SHORT TERM FORECASTING OF WIND POWER PLANTS

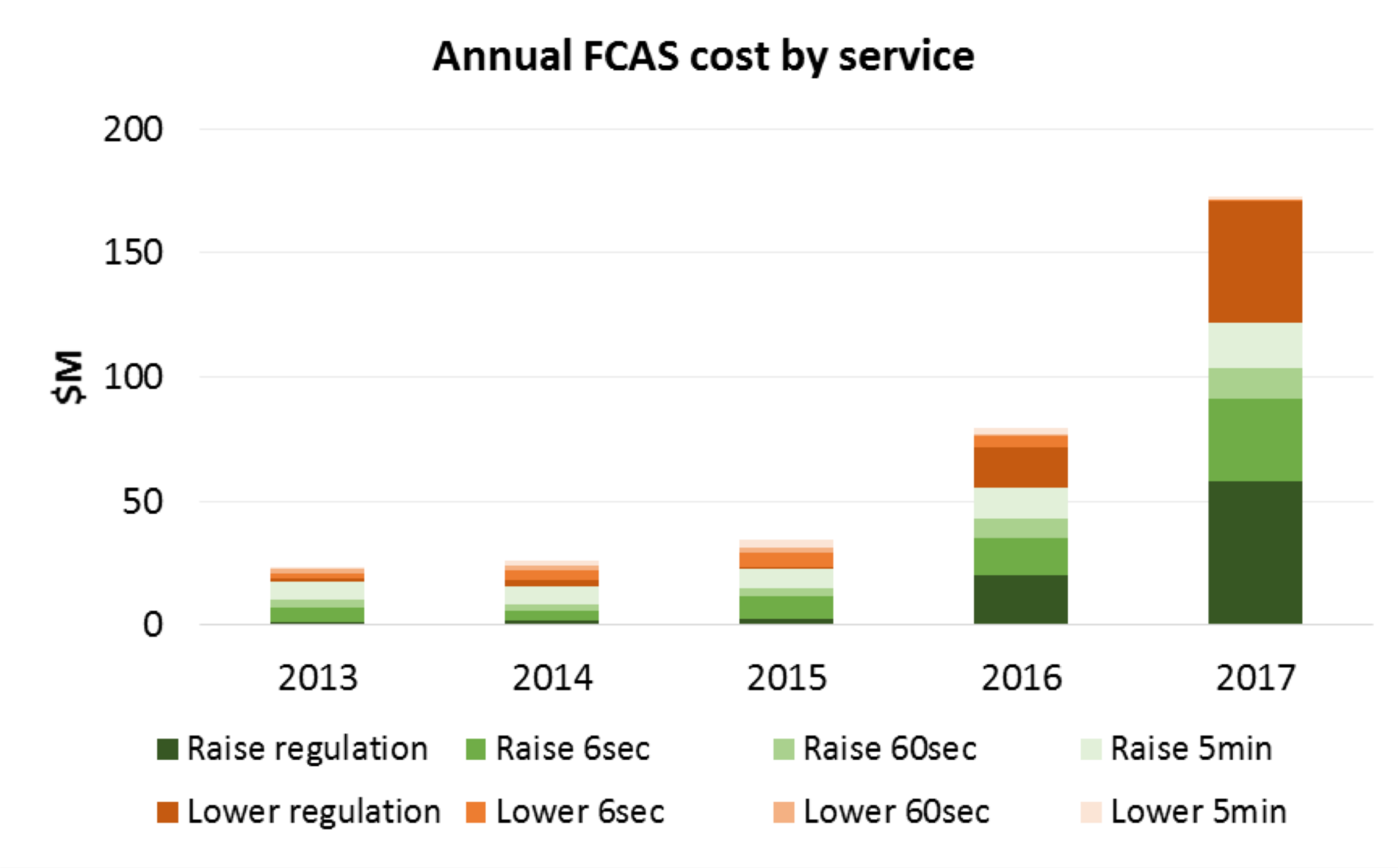
DR. HARLEY MACKENZIE

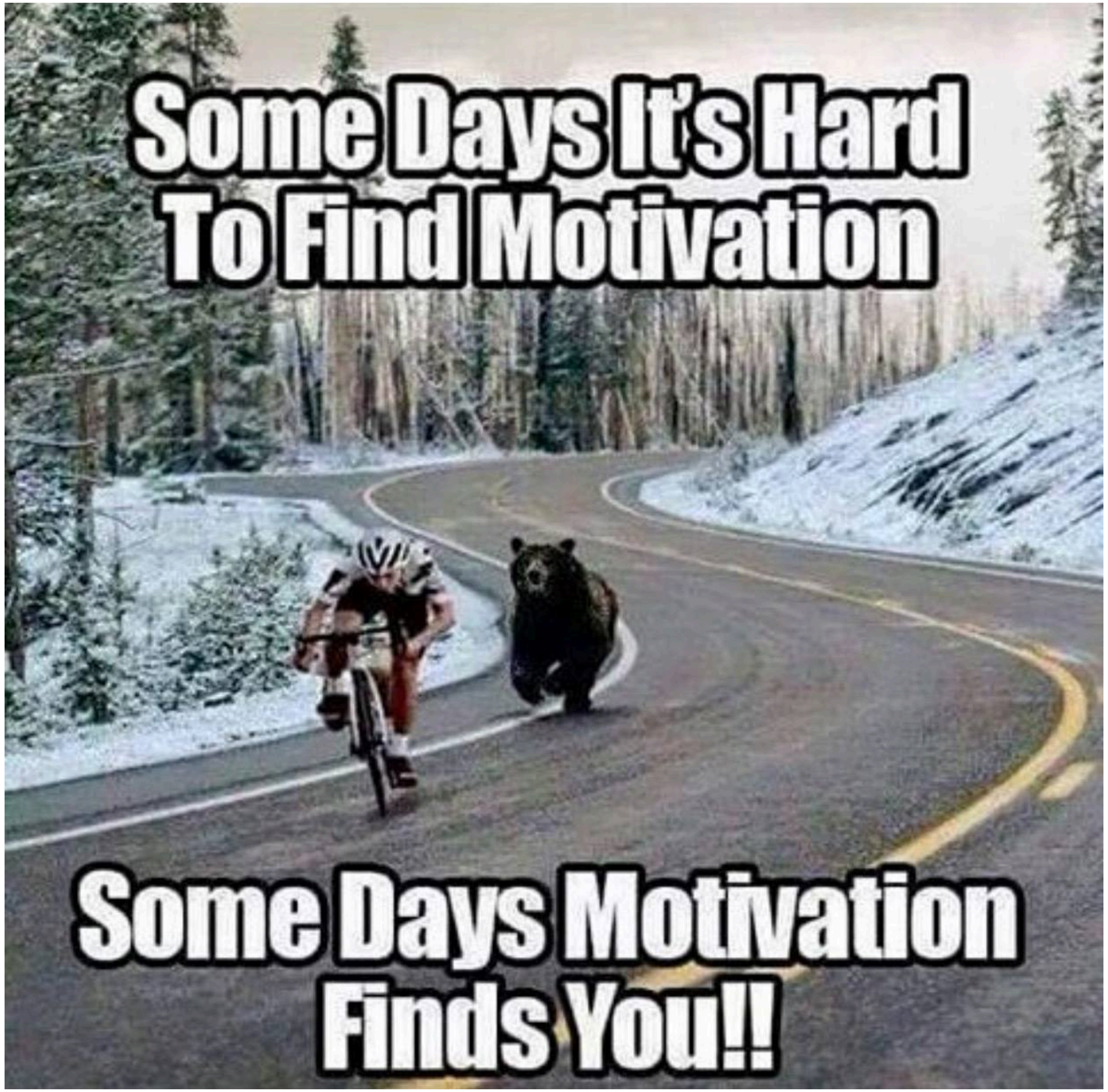
DISPATCH SOLUTIONS

WHAT IS “SHORT TERM” FORECASTING

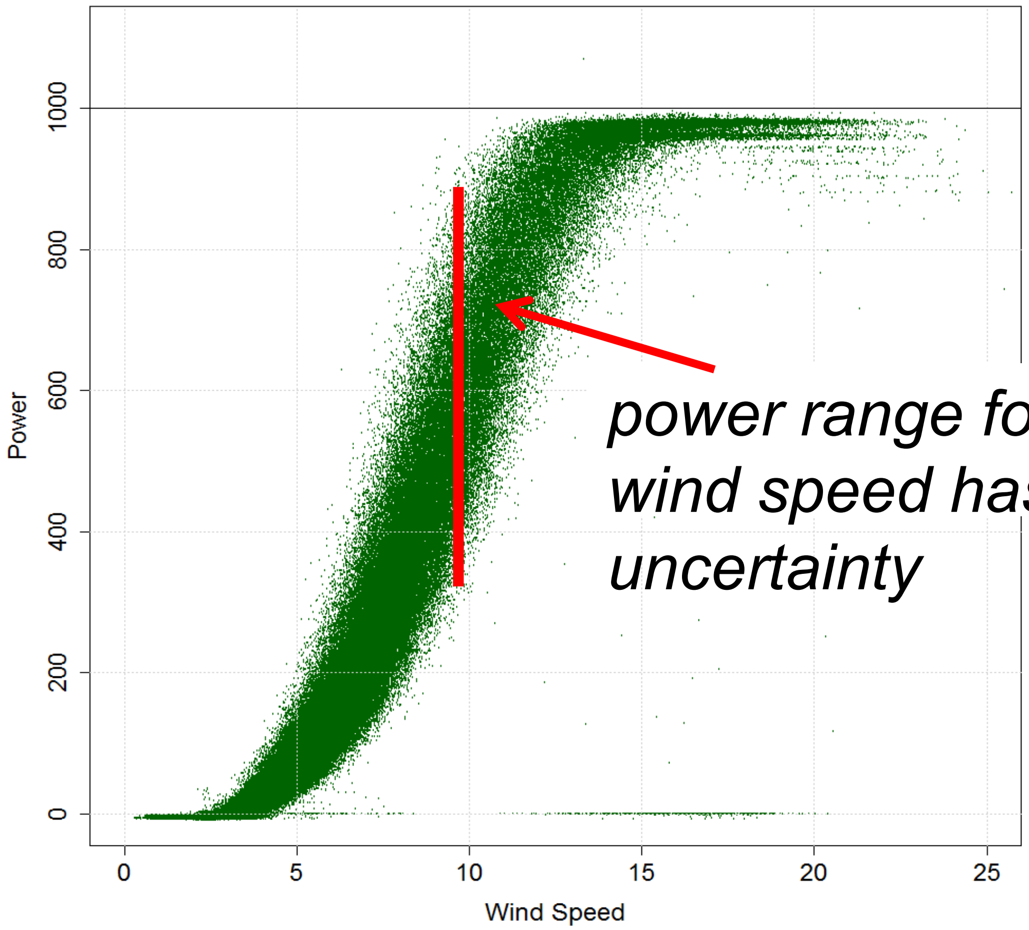
Time horizon	Range	Applications	Forecast technologies
Very short term	A few seconds to 30 mins ahead	Electricity market clearing Regulation actions	Persistence, ML
Short term	0 minutes to 6 hours ahead	Economic load dispatch planning Load increment/decrement decisions	Persistence, NWP, hybrid, ML, statistics
Medium term	6 hours to 1 day ahead	Generator online/offline decisions Operational security in day ahead markets	NWP, hybrid, statistics
Long term	1 day to 1 week or more ahead	Unit commitment decisions Reserve requirement decisions Maintenance scheduling	NWP, statistics

