



Availability Trends in the US Wind Power Market

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Agenda

- Introduction
- Definitions of Availability
- Specific Availability Challenges - revisited
- Availability Analyses - updated
- Availability Conclusions
- Summary





Introduction

- Wind farm performance is always a hot topic
 - Indications of underperformance in last few years
 - Lenders and equity expressing concerns
 - Numerous investigations into actual performance across industry
 - Availability update
 - Last year, we provided some early results indicating longer ramp-ups of availability
 - More results now available
 - Additional mining of results
 - Turbine
 - BoP
 - Update on indications from results
 - 92 possible projects (last year 61)





“Availability” Definitions

- Availability

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

- Machine, or “Turbine”, Availability

- Limited to the turbine system only.
- Includes all down time related directly to the turbine only.
- Turbine Warranty Availability is not the same - multiple definitions.
 - Often includes deduct for annual turbine maintenance.
 - Includes deduct for items outside the control of the turbine.

- Balance of Plant (BoP) Availability

- Excludes Turbine Availability.
- Includes down time from BoP infrastructure through to the point of interconnect.
 - Includes all maintenance and items not under the control of the turbine.





“System Availability”

- Total System Availability = BoP Availability x Turbine Availability
 - Does not include grid curtailment
 - In the end, this is the first part of the financial equation to which the overall performance of a wind power project is measured:

“Is the project producing power when the wind is blowing...
...and is it producing power in correct proportion to the wind blowing?”

(the second part is related to the performance, or efficiency, of the project and the subject of other ongoing efforts)





Availability Challenges - revisited

• US Market

• Parts availability

- Competition with growing wind construction market
- **Component manufacture remains largely dependent upon foreign supply especially in current market**
- Learning curve for each new facility with small number of temporary experienced crew

• Project Staffing

- High level of employee turnover for operators - worker's market
- 20 to 40 turbines per technician crew (2 techs)
- **Relatively few trained expert technicians nationwide**
- **Inexperience = increased time to resolve downtime**

• 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 - normal migration of opportunities
- 10 to 20 turbines per technician crew (2 techs)
- Larger number of trained technicians available
- More experienced crews = faster response times





Availability Challenges - revisited

• 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 and turbines
- 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

