Relevance of forecasting for delivery of secondary control (aFRR) by wind farms

Wind Power Forecasting workshop 2015, EWEA

Jan Voet

Agenda

Introduction to aFRR- Wind technical pilot project

Ancillary services in Belgium

- Context
- aFRR product

aFRR provision by windfarms

- Concept & challenges
- Technical results
- Relevance of forecasting & market results

General conclusions

aFRR- Wind project: technical pilot project

Involved parties	Owner wind farm of Estinnes Manufacturer wind farm BRP R2 contract TSO
Scope of pilot project	• Check technical capability of wind farms to provide downward aFRR • Focus on downward regulation due to loss of green certificates • Perform a two month period test where wind farms participate in downward secondary control (aFRR-) at Elia
Wind farm of Estinnes	• Direct driven (variable speed) synchronous generator / full convertor • 10 x Enercon E-126: 7,5 MW • 1 x Enercon E-126: 6 MW

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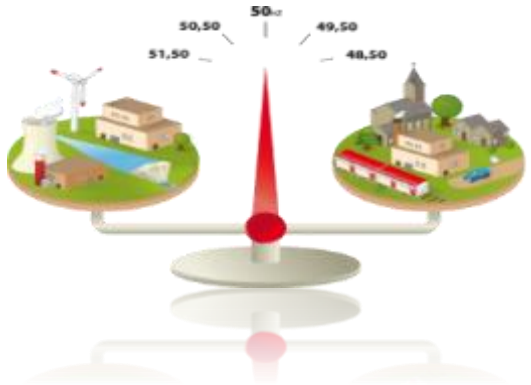
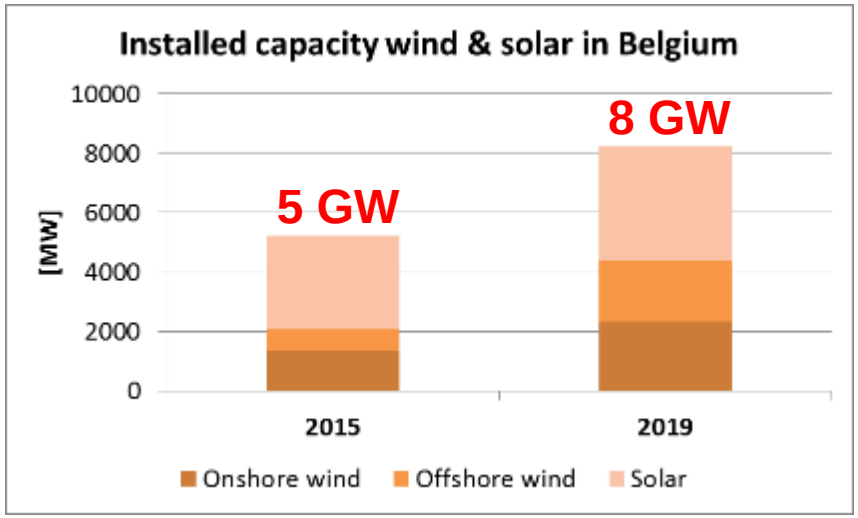
Ancillary services in Belgium: context (1)

Keeping the balance between generation and offtake



With increasing volumes of renewables in the grid



Large scale integration of intermittent renewables represents a balancing challenge…

… intermittent renewables CAN BE flexible and should be part of the solution

BE peakload:
13 – 14 GW

High share of non-flexible baseload

Ancillary services in Belgium: context (2)

TSO contracts reserve capacity for balancing its control area

- Primary reserves (Frequency Containment Reserves, FCR)
- Secondary Reserves (Automatic Frequency Containment Reserves, aFRR)
- Tertiary Reserves (Manual Frequency Restoration Reserves, mFRR)

In Belgium the contracting of aFRR capacity (spinning reserves) often leads **to start-up of gas units, that are out of the money**, to **deliver the service** to the TSO

