



MASSIFCAPITAL

GrafTech (EAF)

INVESTMENT REVIEW

JULY, 2018

MASSIF CAPITAL, LLC | New York, NY

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Investment Thesis

GrafTech (Ticker Symbol: EAF) is a manufacturer of ultra-high-power Graphite Electrodes (UHP-GE) primarily used by the Electric Arc Furnace (EAF) steel production industry. GrafTech is the second largest producer in the world and has a differentiated business model. The firm is vertically integrated, creating a significant production cost advantage vs. peers and ensures the firm has a supply of a critical input to the production process, Petroleum Needle Coke. Additionally, the firm sells UHP-GE on long term take-or-pay contracts, creating significant visibility into the cash flows arising from 60% to 70% of total production.

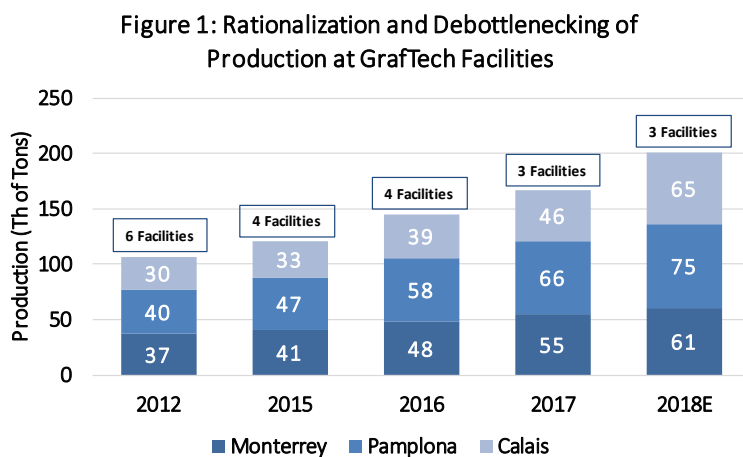
Between now and 2022, investors can look forward to a free cash flow (FCF) yield on revenue of more than 30%.¹ The firm looks set to generate more than \$2.2 billion of net of debt FCF between now and 2022, equivalent to roughly 42% of the current market capitalization. According to management, the majority of FCF generated over the next five years will be used to pay down the existing modest debt levels and will be returned to shareholders via either dividends or share buy backs. At the current time, GrafTech is trading at \$17.30 vs. our intrinsic value estimate of between \$24.00 and \$26.00 and is likely to return significant capital to shareholders over the next five years.

Furthermore, given the significant FCF over the next five years we believe that is a strong possibility that debt reduction and share buybacks by management boosts the stock price to more than \$30.00 a share. Please keep in mind, we are not suggesting that management is creating value via financial engineering but rather that financial engineering in result in a price appreciation, one we as shareholders are happy to accept.

For Readers that are unfamiliar with what Graphite Electrodes are and how they are used in the Steel Industry we suggest reading the section entitled "Introduction to Graphite Electrodes" first. This section can be found in Appendix A.

Business Description and Industry Discussion

Industry Supply and Demand



Graftech has been in business since 1886 and has been publicly traded since 2017 when it was brought to market by Brookfield Business Partners, a Canadian private equity firm that purchased the then publicly traded firm in 2015. Brookfield Business Partners purchased the business in the middle of a multi-year strategic review and portfolio rationalization process that started in 2012-2013 as a result of an

¹ First quarter FCF yield on revenue was 28%.

industry wide slump resulting from a combination of excess production capacity and a glut of Blast Furnace Steel (BOF) produced in China.²

Between 2012-2013, global UHP-GE production capacity was operating at roughly 77% of capacity. At the time, GrafTech was a particularly inefficient producer, operating 6 facilities that produced roughly half of what GrafTech currently produces today with 3 facilities. Following a closure of 2 facilities and the warm idling of a third, the remaining three operating facilities produce roughly 200 thousand tons of electrodes annually, an 86% increase from 2013.

In total, since 2013 roughly 25% of the global GE production capacity has been closed or repurposed. Global UHP-GE production is now running at 100% capacity and expected to be in a deficit later this year.

The supply/demand imbalance, combined with the need to secure supplies of Petroleum Needle Coke has resulted in the average cost per metric ton (MT) of UHP-GE rising from an \$4,100 between 2010 and 2017 to well over \$10,000. Industry participants we have spoken with, and sell-side analysts that cover GrafTech and its competitors, have suggested to us that recent short term transactions that have occurred in the last twelve months support a spot price of between \$15,000 and \$30,000 a ton.³

