Synthetic Wind Traces

30 August 2023

Forecasting Reference Group Meeting

Purpose and agenda

The purpose of this presentation is to *inform* the FRG on AEMO's work on synthetic wind traces.

Today's agenda includes:

- Purpose of Variable Renewable Energy (VRE) traces
- Process for developing wind traces
- Renewable Energy Zones (REZ) resource quality and site selection
- Offshore wind

What are wind traces?

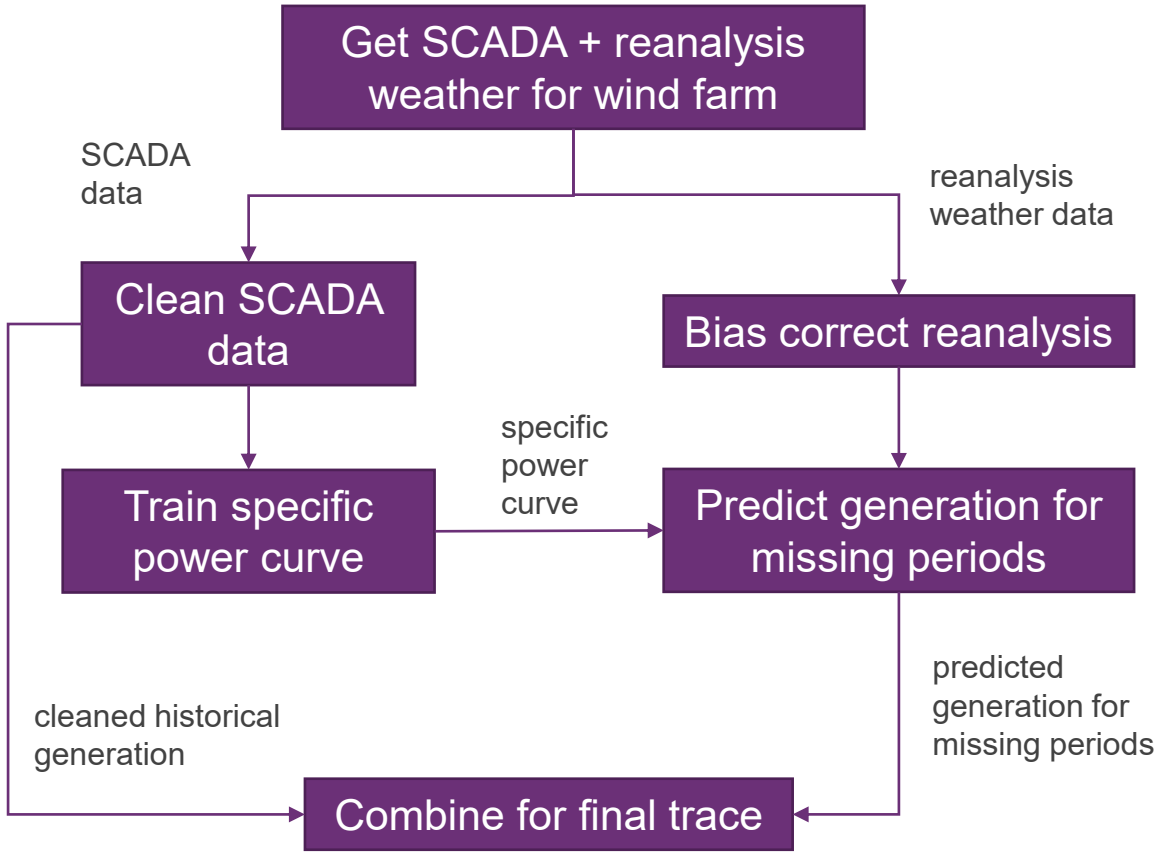
- 30-minute unconstrained generation profiles for wind farms
  - Used in market modelling to represent a wind farm's expected availability in each period of the modelling horizon
- One trace per wind farm and historical reference year (2010-11 to 2022-23)
- Data sources:
  - SCADA – actual generation, wind speed and temperature (existing wind farms)
  - ERA5 reanalysis from ECMWF – gridded hourly wind speed and temperature from 1940 to 2023. Wind speed data is further adjusted to give improved spatial granularity.

