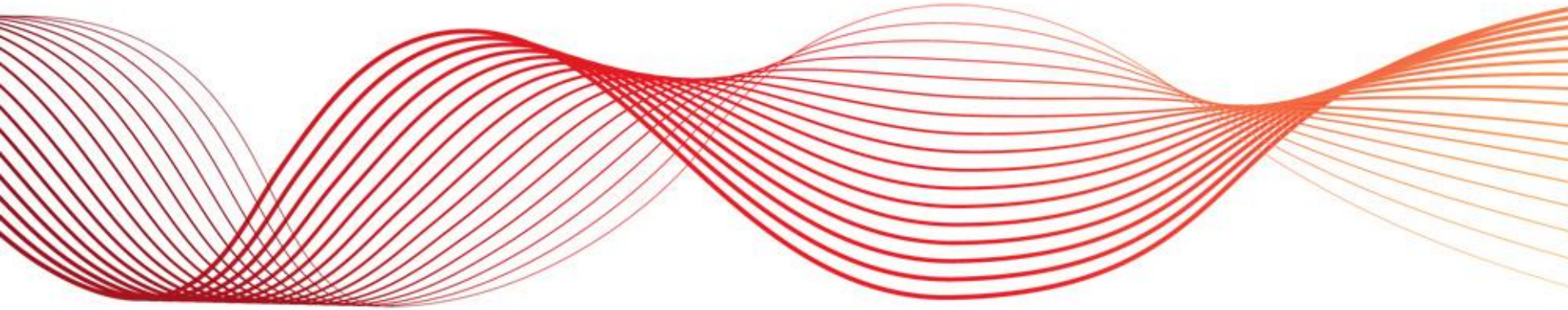
WIND/SOLAR FARM VENDOR DISCUSSION

20 March 2017

Updated with correction to slide 11



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AGENDA

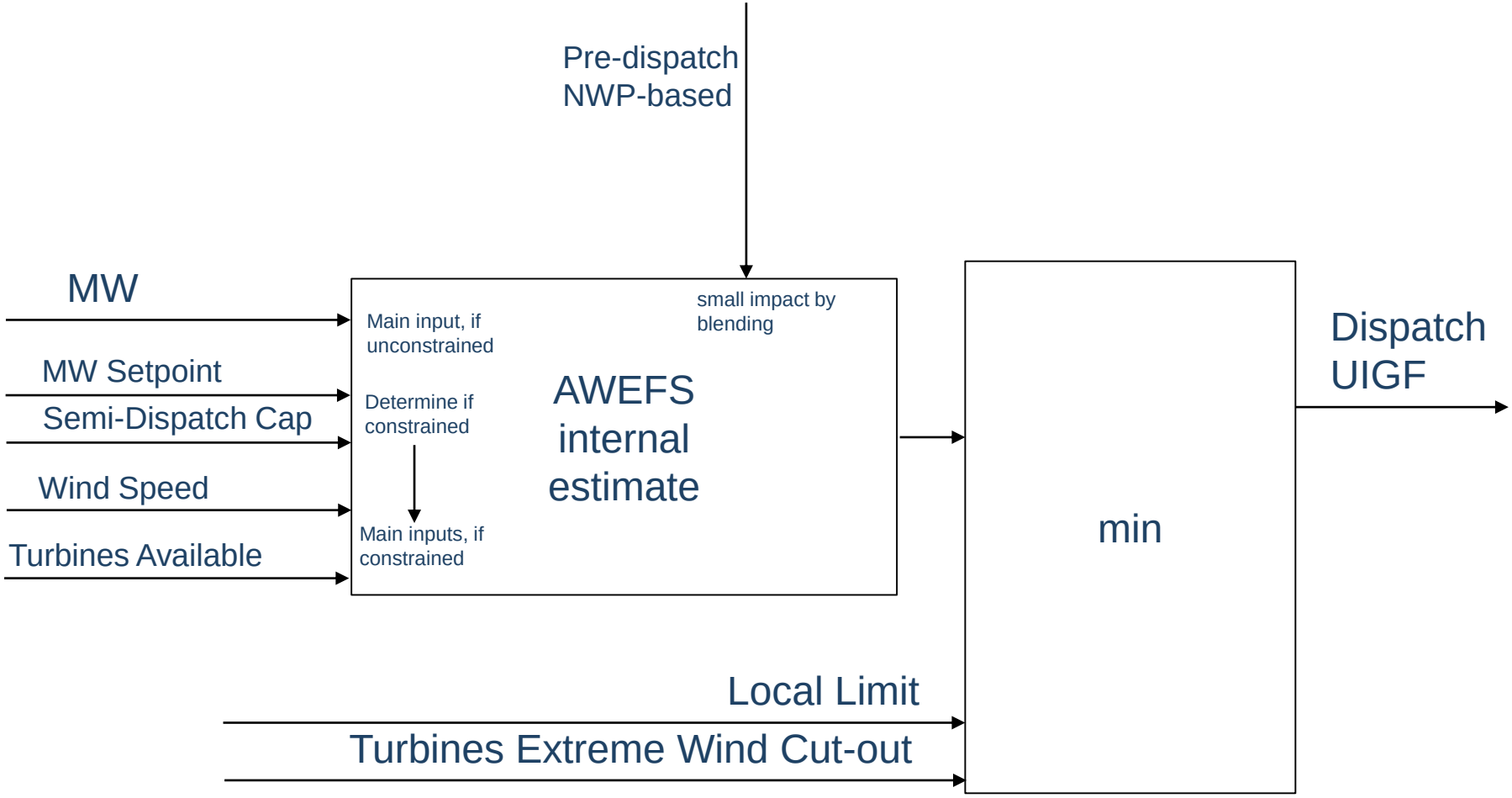
- Welcome
- Introductions & roll call
- SCADA requirements under the Energy Conversion Model (ECM)
- Estimated Power concept
- Possibilities for forward forecasting (5 min +)
- Next steps and other questions

