

# GC0075: Hybrid STATCOMs / SVCs Workgroup Report



**Richard Ierna**

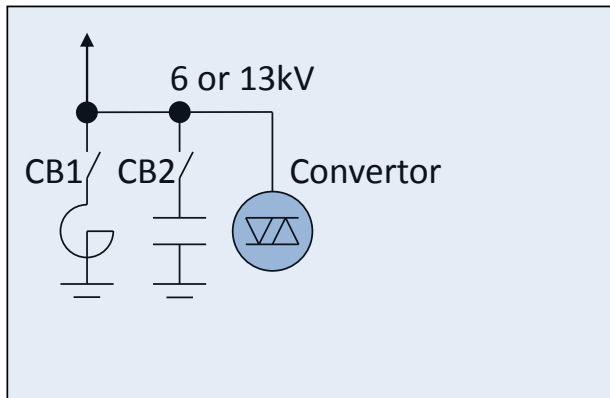
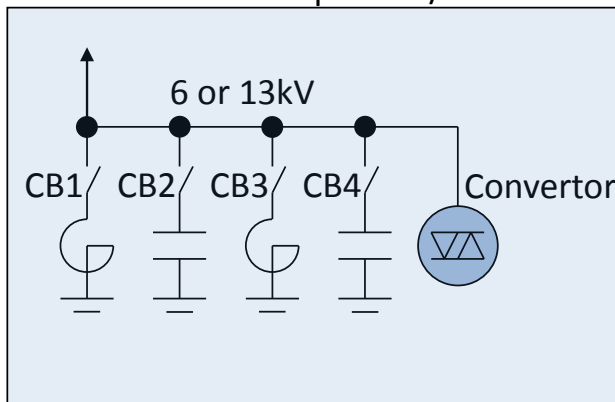
*National Grid – TNS Technical Policy*

**Grid Code Review Panel July 2015**

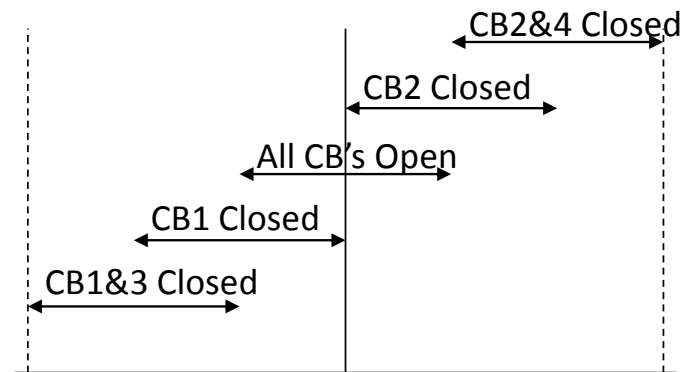
# History & Issue

Typical Hybrid SVC / STATCOM Operating Ranges (50% or 60% of the steady state reactive power produced by the capacitors and reactors)

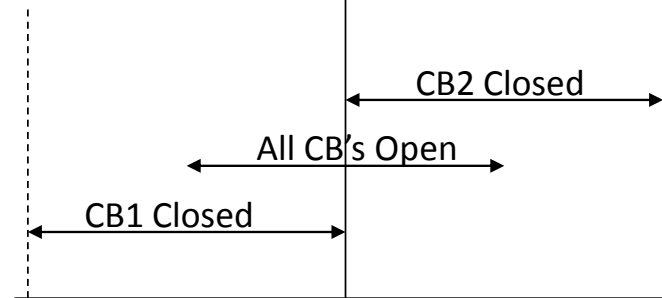
Double switched capacitor / reactor



Single switched capacitor / reactor



100% Reactive Lead (0.95 leading PF at Rated MW)      Unity PF      100% Reactive Lag (0.95 lagging PF at Rated MW)



100% Reactive Lead (0.95 leading PF at Rated MW)      Unity PF      100% Reactive Lag (0.95 lagging PF at Rated MW)