TOTAL NEM FCAS COST RECOVERY



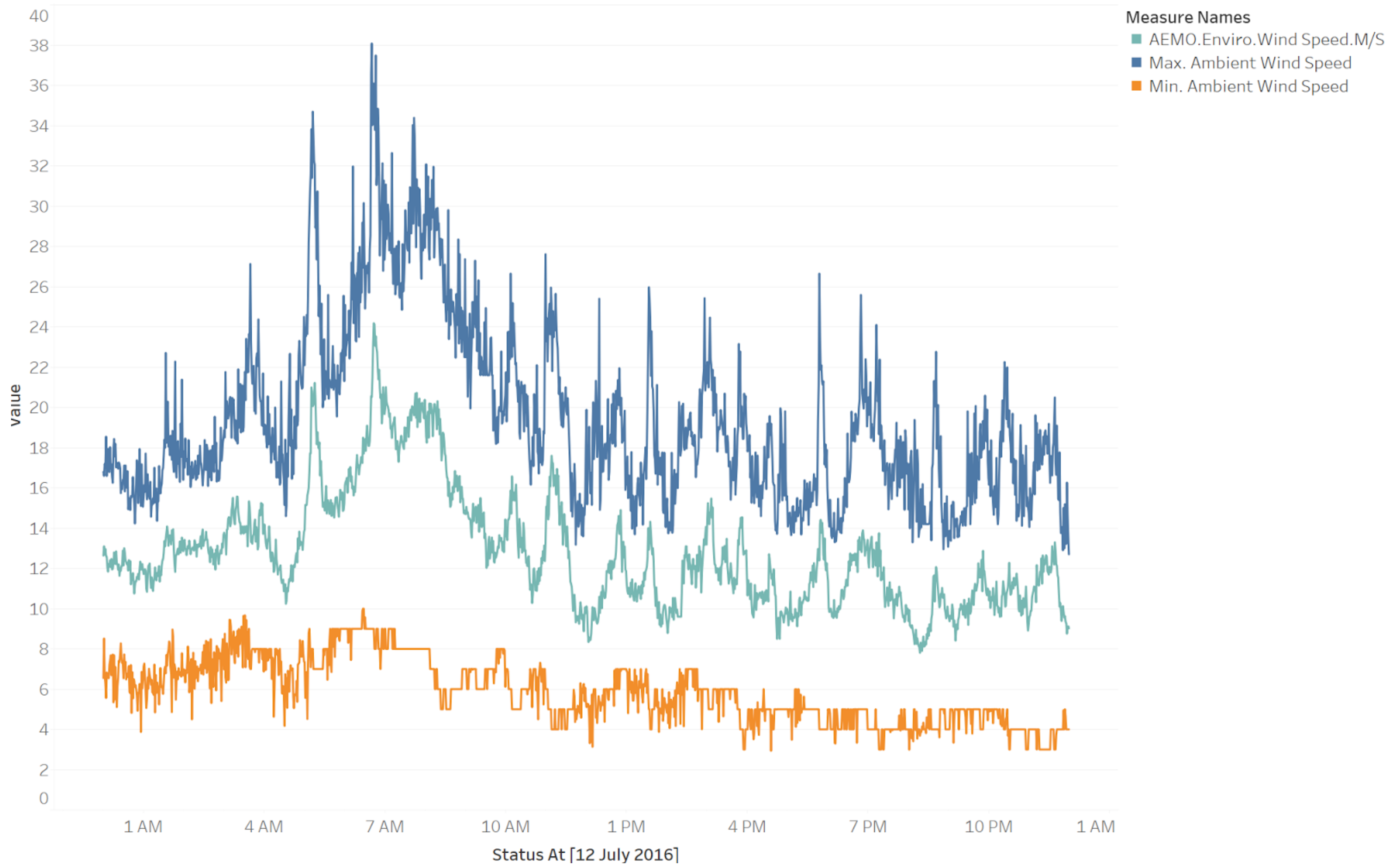

Some Days It's Hard
To Find Motivation
Some Days Motivation
Finds You!!

