Grid Code Frequency Response Working Group
Stewart Whyte – System Development

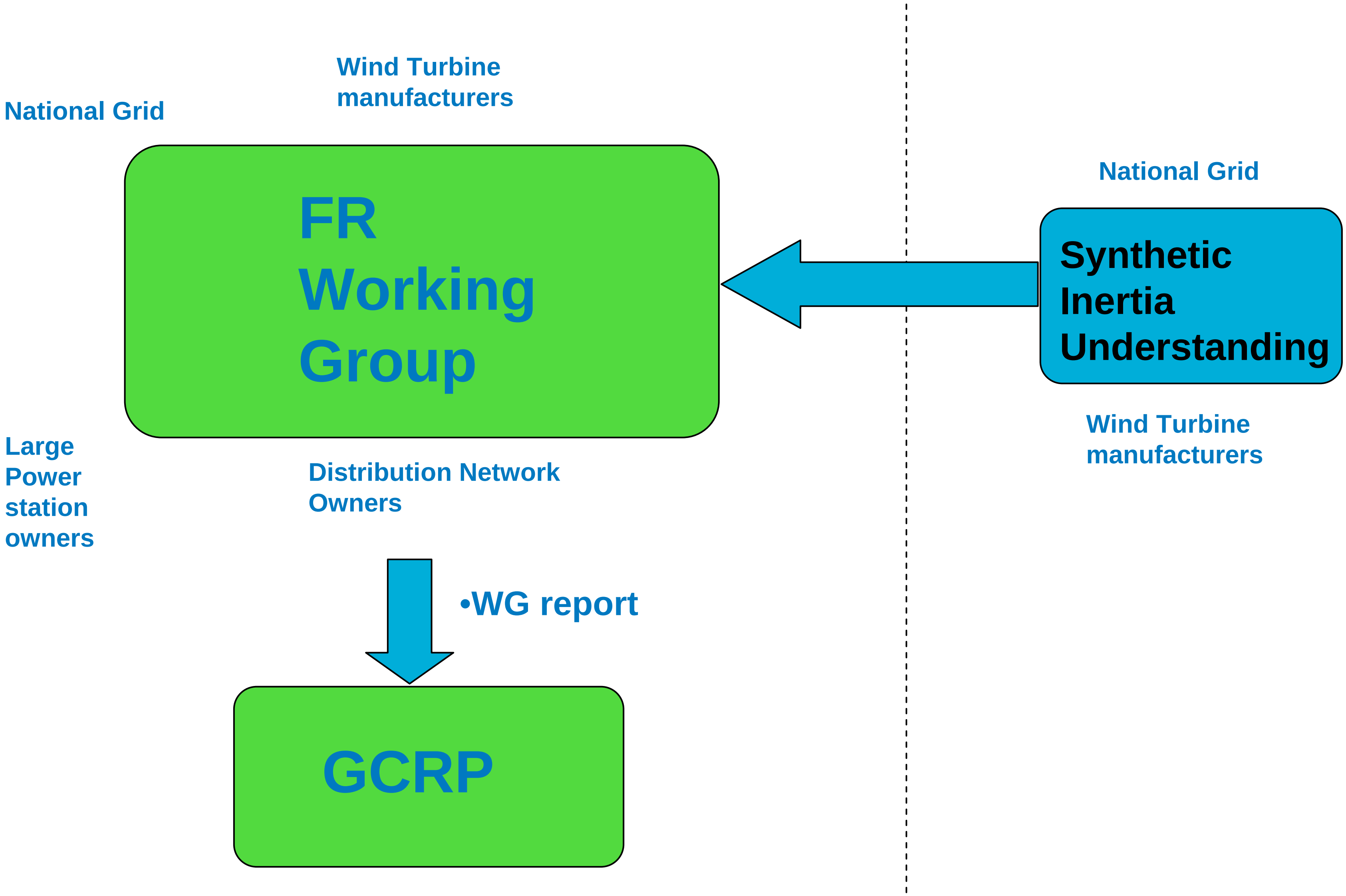
Synthetic Inertia

15th November

Today's Outline

- Understand where the group has emanated from - TI
  - Understand governance of the group - TI
- Produce Terms of Reference - TI
- A future Electricity Transmission system
- Overview of current technical FR obligations – GS/SW
- Issues outlined in previous Meeting
- Largest Infeed Loss
- Proposals for Synthetic Inertia
  - Current SI development
  - Manufacturer Liaison
  - 1320MW loss possible
  - 1800MW more complex?
- Summary of Actions
- Next meeting

