Ofgem Forum To Discuss Grid Code Proposals For New Generation Technologies

Proposed Technical Connection Conditions

Scottish and Southern Energy plc	- Chandra Trikha, Brian Punton
National Grid Transco	- Dr Nasser Tleis, Mark Horley
Scottish Power Transmission & Distribution	- Dr David Nicol, Dr Hamish Dallachy

National Grid Transco

SP Transmission & Distribution

Overview of Transmission Licensee Presentation

- Objectives of the Grid Codes & Licensees Obligations
- Why Review the Grid Codes in Great Britain.
- Licensees Grid Code Review Processes.
- Ofgem process for further development of the Grid Codes in Great Britain.
- Alignment of Grid Code Proposals in Great Britain, Justification of Requirements & Manufacturer Capabilities.
- Summary of Manufacturer Capabilities Agreed For Public knowledge.
- Current Position.
- Conclusions.

National Grid Transco

SP Transmission & Distribution

Objectives of the Grid Codes & Licensee Obligations - Objectives of the Grid Codes

Grid Codes designed to:

- permit the development, maintenance and operation of an efficient, co-ordinated and economical system for the transmission of electricity
- facilitate competition in the generation and supply of electricity
- Promote security and efficiency of electricity generation, transmission and distribution systems

Objectives of the Grid Codes & Licensee Obligations - Licensee Objectives

Each Licensee is obliged to:

- periodically review the Grid Code (in consultation with Authorised Electricity Operators)
- propose revisions that the Licensee reasonably believe fit to achieve the Grid Code objectives
- ensure the Grid Code does not unduly discriminate against or favour Users or categories of User

Overview of Transmission Licensee Presentation

- Objectives of the Grid Codes & Licensees Obligations
- Why Review the Grid Codes in Great Britain.
- Licensees Grid Code Review Processes.
- Ofgem process for further development of the Grid Codes in Great Britain.
- Alignment of Grid Code Proposals in Great Britain, Justification of Requirements & Manufacturer Capabilities.
- Summary of Manufacturer Capabilities Agreed For Public knowledge.
- Current Position.
- Conclusions.

National Grid Transco

SP Transmission & Distribution

Why Review the Grid Codes in Great Britain - Why the Reviews

Limitations of Current Codes

- Lack of clarity for non-synchronous plant
- Exclusion of Renewables no longer appropriate
- The technical characteristics of such plant will have major impact on system security
- Treatment on individual development basis is not transparent, is potentially discriminatory and could create inconsistencies
- Without certain minimum technical capabilities there will be barriers to connection of non-synchronous plant to maintain current levels of system security and stability.
- Could become an issue for Ofgem ?

Why Review the Grid Codes in Great Britain - Why the Reviews

- License Obligations on each Transmission Licensee
  - periodically review and propose revisions to the Grid Code
  - design and operate a safe, secure and economic transmission system
- Ensure continued system security and Power Quality into the future
- This will help facilitate the Government Targets for 2010 and 2015 for electricity generation from renewable sources

National Grid Transco

SP Transmission & Distribution

Why Review the Grid Codes in Great Britain - Why Now

Market Penetration in Great Britain

- Current and forthcoming high level of wind farm activities
  - 4GW commitment, +6 GW activity in Scotland
  - 2GW commitment, +7GW DTI Round 1 & 2 in E&W
- Many developments commissioning from now
- Give clear guidance to manufacturers and Generators of Grid Code Requirements

National Grid Transco

SP Transmission & Distribution

Why Review the Grid Codes in Great Britain - Why Now

Market Penetration - International Scene

Germany	14,609 MW
Spain	6,202 MW
Denmark	3,110 MW
Rest of Europe	4,582 MW
Rest of World	8,538 MW

10,000s of turbines in commercial operation

European statistics figures reported in Platts Renewable Energy Report March 2004

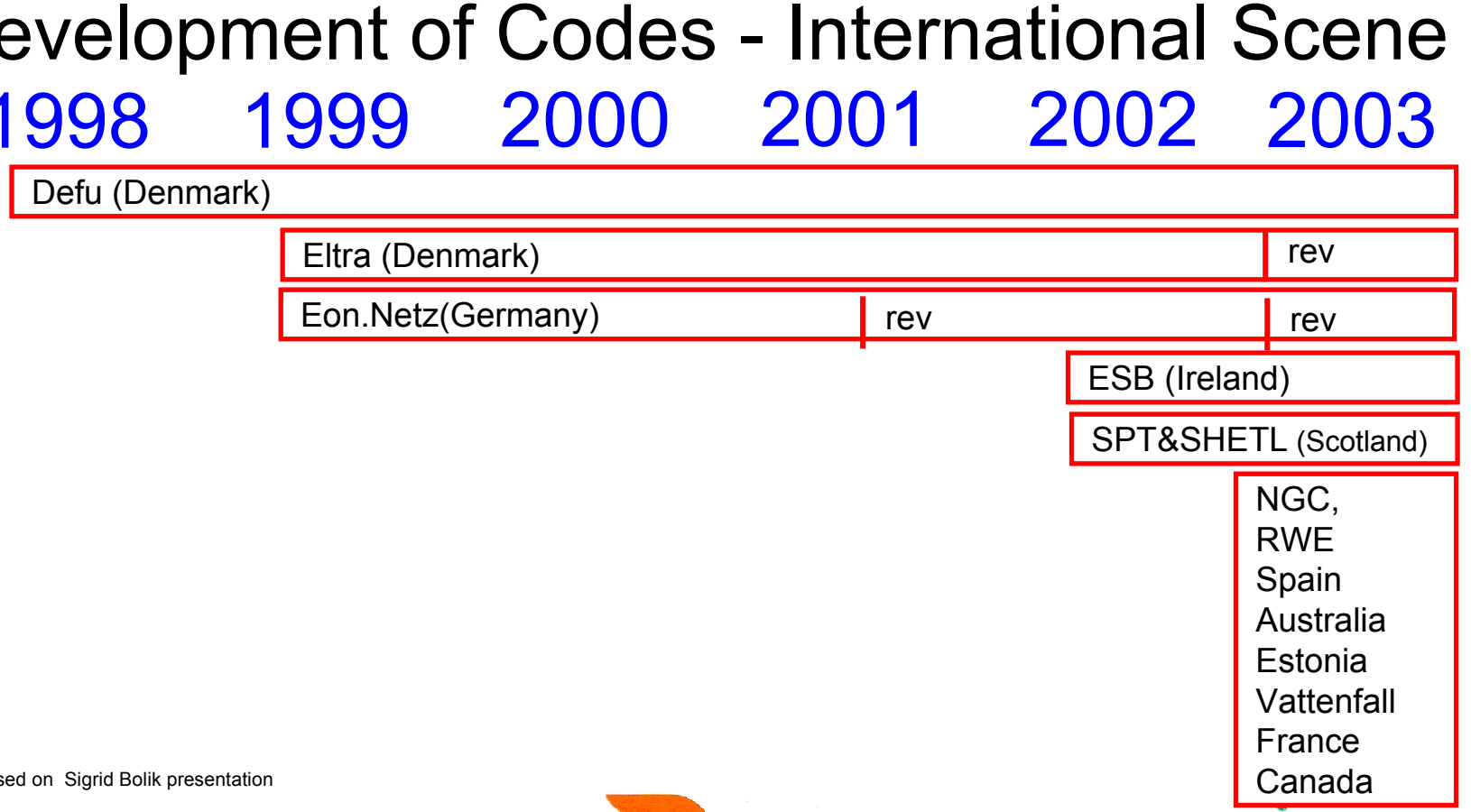
World from BTM world market update March 2003

National Grid Transco

SP Transmission & Distribution

Why Review the Grid Codes in Great Britain - Why Now

Development of Codes - International Scene



Based on Sigrid Bolik presentation

National Grid Transco

SP Transmission & Distribution

Overview of Transmission Licensee Presentation

- Objectives of the Grid Codes & Licensees Obligations
- Why Review the Grid Codes in Great Britain.
- Licensees Grid Code Review Processes.
- Ofgem process for further development of the Grid Codes in Great Britain.
- Alignment of Grid Code Proposals in Great Britain, Justification of Requirements & Manufacturer Capabilities.
- Summary of Manufacturer Capabilities Agreed For Public knowledge.
- Current Position.
- Conclusions.

National Grid Transco

SP Transmission & Distribution

Licensees Grid Code Review Process - Scottish Grid Code

- August 2001 SGCRP set up formal subgroup to review provisions with respect to wind farms
- First consultation SB/2002 produced in March 02 with closure of 19th April
- Consultation extended (closure of 14th June) to pro-actively seek views from wind farm community
- Process of discussion and modifications undertaken by Panel. Most extensive consultation ever carried out by SGCRP
- Proposals submitted to Ofgem in December 2002

National Grid Transco

SP Transmission & Distribution

Licensees Grid Code Review Process - Scottish Grid Code

Post submission of the Scottish Grid Code proposals two meetings were held at the behest of Ofgem:

- 7 May 2003 Presentation of Licensee proposals and presentation of developer views to Ofgem
- 6 Sept 2003 Licensee and Stakeholder Meeting to discuss differences

National Grid Transco

SP Transmission & Distribution

Licensees Grid Code Review Process - England and Wales Grid Code

- Grid Code Review Panel Meeting (5 Sept 2002) and set up the Generic Provisions Working Group
- Report to the GCRP (22 May 03)
- Extensive industry wide consultation with AEOs, developers and others (June 03 - Sept 03)
- Proposals submitted to Ofgem in October 2003

National Grid Transco

SP Transmission & Distribution

Overview of Transmission Licensee Presentation

- Objectives of the Grid Codes & Licensees Obligations
- Why Review the Grid Codes in Great Britain.
- Licensees Grid Code Review Processes.
- Ofgem process for further development of the Grid Codes in Great Britain.
- Alignment of Grid Code Proposals in Great Britain, Justification of Requirements & Manufacturer Capabilities.
- Summary of Manufacturer Capabilities Agreed For Public knowledge.
- Current Position.
- Conclusions.

National Grid Transco

SP Transmission & Distribution

Ofgem Process for Further Development of the Grid Codes in Great Britain

Ofgem requested further development of Codes at IEE Seminar on 16 October 2003 and Press Release on 29 January 2004

- Licensees to align technical requirements
- Further meetings of Licensees with manufacturers to ascertain latest capabilities (Jan/Feb)
- Forum with all Stakeholders to discuss proposals (Mar)
- Licensees to finalise aligned proposals and re-submit to Ofgem (end May)
- Decision from Ofgem (end June)

National Grid Transco

SP Transmission & Distribution

Ofgem Process for Further Development of the Grid Codes in Great Britain

Alignment of Technical Requirements in Two Codes

- Technical requirements were broadly similar.
- Small areas of difference were identified and aligned.
- Alignment is in the context of two different electricity markets and ancillary service mechanisms
- Aligned technical requirements should allow seamless incorporation into BETTA GB Grid Code

National Grid Transco

SP Transmission & Distribution

Ofgem Process for Further Development of the Grid Codes in Great Britain

Aligned Technical Requirements

- Fault Ride Through requirement the same in both codes with immediate effect.
- Reactive Power Range and Voltage Control requirement the same in both codes from 1 January 2006.
- Frequency Response capability required in both Grid Codes from Grid Code change implementation date.

Ofgem Process for Further Development of the Grid Codes in Great Britain - Manufacturer Meetings

- International Manufacturers
- Confidential Meetings with
  - 8 wind turbine generator manufacturers
  - 2 power electronics manufacturers
- Cover >80% World Market Share
- Ofgem attended as an independent observer.

National Grid Transco

SP Transmission & Distribution

Ofgem Process for Further Development of the Grid Codes in Great Britain - Manufacturer Meetings

At each manufacturer meeting

- Grid Code change process explained by Ofgem
- Manufacturer capabilities to meet the proposed technical requirements were discussed
- Existing process for demonstration of compliance with the Grid Code was explained
- Manufacturer was invited to attend the Forum

National Grid Transco

SP Transmission & Distribution

Ofgem Process for Further Development of the Grid Codes in Great Britain - Manufacturer Meetings

Technical capabilities discussed were the issues raised during the consultation .i.e.

- Fault Ride Through
- Frequency Range & Power/Frequency Characteristic
- Frequency Control
- Reactive Range and Voltage Control
- Negative Phase Sequence Withstand
- Modelling

Ofgem Process for Further Development of the Grid Codes in Great Britain - Manufacturer Meetings

On each technical requirement manufacturers were asked:

- Can the product meet the proposed requirement?
- Is this capability available commercially now and if not, when?
- How much, if any, does the requirement add to the turbine cost?
- Can compliance with the Grid Code be guaranteed?

