Reactive Power Support & Control Requirements
Wind Turbine Manufacturer’s Observations

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Senvion’s North American Footprint

North America’s Senvion Fleet.
Over 2 GW proud.

Senvion Projects

01 QC, Senvion Montréal office
02 CO, Senvion Denver office
03 ON, Senvion Toronto office
04 ON, Senvion Kitchener Service Base
05 OR, Senvion Portland Warehouse
06 QC, Rivière-au-Renard, (2), 4 MW
07 QC, Saint-Robert-Bellarmin, (40), 80 MW
08 QC, Lac Alfred, (150), 300 MW
09 QC, Massif du Sud, (75), 150 MW
10 QC, Viger-Denomville, (12), 24 MW
11 QC, Du Granit, (12), 24 MW
12 QC, La Mitis, (12), 24 MW
13 QC, Mont-Rothesy, (37), 76 MW
14 QC, Rivière-du-Moulin, (175), 350 MW
15 QC, Pierre-De-Saurel, (12), 24 MW
16 QC, Mesg’g Ugu’s’n (MUS), (47), 150 MW
17 ON, Oxley, (3), 6 MW
18 ON, Springwood, (4), 8 MW
19 ON, Whittington, (3), 6 MW
20 ON, Napier, (2), 4 MW
21 ON, Grey Highlands ZEP, (5), 10 MW
22 ON, Ganaraska, (10), 20 MW
23 ON, Gunn’s Hill, (10), 20 MW
24 ON, Sumac Ridge, (5), 10 MW
25 ON, Settlers Landing, (5), 10 MW
26 ON, Grey Highlands Clean Energy, (9), 18 MW
27 ON, Snowy Ridge, (5), 10 MW
28 ON, Falmouth, (8), 16 MW
29 ON, White Pines, (29), 60 MW
30 BC, Pennask, (5), 15 MW
31 BC, Shinnish Creek, (5), 15 MW
32 WA, Goodnow Hills, (47), 96 MW
33 WA, Windy Point, (20), 41 MW
34 OR, Echo, (10), 20 MW
35 IN, Hoosier, (53), 191 MW
36 MI, Stoney Corners I/I/II/III, (22), 45 MW
37 WA, Linden, (25), 51 MW
38 NY, Howard, (27), 71 MW
39 CA, Pacific Winds, (70), 145 MW
40 OK, Canadian Hills, (73), 150 MW
41 MN, Community Wind South, (15), 31 MW
42 CA, Shiloh II, (75), 150 MW
43 CA, Shiloh III, (50), 102 MW
44 CA, Shiloh IV, (50), 102 MW
45 AK, Eva Creek, (12), 24 MW
46 PA, Twin Ridges, (68), 140 MW

*Installed capacity and projects under contract
Why is there a reactive power requirement?

How much of the installed reactive power capacity by wind power plant was used in the past 3 years?

- 100% - We need more?
- 50% - We can't use it all?
- 10% - Who needs reactive power?
- Depends on the project?

Let’s look at some data and discuss …
Wind Farm A – Cooperative control structure
Requirements HV $Q = \pm 0.33\text{pu} \ (PF = 0.95)$ and $V \pm 0.1\text{pu}$ Transferred to MV $Z_{tr} = 8.5\%$
Method used for reactive power support analysis from Senvion wind power plants

- SCADA operational data analysed for the last 4 years
- The maximum and minimum measured values within a 10min. period
- Only steady state operation is analysed

- **Green** data points – all measured values
  - envelope of green points
- **Blue** data points – measured values where wind power plant was operating at least 99.7% of the analysed time
  - envelope of blue points
Wind Farm A – 2 x controllers MV side – 168.1MW and 139.4MW = 307.5MW installed
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Wind Farm A - MV requirement and measurement
Relative costs for additional reactive power provided by external equipment

Each additional kVar costs additional money!

If it isn’t used it is a stranded investment.

* Source for the values – Senvion tenders for several wind power plants
Conclusions

- Significant difference in utilization of reactive power in all cases between dynamic and steady-state operation
- Significant differences within same geographical areas
- Dynamic range required for contingencies and installed capacity is available and should be used for ancillary services equally to conventional plants
- Project-specific cost-benefit analysis should be the basis for requirements

More system studies are needed:
- to understand unutilised installed reactive power
- to examine “Repowering” old generators instead of imposing new requirements
- to consider introduction of minimum steady state and larger dynamic ranges
- to consider Active Power dependent requirements
Conclusions

- Reactive power requirements should not exceed system needs to avoid stranded investments and increase in energy costs.
- Extra costs include visible costs (compensation equipment) and non-visible costs (larger turbine converter).
- Grid operators, state regulators, and industry representatives should join forces to ensure safe and cost effective requirements.
Thank you for your attention