

WIND FARM INERTIAL RESPONSE PROJECT IN PARTNERSHIP WITH ENERCON, AESO & ENMAX

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PROJECT BACKGROUND

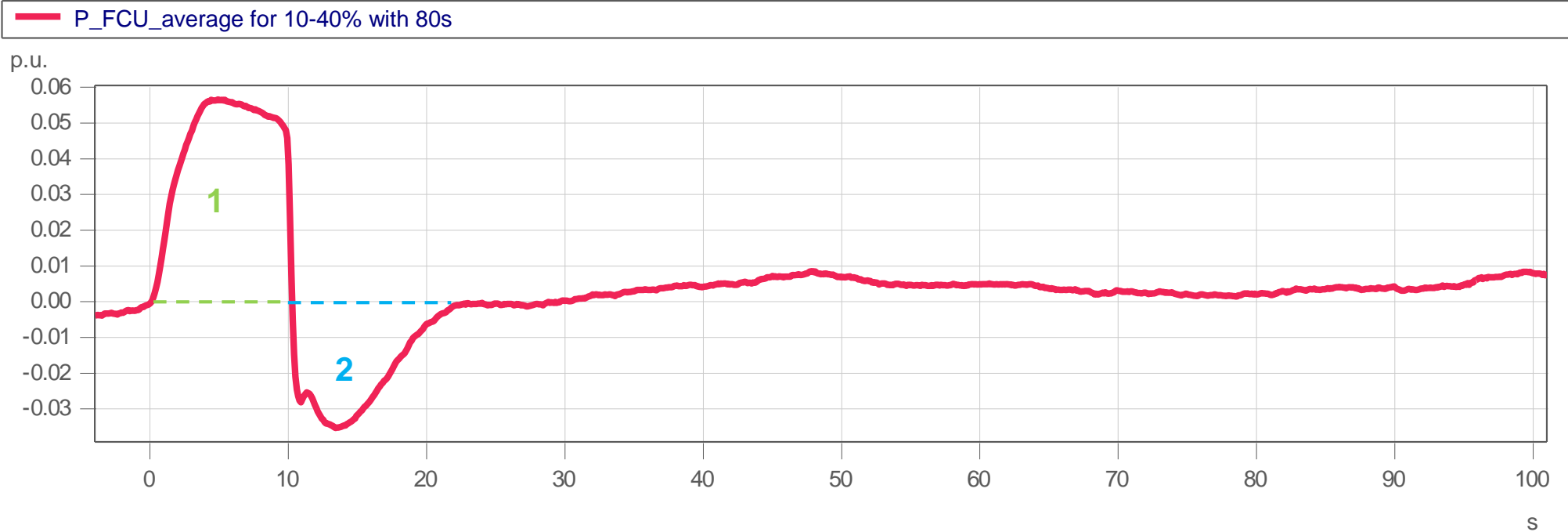
- System services ensure safe and reliable operation
 - Historically provided by hydro and thermal generation
 - Market structure tailored to specific generation
- With higher share of renewables, inherent system inertia decreases
 - What is the opportunity for other participants to provide inertial response?
 - Do we need to move to a technology agnostic market?

PROJECT RESULTS – BEHAVIOR OF INERTIA EMULATION (IE)

Performance Criteria	Objective	Assessment
Response delay of active power increase	<1s	<1s
Amplitude of additional active power contribution	4.8%	4.8%
Duration of additional active power contribution	10s	10s
Maximum subsequent active power drop	25%	<20%

Met or exceed technical performance criteria

PROJECT RESULTS – IMPACT ON ANNUAL YIELD



Energy neutral functionality

PROJECT RESULTS – RETROFIT TIME

- 156 hr = time to retrofit 37 wind turbines
- Deployed retrofit in teams of 2
- Maintained 99.15% technical availability
- Reduce retrofit time, if retrofit completed during a scheduled maintenance

Revenue opportunity for existing and future WTs

PROJECT CONCLUSIONS

- Successfully demonstrated IE feasibility & performance
- AESO now has technical and commercial perspective
- IE technology highly flexible to meet system needs
- Cost benefit of retrofit depends on commercial benefits

Opportunity for a technology agnostic ancillary services market