Ofgem Process for Further Development of the Grid Codes in Great Britain
- Manufacturer Meetings

From each meeting:

- Manufacturer, Licensees and Ofgem agreed a set of Confidential Minutes
- Manufacturer, Licensees and Ofgem agreed a summary of ability of the product to meet the proposed Grid Code requirements to be presented in an anonymous form to protect commercial confidentiality.

National Grid Transco

SP Transmission & Distribution

Ofgem Process for Further Development of the Grid Codes in Great Britain
- Manufacturer Meetings

Improvements to the Grid Code Connection Condition proposals from manufacturer meetings:

- Changes to the drafting of power recovery in the Fault Ride Through drafting.
- Addition of a voltage-duration curve in the Fault Ride Through requirement.

National Grid Transco

SP Transmission & Distribution

Overview of Transmission Licensee Presentation

- Objectives of the Grid Codes & Licensees Obligations
- Why Review the Grid Codes in Great Britain.
- Licensees Grid Code Review Processes.
- Ofgem process for further development of the Grid Codes in Great Britain.
- Alignment of Grid Code Proposals in Great Britain, Justification of Requirements & Manufacturer Capabilities.
- Summary of Manufacturer Capabilities Agreed For Public knowledge.
- Current Position.
- Conclusions.

National Grid Transco

SP Transmission & Distribution

Aligned Proposals, Justification & Manufacturer Capabilities

Reactive Power Capability & Voltage Control

Grid Code requirements prior to 1 January 2006

The Scottish Grid Code proposals require generators to provide Reactive power capability and Voltage Control capability at the point of connection or at the generator terminals.

The England & Wales Grid Code proposals require zero Reactive Power transfer at Connection Point.

National Grid Transco

SP Transmission & Distribution

Aligned Proposals, Justification & Manufacturer Capabilities
Reactive Power Capability & Voltage Control

Grid Code requirements from 1 January 2006 in both England & Wales and Scotland require generators to provide:

- Reactive power capability at the point of connection: 0.95 pf lead and lag
- Voltage control capability at the point of connection

National Grid Transco

SP Transmission & Distribution

Aligned Proposals, Justification & Manufacturer Capabilities

Reactive Power Capability & Voltage Control

Justification for requirement

- Provide steady state control of system voltage at point of connection
- Facilitate active power export and transfer.
- Maintain quality of supply to customers including generators.
- Assist in secure system during and after grid system faults.
- Provide dynamic support of system.
- Assist transient stability and voltage stability.

Aligned Proposals, Justification & Manufacturer Capabilities
Reactive Power Capability & Voltage Control

Justification for requirement: Voltage Stability

Post-fault basic induction generators pull MVArs from the system

- Voltage collapse due to lack of MVArs
- Capacitor MVArs fall with V^2
- Inductive losses increase with I^2
- Induction generator instability and tripping

Aligned Proposals, Justification & Manufacturer Capabilities
Reactive Power Capability & Voltage Control

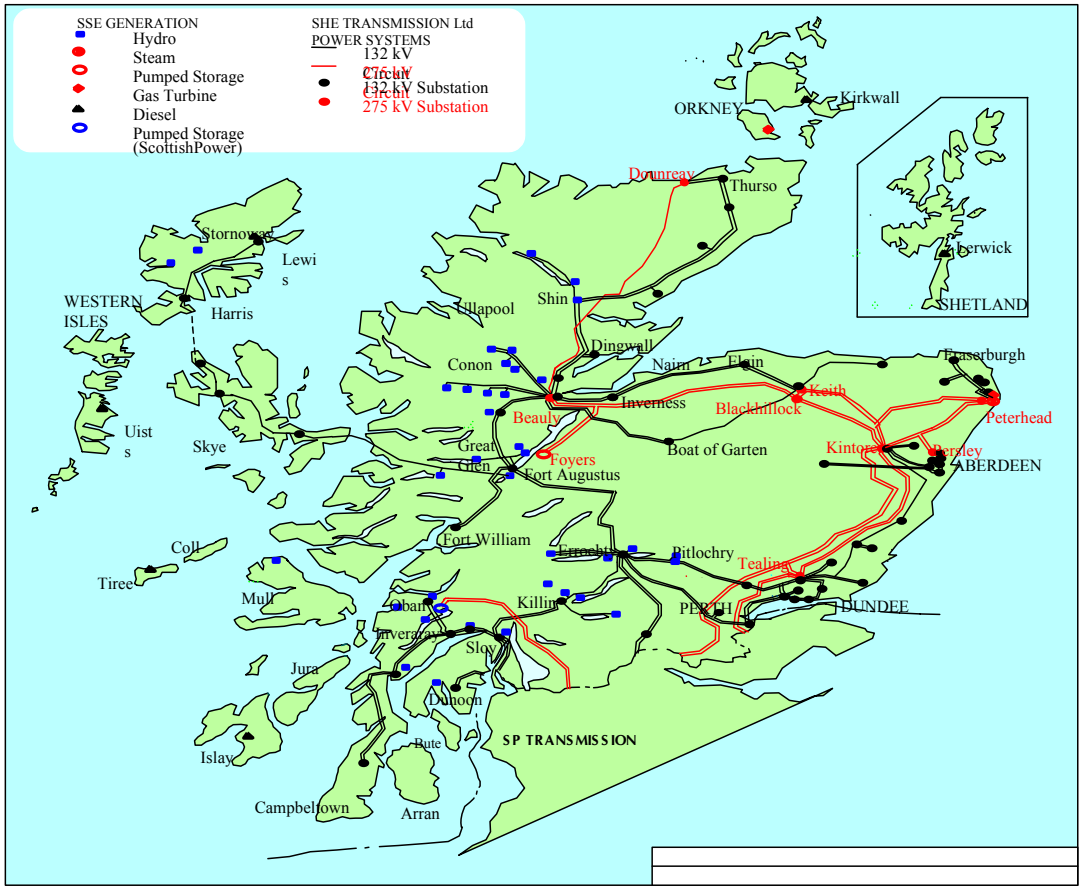
Justification for requirement: Voltage Stability

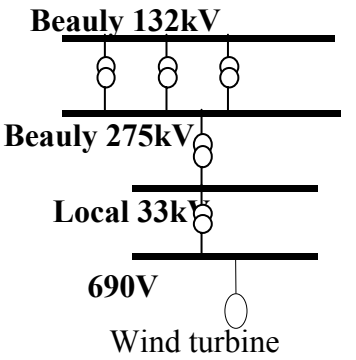
Studies for the North of Beauly

- 300MW voltage stability limit for simple induction generator
- Voltage stability problem resolved by replacing induction generator by basic synchronous generator that has reactive power and voltage control capabilities

Aligned Proposals, Justification & Manufacturer Capabilities

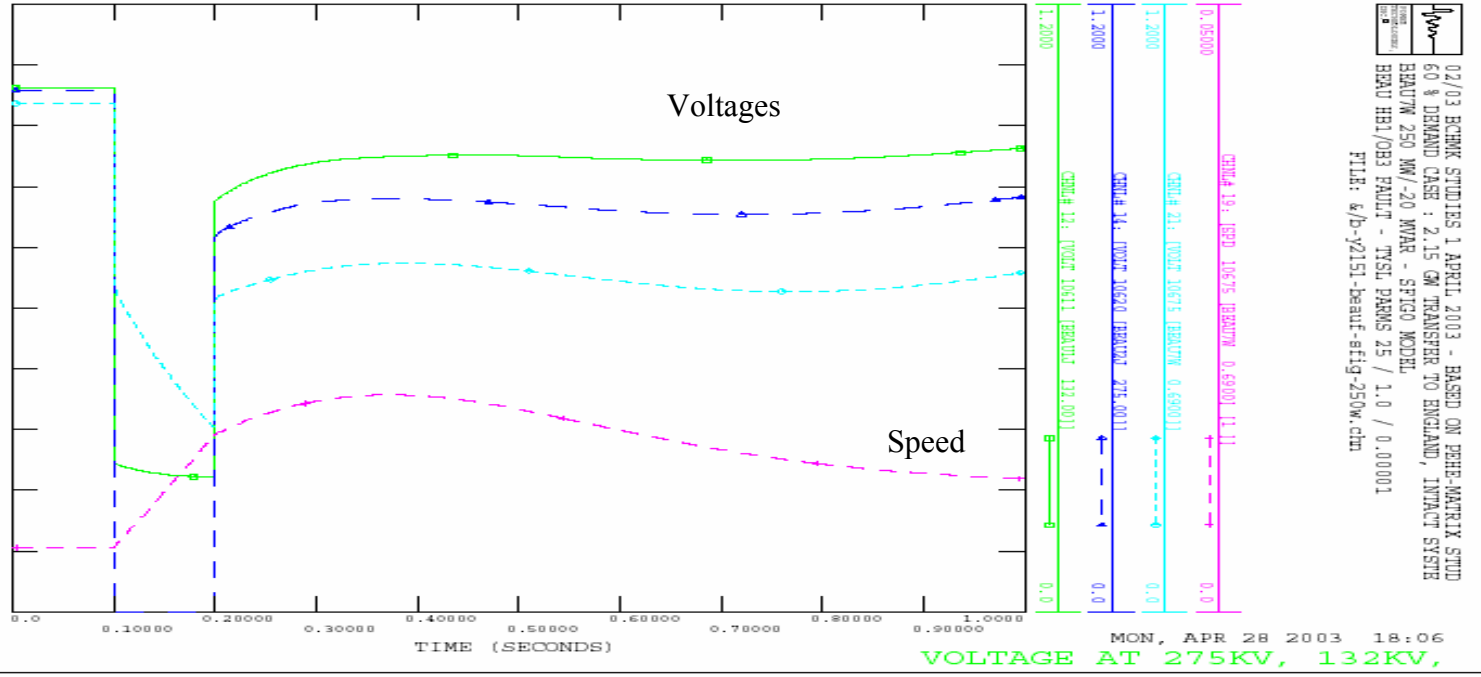
Reactive Power Capability & Voltage Control