Working Group Representation



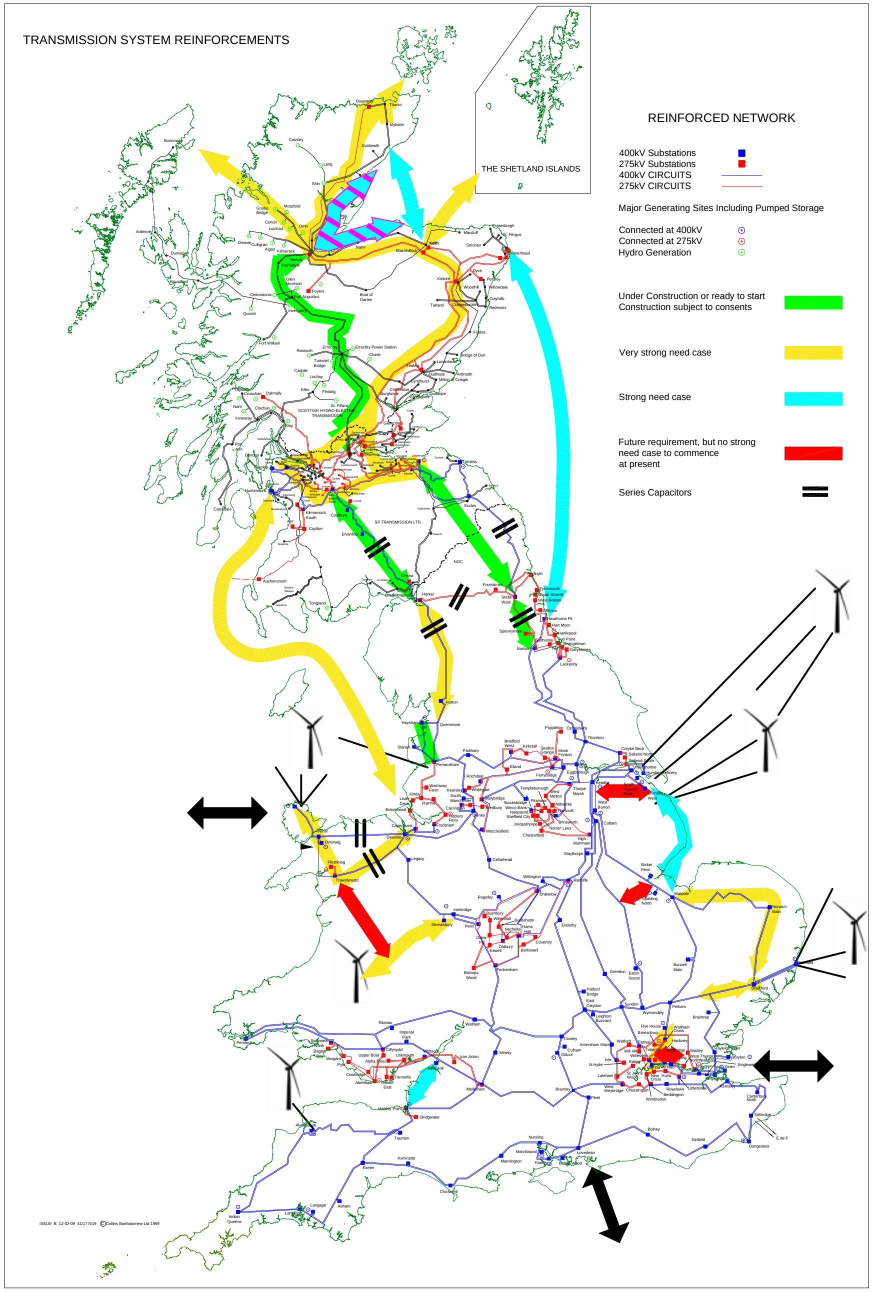
Terms of Reference

- Previous joint BSSG/GC working group draft scope for technical working group
  - Determine the total Transmission system frequency response and synthetic inertia requirements
  - Consider a largest secured loss of both 1320MW and 1800MW for the scenarios described in i) above
  - The initial assumption is that obligations are mandatory and equal. To be expressed on a per MW basis
  - Final proposals will be for the end of February 2011 (this will allow the Working Group to report to either the May or September 2011 meeting)
  - Three meetings are anticipated
  - Coordinate the approach by inviting membership from relevant manufacturers, National Grid, Generators and a representative will be requested from the DCRP
  - A technical report will be delivered with the findings and a summary of discussions.