LIMITATIONS OF AWEFS APPROACH

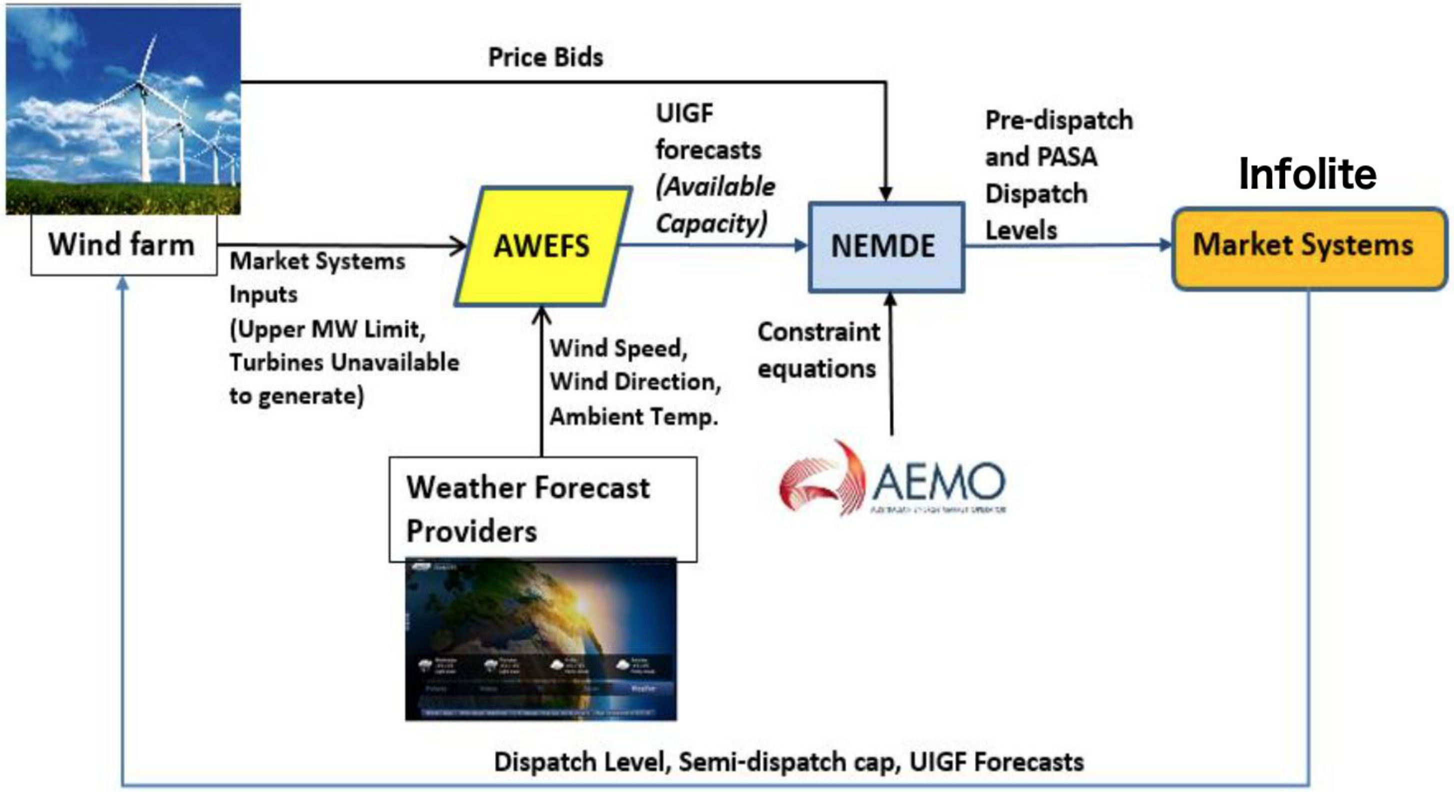


power range for a given wind speed has a large uncertainty

WIND SPEED RANGE FOR LARGE WPP

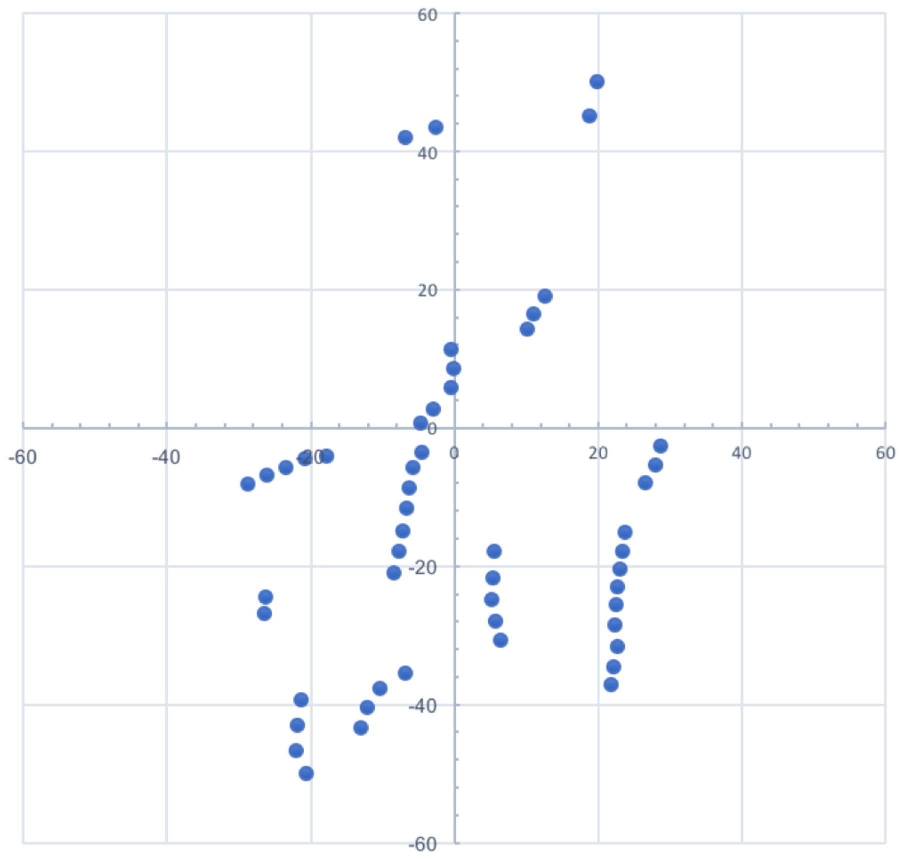


HOW DO AWEFS FORECASTS GET USED IN NEM DISPATCH?