- Situation leads to high “must run”-costs

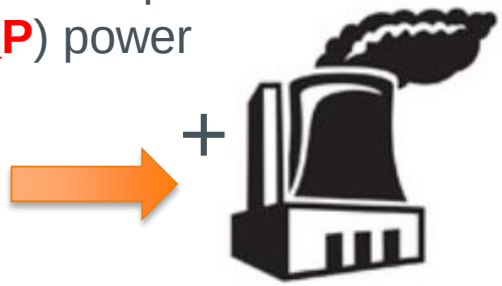
Hence diversification of aFRR resources should be considered:

- Biomass, cogeneration, demand side,…
- **Renewables: wind**, solar

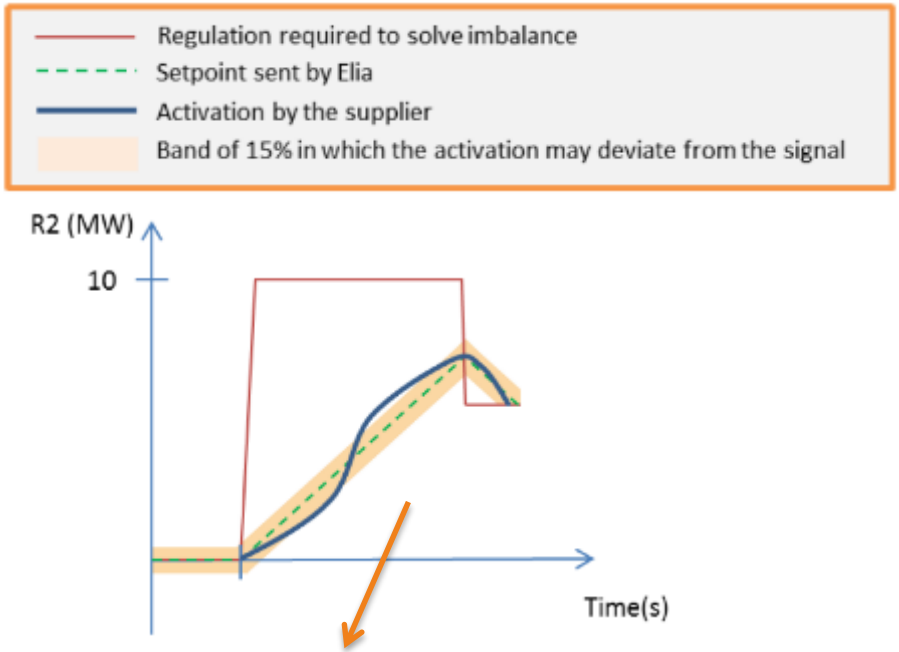
Ancillary services in Belgium: aFRR product

Pref power profile (defined by producer for own purposes)

Elia aFRR setpoint (**delta_P**) power profile



Required power output profile of the unit



- Providers must **deliver the Elia aFRR delta_P setpoint (power profile) on top of their Pref (for own purposes)**
- **Elia aFRR delta_P setpoint**
  - is sent every **4 sec**
  - respects a **full activation time of 7,5'**

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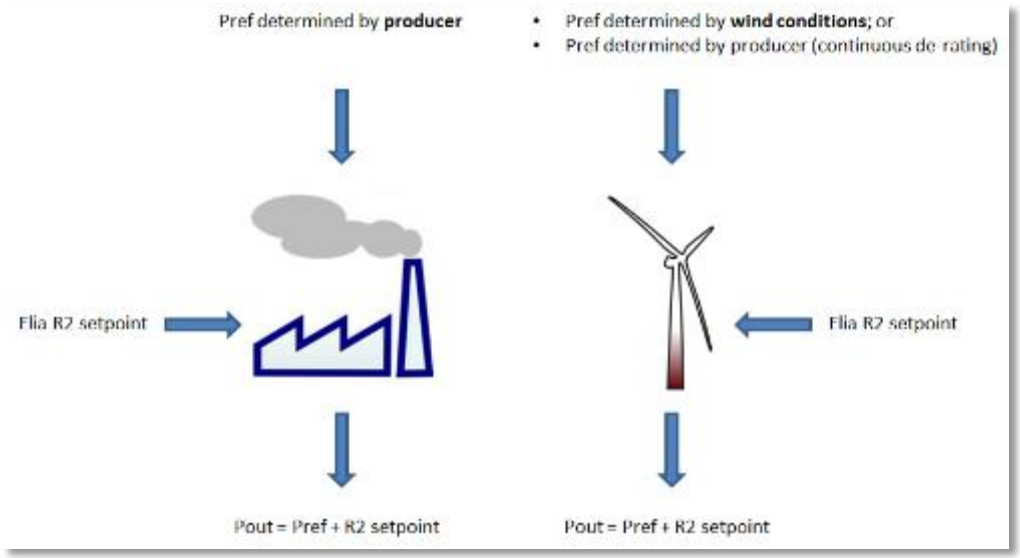
aFRR- delivery by wind: concept



