

Report to the CIGRE Australian Technical Council

Study Committee SC B4 and Australian Panel AU B4 Activities

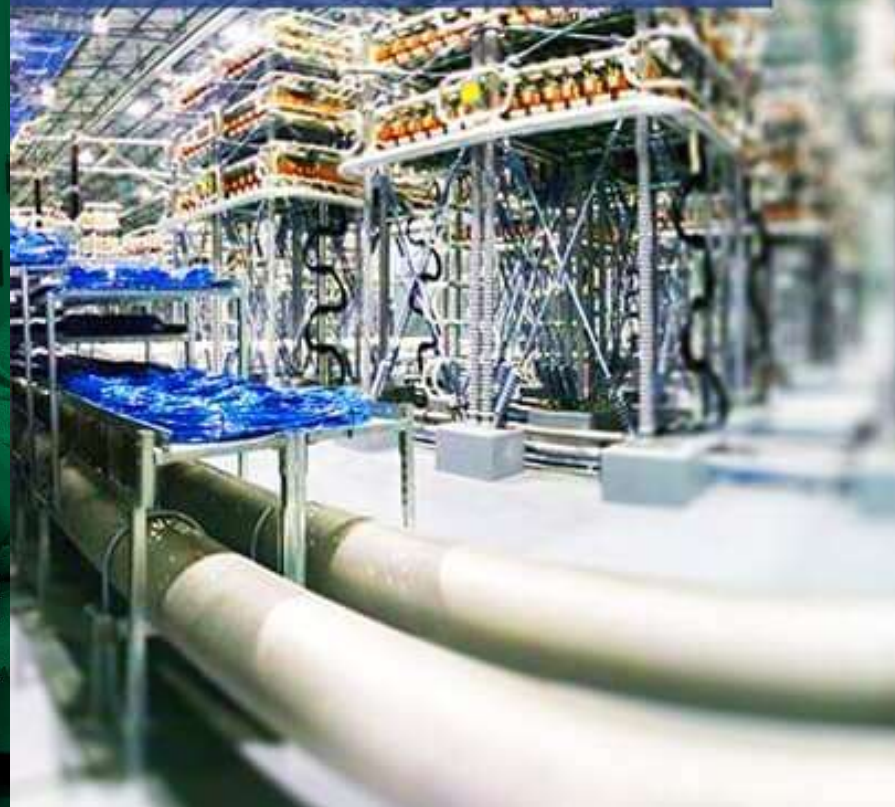
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AU B4 Report 2023
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cigre
For power system expertise

B4

DC systems and power
electronics



Scope of SC B4

HVDC



Source: Siemens

FACTS



Source: GE

DC CONVERTERS



Source: ABB

Australian Panel AU B4 – HVDC and Power Electronics

SC B4 is constituted as follows:

- John Wright-Smith, Chairman
- Ash Gupta, secretary
- 36 regular members, growing
- 8 observer members (→ 8 from 2022)
- 4 additional members (→ 2 from 2022)
- Conveners of WG's B4.90 and B4.92

Technical work performed through working bodies (*)

- 3 Advisory Groups
- 2 Working Groups
- 4 preparatory Task Forces
- 2 Joint Working Groups

With participation of approx. 20 experts, 5% from Next Generation Network

2023 AU B4 Panel Meeting – Cairns

- 2023 Panel Meeting held in Cairns, Sunday 3rd September, 2023
- 16 attendees
- 16 presentations given



ATC Seminar 2023

Australian Panel AU B4 – HVDC and Power Electronics

Strategic advisory group on the topic of Energy Transition to deal with rapidly changing power system.

Goal is to review current and futures scopes of the SC B4 to see if there are overlap and if scope is clear, and to ensure CIGRE is meeting important aspects of the energy transmission.

