Power Curve Working Group 6th Meeting
Introduction

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Tuesday 1st April 2014

Agenda

PCWG Progress Overview

- The 1st meeting gave a clear statement of the **problem**.
- The 2nd meeting examined possible **solutions**.
- The 3rd meeting put some of those solutions into **practice**.
- The 4th meeting **consolidated** the learning by examining new datasets.
- The 5th meeting focused on **validating** the candidate correction methods against real data.
- The 6th meeting will **broaden the validation** to additional datasets, examine the limitations of the correction methods and probe the **Type B effects** associated with these limitations.

Power Curve Working Group Roadmap (Revised)

Definition	Solution / Evolution					Conclusion
Meeting 1	**Meeting 2**	**Round Robin 1**	**Meeting 3**	**Round Robin 2**	**Meetings 4 and 5**	**Final Meeting**
Define what's the problem we are trying to solve.	Identify possible solutions	Trial solutions	Feedback on solutions. Compare experiences & lessons leant. Identify refined and/or alternative solutions	Trial refined solutions	Feedback on refined solutions. Is problem is solved? Should problem be redefined? Iterate solutions as required…	Finalise conclusions ~~Publication of journal paper by working group.~~ Publication of guideline document.

Current Status

Publically disseminate presentations and minutes. Publish interim proposals and guidelines

Time

Dec 2012	Mar 2013	Apr - May 2013	May 2013	Jun – Sep 2013	2014	Dec 2014

Review of Actions from Last Meeting

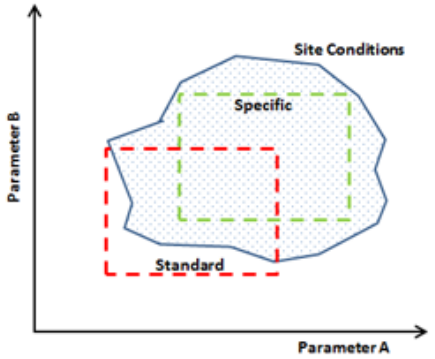
- ✔ Develop glossary of terms.
- ✔ Perform round robin exercise for Veer term of REWS using Dataset 3.
- ✔ Improve consensus analysis for turbulence renormalisation method making calculation steps clearer e.g. flow charts.
- ✔ Publically distribute Inner-Outer range concept document.
- ✔ Identify and distribute additional validation datasets.
- ✔ Dedicate portion of next meeting to Type B effects.

Glossary (In Progress)

Initial draft available at **Dropbox\DRAFT Glossary.docx**

Site Specific Power Curve

A site specific power curve is a power curve which has been defined to be more representative of the conditions on a given site than a standard power curve. The diagram on the right shows a schematic representation of the range of validity of standard and conditions specific power curves relative to the real site conditions. The conditions specific power curve (green dash) is on the whole more representative of the site conditions (solid blue) than the standard power curve (red dash), however some more extreme site conditions are not well represented by the conditions specific power curve.



