Grid codes

Vestas

Grid Compliance and how Vestas turbines can meet the new grid Code demands

By

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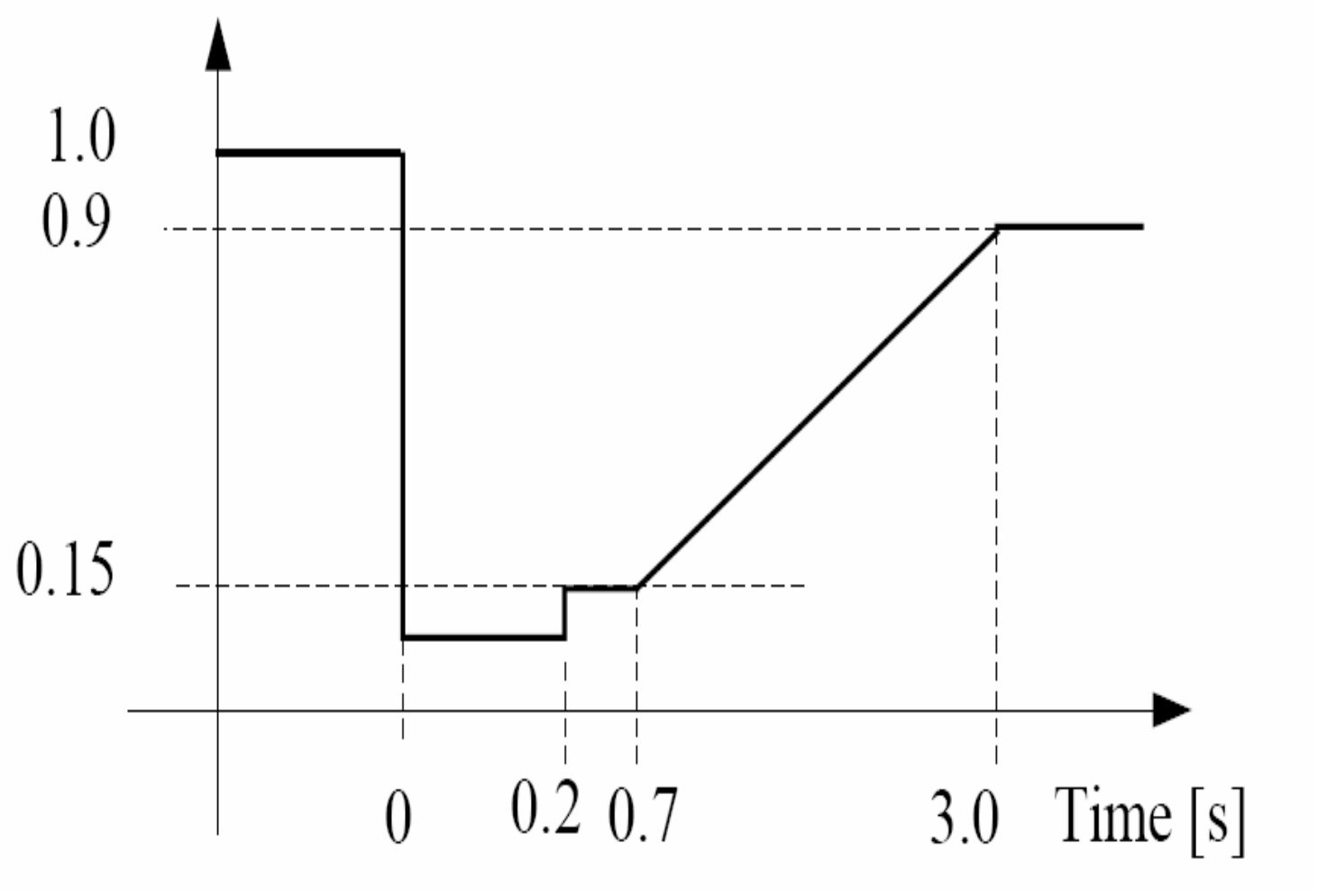
Transmission Grid Code

Demands:

- Fault Ride Through
  - Maintain operation of the turbine during a fault on the grid
- Frequency range
  - Operate the turbine from 47-52 Hz
- Frequency control
  - Control of the active power during frequency variations
- Ramp rate control
  - Limit the power increase to a certain rate
- Reactive power range
  - Supply/consume reactive power
- Voltage Control
  - By adjusting the reactive power based on grid measurement