Baselining: for a windfarm the Pref isn't known

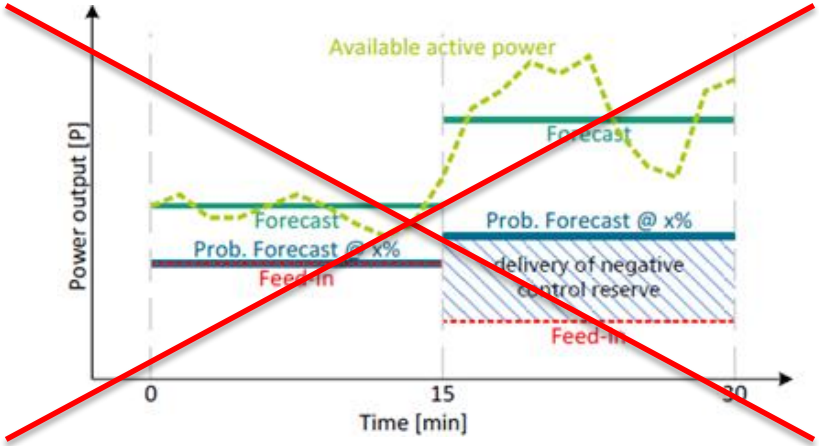
Balancing control mechanism:

- Continuous de-rating towards Pref (starting point for regulation) with high forecasting reliability

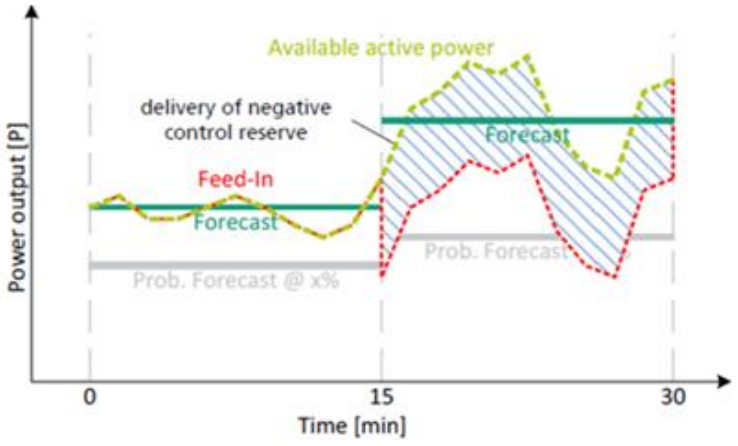
Active Available Power (AAP) mechanism:

- Calculation of the Pref on the basis of power infeed, pitching of the blades, windspeed; or physical model

Balancing control mechanism



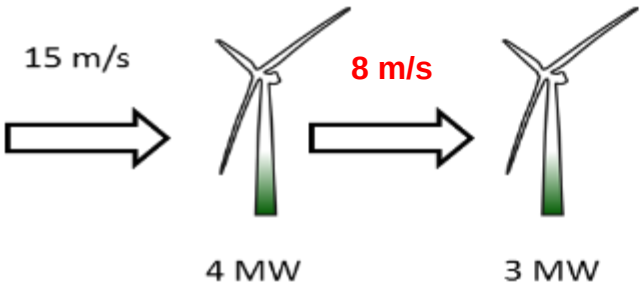
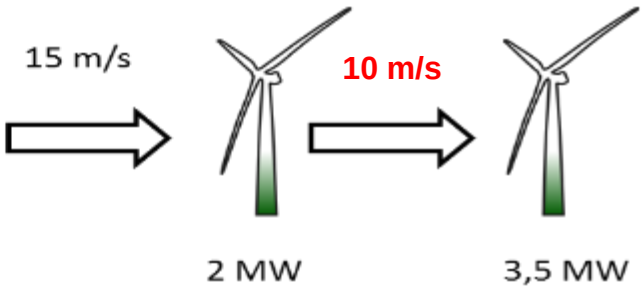
AAP mechanism