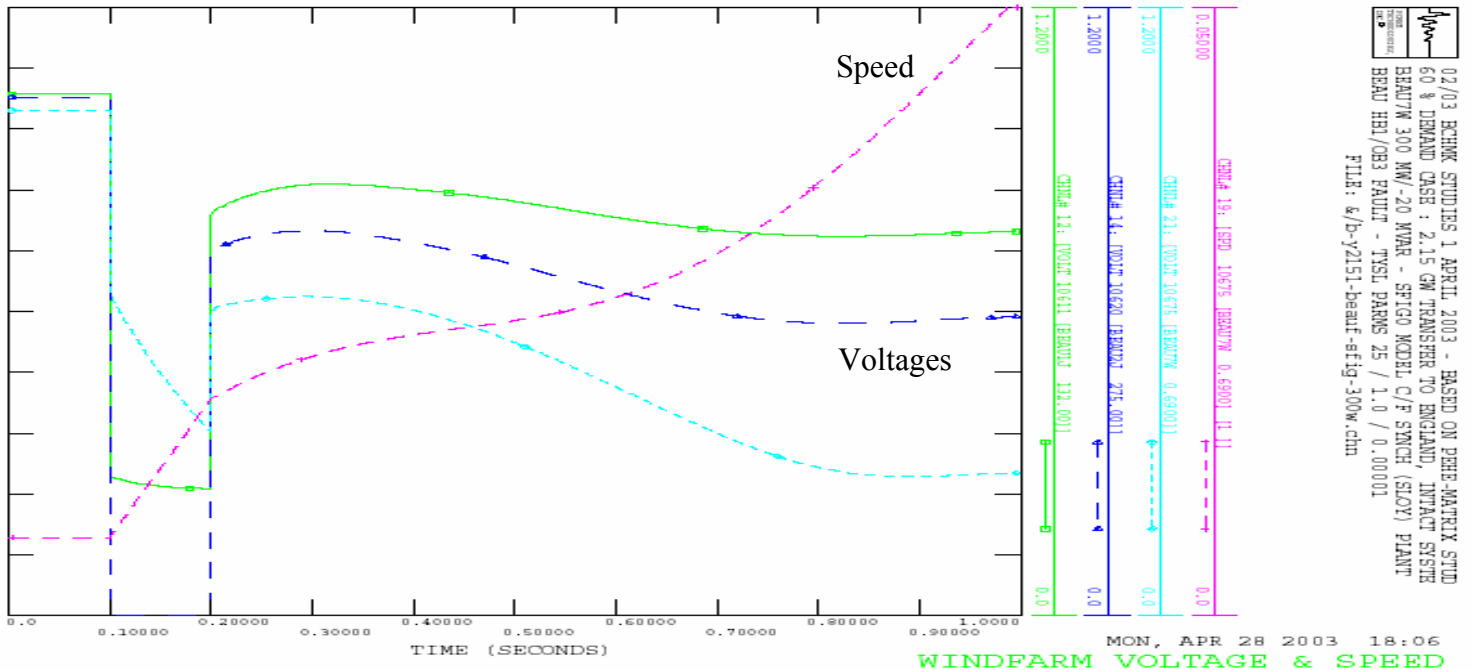


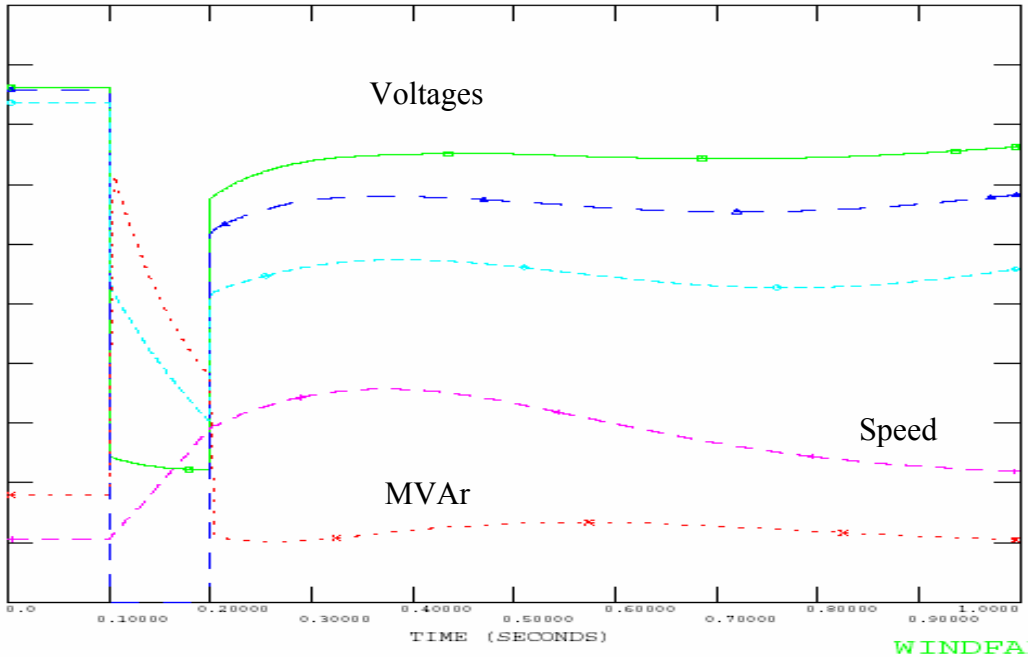


National Grid Transco

SP Transmission & Distribution


Voltages
Speed
TIME (SECONDS)
02/03 BCHMK STUDIES 1 APRIL 2003 - BASED ON PEHE-MATRIX STUD
60 % DEMAND CASE : 2.15 GW TRANSFER TO ENGLAND, INTACT SYSTE
BEAU7W 250 MW/-20 MVAR - SFIGO MODEL
BEAU HB1/OB3 FAULT - TSSL PARMS 25 / 1.0 / 0.00001
FILE: &/b-y2151-beauf-sfig-250w.chn
MON, APR 28 2003 18:06
VOLTAGE AT 275KV, 132KV,

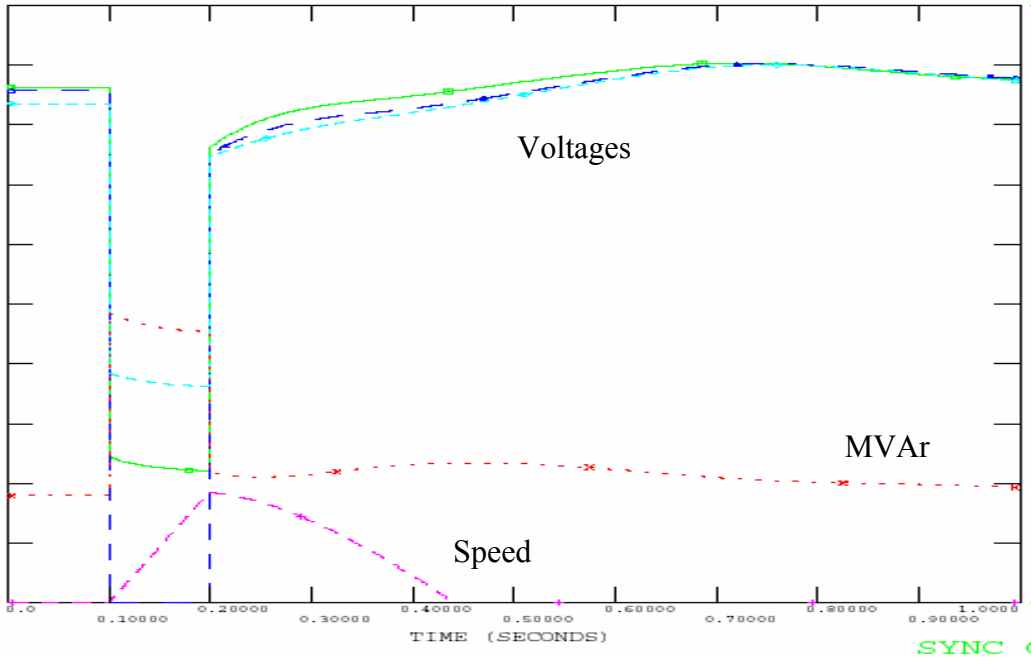

Speed
Voltages
TIME (SECONDS)
02/03 BCHMK STUDIES 1 APRIL 2003 - BASED ON PEHE-MATRIX STUD
60 % DEMAND CASE : 2.15 GW TRANSFER TO ENGLAND, INTACT SYSTE
BEAU7W 300 MW/-20 MVAR - SFIGO MODEL C/F SYNCH (SLOT) PIANT
BEAU HB1/OB3 FAULT - TSSL PARMS 25 / 1.0 / 0.00001
FILE: &/b-y2151-beauf-sfig-300w.chn
MON, APR 28 2003 18:06
WINDFARM VOLTAGE & SPEED



02/03 BCHMK STUDIES 1 APRIL 2003 - BASED ON PEHE-MATRIX STUD
60 % DEMAND CASE : 2.15 GW TRANSFER TO ENGLAND, INTACT SYSTE
BEAU7W 250 MW/-20 MVAR - SFIGO MODEL
BEAU HB1/OB3 FAULT - TYSL PARMS 25 / 1.0 / 0.00001
FILE: &/b-y2151-beauf-sfig-250w.chn

THU, MAY 01 2003 18:25

WINDFARM VOLTAGE AND SPEE



02/03 BCHMK STUDIES 1 APRIL 2003 - BASED ON PEHE-MATRIX STUD
60 % DEMAND CASE : 2.15 GW TRANSFER TO ENGLAND, INTACT SYSTE
BEAU7W 250 MW/-20 MVAR - SYNC MODEL C/F SYNCH (SLOY) PLANT
BEAU HB1/OB3 FAULT - TYSL PARMS 25 / 1.0 / 0.00001
FILE: &/b-y2151-beauf-sfig-250sym.chn

THU, MAY 01 2003 18:25

SYNC GEN VOLTAGE & SPEED

Aligned Proposals, Justification & Manufacturer Capabilities
Reactive Power Capability & Voltage Control

Justification for requirement: Transient Stability

Anglo-Scottish Interconnector Studies

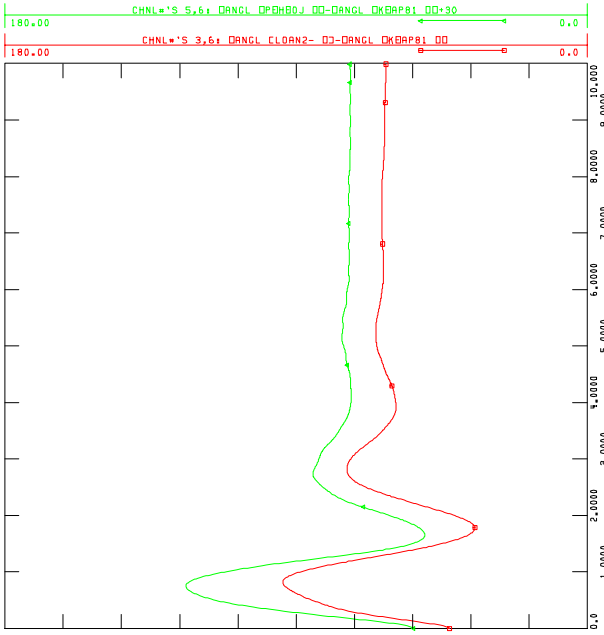
- Full GB dynamic model
- Interconnector capability constrained by transient stability
- Impact of wind on Interconnector capability
  - Standard IG has significant detrimental impact
  - Basic synchronous generator broadly neutral effect

2001 2.5GW STUDIES; 40%; 2300 MW EXPORT
SP AUTHORISED SYST 2004/05;SS SYS01 - YEAR 4 WINTER 04/05;

WIND GENERATORS AS SYNCH MACHINES
FILE: /home/evc/psse/2.5GW_2001/40smd/0405_40pc_02sm_hv.out

WED, APR 30 2003 9:59

SYNCH GEN

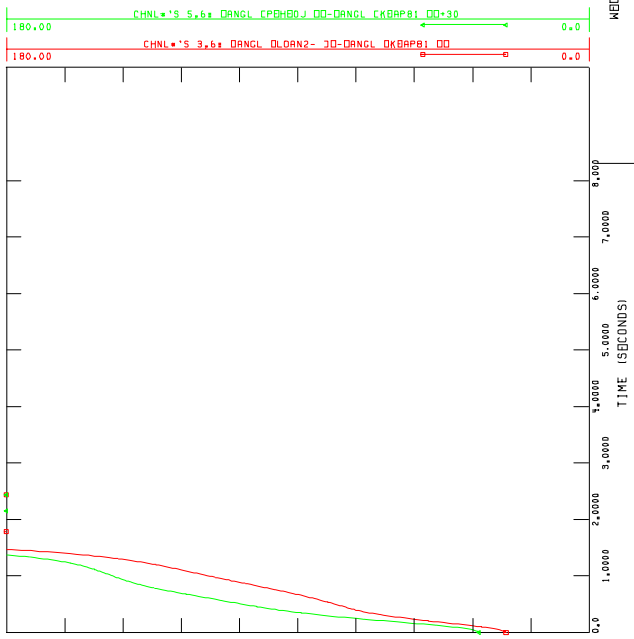


2001 2.5GW STUDIES; 40%; 2300 MW EXPORT
SP AUTHORISED SYST 2004/05;SS SYS01 - YEAR 4 WINTER 04/05;

WIND GENERATORS AS INDUCTION GENERATORS

WED, APR 30 2003 9:59

INDUC GEN

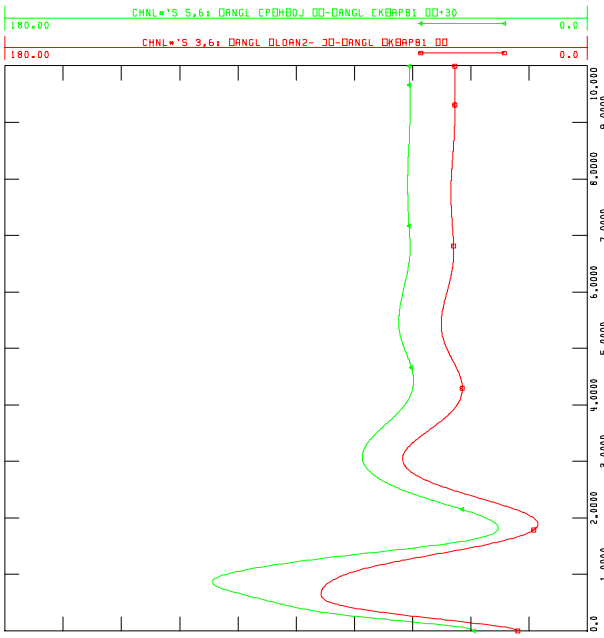


2001 2.5GW STUDIES; 40%; 2300 MW EXPORT
SP AUTHORISED SYST 2004/05;SS SYS01 - YEAR 4 WINTER 04/05;

NO WIND GENERATION
FILE: /home/evc/psse/2.5GW_2001/40smd/0405_40pc_02_hv.out

WED, APR 30 2003 9:59

NO WIND GEN



Aligned Proposals, Justification & Manufacturer Capabilities
Reactive Power Capability & Voltage Control
- Summary of Manufacturer Meetings

Unity Power Factor at Point of Connection:

9 of 10 manufacturers said that capability was commercially available now.