An NGET Future Scenario
‘Gone Green 2020’

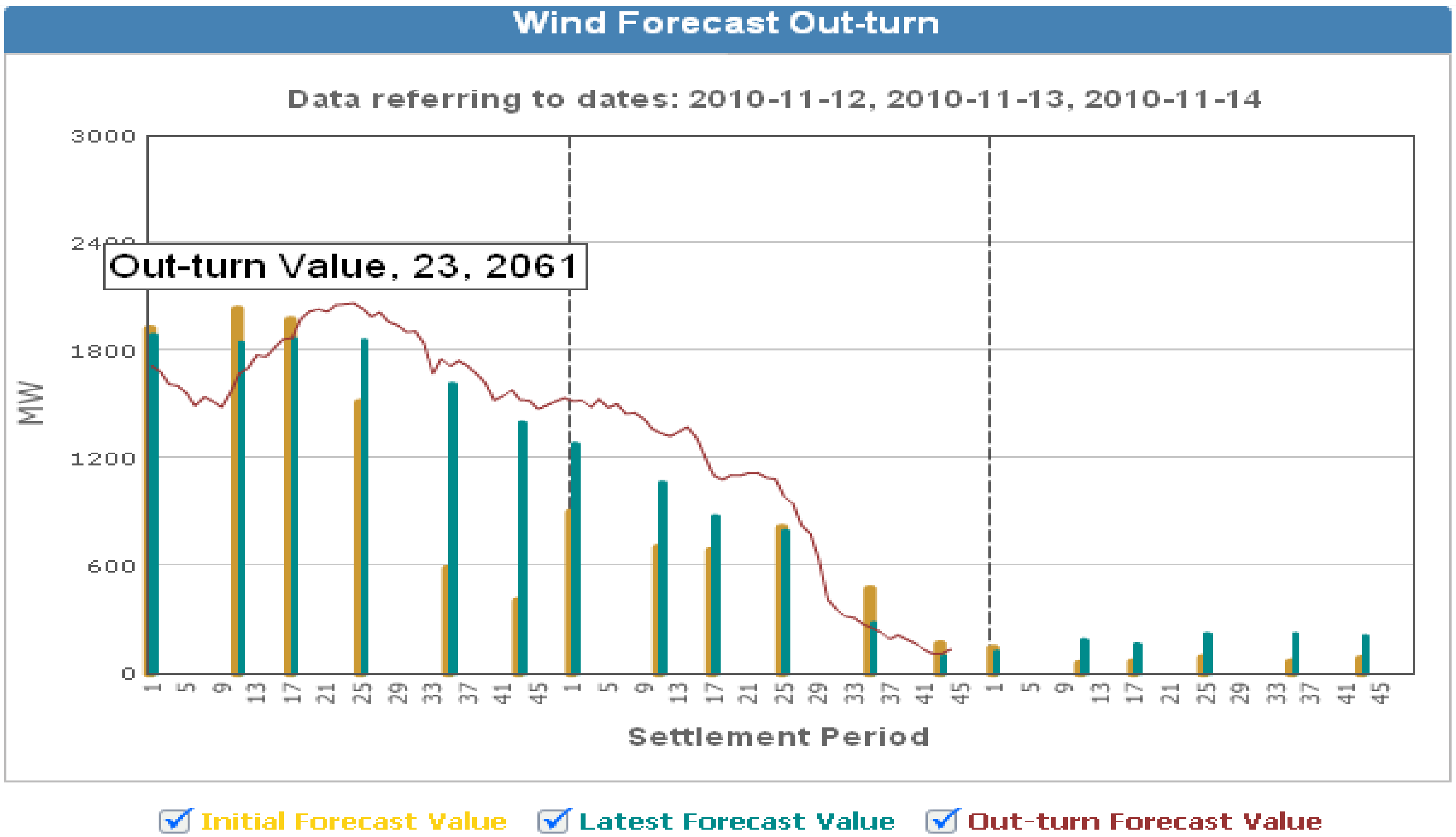
- Plant closures
  - 12GW Coal & oil LCPD
  - 7.5GW nuclear
  - Some gas & additional coal
- Significant new renewable
  - **29 GW wind (2/3 offshore)**
  - Some tidal, wave, biomass & solar PV
  - Renewable share of generation grows from 5% to 36%
- Significant new non renewable build
  - 3GW of new nuclear
  - 3GW of new supercritical coal (some with CCS)
  - 11GW of new gas
- Electricity demand remains flat (approx 60 GW)
  - Reductions from energy efficiency measures
  - Increases from heat pumps & cars
- Largest loss increases to 1800MW?

