ABB FACTS Technology Developments

IEEE HVDC & FACTS Subcommittee

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Anders Bostrom
System lead Engineer
ABB Powergrids/FACTS

ABB FACTS Technology Developments - Presentation outline

STATCOM - Synchronous Condenser Hybrid

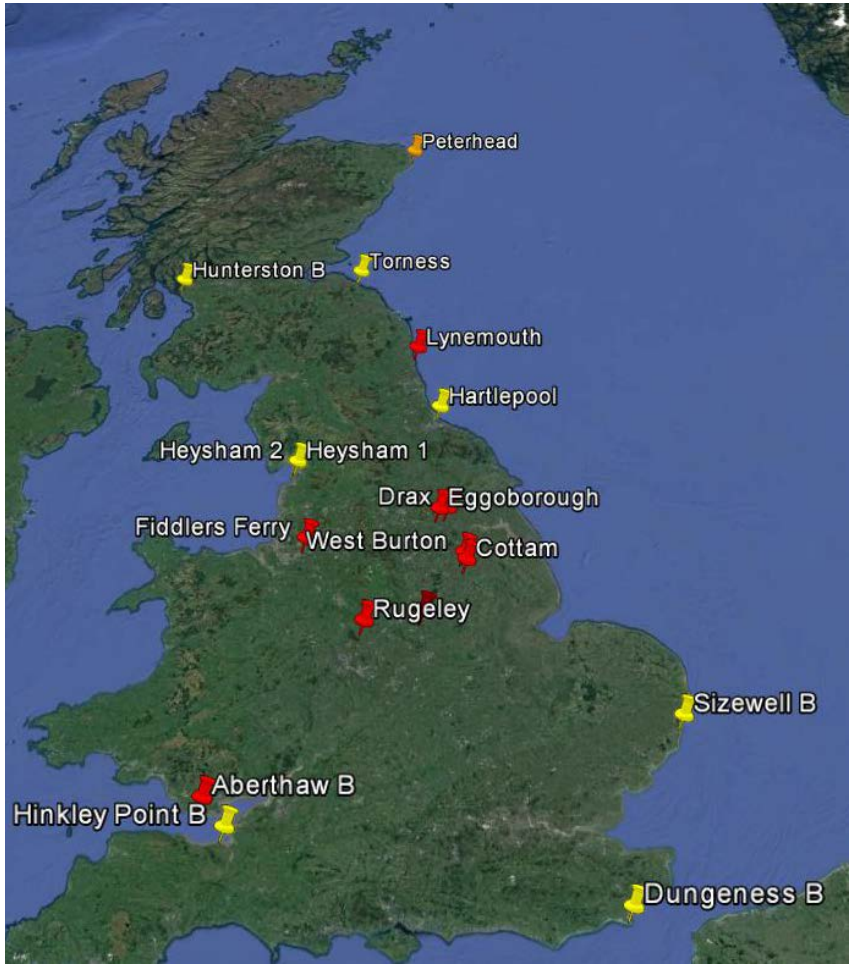
Thyristor controlled Series Compensation

Applications developed to address:

- Retirement of traditional thermal generation to the benefit of renewables
- Variable generation
- Transmission capacity constraints
- Stability issues due to longer distances from source to load
- Reversed power flows
- Voltage and frequency issues
- SSR issues

