



# GRAPHITE ELECTRODE INDUSTRY

1 July 2019

## INDUSTRY OUTLOOK

Graphite Electrode (GE) is a high value, needle coke based raw material primarily used in the electric arc furnaces (EAF) for steelmaking, mine electric furnace for smelting ferrous alloys and electric discharge machining markets to enhance the production of fine surface finishes. In a nutshell, GE is a key component for electric arc furnaces (EAFs) that turn scrap into steel. Needle coke is the main raw material for GE production and critical for the growth of GE industry.

Demand for graphite electrode (GE) keeps on rising with the increasing industrial activity across the various sectors like – agriculture, manufacturing, mining, trade, construction etc.



## Graphite Electrode: A Snapshot

**EAF Steel:** There are two primary methods to produce steel: 1) The BOF (blast oxygen furnace) route where mineral feed (iron ore, coking coal) is used; and, 2) EAF (electric arc furnace) which primarily uses steel scrap as a raw material feed.

**Graphite Electrode (GE):** Because of its high electrical conductivity and low resistivity, GE is used to melt scrap and other raw material in an EAF. GE generates an electric arc, when electricity is passed through it, and this melts scrap.

**GE Types:** There are 2 broad categories of graphite electrodes: 1) UHP (Ultra-high power) electrodes produced with petroleum needle coke; and, 2) Non UHP - HP (high power)/ ladle electrodes/ RP (Regular Power) electrodes. Key raw material is pitch needle coke.

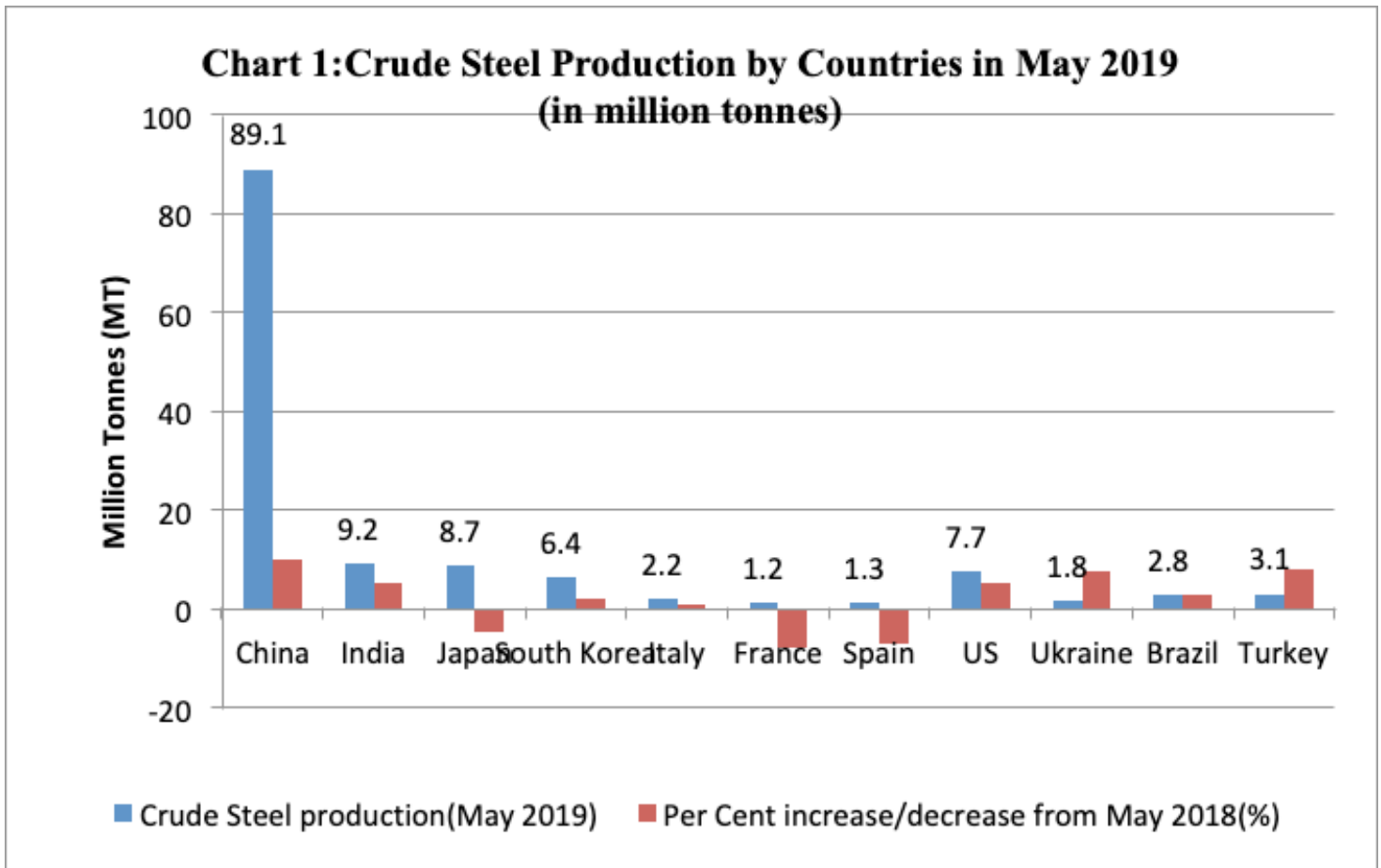
**Needle Coke:** It is the primary raw material for the production of graphite electrodes (GE). There are two types of needle coke. Petroleum needle coke is produced through decant oil (<0.5% sulphur) or sweet crude. Pitch needle coke, used majorly by graphite electrode manufacturers in China, is made from coal tar pitch.