Figure 2: Global Supply and Demand

	2013	2014	2015	2016	2017	2018E	2019E	2020E
Supply/Capacity (Thousands of MT)								
Ex-China	1,040	900	872	830	830	830	830	830
China	1,000	1,000	1,000	800	700	720	750	750
Total Capacity	2,040	1,900	1,872	1,630	1,530	1,550	1,580	1,580
<i>Est. UHP Capacity</i>	<i>979</i>	<i>874</i>	<i>842</i>	<i>799</i>	<i>826</i>	<i>837</i>	<i>853</i>	<i>869</i>
<i>% UHP Capacity</i>	<i>48%</i>	<i>46%</i>	<i>45%</i>	<i>49%</i>	<i>54%</i>	<i>54%</i>	<i>54%</i>	<i>55%</i>
Demand (Thousands of MT)								
EAF Electrode Demand	756	782	733	752	837	892	947	1,002
BOF Electrode Demand	473	472	466	463	462	456	442	427
Non-Steel Demand	32	33	33	34	35	36	37	38
Total Demand	1,261	1,287	1,232	1,249	1,334	1,384	1,426	1,467
<i>Implied Total Utilization</i>	<i>62%</i>	<i>68%</i>	<i>66%</i>	<i>77%</i>	<i>87%</i>	<i>89%</i>	<i>90%</i>	<i>93%</i>
<i>Implied UHP Utilization</i>	<i>77%</i>	<i>89%</i>	<i>87%</i>	<i>94%</i>	<i>101%</i>	<i>107%</i>	<i>111%</i>	<i>115%</i>

Source: Company Reports, Citi Research, Credit Suisse Research, Massif Capital Estimates

We do not believe that “spot prices” at the \$15,000 to \$30,000 price level are sustainable but our analysis of the global supply and demand balance (see Figure 2), suggests that elevated prices are likely to persist for the near future. This contention is supported by the lack of unutilized capacity and the time/capital cost of building new capacity. GrafTech is the only producer with a warm idled plant that can be restarted (capable of producing about 28,000 MT a year of UHP-GE). One competitor, SanGraf, has a facility in Italy that they are looking to restart that has production capacity of 30,000 MT but it is unclear if it is tooled up for UHP-GE, or ladle electrodes, and it is unclear how long restarting it will take.

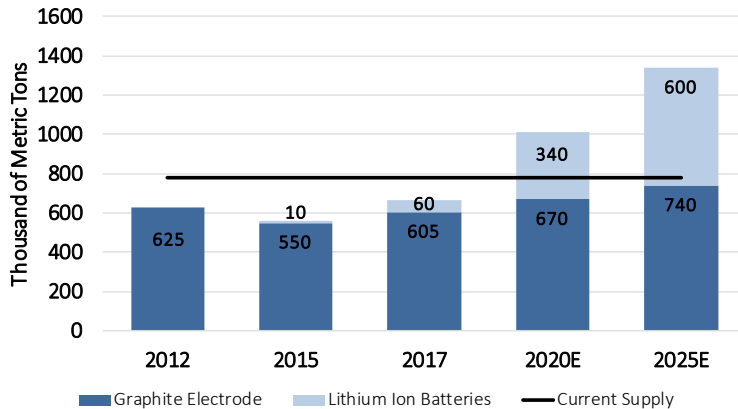
GrafTech’s warm idled facility (St.Mary’s located in Pennsylvania) can, according to management, be restarted for between \$10 million and \$15 million in capital expenditures and a few months of startup time. Beyond those two facilities, it is believed that there could be an additional 40,000 MT of capacity at Indian and Japanese competitors that can be freed up via production debottlenecking but at the current time that is purely speculative production capacity.

² Blast Furnace Steel (BOF) production utilizes graphite electrodes but only for maintaining virgin molten steel in a molten state, as such the electrodes are neither as large, nor require the high level of specification that EAF electrodes require. Electrodes used in the operation of BOF operations are commonly referred to as ladle electrodes.

³ Strictly speaking it is not appropriate to talk about a spot market for UHP-GE as the supply is relatively illiquid and production is on a contracted basis.

Finally, the cost of building new production is prohibitive. Not only is permitting difficult, but UHP-GE plants are notoriously complicated to build and run. The only recent sizeable brownfield expansion was a 30,000-ton expansion by Showa Denko of their Ridgeville SC plant. The expansion contract for that facility was awarded to Fluor in 2011 and they completed the project in 2014 at a cost of \$300 million, or \$10,000 per ton of constructed capacity, which provides a real-world baseline for brownfield and greenfield production construction. Given the existing tight market and the lack of new capacity the price outlook for UHP-GE looks positive.

