SC B4: DC systems and power electronics Newsletter

B4 Newsletter - 30th of September 2022

Editors: Hani SAAD, Rebecca OSTASH, Joanne HU

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1. Greeting from B4 WiE Invited Guest – Maryam Saeedifard

Since starting my career in academia, I have been a member of several B4 working groups over the past decade. Through those working group meetings and workshops, I have been fortunate to interact with many passionate and talented members across the globe, each team member is driven by a continual desire to innovate and contribute. I personally have found B4 events excellent venues to learn from industry leaders, use valuable research resources, stay up to date on the latest technologies, and more.

Our societal goal of reaching net zero by 2050 is a stark reminder that sustainable and clean energy is going to remain a strategic area for research and innovation in the next decades. As such, enabling technologies such as power electronics and HVDC transmission, i.e., the focus area of B4 study committee will play and continue to play a pivotal role. As researchers and scientists, we have a role to play in designing and implementing these new technologies to hopefully help address the daunting challenges that we are facing today. Perhaps most importantly, as educators, we also have a duty to mentor and educate the next generations and inspire them to tackle these challenges with all their creativity and energy. Innovation benefits from diversity in its broadest sense: diversity of talents, of backgrounds, of perspectives, and of visions. As a sustained participant of CIGRE B4 working groups, workshops and symposiums, it has been exciting to see diversity in action over the past decade.

If I had to offer advice to the many talented and driven young women researchers and scientists working in power electronics and HVDC today, I would highly recommend participation in the B4 working groups, for they not only offer an incredible opportunity for continuous learning and contributing but also offer an inclusive and friendly community. As women, we have a key role to play in delivering new ideas and inspiring young female researchers to enter the field and empower them follow their passion. The stakes behind clean energy and future sustainability are too high to not engage everyone!

Kind regards,

Maryam Saeedifard, *received the Ph.D. degree in electrical engineering from the University of Toronto, in 2008. Since January 2014, she is with the School of Electrical and Computer Engineering at Georgia Institute of Technology, where she is currently a professor and holds a Dean's professorship.*

2. Greeting from B4 Regular Member – Hani Saad

As a new French B4 regular member and lead editor of the B4 Newsletter, I am honored to take over these tasks and to be able to continue the work greatly accomplished by my predecessors.

I have received my Ph.D. degree in electrical engineering from the Polytechnic of Montréal and worked, 11 years, with RTE (French TSO), on exciting HVDC projects, EMT studies and grid codes. I recently became an independent consultant to support different stakeholders in the clean energy transition.

France has set itself the goal of achieving 40% renewable energy in the electricity mix in 2030. By the end of this decade, wind power will play an important role to achieve this goal in a context of increasing demand for electricity, particularly linked to the electrification of new users.

An overview on HVDC links in service and ongoing projects in France is illustrated in Figure 1. Up to now, four HVDC links are connecting the French network with his neighboring countries for a cumulated HVDC power of 6 GW. In addition, several other HVDC links are under-construction, in tender stage or in final planning stage as highlighted in Figure 1. The latest published HVDC projects are the two Centre Manche projects. These Centre Manche projects (AO4 and AO8) will host offshore wind turbines for a total capacity up to 2.5 GW, with two HVDC-VSC (1250 MW and ±320 kV), one towards the Cotentin area and the other towards the Calvados or Seine-Maritime regions [1]. The two offshore converters will be connected together to enhance reliability in case of offshore system outages.