- 6 from 10 : Cost unknown as dependent on wind farm network
- 1 from 10 : 1- 2% of total wind farm cost
- 3 from 10 : No answer or confirmation awaited

0.95 pf lead - 0.90pf lag at the wind turbine terminals:

All manufacturers said that capability was commercially available now.

- 3 from 10 : Less than 1% of turbine cost
- 3 from 10 : 1- 4% of turbine cost
- 3 from 10 : No answer or confirmation awaited
- 1 from 10 : Confirmed but confidential

Aligned Proposals, Justification & Manufacturer Capabilities
Reactive Power Capability & Voltage Control
- Summary of Manufacturer Meetings

<u>+/- 0.95 pf at the point of connection from 1 January 2006:</u>

All 10 manufacturers said capability was commercially available now.

- 6 from 10 : Cost unknown as dependent on farm network
- 1 from 10 : 1- 2% of total wind farm cost
- 1 from 10 : No cost
- 2 from 10 : confirmation awaited

Aligned Proposals, Justification & Manufacturer Capabilities
Reactive Power Capability & Voltage Control
- Summary of Manufacturer Meetings

Voltage Control
at the Wind Turbine Generator terminals:

All manufacturers confirmed it was technically possible and available as a standard product

No additional cost.

Aligned Proposals, Justification & Manufacturer Capabilities
Reactive Power Capability & Voltage Control
- Summary of Manufacturer Meetings

Voltage Control at the point of connection:

All manufacturers said that it was available or possible using inherent farm SCADA communication system.

Commercial Availability
- 7 from 10 : Now
- 1 from 10 : Autumn 2004
- 2 from 10 : confirmation awaited

Additional Cost
- 5 from 10 : Negligible
- 1 from 10 : project size dependent
- 4 from 10 : confirmation awaited

Also, pf and reactive power control available now.

National Grid Transco

SP Transmission & Distribution

Aligned Proposals, Justification & Manufacturer Capabilities
Frequency Range Capability

Grid Code Requirement

England & Wales and Scottish Grid Codes both require a frequency range of:

- 47.5 - 52 Hz Continuous Operation
- 47 - 47.5 Hz (Operation for at least 20 s)

National Grid Transco

SP Transmission & Distribution

Aligned Proposals, Justification & Manufacturer Capabilities
Frequency Range Capability

Justification of Requirement

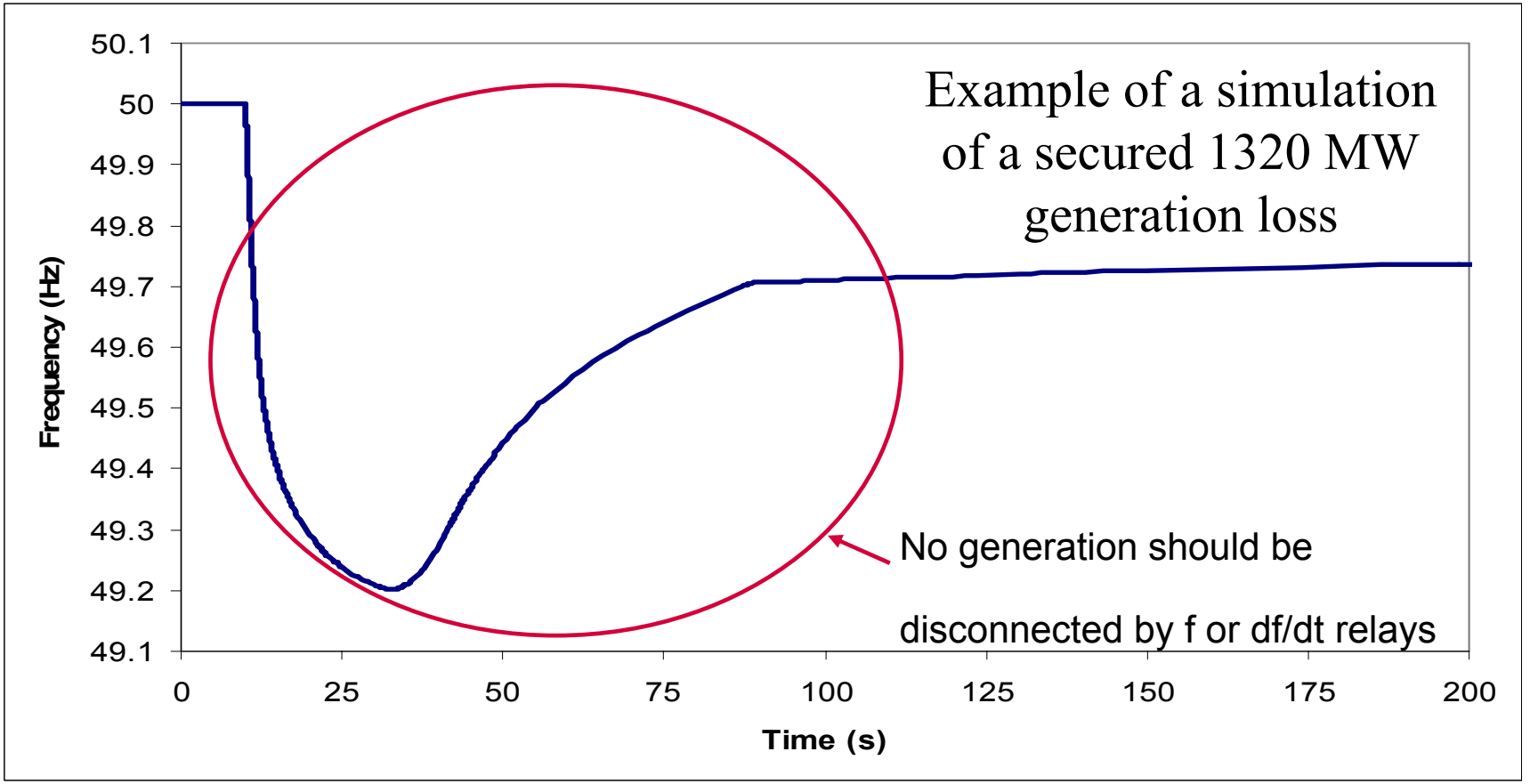
The ability to maintain operation across this frequency range is required to:

- Avoid additional generation losses and demand disconnection
- Ensure stable system operation for secured demand and generation loss events
- Minimise risk of partial or complete system shutdowns during larger system disturbances

Aligned Proposals, Justification & Manufacturer Capabilities

Frequency Range Capability

- Justification of Requirement: Infeed Loss



National Grid Transco

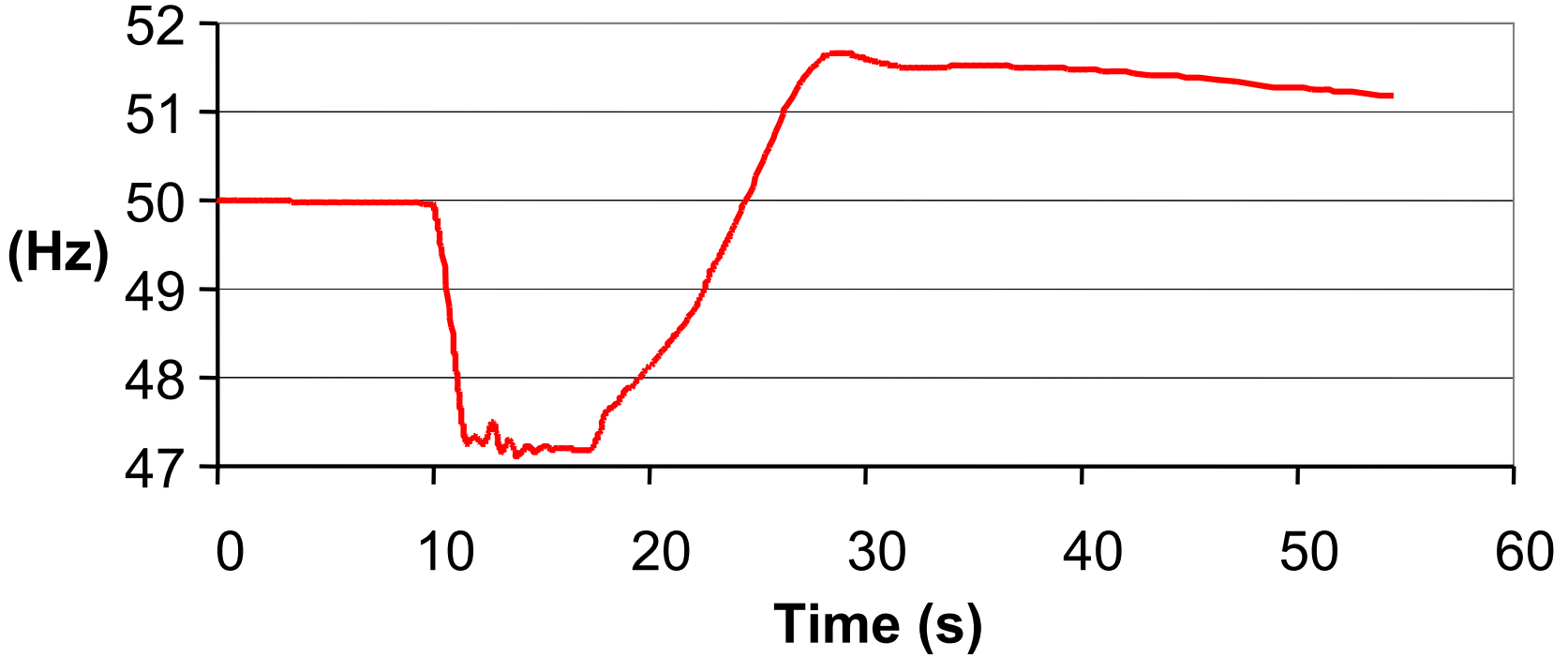
SP Transmission & Distribution

Aligned Proposals, Justification & Manufacturer Capabilities

Frequency Range Capability

- Justification of Requirement: Infeed Loss

System Frequency During a System Split with Operation of the Low Frequency Demand Disconnection Scheme



National Grid Transco

SP Transmission & Distribution

Aligned Proposals, Justification & Manufacturer Capabilities

Frequency Range Capability
- Summary of Manufacturer Meetings

Availability

All manufacturers said the full Frequency Range Capability is available commercially now.

