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## A Study on HVDC Smart Grid Transmission Market

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### **Abstract:**

*A high-voltage direct current (HVDC) electric power transmission system uses direct current for the bulk transmission of electrical power. HVDC transmission is widely adopted across the globe as being the advantageous for asynchronous interconnections, long submarine cable crossings and has the capability to deliver bulk power for long distance. The new innovative technology in converters has opened a new prospect in HVDC transmission, it encompasses in underground, offshore, voltage stabilization application. These applications accounted major surge in HVDC transmission market..This study aims to capture the market roadmap with market sizes, revenue forecasts, market dynamics, application market and product trends, geographical analysis and price trends. The research also identifies different market dynamics, like drivers, restraints and opportunities of each of the markets. The data had been collected using primary and secondary sources. The results of this study helped to capture the market roadmap with market sizes, revenue forecasts, market dynamics, application market, product trends, and geographical analysis.*

**Keywords:** HVDC Grid, Market Revenue, Market Crackdown

### **1. Introduction**

The electric power is an essential component in our society; the absence of power supply will have devastating repercussions on human life. Transmission system are loaded to their limits and; power trading with varying load patterns can contribute to an increasing congestion in urban cities. The recent advancements in HVDC (High Voltage Direct Current) allow transmitting bulk power over long distances, establishing interconnection network with neighboring power grid, and facilitates asynchronous transmission. This development has started in the range of less than 100 MW transmission power and has continuously increased. Today, transmission ratings of 3 GW over a long range with only one bipolar DC line are also being used. The study is extensively segmented into segments like components and services, production process technology, applications and geography; each of these segments is further divided into sub-segments. The study also identifies different market dynamics, like drivers, restraints and opportunities of each of the markets. Major players of the current market and the players with high potential to enter the market have been identified and profiled. Apart from the company profiles, competitive landscape (CL) of the key players for each of the markets has been discussed in the report. The CL includes detailed market share analysis, mergers and acquisitions, collaborations, partnerships, new product developments, and the key growth strategies of each player.

### **2. Literature Review**

According to Dusan Povh(2000), the new developments that drive the technologies and are transforming the HVDC Grid. The paper discusses about the new trends in power electronics equipment for power systems starting with HVDC and extending to FACTS. HVDC emerged as a technically and economically competitive technology to the ac transmission. It is used in vital large-scale projects transmitting power over long distances and to interconnect power systems even in cases when ac interconnection is technically not feasible. According to Daelemans et al., (2009), Minimization of Steady-State losses in meshed networks using VSC HVDC. The paper discusses minimization by performing the simulation on two networks: the IEEE 14 bus and the IEEE 118 bus network considering both original state and the state of increased loading. The results obtained exhibit that the VSC HVDC has a favourable effect on the losses in the meshed network, which are reduced. According to Biren Prasad (1998), the improvement of product by combining the real time markets with quality function deployment (QFD), value engineering and value graph. The QFD base value engineering benefits the designer to know the requirements of the company, supplier and the customer as well as how to improve the product. Companies which use the new concepts and new technology will fight with the largest market share. According to Julie Schoenfelder et.al (2004), Shows how the market research in branding can be enhanced by qualitative methods in following decade. The first imprint which is a means of brand association of a product is determined by

the features and design of the product. According to Christian Kowalkowski et.al (2008), information and communication technology is affecting and changing the service processes. Customers contribute in service production process influences the satisfaction level and the quality. Relations between the customer and the provider are an important source of service development and innovation. According to ICC/ESOMAR International Code “Market research is the systematic gathering and interpretation of information about individuals or organizations using statistical and analytical methods and techniques of the applied social sciences to gain insight or support decision making”. According to James et al (1994) “Forecasting is predicting, projecting, or estimating some future event or condition which is outside an organization’s control and provides a basis for managerial planning.” According to Aliaga and Gunderson (2000) “Quantitative research is explaining phenomena by collecting numerical data that are analyzed using mathematically based methods (in particular statistics)”.

