Delivering a Secure Sustainable Electricity System(DS3)

Voltage Control

Jonathan O'Sullivan

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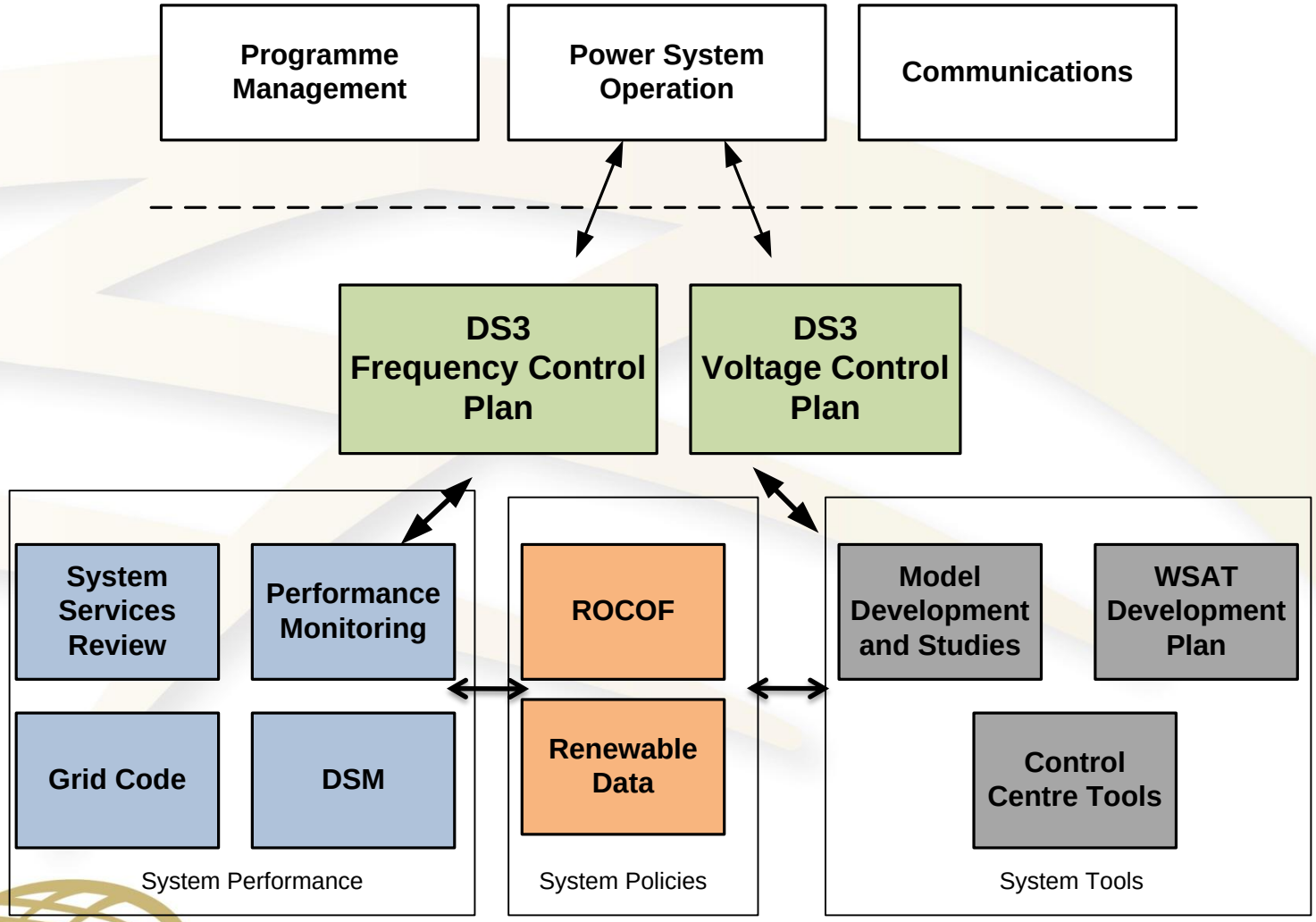
DS3 Programme Overview



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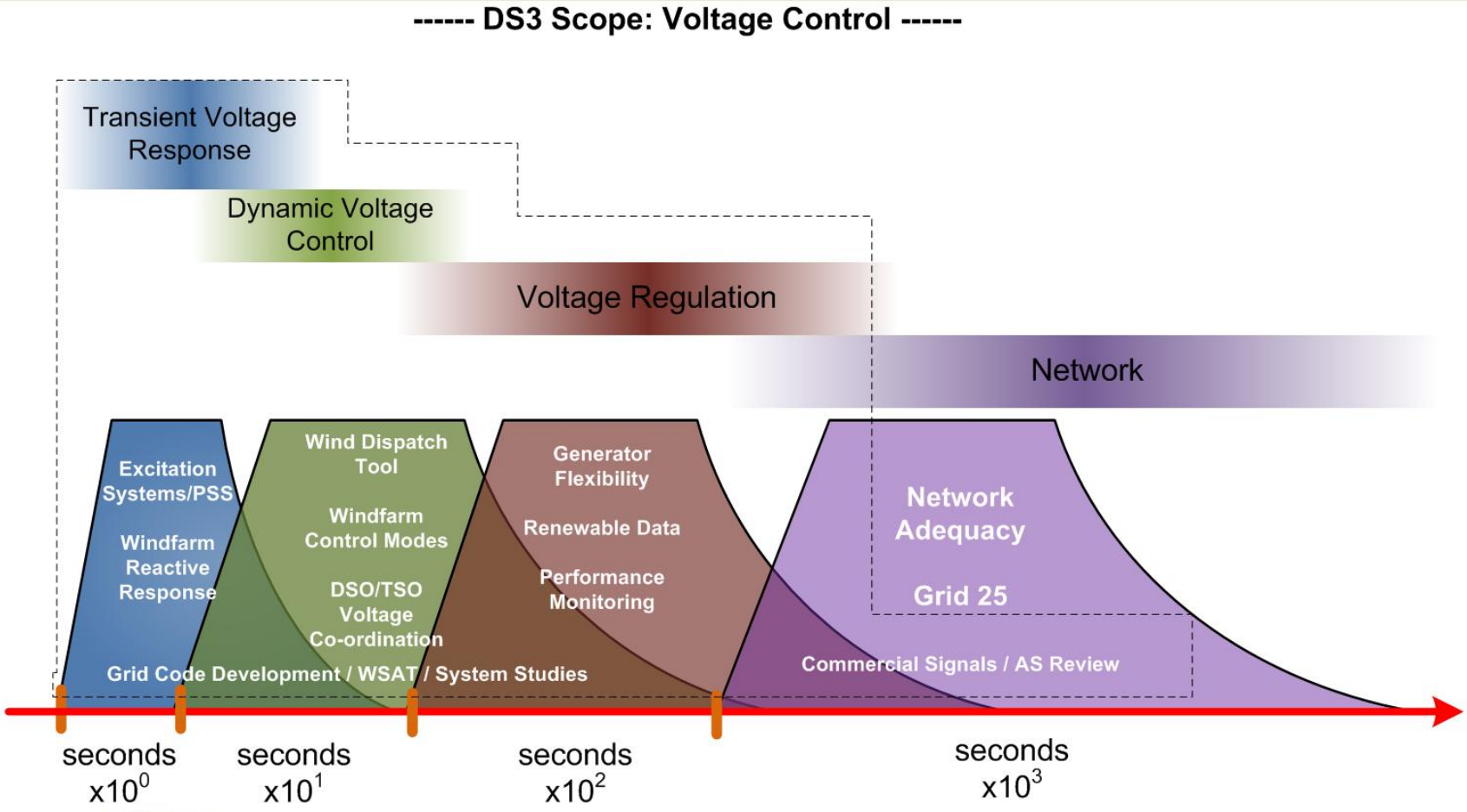
DS3 Voltage Control Scope