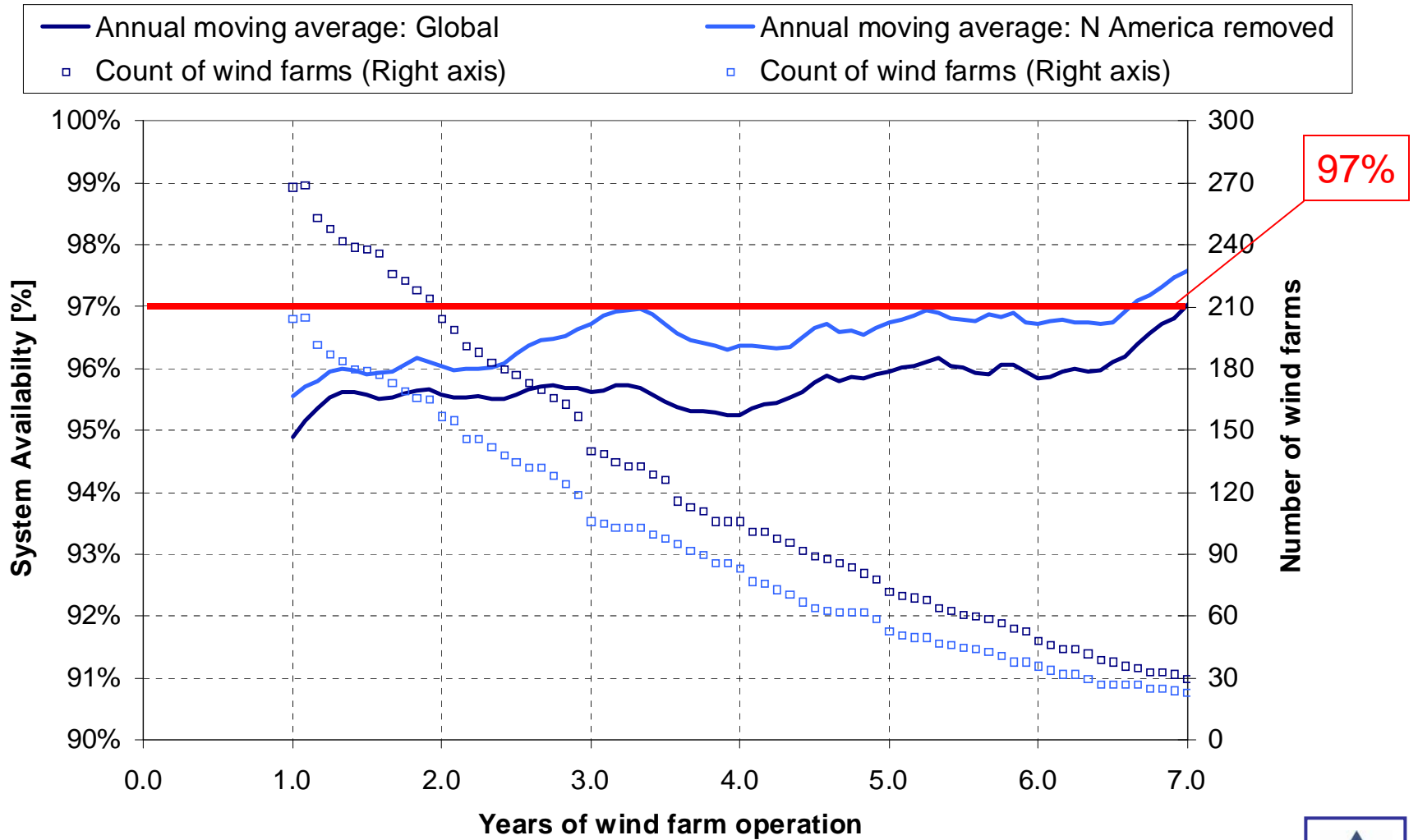
- 2 weeks + for turbine erection and commissioning
- Sometimes 250 to 500 hours and maintenance prior to reliability testing