### 3. Research Methodology

The below figure explains the steps of research, within which, three broad level approaches have been considered: secondary research, primary research and the market crackdown. Within secondary research, value chain, key players, end-user applications, annual reports of key suppliers and few other parameters have been analyzed. During primary interviews, market numbers have been validated, market dynamics has been discussed, geographic market has been discussed and analyzed and the competitive landscape of the industry is discussed and verified.

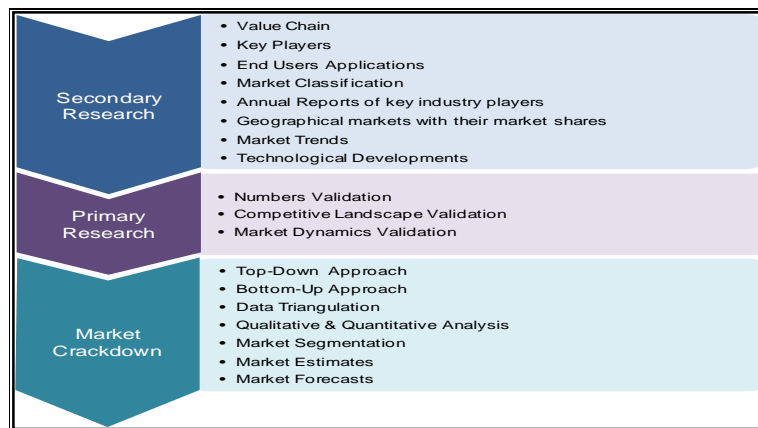


Figure 1: Research Methodology

#### 3.1. Market Crackdown

Both – “top-down” and “bottom-up” procedures were used and data triangulation procedure was implemented for market crackdown with respect to the “HVDC Grid Market. The bottom-up procedure was implemented in deriving the overall PA market by adding up the figures product-wise. Total market size was validated through revenue and revenue shares of the listed companies in the HVDC Grid market size. This overall HVDC Grid market size (revenue) was used in the top-down procedure to arrive at the market sizes of all individual sub-markets in the HVDC Grid technology market segmentation. This was validated with the original market size of the sub-segment markets.

#### 3.2. Porters Five Force Analysis

Porter’s Five Forces model describes the current industry and market scenario of the global HVDC market. This model provides information on profitability and enables the companies in making decisions regarding the entry and exit strategies in a particular segment or an industry. Changes in these forces can have a significant impact on the HVDC market. Porter’s five forces basically analyzes the competition in the HVDC market from five different directions such as intensity of rivalry within the industry, threat from new entrants, bargaining power of suppliers, bargaining power of buyers, and threat from substitutes.

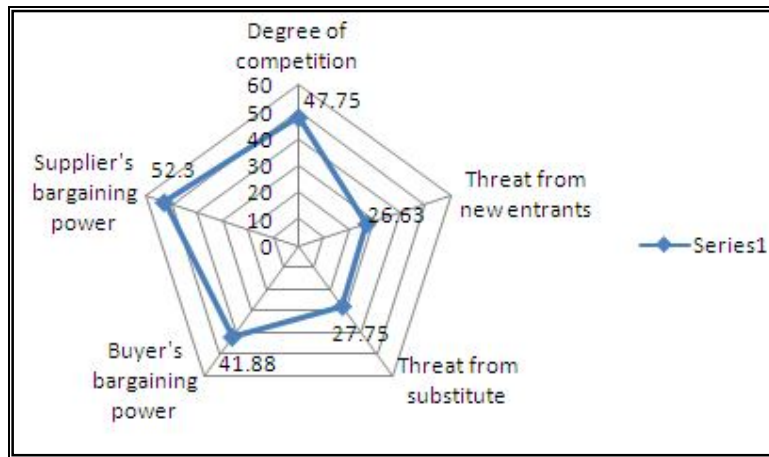


Figure 2: Porter's five force analysis

3.2.1. Degree of competition

The degree of competition force assesses the capability and the level of rivalry among competitors in the same market. The major factors affecting this force include Entry barriers, Number of players, Company's Brand name, Product launches and R&D Capability, Customer services and warranties, Competitor financial muscle, Competitor Market shares and Exit Barriers. All these factors are not going to affect the market in a significant manner because of the existing gap between supply and demand figures, new technology development and high supplier powers in the total supply chain ultimately balance the industry equilibrium and do not affect the degree of competition in coming future.

