

The HVDC transmission market itself is projected to reach approximately \$13 billion by 2024



Converter transformers - A crucial component of HVDC system

ABSTRACT

Global HVDC converter transformer market is projected to reach \$5.3 billion by 2025 at a CAGR of approximately 18 %. The market is mainly driven by new installations of HVDC systems for new off-shore wind systems and long-distance power

transfer to load centers, however, refurbishments also plays a significant role. Some of the leading players in the global HVDC converter transformer market today are ABB, Siemens, GE-Alstom, BHEL, TBEA, XD transformers, NR Electric, RXPE and C-EPRI. ABB and Siemens still have the largest market share of HVDC sys-

tems globally and are well positioned to win projects in Europe, North and South America.

KEYWORDS

Converter transformers market, HVDC, LCC, VSC



Global HVDC converter transformer market is projected to reach \$5.3 billion by 2025 at a CAGR of approximately 18 %.

1. Introduction

With more and more generation being distributed unevenly and often at long distances from load centers (e.g. offshore wind), AC transmission systems are being replaced by DC transmission to avoid losses and reactive power issues. Moreover, interconnected AC power grids at different frequencies across countries (e.g. in Europe) makes HVDC a highly reliable solution for transporting energy between two asynchronous systems.

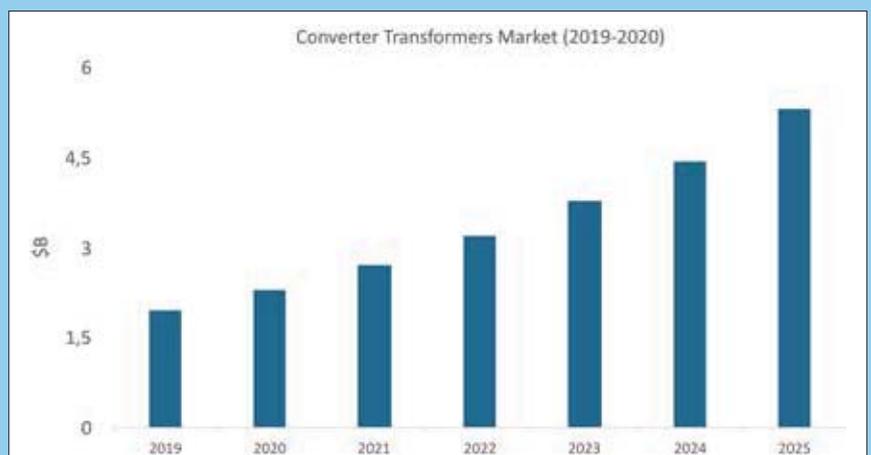
An HVDC system consists of two or more converter stations connected with a transmission medium (underground/subsea cable or overhead line). A converter station is equipped with following sub-components depending on the technology:

1. Converter transformer
2. Converter valves

3. Filters (AC and DC)
4. Smoothing reactors
5. Reactive compensation equipment
6. Control and protection equipment

The most important component out of these are the HVDC converter transform-

ers; their efficiency and reliability play an extremely important role in the overall functioning of the system. Since converter transformers act as the interface between AC and DC systems, they must fulfil superimposed requirements related to AC and DC systems.



2. Converter transformers market overview

HVDC is a mature technology with hundreds of projects installed and several projects in planning. As a

result, the global HVDC converter transformer market has also gained remarkable momentum during the last few years. More than 700 single-phase two-winding transformers were installed in more than sixty HVDC

projects commissioned around the globe in the last five years.

3. Market size

According to Power Technology Research, the HVDC converter transformer market is projected to reach \$5.3 billion by 2025 at a CAGR of approximately 18 %. The market is mainly driven by new installations of HVDC systems for new off-shore wind systems and long-distance power transfer to load centers, however refurbishments also plays a significant role.