ENERGY CONVERSION MODEL

- All semi-scheduled wind and solar farms provide an "ECM"
  - Used by AWEFS/ASEFS to calculate forecasts
  - Rules requirement
  - Modified only by formal consultation
- Spreadsheet listing static parameters (location of farm, size of turbines / panels, etc)
- Set of SCADA signals
- Current – December 2016: http://aemo.com.au/Stakeholder-Consultation/Consultations/Energy-Conversion-Model-Guidelines-Consultation---Wind-and-Solar-Farms

CURRENT STATE OF AWEFS & INPUTS – FOR DISPATCH FORECAST

This is an approximation of the logical behaviour – not to be taken as the actual design



SCADA – ACTIVE POWER

- From the ECM:
  - Farm level: “Total wind farm active power”, “Active power generation per facility”
  - Cluster level: “Total cluster active power”

SCADA – MW SETPOINT

- From the ECM:
  - **MW set-point applied in the wind/solar farm's control system to limit (down regulate) its output. At other time when no limit applies, the set-point to be set to above the wind/solar farm's nameplate rating, but below 250% of it.**
- MW Setpoint tells AWEFS/ASEFS when the farm's output is MW limited for any reason.
  - Reasons include:
    - Semi-dispatch cap signal from AEMO (i.e. the wind/solar farm must stay under the dispatch level for this dispatch interval, usually due to a binding network constraint)
    - Transmission/distribution network constraint
    - MW Limit local to the farm e.g. transformer outage, DVAR outage
- The dispatch forecast **is not capped** by the MW Setpoint value.

SCADA – TURBINES / INVERTERS AVAILABLE

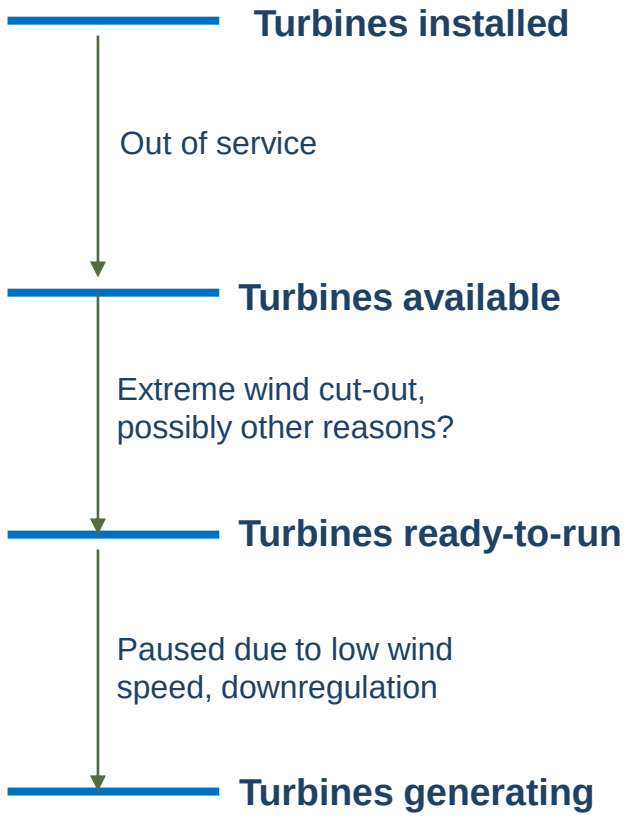
- From the Solar ECM:
  - Per cluster
    The number of inverters that are available to deliver active power if sufficient sunlight is available
- From the Wind ECM:
  - Number of turbines available for generation. This definition is the summation of:
    • Turbines operating
    • Turbines available to operate, but not operating due to ambient wind conditions (very low / high wind speeds, extreme direction change)
    • Turbines available to operate, but paused due to down regulation.