Inner-Outer Range

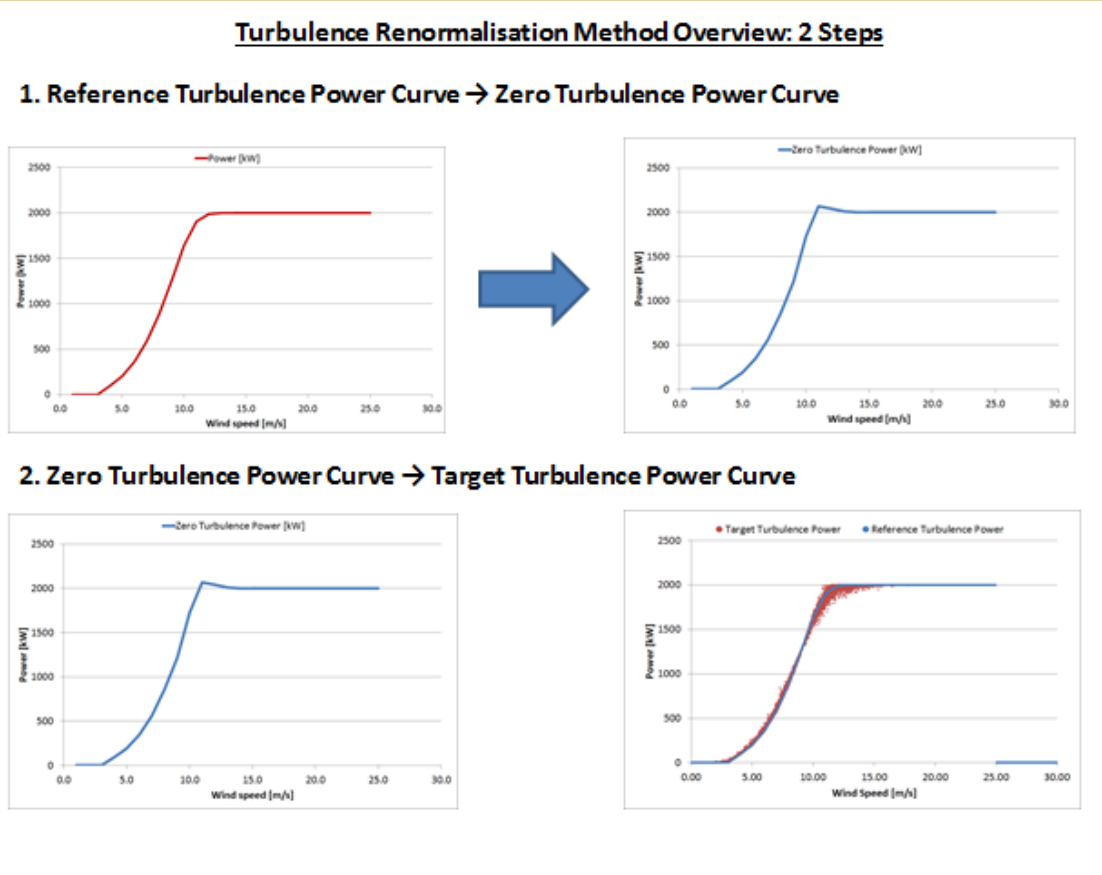
The Inner-Outer range concept is a simplified representation of power curve behaviour under non-ideal conditions whereby two ranges of conditions are defined:

- **Inner Range:** the range of conditions for which one can expect to achieve an Annual Energy Production (AEP) of 100% (relative to a reference power curve).
- **Outer Range:** the range of conditions for which one can expect to achieve an AEP of less than 100%. Stated another way the outer range is the range of all possible conditions excluding those in the inner range.

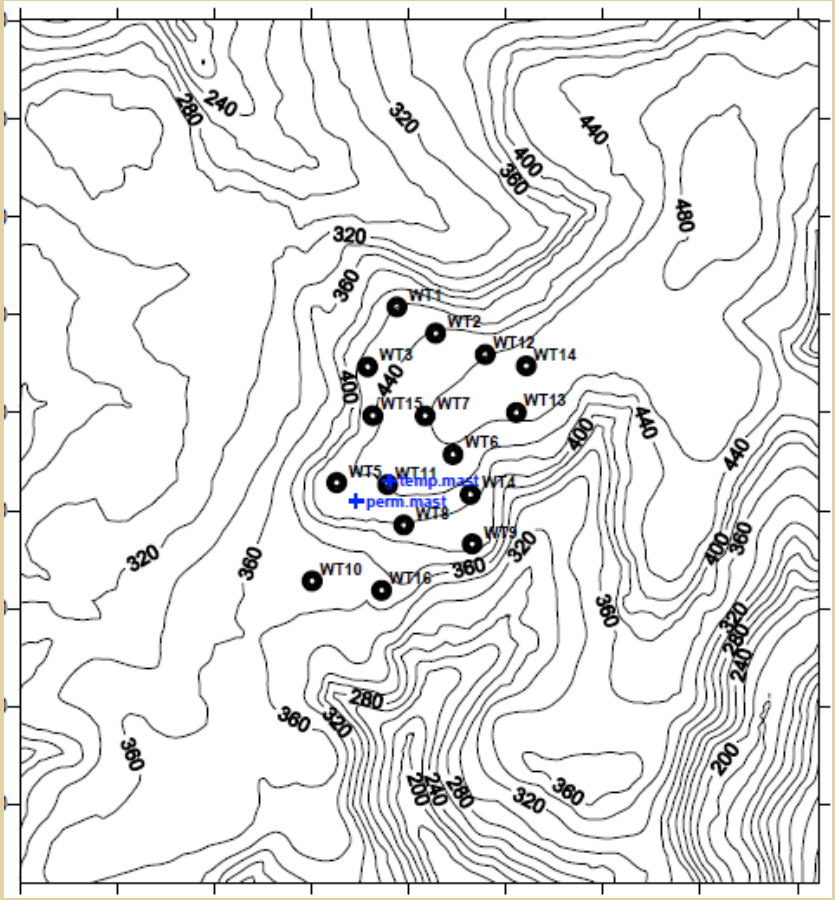
It is envisaged that suppliers may offer some level of reduced warranty for the outer range. For more details see http://www.ewea.org/events/workshops/resource-assessment-2013