Figure 3: Petroleum Needle Coke Demand and Supply



Vertical Integration and the Petroleum Needle Coke Market

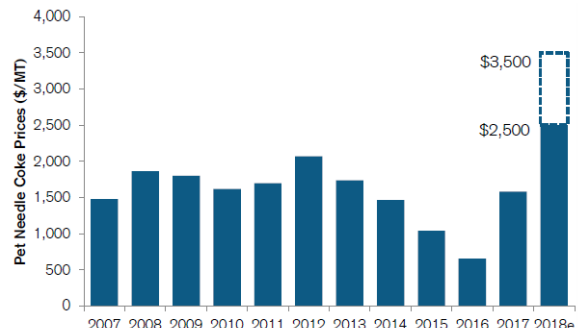
It is in the currently tight market for UHP-GE that the value-add of GrafTech’s vertical integration with the Petroleum Needle Coke market becomes most clear. UHP-GE are manufactured primarily from Petroleum Needle Coke. Petroleum Needle Coke is a carbon rich solid material derived from cracking

petroleum in a complex refinery. The cracking process splits long chains of hydrocarbons into shorter chains. This is accomplished by taking residual oils from the refining process⁴ and treating them at high temperatures and pressure. The process is complex and time consuming. Additionally, impurities, specifically sulfur, must be low which creates additional complication and feedstock constraints.

The market for Petroleum Needle Coke is highly concentrated with only four producers. Roughly 75% of the market is controlled by Phillips 66 and GrafTech. GrafTech owns a facility called SeaDrift that can produce roughly 60% to 70% of the needle coke that they need for UHP-GE production. Figure 3 shows our best estimate of what the demand and supply market looks like at the current time. Supply is very difficult to estimate and so we have assumed the highest estimate of global supply that we have uncovered in our research.

Regardless of the exact state of supply and demand, there is no question that the market is currently tight, with prices in the spot market ranging between \$2,500 and \$3,500 a ton. Industry participants have told us that there is no supply available. This is supported by the continued shortening of supply contracts by the three producers that sell into the open market. Historically, Petroleum Needle Coke was sold on one-year contracts, last year producers changed to six months contracts due to the fast-increasing spot price resulting from limited supply. Producers are now selling on three-month contracts.

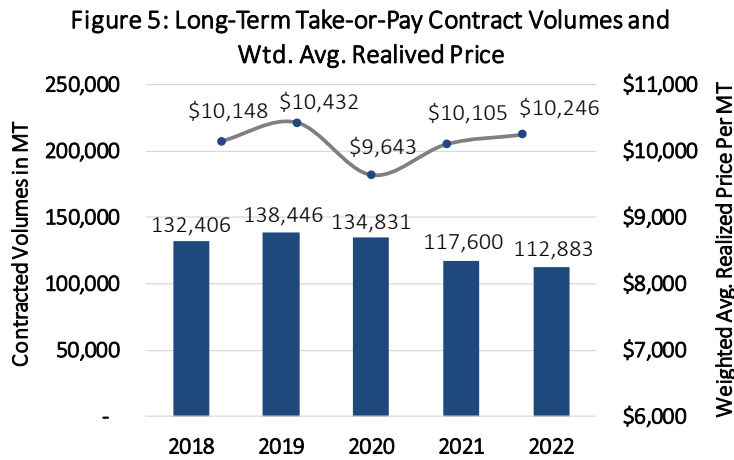
Figure 4: Petroleum Needle Coke Price



⁴ Specifically, what is referred to as decant oil from a refineries fluid catalytic cracking unit.

Because of the tight Petroleum Needle Coke market, the surety of supply that GrafTech can provide their customers that their competitors cannot is of significant value. GrafTech has taken advantage of this situation to change how they sell electrodes, shifting sales from one-year contracts to three to five years take-or-pay contracts. This has created significant earnings and cashflow visibility in a historically cyclical industry. Furthermore, Graftech accomplished this sales paradigm shift at, or near, a high point in UHP-GE prices.

Long-Term Take-or-Pay Contracts and the Margin Advantage of Vertical Integration



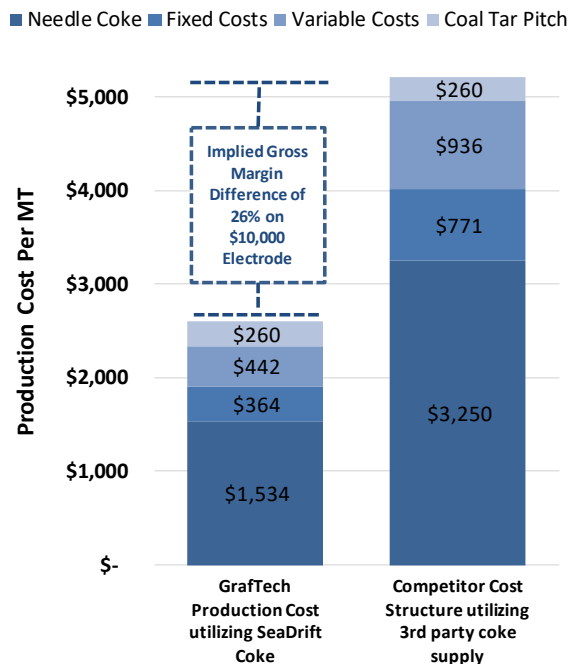
Historically, the weighted average realized price that GrafTech received for their electrodes from 2006 to 2016 was \$4,500 a metric ton. The weighted average price for their take or pay contracts for the next five years is a little more than \$10,000 a metric ton. The result is that between 60% and 70% of GrafTechs production over the next five years has locked in gross margins of between 70 and 75% with what we estimate to be a free cash flow yield of about 52%. Over the course of the

next five years this translates into FCF of roughly \$3.6 billion which is equal to about 67% of the company’s current market capitalization.