- 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



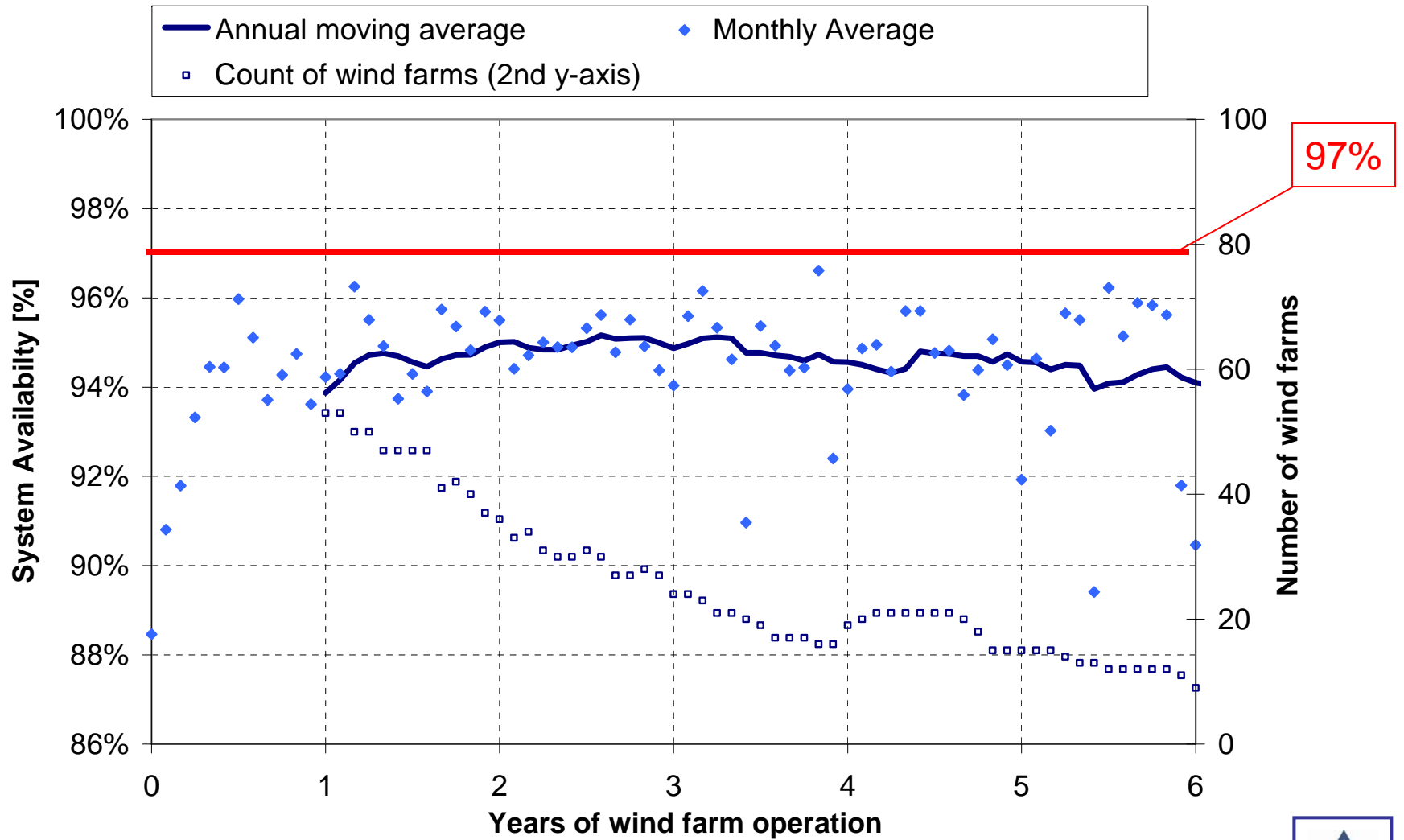


System Availability - Global Market



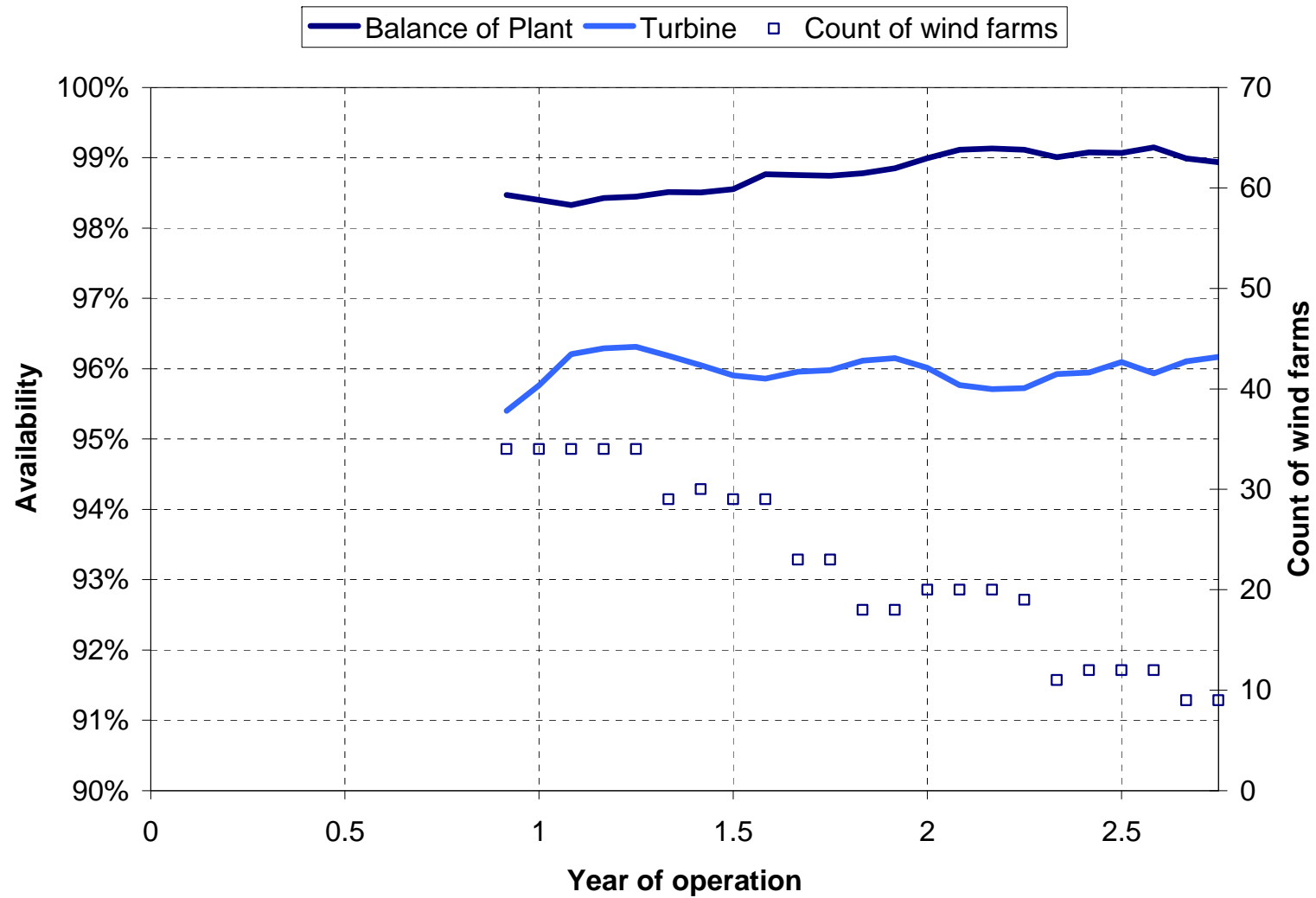


System Availability - US Market





Turbine and BoP Availability - US





Actual Availability - Summary

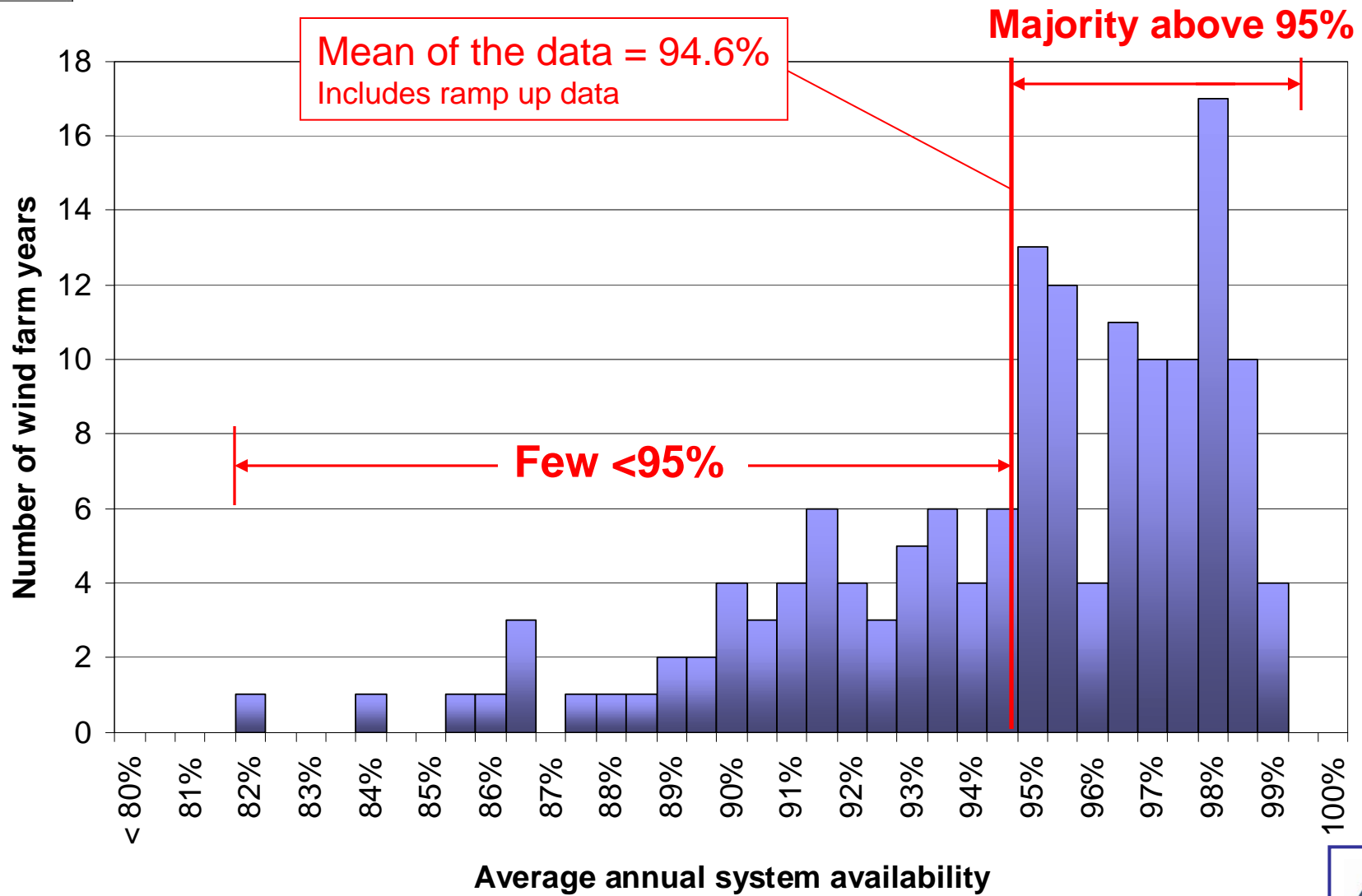
Years of Operation	Annual Turbine Availability	BoP Availability
Year 1	95.0%	98.0%
Year 2	96.0%	98.5%
Year 3	96.0%	99.0%
Year 4 and beyond	96.0%	99.0%

- The availability ramp up in the financial model must be evaluated on a case by case basis
 - Will be lower for newer or problematic turbines
 - Project must *always* substantiate Availability assumptions
- Data contains some uncertainty, most likely optimistically
 - Real performance, with respect to financial return, very likely lower
