



Why is America's Availability Lower than Europe's?

Joe Stevens and Keir Harman
Garrad Hassan America, Inc.

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Agenda

- Introduction
- Definition of Availability
- Specific Availability Challenges
- Availability Analyses
- Ramp up of Availability
- Summary

Introduction

- Wind farm performance is always a hot topic
 - More so lately due to recent indications of underperformance
 - Lenders and equity expressing concerns.
 - What role does *Availability* play in this?
 - Is *Availability* in the US worse than in Europe?
 - Perception is that it is...



Definition of “Availability”

- Availability

$$\text{Availability} = \frac{\text{Time during which the System is available to produce}}{\text{Entire time within a specified period}}$$

- Machine Availability

- Limited to the turbine system only.
- This is the focus of the Turbine Warranty – multiple definitions.
- Includes deduct for items outside the control of the turbine.
- Often includes deduct for annual turbine maintenance.

- System Availability

- Includes Machine Availability.
- Includes the balance of plant through to the point of interconnect.
- Includes all maintenance and items not under the control of the turbine.

Availability Challenges

US Market

- **Parts availability**
 - Competition with growing wind construction market
 - Component manufacture is still growing or dependent upon foreign supply
 - Learning curve for each new facility with small number of temporary experienced crew
- **Project Staffing**
 - High level of employee turnover for operators
 - Explosion of opportunities for those with any experience - worker's market
 - 20 to 40 turbines per technician crew (2 techs)
 - Relatively few trained technicians nationwide

European Market

- Wind construction market is generally stable
- Component manufacture is generally well established and regionally available
- Larger experienced staff typically on site for new facilities
- Longer term employment
- Stable growth of industry – normal migration of opportunities
- 10 to 20 turbines per technician crew (2 techs)
- Larger number of trained technicians available