MODELLED WIND POWER PLANT

- LOCATED IN SOUTH EAST NSW IN THE AUSTRALIAN NATIONAL ELECTRICITY MARKET
- 21 VESTAS V90 2 MW TURBINES
- 21 VESTAS V100 1.8 MW TURBINES
- 9 VESTAS V90 3 MW TURBINES
- TOTAL CAPACITY OF 51 TURBINES AND 107 MW
- TOPOLOGY INCLUDES BOTH HILL TOP RIDGES & FLAT PLAINS
- VERTICAL DISTANCE OF 90 M BETWEEN LOWEST & HIGHEST TURBINES

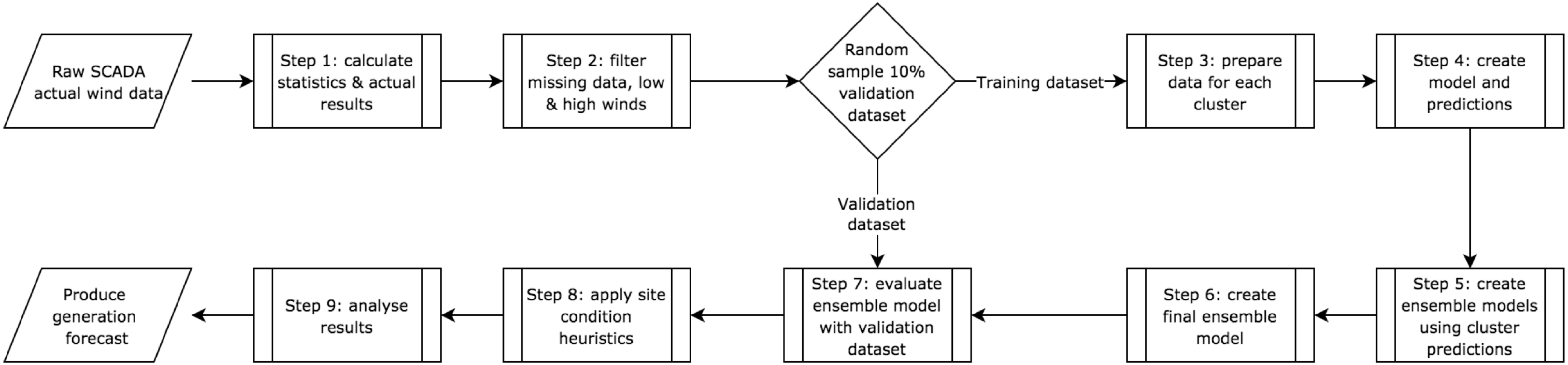


INITIAL MODELLING APPROACH

- EXPLORATORY DATA ANALYSIS
  - VARIABLE CORRELATIONS
  - ML TECHNIQUE EFFECTIVENESS
  - FEATURE IMPORTANCE
  - MOST TECHNIQUES PERFORMED WORSE THAN PERSISTENCE FORECAST

- SINGLE GENERATOR FORECAST MODEL
  - DATA FILTERED FOR WIND CONDITIONS, DATA FAILURE & CONSTRAINTS
  - ANN & STOCHASTIC GRADIENT BOOSTING MODELS
  - PERFORMED ABOUT THE SAME AS PERSISTENCE FORECAST