# Issues & Objectives of TO's & SO

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- Short Circuit Performance – Prevent or define performance regarding switching out capacitors during faults
- Clearly define the requirement which should be universally applied to all PPM's
- To ensure a response within DAR and event switching times
- Define repeatability in light of system events such as:
  - **Lightning**
  - **Storms / High Winds**
  - **Debris on a line (e.g. polythene sheet caught on a line)**
  - Operator Error
  - Voltage Instability
  - Ice Forming on Conductors
  - Cascade Tripping Events
  - **Angular Instability – May not be covered by requirement**
  - **Interaction Between Controllers – May not be covered by requirement**
- Specify a requirement which is technology neutral allowing for STATCOMs, SVCs, Hybrids & PPM's.
- General degradation in reactive capability of Generating Plant.
- TO's & SO concerned that clarification will result in further reduction in fleet's reactive capability.

# Issues & Objectives of Developers, Manufacturers & Generators

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- Commercial Issues:
  - Risks associated with failing compliance
  - Cost Impact – In particular on smaller projects
  - Implementation – Timescales & the resourcing of design changes
  - Need for clarity of the requirement
  - Definition of the requirement – Articulation in the Grid Code & ensuring technology neutrality
  - Validity of the need case
- Technical Issues:
  - Switch Recharge Time
  - Capacitor Discharge Time
  - Convertor Overrating Capability
  - Mechanical Wear
  - Others – Communications & Control, Complexity of projects & interfacing and co-ordination between controllers

# Summary of Workgroup Discussions

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- Voltage Control and Reactive Power Provision
- Response of STATCOM/SVC's and effects of Limited Reactive Reserve
- Lightning Storm Data & Future Operating Scenarios
- Winter Storm Data
- Consistency with the ENTSO-E 'Requirements for Generators' Code
- **Manufacturers' Survey – Establish Impact**
- **CBA (Cost Benefit Analysis)**
- Dynamic stability using Hybrid STATCOM's
- **Understanding of the Existing Grid Code**

NB Items in **blue** covered in next slides

# Discussions – Manufacturers’ Survey

Manufacturer	Compliant with new repeatability Requirement	% Unit cost if not compliant	Availability	Compliant with new FRT requirement	% Unit cost if not compliant	Availability
A	Current design meets proposed change	0%	Now	Current design meets proposed change or Blocks at 0.4pu (Both Available Now)	0.5%	Now
B	Current design meets proposed change	0%	Now	Current design meets proposed change	0%	Now
C	Current design meets proposed change	0%	Now	Current design meets proposed change	0%	Now
D	Proposed change is feasible	0%	Now	Current design meets proposed change	0%	Now
E	Proposed change is feasible	-13% to +7% *1	12 Mths	Current design meets proposed change	0%	Now
F	Current design meets proposed change	0%	Now	No Answer – still investigating.	-	-

## Effect on Smaller Installations:

For switched capacitors at the substations, the proposed repeatability requirement could result in increased costs of 20% due to design and equipment modifications to the ancillary and/or control equipment. Considered significant on small installations.

- Affects Power Park Modules greater than 50MW in E&W, 30MW in Southern Scotland and 10MW in Northern Scotland.
- Looking at typical published costs / MW of an installed onshore wind farm (e.g. £800k/MW) the total impact on the cost of the smallest wind farm in Northern Scotland (i.e. 10MW) is 0.33% on the total cost.
- Only one solution considered / available from one supplier.
- Whilst the % cost increase on the wind farm is small, any incremental cost will have an impact on profitability of a project, especially if not identified at the design stage.