Availability Challenges

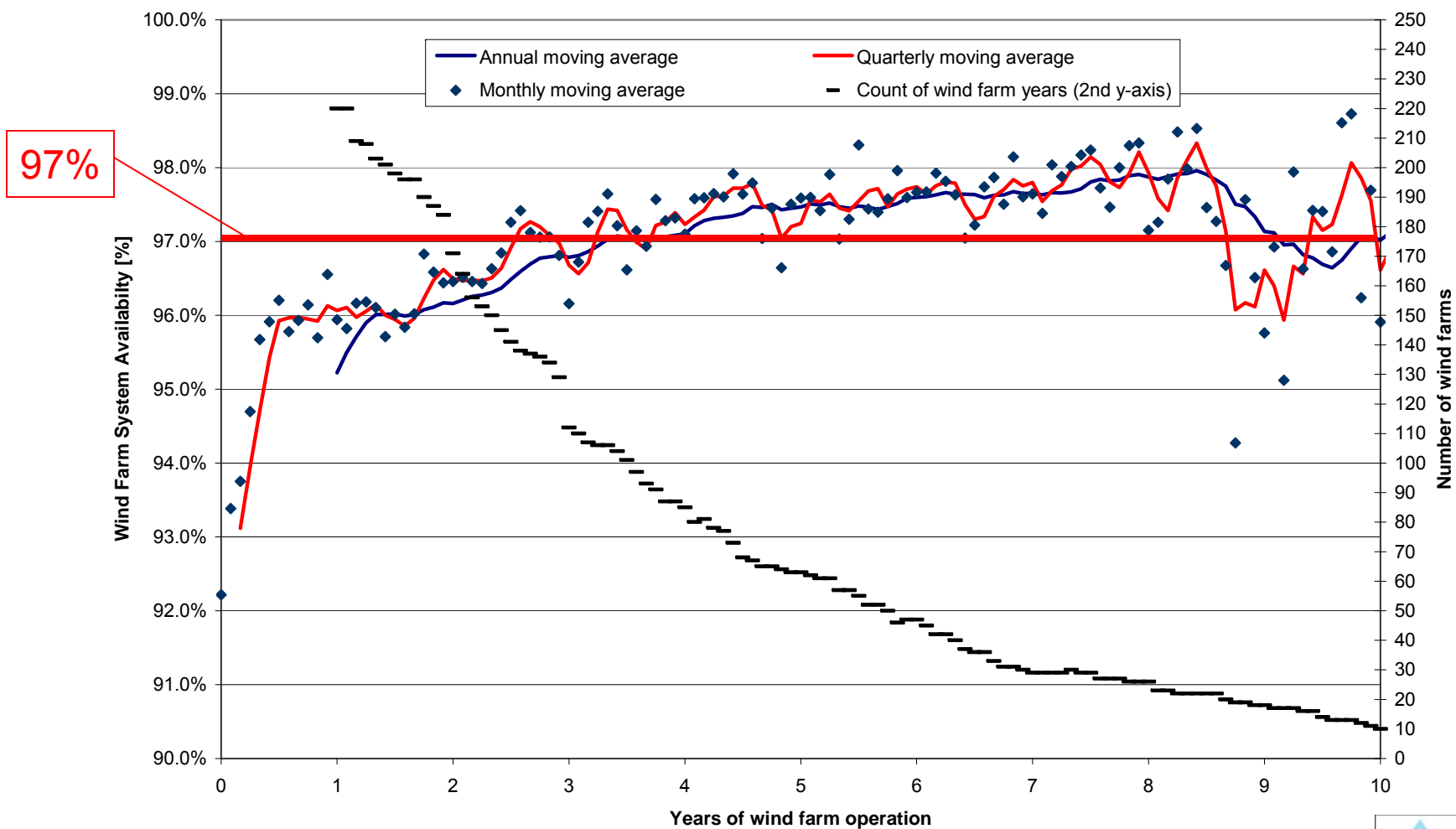
US Market

- **Manufacturer Technical Support**
 - Technical support can be difficult to track down if foreign based
 - US based support may be dependent upon foreign engineering support = delay in response
- **Project Construction**
 - 1 to 2 weeks for turbine erection and commissioning
 - Shorter reliability runs – PTC driven
- **Miscellaneous**
 - Climate can be extreme high and low – affects performance of crews
 - Many projects quite remote
 - Larger projects – 100 + turbines common = difficulty managing issues