Strategic Reinforcements



A changing system

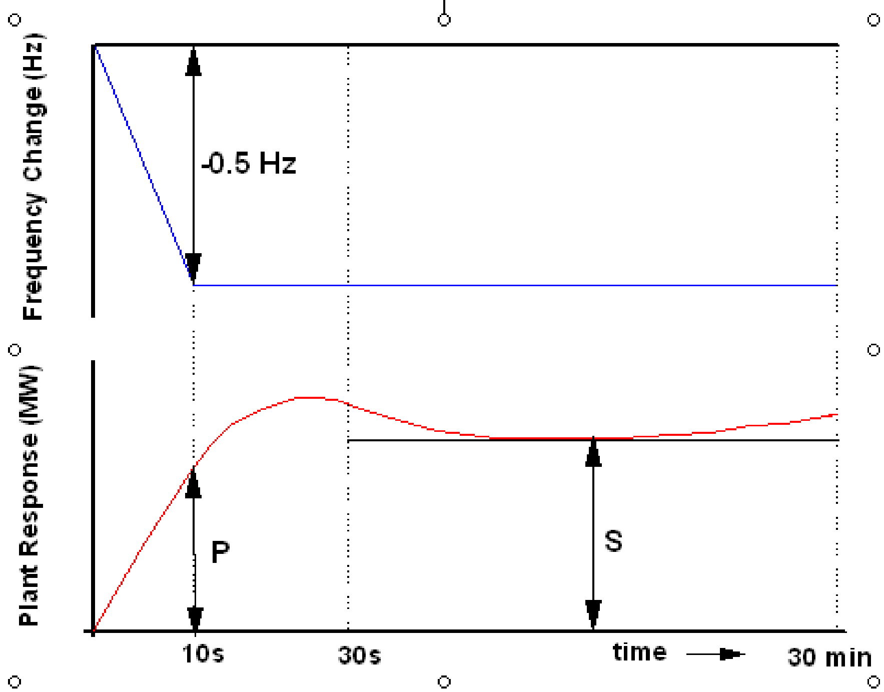
- Metered Wind generation 12th November 2010



Current Grid Code Requirements

- Frequency Response
  - Primary, secondary and high
  - 10% of Registered Capacity minimum energy delivery
- Primary timescales 10-30s
  - Linear and proportion
- Secondary timescales 30s – 30min
- High in 10s
- No requirement for inertia