Net of debt, this level of FCF production leaves management with \$2.2 billion in unlevered FCF, much of which they intended to return to shareholders via either share buybacks or dividends. At the same time, between 30% and 40% of production capacity is still available in the period 2019 to 2022 for sale on short term contracts. The contracted volumes also mean that GrafTech can afford to be a little more aggressive in pricing of short-term contracts. 96% of the supply this year is already sold with an expected average price of more than \$10,000 a ton.

Even in the absence of long-term contracts, GrafTech’s vertical integration creates a significant cost advantage vs. competition. According to management, UHP-GE produced from Petroleum Needle Coke sourced from SeaDrift have an all-in cost of production of \$2,600 a metric ton, or as much as \$900 a ton less than the current cost of a metric ton of Petroleum Needle Coke in the spot market. As Figure 6 shows, we believe that this

Figure 6: Electrode Production Cost Structure



results in an implied Gross Margin difference of 26% on a \$10,000 electrode relative to the cost structure of competitors utilizing Petroleum Needle Coke sourced from a third party supplier.

Why this Opportunity Exists

Tight Market & Vertical Integration: Corporate profitability does not persist indefinitely, most research suggests that above average profitability in fact fades rather quickly. As such, opportunities where one has clear vision into the time frame in which above average profitability by a corporation is possible, are highly valuable. For the next five years, GrafTech has a significant advantage in comparison to peers. The firm has a secure source of a limited supply input, has locked in prices on both the key input to their product and on the price from customers that they will receive for their product, and done so at or near a cyclical peak price. Maintenance capital expenditures are limited to between \$30.0 and \$40.0 million a year and debt levels/costs do not pose a significant threat to the credit worthiness of the business. GrafTech has a window of five years where their return on invested capital will be significantly higher than not only their historical average but also the historical industry average, and as such means the company presents investors an excellent opportunity. The persistence of this advantage may be limited, and over time will certainly revert to the industry mean, but for the next five years it appears that GrafTech has clear path to outperform.

China EAF Growth: Historically, Chinese steel production has been almost exclusively via Blast Furnace production, usually accounting for 94% of the total. With growing environmental concerns, and sufficient domestic scrap steel to support an EAF industry, the Chinese Government has pushed the steel industry to rationalize and convert from Blast Furnace operations to EAF production. The industry has responded and ordered or installed 105 new EAF facilities in 2017 alone. Should all 105 ordered and under construction EAF plants be built, they will add a combined capacity of 66 million metric tons of production to the Chinese Steel Industry between now and 2019/2020. If all 66 million metric tons of new EAF capacity come online it will increase global demand for UHP electrodes by $\approx 112,200$ MT a year. This is new demand that will need to be filled either through domestic production of UHP-GE, which China does not currently possess, or through imports.

In addition to tightening the UHP-GE market, new Chinese demand will have an equally significant impact on the Petroleum Needle Coke market. As one ton of Petroleum Needle Coke is required to make one ton of UHP-GE, the potential new Chinese EAF demand for UHP-GE's implies a 112,000 MT of new Petroleum Needle Coke demand as well.

Wildcard – Batteries: Lithium-ion battery anodes, specifically for Electric Vehicles, are typically a mixture of natural graphite and synthetic graphite. One of the best sources of synthetic graphite is from petroleum needle coke. The consistency of synthetic graphite from petroleum needle coke makes it highly appealing to Lithium-ion battery producers. Lithium-ion demand for Petroleum Needle Coke has grown from nothing in 2012 to roughly 60,000 tons in 2017, close to 9% of global supply. The range of estimates of electric vehicle uptake are too speculative at the current time to be relied upon, but the potential demand is an interesting wildcard that could drive an already tight needle coke market into deficit. Should this occur the value of Graftech's vertical integration will increase, and the prices for UHP-GE in the short term/spot market should remain elevated.

Valuation

The take-or-pay contracts that GrafTech has on the books create a bifurcation in the business; one side, the contracted side has significant predictability, the other, the spot side, much less so. As such, our primary valuation is a sum-of-parts of those two separate “businesses.”