Source: Compiled from HEG Annual Report (2017-18)

**Table 1: Crude Steel Production in Different Countries (May 2019) in Million Tonne(MT)**

Countries	Crude Steel production (MT) (May 2019)	Per Cent increase/decrease in May 2019 from May 2018
China	89.1	10.0
India	9.2	5.1
Japan	8.7	-4.6
South Korea	6.4	2.2
Italy	2.2	1.1
France	1.2	-7.6
Spain	1.3	-7.1
US	7.7	5.4
Ukraine	1.8	7.8
Brazil	2.8	2.9
Turkey	3.1	8.0

Source: WorldSteel "May 2019 crude steel production" published on 24 June 2019 <https://www.worldsteel.org/media-centre/press-releases/2019/May-2019-crude-steel-production.html>



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## NATURE OF THE INDUSTRY

Graphite electrode is a key component for electric arc furnaces (EAFs) that turn scrap into steel. Their manufacturers came into the limelight following China's policy to curb pollution that was introduced in late-2016. The policy was seen as the trigger for a multi-year demand upcycle for electrodes as it required blast furnaces to be replaced by environment-friendly EAFs.

GEs are made out of needle coke, which is used as a primary material for graphite electrodes in electric furnace. Coal-based needle coke is produced from coal tar that appears during coke production. Compared to petroleum-based needle coke, coal-based needle coke has excellent physical properties, such as low co-efficient of thermal expansion and low electric resistance, along with less spalling and less breakage<sup>1</sup>.

Needle coke has also found a new application in lithium ion batteries, mainly in China, which are expected to be in high demand owing to the thrust on e-mobility across the globe. This further restricts any significant expansion in the production of graphite electrodes.

Due to the abovementioned factors, the graphite electrode sector has seen no large capacity increase over decades. Further, there are only two major players in this business – Graphite India Limited (GIL) and HEG Limited (HEG).

## THE ELECTRODE SECTOR

Graphite electrodes are primarily used in Electric Arc Furnaces (EAF) and Ladle furnaces in steel making. So far electrode consumption accounted for only 2-3% of steel making cost<sup>2</sup>. In the recent years, electrode prices fell to unviable levels as cheap iron ore and coking coal made BOF route cheaper as compared to EAF steel, hitting the EAF steel mills who chose to re-roll blast furnace produced semis, or utilise merchant pig iron. For every electrode they made, western producers lost money, and consequently shuttered capacity as a survival strategy.