Figure CC.A.3.2 - Interpretation of Primary and Secondary Response Values



Frequency Response issues

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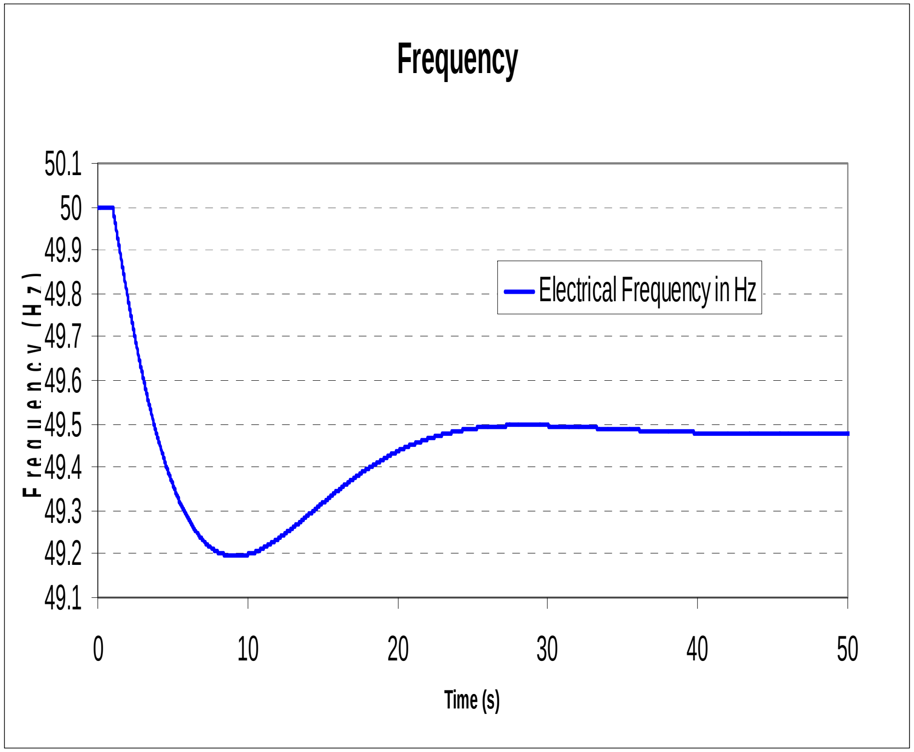
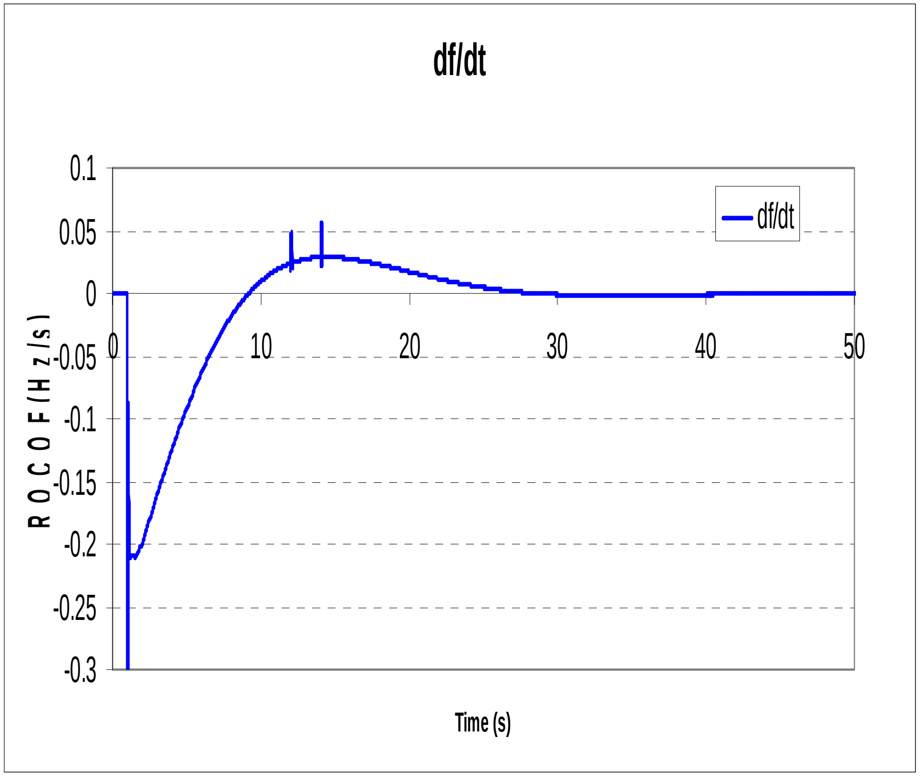
Frequency Response

- All technologies are required to provide Frequency response
  - Generator has to be larger than 50MW and defined as large
- Current largest loss is 1320MW
  - Moving to 1800MW
- National Grid hold Frequency response to secure for the largest loss