    This definition excludes all the following cases:
    • Turbines under maintenance or repair
    • Turbines with a fault or damage
    • Turbines not yet built
    • Transmission/distribution network not available

    If agreed with AEMO, turbines paused due to ambient temperature may be counted as available in this signal.
- Used for two purposes:
  - Calculating the dispatch forecast
  - Adjusting the measured MW by turbines available to use in tuning the pre-dispatch & PASA statistical models

SCADA – TURBINES / INVERTERS AVAILABLE

- Questions on the detail of these?
  - What do you currently send?
- Wind question: To improve dispatch accuracy:
  - Define a “Turbines Ready-to-Run” SCADA
    - For input into the dispatch forecast calculation
    - Turbines that are actually able to run
      - In service
      - Not currently paused due to cut-out
      - Not currently in error



SCADA – WIND SPEED / IRRADIANCE

- From Solar ECM:
  - Same orientation of the panel
    Per cluster
    Measured using a ISO First class pyranometer
- From Wind ECM:
  - Measurements from turbine nacelle anemometers are much preferred over measurements from meteorological mast(s).
    SCADA Wind Speed – Farm level is a single wind speed measurement, which must be representative of wind conditions across the site for calculation of dispatch UIGF. For large wind farms, an average of several turbine nacelle wind speed measurements may be used to achieve this. **Ideally this average is of all turbine nacelles**, or of several geographically-distributed meteorological masts.
    The measurement is considered representative if, on the advice of the AWEFS vendor, the wind speed measurement is sufficiently stable and there is adequate correlation between the wind speed measurement and the farm's active power output when not downregulated.
- For wind – average of all turbine nacelles as preference is new in this ECM version.

SCADA – LOCAL LIMIT

- From ECM:
- In MW, the SCADA Local Limit for a wind farm is the lower of its *plant availability* and all technical limits on the capacity of its connection assets to export energy.
- When implemented in AWEFS, the SCADA Local Limit is used to cap the UIGF for the wind farm in the dispatch timeframe.
- The SCADA Local Limit excludes limits on a *transmission network* and *distribution network* (to ensure AEMO's compliance with clause 3.7B(c)(6) of the Rules), and may exclude other limits managed by AEMO through the central dispatch process.
- Limits already communicated in the SCADA Turbines Available signal may be excluded from the SCADA Local Limit.
- Manually-applied transient limits not intended to apply at the end of the next dispatch interval may be excluded from the SCADA Local Limit.
- The SCADA Local Limit should not exceed the higher of the *nameplate rating* and the Maximum Capacity of the wind farm.

SCADA – LOCAL LIMIT

- In short:
  - Tell us any **technical** MW limit to the output of the wind / solar farm
    - DVAR outage limiting active power output
    - one of several transformers out of service
    - internal cable de-rating
  - AWEFS/ASEFS dispatch forecast **is capped** to this limit
  - Must exclude distribution and transmission network limits
  - If you only have a manual process to apply such limits, a manual SCADA Local Limit signal is acceptable.
- Will be implemented in AWEFS/ASEFS likely early April 2017

SCADA – TURBINES EXTREME WIND CUT-OUT

- Wind ECM (Optional signal)
  - This is the number of turbines counted in the Turbines Available signal that are currently in cut-out mode due to extreme high wind speed or extreme wind direction change.
    If agreed with AEMO, this signal may be provided at a farm level. If agreed with AEMO, extreme wind direction change may be excluded.
- Improves the accuracy of AWEFS forecast for next dispatch interval.
- Will be implemented in AWEFS likely early April 2017

SCADA - ESTIMATED POWER

- New optional SCADA signal: wind or solar generator's estimate of active power generation at the end of the next dispatch interval, assuming no network constraints
- **Critical implementation requirements:**
  - When generator is constrained (e.g. by Semi-Dispatch Cap), Estimated Power represents the **unconstrained forecast**.
  - When turbines are in **high-wind cut-out** and not coming back next dispatch interval, the Estimated Power reflects this.
- Questions:
  - What do you have that's like this?
  - Do you have a "current" estimate e.g. "Possible Power"?
  - What could you do in the future?

FORWARD FORECASTING

- “Estimated Power” technically refers to a forecast for the end of the next dispatch interval
  - Around 5-7 minutes ahead
- AEMO also produces 5MPD (5 minute pre-dispatch) forecasts for 5 minute intervals out to 2 hours.
  - Wind or solar farms may be able to provide good data for the first few 5-minute intervals with emerging technologies.

NEXT STEPS

- Informal consultation continuing
- Further meetings will be arranged to discuss Estimated Power implementation approaches
- Please send follow-up questions and ideas by email to op.forecasting@aemo.com.au