However, the year 2017 saw an unusual increase in electrodes demand even as supply remained cuddled. The Chinese Government cracked down on some of the highly polluting industries due to serious environmental concerns in 2017. About 270 mmt of Induction furnaces, Mini blast furnaces and some very old Blast furnaces have been shut down. These closures have led to a sudden huge decline in export of finished and semi-finished steel from China to the rest of the world which helped other countries of the world to increase their own production of steel, leading to a sudden increase in the demand for electrodes.

China's closure of inefficient induction furnaces and polluting blast furnaces is expected to be replaced by EAF's. In 2017, about 66 mmt /year of new EAF capacity was granted approval in China. Thus, the Chinese production through the EAF route is expected to rise. According to industry estimates, China's EAF output in 2016 was around 52 mmt and is likely to increase by 110 mmt by 2020, which means an additional demand of 275,000 tons of graphite electrodes<sup>3</sup>.

### **Electric Arc Furnace (EAF) vs. Blast Oxygen Furnace (BOF) to produce steel!**

Electric Arc Furnace (EAF) route of manufacturing enjoys following advantages over traditional Blast Oxygen Furnace (BOF) route:

- Lower capital investment
- Lower break-even tonnage
- Flexibility in locating plants closer to consumption
- Less polluting than integrated steel plants

One positive factor for India and other countries is that since China is replacing its BOF plants via EAF to reduce pollution, immediate production of steel in China might be impeded to some extent providing some leeway to other countries.

Source: <https://www.graphiteindia.com/wp-content/uploads/GIL-Corporate-Presentation-September-2018.pdf>



**Table 2: Share of Electric Arc Furnace (EAF) in Total Steel production (in Per Cent)**

Year	Total Steel Production (in Million Tonnes)	Steel production via Electric Arc Furnace(EAF) (in Million Tonnes)	% of EAF in total steel
2013	1606	453	28.2
2014	1663	426	25.6
2015	1617	406	25.1
2016	1627	412	25.3
2017	1689	473	28.0
2018	1729	Not Available(NA)	Not Available (NA)
2019	1808	Not Available (NA)	Not Available (NA)

Source: WorldSteel and Graphite India Ltd (GIL) corporate presentation (2018) slide:21; <https://www.graphiteindia.com/wp-content/uploads/GIL-Corporate-Presentation-September-2018.pdf>

## PRICE TRENDS OF GRAPHITE ELECTRODES (GE)

China is a major GE producing and exporting country, and its price trends usually affect global GE prices. In March 2019, GE prices in India registered a decline of INR 50,000/ Metric Tonne (MT) or USD 721/MT compared to its prices in January and February 2019<sup>4</sup>. The price of UHP Grade Graphite Electrodes (GEs) of size 600 mm is likely to be around INR 80,0000/MT and that of lower grade electrodes (HP Grade) of size 400-450 mm the same is estimated to be around INR 45,0000/MT in 2019<sup>5</sup>.