Additional cost

- 9 from 10 : No cost
- 1 from 10 : confirmation awaited

Aligned Proposals, Justification & Manufacturer Capabilities

Power/Frequency Characteristic

Grid Code Requirements

England & Wales and Scottish Grid Code proposals both require:

- Power Output/System Frequency Characteristic

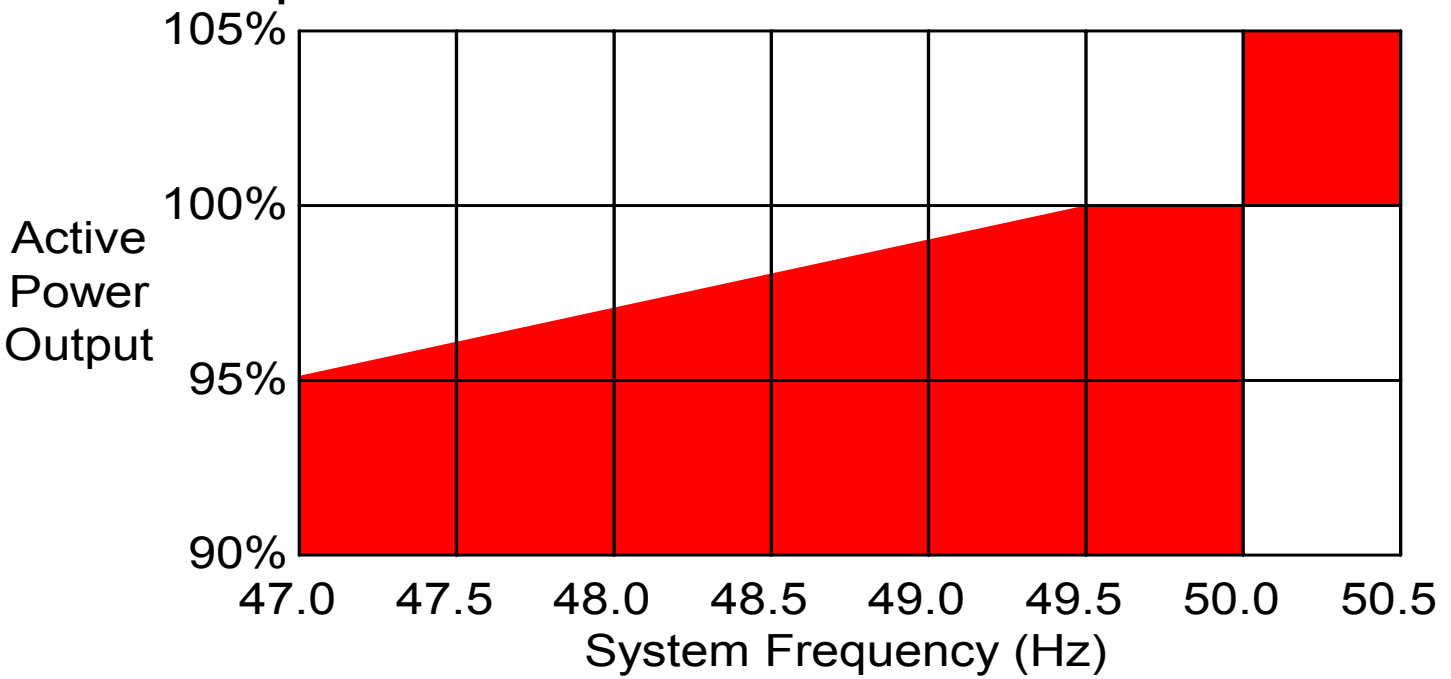
Justification

- Avoid adverse interaction between system frequency and generation active power output causing frequency collapse and demand disconnection

Aligned Proposals, Justification & Manufacturer Capabilities

Power/Frequency Characteristic

Grid Code Requirements



Zones of Unacceptable Operation

National Grid Transco

SP Transmission & Distribution

Aligned Proposals, Justification & Manufacturer Capabilities

Power / Frequency Characteristic - Summary of Manufacturer Meetings

Availability

All 10 manufacturers said that the Power Frequency Characteristic was commercially available now.

Additional Cost

7 from 10 : No cost

3 from 10 : No answer or confirmation awaited

Aligned Proposals, Justification & Manufacturer Capabilities

Frequency Control Capability

Grid Code Requirements

England & Wales and Scottish Grid Code proposals both require:

- Primary Response Capability; minimum 10%
- Secondary Response Capability; minimum 10%
- High Frequency Response Capability; minimum 10%
- Requirement applicable at Grid Code implementation date
- Limited High Frequency Response Capability; minimum 2%/0.1Hz

National Grid Transco

SP Transmission & Distribution

Aligned Proposals, Justification & Manufacturer Capabilities

Frequency Control Capability

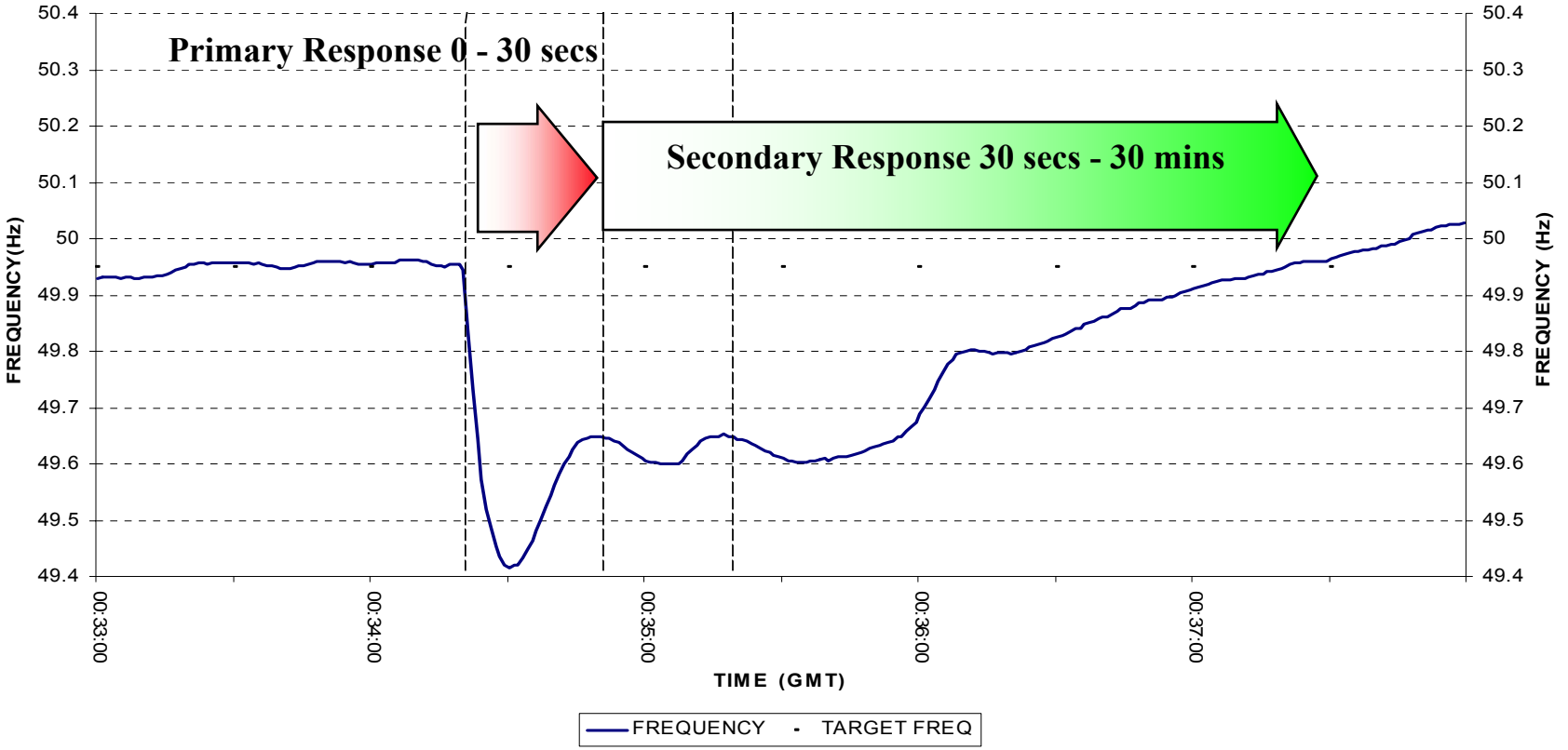
Justification for Requirement

Transmission Licensees require Frequency Control Capability in order to:

- Fundamental to balancing generation and demand automatically following a sudden mismatch and hence preventing frequency collapse and demand disconnection.
- Maintain the quality of power supplied to customers
- Meet statutory License requirement

Aligned Proposals, Justification & Manufacturer Capabilities
Frequency Control Capability
- Justification for Requirement

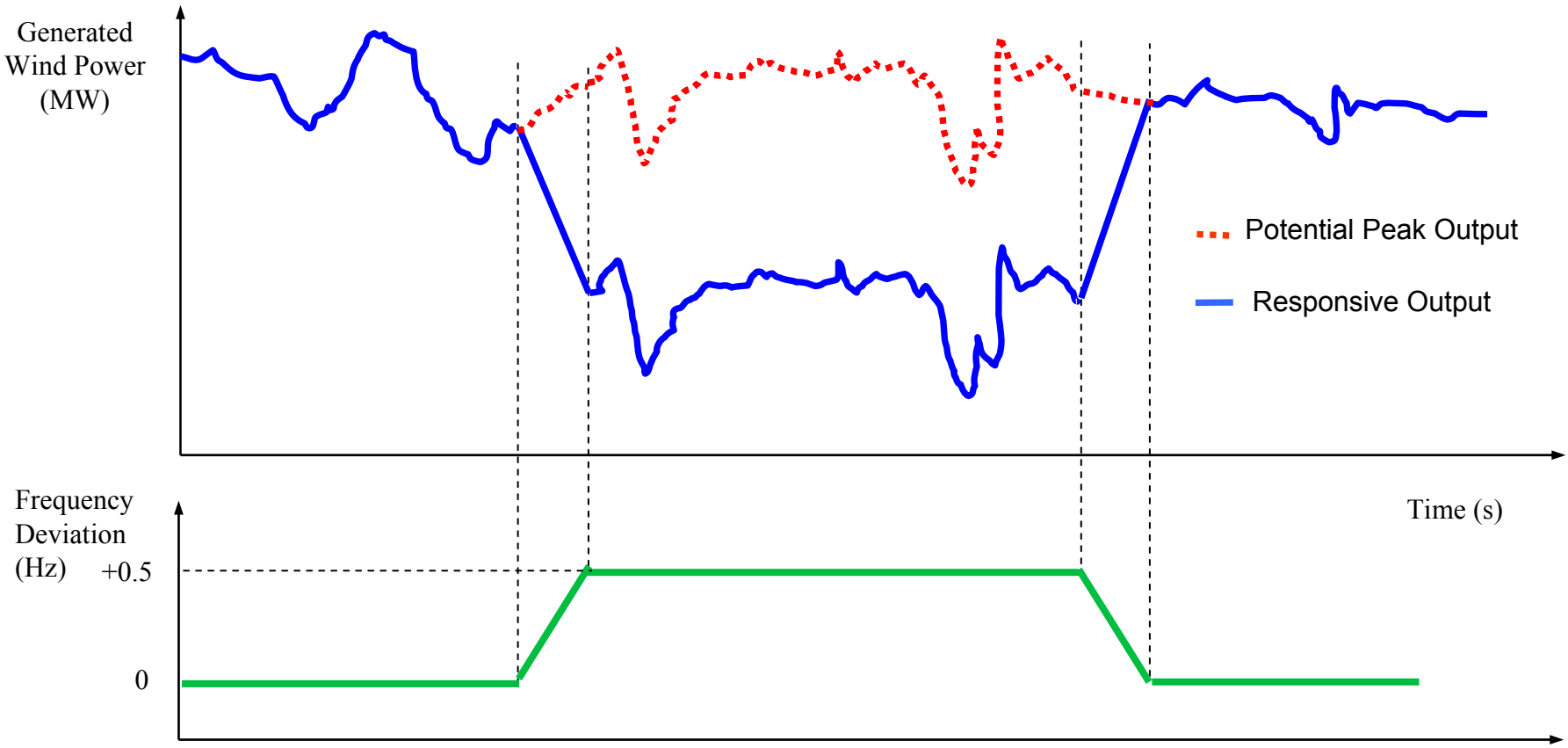
Example of a Secured Incident *26 May 2003 (1175 MW loss)*