Figure 7: Discount Cash Flow Analysis of Take-or-Pay Contracts

	2018E	2019E	2020E	2021E	2022E	Perpetuity	Assumptions and NPV of Existing Take or Pay Contracts			
Sales Volume ⁵	165,381	138,226	134,761	137,320	137,603	138,298	Discount Rate for Existing Take-or-Pay	5.0%		
Average Realized Price	9,530	10,432	9,643	10,105	10,246	8,500	Discount on Terminal	10.0%		
Revenues	1,576	1,442	1,300	1,388	1,410	1,176	NPV of FCF	3,172		
Seadrift Coke	97	103	98	101	103	104	Gordon Growth (GG) Method	Multiples Method (MM)		
Fixed Costs	132	105	95	95	94	95	Terminal Growth Rate	1.0%	Exit EBIT Multiple	10.0x
Other Variable Costs	199	174	173	178	183	183	Terminal Value	6,612	Terminal Value	7,635
COGS	428	382	366	374	380	382	PV of Terminal Value	3,732	PV of Terminal Value	4,310
SG&A	60	60	60	60	60	30	Enterprise Value	6,905	Enterprise Value	7,482
EBIT	1,088	1,000	874	954	970	764	EV to Equity Value			
EBIT Margin	69%	69%	67%	69%	69%	65%	- 2018E Net Debt			1,469
- Taxes (21%)	(228)	(210)	(183)	(200)	(204)	(160)	GG Equity Value			5,436
Tax Effected EBIT	860	790	690	753	766	603	MM Equity Value			6,013
+ DD&A	58	42	36	34	32	32	Share Count			302
- Capital Expenditures	(75)	(40)	(40)	(40)	(40)	(40)	GG Implied Share Price			\$18.00
(+/-) Changes in WC	(122)	(21)	(8)	(5)	(5)	(6)	MM Implied Share Price			\$19.91
Free Cash Flow	721	771	678	742	753	589	Blended Price			\$18.96

Our valuation of the take-or-pay contracts, via a discounted cash flow analysis, assumes a discount rate of 5% on the existing contracts, 87% of which are 5-year contracts, and a 10% discount on the terminal value, a period in which there is increased uncertainty. The result is a valuation of the contracted supply business of roughly \$19 a share.

We believe that the significantly lower discount rate is justified in this case as the key questions necessary to value the existing take-or-pay contracts are:

- 1) What is the credit risk of the purchasers?
- 2) What are the odds that GrafTech cannot produce the electrodes they say they can?

The credit risk of the purchasers is relatively limited. The reason for this is that the purchasers pool is roughly 100 buyers with no buyer making up more than 8% of pool. The take or pay contracts have breakage clauses that impose a significant penalty on buyers, often as high as 75% of the remaining contract, and where necessary, have collateral arrangements or parental guarantees. Additionally, barring a bankruptcy of a buyer that takes a company directly from operating to shut down and liquidating, we believe that because of the criticality of the electrodes that GrafTech produces to steel producers, and the limited world of UHP GE producers, in a Chapter 11 bankruptcy GrafTech would be designated a “Critical Vendor”⁵ increasing the likelihood of repayment from the debtor in possession loan.

Regarding GrafTech’s hypothetical inability to fulfill their responsibilities under the contracts, that too appears a low probability situation. GrafTech has balanced the contracted volumes with their ability to produce Petroleum Needle Coke, ensuring they do not find themselves in a situation where they are contractually obligated to deliver UHP-GE’s but are not able to produce them owing to a lack of the primary production input, and have hedged the cost of Decant Oil, the primary input into the production of Petroleum Needle Coke. The hedging ensures cost of production predictability for GrafTech. Baring

⁵ [LexisNexis Legal Newsroom – Bankruptcy – Critical Vendor Status in a Business Reorganization](#)

force majeure, there is very little reason to expect significant production issues beyond the typical production challenges that can occur in a complex manufacturing process.

We believe that the appropriate way to think about valuing the existing take-or-pay contracts is from a credit insurance perspective. As such we must ask ourselves: “What would we charge GrafTech to insure against non-payment on a pool of contracted cashflows for failure of a buyer to pay?” Given the criticality of the UHP GE, the cost of breaking a contract, collateral arrangements and the diversity of buyers within the pool, the risk of non-payment is very low. Clearly, as equity buyers, we are also exposed to operational risk on the part of GrafTech, a risk a credit insurance policy on take-or-pay contracts are not exposed to, but the foreseeable and discountable risks related to operational issues on these contracts appears limited.