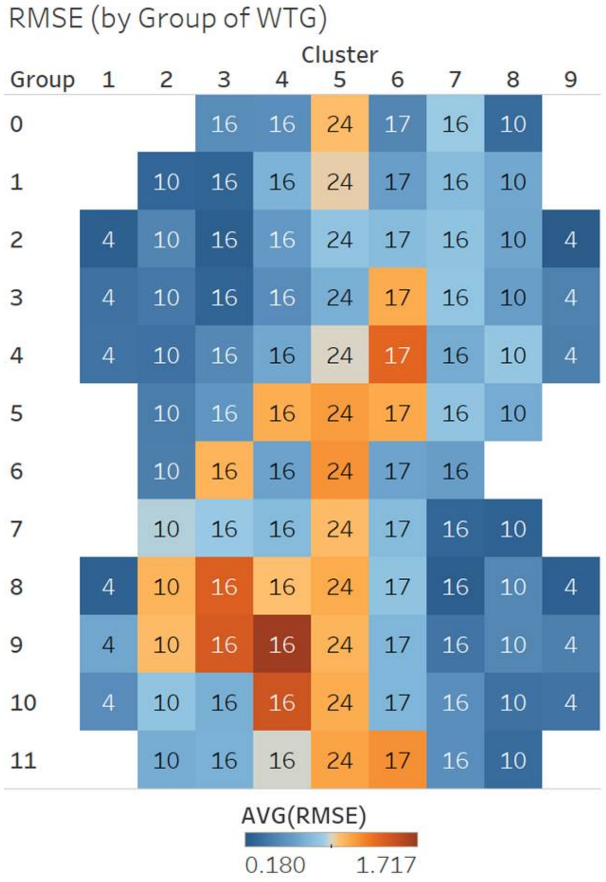
MODEL DEVELOPMENT PROCEDURE

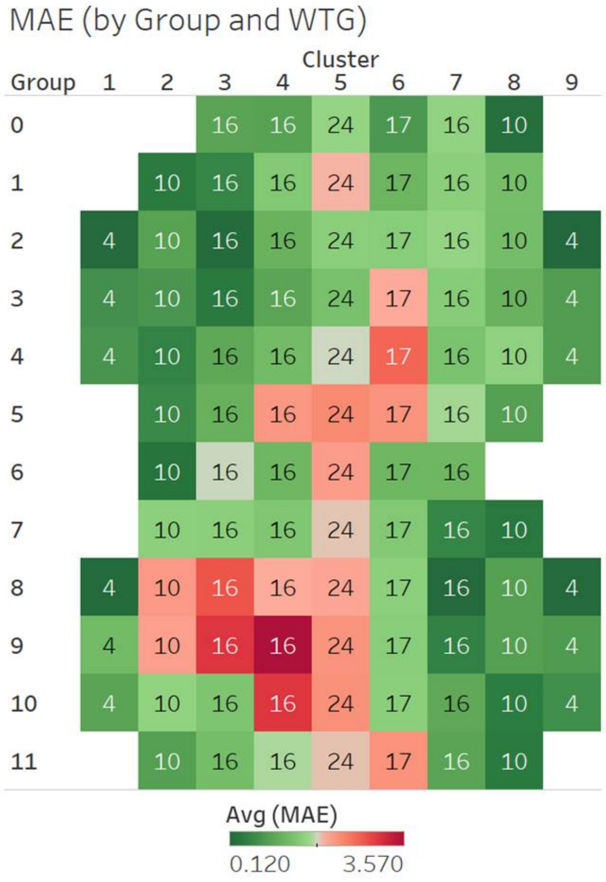


CLUSTERED MODEL APPROACH

- TURBINES CLUSTERED BASED ON PHYSICAL LOCATION, TOPOLOGY & DYNAMIC PARAMETERS
- CLUSTERS WERE MODELLED INDIVIDUALLY WITH STOCHASTIC GRADIENT BOOSTING (SGB) MODELS USING FILTERED DATA
- ENSEMBLE MODEL OF CLUSTER MODEL FORECASTS USING EITHER SGB OR ANN MODEL
- MODELS PRODUCED A RANGE OF FORECASTS UNDER DIFFERENT DYNAMIC CONDITIONS:
  - RSME IMPROVEMENT OF MIN -12.9% MAX 27.1% MEAN 10.67%
  - MAE IMPROVEMENT OF MIN -7.8% MAX 18.7% MEAN 7.5%