How are they applied?

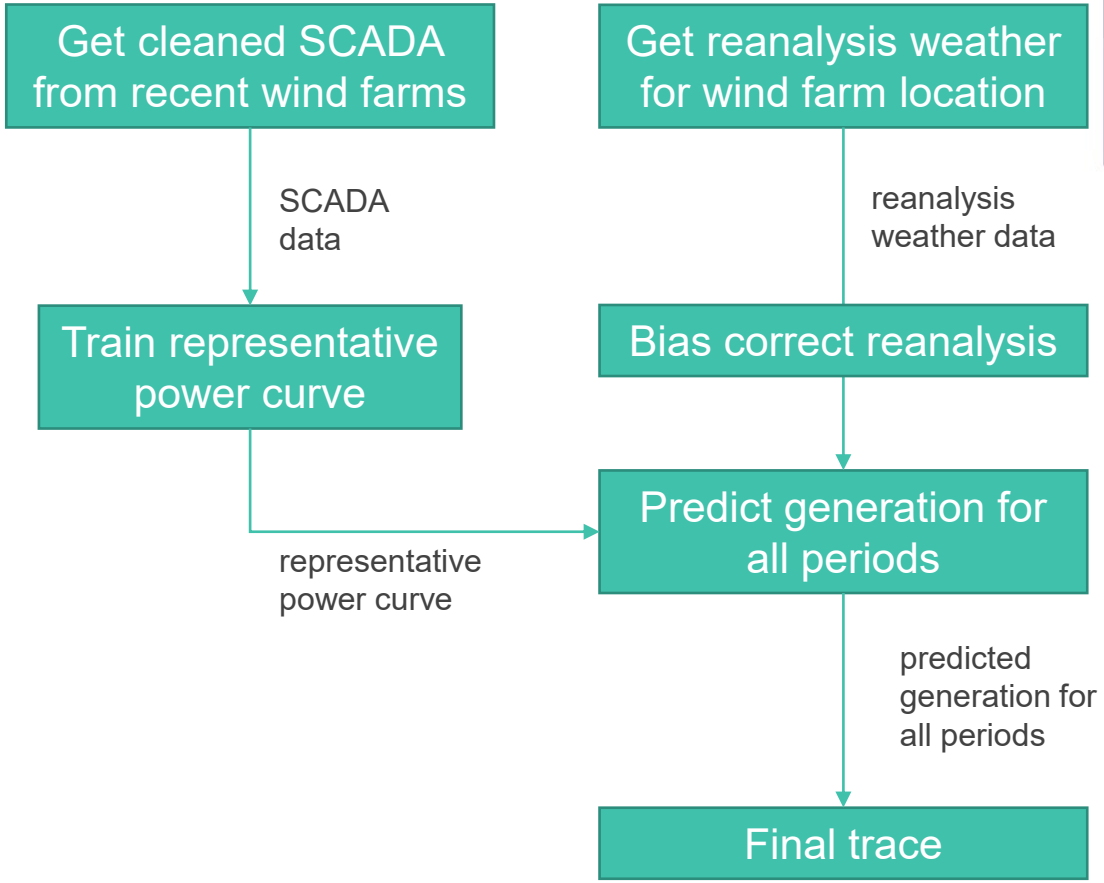
- **Existing wind farms** – use actual generation data *where suitable*. Gaps are filled using weather data and a power curve specific to each wind farm.
- **Committed, anticipated, REZ** – use weather data and a representative power curve
  - The representative power curve is trained on SCADA data from a selection of recent wind farms and is intended to be representative of expected technological performance.