Key growth drivers of global converter transformers market in the future are expected to be:

- Increasing addition of generation away from demand centers in Asia Pacific (APAC), especially in countries like China, India and Indonesia.
- Cross-border grid interconnection projects between countries within Europe, GCC (Gulf Cooperation Council) and South America.
- Integration of renewables, including off-shore wind in Europe, especially in UK and Germany.
- Electricity import from MENA (Middle East and North Africa) to European demand centers (e.g. EU-GCC clean energy)

4. Regional dynamics

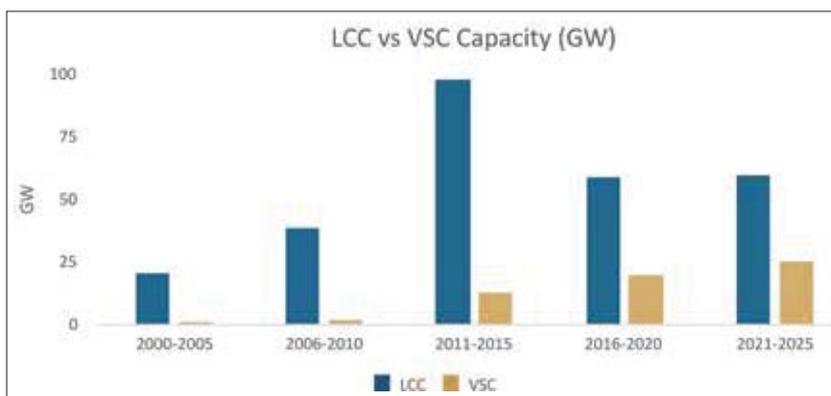
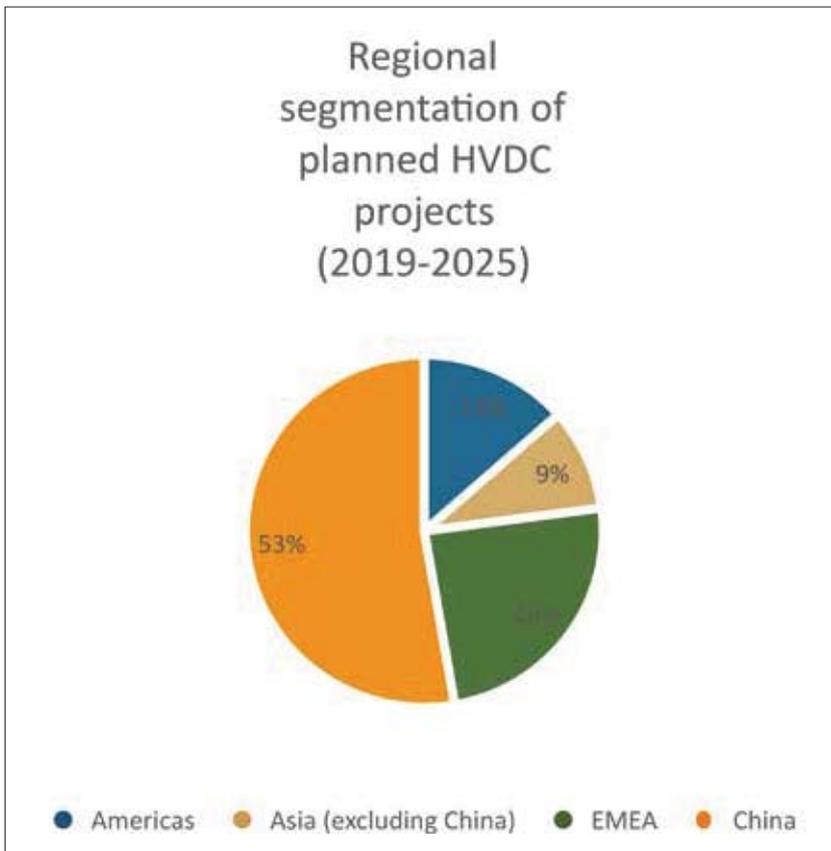
APAC is expected to be the largest market for converter transformers. Transmission infrastructure in APAC is being developed accounting for more than one third of the total market in the last few years. In the next 5 years, around 62 % of the total new converter transformers capacity is planned to be installed in APAC. Chinese market alone is the largest factor behind this with 53 % of planned converter transformer installations expected in the country.