Short-term 1-2 year actions, on energy transition topics including:

- Hydrogen
- Storage
- Solar PV and Wind Sources
- Grid & Flexibility
- Consumer Participation
- Sustainability and Climate
- Grids & Microgrids Integration

Sector CouplingB4 Current thoughts/activities in Energy Transition:

- HVDC is key enabler in the energy transition
- Standardization is key for producing more HVDC
- Work to break manufacturer secrecy and work together
- Need more energy storage experts in B4
- Hydrogen – HVDC is interface between hydrogen and system – need new WG and experts in hydrogen

Global Trends in HVDC

- Incredible increased demand for VSC HVDC technology for long distance renewable energy applications.
- Country renewable targets approaching date deadlines.
- Greater exploitation of offshore wind at greater distances from the coast necessitating HVDC submarine cable connections.
- Easements and approval restrictions on construction of overhead lines are driving demand for HVDC underground systems which require HVDC converter systems.
- Global push for Grid Forming VSC converters, noting the following definitions determined by CIGRE SC B4 TF-77:
 1. **Grid-Following (or Grid-Connected) converter** is one that matches the AC grid voltage and frequency and can provide reactive current equal to the steady-state rated current during AC faults.
 2. **Grid-Forming converter** is one that can regulate both instantaneous AC frequency and AC voltage. Such a converter is also able to provide reactive current equal to the steady-state rated current during AC faults.
 3. **Synchronous Grid-Forming converter** is a Grid-Forming converter that is also able to operate in parallel with other AC frequency regulating equipment and converters.
 4. **Virtual Synchronous Machine (VSM)** is a (Synchronous) Grid-Forming converter with energy storage capable to deliver additional energy, for a short period of time, from the converter rather than the DC link and rated to provide a current greater than the steady-state rated current during a fault



Source: Siemens



Source: CSPG "Ongoing HVDC Project Introduction"



Global Trends in FACTS

- Engineering, equipment lead time and pricing blowing out, requires recalibration of project commissioning lead times.
- SVC PLUS Grid Forming, inertia support with power semiconductors and grid forming control.
- Surprisingly, a move back to SynCon + Flywheel, inertia as enabler for renewable energy system strength and frequency control.
- SVC Retrofits with Statcoms + Cap Banks
- AEMO connection requirements demanding larger and larger STATCOM's (up to 300MVAR with 3X overload for 2 seconds)



Source: Siemens



Source: Siemens



Recent publications

WG number	Name of the Publication	Publication details
C4/B4.52	Guidelines for Sub-synchronous Oscillation Studies in Power Electronics Dominated Power Systems (TB 909)	
B4/B1/C4.73	Surge and extended overvoltage testing of HVDC cable systems	

Upcoming publications

Technical Brochures under completion/review:

WG number	Name of the Publication	Publication details
B4.64	Impact of AC System Characteristics on the Performance of HVDC schemes	
B4.71	Application guide for the insulation coordination of Voltage Source Converter HVDC (VSC HVDC) stations	
B4.79	Hybrid LCC/VSC HVDC Systems	
B4.84	Feasibility study and application of electric energy storage systems embedded in HVDC systems	
B4.85	Interoperability in HVDC systems based on partially open-source software	

Green Books on HVDC progress: HVDC Green Book is expected in June, 2024.

Tutorials and webinars

Year	Date	Type	Title
2023	18th January	Webinar	Development of Grid Forming Converters for Secure & Reliable Operation of Future Electricity Systems
2023	9th February	Webinar	Market readiness for 132 kV offshore wind farms
2023	16th March	Webinar	Future Distribution Networks
2023	3rd May	Webinar	Power Grid Resilience Through HVDC Technology
2023	25th May	Webinar	Interconnection & Solar Development
2023	14th June	Webinar	Electric Grid Reliability and Resilience in a Warming Climate
2023	5th July	Webinar	Operation of power systems with high penetration of power electronics converters – A TSO perspective
2023	7th July	Webinar	Grid Enhancing Technologies
2023	19th July	Webinar	Hydrogen and Energy Storage, Enabling the Net Zero Transition
2023	15th November	Webinar	Technical Essentials: Grid-forming Inverters