National Grid Transco

SP Transmission & Distribution

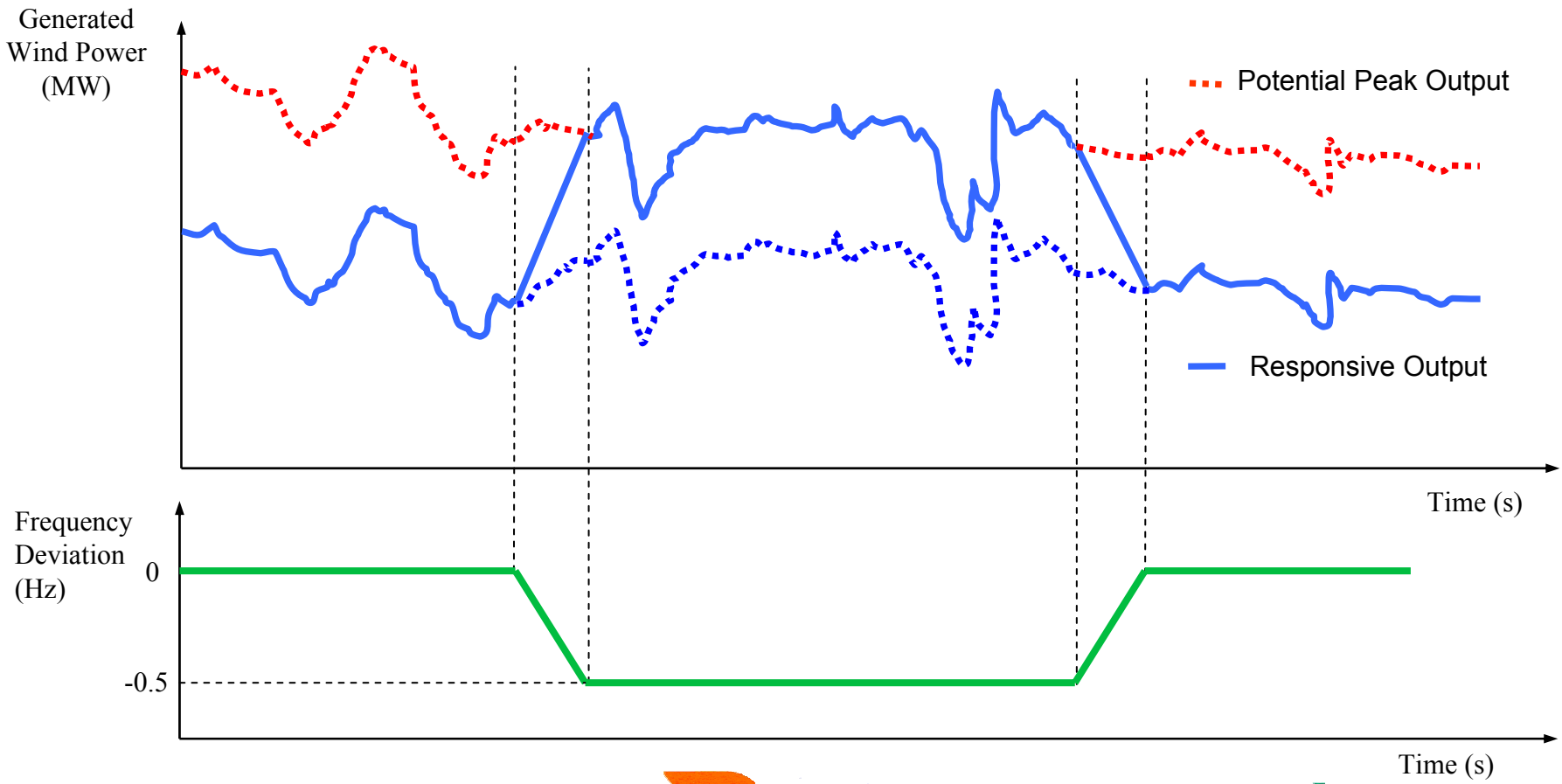
Aligned Proposals, Justification & Manufacturer Capabilities
Frequency Control Capability
- High Frequency Response from a Wind Farm



National Grid Transco

SP Transmission & Distribution

Aligned Proposals, Justification & Manufacturer Capabilities
Frequency Control Capability
- Low Frequency Response from a Wind Farm



National Grid Transco

SP Transmission & Distribution

Aligned Proposals, Justification & Manufacturer Capabilities

Frequency Control Capability
- Summary of Manufacturer Meetings

All 8 turbine manufacturer said Frequency Response & Control was possible. Local or wind farm level using SCADA system may be used to provide the capability

Commercial Availability

- 4 from 8 : now or by early 2005
- 2 from 8 : LFSM & HF now, P&S by early 2005.
- 1 from 8 : Confirmation awaited
- 1 from 8 : not yet, project dependent

Cost

- 6 from 8 : Negligible
- 1 from 8 : Confirmation awaited
- 1 from 8 : No answer

National Grid Transco

SP Transmission & Distribution

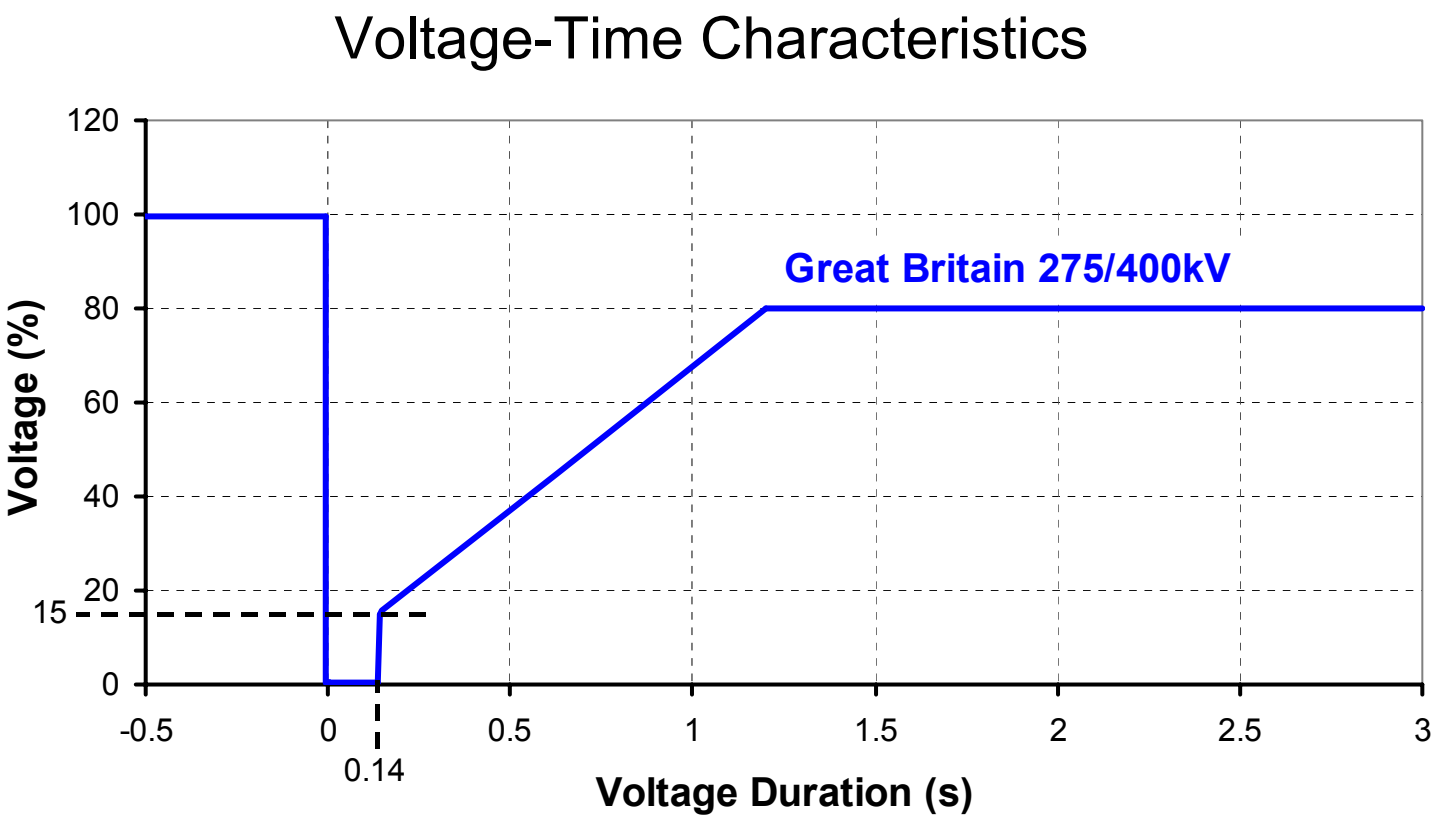
Aligned Proposals, Justification & Manufacturer Capabilities

Fault Ride Through Capability - Grid Code Requirements

England & Wales and Scottish Grid Codes proposals both require:

- The generator must remain connected and stable for a close-up solid 3 phase or unbalanced fault on the transmission system that is cleared in normal protection operating times (up to 140 ms).
- Mechanical power output immediately after the fault has cleared must be fully available.
- Relaxation for low wind and excessive high wind conditions.
- Voltage-Time characteristic

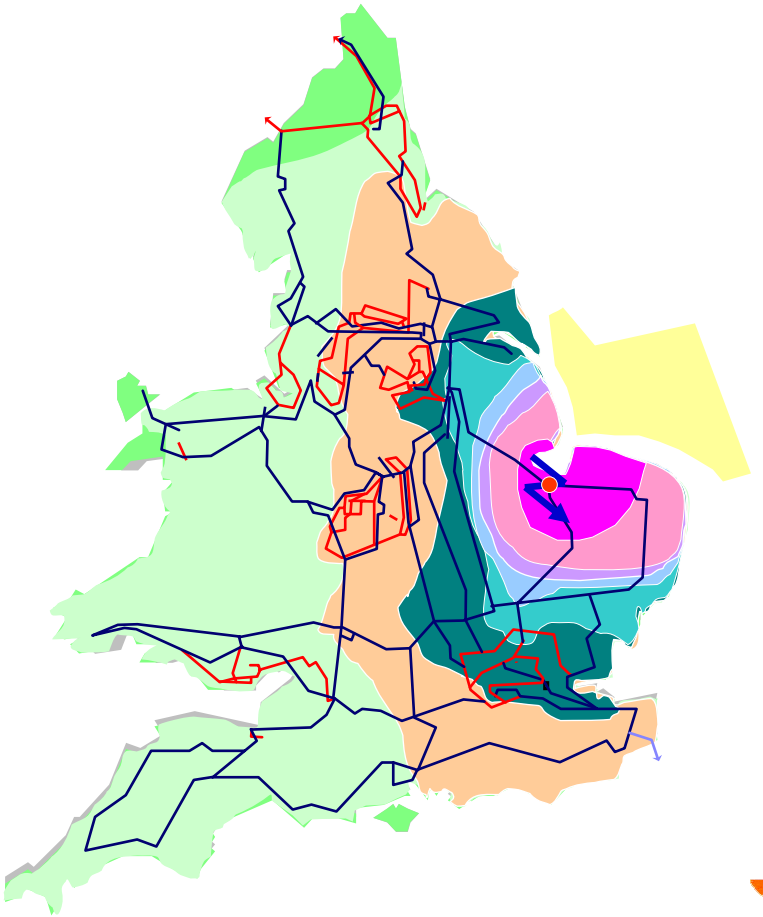
Aligned Proposals, Justification & Manufacturer Capabilities
Fault Ride Through Capability
- Grid Code Requirements



National Grid Transco

SP Transmission & Distribution

Aligned Proposals, Justification & Manufacturer Capabilities
Fault Ride Through Capability
Justification: Voltage Dip Propagation - The Wash



3 phase fault applied at Walpole 400 kV substation

- Fault Location 0 % Volts
- 0 - 15 % Volts
- 15 - 30 % Volts
- 30 - 40 % Volts
- 40 - 50 % Volts
- 50 - 60 % Volts
- 60 - 70 % Volts
- 70 - 80 % Volts
- 80 - 90 % Volts