Background

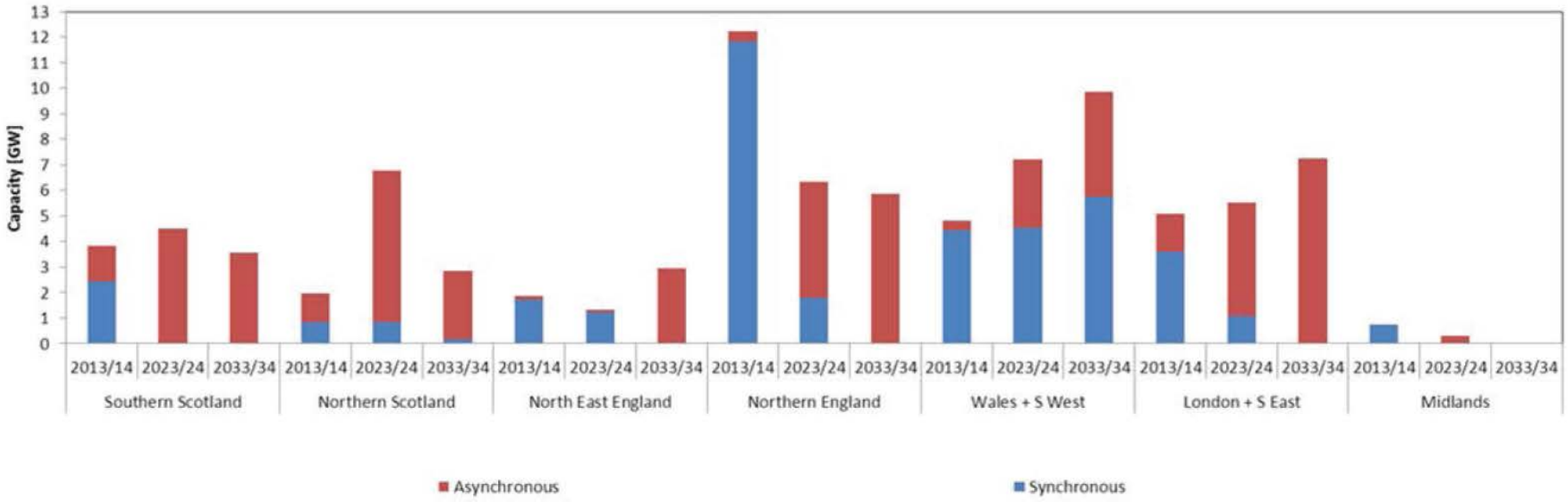
Currently Operating Coal (red) & Nuclear (yellow) Generation vs. 2025 scenario



Impact on System Reliability – Generation Mix