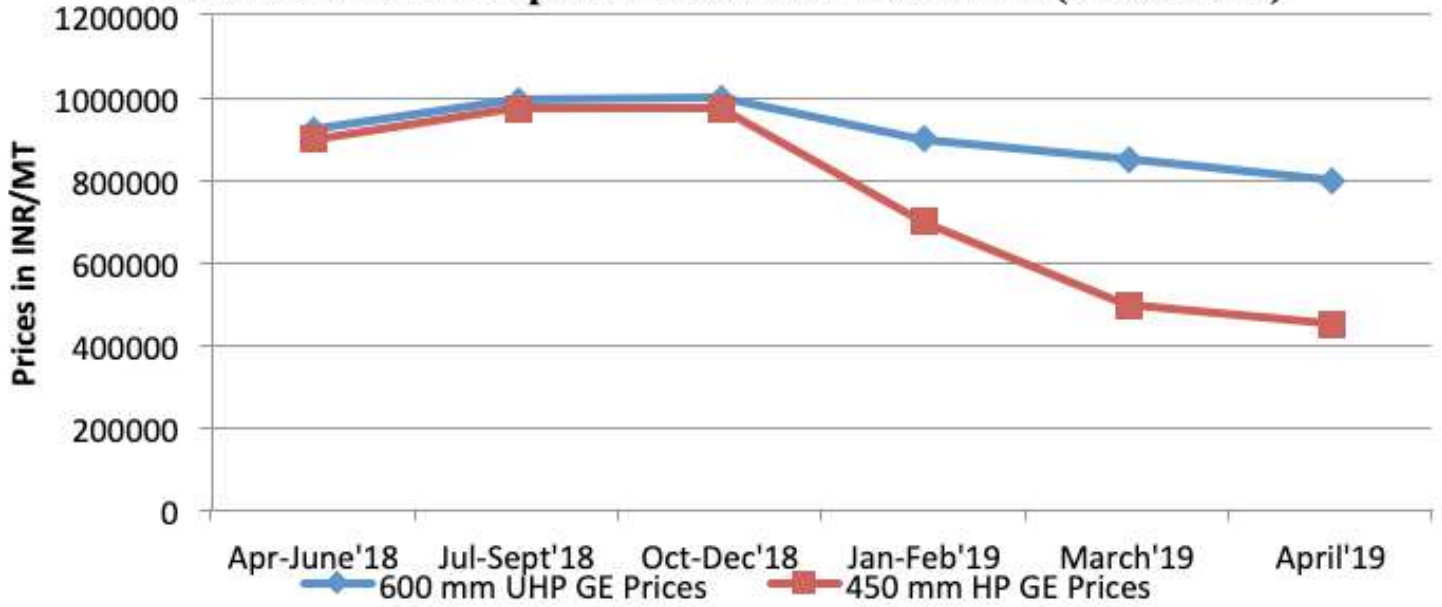
Amid the rapid increase in GE demand and prices in the latter half of 2017, the Indian manufactures entered into quarterly contracts with the GE consumers. However, the market dynamics changed towards the end of 2018 that led to a decline of Chinese GE prices, which indirectly impacted the Indian GE market. Given the market condition, instead of entering into the quarterly contracts like before, GE buyers have started negotiating for prices contracts on monthly basis and this is why prices have changed over in recent months.

The decline in GE prices can be attributed to the ongoing downtrend in Chinese GE prices since the start of the winter heating season from mid-November 2018. During the season (November-March), steel demand in China takes a beating and the country imposes production cuts in steel sector that indirectly affect GE demand (which is a major raw material in steel production via the electric furnace route).

In August-September 2018, India removed anti-dumping duty from China on GE products that created fear that Chinese GE products can enter India's market. Indian EAF steel producers anticipated further fall in GE prices, as according to them importing China's UHP Grade GE will be cheaper compared to Indian electrodes. The price of China's 600 mm UHP Grade GE is currently RMB 65,000/MT (USD 9700/MT) and importing the same to India even including customs duty still makes it cheaper by USD 800-1000/MT against India's domestic GE price.

Lower Grade GE prices are under more pressure as Indian GE manufacturers face tough competition from Chinese imports of lower Grade HP (High Power) and RP (regular Power) GEs. This is because production of lower grade GE in China is rising and plenty in availability<sup>6</sup>.

**Chart 2: India's Graphite Electrodes Price Trend (in INR/MT)**



Note: UHP: Ultra High Power; HP: High Power

Source: 'Where are Indian Graphite Electrodes Prices Heading?' (1 April 2019) SteelMint <https://events.steelmintgroup.com/where-are-indian-graphite-electrodes-prices-heading/>