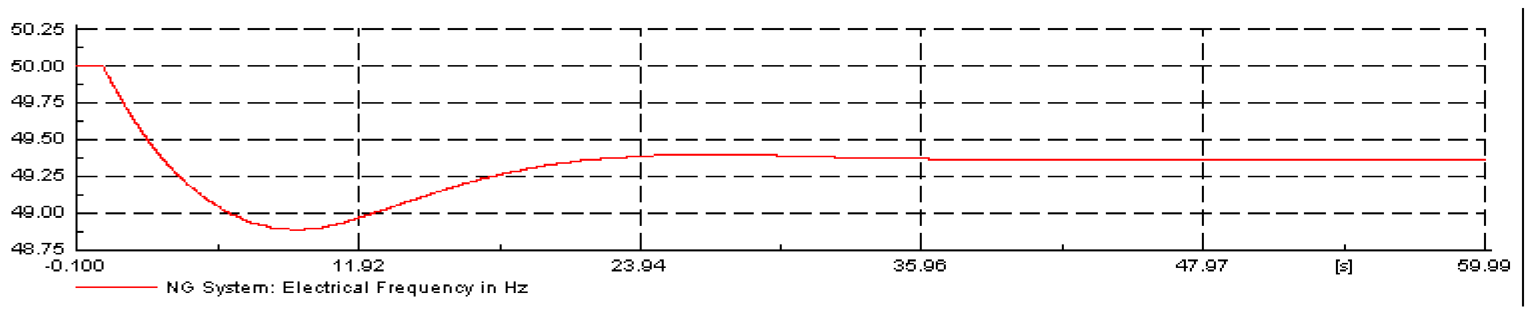
Current largest infeed loss



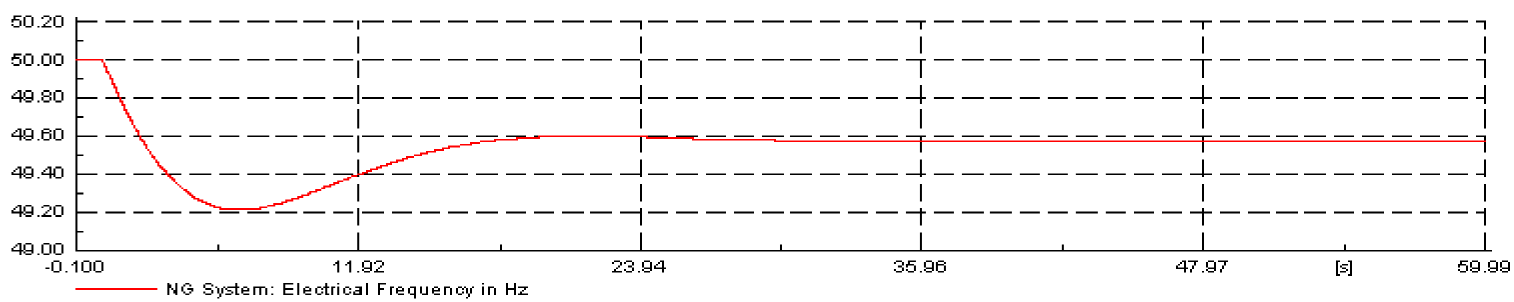


Future largest loss infeed

- 1800MW loss
- 30000MVA system



- 1800MW loss
- 33000MVA system



- Scheduling issues

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Current Synthetic Inertia proposals

Stewart Whyte, National Grid

Current SI position

- System need has been developed
- Studies conducted on simplified network
- Manufacture Liaison
  - How it can be achieved
  - What is achievable
  - Implications for wind turbine
- Initial proposals put to BSSG/GC group and to GCRP

System model and system conditions

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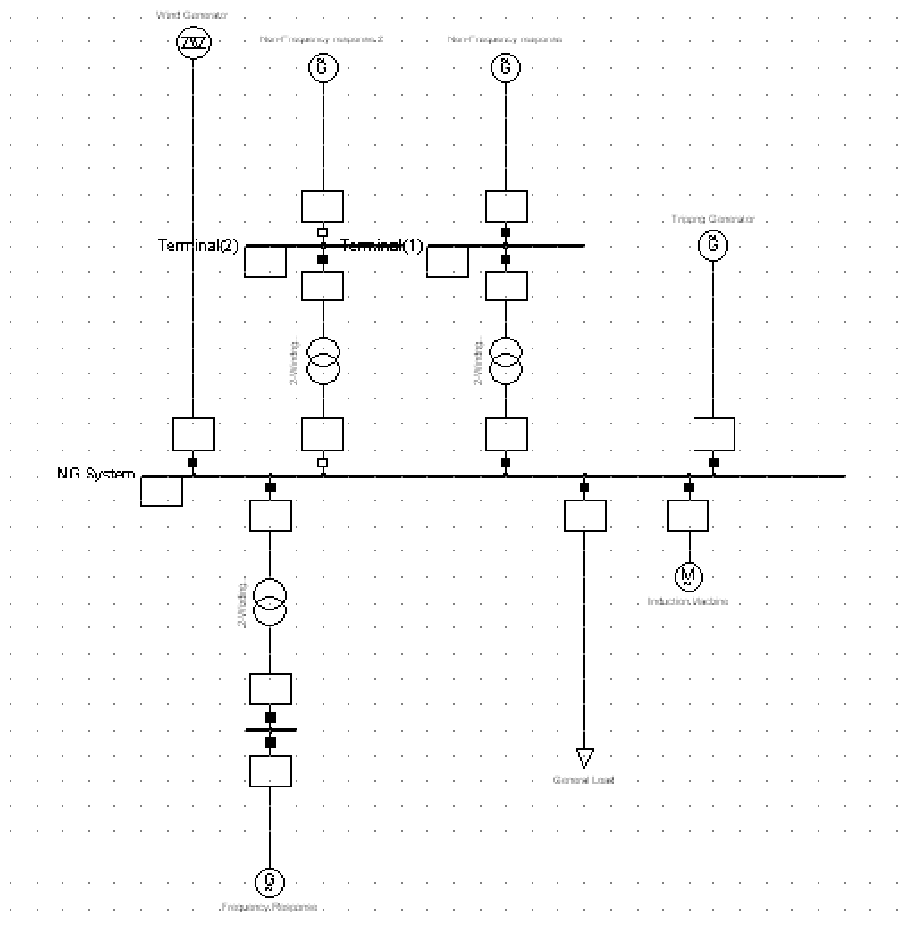
- Generation
  - Wind
  - Conventional
- Trip a single generator
  - 1320MW and 1800MW
- Demand
  - 25GW
  - Static and Rotating
- Frequency Responsive Generator
- Non Frequency Responsive Generator
- Wind generator (static generator)