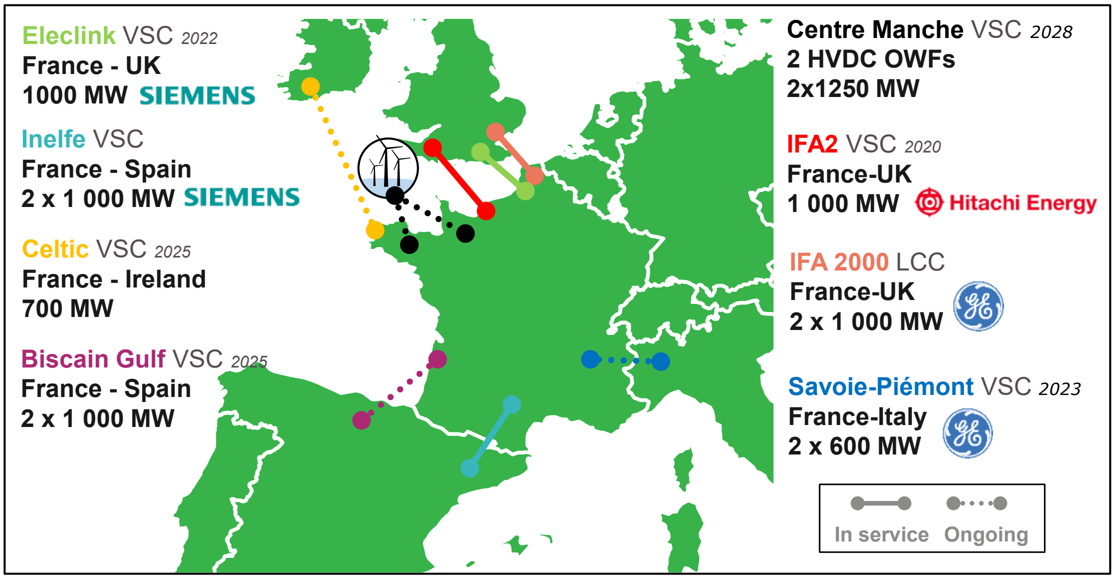

Figure 1: HVDC Projects in service and ongoing in France

Reference :

[1] https://www.eoliennesenmer.fr/presentation

3. Retirement of SC B4 Member – Dr. Ting An

Dear SC B4 Members and Guests,

I would like to take this opportinity to thank one of our special SC B4 members, **Dr. Ting An,** for her tremendous contribution to SC B4. Dr. Ting An has been a very active and valuable member to B4. She has made signgificant contributions to CIGRE SC B4 as highligthed below

- Member of WG B4/C1.65 and B4/A1.85
- Convenor of WG B4.72 WG
- Convenor of AG02 – B4 Newsletters
- B4 China regular member (2020 - 2022)

- Member of B4 advisory group AG01
- Member of B4 WiE
- Lead author of about 10 chapters of B4 HVDC Green Book
- Special reporter of Cigre 2020 and 2021 Session
- Workshop on HVDC Circuit Breakers (2018)
- Tutorial on DC Grid Benchmark Models for System Studies
- Promotion of young engineers to participate in B4 activities
- Technical paper review for several Cigre B4 events
- Chaired B4 paper sessions at various B4 conferences

Dr. An is a very pleasant colleague to work with. She held a high standard delivering all the CIGRE WORK and activities with her outstanding leadership, responsibility and dedication. We were so forturnate to have her and deeply appreicated all her efforts in supporting our B4 community. We wish all the best to Dr. An's life of retirement! We will miss you!

Joanne Hu

Chair of SC B4

4. Completed WGs and New WGs

New Working Groups

- New **JWG C4/B4.72 – Lightning and Switching Induced Electromagnetic Compatibility (EMC) Issues in DC power systems and new emerging power electronics-based DC equipment**
  Convenor – Qingmin Li (CN)
- New **JWG C2/B4.43 – The Impact of offshore wind power hybrid AC/AC connections on system operations and system design**
  Convenor – Christer Norlander (SE)
- New **WG B4.94 – Application of VSC-HVDC in a System Black Start Restoration**
  Convenor – Arash FazelDarbandi (CA)

Completed Working Groups

- WG B4.74 - Guide to Develop Real Time Simulation Models (RTSM) for HVDC Operational Studies (TB 864) – Qi Guo

Members

Q. GUO, **Convenor**	CN	P. WANG, **Secretary**	CA
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Y. ZHANG	CA	Z. WANG	CA
A. ZAMA	FR	W. El-KHATIB	DK
W. WANG	CA	H. RAO	CN
J. JOSE	BR	S. SANTO	BR
D. LIU	CN	G. LI	GB
F. ZERIHUN	BE	A. Sautua	ES
D. SHEARER	SE	Y. ZHU	CN
A. Al-MUBARAK	SA		

Corresponding Members

D. MENZIES	CA	C. KRIEGER	DE

- WG B4.83 - Flexible AC Transmission Systems (FACTS) controllers' commissioning, compliance testing and model validation tests (TB 867) – Babak Badrzadeh