Process for creating traces

Existing wind farms



Committed, anticipated, REZ wind farms

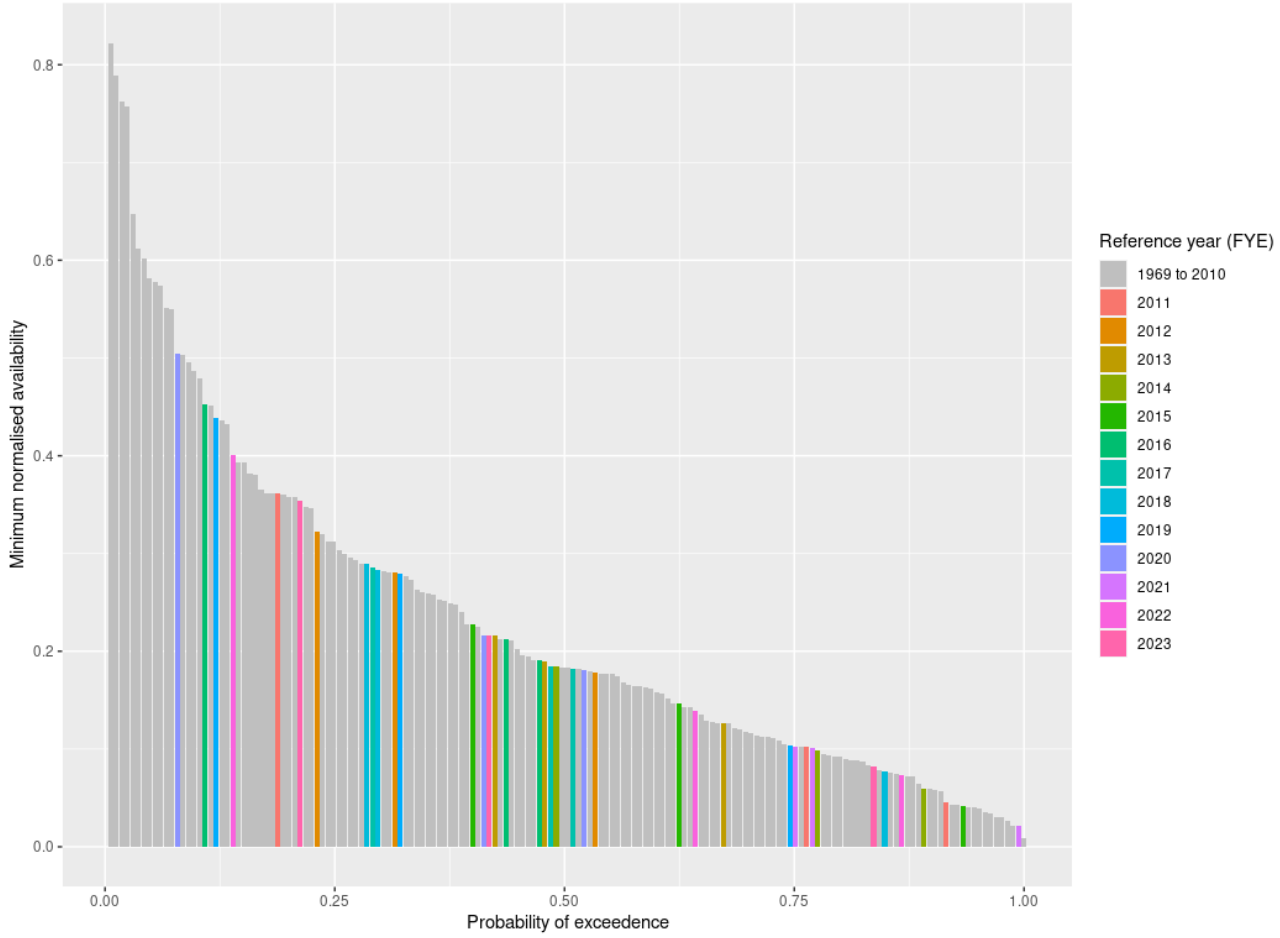


Wind farm power curves

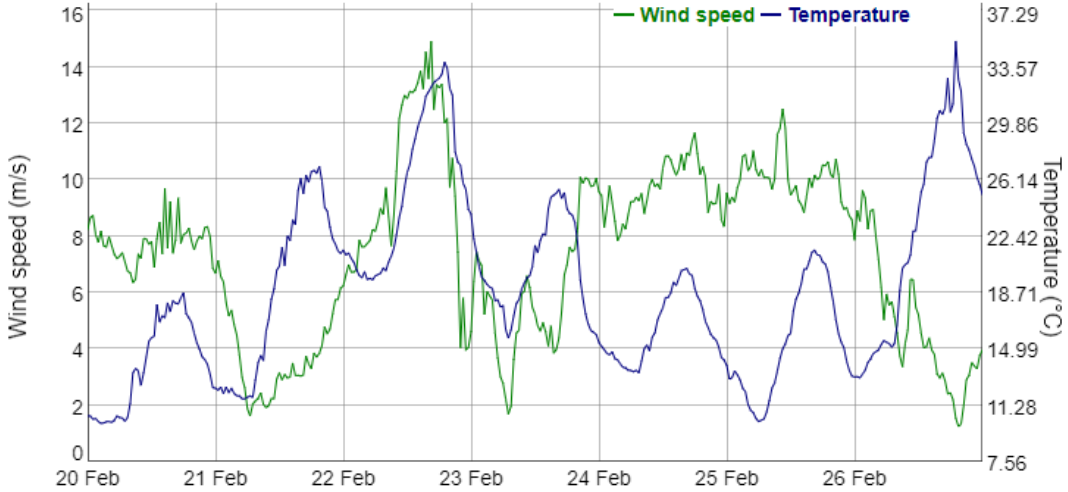
- Resource to power conversion model, trained on SCADA data using machine learning
- Each existing wind farm has its own power curve, plus one representative power curve for all others
- **Inputs:** wind speed, temperature
- **Output:** normalised generation (as a percentage of installed capacity)

Representativeness of reference years