Figure 5.23

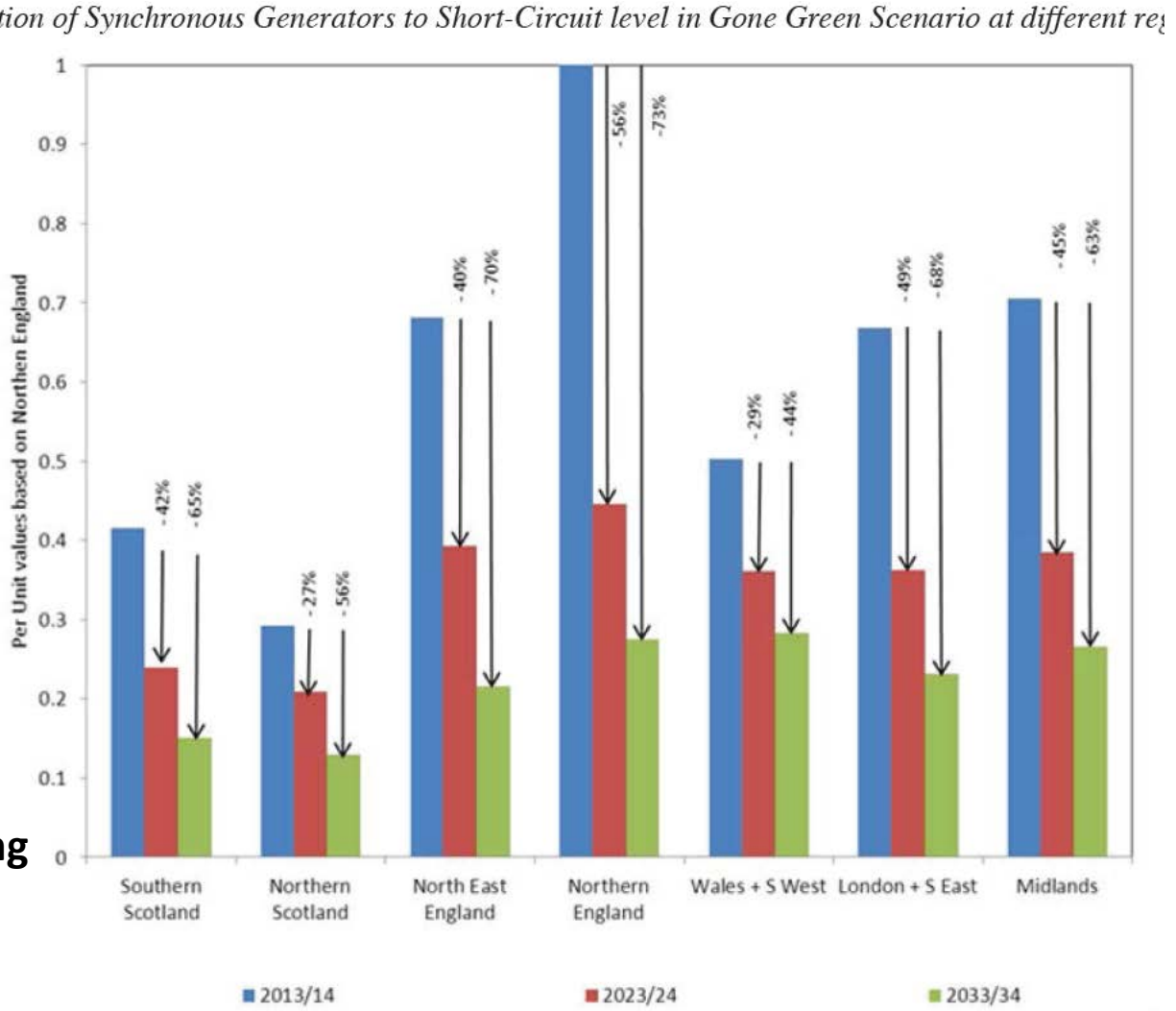
Installed Capacity of Synchronous vs Asynchronous Generation Contributing to 30GW demand in Gone Green Scenario at different regions