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DS3 Voltage Control Challenges

- Changing location of reactive sources
  - More embedded generation
  - Sources may not be coincident with network needs
- Changing nature of sources
  - Less “conventional” synchronous generation sources
  - Different steady state capabilities
- Uncertain control capability and long term strategy

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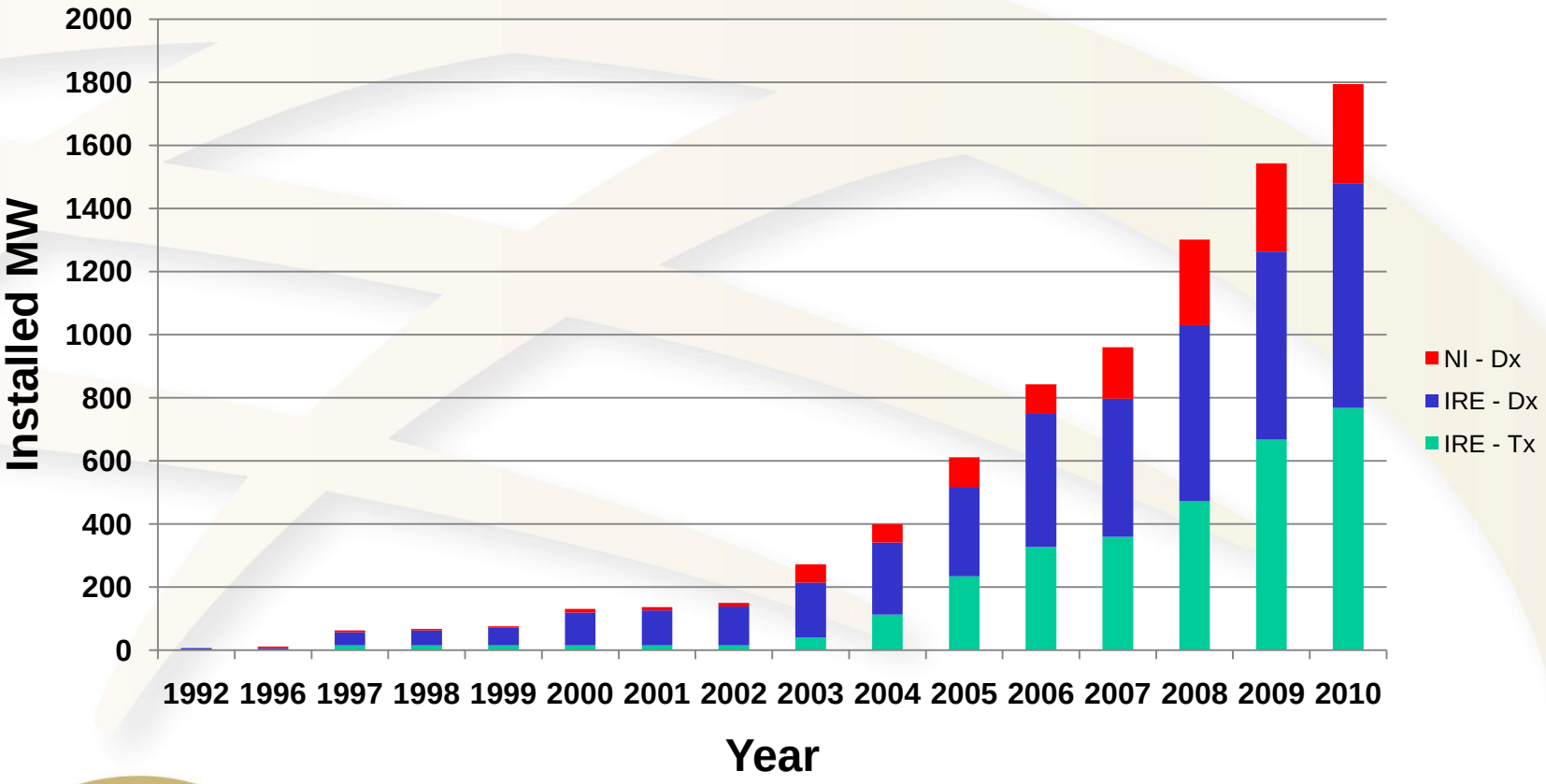
DS3 Changing Reactive Source Location Ireland and Northern Ireland installed Wind