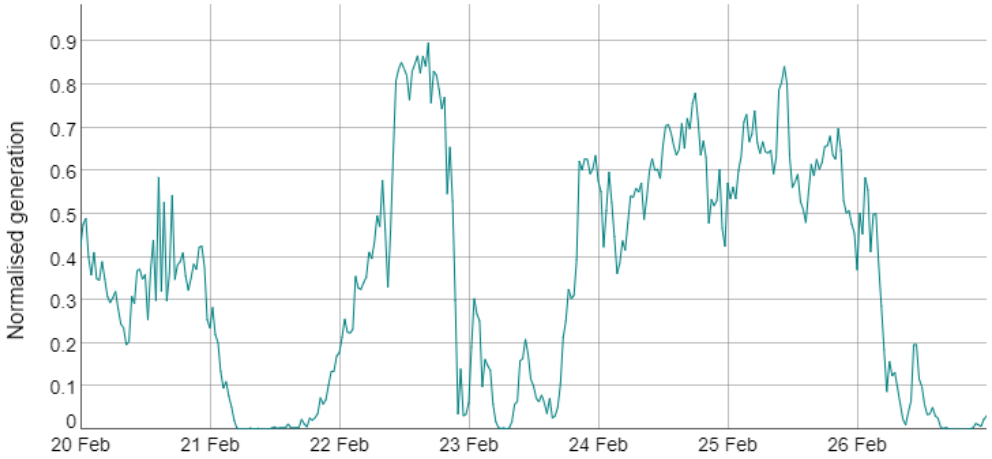
- AEMO's market modelling uses the historical reference years 2010-11 to 2022-23
- Analysis was recently done on how wind farms would be expected to perform under weather conditions prior to 2010
- This chart shows the minimum availability of Victorian wind farms during the evening (6-9PM), for each of the three hottest days of each reference year since 1968-69
- The days covered by AEMO's set of reference years are highlighted, and suggest reasonable coverage of the range of conditions observed over the past 50+ years