# Discussions – Cost Benefit Analysis & Wording

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## Cost Benefit Analysis

- Network Options Considered:
  - Transmission Owner Provides Reactive Compensation
  - High Speed Auto Reclose
- Manufacturing Options Considered:
  - Full Convertor
  - Hybrid STATCOM / SVC with Improved Performance

## Grid Code Changes

- New Repeatability Requirement. Addition of a new clause CC.A.7.2.3.2 which:
  - CC.A.7.2.3.2(i) Defines capability of 5 events in 5 minutes minimum of 15 seconds apart
  - CC.A.7.2.3.2(ii) Maximum of 25 events in one day after which may disable switching
- Amendments to Fault Ride Through
  - CC.6.3.15.1(a)(i), CC.6.3.15.2(a)(i) and CC.6.3.15.2(a)(ii) simply adds ...Power Park Module and / or any constituent Power Park Unit **or reactive compensation equipment...**
  - CC.6.3.15.1(a)(ii) and CC.6.3.15.2(b)(ii) adds ...and / or any constituent Power Park Unit **or reactive compensation equipment. Switched reactive compensation equipment's (such as mechanically switched capacitors and reactors) will not connect or disconnect during the fault but may act to assist in post fault voltage recovery.**
- Amendments to Balancing Code
  - Change BC2.11.4 to cover notification after automatically limiting the reactive power after 25 events

# Comments Received on Workgroup Report

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- RWE believes an opportunity to rectify an existing Grid Code anomaly has been missed and has possibly been further complicated by the new code (Siemens also have some sympathy with this view).
  - Existing wording of CC.A.7.2.3.1(ii) could be interpreted as requiring delivery of 90% of the transition from fully leading to fully lagging or visa versa in 1 second.
  - It has become accepted by National Grid and the wider community (i.e. Generators, Developers and Manufacturers) that achieving 90% of unity to fully leading or fully lagging in 1 second is acceptable.
  - CC.A.7.2.2.5 is currently used to define performance across the range which requires the system has completed its full response (i.e. is fully settled) within 5 seconds.
  - The above position has been clarified in the report and the new text refers to both CC.A.7.2.3.1 and CC.A.7.2.2.5 but refers to the full range and doesn't rectify the original code.
- **If the panel feels it is appropriate, the original code CC.A.7.2.3.1(ii) & (iv) could be changed to:**
  - (ii) the response shall be such that, for a sufficiently large step, 90% of the full leading or lagging reactive capability of the **Onshore Non-Synchronous Generating Unit, Onshore DC Converter, OTSDUW Plant and Apparatus or Onshore Power Park Module**, as required by CC.6.3.2 (or, if appropriate, C.A.7.2.2.6 or CC.A.7.2.2.7), from unity power factor will be produced within 1 second. For reactive compensation plant and equipment Plant and Apparatus installed on or after 1 December 2017, 90% of a change in reactive output from full leading to full lagging or full lagging to full leading shall be achieved within 2.5 seconds.
  - (iv) ~~the settling time shall be no greater than 2 seconds from 90% of the response being achieved as defined in CC.A.7.2.3.1 (ii) from the application of the step change in voltage and after which the peak to peak magnitude of any oscillations shall be less than 5% of the change in steady state Reactive Power within this time.~~ take no longer than 2 seconds from 90% of the response being achieved as defined in CC.A.7.2.3.1 (ii) from the application of the step change in voltage and after which the peak to peak magnitude of any oscillations shall be less than 5% of the change in steady state Reactive Power within this time.



# Conclusions & Recommendations

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## Conclusions:

- There are various opinions across the workgroup for and against, including:
  - Some parties consider the requirement unnecessarily onerous
  - Some parties welcome clarification & see it as a benefit
  - Some parties believe it has unnecessary cost implications
  - One party has identified possible savings (see CBA)
  - One party does not believe it is in the best interest of the industry
- Repeatability criteria is clearly defined and is based on the minimum needs of the transmission system at reasonable cost

## Recommendations:

- It is recommended the GCRP approve the report and ask for NGET to progress the proposals to wider industry consultation
- It is recommended that the amendment to CC.A.7.2.3.1(ii) & (iv) is put to the workgroup
  - If all members accept the amendment we recommend it is incorporated in the consultation
  - If there are objections it is recommended the proposal is retained in its original form and dealt with in consultation questions