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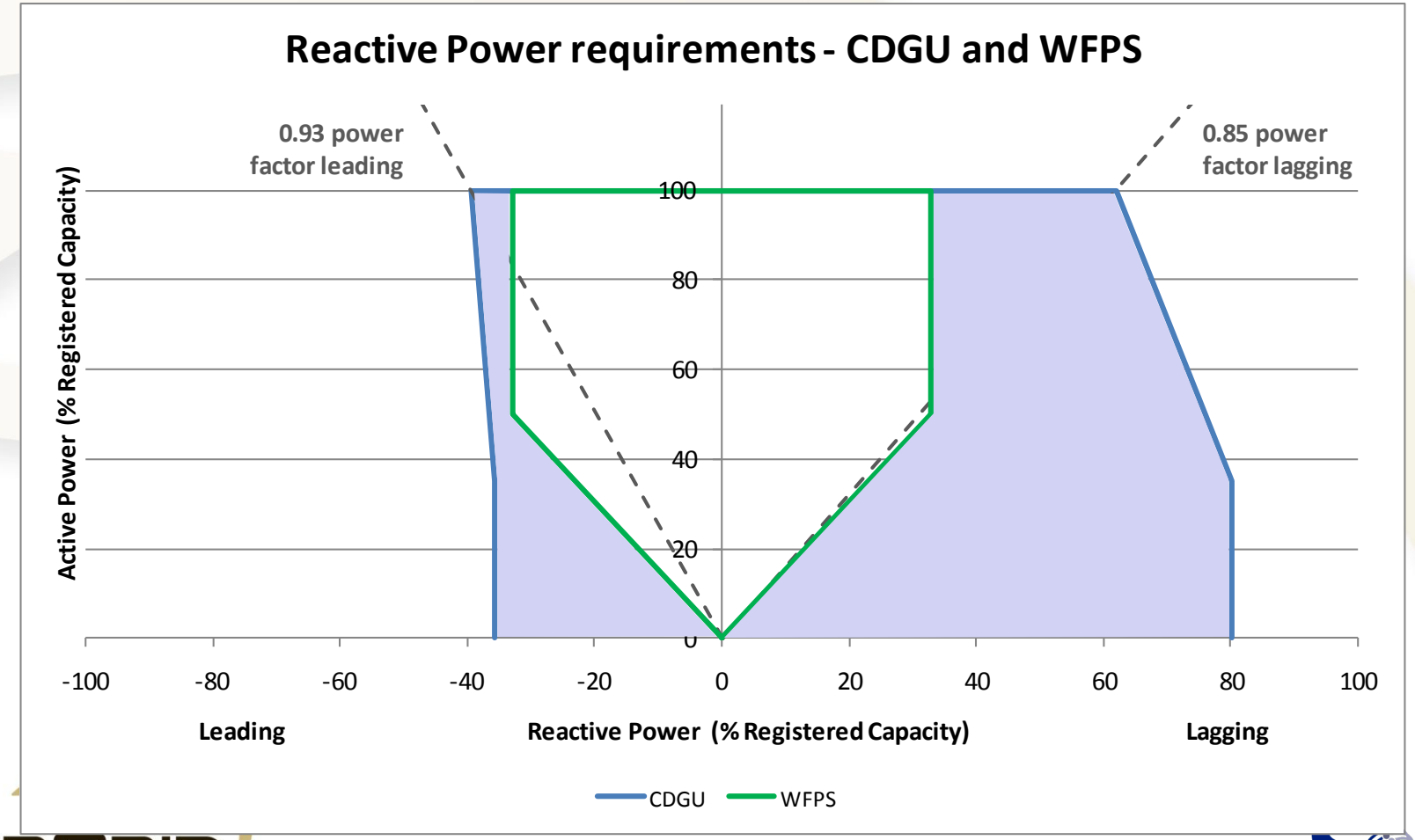
Reactive Power – Grid Code (Ireland)



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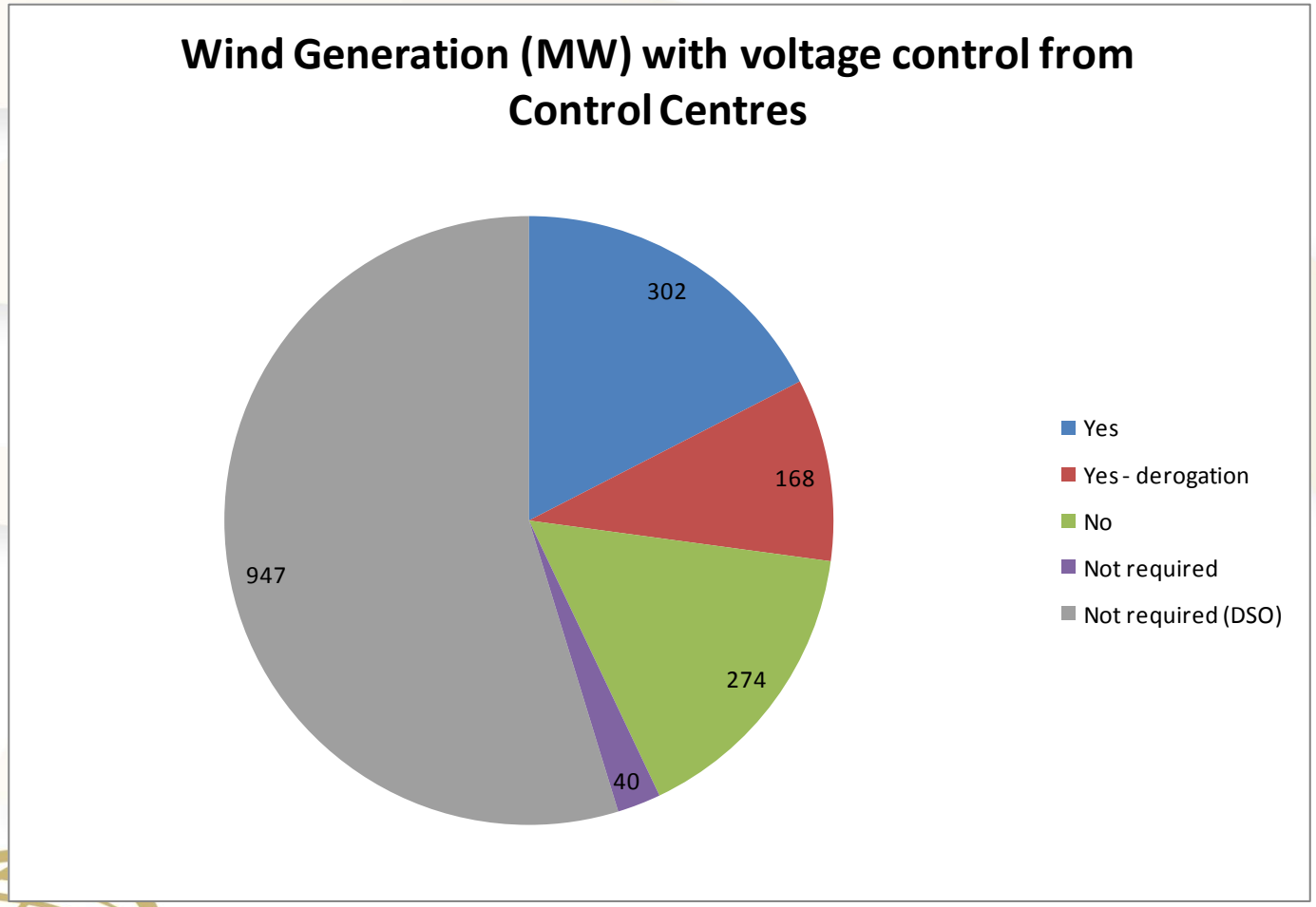
DS3 Challenge Reactive Power – Windfarm Control