Figure 8: Discounted Cash Flow Analysis of Spot Volumes

	2018E	2019E	2020E	2021E	2022E	Perpetuity	Assumptions and NPV of Existing Take or Pay Contracts			
Sales Volume	1,619	63,774	76,572	83,347	92,397	92,397	Discount Rate for Spot	10.0%		
Average Realized Price	10,000	10,000	9,000	8,500	8,000	7,500	Discount Rate for Spot Terminal	10.0%		
Other Revenue	48	48	48	48	48	48	NPV of FCF	613		
Revenues	16	638	689	708	739	693				
3rd Party Needle Coke	5	212	261	292	331	331	Gordon Growth (GG) Method	Multiples Method (MM)		
Fixed Costs	1	49	59	64	71	71	Terminal Growth Rate	1.0%	Exit EBIT Multiple	10.0x
Other Variable Costs	2	76	92	100	111	111	Terminal Value	1,593	Terminal Value	1,797
COGS	8	338	412	456	513	513	PV of Terminal Value	899	PV of Terminal Value	1,014
SG&A	0	0	0	0	0	0	Enterprise Value	1,512	Enterprise Value	1,627
EBIT	8	300	277	253	226	180	EV to Equity Value			
- Taxes (21%)	(2)	(63)	(58)	(53)	(47)	(38)	GG Equity Value	1,512		
Tax Effected EBIT	6	237	219	200	178	142	MM Equity Value	1,627		
+ DD&A	0	0	0	0	0	0	Share Count	302		
- Capital Expenditures	0	0	0	0	0	0	GG Implied Share Price	\$5.01		
(+/-) Changes in WC	0	0	0	0	0	0	MM Implied Share Price	\$5.39		
Free Cash Flow	6	237	219	200	178	142	Blended Price	\$5.20		

Our valuation of the spot volumes assumes a decreasing average realized price on UHP-GE on a per ton basis from the current \$10,000 a ton to \$8,000 a ton by 2022 and \$7,500 a ton in the terminal phase. Although higher than the average per ton cost for the last ten years, the industry supply constraints, the Petroleum Needle Coke supply constraints and the continued growth in EAF steel production are supportive of higher prices. We assume a discount rate of 10% in both the forecasted and terminal phase. Also note that we dealt with all depreciation, capital expenditures, SG&A and debt in the contract volumes valuation. Additionally, we forecast that GrafTech management does bring the spare warm idled capacity at their St. Mary's facility online.

The discounted cash flow analysis suggests a value of roughly \$24.0 a share for the company, a margin of safety of 28% at current price as of June 17th, 2018.⁶

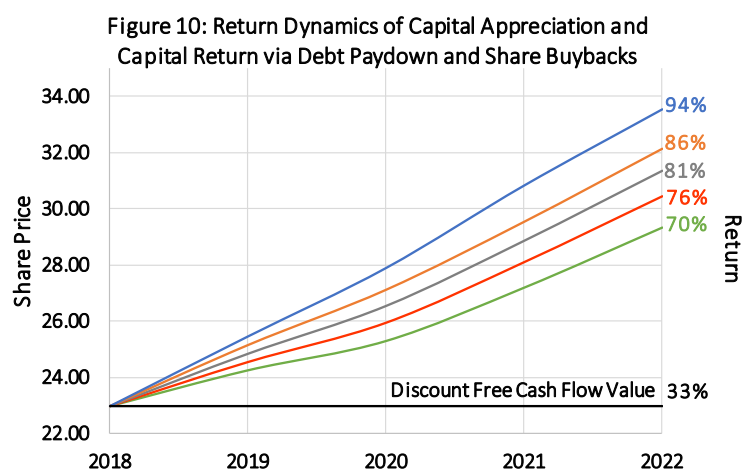
⁶ Please note that in 2018 more than 95% of production volume is contracted and so we included that production volume in the DCF of contracted volumes as opposed to spot volumes. Additionally, please note that GrafTech is engaged in a debottlenecking process at its existing facilities that will add production capacity of roughly 35,000 tons annually, this additional volume is included in years 2019 through the terminal phase, but not in 2018.

Figure 9: EV/EBIT Analysis

	Bear	Base	Bull
Normalized Revenue Estimate	1,592.27	1,592.27	1,592.27
Operating Margin	65.00%	65.00%	65.00%
EBIT Estimate	1,034.98	1,034.98	1,034.98
EV/EBIT Multiple	6.0x	8.0x	10.0x
Estimated EV of Business	6,209.86	8,279.81	10,349.76
Plus Cash & ST Investments	138.30	138.30	138.30
Total Value of Business+Cash	6,348.16	8,418.11	10,488.06
Less Total Debt	1,468.86	1,468.86	1,468.86
Estimate Fair Value of Business	4,879.29	6,949.24	9,019.20
Shares Outstanding	302.23	302.23	302.23
Estimated Value Per Share	\$16.14	\$22.99	\$29.84
Margin of Safety	-13%	21%	39%
Blended Rate		\$22.99	

This valuation is also supported by an EV/EBIT multiple analysis. Assuming our 2018E revenue of \$1,592 million, operating margins of 65%, which is roughly the 3-year average operating margin and looking at EV/EBIT multiples of 6.0x, 8.0x and 10.0x we calculate a blended valuation of roughly \$23.0. Our DCF analysis suggests that this range of EV/EBIT multiples is appropriate given the five-year outlook. The DCF analysis above suggests a 2018E EV/EBIT multiple of 7.6x with an EV/EBIT in out years ranging between 6.5x and 9.0x.