Wind trace creation



Wind speed and temperature passed into the power curve model as inputs



Model predicts normalised generation

REZ resource quality

- Largely driven by average wind speeds
- Fed into the market models as traces for new REZ generation candidates that the model can choose to build
- Summarised as capacity factors in the IASR workbook for each technology / REZ / reference year

Go to Assumptions Summary

Capacity factors for new large-scale renewables

Approximate capacity factors of solar and wind technology based on renewable resource quality. Capacity factors depend on the reference year modelled and are presented below for reference years where data is av

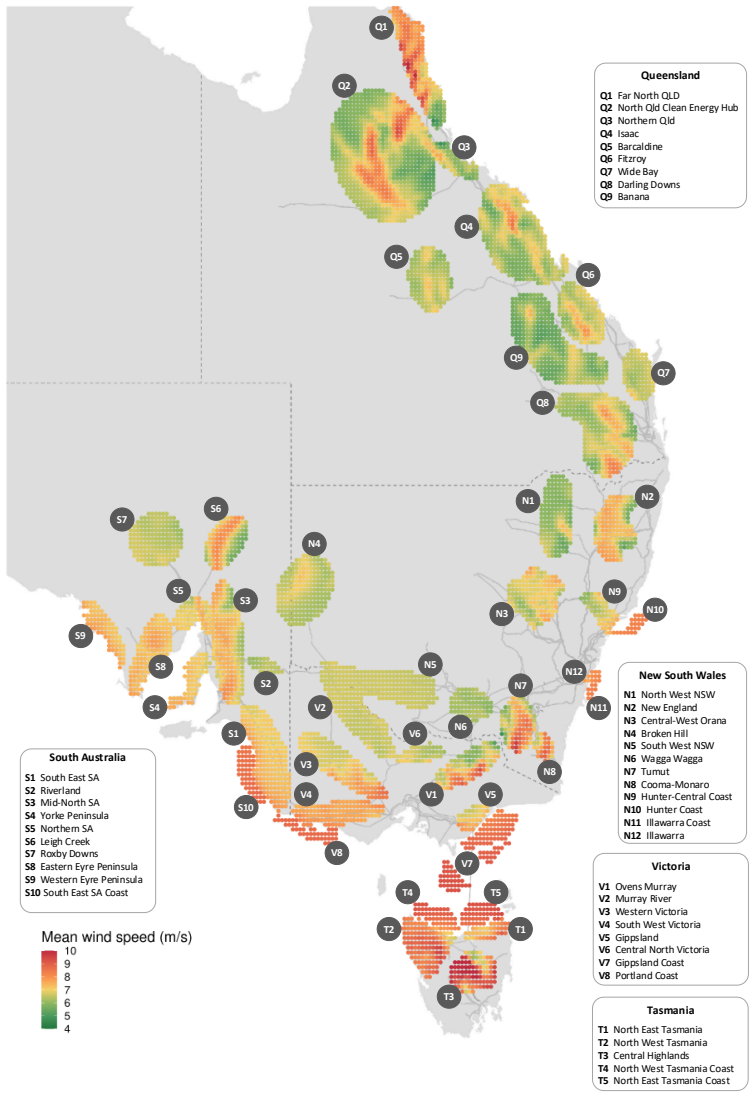
Capacity factors are static for all installations. Changes in capacity factor due to technology improvement or natural reduction in preferred installation sites are not modelled.

Capacity factors are only included for REZs and technologies where the build limit is above 0 MW.