Source: National Grid Electricity UKTen Year Statement, issued 2014

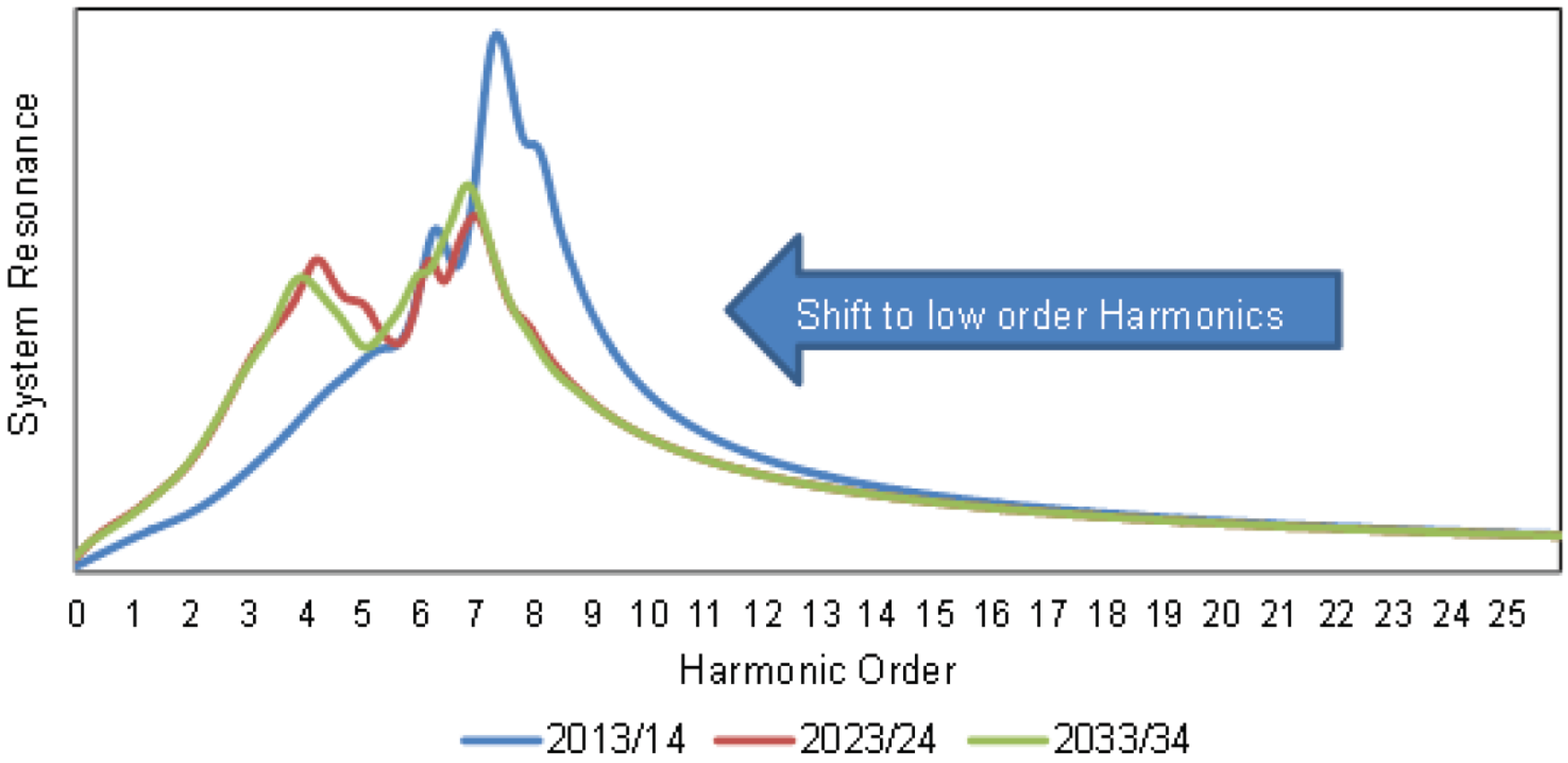
Impact on System Reliability – System Fault Level

- Fault Level ~ system strength
- Transferring Capability
- Angular stability
- Voltage Stability
- Selectivity
- Susceptibility to harmonic distortion
- **With decreasing fault levels, transmission systems are becoming more susceptible to disturbance – periods of varying voltage and frequency**