Turbulence Renormalisation Consensus Analysis Documentation (In Progress)

Initial draft available at: **Dropbox\Consensus Analysis\DRAFT Turbulence Renormalisation Documentation.pptx**



Dataset 4 (Released)



- Validation dataset which includes power and hub wind speed measurements.
- Does not include remote sensing measurements.
- Useful for validating turbulence renormalisation method, but cannot be used to apply REWS method.

Dataset 5 (In progress)

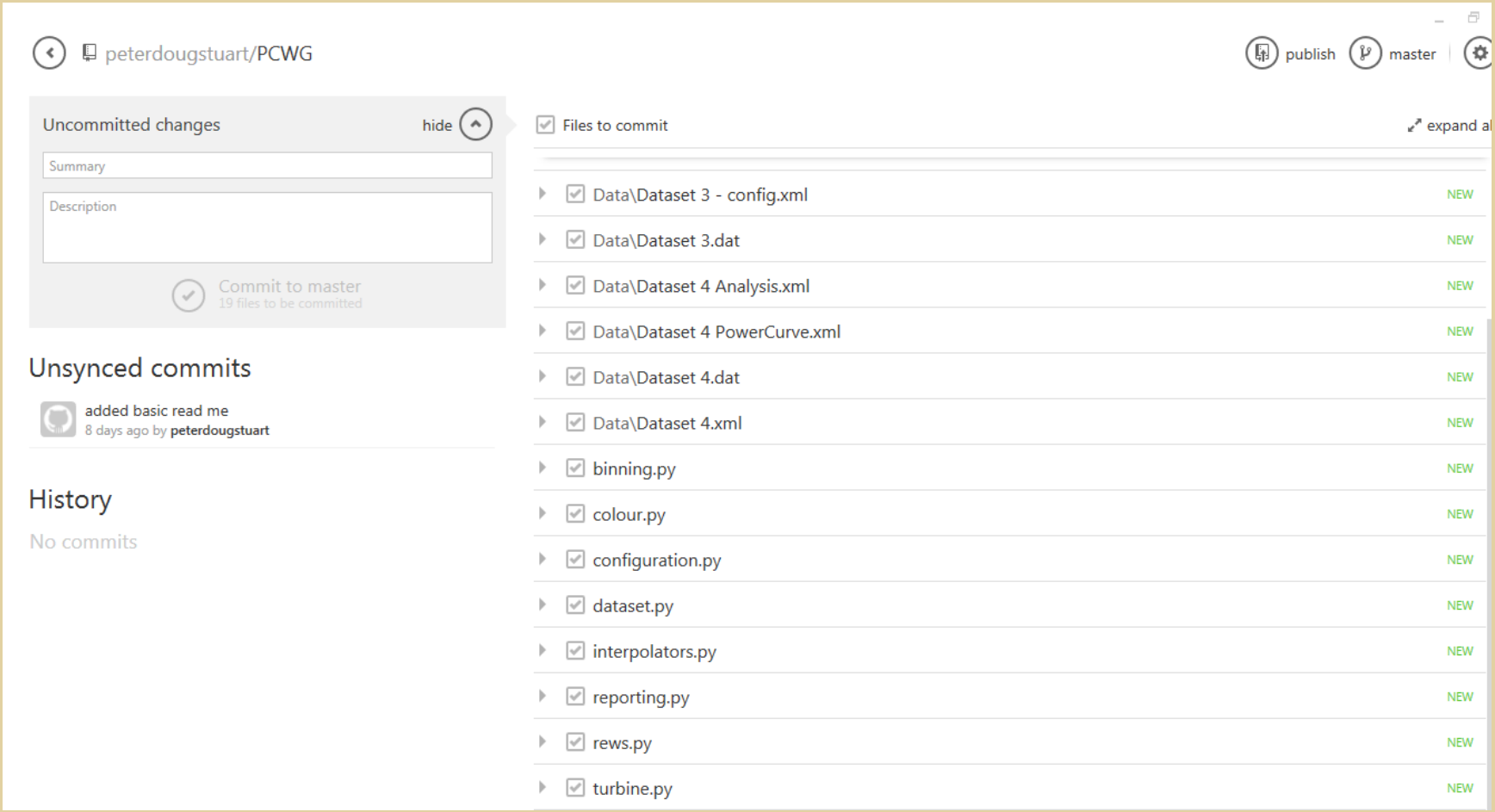
Griffin WTG2 - Mast And Galion concurent data