Fault Ride Through requirement



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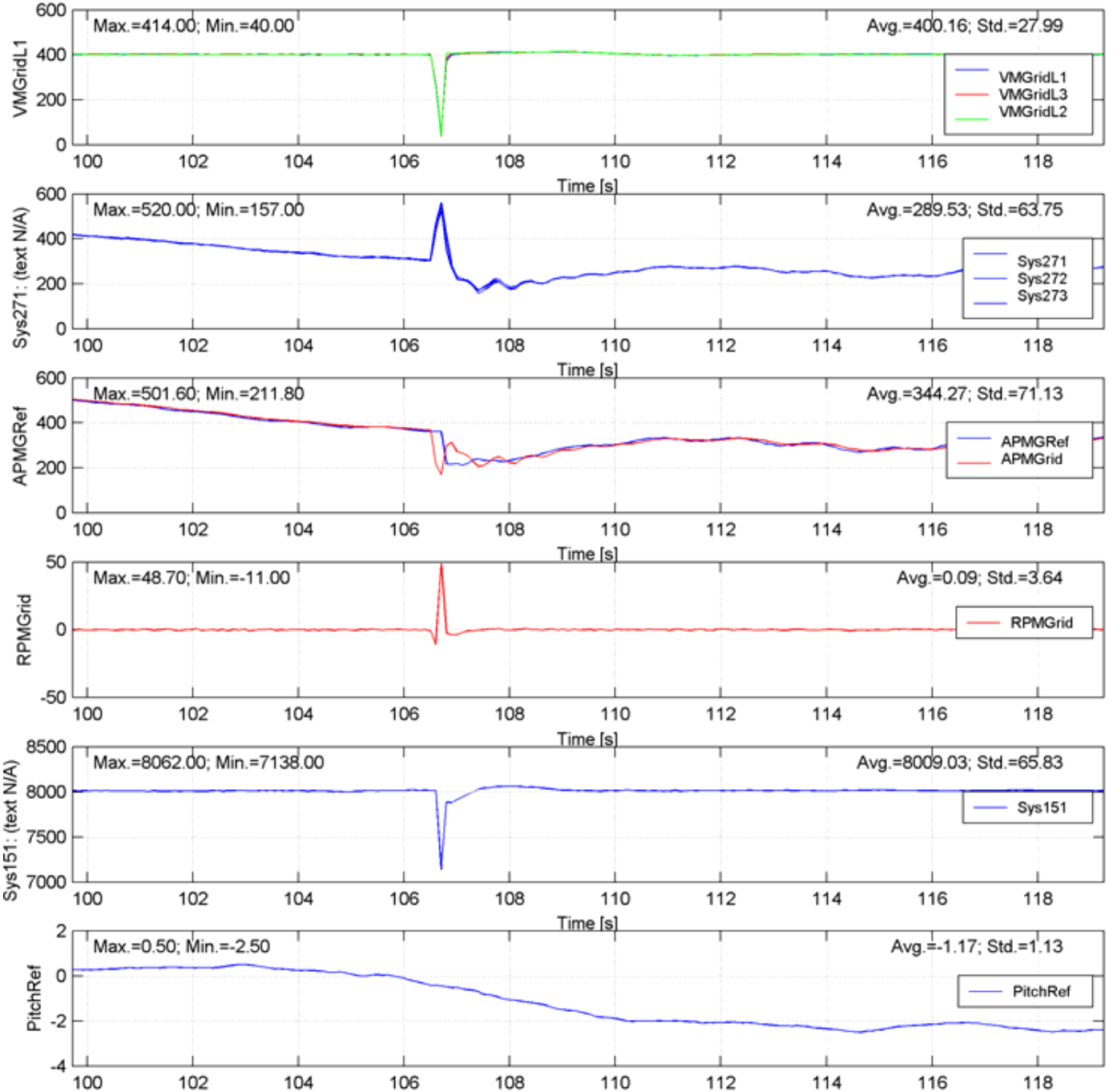
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Avg.=400.16; Std.=27.99
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VMGridL3
VMGridL2
Time [s]
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Avg.=289.53; Std.=63.75
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Sys271
Sys272
Sys273
Time [s]
Max.=501.60; Min.=211.80
Avg.=344.27; Std.=71.13
APMGRef
APMGrid
Time [s]
Max.=48.70; Min.=-11.00
Avg.=0.09; Std.=3.64
RPMGrid
Time [s]
Max.=8062.00; Min.=7138.00
Avg.=8009.03; Std.=65.83
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Sys151
Time [s]
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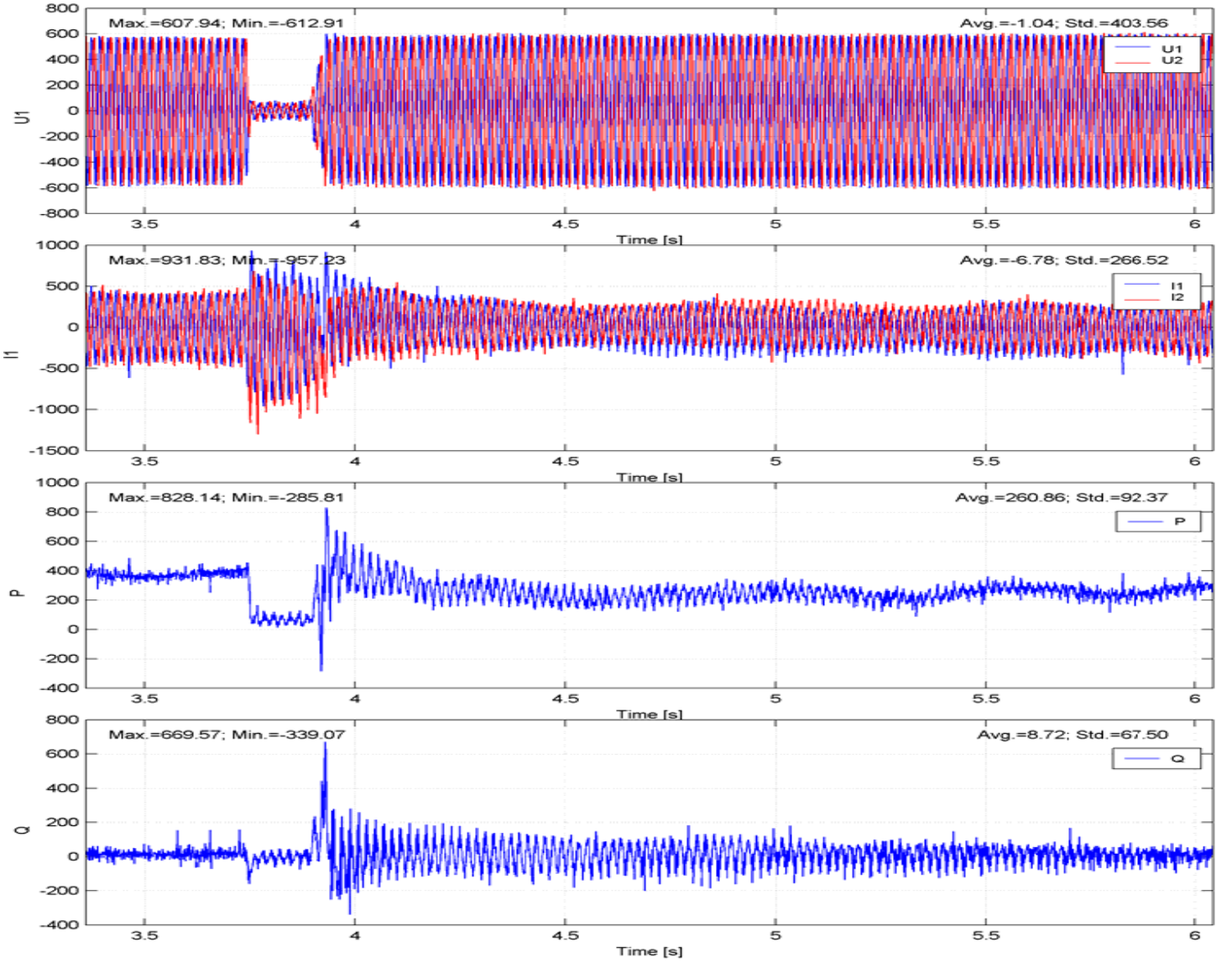
PitchRef