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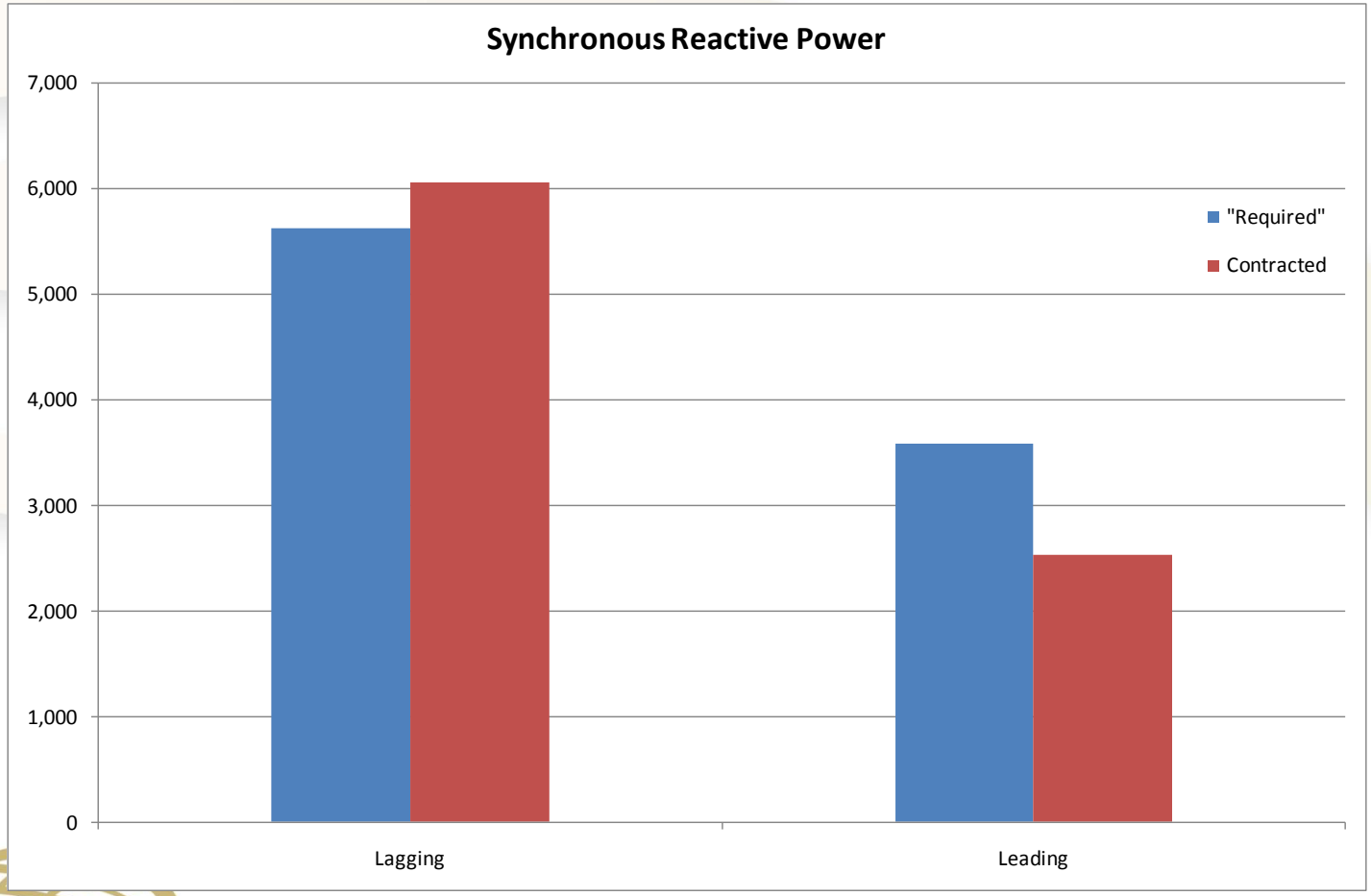
DS3 Changing Reactive Power – Portfolio Capability



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Facilitation of Renewables and DS3 Report: Reactive Power Control Key Findings

- Steady State Reactive Control difficult
- Over reliance on SVC-compensation (or capacitors) leads to voltage collapse scenarios
- Co-ordinated planning, operation and generator capability required