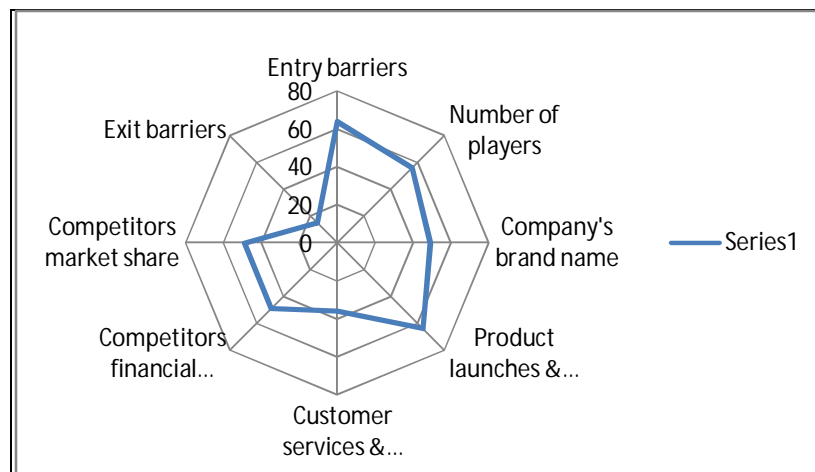


Figure 3: Degree of competition

3.2.2. Bargaining power of buyers

The bargaining power of the buyers assesses how easy it is for the buyers to drive-down the price of HVDC. The major factors affecting this force includes: Product Reliability, Ratio of size - Supplier to Buyer Pool, Buyer's Switching Costs & Trends, Customer Awareness, Buyer Options - Product Differentiation, Technology Factors - Products & Solutions, Consumer Acceptance & Adoption and Customized Solutions. The buyer's bargaining power will remain medium in the forecast period as the cost of the HVDC is high and the consumer preferences differ in the developed and developing economies with respect to their buying attitude and financial situation. The price factor in HVDC market is stable and it depends on the technological advancements in power electronics such as in semiconductor materials used in the HVDC converters.

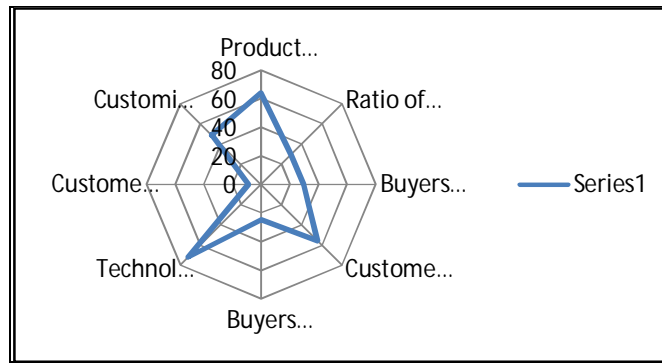


Figure 4: The bargaining power of buyers

**3.2.3. Bargaining power of suppliers**

The major factors affecting this force include Product Substitutes, Indispensability, Product Differentiation, Ratio of size - Supplier to Buyer Pool, financial Power of Suppliers, switching of Suppliers by Buyers, Quality & Reliability, Brand Value, Technology Factors and Demand Variability. The overall bargaining power of suppliers is projected to be high as there are only few players in the HVDC market. In spite of increasing the number of local suppliers, only the well established players have the capability of offering high capacity and advanced HVDC solutions as they have long experience and high expertise in this technology. The high quality and reliable HVDC solutions require high amount of capital expenditure especially in R&D activities which provides big market players with a competitive edge over small competitors. Except a few major companies, the remaining market is fragmented which further ensures the high power of suppliers in HVDC market in the forecast period. The strong financial muscle and brand name of suppliers will remain two major factors which contribute to the higher supplier’s bargaining power in the forecast period.