Wind High																
REZ ID	REZ Name	Region	Reference year (Financial year ending)													Avg of ref years
			2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
Q1	Far North QLD	QLD	43%	46%	47%	49%	48%	43%	46%	49%	49%	46%	44%	42%	42%	46%
Q2	North Qld Clean Energy Hub	QLD	41%	42%	43%	45%	43%	39%	41%	43%	45%	41%	41%	38%	39%	42%
Q3	Northern Qld	QLD	Resource limit of 0 MW													
Q4	Isaac	QLD	32%	32%	34%	37%	34%	33%	34%	34%	39%	33%	36%	35%	34%	34%
Q5	Barcaldine	QLD	33%	31%	35%	34%	35%	32%	32%	33%	36%	31%	32%	31%	30%	33%
Q6	Fitzroy	QLD	37%	38%	37%	37%	37%	35%	36%	35%	41%	34%	38%	36%	35%	37%
Q7	Wide Bay	QLD	30%	30%	30%	28%	29%	28%	28%	29%	31%	27%	29%	29%	29%	29%
Q8	Darling Downs	QLD	38%	37%	37%	35%	38%	36%	35%	37%	39%	36%	38%	40%	38%	37%
Q9	Banana	QLD	30%	30%	30%	29%	30%	28%	29%	30%	32%	28%	30%	30%	28%	30%
N1	North West NSW	NSW	Resource limit of 0 MW													
N2	New England	NSW	39%	36%	38%	36%	37%	37%	37%	38%	39%	38%	40%	41%	39%	38%
N3	Central-West Orana	NSW	37%	34%	35%	34%	35%	34%	34%	36%	35%	37%	36%	37%	36%	35%
N4	Broken Hill	NSW	30%	32%	32%	33%	32%	31%	31%	33%	31%	32%	32%	32%	31%	32%
N5	South West NSW	NSW	27%	29%	29%	31%	28%	28%	29%	31%	31%	31%	30%	30%	29%	29%
N6	Wagga Wagga	NSW	27%	27%	26%	28%	27%	26%	26%	28%	28%	28%	27%	27%	27%	27%
N7	Tumut	NSW	Resource limit of 0 MW													
N8	Cooma-Monaro	NSW	40%	39%	42%	43%	40%	41%	41%	44%	42%	41%	42%	42%	43%	41%

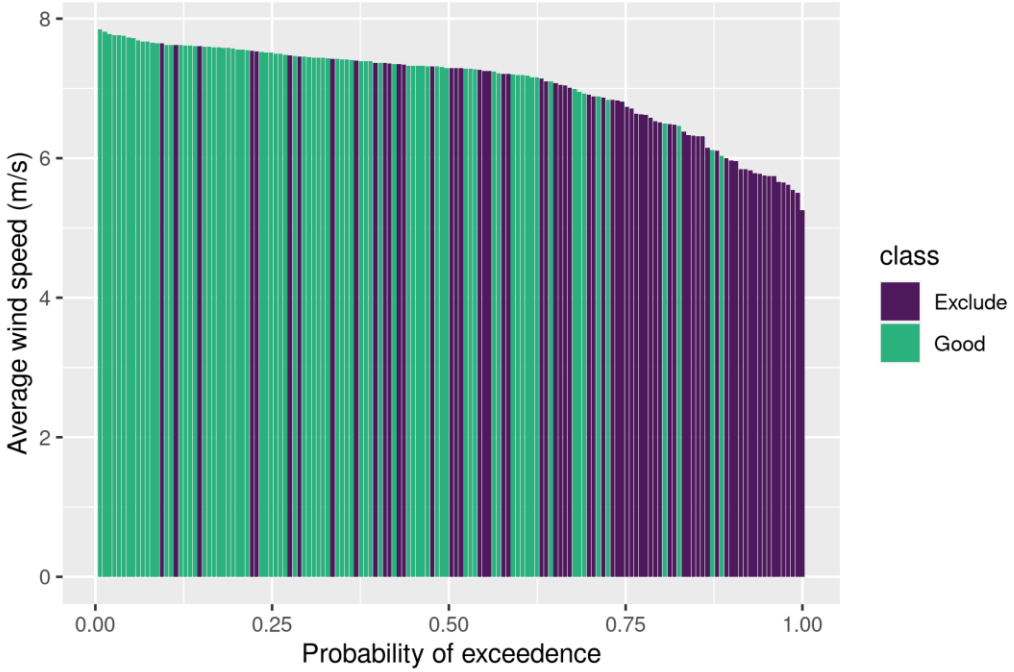
... Build costs | Locational Cost Factors | Lead time and project life | Financial parameters | Capacity Factors | Connection cost | Connection Costs forecast | REZ