Wind Speed Bin	Number of 10 minute records	Hours Captured	Percentage of the required data for each bin
1.75-2.25	0	0.00	0%
2.25-2.75	4	0.67	133%
2.75-3.25	24	4.00	800%
3.25-3.75	50	8.33	1667%
3.75-4.25	72	12.00	2400%
4.25-4.75	89	14.83	2967%
4.75-5.25	93	15.50	3100%
5.25-5.75	90	15.00	3000%
5.75-6.25	94	15.67	3133%
6.25-6.75	71	11.83	2367%
6.75-7.25	56	9.33	1867%
7.25-7.75	60	10.00	2000%
7.75-8.25	40	6.67	1333%
8.25-8.75	23	3.83	767%
8.75-9.25	17	2.83	567%
9.25-9.75	14	2.33	467%
9.75-10.25	9	1.50	300%
10.25-10.75	7	1.17	233%
10.75-11.25	2	0.33	67%
11.25-11.75	0	0.00	0%
11.75-12.25	1	0.17	33%
12.25-12.75	0	0.00	0%
12.75-13.25	0	0.00	0%
13.25-13.75	0	0.00	0%
13.75-14.25	1	0.17	33%
14.25-14.75	1	0.17	33%
14.47-15.25	0	0.00	0%
15.25-15.75	0	0.00	0%
15.75-16.25	0	0.00	0%
16.25-16.75	0	0.00	0%
Total	818	136.33	

- Only outline information currently available → full dataset to follow.
- Includes both met mast and Galion LiDAR data.
- Useful for validating both turbulence renormalisation method and REWS method.