Vestas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U2
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Avg.=-6.78; Std.=266.52
I1
I2
Time [s]
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P
Time [s]
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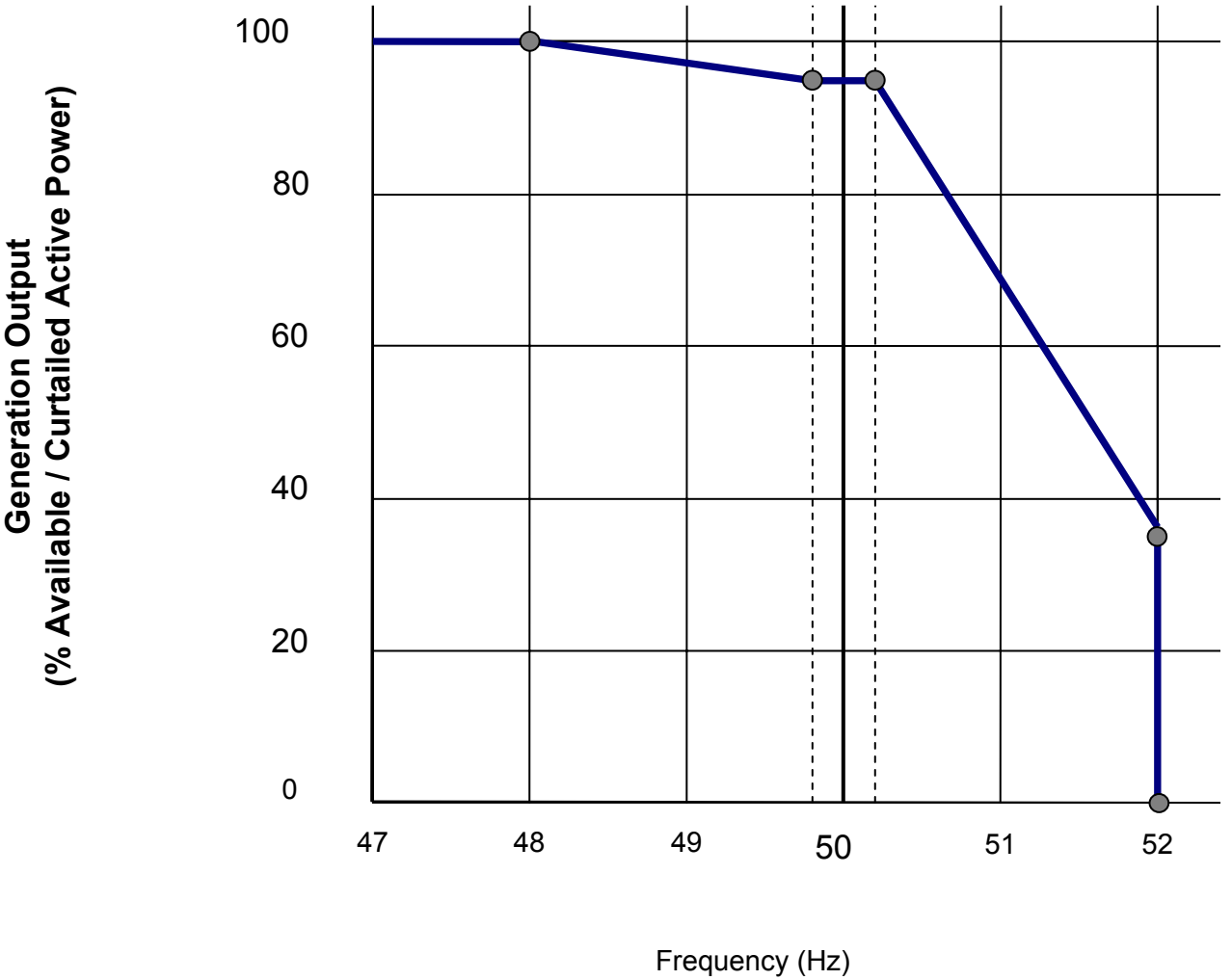
Q
Time [s]

