



GLOBAL GRAPHITE ELECTRODE INDUSTRY

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Table of Contents

1. Graphite Electrode Industry	
▪ Overview	3
▪ Graphite Electrode Manufacturing Process	5
▪ Key Inputs	6
▪ Key Raw Material: Needle Coke	7
▪ Major Raw Material Suppliers	10
2. End User Industry (EAF Steel Manufacturing) Overview	
▪ Overview	12
▪ EAF Steel Production Process	16
▪ EAF Steel Production Cost Structure	17
▪ BOF vs EAF Steel Manufacturing	19
▪ BOF Steel Production Cost Structure	19
▪ Steel Scrap	21
3. Graphite Electrode Industry Structure	
▪ Global Capacity	23
▪ Player's Competitive Advantage	24
▪ Business Dynamics	27
▪ Industry Cost Structure	30
▪ Capital Requirement and Intensity	32
▪ Porter's Five Forces Analysis	34
▪ Key Success Drivers	36
4. Changing Industry Dynamics	
▪ Industry Cycle	37
▪ Chinese Crack Down on Polluting Industries	39
▪ China's Graphite Electrode and EAF Dynamics	42
▪ Graphite Electrode Demand Sustainability	44
5. Key Industry Constraints and Potential Threats	
▪ Industry Constraints	45
▪ Impact of Lithium Ion Battery Demand Graphite Anodes	46
▪ Impact of Chemical Energy on Electrode Consumption	47
6. Graphite Electrode Demand and Price Outlook	
▪ China EAF Steel Production Outlook	49
▪ China Graphite Electrode Production Outlook	51
▪ World excluding China EAF Steel Production Outlook	52
▪ World excluding China Graphite Electrode Production Outlook	55
▪ Price Outlook	57
7. Electrode Manufacturer Company Profile	59
8. Annexures	76

Industry Overview

Graphite electrodes are consumables in the Electric Arc Furnace (EAF) process of steel production. EAF steel is produced by melting the scrap steel in the Electric Arc Furnace at temperatures of around ~ 2,000 degrees Celsius. Graphite electrodes are used as conductors of high voltage of electricity due to their high electrical and thermal conductivity and high temperature strength. It is the only material which can conduct such high temperatures, making it the only suitable material for this process. Electrodes are a 100% consumable product with no substitute in the EAF process. Thus, the demand for graphite electrodes is solely dependent on the volume of steel produced through the EAF route.

Manufacturing of steel through the EAF furnaces has been in use since the early 1900s. At that time, carbon derived from anthracite coal and natural graphite was used as raw material to manufacture natural graphite electrodes. These electrodes were in use in EAF steel manufacturing till the early 1960s. In 1964, W. E. Schwabe introduced UHP electrodes made from Needle Coke as an alternative to the use of Natural Graphite Electrodes in the EAF process. With the introduction of UHP and improved quality of non UHP grade electrodes, the per tonne steel production requirement of electrodes through the EAF process has declined significantly due to increased operational efficiency. The consumption of electrode per tonne of steel production reduced from XX kg of lower grade electrodes during pre-1960 era to XX kg of UHP electrode per tonne post 1970.

There are three grades of Graphite Electrodes which are used in EAF based on its Electric Carrying Capacity, Thermal resistance, Strength and the Design of the Furnace:

- **Ultra-High Power (UHP) Electrodes**
- **High Power (HP) Electrodes**
- **Regular Power (RP) Electrodes**

As per industry estimates, 1 Tonne of steel production through the EAF route on average requires XX kg of UHP electrodes or XX – XX kg of non UHP grade electrode. Most major EAF steelmaking plants around the globe are powered through UHP grade electrodes as they generate XXXX through the arc in the furnace and give a higher XXXX ratio. A minor proportion of small mills globally and large furnaces primarily in XXXX and XXXX require the use of non UHP grade electrodes.

Table XX: Characteristics of Different Grades of Electrodes

Grade	Thermal Strength	Structural Strength	Spalling Risk	Electric Conductivity	Electrode Consumption per Tonne of Steel
UHP	XXXX	XXXX	XXXX	XXXX	XXXX
HP	XXXX	XXXX	XXXX	XXXX	XXXX
RP	XXXX	XXXX	XXXX	XXXX	XXXX

Source: XXXX

Graphite Electrode Industry Structure

The Graphite Electrode Industry is highly concentrated due to the XXXX in the manufacturing process. The industry has high economic relevance in the EAF steel production process. The sustainable growth rate of the electrode industry is directly dependent upon the long-term growth rate of EAF steel production.

The industry focuses on the market of EAF Steel producers. There are XX key players in the Graphite Electrode Market excluding China which account for ~ XX% of the global graphite electrode manufacturing capacity. The combined capacity of these players is ~ XX thousand tonnes in 2017. The industry also includes XXXX electrode manufacturers accounting for around XXXX thousand tonnes of capacity.