Source: National Grid Electricity Ten Year Statement, issued 2014

Impact on System Reliability – Resonant Conditions

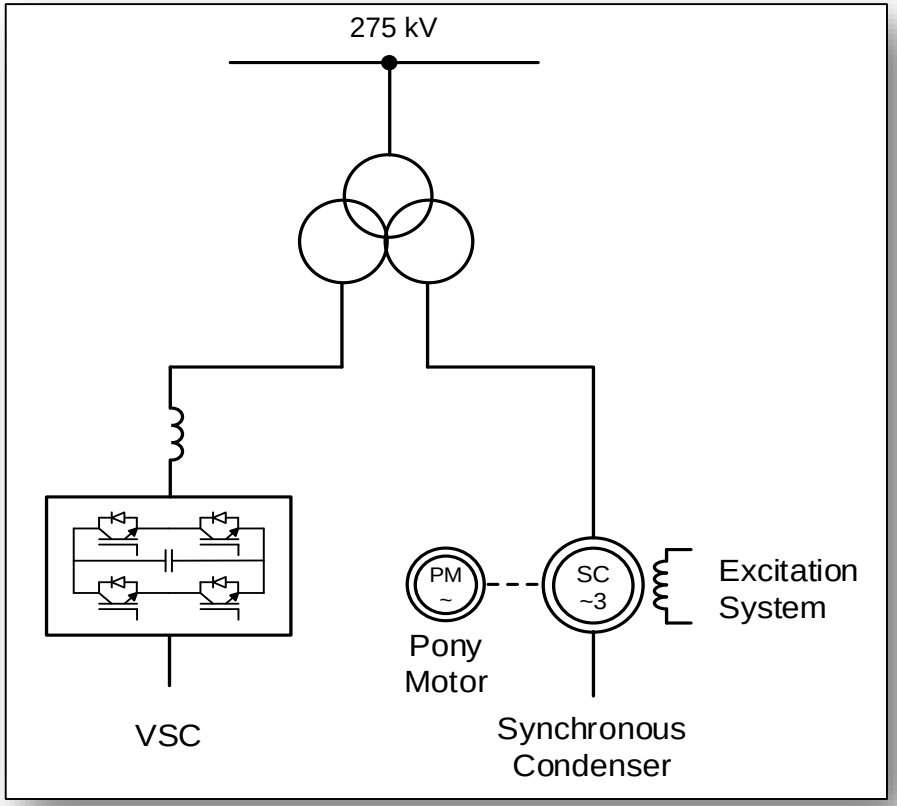


Source: National Grid Electricity Ten Year Statement, issued 2014

Phoenix project: STATCOM - Synchronous Condenser Hybrid

Scottish Power, UK

- SVC Light HighPower
- Synchronous Condenser
- Transformer: Three -winding, with separate windings for SVC Light and Synch. Condenser or two separate two-winding transformers
- MACH® Control and Protection
- Simulation Models and System Studies
- Civil Works
- Installation, Testing and Commissioning
- In service: November 2019



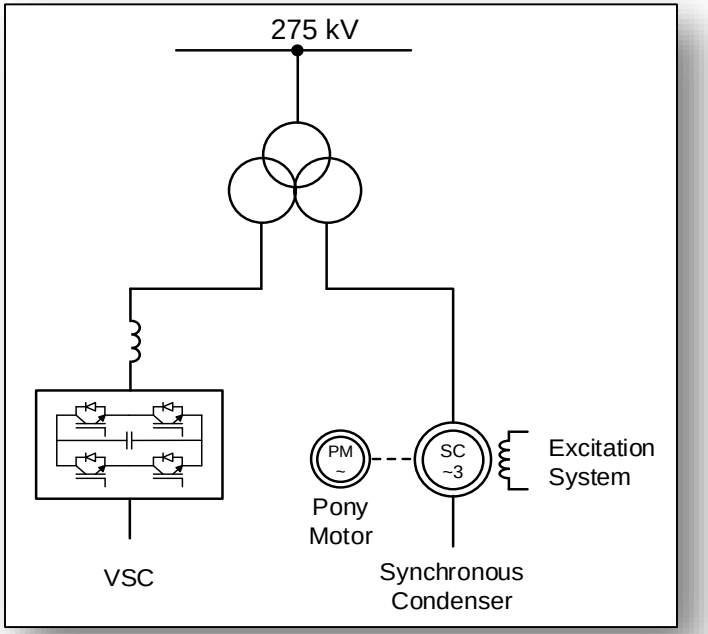
Phoenix project: STATCOM - Synchronous Condenser Hybrid

The Project addresses system issues that risk the security and reliability of supply to UK customers, including:

- Reduced inertia
- Reduced fault level
- Limitations of voltage and frequency control

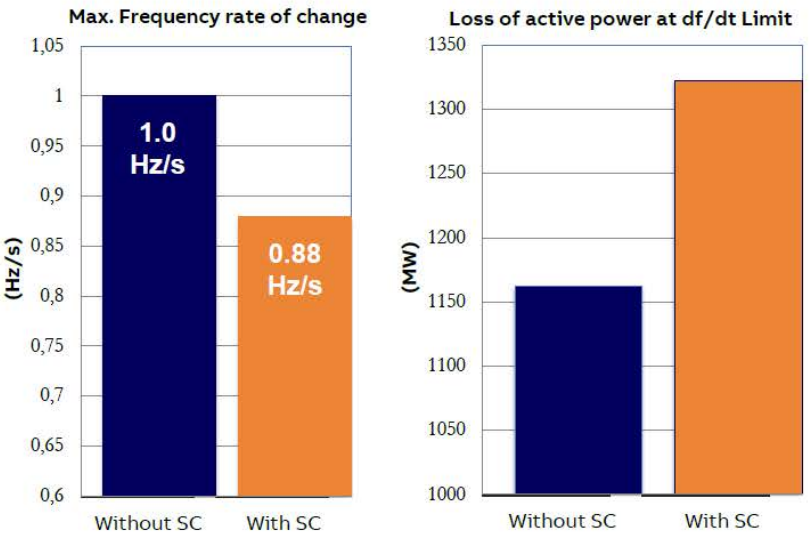
Purpose of the project:

- Prove the concept in the transmission system.
- Identify future installations through system studies.
- Provide an alternative and complement to converting existing thermal units to synchronous condensers.



Phoenix project: STATCOM - Synchronous Condenser Hybrid

Objectives	Synchronous Condenser	STATCOM
System short circuit level	Main contributor, high overload	Limited capability
System inertia	Main contribution, higher stored energy	Limited capability, Inertia emulation
Provide dynamic voltage regulation	Support with high overload capability	Main contributor with fast response
Reactive power support for alleviate voltage dip	Support with high overload capability	Main contributor with fast response
Reactive power absorption at potential over-voltages	Good contribution for low load situations	Fast reaction at fault recovery and switching events
Enhance oscillation damping capability	Main contributor for low frequency oscillations	Main contributor for high frequency oscillations
Aid in maintaining power quality in the network	Contributes with possible overload	Contributes with high controllability and fast response
Active filtering	No capability	Main contributor with fast response
Damping of sub-synchronous control interaction (SSCI)	No capability	Main contributor with fast response
Negative sequence control (load balancing)	No capability	Main contributor with fast response



Example

- System inertia 75 GVAs
- Synchronous Condenser:
  - 5 GVA
  - Inertia constant 2 s

Result

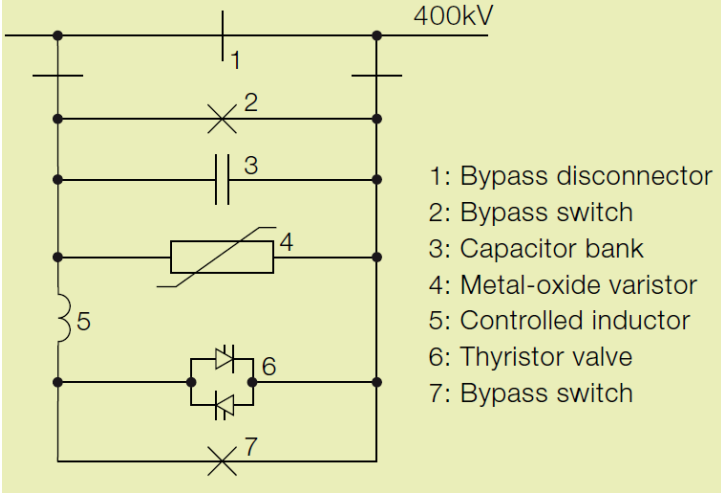
- SC provides improvement of maximum Frequency rate of change and loss of power tolerances

Hutton TCSC, National Grid UK

Hutton TCSC, National Grid UK

Background

- Generation mix of thermal and wind (Onshore and Offshore)
- North to south power transfer to increase by >1 GW in the near future.
- TCSCs part of multiple transmission reinforcements to meet transfer increase
- Two TCSC units at
  - 400 kV, 393 Mvar
  - 35% degree of compensation
  - 100 % TCSC, no FSC segment
  - SSR mitigation
  - Power flow control
  - POD