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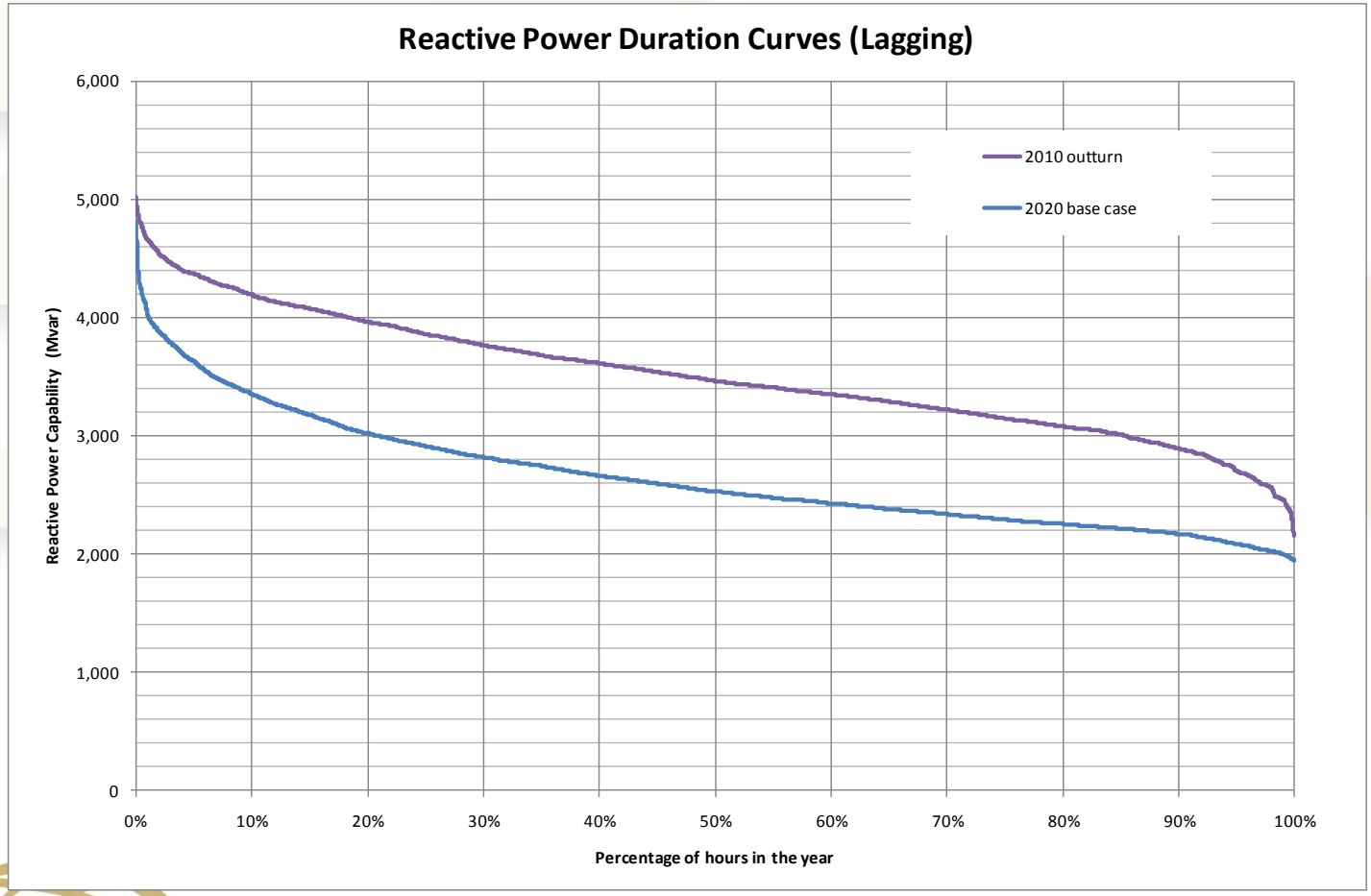
DS3 Changing Reactive Power Availability – Synchronised



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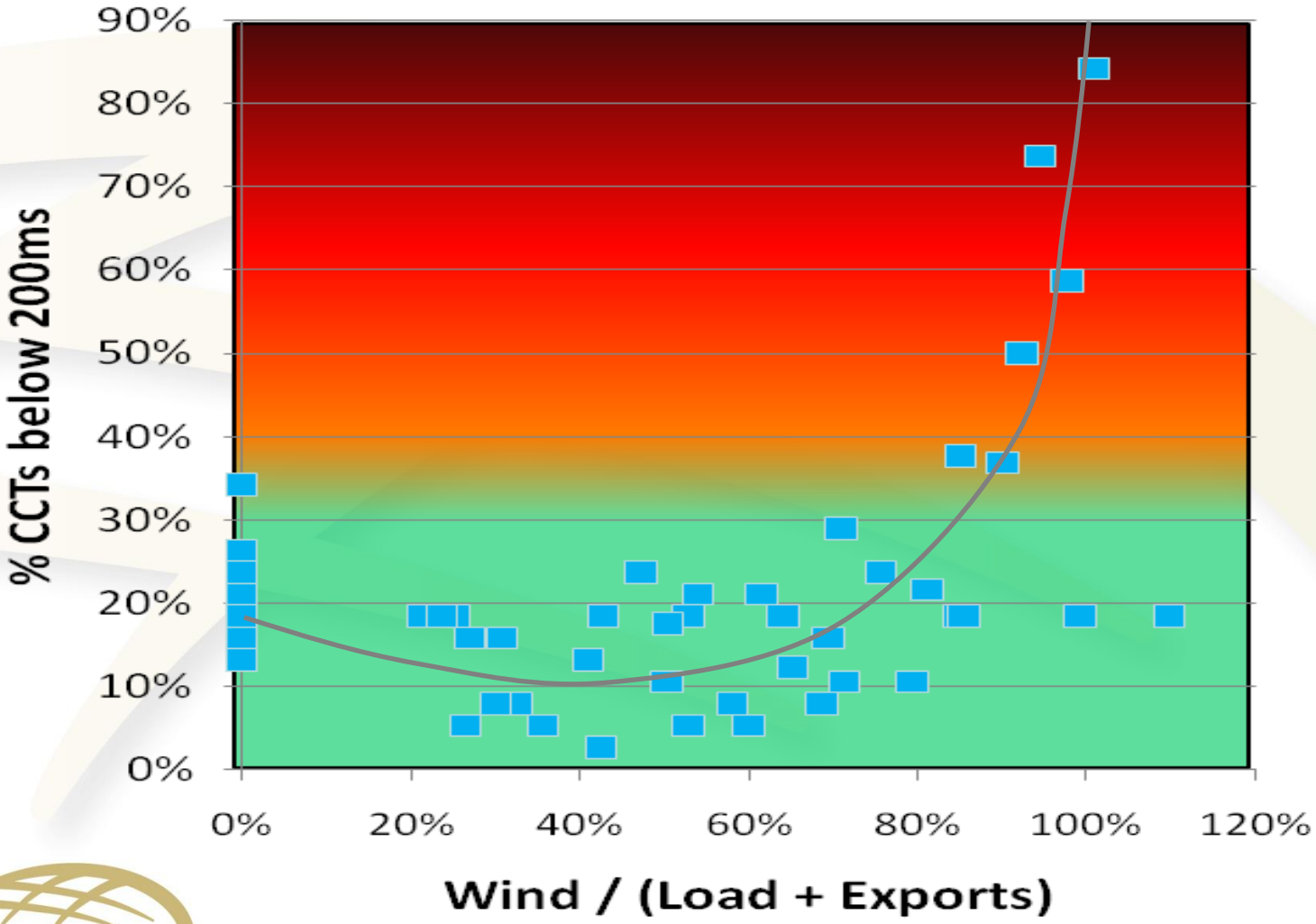
FoR Key Finding: Dynamic Stability Issues