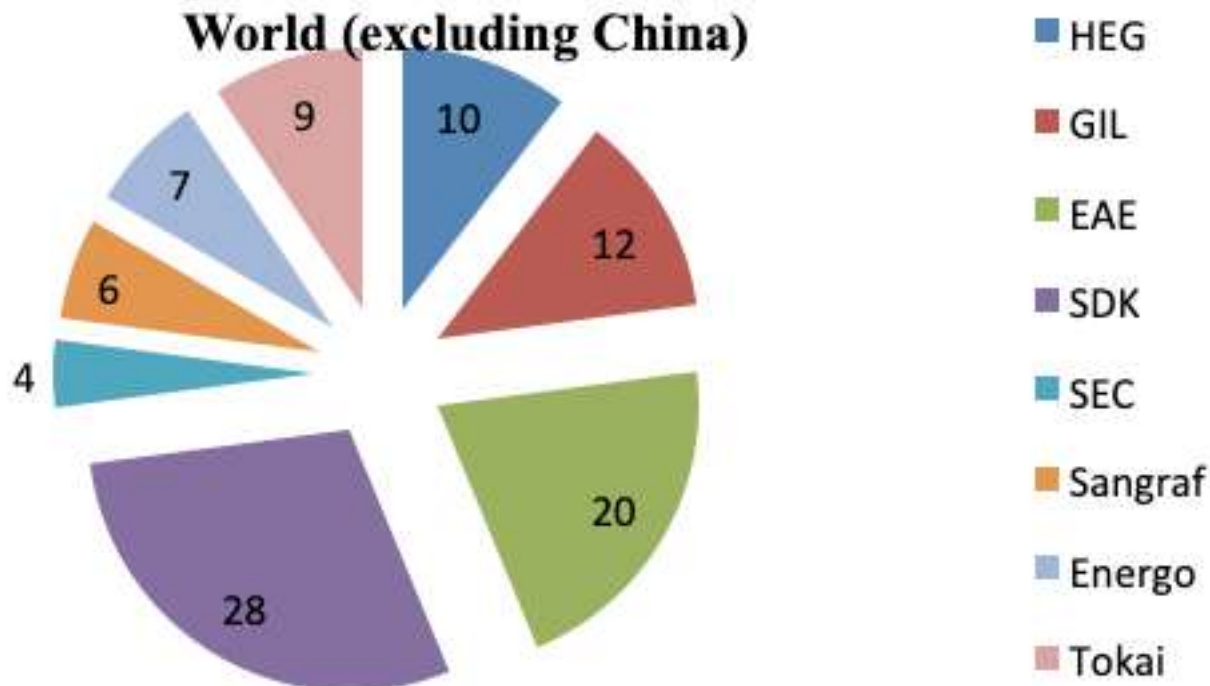
**Table 3: Major Players**

SI No.	Company	Major Products and Business
1	Graphite India Ltd. (GIL)	<p>Leading Graphite electrode manufacture in India with 98,000 MT capacity with plants at four locations</p> <p>(Bangalore(13,000/MT)1, Durgapur(54,000 MT/year), Nashik (13,000/MT) and Nurnberg (Germany)(18,000/MT)2 with total capacity of</p> <p>98,000 tonnes/year (TPA), with flexibility to produce all grades of electrode, with core expertise in value-added Ultra High Power (UHP) electrodes.</p> <p>Enhanced product range – large diameter UHP electrodes and specialty graphite products; apart from GE products it also produces GRP Pipes and High Speed Steel.</p> <p>Its overseas clients are based in Mexico (Exiros), North America (Nucor, SDI group etc.), Middle East(Qatar, Emirates and Kuwait steel), South East Asia and Far East (PTCT Indonesia, Hyundai Steel Korea, Tokyo Steel Japan etc.) and India (Essar steel, Jindal Steel &amp; Power, JSW Steel, Steel Authority of India etc.).</p>
2	HEG Limited	<p>HEG Limited is located at Mandideep, Near Bhopal. Madhya Pradesh, India with a capacity of 80,000 MT per annum. It is one of the largest manufacturers and exporters of graphite electrodes in South Asia. Its product range comprises of Graphite electrodes – UHP Graphite electrodes and HP grade graphite electrodes. Exports approximately 70% of its production to about 30 countries around the world.<sup>39</sup></p>

Source: Company latest Annual Reports

Together, the HEG Ltd and GIL have 22 per cent market share in global production.