Frequency control

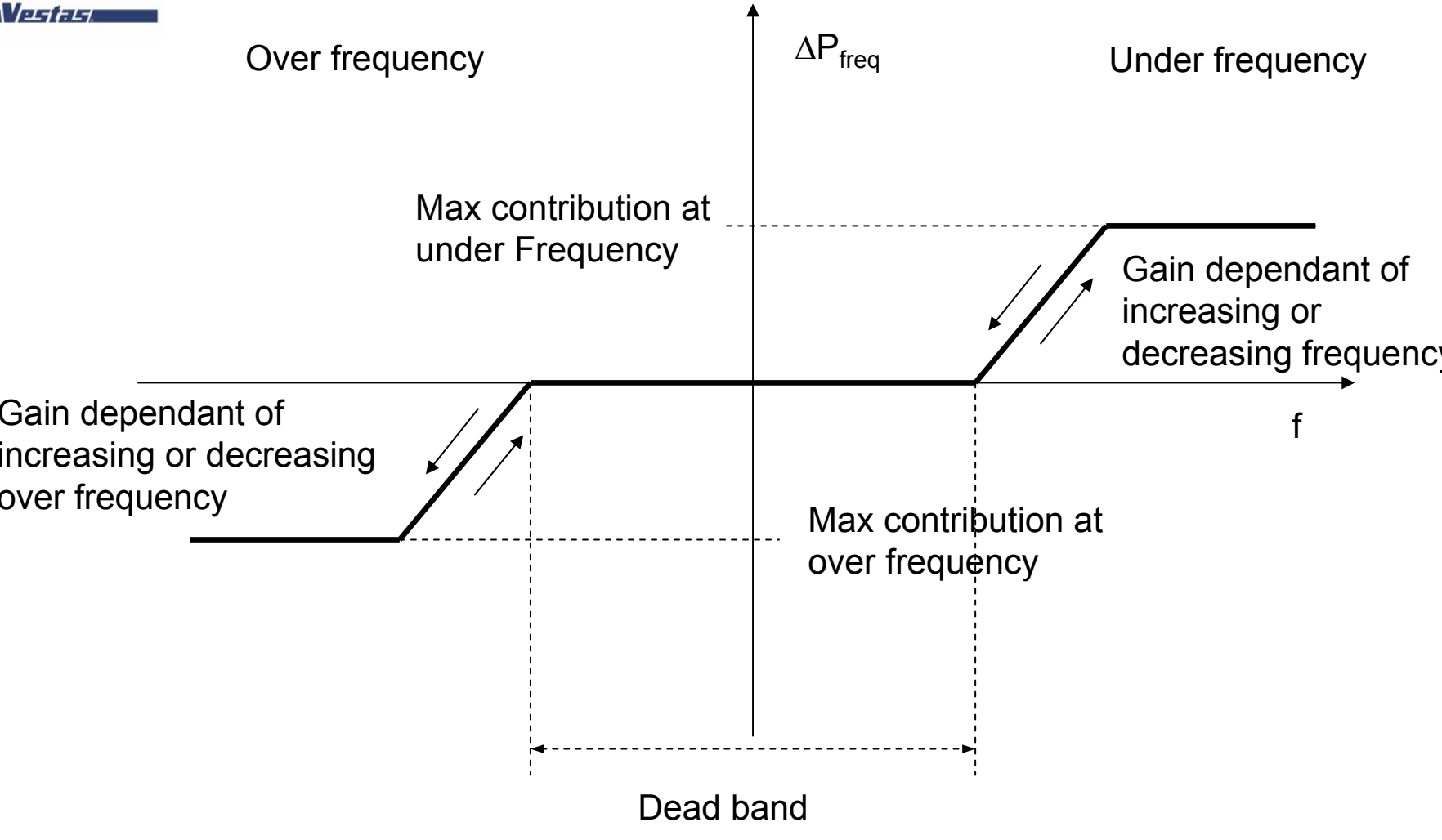
- **Frequency**
  - Frequency Control
  - Operating between 47 and 52 Hz