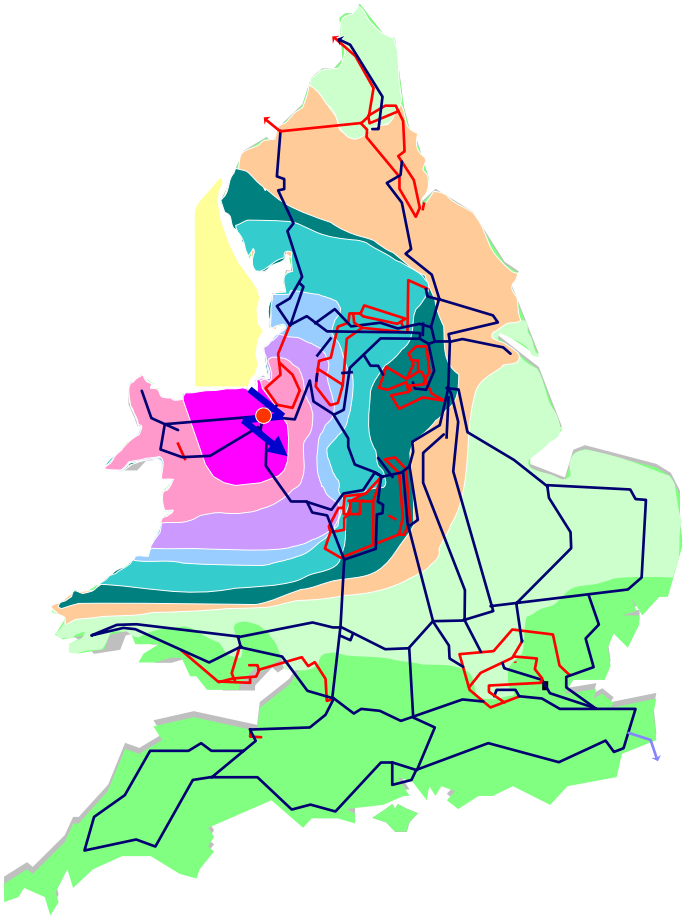
National Grid Transco

SP Transmission & Distribution

Aligned Proposals, Justification & Manufacturer Capabilities

Fault Ride Through Capability

Justification: Voltage Dip Propagation - North West



3 phase fault applied at
Deeside 400 kV substation

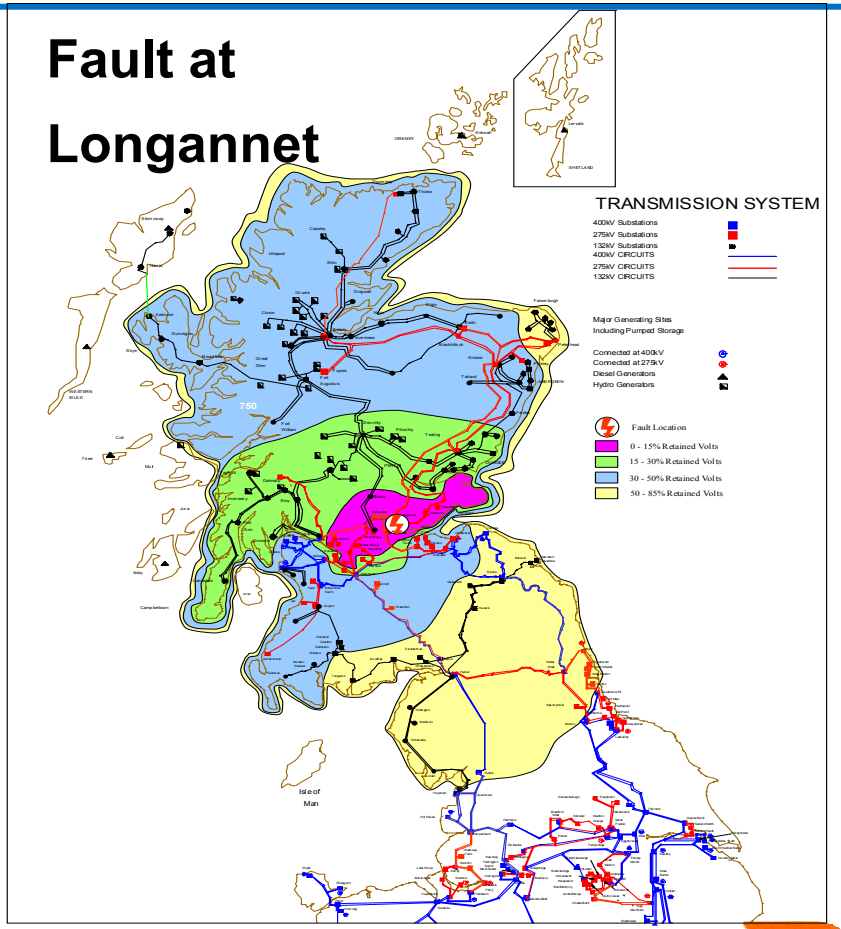
- Fault Location 0 % Volts
- 0 - 15 % Volts
- 15 - 30 % Volts
- 30 - 40 % Volts
- 40 - 50 % Volts
- 50 - 60 % Volts
- 60 - 70 % Volts
- 70 - 80 % Volts
- 80 - 90 % Volts

National Grid Transco

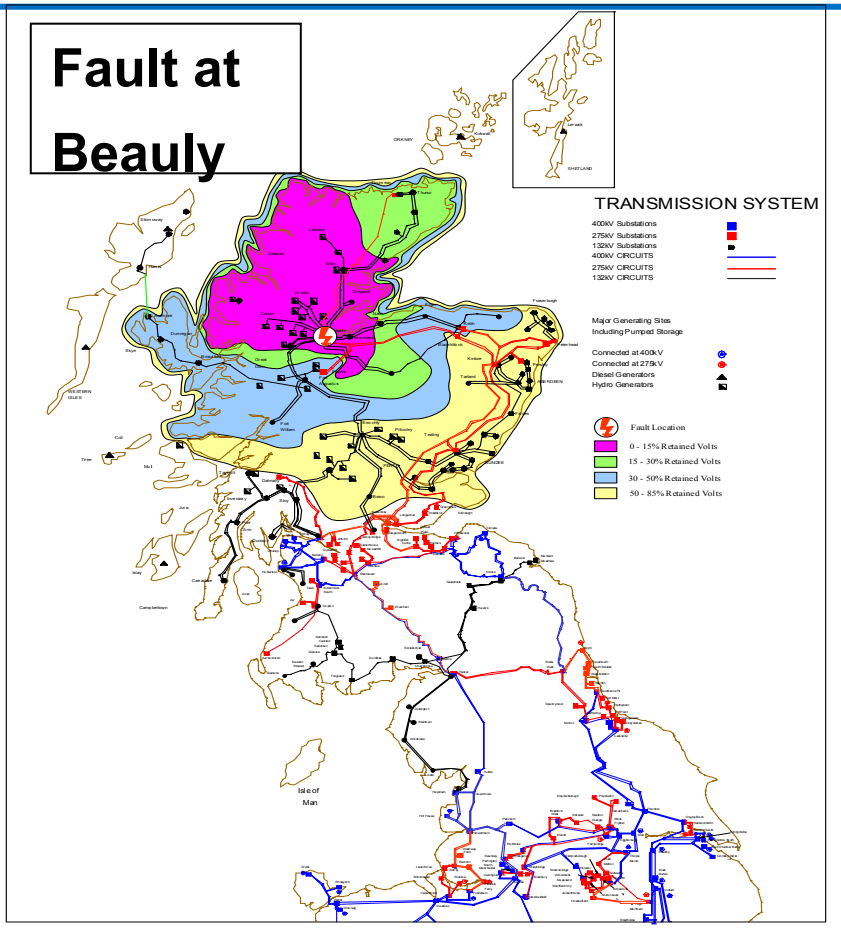
SP Transmission & Distribution

Aligned Proposals, Justification & Manufacturer Capabilities
Fault Ride Through Capability
Justification: Voltage Dip Propagation - Scotland

Fault at Longannet



Fault at Beauly



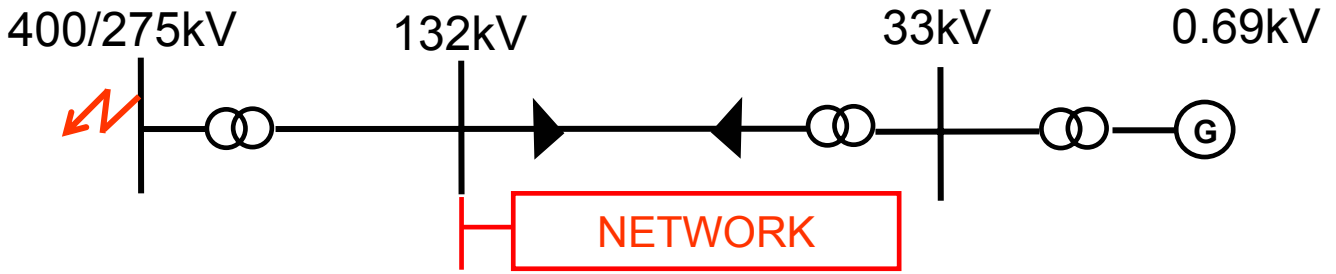
National Grid Transco

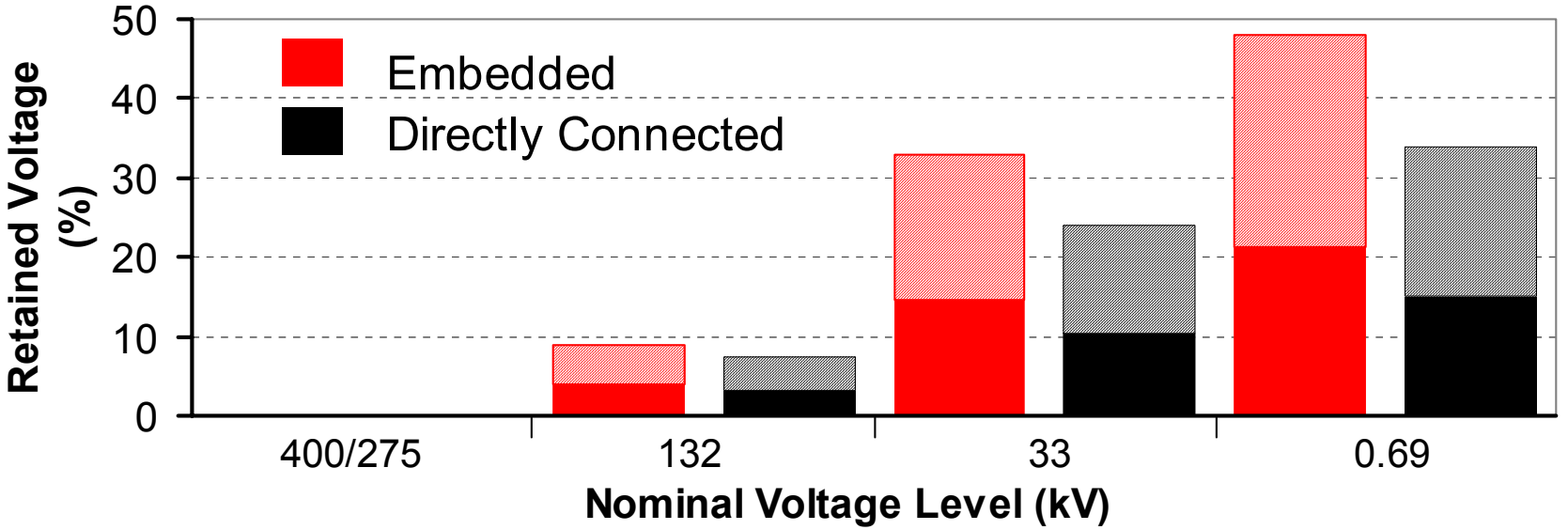
SP Transmission & Distribution

Aligned Proposals, Justification & Manufacturer Capabilities

Fault Ride Through Capability Justification:

Retained Voltage in a Windfarm during a Transmission System Fault





National Grid Transco

SP Transmission & Distribution

Aligned Proposals, Justification & Manufacturer Capabilities
Fault Ride Through Capability
Justification: South West Scotland

- During Period April 2002 to January 2003
  - Ten 132kV fault reports within 100 miles of Kintyre
  - Only some of these faults have associated voltage dips
  - Four occasions when localised 132kV single-circuit faults caused all 3 windfarms to trip
  - One fault approximately 100 miles away resulted in a trip of all 3 wind farms
  - Two occasions when local Carradale 33kV feeder faults caused both Carradale wind farms to trip
  - One occasion when a 33kV fault on a remote Grid Supply Point resulted in all 3 wind farms tripping

Aligned Proposals, Justification & Manufacturer Capabilities
Fault Ride Through Capability
- Summary of Manufacturer Meetings

All Manufacturers Agreed Technically Possible

Commercial Availability

- 8 from 10 : now
- 1 from 10 : winter 2004/5
- 1 from 10 : zero impedance faults excluded

Cost

- 4 from 10 : <1% turbine cost
- 3 from 10 : 1-3% turbine cost
- 1 from 10 : confirmation awaited
- 1 from 10 : No answer
- 1 from 10 : Confidential

National Grid Transco

SP Transmission & Distribution

Aligned Proposals, Justification & Manufacturer Capabilities
Negative Phase Sequence

Grid Code Requirements

- Steady State Capability of up to 2% negative phase sequence voltage at the connection point
- Short term requirement to withstand the negative phase sequence current during a two-phase fault at the connection point cleared in Back-up protection time

Aligned Proposals, Justification & Manufacturer Capabilities
Negative Phase Sequence

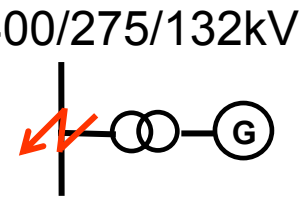
Justification

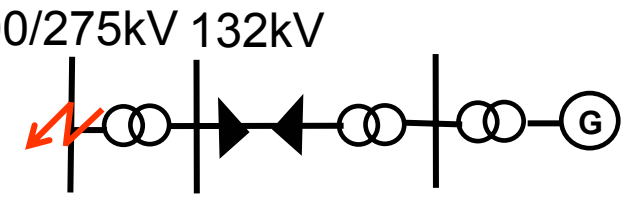
- All synchronous and non-synchronous generation must have this capability to avoid common mode generation losses that threaten system security.