EMEA is the second largest market by capacity of converter transformers at 24 % followed by Americas at 14 %. Most of these installations are going to be HVDC connection of off-shore wind projects expected to come online in Germany and UK, followed by grid interconnection projects in Europe, GCC and South America.

5. Technology trends

HVDC transmission systems market has undergone great evolutionary changes

More than 700 single-phase two-winding transformers were installed in more than sixty HVDC projects commissioned around the globe in the last five years



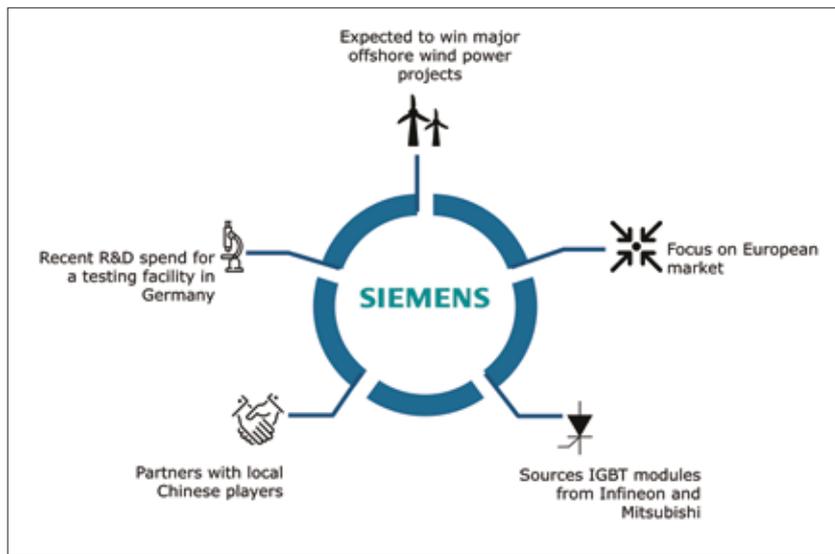
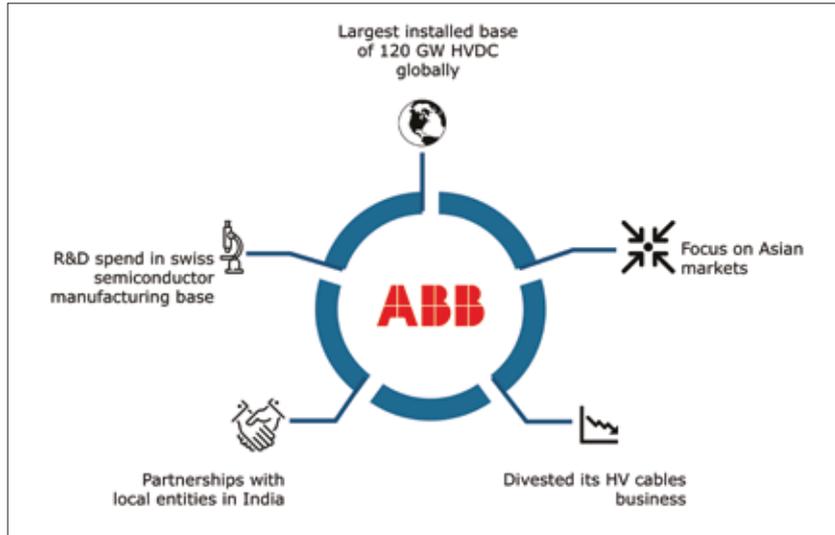


ABB has the largest installed base of projects around the world, having supplied more than 550 converter transformers globally

and so has the converter transformers market. There have been significant improvements in the converter transformer industry, from the first converter transformers rated 13 MVA installed by ABB in the Gotland system back in 1954 to the recently installed 587 MVA transformers in 1100 kV/12 GW Changji-Guquan HVDC system by Siemens, all thanks to the improved testing standards, advanced monitoring equipment, and enhancements in the design of insulation systems.