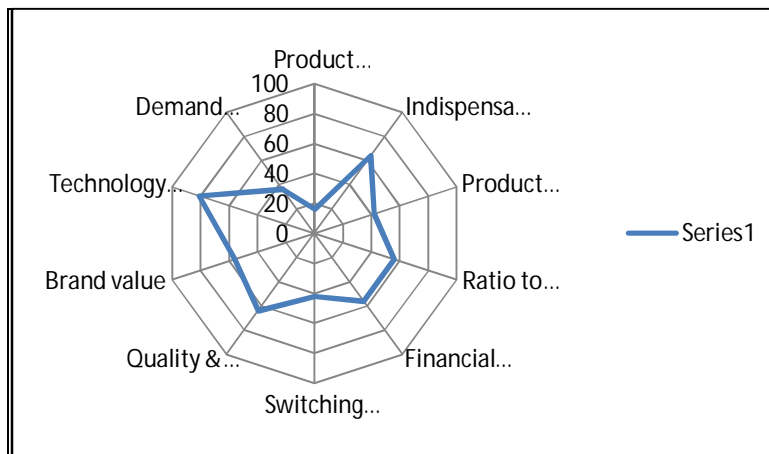


Figure 5: Bargaining power of suppliers

**3.2.4. Threat from substitutes**

The threat from the substitutes is forecast to be low as there are no major substitutes of HVDC for power transmission networks. The customer switching index is also very low for the HVDC market; hence from all these factors, the threat from the substitutes would be low in the forecast period. The Government regulations regarding high efficiency power transmission and environment friendly technologies also act as the major driving force behind the increasing demand of the HVDC.

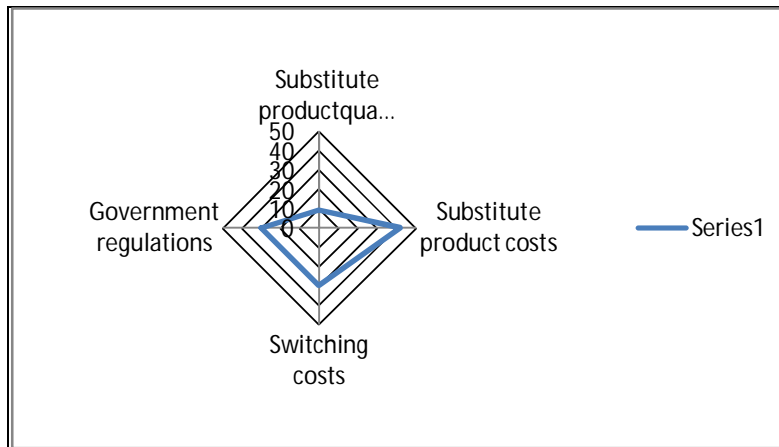


Figure 7: Threat from substitutes

3.2.5. Threat from new entrants

The HVDC market is a well-established and matured market and there are few players which currently dominate this market. The high investment price involved with the manufacturing, R&D, upgrading and servicing acts as a major restraining factor for the entry of new players. The big players with huge financial muscle and strong R&D facilities have a competitive edge in this market. Hence, the threat from the new entrants will have a low impact on this market in the coming future. As the market attractiveness is not very high because HVDC is a matured technology, the threat from new entrants will remain low and is expected to increase slightly in the forecast period due to increased demand of HVDC in different applications such as railways and wind power integration in power grids.