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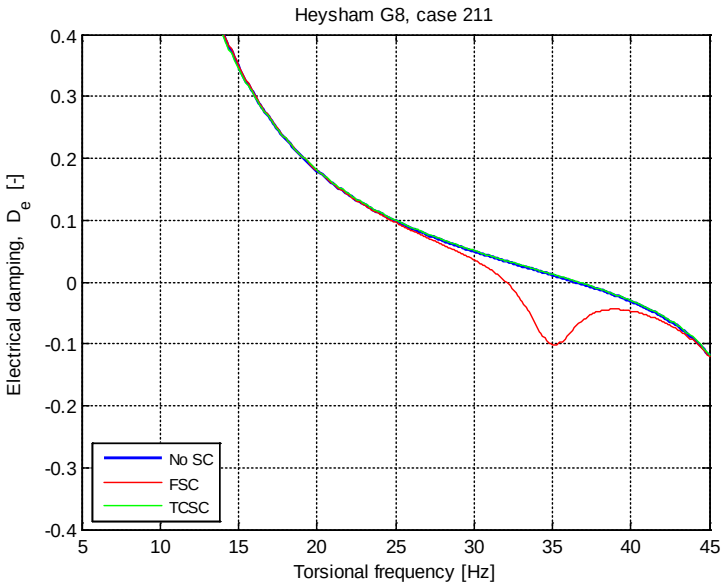
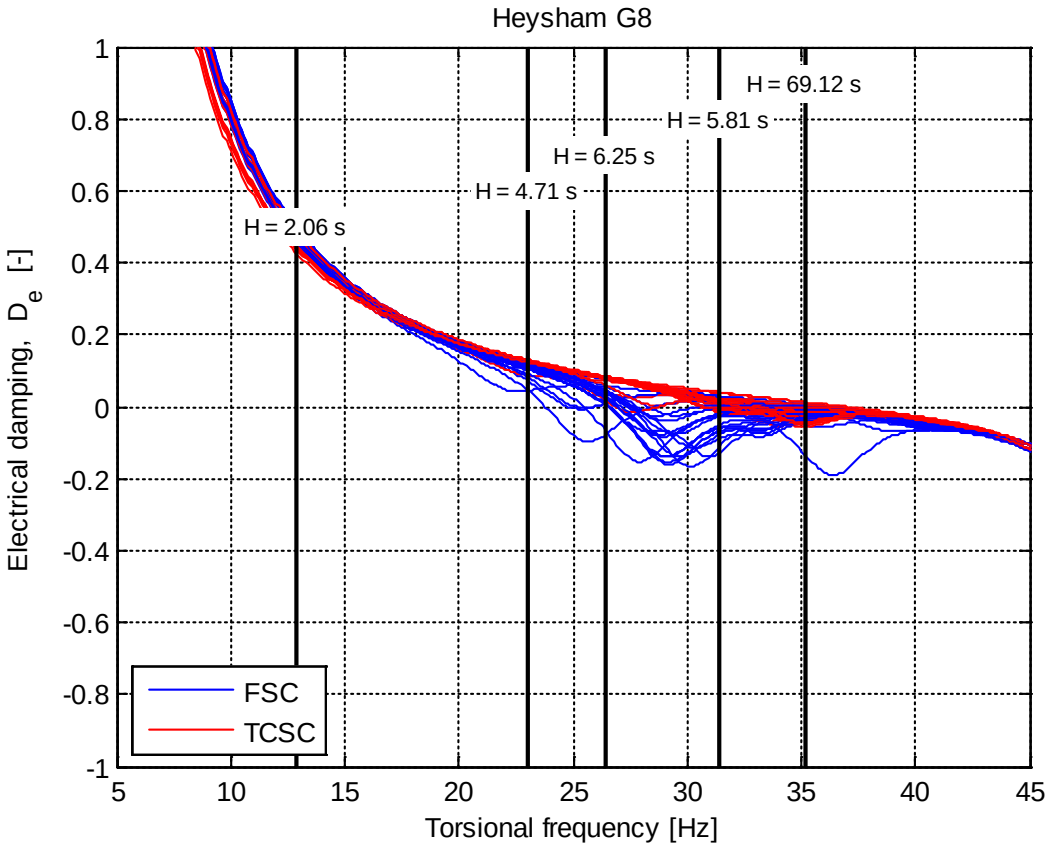
Torsional Modes

Freq. mode	Fequency [Hz]
1	12.85
2	23.00
3	26.43
4	31.43
5	35.17



Screening Studies



Thank You