**Chart 3: Graphite Electrode (GE) Market Share in World (excluding China)**



Source: Indian graphite electrode sector 'Strategic resource', not 'commodity' (28 June 2018) Macquarie Research

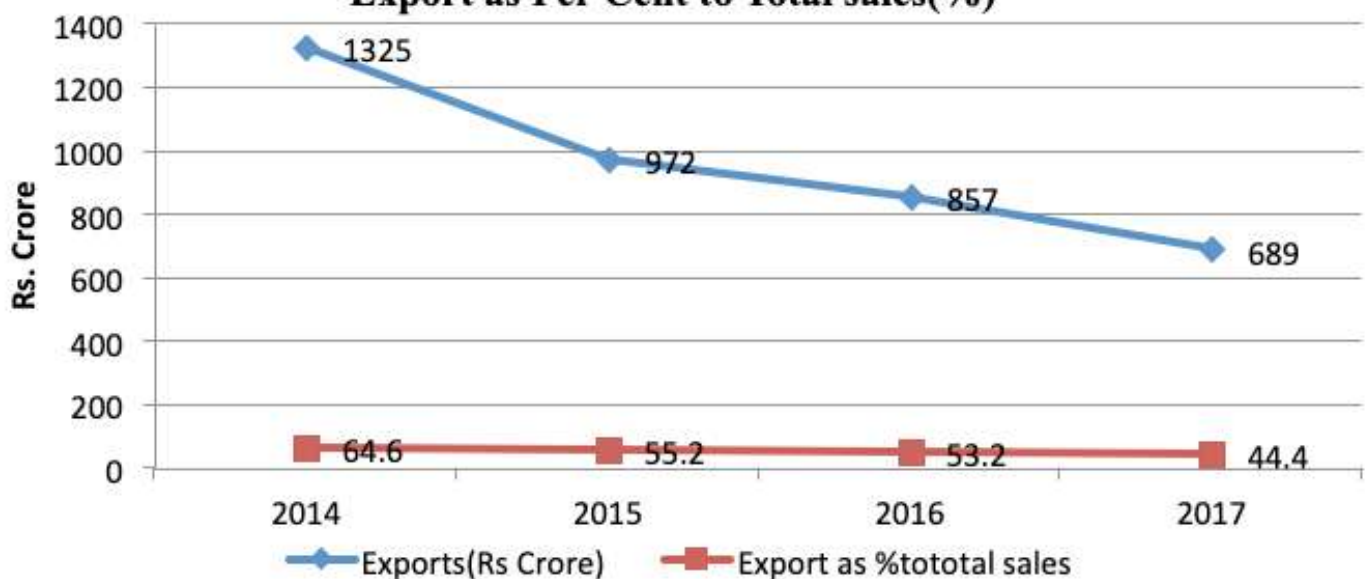
In recent times, Graphite India Ltd. (GIL) has sought shareholders' nod to raise up to INR 5,000 crore to meet the company's resource requirements including capex and acquisitions. The fund will be raised in one or multiple tranches in the Indian or overseas markets. The company was planning to scale the capacity of its Durgapur unit in West Bengal after the closure of the Bangalore plant following green tribunal orders. GIL would debottleneck its Durgapur unit along with the Nasik facility to cover the gap caused by the closure of the Bangalore plant. Durgapur is the largest electrode producer for GIL, accounting for around 59 per cent of its capacity of 98,000 tonnes<sup>10</sup>.

In 2018, GIL through its wholly-owned subsidiary in Netherlands has signed a definitive agreement to acquire 46 per cent stake in General Graphene Corporation<sup>11</sup> for USD 18.6 million. The following Table provides details:

Sl No.	Items	Details
1	About General Graphene	US based unlisted company. The company has developed a breakthrough proprietary technology that would allow them to produce large area, low cost graphene sheets in industrial volumes for commercial applications.
2	Transaction details	Cash investment up to USD 18.6 million in General Graphene. The investment will be made in multiple tranches over 2 to 3 years based on the achievement of agreed milestones in the process of commercial production of graphene sheets.
3	Graphene Properties	Graphene is a two dimensional sheet of pure carbon structured in a single layer of carbon atoms. Though it is chemically identical to both graphite and diamond, it is remarkably different.
4	Product Applications	Bio electric sensory devices, electronic touch screens, Filtration, Aerospace, Energy storage.