Frequency control requirement



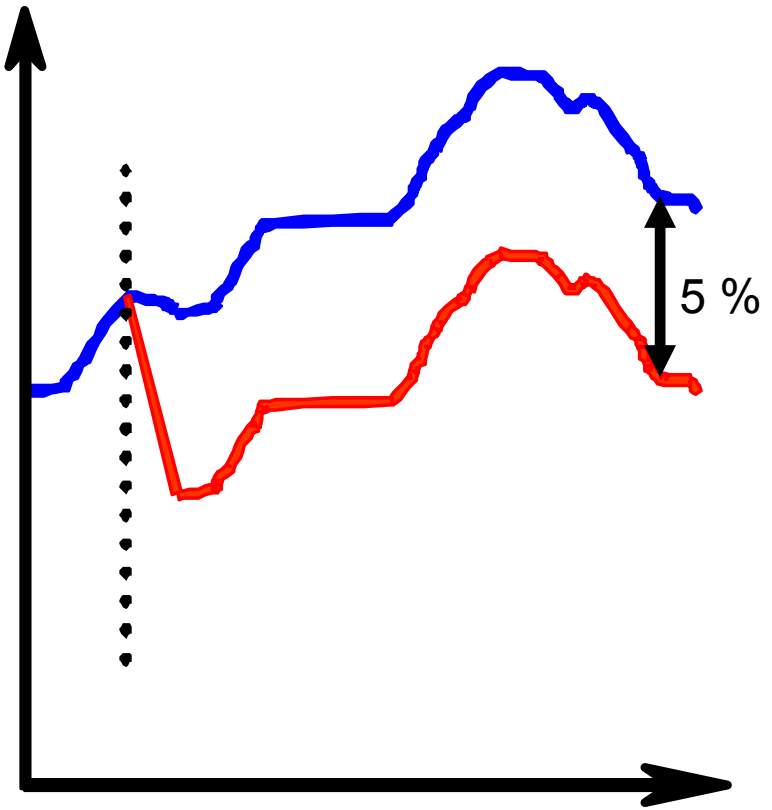
Frequency control

Characteristics and options



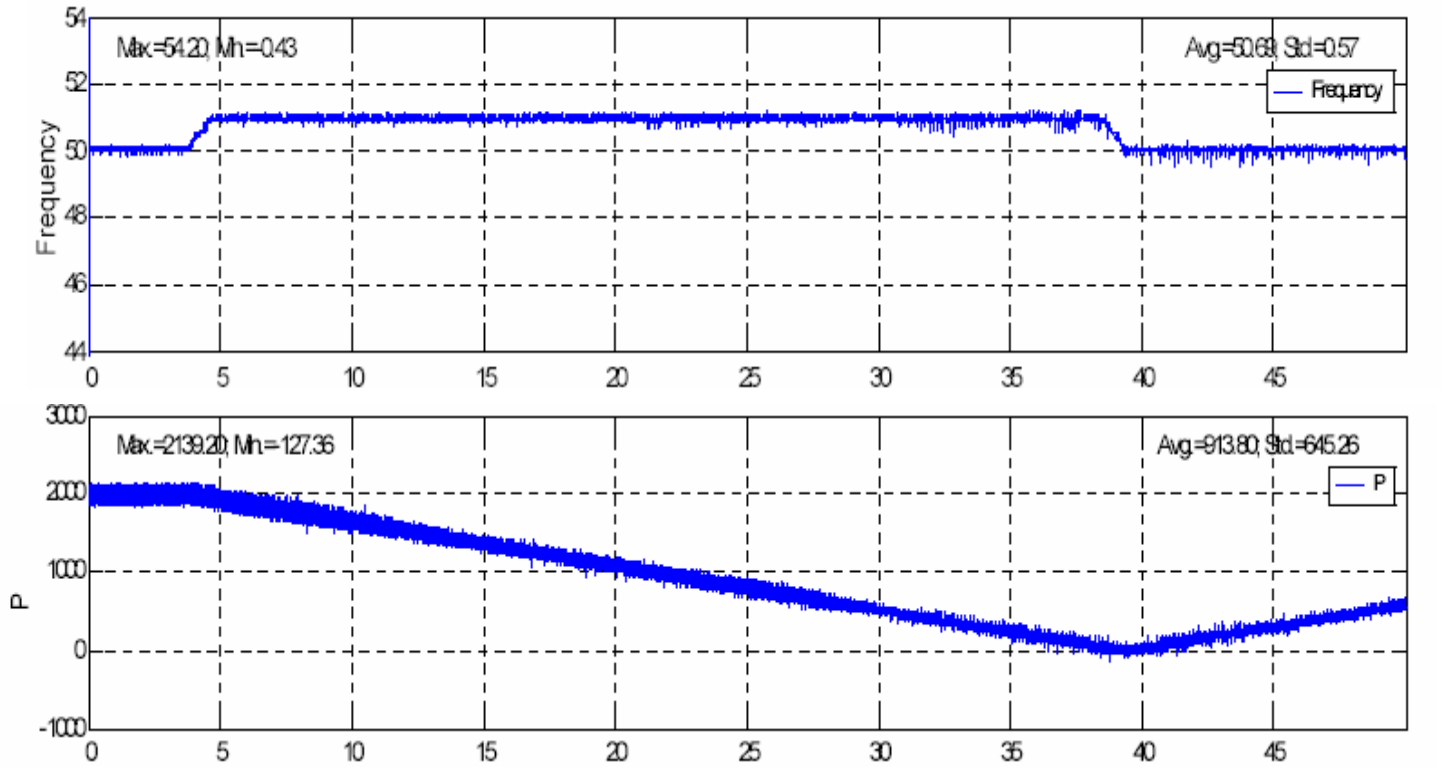
Delta control for Frequency control

- Delta control is used at under frequency support