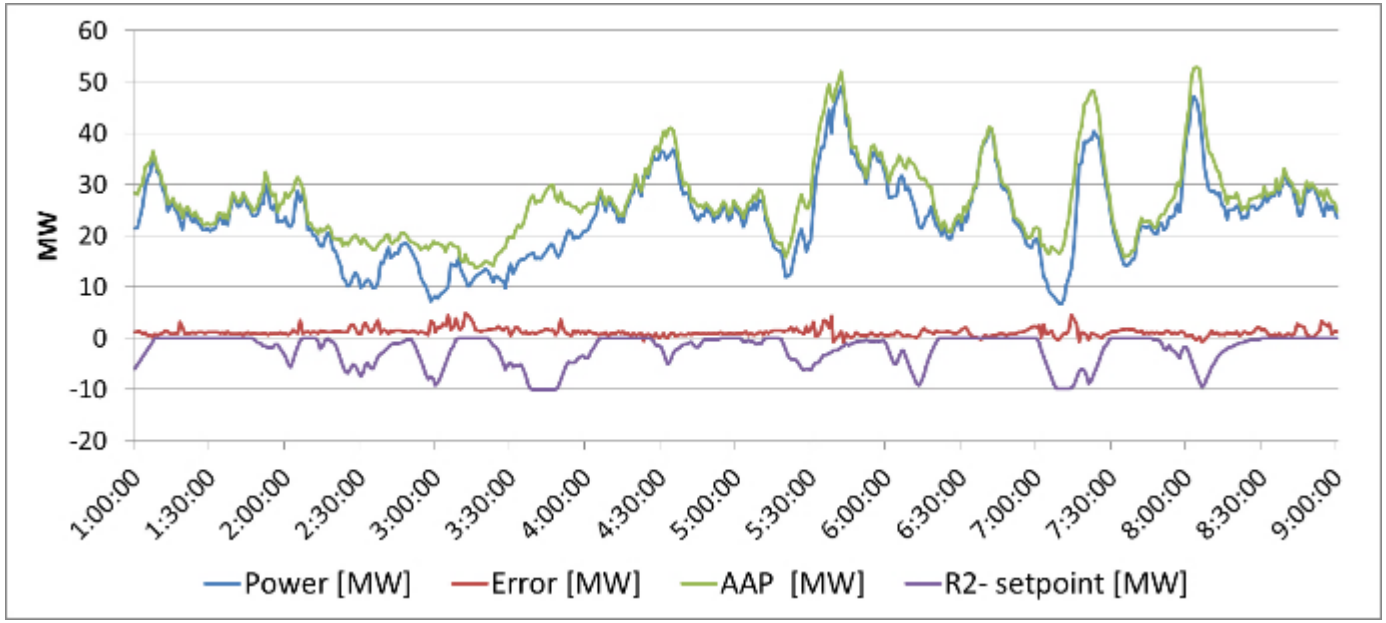
Source: Jansen, M., Speckmann, M., "Wind turbine participation on control reserve markets", EWEA 2013, February 4-7 2013, Vienna, Austria

aFRR- delivery by wind: challenges

- ✓ **Loss of green certificates in case of downward curtailment**
- ✓ **Intermittency of wind production / reliability of R2 nominations**
- ✓ **Curtailment on specific windmill can impact (increase) production of other windmills in the park (windfarm effect)**

Non-curtailed conditions	Curtailment of 2 MW on first wind turbine
	

aFRR- delivery by wind: technical results



AAP

Infeed

Error

Elia aFRR setpoint

Wind farms are highly flexible (low Pmin, high ramp rates,…) and can follow a set-point