The significant FCF raises the important question of what management intends to do with the cash, which could, if used poorly be value destructive. Based on conversations with management, the majority of FCF is going to be used to buy back shares, decrease debt and be returned to shareholders via a dividend. In our analysis we look at 5 different cash use scenarios that might arise from our FCF scenario presented above. Our scenarios examine what might happen to the share price if management utilizes 50%, 60%, 70%, 80% or 90% of cash on the balance sheet at year end in 2018, 2019, 2020, 2021 and 2022 to pay down debt and buy back shares in equal amounts each year. In all cases debt paydown and share buy backs significantly boosts share price, increasing shareholder return relative to the basic intrinsic value estimate by between 37% and 61%. Please keep in mind we are not suggesting that the value of the company is increasing, this is pure financial engineering, but it does increase the share price in a meaningful way.



Risks to Thesis and Catalysts/Milestones

China: No discussion of any industry that is steel related would be complete without at least acknowledging the risk that China represents. China has a long history of producing more steel than they have domestic demand for and in sufficient quantities to overwhelm global demand. The electrode market is slightly different than the steel market though, so the risk is not nearly the same. China has limited domestic graphite electrode capacity and all of it is believed to be geared towards ladle electrodes, which as discussed in the electrode review in Appendix A are very different from UHP-GE and not a substitute. Furthermore, China has no domestic source of high quality Petroleum Needle Coke, in fact they are already running short of pitch coke, a coal derivative product used to make ladle electrodes, due to the governments push to shut down coal fired power plants.

Between 2015 and 2017, at the governments direction, the Chinese GE industry cut production by 40%, a significant enough reduction that both Platts and Jefferies believe that China may have become a net importer of ladle electrodes in 2017. This means that to swamp the global market with UHP-GE China must do two things: first, they must restart and retool existing GE plants to produce high quality UHP-GE or build a new factory, and second, they must find or build a source of high quality Petroleum Needle Coke. Based on conversations with industry participants and GrafTech, the consensus is that China does not yet possess the technological knowhow to produce UHP GE, nor is it clear it possesses the facilities and know how to produce high quality Petroleum Needle Coke. Additionally, the best estimates we had suggest that in both the case of a new Petroleum Needle Coke facility or a new UHP-GE manufacturing facility, the timeline from paper to production is between 5 and 10 years, more than enough time for GrafTech to take advantage of their significant production advantages vs. competitors.

Additional Risks

- Significant decrease in spot graphite electrode prices
- Decline in EAF steel production reducing the demand for UHP GE.
- Constrained petroleum needle coke supply that limits GrafTech ability to fully utilize production capacity.
- Remaining sell-down of Brookfield stake into open market (Brookfield still owns ~85%, 180 day lock up period still in place).
- Delays/cost overruns for capacity expansions.
- Competitor capacity addition announcements

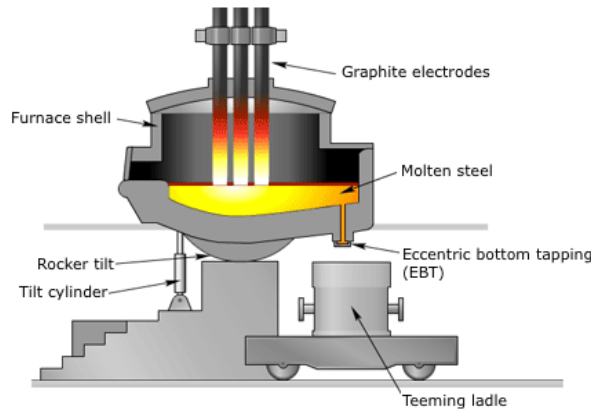
Potential Catalysts and Milestones to Watch For

- (Milestone – Timeline: Ongoing) Higher electrode or petroleum needle coke prices.
- (Catalysts – Timeline: Ongoing) Increase in EAF steel production global. In the developed world this will depend on continued strong industrial production and GDP growth. In China, a continued push by the government to shift steel production away from blast furnace production and towards EAF production should drive growth in UHP-GE demand for several more years.
- (Milestone – Timeline: Q4 2018) Successful final stage of existing plant debottlenecking
- (Milestone/Catalyst – Timeline: Ongoing) Dividend and/or Stock buy backs
- (Catalyst – Timeline: Present Through Q4-2018) Announcement of secured 3rd party supply of Petroleum Needle Coke
- (Catalyst – Timeline: Present Through FY2019) Announcement of restart of warm idled St. Mary's facility.