Chart XX: Global Electrode Ex China Capacity ('000 Tonnes)

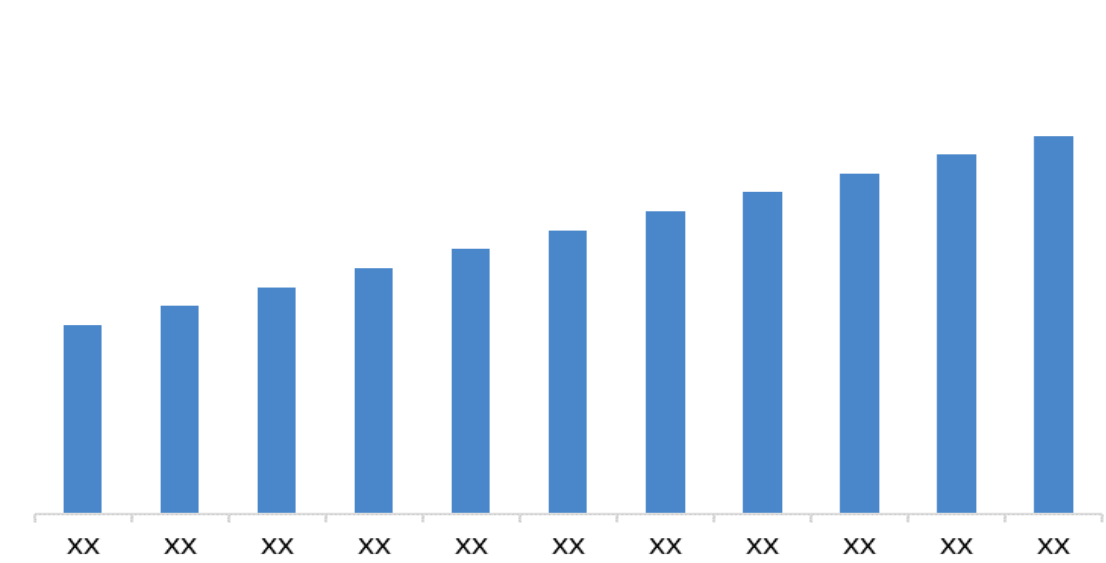


Source: XXXX

Changing Industry Dynamics

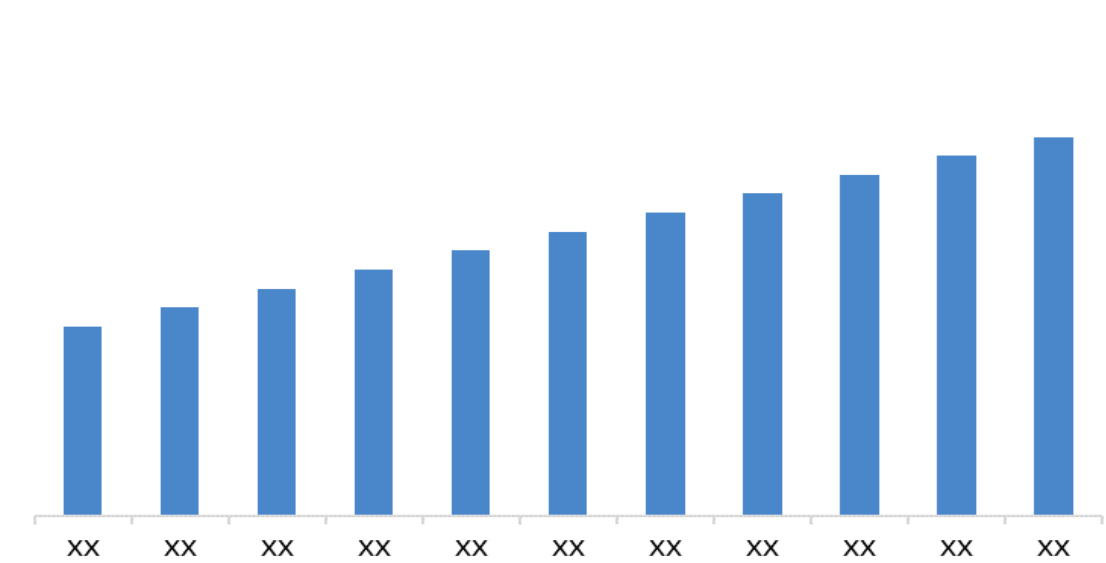
The Global Graphite Electrode Industry has seen volatile cycles, both peaks and troughs in the last XX years. The World Electrode Capacity had changed from XXXX thousand tonnes in XXXX to XXXX thousand tonnes in XXXX. The increased production of steel through the EAF route after XXXX created an expansionary stage for the industry. Increased production through EAF route had augured well for the industry participants leading to XXXX in XXXX. Global Graphite Electrode Utilization was around ~ XX% during the period.