- Promising performance of wind farm of Estinnes in providing aFRR- service to Elia

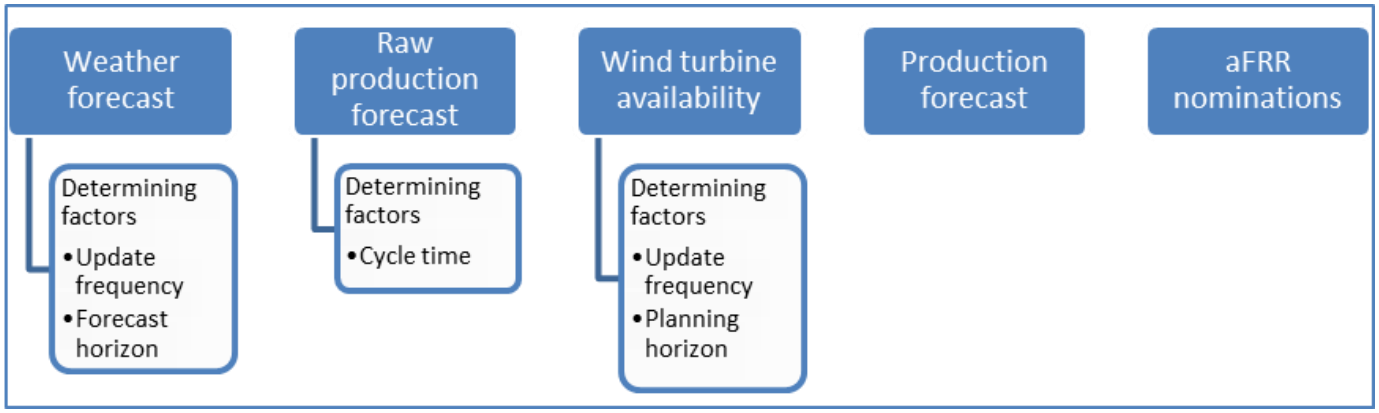
AAP quality, both under curtailed and non-curtailed conditions, is key:

- AAP is starting point for regulation; hence wrong estimation leads to incorrect delivery of the service. In general good performance during tests;
- Wind farm effect (overestimation of AAP during curtailment) to be avoided; and
- Some working points identified for AAP, but improvement towards future expected.

aFRR- delivery by wind: relevance of forecasting

TSOs require a reliable delivery of aFRR- service

- Ex-ante contracted aFRR- volume on a wind farm should be effectively available in RT



Production forecast

- Correction based on observed and expected inaccuracies (unstable clime conditions, unusual turbine behavior,…)
- Safety margin