Members

B. BADRZADEH, **Convener**	AU	T. MILLS	GB
A. VAN EYK	AU	R. FENLON	IE
P. MUTTIK	AU	S. GHOSH	IN
S. ELIMBAN	CA	S. MORELLO, **Secretary**	US
C. FANG	CA	G. ALVAREZ, **Secretary**	US
T. ENGELBRECHT	DE	X. WANG	US
Y. VERNAY	FR	T. MAGG	ZA
G. BATHURST	GB		

- WG C6/B4.37 - Medium Voltage DC distribution systems (TB 875) –James Yu

Members

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P. ATTAVIRIYANUPAP	JP	P. DWORAKOWSKI	FR
S. RUPP	DE	D. CORBET	FR
P. LURKENS	DE	P. MAIBACH	CH
G. D. CARNE	DE	M. CORTI	IT
A. LUKASCHIK	DE	T. MANNA	US
G. KONSTANTINOU	AU		

- WG B4/A3.80 – Design, test and application of HVDC circuit breakers (TB 873) – Junzheng Cao

Members

J.Z. CAO, **Convenor**	CN	J.C. WANG, **Secretary**	CN	R. HUGHES, **KMS Manager**	AU
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C. GAO, **Chapter Lead**	CN	M. WANG, **Chapter Lead**	BE	M. ABEDRABBO, **Chapter Lead**	BE
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T. AN	CN	X. LI	CN	H. GUO	CN
S. AZAD	CA	T. KARMOKAR, **SC B1 Liaison**	DE		

Non Member Contributors

R. ZENG	CN	X. ZHAN	CN	Z.R.	CN
Y.S. CHEN	CN	Y.H. SHAN	CN	W. LIU	CN
W.D. ZHOU	CN	J.L. ZHANG	CN	X.	CN

5. Recent Activities and Upcoming Events

Recent Activities B4 events

2022 CIGRE Session - Paris

The 2022 CIGRE Session was held in Paris, France at the Palais des Congress from Sunday to Friday, 28 August to 02 September 2022. SC B4 joined the celebration and all the regular activities were held, including the Group Discussion Meeting (GDM), poster session, tutorial, workshop and SC meeting.

The B4 GDM session was attended by approximately 150-200 in-person delegates and by approximately 7-10 remote delegates. The 67 papers covered by Study Committee B4 during the 2022 CIGRE and the 21 questions prepared by Kamran Sharifabadi, Ricardo Tenorio and Christian Winter in the special report were used as the basis for the discussion. The discussion included 60 prepared contributions and one invited presentation from CIGRE young (NGN) members. Spontaneous contributions were encouraged by the Special Reporters, and as a result, 32 spontaneous contributions were made, one of these included a spontaneous contribution by a remote delegate. The large number of submitted contributions reflect the large interest in the preferential subjects and the area of HVDC and Power Electronics in general.

It was great to be back in Paris to see everyone in person!

Recent Activities from CIGRE National SC B4 Panels

Canada

CIGRE Canada is planning to hold its annual conference from October 31 to November 3, 2022 in Calgary, AB.

https://cigre.ca/en/

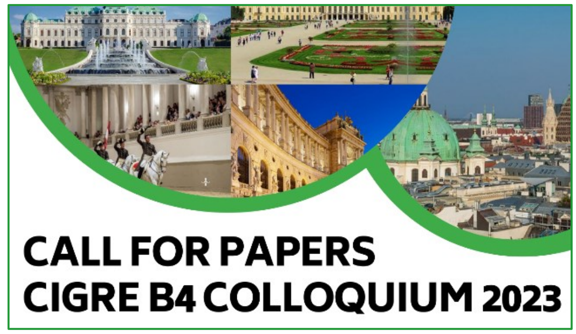
New Zealand

The CIGRE New Zealand National Committee has been forming local mirror panels across the B group of study committees. B4 was the last mirror panel that was yet to be formed and they have just kicked off a NZ B4 mirror panel. The main objective is promoting Cigre to local experts attracting more local expertise in to Cigre activities. After seeking feedback from our local experts, we held an introductory session on Monday 19th September to introduce our NZ B4 mirror panel and set out our objectives. ToR document is still being finalised and we also intend to run some workshops early next year.

Upcoming B4 Events

2023 Meeting & B4 Colloquium

Vienna, Austria, September 9-15, 2023



The SC B4 2023 meeting will be held at the event in September 2023 in Vienna, Austria. Preliminary dates are September 9 to 15, 2023. Events to take place include working group meetings, SC-B4 meeting, Colloquium, Tutorials and a Technical tour.