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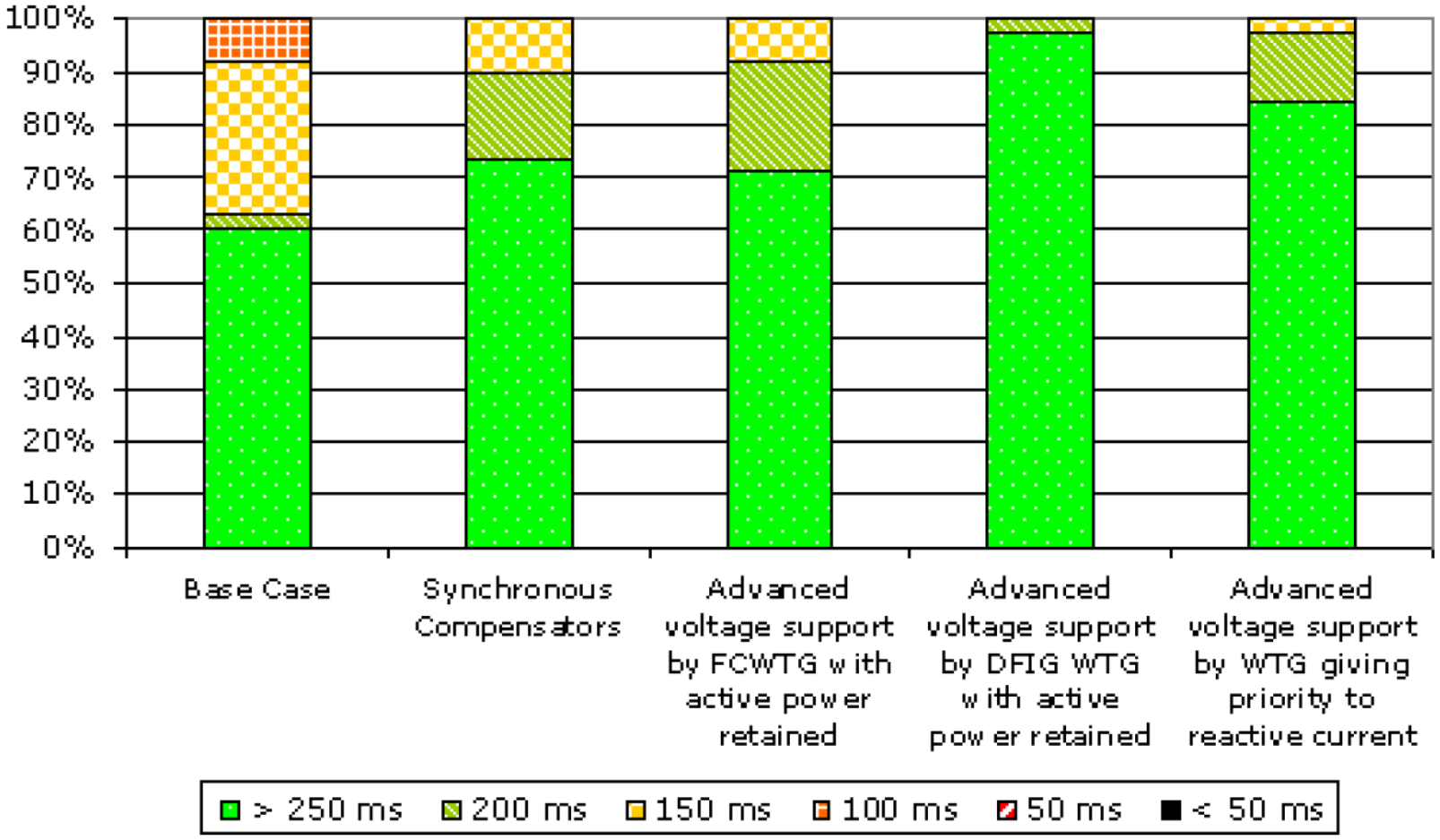
FoR: Dynamic Stability Issues Mitigation Measures



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DS3 Voltage Control Approach

- Clarify, agree and enforce universal standards on all controllable windfarms on Tx and Dx
  - Full active and reactive control
  - Universal reactive power capability
  - Clarified transient stability capability
- Develop voltage and reactive control strategy between TSO and DSO
  - Pilot projects
  - Regional tests
  - Full implementation
- Refine transmission voltage control strategy
- Review needs of system from planning perspective
  - Statcom, Syn Compensators, Reactive compensation

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DS3 Voltage Control Engagement

- DS3 Advisory Council
  - Input and advice
- EirGrid-SONI-ESB Networks-NIE
  - Close collaboration, regular working meetings
- EirGrid-SONI-Industry
  - Working group under the Joint Grid Code Review Panel
  - Grid Code Review Panels
  - DS3 Forum
- EirGrid-SONI-Innovation
  - Pilot projects