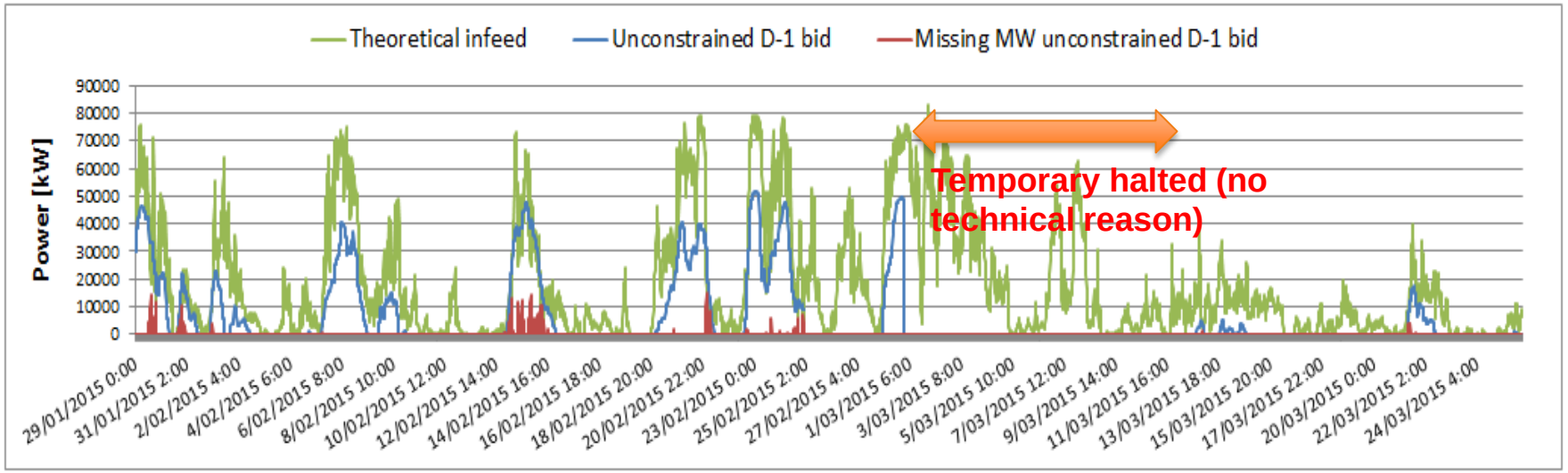
Adjusted production

Nominated aFRR down capacity

Less reliable forecast at low production levels

Relevance of forecasting & market results

- **High reliability of D-1 nominations: up to 99% reliable nominations for single windfarm**



- **Energy based support scheme acts as barrier for participation of wind farms in aFRR- capacity market in Belgium (under current aFRR market design)**
  - Loss of green certificates cannot be priced in the energy bid

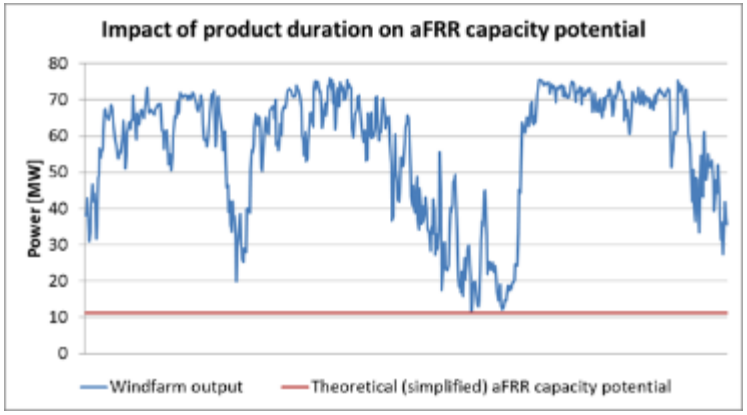
Bidding gate closure time & product resolution

Today in Belgium:

- Monthly procurement of aFRR capacity (obligation to submit aFRR energy bids in D-1)
- Product resolution: peak and long offpeak (incl. WE)
- GCT for aFRR energy bids: day-1 at 15h00

Pilot project shows that higher procurement cycle and lower product resolution would facilitate participation of wind in downward aFRR capacity market:

Weekly wind farm production



Potential of produced energy that could be offered as downward capacity (if perfect forecasting and no minimum power)

	Product duration / product resolution	Peak & long-off-peak	8h blocks	4h blocks
Onshore wind farm	Month	0%	1%	1%
	Week	4%	5%	8%
	Day	**34%**	**50%**	**65%**
BE aggregated offshore production	Month	1%	1%	1%
	Week	6%	7%	11%
	Day	**47%**	**65%**	**78%**

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Technical pilot project: general conclusions

Wind farms are highly flexible and can provide ancillaries to the grid

- High ramping / low minimum power / …

AAP method very promising to ensure efficient delivery of aFRR capacity by windfarms

- Pilot project elaborates some testing methods for AAP quality under curtailed and non-curtailed conditions

Pilot project identifies both technical and market aspects that need to be investigated further for provision of aFRR- capacity by windfarms

- How to handle loss of green certificates, transition to daily procurement of aFRR capacity, improvements for AAP calculation,…

Thanks for your attention!

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An Elia Group company

Enercon E-126	Product specifications
Type	• Directly driven (variable speed) synchronous generator • Full convertor
Hub height [m]	135
Rotor diameter [m]	125
Pitching mechanism	Independent pitching mechanism per blade
Braking	• Pitching • Rotor brake • Rotor lock
Cut-off speed [m/s]	28 - 34
Storm control	Yes
Yaw-control	Active via adjustment gears, load-dependent damping