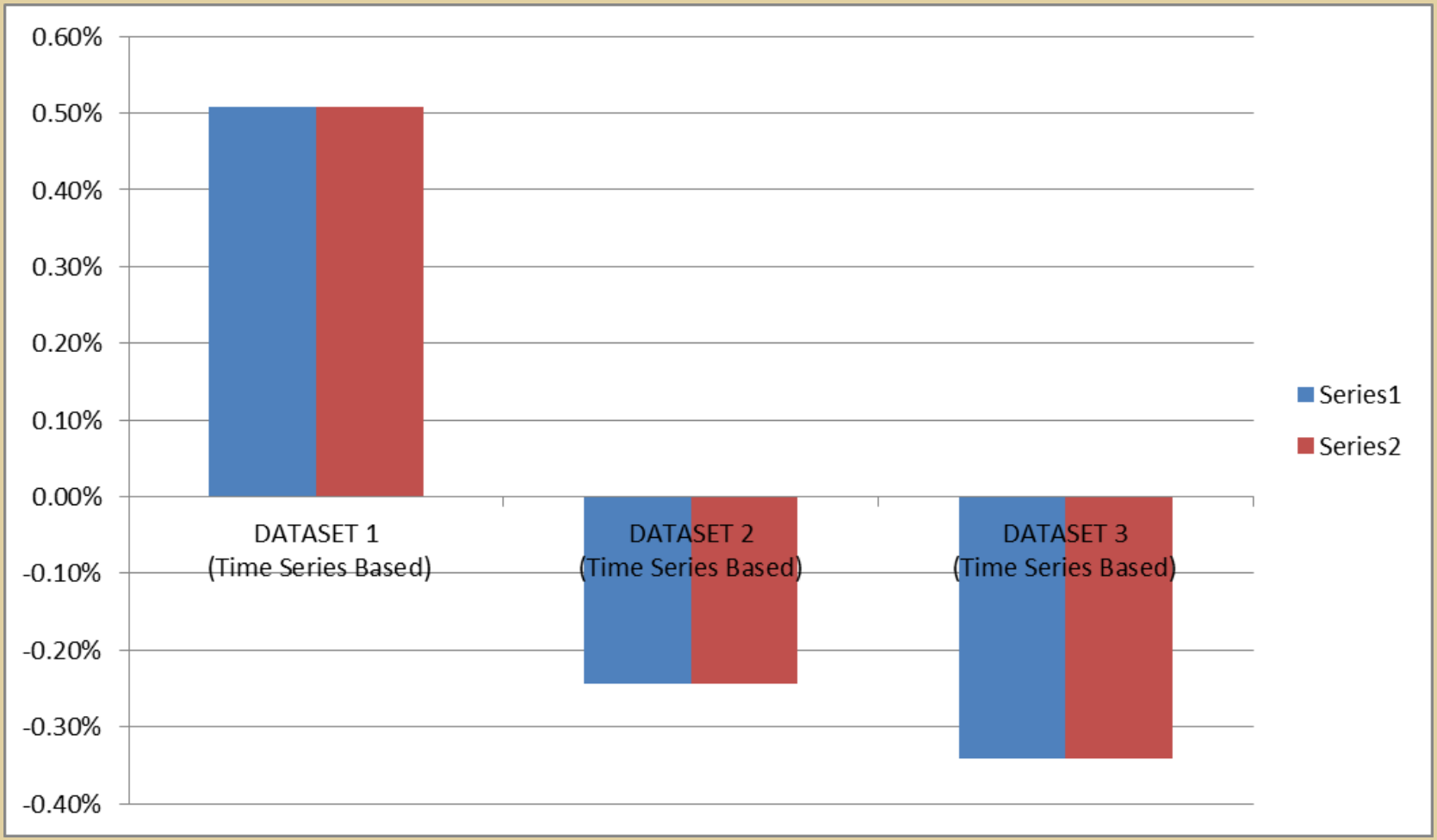
Python Implementation of Consensus Analysis