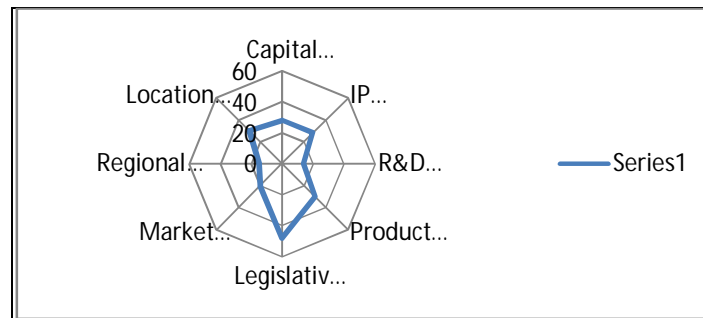


Figure 8: Threat from new entrants

4. Result & Analysis

The global HVDC grid market is expected to grow from \$3.86 billion in 2012 to \$9.62 billion in 2018, at an estimated CAGR of 16.97% from 2013 to 2018. The increasing wind farm installation across the globe and emphasis on the reduction of CO2 emission are the driving factors behind the growth of HVDC market. The Europe region is also focusing on the adoption of the HVDC as they have set a target to generate 20% of their electricity from renewable sources by 2020. The commissioning of high MW power project is the major driving factor for this market. In APAC region, countries like China and India are developing power infrastructure. Low project development barriers and supporting the government regulation also strengthens the growth of higher MW power projects. The increasing wind farms installation in European region also raise the demand for higher MW power plant. The growing power demand and efficient power supply is the main reason behind the growth in interconnecting networks. The commissioning of high MW power project is the major driving factor for this market. In APAC region, countries like China and India are developing power infrastructure. Low project development barriers and supporting government regulation also strengthens the growth of higher MW power projects. The increasing wind farms installation in European region also raise the demand for higher MW power plant. In global scenario, Europe and APAC region constitute the major market share of overall HVDC market. High growth in HVDC market is witnessing in the European region, since the strong initiatives taken by the government to integrate wind energy in power grids in order to ensure clean energy generation. It is expected, by 2020, the European region will generate 20% power from renewable resources. In APAC regions, China and India is the major contributor towards the HVDC grid market due their growing power demand. The HVDC grid market is segregated by component, configuration, technology, power rating, application, and by geography. HVDC Grid configuration market is categorized into back to back, monopolar, bipolar and multi-terminal configurations. Technology market is broadly segmented into line commutated converters (LCC) and Voltage Source Converters (VSC). The various components comprised in HVDC Grid, it mainly segmented into thyristor, IGBTs, converter transformer, DC circuit, smoothing reactors, harmonic filters, surge arrester and control and protection. By power rating comprised by below 500 MW, 501 MW – 999 MW, 1000 MW – 1499 MW and above 2000 MW. By application HVDC grid market segregated into underground power link, connecting wind farms, interconnection networks,

powering island and remote load, oil and gas offshore. Global HVDC geography region consist of Europe, APAC, Americas and Rest of the world. The major players in HVDC transmission market are Siemens Energy (U.S.), Alstom (France), ABB (Switzerland), Crompton Greaves (India), Toshiba Corp (Japan), Nexans S.A.(France), and Hitachi (Japan).

### 5. Future Scope

HVDC companies are now diversifying their portfolio and increasing the scope of their products to suit various industries. One of the major factors which increased the HVDC market's revenue is, mergers and acquisitions activities, which happened in last few years. There are significant installations of offshore wind farms across the European region to generate power from renewable sources and developments in power infrastructure in countries like China and India. They are the key reason behind the surge of HVDC grid in the market. The HVDC grid are majorly deployed to strengthens the weak AC transmission, interconnecting network with neighboring grids, asynchronous transmission, and reliable transmission of bulk power over long distances. New product development in HVDC also has the significant market as companies are investing highly on the R&D. The Swiss (ABB) and German (Siemens) groups are pouring millions into research and development for high voltage direct current (HVDC) power lines, the most efficient way of transmitting electricity over long distances. The key players in HVDC grid markets are Siemens (Germany), ABB (Switzerland), Alstom (France), Toshiba (Japan), Mitsubishi (Japan) and so on. The Siemens, ABB constituted more than 80% of the overall market share. The two players rely on their strong R&D capabilities, global reach, and diversified product portfolio to capture the major part in HVDC market.

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