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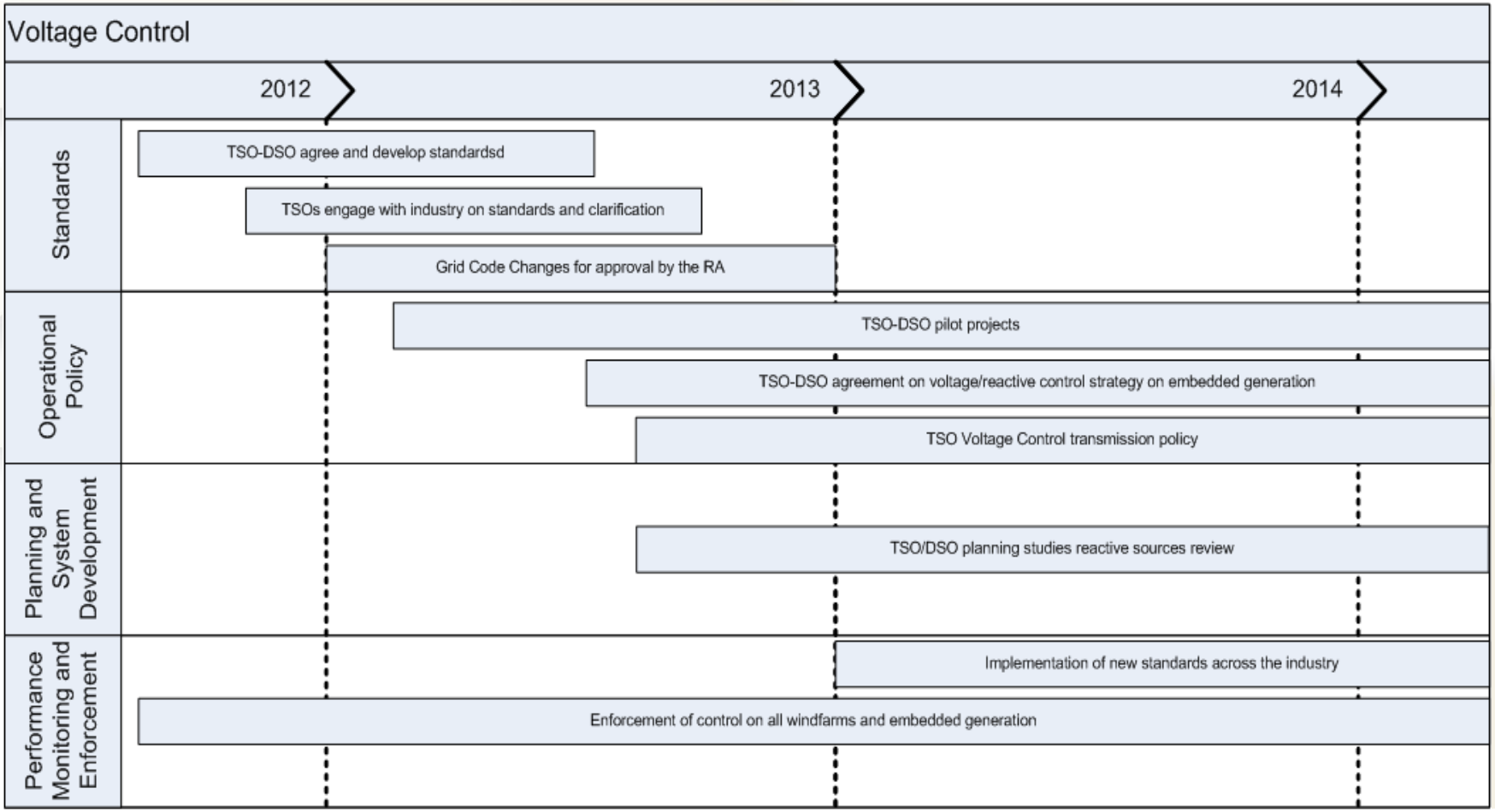
DS3 Voltage Control Timelines



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Questions, Advice, Input?

- Does the approach make sense?
  - Are we missing anything?
  - Can we improve it?
- Does the focus on standards seem appropriate?
  - Should we circulate to Council Members for input?

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Rate of Change of Frequency - Update
DS3 Advisory Council Discussion

Alan Rogers
Sustainable Power Systems
EirGrid Operations
2nd February, 2012

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Outline

- Background to the revised paper
- Revisions to approach
- International Context / Past RoCoF events
- RoCoF Plan: Next Steps

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Background

- RoCoF issue was discussed at Advisory Council on 24/10/11

- Approach in initial RoCoF discussion paper:
  - Either increase Grid Code limit to X Hz/sec or
  - Ensure sufficient inertia on system so that RoCoF not an issue

- Needed to revise our approach – wider menu of solutions/approaches needed; cost implications etc.

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Revised Discussion Paper on RoCoF

- Extended background material on power systems and frequency
- Improved discussion of the challenges

- Breakdown of RoCoF-related issues

- Wider variety of solutions to meet the challenges
  - Not mutually exclusive solutions
- Next Steps: Further Investigations / Demo Projects etc

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RoCoF Issue 1: Loss of Largest Infeed/Outfeed

Issue: Loss of a large infeed (or outfeed, e.g. EWIC) in a low inertia scenario could cause RoCoF > 0.5Hz/s

→Potential cascade tripping of generators & blackout

Potential Solutions:

a. Mandate higher RoCoF standard via Grid Code

b. Maintain enough system inertia so RoCoF < X Hz/s (X to be agreed)

i. Keep conventional plant online

ii. Lower minimum generation levels

iii. Incentivise new machines with more inertia

iv. Network solutions: Synchronous Condensers etc

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RoCoF Issue 2: Voltage Dip-Induced Frequency Dips

Issue: In future high wind scenarios, (2020) severe faults near a large cluster of windfarms will cause them to see a large voltage dip

→ a significant temporary energy imbalance

→ Potentially high RoCoF value

- Not currently an operational issue.