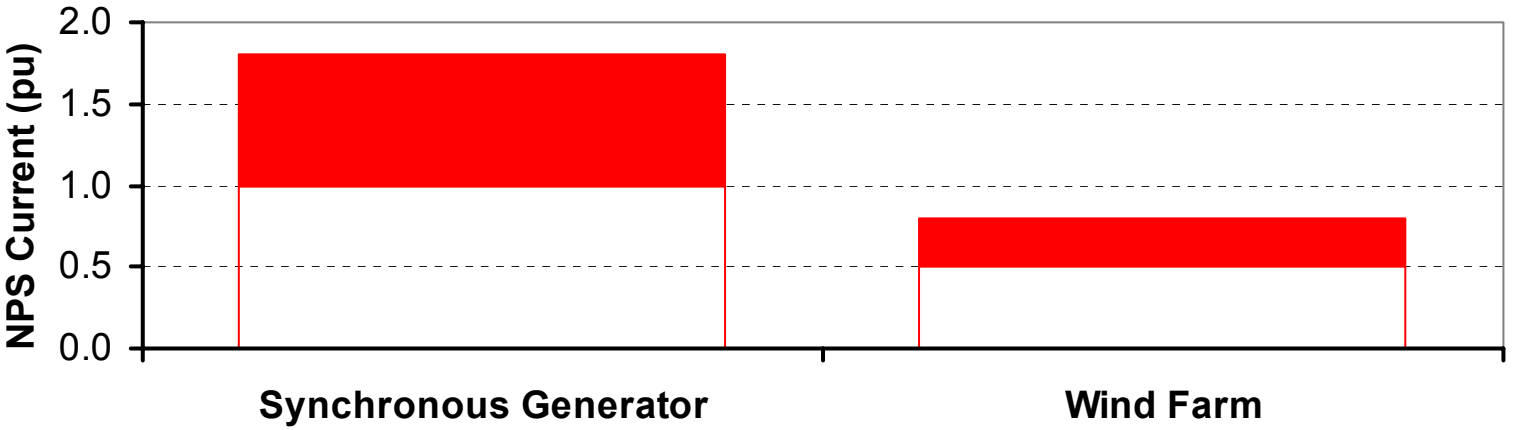
Aligned Proposals, Justification & Manufacturer Capabilities

Negative Phase Sequence

2 phase fault at point of connection







National Grid Transco

SP Transmission & Distribution

Aligned Proposals, Justification & Manufacturer Capabilities
Negative Phase Sequence
- Summary of Manufacturer Meetings

Steady State NPS

- 7 from 10 : Commercial Availability now at no additional cost
- 3 from 10 : confirmation Awaited

Transient NPS

- 6 from 10 : Commercial Availability now at no additional cost
- 4 from 10 : confirmation awaited

National Grid Transco

SP Transmission & Distribution

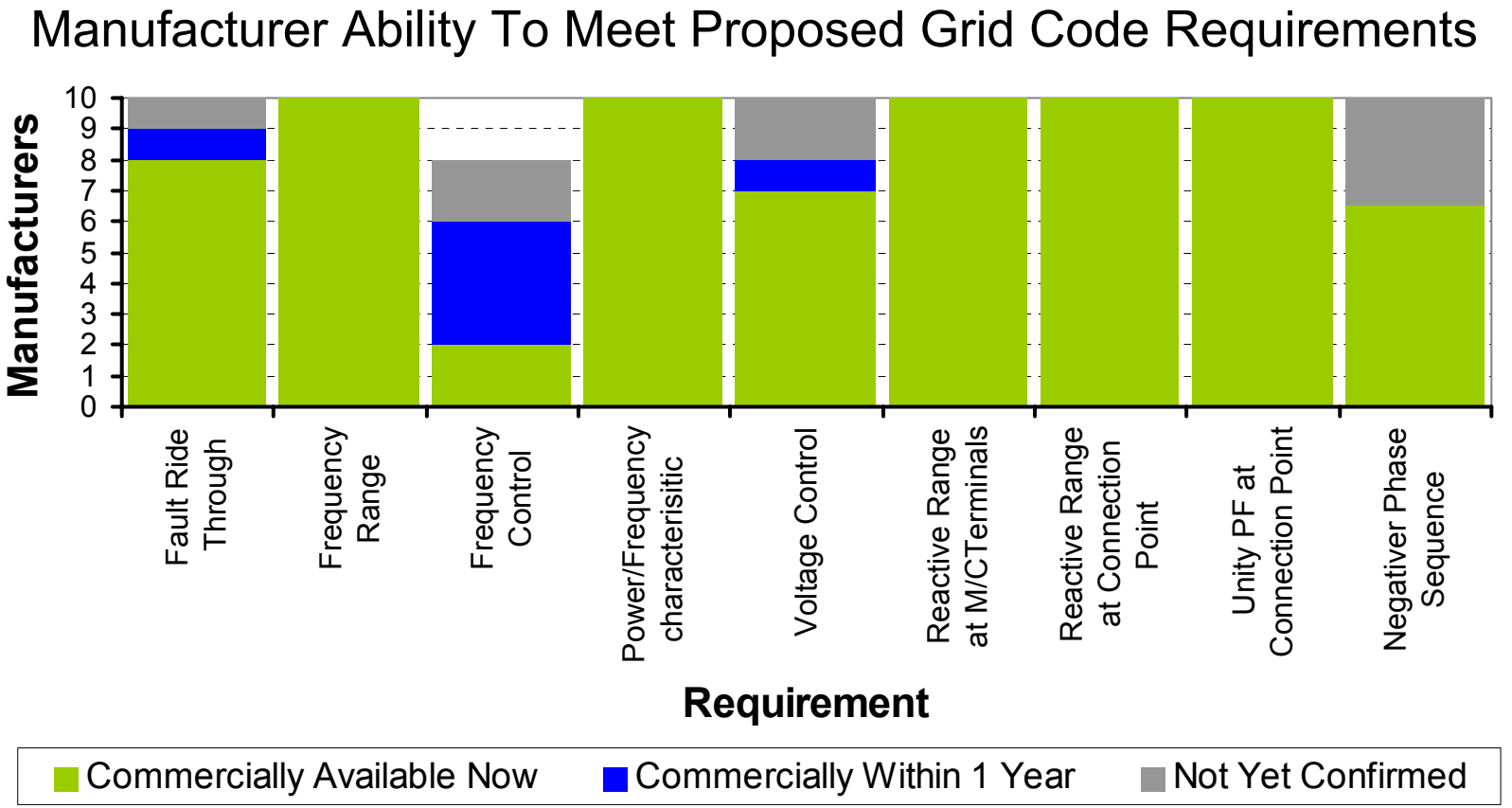
Overview of Transmission Licensee Presentation

- Objectives of the Grid Codes & Licensees Obligations
- Why Review the Grid Codes in Great Britain.
- Licensees Grid Code Review Processes.
- Ofgem process for further development of the Grid Codes in Great Britain.
- Alignment of Grid Code Proposals in Great Britain, Justification of Requirements & Manufacturer Capabilities.
- Summary of Manufacturer Capabilities Agreed For Public knowledge.
- Current Position.
- Conclusions.

National Grid Transco

SP Transmission & Distribution

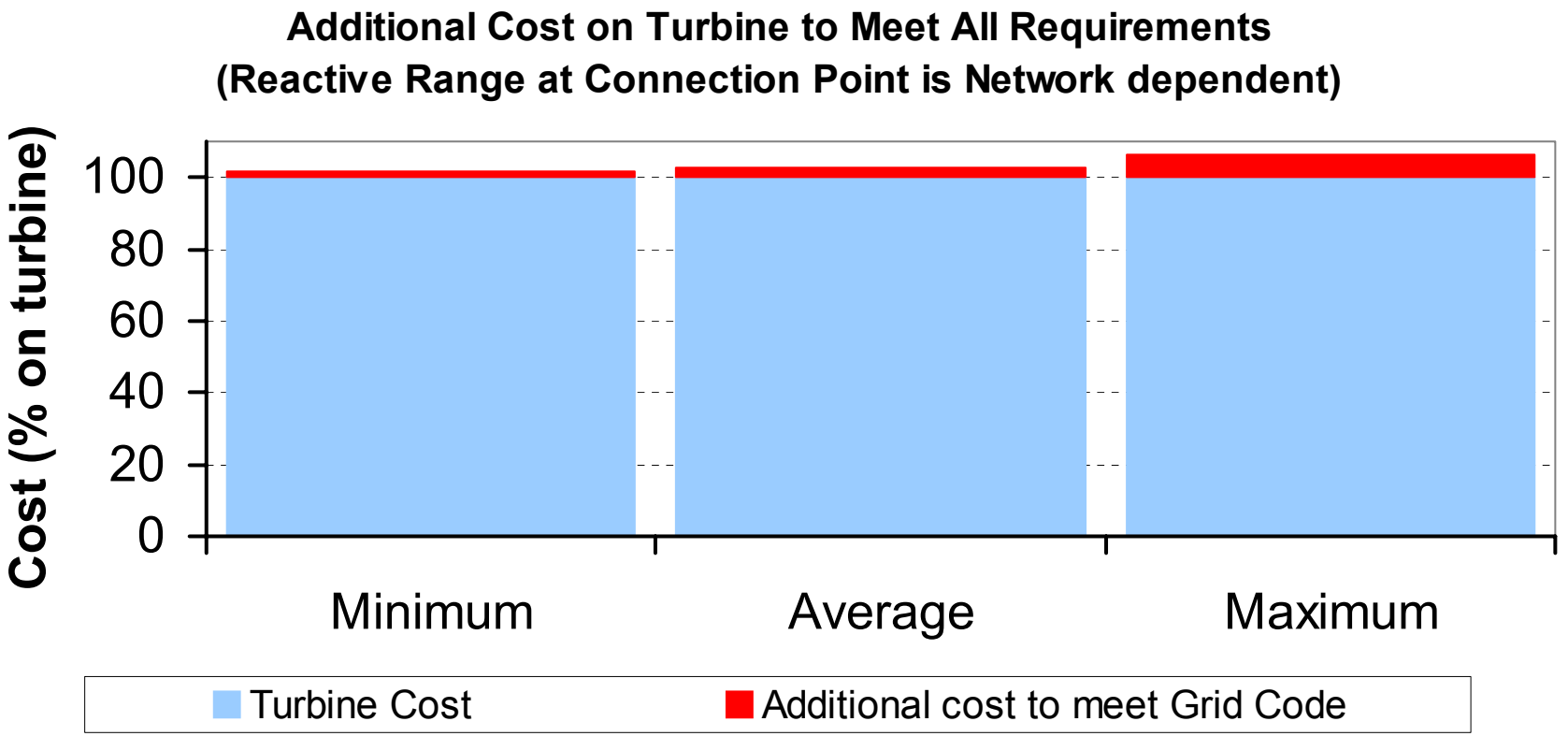
Summary of Manufacturer Capabilities Agreed for Public Knowledge



National Grid Transco

SP Transmission & Distribution

Summary of Manufacturer Capabilities Agreed for Public Knowledge



National Grid Transco

SP Transmission & Distribution

Overview of Transmission Licensee Presentation

- Objectives of the Grid Codes & Licensees Obligations
- Why Review the Grid Codes in Great Britain.
- Licensees Grid Code Review Processes.
- Ofgem process for further development of the Grid Codes in Great Britain.
- Alignment of Grid Code Proposals in Great Britain, Justification of Requirements & Manufacturer Capabilities.
- Summary of Manufacturer Capabilities Agreed For Public knowledge.
- Current Position.
- Conclusions.

National Grid Transco

SP Transmission & Distribution

Current Position

- This Stakeholder Meeting to discuss the aligned Grid Code proposals for Scotland and England & Wales
- Licensees to further consider appropriate issues raised.
- Licensees to resubmit to Ofgem the final proposals by the end of May 2004 in accordance with Ofgem process.
- Ofgem to issue decision by end of June 2004
- Until the proposals are approved, connection applications are and will continue to be dealt with bilaterally based on the current proposals.

National Grid Transco

SP Transmission & Distribution

Conclusions

The aligned Grid Code proposals:

- Are needed to allow Transmission Licensees to meet their Licence Obligations
- Ensure no deterioration of system security and power quality to customers into the future
- Provide clarity to Generators and manufacturers
- Help the growth of renewable generation
- Can be met by commercially available technology with minimal increase in cost

Recommendations

The 3 Transmission Licensees recommend that Ofgem approves the proposals following Ofgem's further development process for the Scottish and England & Wales Grid Codes

National Grid Transco

SP Transmission & Distribution

End

We look forward to a productive discussion tomorrow

National Grid Transco

SP Transmission & Distribution