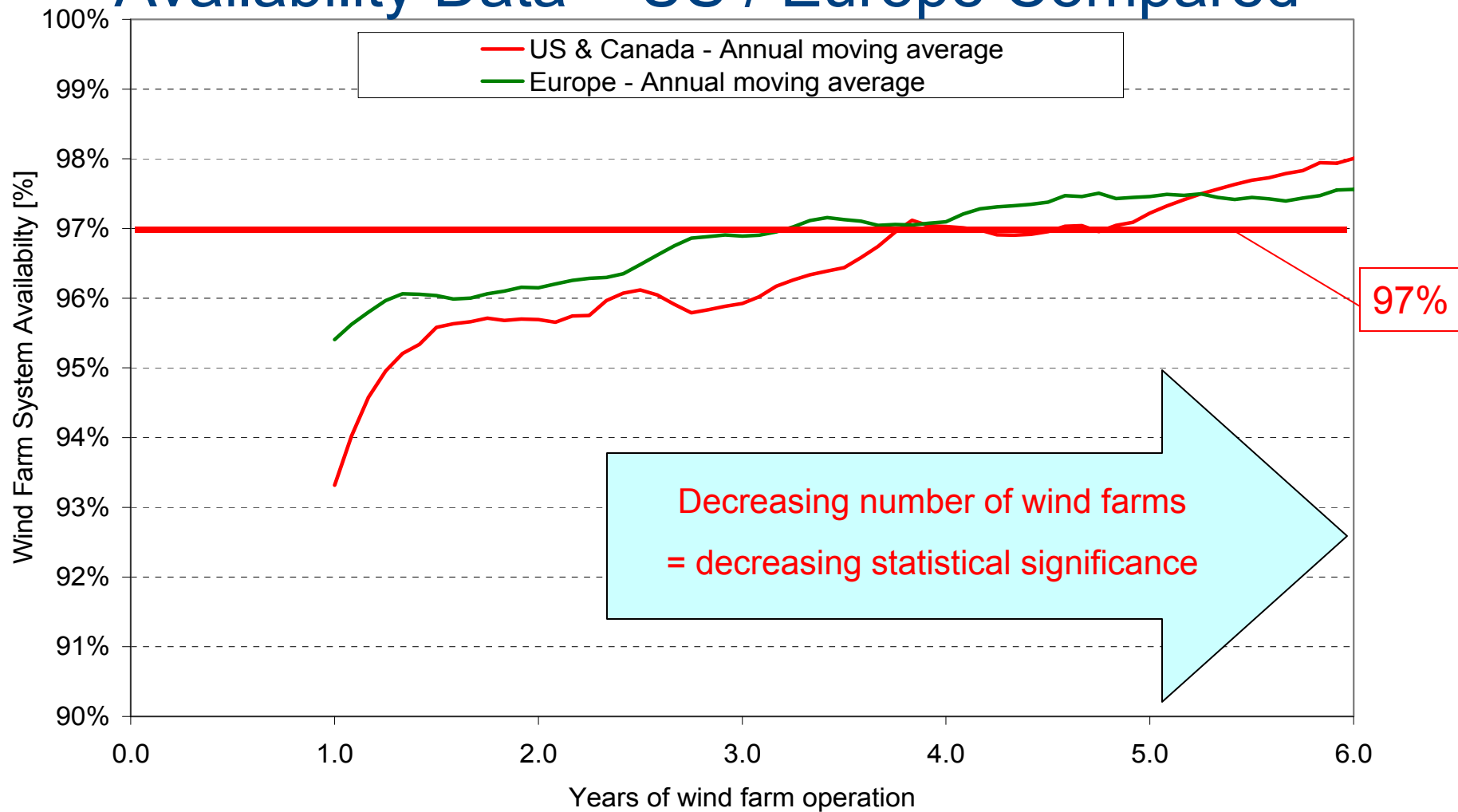
European Market

- Technical support in same time region and easier to bring to bear
- Technical support is easily referred to main engineering group = same day response
- 2 weeks + for turbine erection and commissioning
- Sometimes 250 to 500 hours and maintenance prior to reliability testing
- Rare for projects to have both high and low extremes
- Large population centers within nominal distance for most all projects
Smaller projects – 10 to 40 turbines common = fewer issues to manage