VRE capacity factors. Source: IASR workbook, Capacity Factors sheet

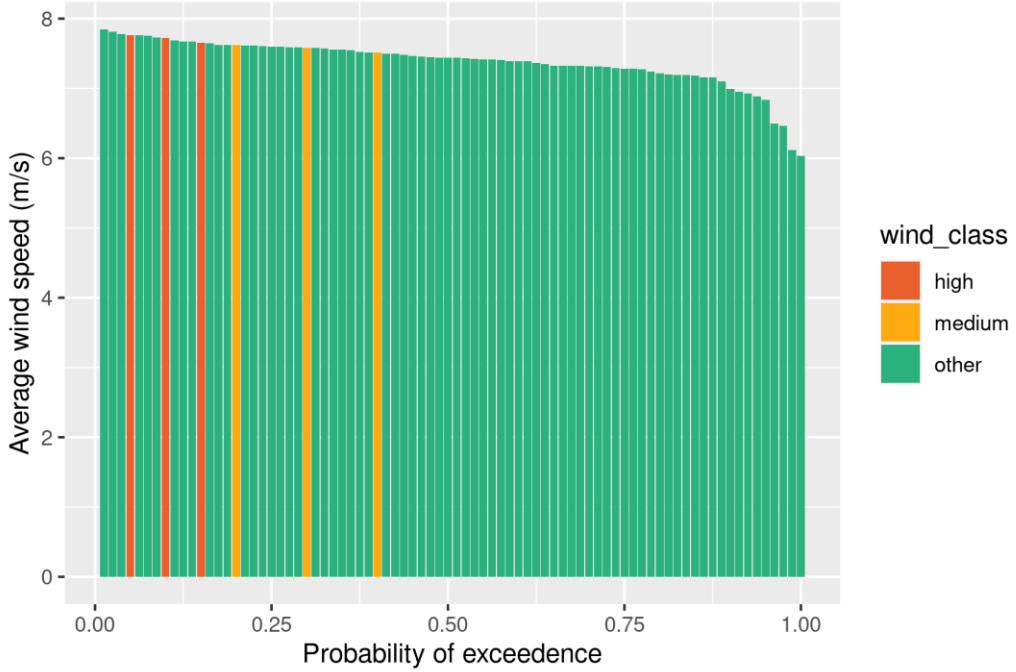


Average wind speeds at hub height
Source: 2023 IASR, Figure 51, page 121

Onshore wind REZ site-selection



Identify and filter out sites to exclude based on land use dataset (e.g. those in national parks, world heritage sites, or near residential areas / airports)



Select high and medium wind sites from remaining sites based on average wind speed percentiles

REZ site-selection process for onshore wind

- REZs are divided into two tranches (**high** and **medium** quality wind sites) to represent varying resource quality within onshore REZs. Build limits are applied to each tranche to ensure better resources are not overbuilt.

Site-selection process:

1) Rule out unsuitable sites based on a land use dataset – considers factors such as environmental complexity, cultural heritage, proximity to airports and residential areas
2) Get resource quality (average wind speed) for all remaining sites
3) Rank sites based on resource quality and choose the high and medium wind sites
   - High and medium sites are chosen using percentiles, which are calibrated to align with historical performance from better performing wind farms in the NEM
4) Generate traces for each site and average across each REZ and tranche

Offshore wind

- Split into two categories:
  - **Fixed offshore wind** – ocean depths of less than 70m
  - **Floating offshore wind** – ocean depths between 70m and 1,000m
- One tranche per category (no high / medium split) as resource quality is a lot more uniform within offshore REZs
- Assumes a higher hub height of 250m (compared to 150m for onshore wind)
- Site-selection is performed using a similar process to onshore wind, with percentiles calibrated to align with expected performance from data supplied by offshore wind developers

Discussion

Put your comments or questions in the chat, or raise your hand.

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