Python Implementation of Consensus Analysis

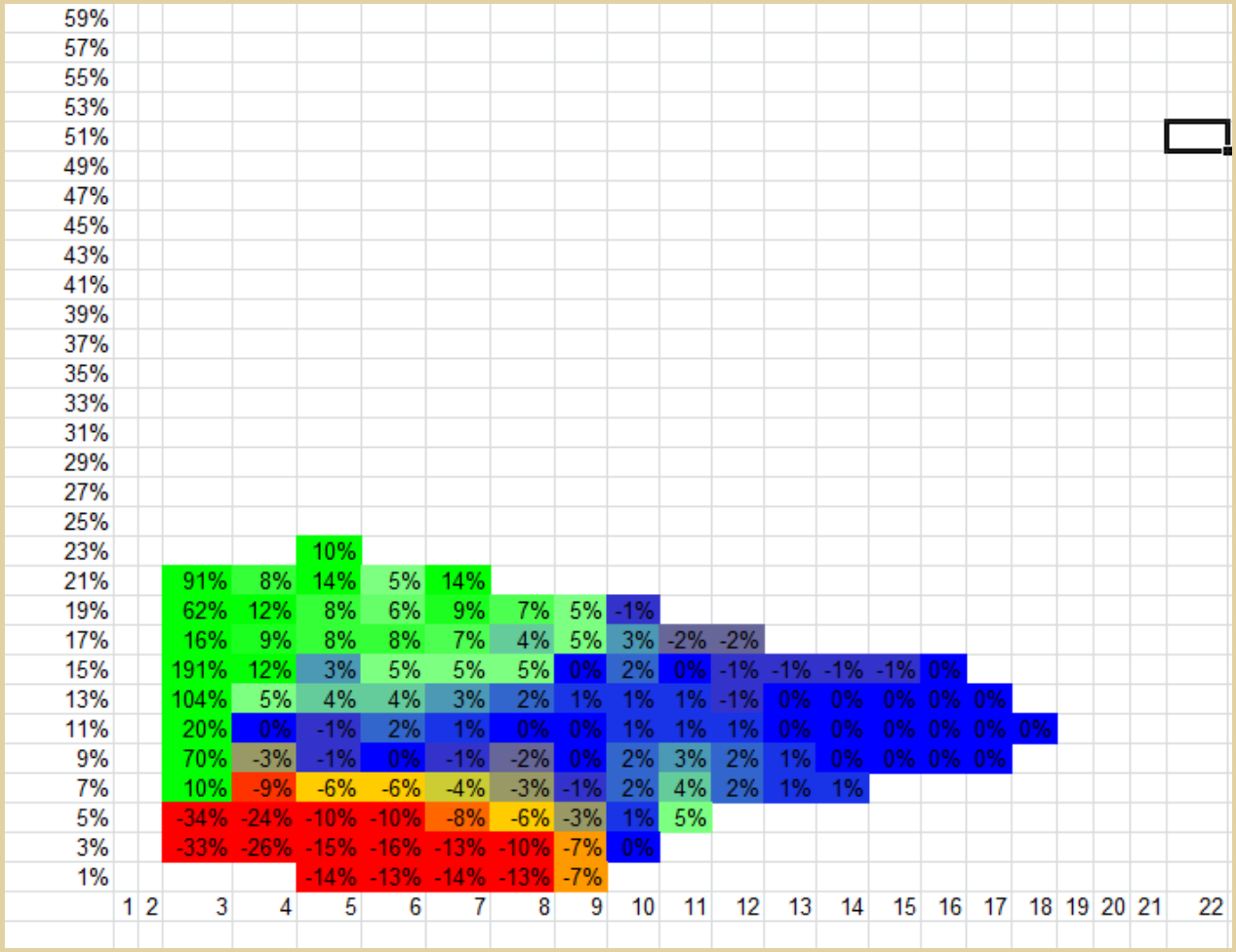


https://github.com/peterdougstuart/PCWG

Benchmark Against Consensus Analysis



Python Code: Power Deviation Matrices



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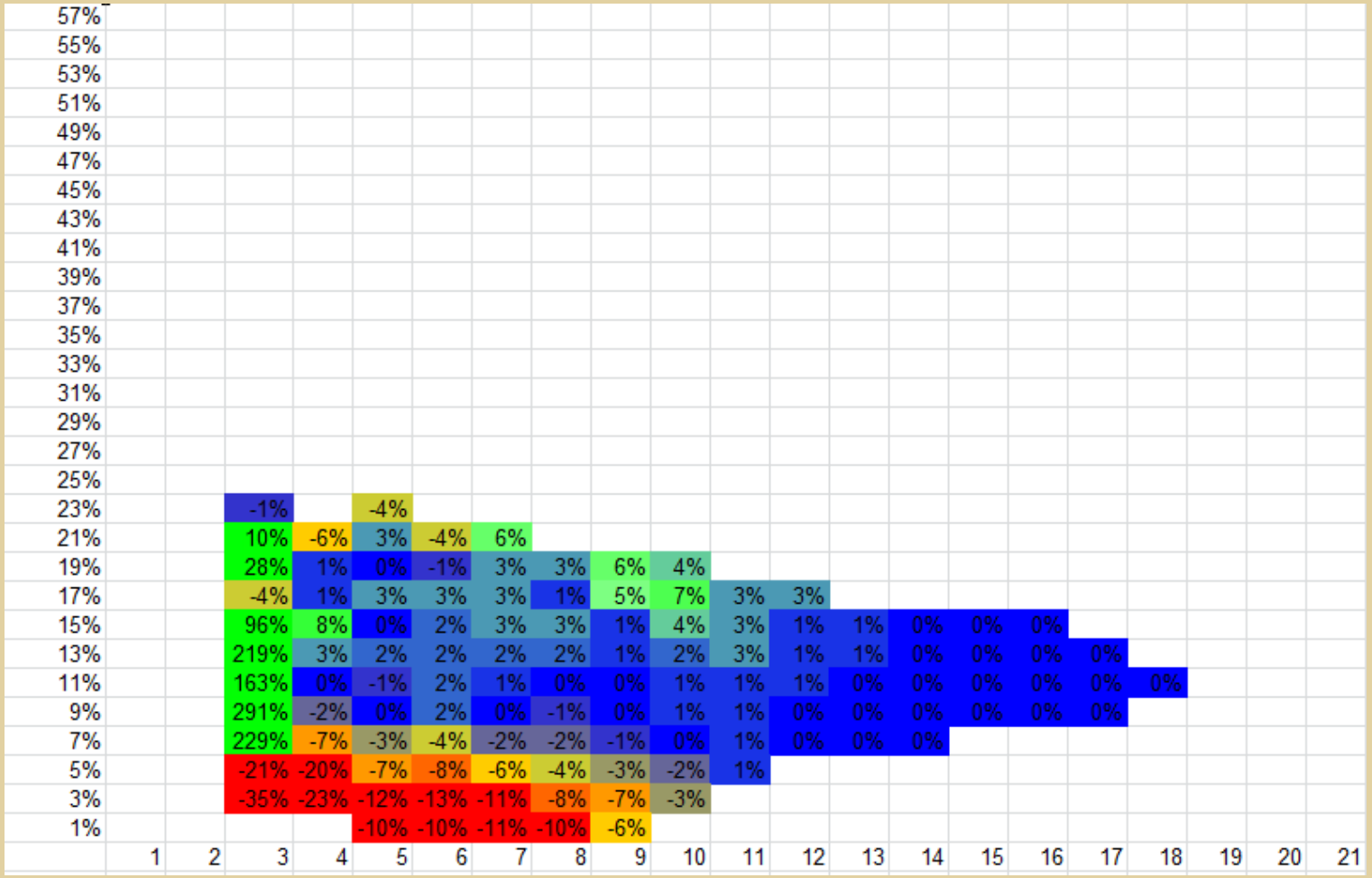
Python Code: Power Deviation Matrices (after turbulence correction)



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1%					-10%	-10%	-11%	-10%	-6%												

Agenda

Morning Agenda Part 1

10.15 – 11.45 Working Group Presentations: Validation of the analytical corrections and the impact of Type B effects.

10.15 – 10.30	"Validation Study", **Alex Clerc** (RES)
10.30 – 10.45	"Correction methods Vs real performance trends observed", **Diego Azofra** (Barlevento)
10.45 – 11.00	"Validation and Calibrations", **Richard Whiting** (DNV GL)
11.00 – 11.15	"Tip Stall" , **Andreas Fischer** (DTU)
11.15 – 11.30	'Steps towards comparison of turbine performance across varying geometries.', **Matthew Colls** (Prevailing)