More information can be found here:

B4-Colloquium Vienna 2023 (cigre-b4-vienna2023.at)

Special Message from the Austrian NC :

"*The Austrian NC would like to invite you to join the CIGRE B4 SC Meeting and Colloquium in Vienna in 2023! Please mark your calendars, submit a paper and plan to attend! The Call for Papers can be found here: Call for Paper Cigre SC B4 2023 (cigre-b4-vienna2023.at). Kindly note the deadline for submission of synopsis is November 15, 2022* "

2023 CIGRE/GCC Muscat Symposium

Muscat, Oman, March 6-8, 2023

There is a Symposium in Muscat, Oman during March 6-8, 2023 on "Transition to Resilient Power Systems in Future Grids". The topic for B4 would be "Multi-terminal HVDC and HVDC Grids". The call for papers has been issued and synopsis are due on SEPTEMBER 30, 2022.

More information can be found here: CIGRE SYMPOSIUM OMAN 2023 (cigre-gcc.org)

6. Updates on ongoing WGs

WG B4-84 Interaction between nearby VSC-HVDC converters, FACTs devices, HV power electronic devices and conventional AC equipment

Convenor - Kamran Torki Sharifabadi

This WG started in 2019 and is planned to be finalized in 2022. The outcome of this WG will provide insight into interactions between VSC-HVDC converters and other power electronics devices or passive HV components installed on the network, that can occur over a wide range of frequencies: from inter-area oscillations, to sub-synchronous interaction (as SSRI and SSTI) and even to high frequency interaction (between 100 Hz to several kHz). In addition, interactions due to non-linear behaviours such as transformer saturation and control non-linearity are also covered.

This WG aims to provide an overview on the interaction phenomena and to provide recommendation on the appropriate simulation tools (RMS, EMT, real-time simulation, small-signal stability, etc.) to analyse

such phenomena. The WG provides an insight interaction phenomena in various scenarios and classify the possible interactions with reference to simulation tools for appropriate analysis,.

Multi-Infeed and Interaction Study Interaction between : at least two main power electronic devices (HVDC, FACTS, Renewables, etc.)					
Control loop interaction		**Interaction due to non-linear functions**		**Harmonic and Resonance interaction**	
Near steady-state (slow control)	**Dynamic (fast controls)**	**AC fault performance**	**Transient stress and other non-linear interaction**	**Sub-synchronous resonance**	**Harmonic emission and resonance**
• AC filter hunting • Voltage control conflicts • P/V stability	• Power oscillation • Control loop interaction • Sub-synchronous control interaction • Voltage stability	• Commutation failure • Voltage distortion • Phase imbalance • Fault recovery • Protection performance	• Load rejection • Voltage phase shift • Network switching • Transformer saturation • Insulation coordination • Transition between control modes	• Sub-synchronous torsional interaction • Sub-synchronous resonance	• Resonance effects • Harmonic emission • Harmonic instability • Core saturation instability
• Static analysis • RMS time domain	• RMS time domain • EMT time domain • Small-signal analysis	• RMS time domain • EMT time domain	• EMT time domain	• EMT time domain • Small-signal analysis	• Harmonic analysis • EMT time domain • Small-signal analysis

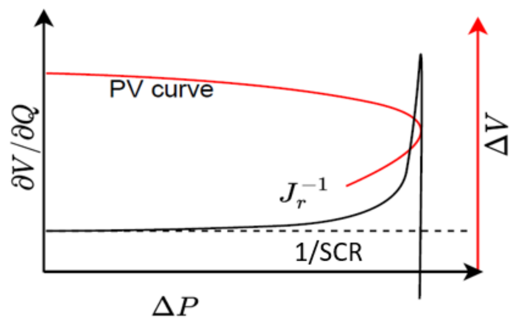
Figure 2: Multi-infeed and interaction classification B4-84

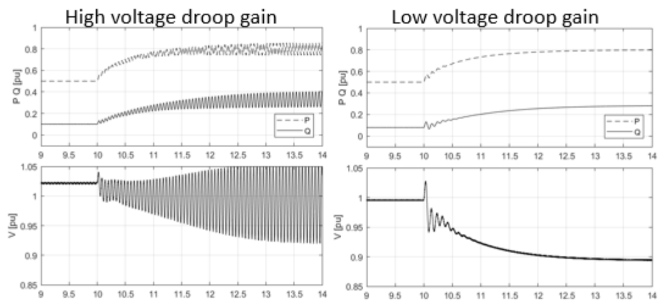
WG B4-64 Impact of AC System Characteristics on the Performance of HVDC schemes