FORECAST ERROR DISTRIBUTION

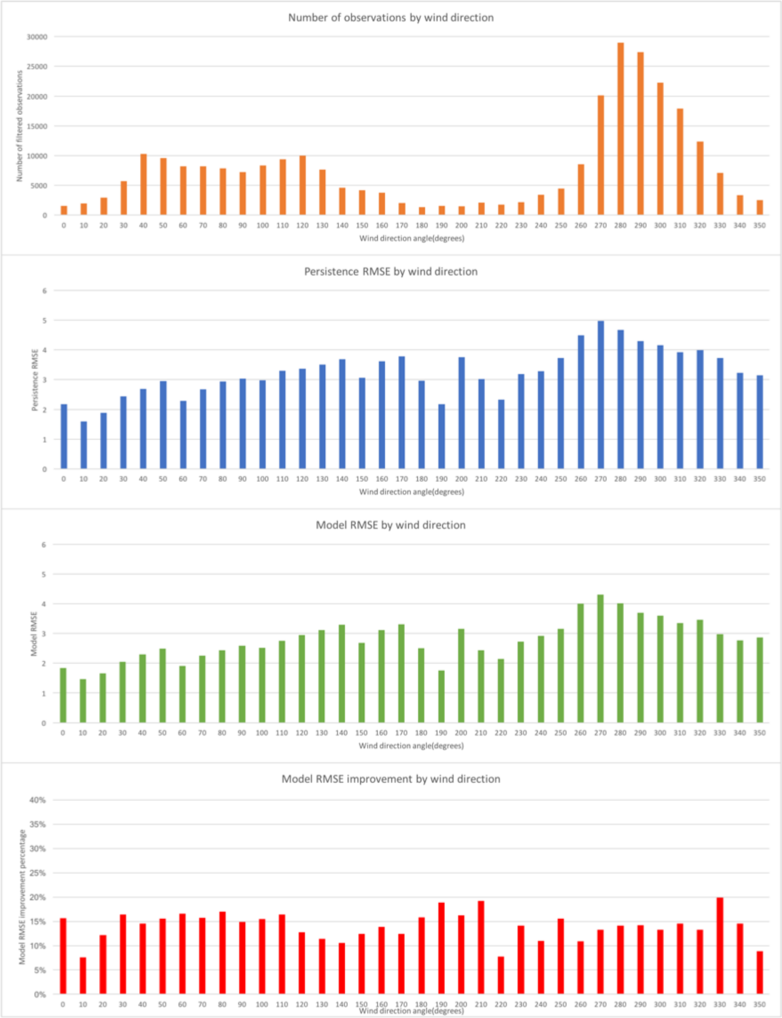




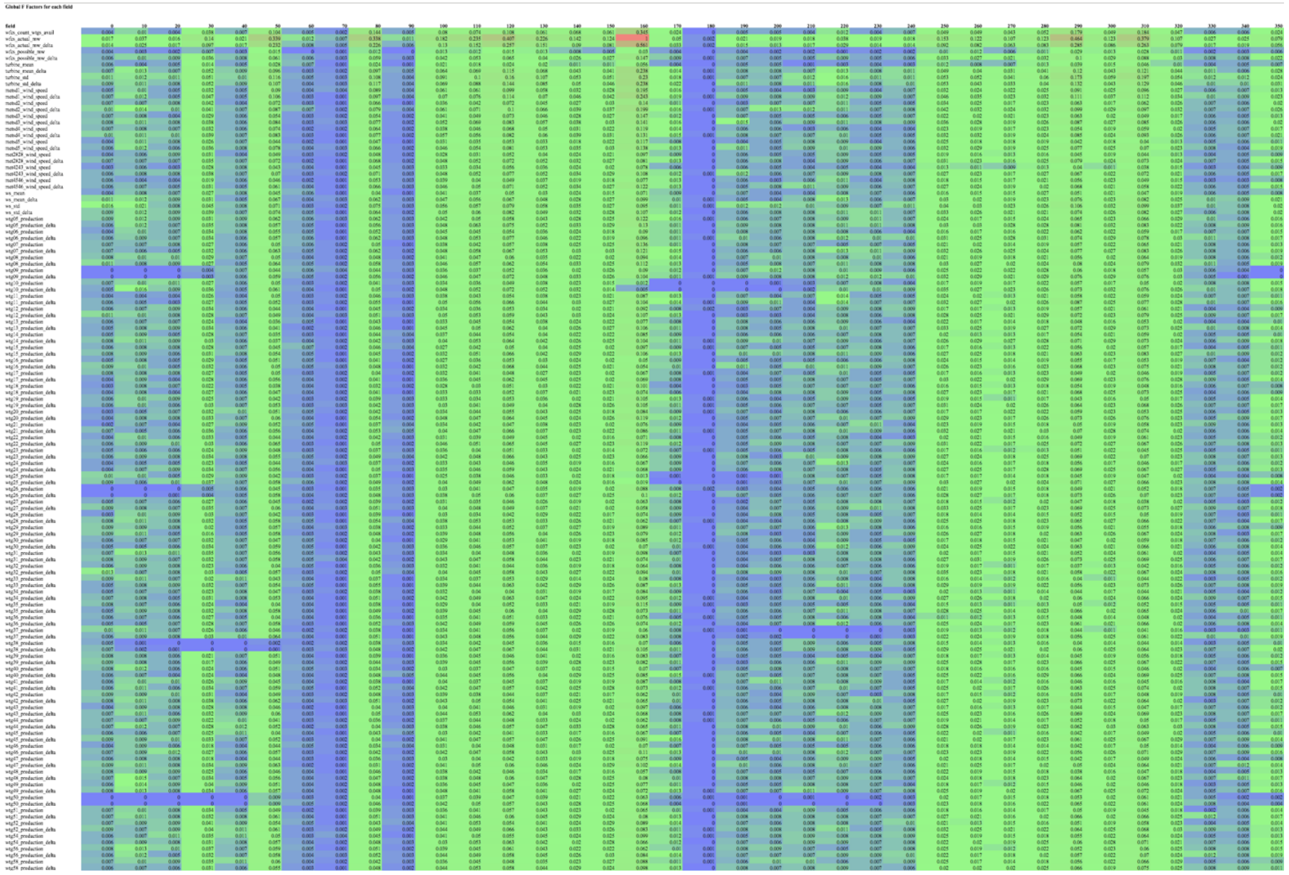
ANN & SGB SITE MODEL APPROACH

- REMOVED INDIVIDUAL TURBINE CLUSTERS
- MODEL FORECASTS USING EITHER SGB OR ANN MODEL
- MODELS PRODUCED A RANGE OF FORECASTS UNDER DIFFERENT DYNAMIC CONDITIONS:
  - RSME IMPROVEMENT OF MIN 7.6% MAX 19.9% MEAN 14.2%
  - MAE IMPROVEMENT OF MIN 8.4% MAX 27.6% MEAN 14.6%
- SGB BETTER THAN ANN BY ABOUT 3%
- REMOVED THE POOR PERFORMANCE FOR SOME WIND DIRECTIONS THAT OCCURRED IN THE PREVIOUS MODEL