A key challenge for system operators (utilities) has been multi-vendor interoperability of HVDC converter stations. HVDC systems are provided as a turnkey solution to system operators. However, utilities expect to be able to install HVDC converters from different manufacturers in one multiterminal project. A multivendor solution, if made possi-

Photo credit: www.siemens.com/press



In the next 5 years, around 62 % of the total new converter transformers capacity is planned to be installed in APAC

ble, can also result in a cost competitive environment bringing HVDC prices down. An exception to this scenario is converter transformers market, especially in China, where most of the converter transformers projects are split among multiple manufacturers due to the sheer size of the order.

Overall, the market is highly segmented based on geographical locations in terms of technology. Converter transformers for Line Commutated Converter technology (LCC) are specially designed, whereas converter transformers for Voltage Source Converter technology (VSC) are simple and conventional in design. So far, LCC based HVDC systems have been the dominant technology; however, steady growth is expected in VSC market in the coming years.

6. Supply landscape

HVDC converter transformer supply side has been dominated in the past by western players like ABB and Siemens. Initially, APAC remained dependent on the external players for HVDC equipment including converter transformers. But continued R&D efforts coupled with policies around domestic content requirements have resulted in partnerships between HVDC converter manufacturers and local players, enabling local players to capture a significant amount of market share. Some of the leading players in the global HVDC converter transformer market today are ABB, Siemens, GE-Alstom, BHEL, TBEA, XD transformers, NR Electric, RXPE and C-EPRI.

ABB and Siemens still have the largest market share of HVDC systems globally and are well positioned to win projects across the world.

7. ABB Power Systems

ABB has the largest installed base of projects around the world. To this date, ABB has supplied more than 550 converter transformers globally. Due to their specific focus on Asian markets, where they work in partnership with local companies, they have been able

to maintain a leading position in the market. In the recent years, they have divested from the cables business and have expanded their R&D spend to focus on the core competency of converter station manufacturing. The group's recent acquisition by Hitachi (still to be completed in two years) is, however, something to be keenly tracked and will certainly result in changing supply side dynamics of HVDC converter transformers market.

8. Siemens Energy Management

Siemens Energy Management division is also a strong contender for the HVDC market share. In recent years, Siemens has been focusing on supplying its VSC technology to the market. With key focus on western markets, Siemens has been winning HVDC tenders in Europe. The division is also well positioned to win connection projects of off-shore wind power plants in Germany, UK and Americas.

Conclusion

HVDC converter transformers market outlook seems promising in the next five years. The HVDC transmission market itself is projected to reach approximately \$13 billion by 2024 fueling the HVDC converter transformer market resultantly. Along with APAC, we can see impressive expansion and development plans for implementation of HVDC technology in the EMEA and Americas depicting healthy industry growth in the coming years. Medium voltage DC technology is also expected to penetrate lower voltages, and medium voltage DC (MVDC), eventually turning into a big opportunity as more and more utilities across the world install MVDC systems.

Lack of multi-vendor interoperability is expected to continue, with converters on both sides still sourced from same supplier; however, other components like transmission medium, reactive compensation equipment, and converter transformers can be sourced from different manufacturers. So HVDC, seemingly a highly consolidated market, offers opportunities for tier 2 players as well. This also provides a new market for component suppliers such as bushings, sensing, and control and protection equipment for transformers. Moving forward, Power Technology Research anticipates that the market will become less consolidated with more players emerging from Asian markets.

Authors



Saifa Khalid is a research analyst working on power electronics market research including HVDC and FACTS systems. For her research, she focuses on creating market models of semiconductor equipment combining in-depth technical knowledge with understanding of the market dynamics. Saifa has a B.Sc. in Electrical Engineering from University of Engineering and Technology Lahore.



Saqib Saeed is a principal analyst at Power Technology Research. He is an expert in power system design and power electronics components. He has prior experience in commissioning and maintenance of power systems. Since 2015, he has been involved in consulting projects with transmission and distribution (T&D) OEMs and utilities conducting online and offline market research to identify business opportunities for equipment manufacturers like HVDC, FACTS, power transformers and gas insulated substations. His role in the Power Technology Research is to lead grid equipment research topics and develop coherent methodologies for substation equipment sizing and power electronics areas. Saqib has a Master of Sciences in Power Engineering from Technical University of Munich.