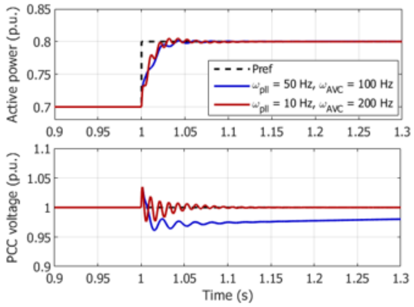
Convenor - Jef Beerten and Alejandro Bayo Salas

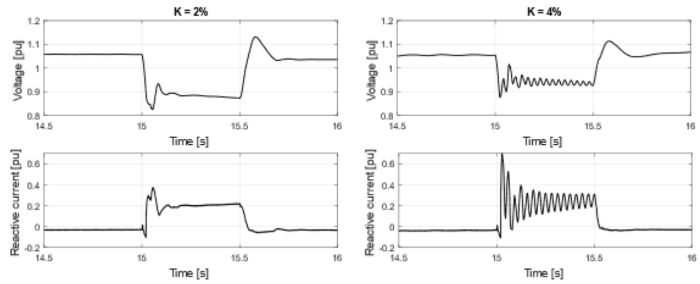
This WG studies the applicability of different indicators commonly used to assess the performance of HVDC systems. The WG started in 2013, and will be finalized by the end of the year. With the focus being on the impact of voltage dynamics on the operation of HVDC schemes, the WG demonstrates the limitations of performance indicators and stability evaluation based on short-circuit levels. One example of such limitations is the fact that the SCR does not take into account the dependency of the sensitivity on the operating point, as sketched in the figure. The outcomes of the WG will provide much needed insights on the operation of VSC-HVDC systems connected to weak AC networks, and the impact of different reactive power compensation options (such as SVCs, synchronous conders or STATCOMs) on the voltage dynamics in systems involving inverter-based generation.

Among other contributions, the WG also studies the impact of high voltage sensitivity on the different controllers and tuning of several control loops in the VSC. As illustrated in the figure, the changing the settings for different control loops has a larger impact on network dynamics due to a higher sensitivity of the voltage to network changes. Examples include changes in the PLL and outer loop bandwidth (bottom left), FRT current injection gains (bottom right) or voltage droop gains (top right). Overall, the voltage sensitivity is seen to have a major influence on the control dynamics and, reciprocally, any change from the VSC output has a further impact on the network, thus resulting in a higher degree of interaction between both systems.









7. Updates on SC members

Welcome to new B4 members & thank-you to outgoing B4 members!

Regular members				
	Leaving Members		**Incoming Members**	
Brazil	MATOS TENORIO Antonio Ricardo	2017-2022	DOBBIN Trevor	2022
Canada	VALIQUETTE Rick	2016-2022	JACOBSON David	2022
Chile	OLGUIN Gabriel	2018-2022	ALEGRIA Alex	2022
Denmark	WEINREICH-JENSEN Peter	2016-2022	DA SILVA Filipe Faria	2022
Finland	RAUHALA Tuomas	2016-2022	LINDBLAD Patrik	2022
France	DESPOUYS Olivier	2016-2022	SAAD Hani	2022
India	ARORA Anil Kumar	2020-2022	MUKHERJEE Mr. Biswajit Bandhu	2022
Italy	MALGAROTTI Stefano	2016-2022	MARZINOTTO Massimo	2022
South Africa	MUGIVHI Elekanyani	2020-2022	MAGG Thomas	2022
Spain	LONGÁS Carmen	2018-2022	SANZ Silvia	2022
Regular additional				
Canada			MACNEILL Rory	2022
China	AN Ting	2020-2022	HE Zhiyuan	2022
Observer				
Iran			GEVORK Gharehpetian	2022
New Zealand	DALZELL Michael	2016-2022	WHYTE Peter	2022
Portugal	SILVA Bernardo	2016-2022	MOREIRA Carlos	2022
Romania	TOMA Lucian	2014-2022	SANDULEAC Mihai	2022

8. News on HVDC Projects and Status

This section is supported by RTE international

East Anglia three, Scotland

Construction begins on the third offshore wind farm of the East Anglia Hub in UK

ScottishPower Renewables has started onshore construction this summer for its 1,400 MW East Anglia Three offshore wind farm in the UK. The first phase focuses on the installation of the **HVDC onshore converter station** at Bramford in Suffolk, built in partnership with Siemens Energy and Aker, and along the cable route that will connect the park to the national grid.