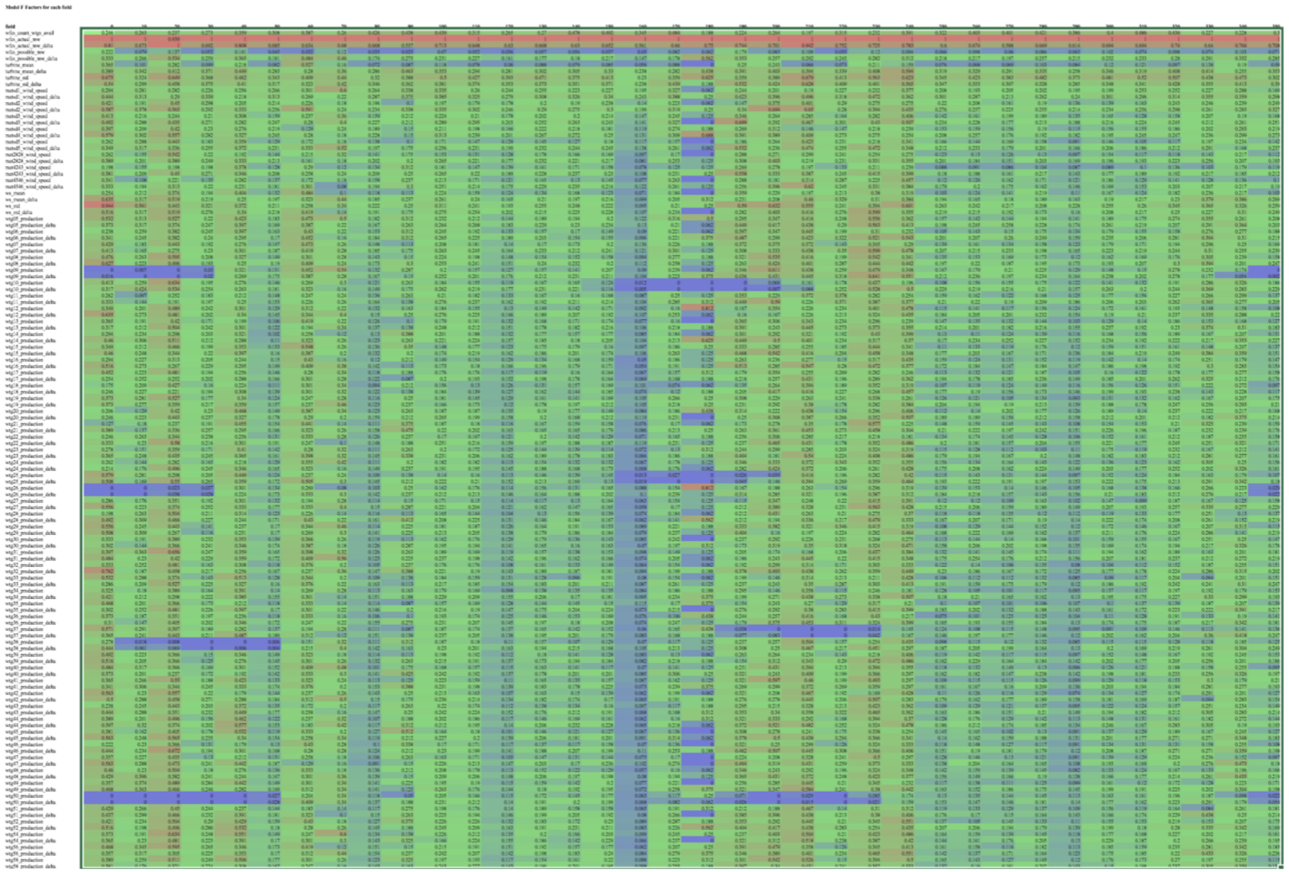
ERROR DISTRIBUTION BY WIND DIRECTION



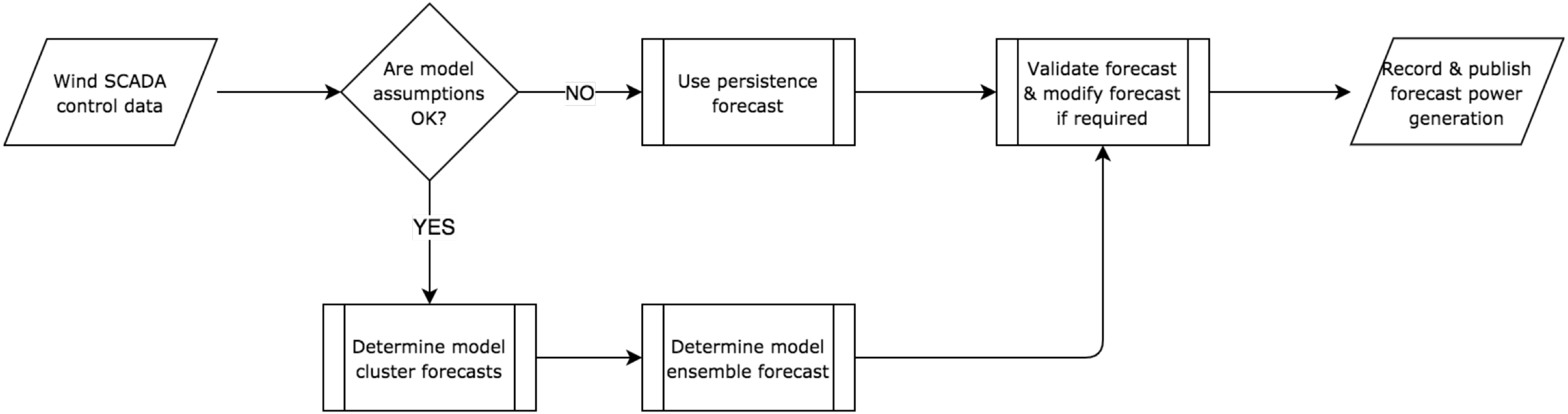
GLOBAL F FACTOR DISTRIBUTION



F FACTOR DISTRIBUTION BY WIND DIRECTION



MODEL PRODUCTION PROCEDURE



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