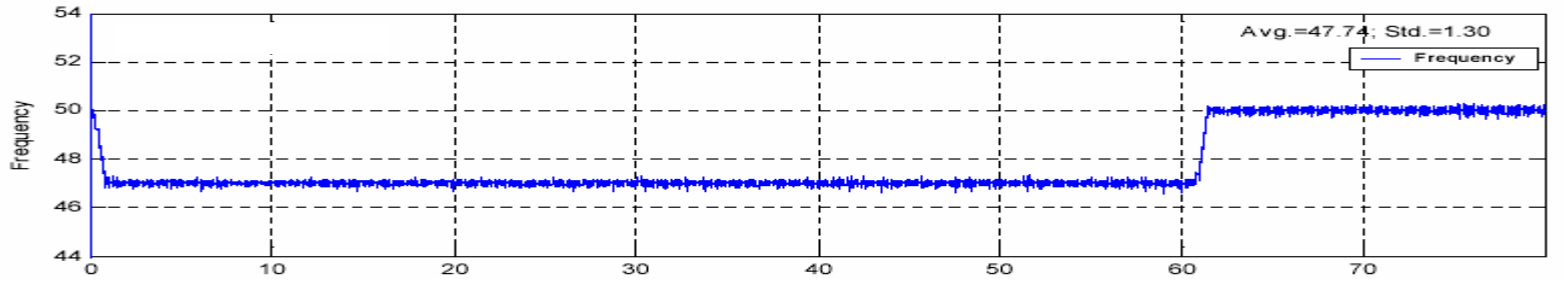


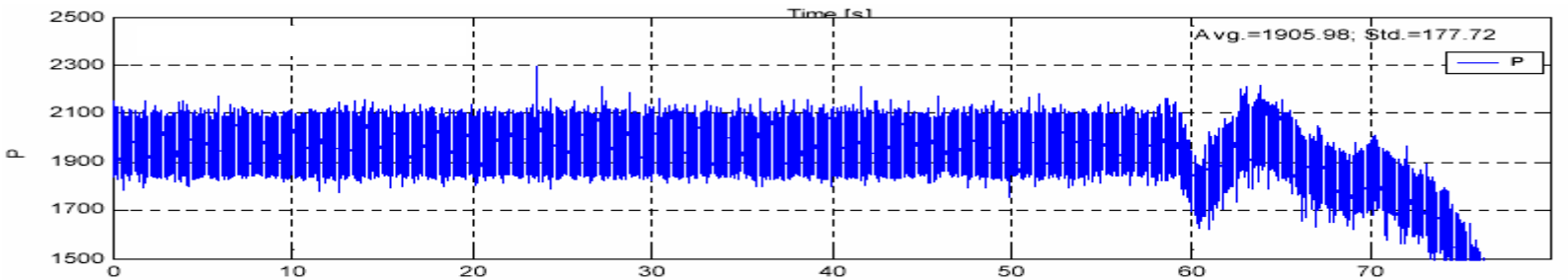
V80-2,0 MW
Frequency measurement

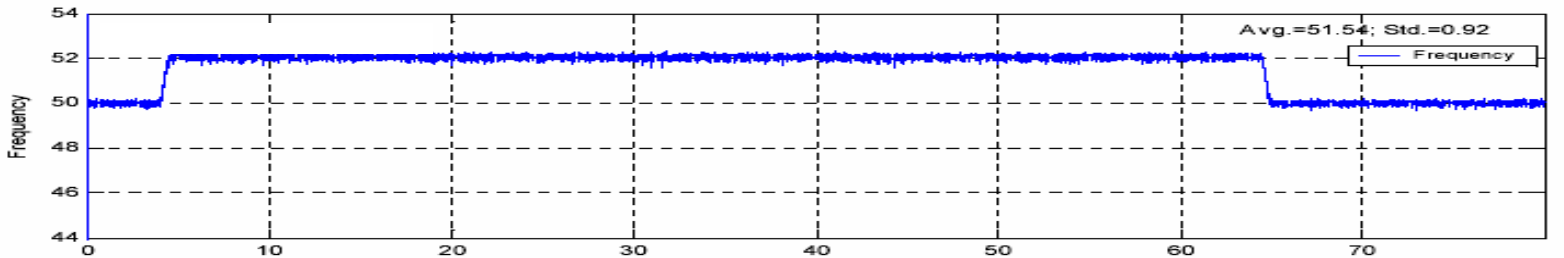
- Step change in the frequency from 50 Hz to 51 Hz
- The turbine is decreasing the active power by 50 kW/s