Chart XX: Industry Average EBIT Margin



Source: XXXX

Chart XX: Global Electrode Capacity & Demand ('000 Tonnes)



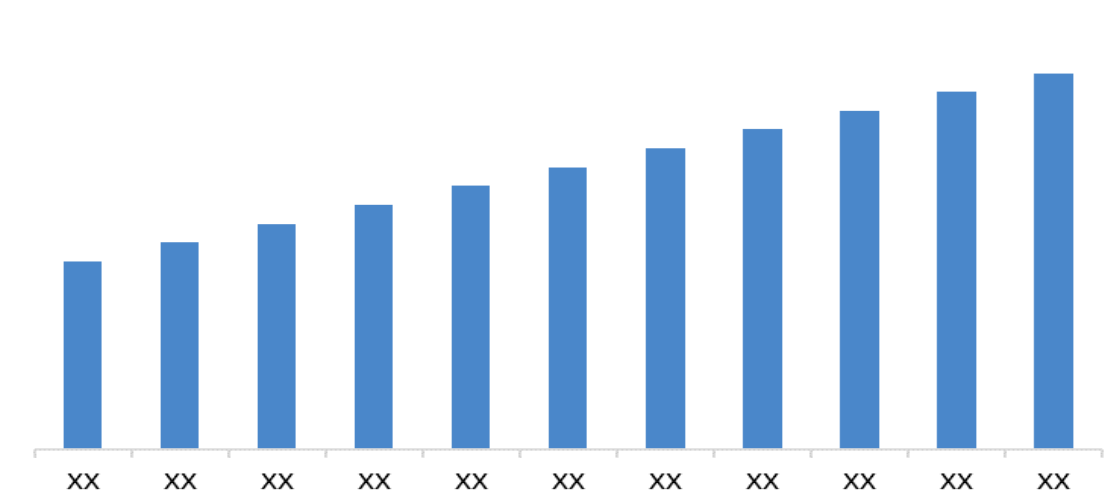
Source: XXXX

Graphite Electrode Demand and Price Outlook

The Global Graphite Electrode Industry is estimated to have reached ~\$ XXXX Billion in size at year end 2017 from ~\$ XXXX Billion in 2010.

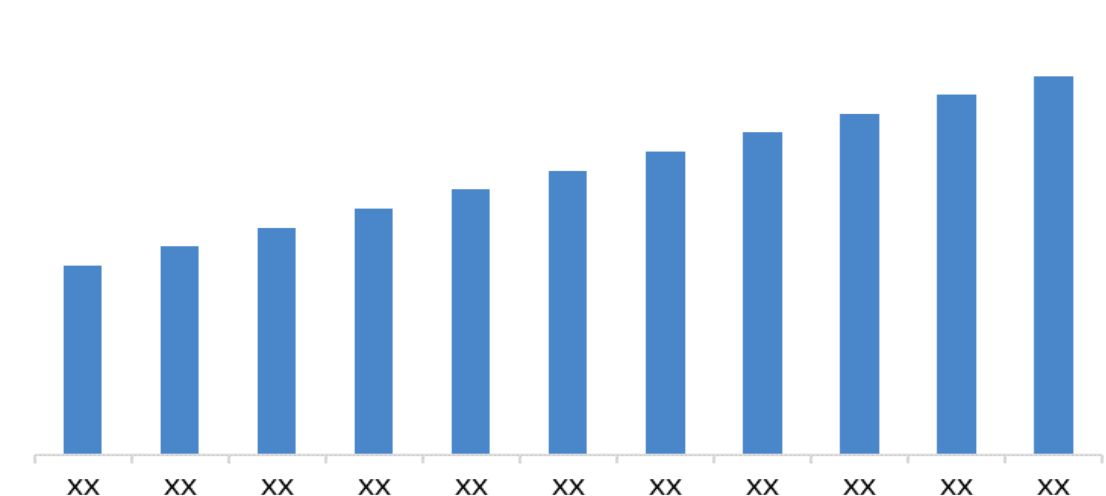
The global graphite electrode industry’s annual production capacity stands at nearly XXXX thousand tonnes in 2017. The industry is marked by barriers in the form of XXXX to manufacture UHP electrodes. As a result, the global industry for UHP electrodes is marked by the presence of XXXX players. The combined capacity of these players is ~ XXXX thousand tonnes in 2017 and the total revenue of these players stood at ~\$ XXXX Billion at year end 2017. The top players in the industry have a significant share in the global electrode market and ~ XX% market share of UHP electrodes.

Chart XX: World Ex-China Graphite Electrode Demand (Thousand Tonnes)



Source: XXXX

Chart XX: China Domestic Graphite Electrode Consumption (Thousand Tonnes)



Source: XXXX