 - Appropriate starting point is slightly below the average results





North America Availability Distribution





Downtime - Turbine Availability

- Parts availability
 - Major component lead times
- Response time to faults
 - General efficiency
 - Motivation
 - Nights / weekends
 - Troubleshooting / understanding the problem
 - Expertise of O&M staff
- Turbine faults
 - Major component failures
 - Vibration
 - Lightning strike damage
 - Control / electrical system failures





Downtime - BoP Availability

- Electrical connections
 - Collection system splice connections
 - Collection system terminal connections
 - Pad Mount transformers
 - Other terminal connections
- Response time to faults
 - General efficiency
 - Motivation
 - Nights / weekends
 - Troubleshooting / understanding the problem
 - Expertise of O&M staff





Availability Data - Results

- Conclusions that can be drawn:
 - US Market continues to struggle with availability challenges
 - System availability of wind farm projects may not be achieving 97% long term on average
 - BoP and Turbine availability must be monitored and addressed simultaneously
 - Objective and routine evaluation of the SCADA data of projects is key to understanding how the project is performing financially
 - Operating staff motivation is key to improving real performance of projects as opposed to “just meeting numerical goals”
 - Differing definitions of availability, as calculated by projects, lends some level of uncertainty around results, but trends of the results appropriately indicate areas for improvement





Questions?

Additional Info at:

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