Further studies: To be studied in more detail as part of the DS3 programme

Grid Code Standards: Fast active power recovery of windfarms will be considered as part of the Universal Standards on Windfarms

→Try to close off Voltage Dip-Induced Frequency Dips as an operational issue

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RoCoF Issue 3: Anti-Islanding RoCoF Relays

Issue: A high value of RoCoF could cause the simultaneous tripping of all Distribution-connected windfarms and generation due to operation of anti-islanding RoCoF relays

Potential Solutions:

a. The DSOs are working on increasing the acceptable RoCoF relay setting for G10/G59 protection, and incorporating a time delay

b. The DSOs are also considering if alternative protection philosophies could be used instead of RoCoF relays for detecting electrical islands in the distribution system

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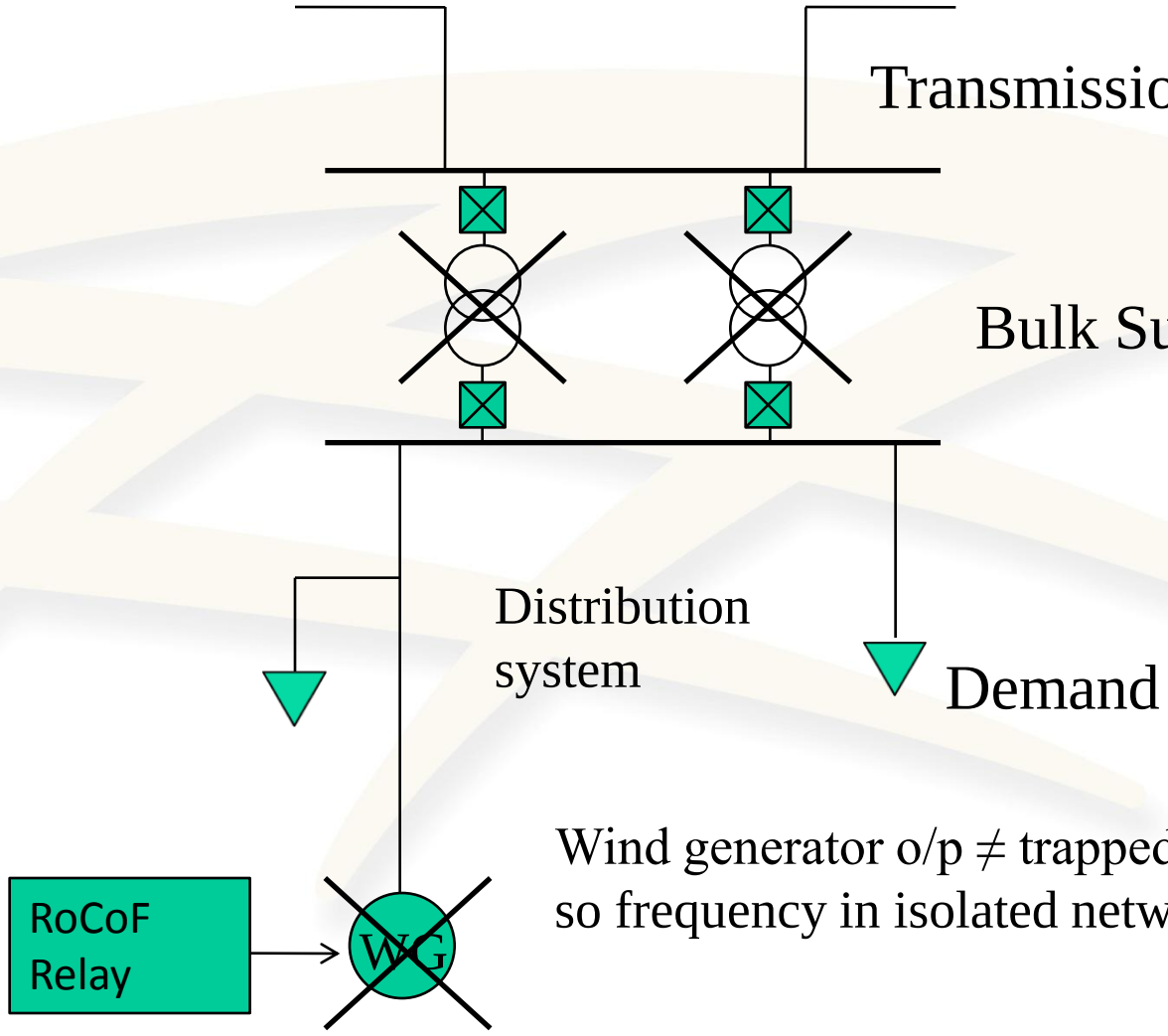
Islanding Protection



RoCoF providing protection of islanded system

Wind generator o/p ≠ trapped demand,
so frequency in isolated network will change rapidly.

Further Investigations

There are various potential solutions to the RoCoF issue, some of which may have merit, but further investigation is required to explore all possible solutions

- International Review: EirGrid/SONI is attempting to determine if other island systems have seen high values of RoCoF. Also trying to get information from manufacturers

- Demonstration Projects: EirGrid/SONI are seeking partners to help explore other avenues on the RoCoF challenge, such as emulated inertia and ways to test generator RoCoF capabilities

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International Context

- EirGrid have been in touch with the Hawaiian TSO and the New Zealand TSO TransGrid
  - Hawaii has seen RoCoF of 0.373Hz/s; Main concern is ensure gas turbine controls properly tuned (valve positions/temperature controls)
  - New Zealand had a RoCoF event of 0.75Hz/s with no cascade trips
  - Studies by TransGrid showed RoCoF up to 1.5Hz/s for some credible contingencies
- ENTSOE are proposing 2Hz/s as their RoCoF standard – this will become the standard in Ireland and Northern Ireland

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Plans / Implementation Phase

- Joint Grid Code Working Group is being set up to consider RoCoF and other DS3 issues
- Generator Testing: It will be necessary for generators to confirm their ability to meet any new RoCoF standard
- RoCoF Protection Changes: There may be a substantial cost (financial and labour) to implement changes to distribution protection. DSOs will need to estimate these costs
- New Windfarm Standards: A new set of Universal Standards for Windfarms is being developed and agreed between TSOs and DSOs in Ireland and Northern Ireland for consideration by the JGCWG
- Studies / Operational Policy Reviews: The operational policy on SNSP will be reviewed at six-monthly intervals

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Next Steps

- Costs: Significant time/money may be required to address RoCoF relay issue; Conventional generator tuning/testing? What is the cost of addressing the issue and who pays?
- How should we best combine the different solutions?
- How are we going to test what machines (conventional / WTGs) are capable of in the future?
- What commercial incentives do we need to increase inertia and reduce minimum generation levels?

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