Source: Graphite India Ltd, latest available Annual Report (September 2018) <https://www.graphiteindia.com/wp-content/uploads/GIL-Corporate-Presentation-September-2018.pdf>

**Chart 4: Graphite India Ltd (GIL)'s Exports (Rs Crore) and Export as Per Cent to Total sales (%)**



Source: Graphite India Ltd, latest available Annual Report (September 2018) <https://www.graphiteindia.com/wp-content/uploads/GIL-Corporate-Presentation-September-2018.pdf>





Major export destinations are Mexico (Exiros), North America (Nucor, SDI group etc.), Middle East(Qatar, Emirates and Kuwait steel), South East Asia and Far East (PTCT Indonesia, Hyundai Steel Korea, Tokyo Steel Japan etc.) and clients in India include Essar steel, Jindal Steel & Power, JSW Steel, Steel Authority of India etc.

According to HEG's Annual Report 2017-18, the company has repaid its long-term debt which is expected to enhance its financial performance going forward. HEG is also considering to a capacity expansion plan for its graphite electrode by 20,000 TPA. HEG is also a net exporter of goods; it has a natural hedge against extreme currency volatility. The company has also formulated a foreign exchange hedging policy the compliance is monitored by external and internal audit teams<sup>13</sup>. HEG is exporting around 65-70% of production to more than 30 countries and to more than 100 customers around the world including ArcelorMittal, Nucor, Posco, Tata, Sail, Jindals, Sabic, Gerdau, Ferroatlantica, Celsa etc.

## INDUSTRY RISK

Rising cost of raw material is posing challenges for the industry. Needle coke is the main raw material for GE production which is very critical for the growth of GE industry. With the sudden increase in demand for GE, needle coke availability has become a bottleneck. The supply constraints of needle coke imply lower capacity addition for future. The possibility of price rise of needle coke coupled with subdued GE prices might reduce the profitability for the GE industry.

In recent years, electrode prices have been extremely low, as cheap iron ore and coking coal saw EAF players choosing to reroll blast furnace-produced semis, or utilise merchant pig iron. For every electrode they made, producers lost money, and consequently shuttered capacity as a survival strategy. Demand for Indian graphite electrodes is seen weakening after the US tightened its sanctions against Iran, among biggest buyers from India. The list of companies under US' sanctions includes Esfahan Steel Co and Mobarekh Steel Complex—the latter accounts for a third of total steel exports from India to Iran<sup>14</sup>.

Possibility of a slowdown in demand for steel also dampened sentiment as graphite electrode is a key raw material used in the manufacture of steel. The Steel Ministry has also sought increase of import duty on finished steel products citing threat from Chinese imports and excess global capacity. Due to US- China trade war, China seeks alternative markets, which also includes their steel products. The ministry has also sought cuts to import duties on coking coal, steel scrap and graphite electrodes to reduce raw material costs for making steel<sup>15</sup>.

# FUTURE OUTLOOK

Capacity addition might be limited, due to technology, capital and raw material constraints. Needle coke, a key raw material for Ultra High Power (UHP) grade GE, is seeing no supply growth. A Macquarie report forecasted that going forward, the GE prices would be in the range of USD 12,500-13,500 per tonne, and needle coke would be at USD 3,000-3,500 per tonne in FY19-21 (estimated figures)<sup>16</sup>. Though EAF steel production is likely to increase in future which provides brighter outlook for GE production, future outlook for GE prices and cost of needle coke remain a matter of concern. Moreover, how the US-China trade issue would pan out as well as US policies for other countries in near future also pose further risk.



## FOOTNOTES

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6. 'Where are Indian Graphite Electrodes Prices Heading?' (1 April 2019)SteelMint <https://events.steelmintgroup.com/where-are-indian-graphite-electrodes-prices-heading/>
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