# Questions



# Appendix A - Future Operating Scenario

Figure 2.7  
Gone Green (transmission) generation mix

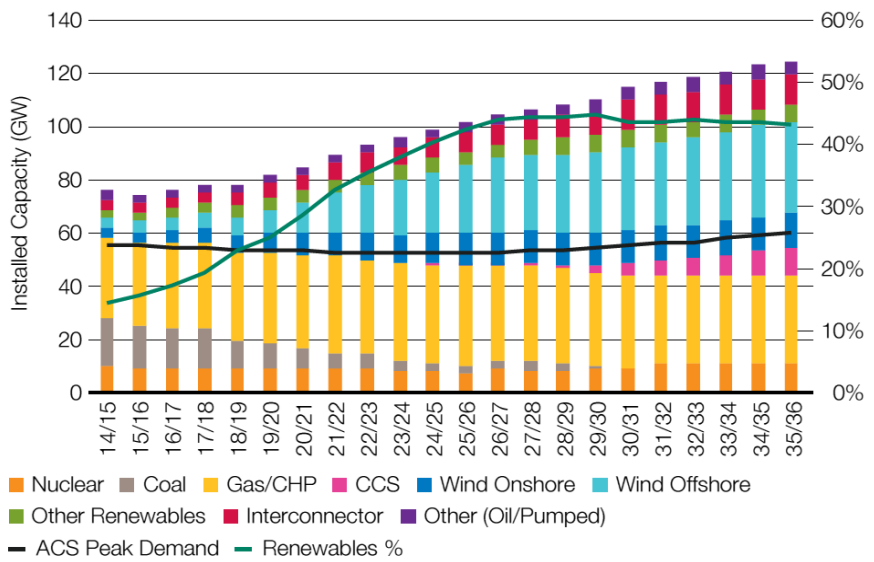


Figure 2.8  
Slow Progression (transmission) generation mix

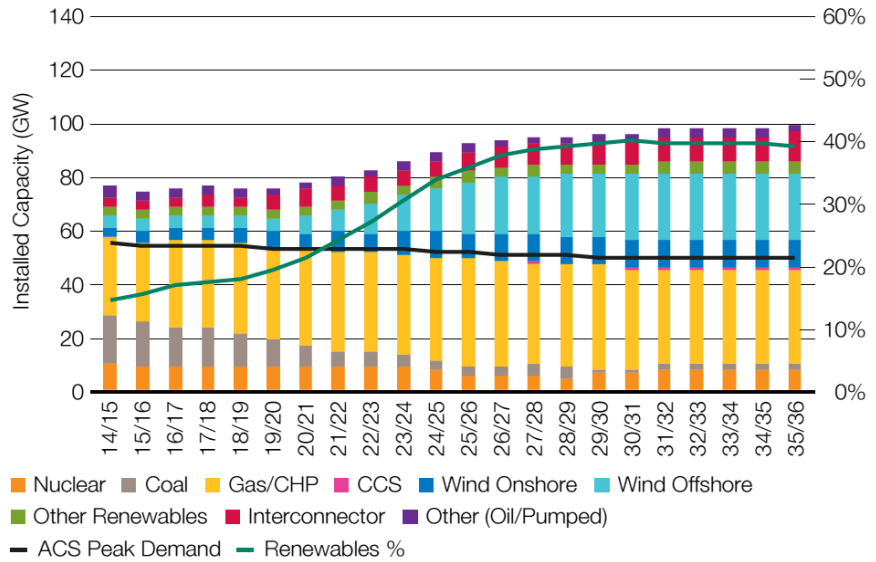
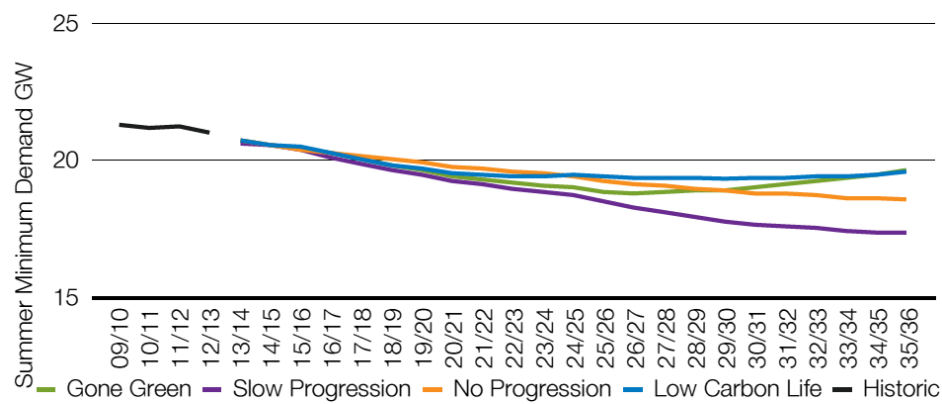