Fast facts:

- 100-120 offshore wind turbines on 305 km² with a capacity of 7MW to 12MW each provided by Siemens Gamesa Renewable Energy
- ±320 kV DC export cable manufactured by NKT

References

[1] East Anglia Three Offshore Wind Farm, UK (power-technology.com)

North Seas offshore wind, NSEC

NSEC targets 260 GW of offshore wind in the North Sea by 2050

At the North Seas Energy Cooperation (NSEC) event in Dublin on 12 September 2022, the nine NSEC countries agreed in a Joint Statement to reach at least 260 GW of offshore wind energy by 2050, which will represent more than 85% of the EU-wide ambition of reaching at least 300 GW by 2050. The 2050 NSEC ambitions are complemented with intermediate targets of at least 76 GW by 2030 and 193 GW by 2040. More information on the European Commission web site [1].

References

[1] The North Seas Energy Cooperation (europa.eu)

CHPE HVDC link, Canada-USA

Hitachi Energy selected for HVDC interconnection from Quebec to New York

Hitachi Energy was selected by Transmission Developers Inc., a Blackstone portfolio company specializing in renewable power development, to supply the HVDC converter stations for the Champlain Hudson Power Express (CHPE) interconnection between Québec, Canada and the New York City metro area, the United States. Fast facts:

- 1,250 MW VSC HVSC provided by HIE
- ±400 kV DC underground cable for 600 kms (372 miles)

Reference

[1] Hitachi Energy to support major renewable electricity transmission between Canada and New York City

9. CIGRE Awards 2022

A big congratulations goes out to the following B4 members for receiving the following 2022 awards:

Mohamed Rashwan -> CIGRE Medal

Every Session year, the CIGRE Medal is granted to maximum two members of CIGRE, in recognition of an outstanding contribution to the development of CIGRE (either administrative or technical achievement).

Mohamed Rashwan is the Former Chair of Study Committee B4 "DC systems and power electronics", former Chair of the Canadian National Committee, and a member of the Steering Committee.

Joanne Hu -> Women in Energy Award

This award is intended to recognize the outstanding contributions of WiE members to CIGRE activities.

Joanne's activities started as the convenor of WG B4.61, She was also the secretary of SC B4 for 6 years and is the current Chair of the B4 Study Committee; she is a member of the Technical Council.

Oliver Despouys -> Technical Council Award and Distinguished Member

The “Technical Council Award” is granted to a few CIGRE Members as a reward for their active participation in the activities of the technical work of the Study Committees

The “Distinguished Member” title is granted to a number of long-standing members who have contributed to the Association through participation in the technical work or within the National Committees.

10. Insight on new technologies

Smart DC Distribution Solution for LVDC Grid

Due to the energy transition from fossil energy to clean energy, the expansion of distributed power generation, and the fast growth of DC loads, the need for DC distribution grid is increasing in many counties. According to CIGRE Report, Medium Voltage(MV) DC power supply capability is 1.23 to 2.93 times that of the equivalent MVAC grid. Furthermore, since the power conversion stage from AC to DC is not necessary in Low-voltage DC(LVDC) grid, LVDC grid has the advantages such as the efficiency improvement and cost reduction. Fig.1 shows an example of low-voltage DC(LVDC) grid which connected with AC grid, MV/HVDC grid, renewable energy sources, and low-voltage DC load. In this article, as the solution to increase the efficiency and to protect LVDC grid from the fault event, Solid State Transformer(SST), DC/DC Converter, Solid State Circuit Breaker(SSCB), and DC Fault Current Limiter will be introduced.

Power Transformer and Power Conversion System are necessary to convert AC power to DC power in DC grid. From this point of view, Solid State Transformer(SST) has the advantage of reducing weight and volume, and improving system efficiency by configuring the power transformer and power conversion system as one system. In particular, depending on the purpose of use, it is possible to output medium voltage, low voltage, AC and DC. And it is also possible to actively control the output voltage and current, harmonics, and system disturbance, and SST has the function of the power compensation through power factor control. SST with such characteristics can be said to be a device suitable for configuring a composite network in which DC and AC are mixed, such as renewable energy, EV charging, and LVDC grid.

