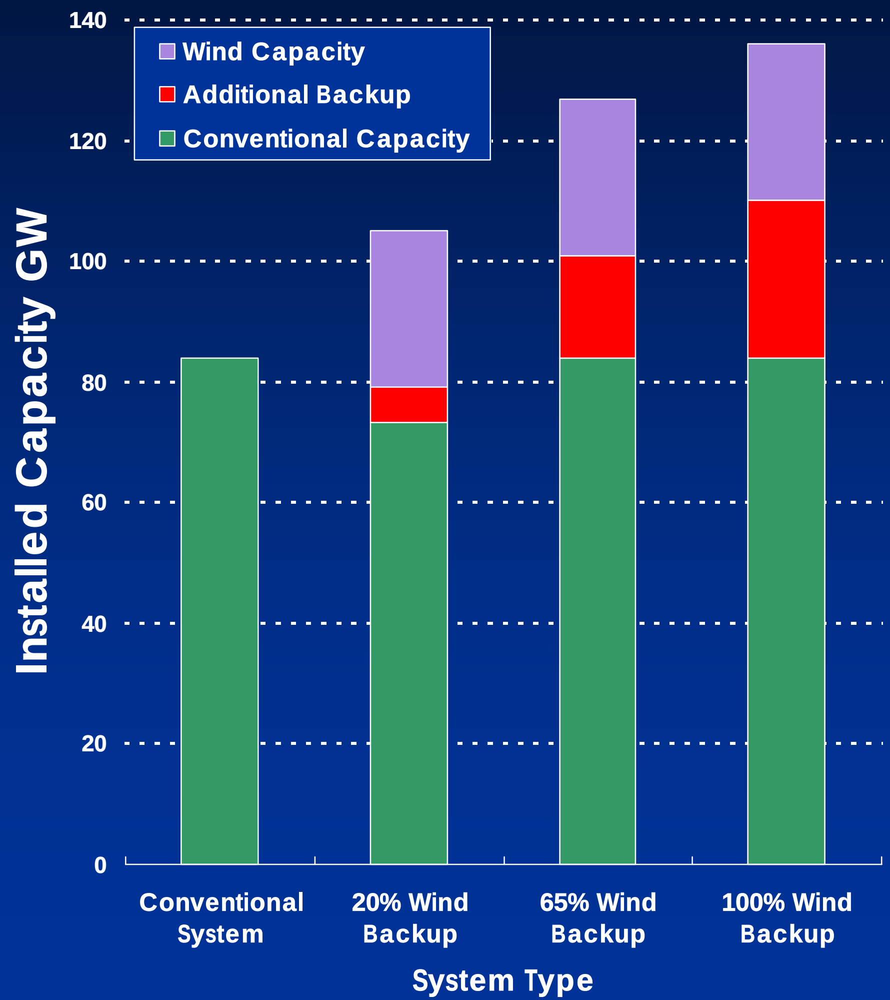
Additional backup as a percentage of installed wind capacity

100%	Adam Smith Institute
100%	Prof Michael Laughton
100%	Country Guardian
73-86%	Royal Academy of Engineering
65%	PB Power / RAEng
22%	Dale, Milborrow, Slark & Strbac*
20%	House of Lords*
19%	ILEX*

*Method of assessment consistent with: Ilex (2002) Quantifying the System Costs of Additional Renewables in 2020

Backup

What these additional backup claims mean in practice



- The <u>objective</u> is for the system to meet a peak load of **70GW** while achieving the current level of reliability.
- The installed capacities for the different backup assumptions are shown in the graph.
- The <u>actual</u> peak demand met by the different backup scenarios are:
  - Conventional system – **70GW**
  - 20% Wind Backup system – **70GW**
  - 65% Wind Backup system – **90GW**
  - 100% Wind Backup system – **98GW**
- The artificially high backup levels for the 100% and 65% backup scenarios result in a massively oversized system.

Backup

How can such a difference in additional backup estimates occur?

- Different models for assessment;
- Different treatment of wind and conventional capacity;
- Poor understanding of the properties of variable generators;
- Evaluation of different scenarios;
- Different definitions of additional backup and system security

Scenarios

- Scenarios are central to understanding the results of cost modelling. Factors affecting costs include:
  - Percentage of renewable generation in the mix
  - Composition and location of the renewable generation mix

- A 20% contribution from wind power has emerged as a common scenario for evaluation.
  - Provides a convenient and consistent benchmark for comparison
  - Tends to exaggerate reserve costs, and in some cases backup costs, in comparison to a mixed renewables scenario.
  - A target of 20% UK electricity from renewables does not equal 20% electricity from wind power.
    - Wind is currently 0.49% of generation (14% of renewables), forecast to rise to 16.5% (82.5% of renewables) by 2020.

Do Renewables Add Value?

- The "cost" debate currently has a down-side focus, however…
- There may be areas where renewables may bring additional value:
  - Diversity of generating capacity – diversified systems are inherently more reliable, and renewables bring diversity.
  - Energy independence – at a time when the UK is moving very quickly towards energy dependence, renewables offer true independence.
  - Price independence – fuel prices are set by global energy markets. The cost of electricity from many renewables is independent of fuel price.
  - Energy Availability – imports of fuels may be interrupted for a variety of reasons. No geopolitical event will affect the wind, stop the waves hitting the shore, the sun from rising, or the tide rising and falling.
  - Carbon Costs – carbon costs may rise, however renewables are independent of these costs.

Summary

- There is a pressing need to clarify the “intermittency” debate
  - The public and policy makers will lose confidence in experts and professional bodies if we continue to get basic concepts wrong.

- There are some key aspects to evaluating costs:
  - Understanding the resource must be a starting point for analysis
  - Models must reflect reality
  - Scenarios must be relevant
  - Decisions and assumptions must be defendable

- Assessing the potential benefits of renewables will result in a more robust view of their value as well as cost.

- **The development of good policy requires reliable information**

For further information on renewable electricity generation, intermittency and system security, contact:

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