11.30 – 11.45	"Calculating site specific power curve loss estimates", **Dan Bernadette** (AWS TruePower)
TBC*	"Illustrating the Importance of Site Specific Power Curve", **Alan Derrick** (RES)

***** Presentation after lunch if no time in morning session.

Morning Agenda Part 2

Coffee Break 11:45 – 12:00

12.00 – 12.15 “Inflow effects on power performance, focusing mainly on the effects of yaw misalignment and inflow angle”, **Troels Friis Pedersen** (DTU)

12.15 – 12.30 “Effect of shear and turbulence on AEP estimate”, **Mark Kelly** (DTU)

12.30 – 12.45 “Rotor Equivalent Wind Speed”, **IÑAKI LEZAUN MAS** (Gamesa)

12.45 – 13.00 “Experimental data and BEM Calculations”, **Ioannis Antoniou** (Siemens)

Lunch 13:00 – 14:00

Afternoon Agenda

14.00 – 14.30 New Datasets and REWS Veer Round Robin:

- Overview of datasets and Veer Round Robin Exercise
- Dataset discussion and clarifications

14.30 – 15.45 Discussion Session (chaired by Richard Whiting DNV GL)

15.45 – 16.00 Coffee Break

16.00 – 17.00 Further Discussion and Wrap Up


power for good