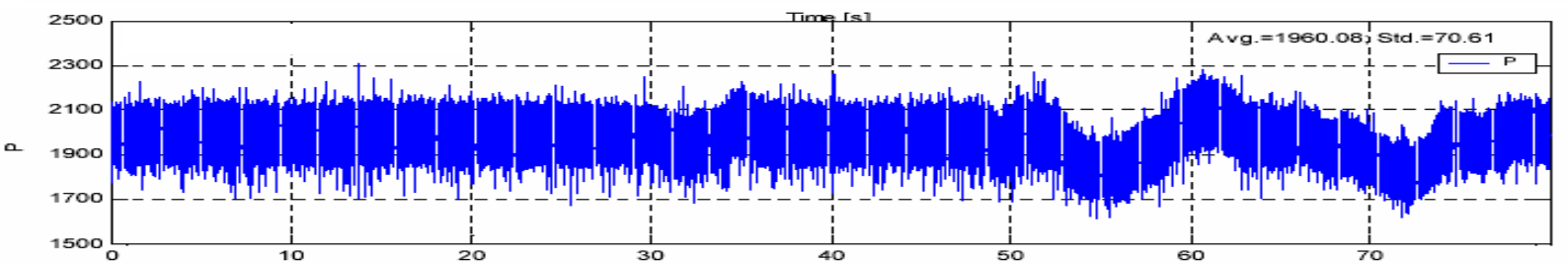


V80-2,0 MW
Frequency measurement



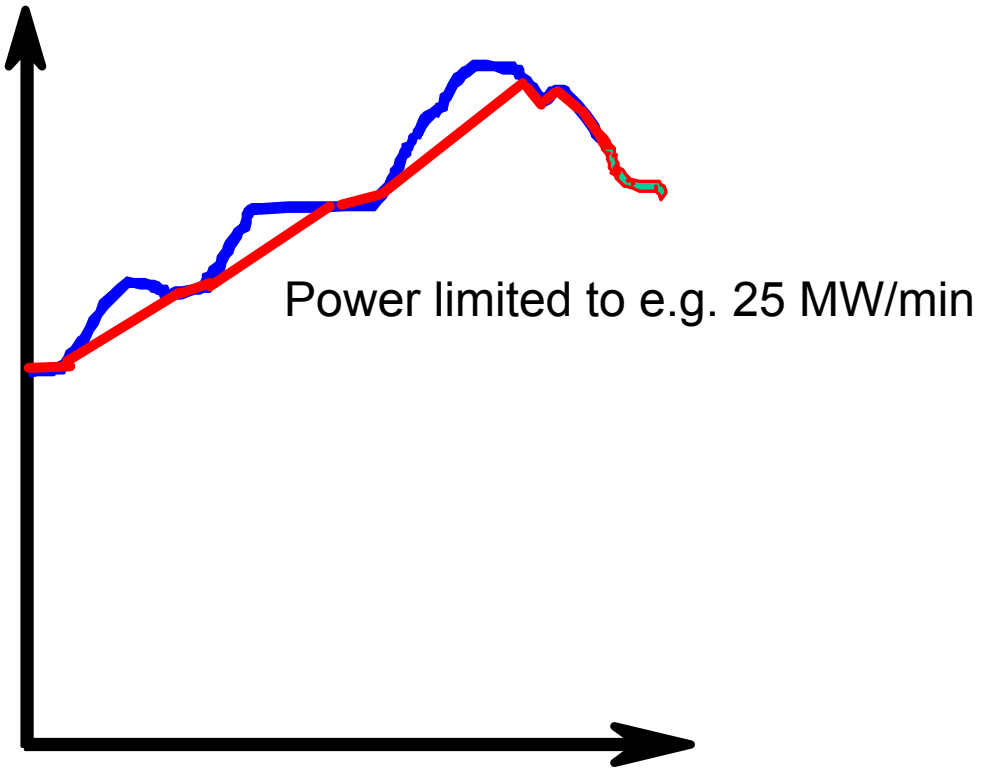






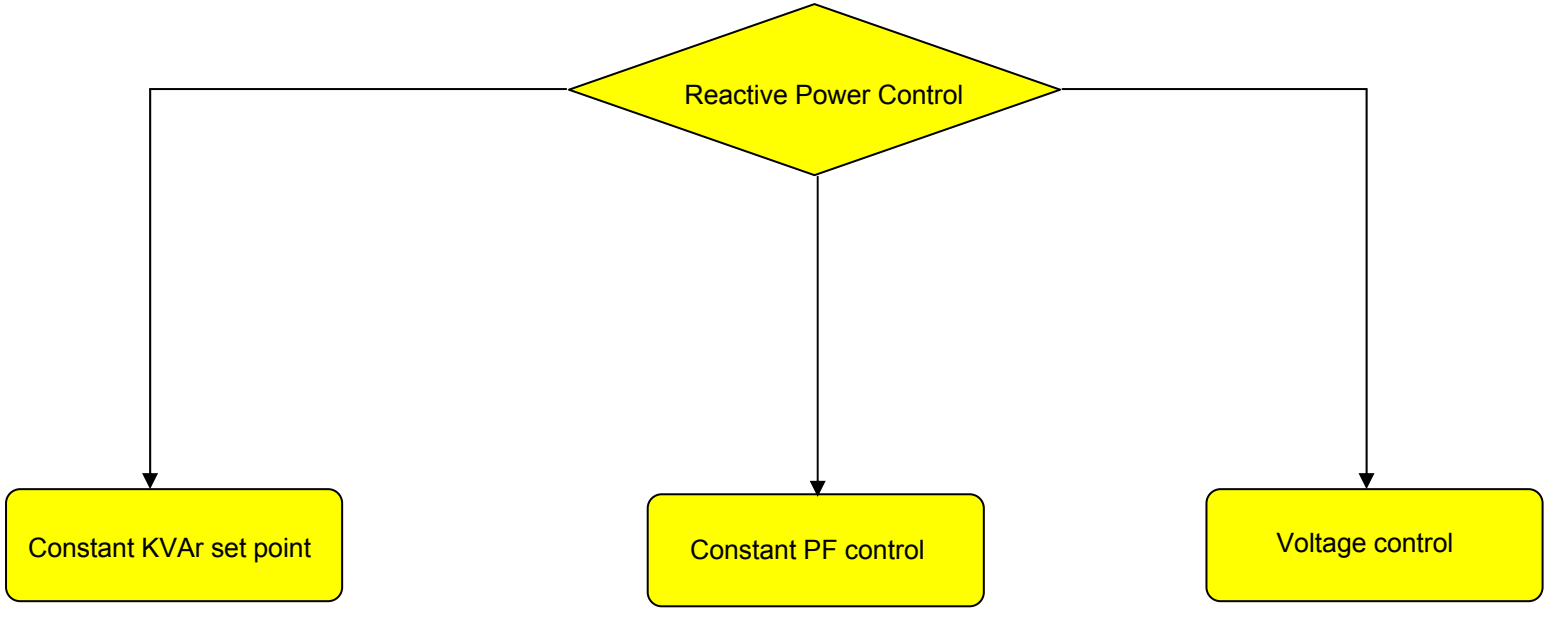
Power Ramp Rate Control

- **Power Ramp Rate Control**
  - by VestasOnline™ for the wind farm

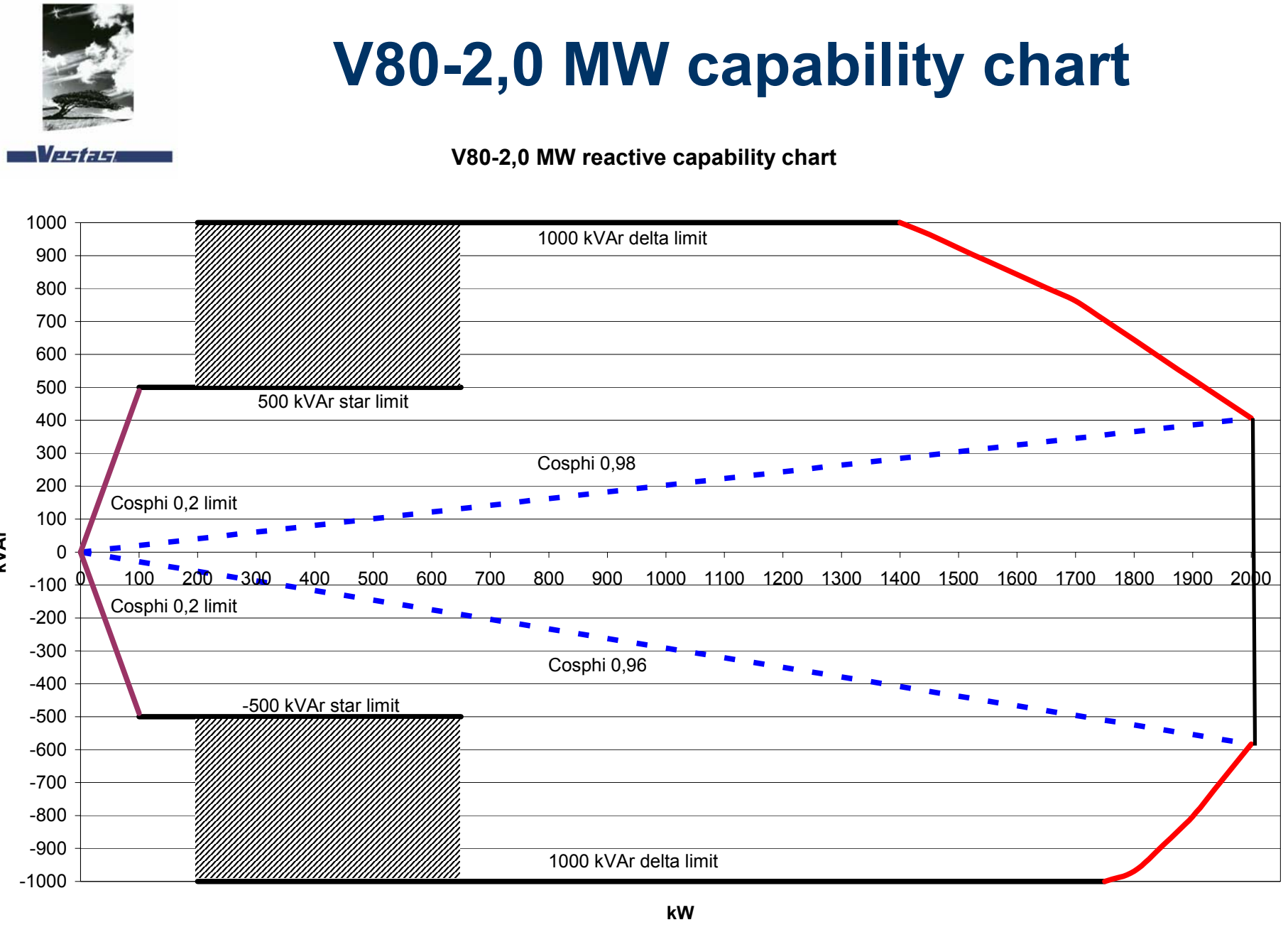


Reactive Power Control