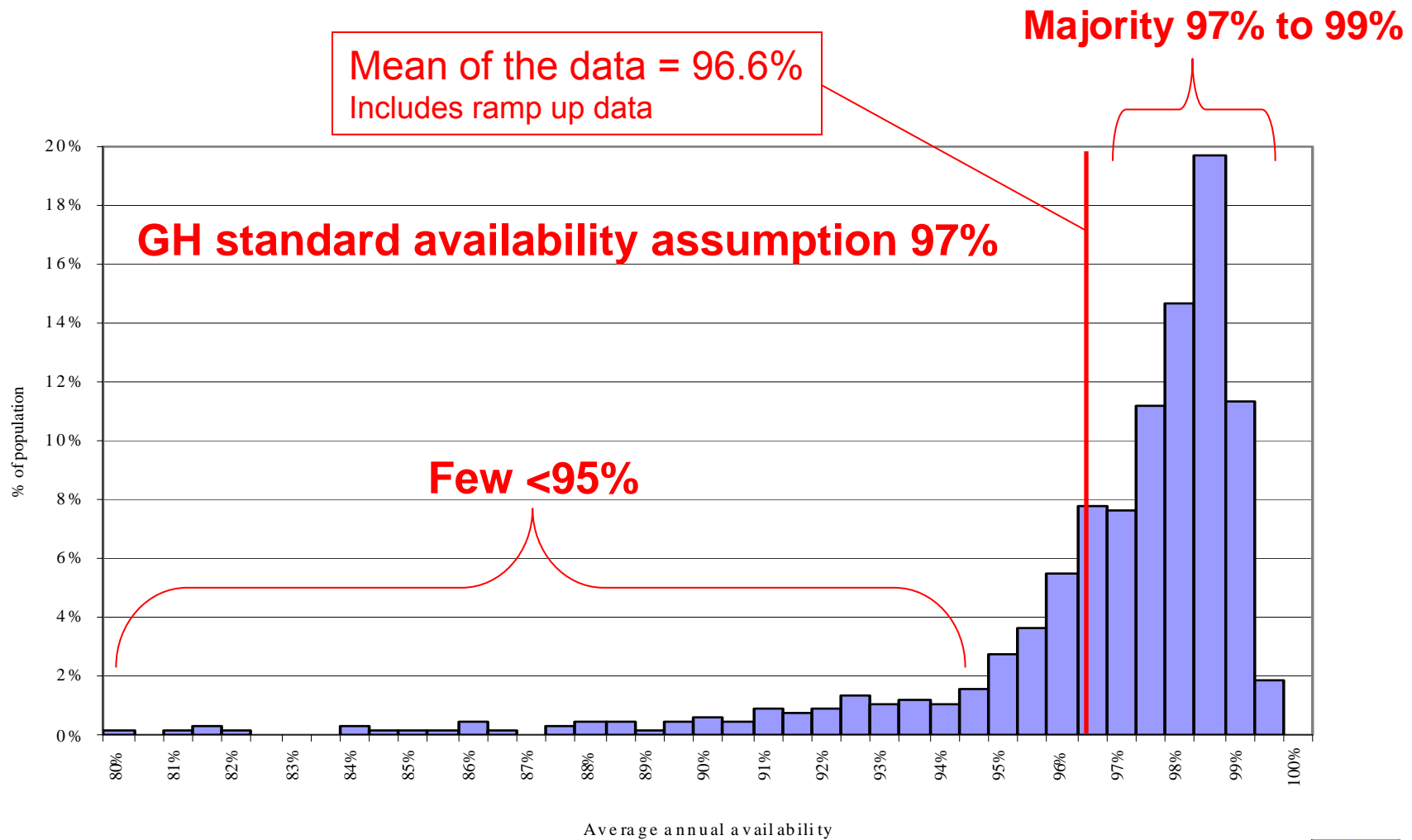
Availability Data – Global Market



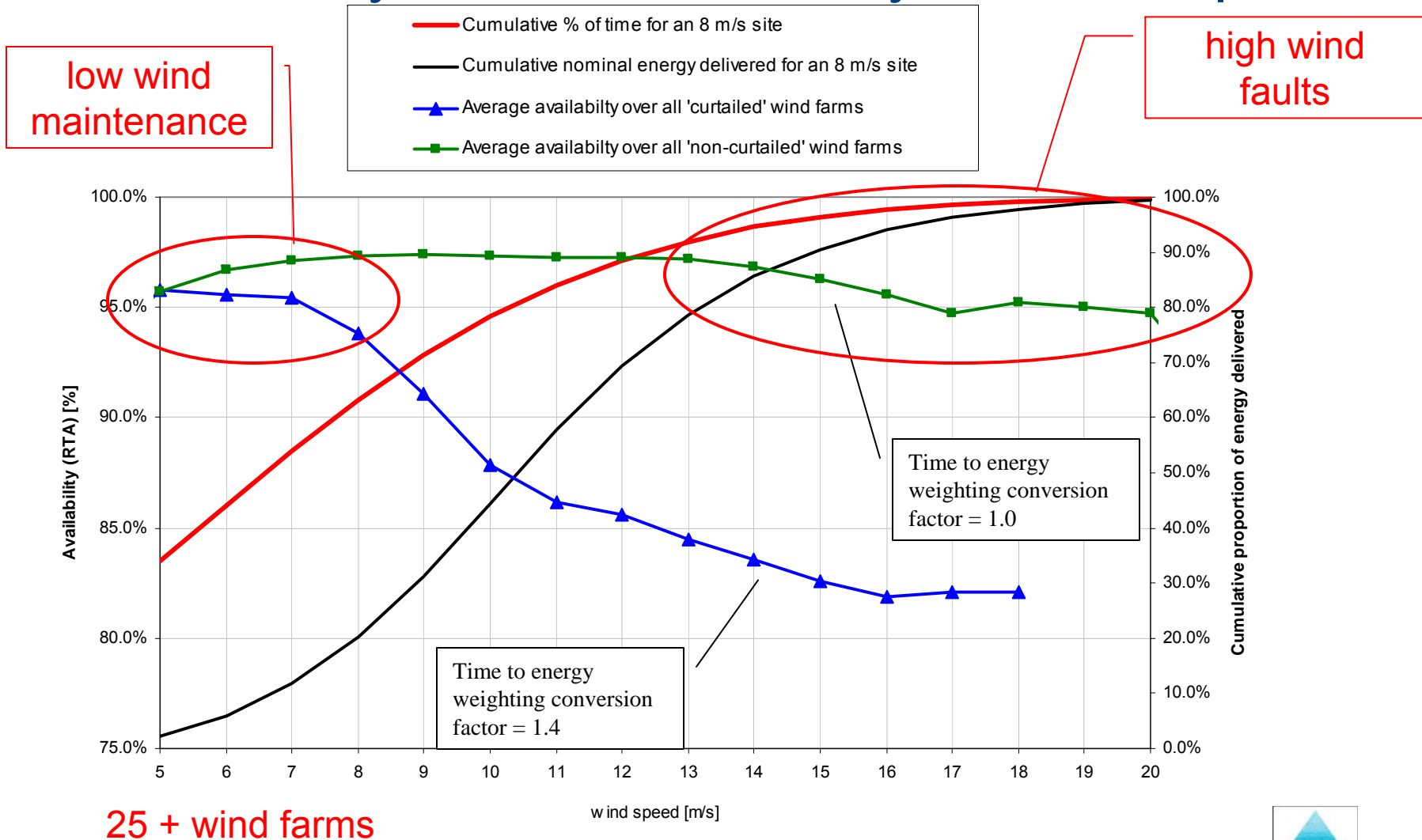
Availability Data – US / Europe Compared



Availability Data – distribution of results



Availability Data – Availability vs. wind speed



Limitations of Data

- The data does have some limitations that must be recognized:
 - The data set for the US projects is less than 40 projects.
 - Even fewer US projects with more than 2 years operational data.
 - Several Owners/Operators are represented, but not all.
 - Graphs show results only of data made available – to be updated as more project data becomes available.
 - Much data from < 1 MW turbine wind farms, more so for wind farms with 5 + years of operation.
 - No weighting given for wind farm size or wind turbine size.
 - Where only turbine availability provided, 99.5% adjustment to get system availability.

Availability ramp up

- A base availability ramp up in the energy assessment can be inferred as follows:

Years of Operation	Annual System Availability
Year 1	93.5%
Year 2	95.5%
Year 3	96%
Year 4 and beyond	97% (??)

- The availability ramp up in the financial model must be evaluated on a case by case basis.

Availability Data – Results

- The data does have some limitations
- Conclusions that can be drawn:
 - Socioeconomic and geographic challenges are different between US and European markets.
 - Unable to demonstrate that long term availability is, in fact, less than long term projections.
 - Indications are that ramp up periods, as assumed in financial models, may need to be adjusted.
 - Energy weighted availability generally in line with run time availability (not including curtailment).
- Conclusions that can not be drawn:
 - Not clear that the US Market is, in fact, performing materially worse than the European Market. Additional data must be obtained.
 - Not clear what generic long term availability assumptions can be made. Requires evaluation of more project specific information.
 - A comprehensive conclusion regarding availability impact on project underperformance cannot yet be ascertained.

Questions?



Additional Info at:

www.garradhassan.com/services/energyassessment

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