Fig.2 shows 3-phase 22.9kVac/±750Vdc 1MW SST and 25kW SST module. 25kW SST module consists of AFE(Active-Front-End) Converter, Isolated DC/DC Converter, and a high-frequency transformer to increase the efficiency of power conversion and to insulate between the primary side and the second side. Each phase of 1MW SST consists of 14 modules. The total efficiency of SST is higher than 98%, and it is possible to control and monitor remotely with CAN communication.

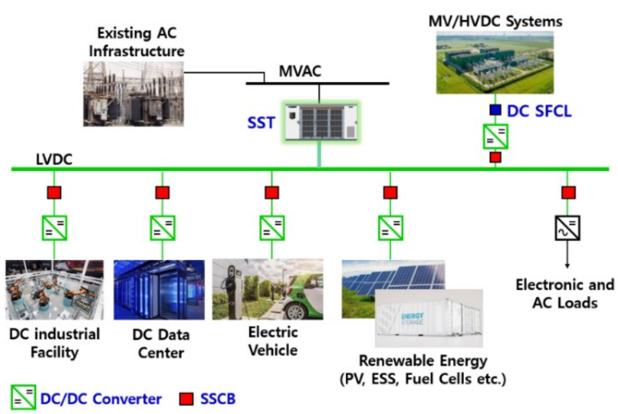


Fig.1 LVDC distribution grid and system configuration

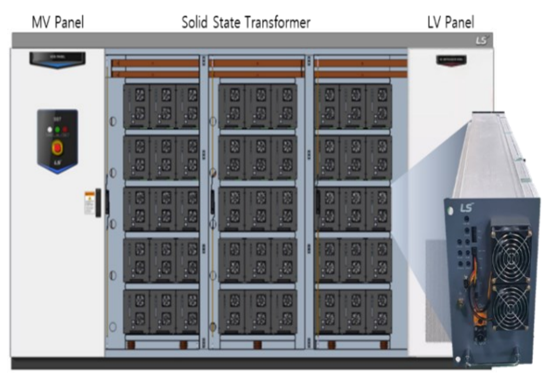


Fig.2 3phase 22.9kVac/±750Vdc SST and module

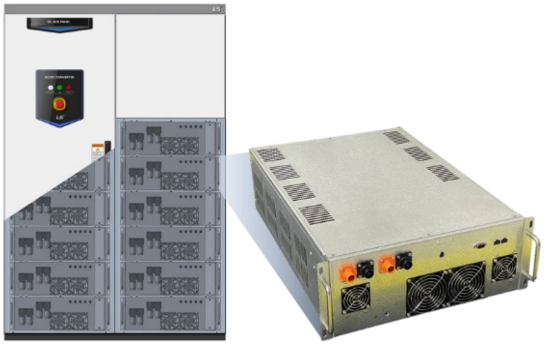


Fig.3 1500V DC/DC converter and module

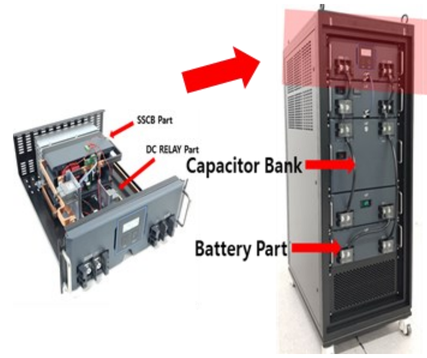


Fig.4 Solid State Circuit Breaker(SSCB)

In case of renewable power generation and EV charging systems that mainly use DC power, it is much more efficient to be connected directly from DC grid than to be connected through AC grid. It is possible to operate the energy efficiently by creating LVDC power using DC output terminal of SST and connecting DC renewable energy sources and loads such as PV, ESS, and EV charging system. As each renewable energy sources and DC load have different operating voltage ranges, DC/DC Converter is essential for a stable connection with DC grid. DC/DC Converter converts the voltage and power to connect DC grid with various renewable energy such as PV, ESS, and Fuel Cell, and it play a role to safely and smoothly transfer the power between DC grid and DC load such as EV chargers and factories with DC distribution networks. Fig.3 shows 1500V 1MW DC/DC Converter and 80kW module. 1MW DC/DC Converter consists of 12 modules, and it has the high efficiency of over 99% at full load.