Most webinars are available at e-cigre.org as recordings

Next planned activities: See Event calendar at cigre.org

Active WGs and JWGs

- B4.64: Impact of AC System Characteristics on the Performance of HVDC schemes
- WG B4-69 Minimizing loss of transmitted power by VSC during Overhead Line Fault
- WG B4-71: Application guide for the insulation coordination of Voltage Source Converter HVDC (VSC HVDC) stations
- JWG B4/B1/C4.73 – Surge and extended overvoltage testing of HVDC Cable Systems
- WG B4.79 – Hybrid LCC/VSC HVDC Systems
- WG B4.81 – Interaction between nearby VSC-HVDC converters, FACTS devices, HV power electronic devices and conventional AC equipment
- WG B4.82 – Guidelines for Use of Real-Code in EMT Models for HVDC, FACTS and Inverter based generators in Power Systems Analysis
- WG B4.84 – Feasibility study and application of electric energy storage systems embedded in HVDC systems
- WG B4.85 – Interoperability in HVDC systems based on partially open-source software
- JWG B4/A3.86 – Fault Current Limiting Technologies for DC Grids
- WG B4.87 – Voltage Source Converter (VSC) HVDC responses to disturbances and faults in AC systems which have low synchronous generation
- TF B4/B1.88 – Insulation coordination procedure for DC cable systems in HVDC stations with Voltage Source Converters (VSC)

Active WGs and JVGs

- WG B4.89 – Condition Health Monitoring and predictive maintenance of HVDC Converter Stations
- WG B4.90 – Operation and Maintenance of HVDC and FACTS Facilities
- WG B4.91 – Power-Electronics-Based Transformer Technology, Design, Grid Integration and Services Provision to the Distribution Grid
- WG B4.92 – STATCOMs at Distribution Voltages
- WG B4.93 – Development of Grid-Forming Converters for Secure and Reliable Operation of Future Electricity Systems
- JWG C2/B4.43 – The impact of Offshore Wind power hybrid AC/DC connections on System Operations and System Design
- WG B4.94 – Application of grid-forming VSC-HVDC system in black start restoration
- TF B1/B3/B4/C4/D1.95 – Harmonization of voltage designations and definitions across different HVDC component technologies
- JWG C4/B4.72 – Lightning and Switching Induced Electromagnetic Compatibility (EMC) issues in DC power systems and new emerging power electronics-based DC equipment
- WG B4.95 – Developments in Power Semiconductor Technologies and Applications in HVDC/FACTS
- WG B4.96 – HVDC connection of power system with high proportion of photovoltaic (PV) generation
- JWG C4/A3/B2/B4.75 – Guide to procedures for the creation of contamination maps required for outdoor insulation coordination
- JWG B4/C1.97 – Benchmarking of simulations models for control interaction in meshed AC networks with multiple converters
- JWG C1/B4.49 – Offshore transmission planning

New works / planned

WG/JWG/ TF	Number	Title	Convener Name (Location)
?	?	Design considerations in integration of DC system to meshed DC/AC transmission networks	Afshin Pashei
?	?	Offshore converter	Kees Korman
?	?	Operational Experience of VSC HVDC through cable connection	Chandana Karawita
?	?	Grid-forming Topics	Les Brand

Proposed by other SCs

WG/JWG/ TF	Number	Title	Convener Name (Location)

2023 Events

- CIGRE/GCC Muscat Symposium, Muscat, Oman, 6th – 8th March, 2023, A3, C6, B2 and B4
- Participation in CIGRE Study Committee B4 Symposium, 80 attendees, in-person Meeting (Vienna B4 Colloquium), 11th September 2023
 - HVDC suppliers, owners and B4 members provided presentations on their HVDC and FACTS schemes being constructed or planned.
 - READY4DC - Ilka Jahn
 - InterOPERA - John Moore
 - Hitachi Energy HVDC Projects - Bo Westman
 - GE Projects - Neil Kirby
 - Siemens Energy Projects - Joerg Dorn
 - Upcoming projects in Brazil - Trevor Dobbin
 - Application of STATCOMs in Multi-infeed HVDCs
 - TenneT 2GW Grid Connection Systems - Nadew A



Events after 2023

2024

- CIGRE Session in Paris

2025

- Norway NC – 2025 symposium in Trondheim (MOM-Annex 8.2)
- Israel NC – 2025 symposium in Jerusalem (MOM-Annex 8.3)

2026

- Montreal – 2027 Symposium (B2/B4 lead)
- India NC – 2027 or 2029 symposium



**Thank You
For Your
Time!**



ATC Seminar 2023