Figure 2.4  
National historic Q/P ratios



**Predicted summer minimum scenarios indicate an increased reliance on PPMs for voltage support.**

**Under these scenario's the demand can be met by PPMs and Nuclear alone.**

# Appendix B – Cost Benefit Analysis

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## Network Options Considered:

### Transmission Owner Provides Reactive Compensation

30MVAR's from an OFTO (Hybrid)	£2,450,535
30MVAR's from an OFTO (Full STATCOM)	£4,105,750
15MVAR's from an onshore PPM	£1,225,268
30MVAR's from a Transmission Owner	<b>£3,765,000</b>

\*TO replacement of 50-100% of the STATCOM / SVC's with capacitors and reactors, would only achieve a 7.5-15.5% saving.

### High Speed Auto Reclose

Breaker replacement at one end of the line	£1.1M-£4.0M
Switch gear control only	£500k

## Manufacturing Options Considered:

### Full Convertor

Cost increase of 35 to 40% on installed equipment cost

### Hybrid STATCOM / SVC with Improved Performance

See next slide...

# Appendix C – Proposed Grid Code Wording

## New Repeatability Requirement

CC.A.7.2.3.2 In addition to the requirements of CC.A.7.2.3.1, reactive compensation plant and equipment installed on or after 1 December 2017 should be capable of:

- (i) providing 5 or more responses in accordance with CC.A.7.2.2.5 and CC.A.7.2.3.1 in any 5 minute period, where each response crosses the reactive range (0.95PF leading to 0.95PF lagging or visa-versa) and returns again. The 5 consecutive responses may occur at intervals of 15 seconds or more.
- (ii) providing 5 or more response sequences (25 or more responses) as described in CC.A.7.2.3.2(i) in any 24 hour period. After which the Generator may if necessary, restrict the reactive capability. The user must declare to NGET any restriction to reactive capability as defined in BC2.11.4. The full reactive capability as defined under CC.6.3.2(c) shall be fully available as soon as practicable and within 6 hours of the final event unless otherwise agreed with NGET.

## Amendments to Fault Ride Through

CC.6.3.15.1(a)(i), CC.6.3.15.2(a)(i) and CC.6.3.15.2(a)(ii) ...Power Park Module and / or any constituent Power Park Unit or reactive compensation equipment...

CC.6.3.15.1(a)(ii) and CC.6.3.15.2(b)(ii) ...and / or any constituent Power Park Unit or reactive compensation equipment. Switched reactive compensation equipment's (such as mechanically switched capacitors and reactors) will not connect or disconnect during the fault but may act to assist in post fault voltage recovery.

## Amendments to Balancing Code

BC2.11.4 Each Generator and / or DC Converter shall operate its dynamically controlled OTSDUW Plant and Apparatus, Power Park Module and / or DC Converter (as applicable) to ensure that the reactive capability and voltage control performance requirements as specified in CC.6.3.2, CC.6.3.8, CC.A.7 and the Bilateral Agreement can be satisfied in response to the Setpoint Voltage and Slope as instructed by NGET at the Transmission Interface Point or Grid Entry Point or User System Entry Point (where Embedded). Where a Power Park Module, DC Converter or OTSDUW Plant and Apparatus has been subject to more than the defined number of events as defined in CC.A.7.2.3.2(ii), each Generator or DC Converter OTSDUW Plant and Apparatus must notify NGET of any reduction in reactive capability and subsequently when full reactive capability is restored, which shall be not greater than 6 hours for events described in CC.A.7.2.3.2(ii).