As most of DC grids are composed of sensitive power conversion systems, quick protection is required in the even of a failure. In particular, in DC distribution grid, it is important to cut off the failure current in a short period of time because the risk of damage or fire of the related equipment is greater than that of AC distribution network. For this reason, the researches on the semiconductor breakers are currently being conducted. SSCB(Solid State Circuit Breaker) which use the power semiconductor do not generate arcs during the fault current interruption, and can block the fault current at a high speed that is 1,000 times faster than the mechanical circuit breakers. In particular, unlike the mechanical breakers, it can be used continuously without replacement, so it is being considered for use in places where users have limited access or in environments such as electric propulsion ships. Fig.4 shows a stand-alone type SSCB and a rack type SSCB for the battery system. Rated voltage of IGBT SSCB is 1000Vdc, and SiC SSCB is 1500Vdc. It can be used up to 150A of rated current by applying an air-cooled type and 250A by applying a water-cooled type.

In the event of a failure in MV/HVDC grid, unlike AC grid, the fault current increases at a very high speed, therefore it is required rapid cut-off the fault current. However, due to the high voltage and high current, a large number of the semiconductor device must be used for SSCB, so the operating loss is large, which reduces economic feasibility. The various types of MV/HVDC circuit breakers are being developed to overcome this disadvantage, but the circuit breaker structure is complicated and expensive to block the fault current at high speed before a short-circuit current reaches over a current allowed by DC system. The solution of this problem is to limit the magnitude of the short-circuit current to a low current sufficiently tolerable by MV/HVDC system through DC Fault Current Limiter System, making it possible to apply a slower and economical circuit breaker than the existing MV/HVDC circuit breaker.

Fig.5 shows 22.9kV 2000A Superconducting Fault Current Limiter(SFCL) that can effectively limit the fault current in MV AC grid and the test result of the short-circuit current limitation performance. SFCL consists of a superconducting unit and a High-speed Impedance Unit. The superconducting unit consists of High Temperature Superconducting(HTS) and Cryogenic Cooling System(CCS), and the high-speed Impedance Unit consists of Current Limiting Resistor (CLS) and Fast Switch (FS). The main performances of the superconducting current limiter were verified by KERI and the long-term operating reliability will be evaluated through a pilot project at a commercially operating substation with KEPCO from 2023.

If high-speed impedance unit of AC SFCL is replaced with DC switch, it can be used as DC SFCL that can effectively reduce the fault current in DC grid. LS ELECTRIC is looking forward to cooperative development of DC SFCL with utilities from around the world, which have plans to expand and distribute large-scale renewable energy.

Fig.5 Superconducting Fault Current Limiter(SFCL) and fault current limiting test result

References

1. CIGRE WG C6.31, *Medium voltage direct current (MVDC) grid feasibility study*, CIGRE TB 793, 2020
2. Seung-Yeol Oh, "Technical trends and development strategies for low voltage direct current distribution," Korean Institute of Power Electronics (KIPE) Magazine, No.27 vol.4, pp. 28-33, 2022.
3. Introduction to 22.9kV/2,000A Superconducting Fault Current Limiter developed by LS ELECTRIC, *https://www.youtube.com/watch?v=z_OnKzSLeMs*, 2022
4. Next Generation Smart DC Distribution Solution, *https://www.youtube.com/watch?v=_BzN8u1k4T8*, 2022

11. Contact and Call for information

We warmly welcome and encourage all of you to share your feedback on this newsletter and/or to propose new contributions for upcoming newsletter related to B4 activities. A list of non-exhaustive topics for your contributions are :

- New developments of Power Electronic Based Device and System
- B4 activities performed by CIGRE national committees
- Latest news on HVDC projects and status. Frequently, the new development of DC projects is shared by developers, owners and dc contractors through various medias such as LinkedIn and twitter. We encourage you to share news of ongoing and planned DC projects through the B4 newsletter as well.
- Your experience with CIGRE especially with CIGRE B4
- Any suggestions/idea(s) and questions to B4

All newsletters are available in the following link: **https://b4.cigre.org/GB/publications/b4-newsletters**

Contact

Feel free to contact one of the newsletter editors :

- Hani Saad hani.saad@acdctransient.com
- Joanne Hu j.hu@rbjengineering.com
- Rebecca Ostash rostash@tgs.biz