Appendix A: Introduction to Graphite Electrodes

Graphite Electrodes (GE) are an industrial consumable used principally in the Electric Arc Furnace (EAF) steel industry. For EAF steel producers, GEs are a critical input into the steel production process that has no existing substitute. Despite the significance of the GEs to the production process, they make up only 1% to 5% of the total cost of steel production.

Figure 1: Electric Arc Furnace

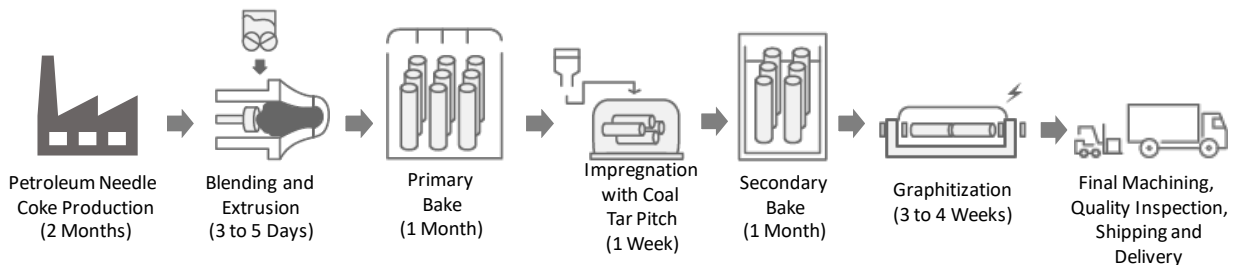


GE are the only medium capable of withstanding and tolerating the harsh EAF operating environment. EAF's melt cold scrap steel into liquid molten steel, requiring a significant amount of electricity, entirely conducted by the GE. Within the furnace, electricity is passed from one electrode to another through an oxygen and scrap steel rich environment. This process produces temperatures within the furnace as high as 5,000 degrees Fahrenheit, which is roughly half the temperature of the earth's core. By way of comparison, the electricity flowing through the electrodes used in a EAF every second is about the

same as the amount of electricity that 300,000 60-watt lightbulbs would draw.⁷

As depicted in Figure 1, EAF typically utilize three columns of three GEs. Depending on the productivity and operational cycle of the EAF, a single GE is consumed every 8 to 10 hours. A steel mill operating three shifts a day will consume about nine GE. Steel manufacturers prefer to source GE from either a single supplier because of the consumption rate and the material integrity associated with like product. GE from different suppliers may vary slightly. GE are also screwed together in columns; the material consistency at the point of connection is important to maintain electric efficiency. In the worst-case scenario, lack of integrity may cause the GE to break, typically requiring a furnace to be shut down which can cost steel producers more than \$1.5 million a day.

Figure 2: Graphite Electrode Manufacturing Process



The GE production process is not only notoriously tricky, as it requires high levels of pure carbon, but it is also time and energy intensive. As Figure 2 suggests, the process for creating a GE can take between 4 and 6 months. The type of large high-spec electrodes produced by GrafTech, which are up to 30 inches in diameter, 11 feet long and 2.6 metric tons, take closer to 6 months on average than 4. Despite the size and the manufacturing time, the larger electrodes are still consumed in 8 to 10 hours by high

⁷ Assuming a typically 60-watt Light Bulb draws of about 0.54 Amps and paired with a US electrical outlet rated at 110 volts.

performance EAF. The significant time required to produce a GE meaningfully constrains the ability of GE producers to react to real time changes in the steel market environment.

Part of the process complexity is the need for high quality Petroleum Needle Coke, a refined petroleum product originally developed in the 1980s by Phillips 66 and GrafTech. We will discuss the Petroleum Needle Coke market at length in the discussion above, but it is worth noting at this point that it is a very small market with only four producers, of which Phillips 66 is the largest producer followed by GrafTech, the only GE producer that is vertically integrated. Once the Petroleum Needle Coke is produced (which takes as much as 2 months) it is blended with coal tar pitch and the GE are extruded, which, depending on size, takes anywhere from 3 to 5 days.

Once manufacturers have the extruded GE it is baked for about a month in a furnace, a process that removes impurities in the blended Petroleum Needle Coke/coal tar pitch mixture. The GE is then impregnated with coal tar pitch again to strengthen the GE by filling the gaps left by impurities leaving the mix during the first bake. The GE is then baked again, for another month, and finally it is Graphitized. Graphitization is a process that turns the carbon in the Petroleum Needle Coke into Graphite.

The Graphitization process takes 3 to 4 weeks and requires around 3,200 to 4,800 kWh electricity per MT, representing 20% to 35% of the total GE cost. To put the amount of electricity used in the Graphitization process into context, the average US household uses about 750 Kilo-Watt Hours of electricity a month, which means that the Graphitization process of the largest GE GrafTech produces require about the same amount of electricity as is used by the average US household in 13 to 14 months. Finally, the electrode is machined and shipped out to customers.

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