Synthetic Inertia controller used for National Grid modelling

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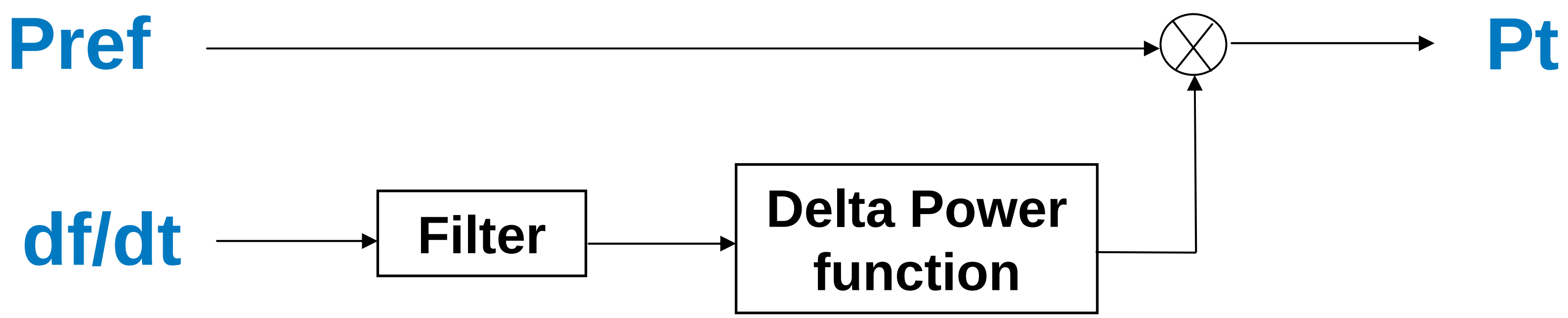
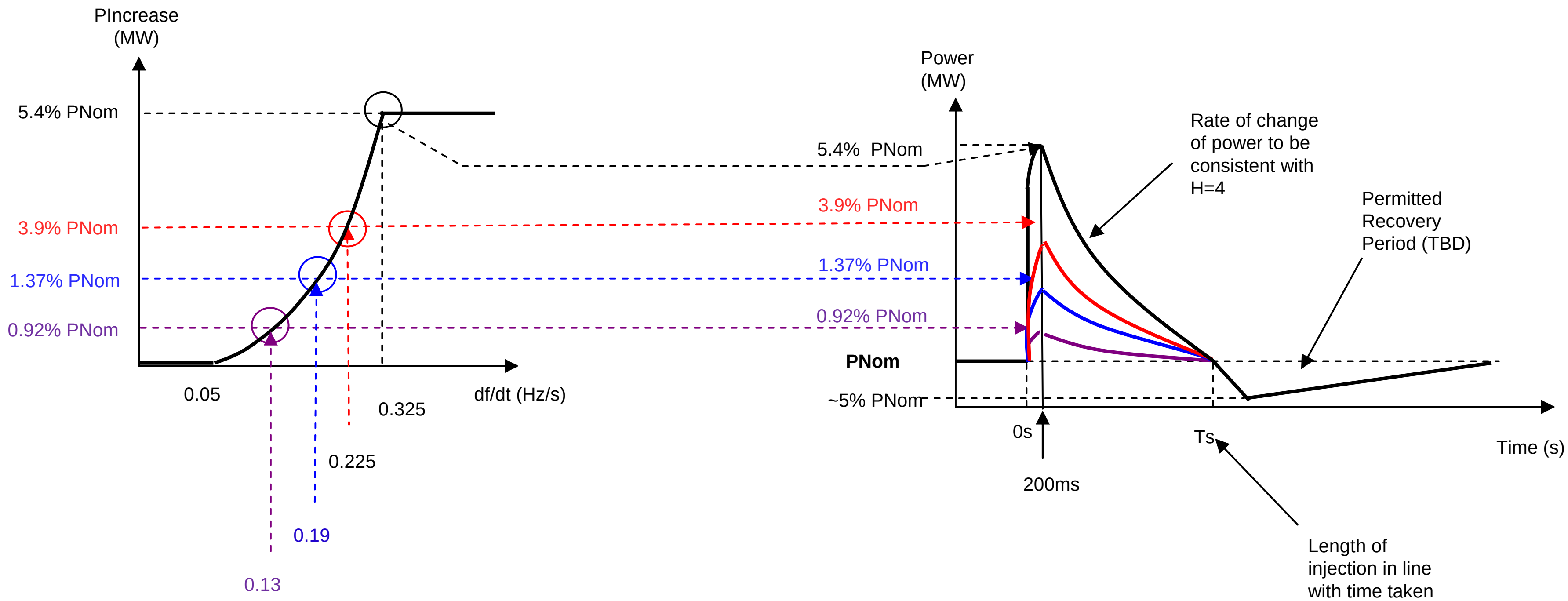