- **Reactive Power Capability**
  - Constant kVAr set point
  - Power factor control
  - Voltage control

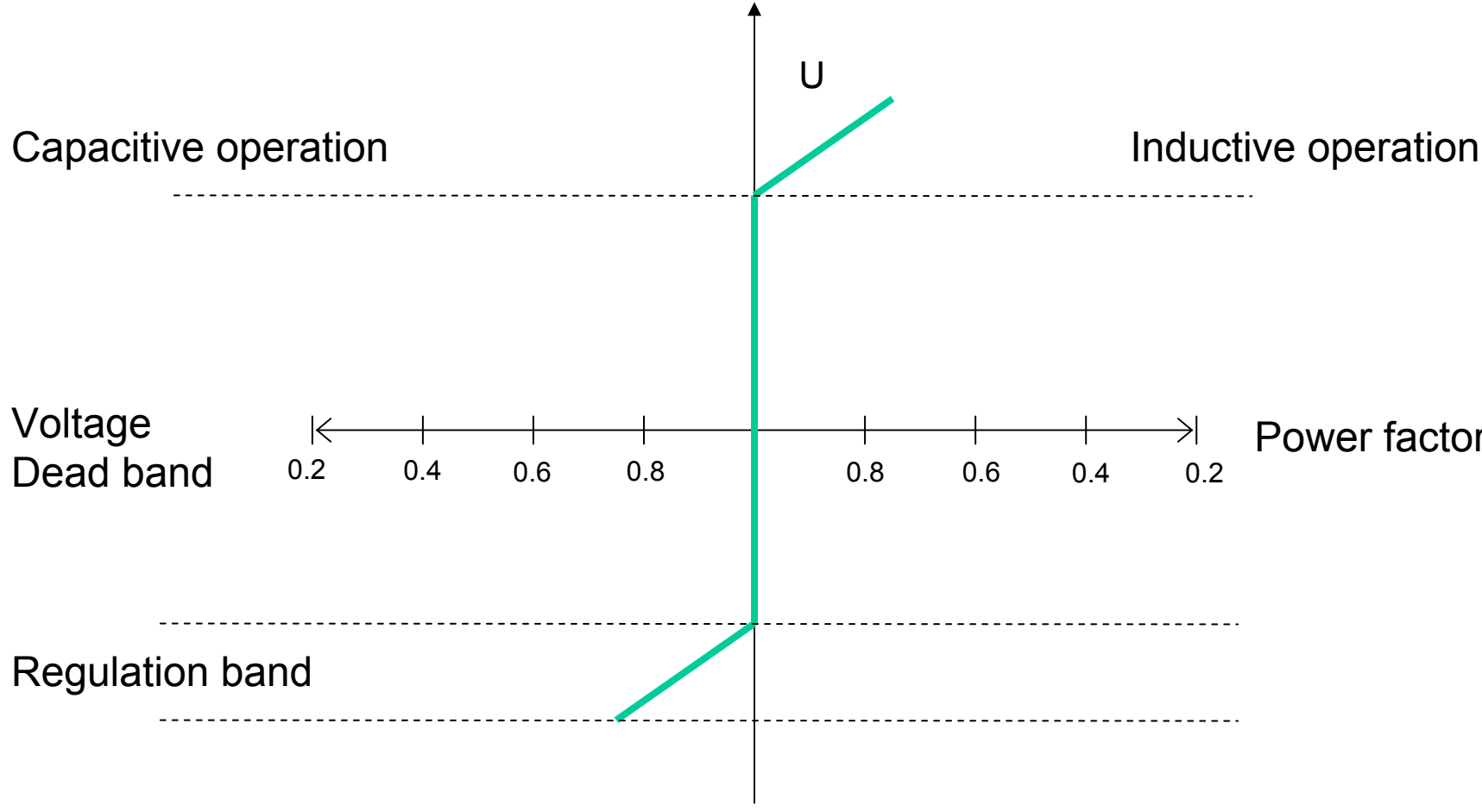


V80-2,0 MW capability chart



Reactive power control

Characteristic of voltage control



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Thank you for your attention