Current Synthetic Inertia proposals



SI key questions

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- What can be achieved?
- How fast can it be achieved?
- Recovery period
  - At what wind speeds is the recovery period worst
  - How can it be minimised
- Cost

How is it achieved?

- Control signal used
- Turbine moved off its most optimal operating point
- Advantage is energy is extracted from turbine
  - Do not need to pitch turbine out of the wind to create headroom
  - Extract energy in normal means by pitching back into the wind
  - No spilled wind

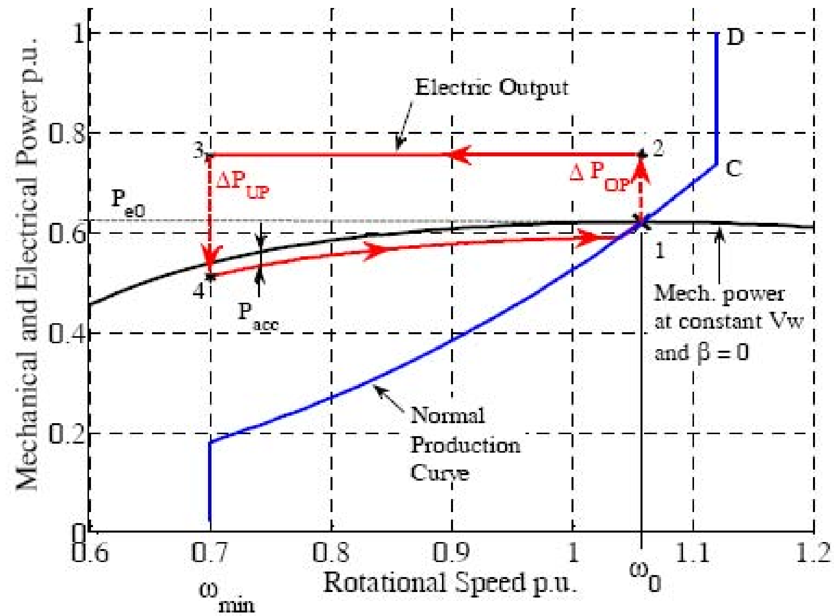

Fig. 3. WT power vs. rotational speed. The blue line is the WT normal (static) production power. The black line is the blade's mechanical power for a constant wind speed. The red line is the electric power set point for over-production process.

- Diagram taken from Variable Speed Wind Turbines Capability for Temporary Over-Production – German Claudio Tarnowski, Philip Carne Kjaer, Poul E Sorensen and Jacob Ostergaard

SI issues

- df/dt deadband
- Appropriateness of df/dt control
- National Grid models used
- Current requirements developed for 1320MW
  - Does 1800MW need to be looked at
- Control scheme interactions
  - FRT and SI
  - Frequency Response and SI
- Recovery period
- Filtering of df/dt
- ROCOF

Power Recovery

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- Manufacturer liaison has identified an issue with the recovery period
- Recovery period characteristics
  - Wind speed dependant
  - Under worst case can be as deep as 25% of MW output resulting a double dip
  - Recovery can last for as long as 40s
  - Recovery at lower wind speeds is managable – examples provided in previous meetings
  - There is no recovery period when operation is at or beyond rated wind speed
- Reduce the upfront power extraction
- Return to optimal rotational speed can be controlled

Next steps

- Understand if SI requirements can be met
- Develop a coordinated FR and SI requirement
  - Potentially for 1800MW
- Decide on the work to be done
- Define requirements
- Propose Grid Code text