Consulting

Leveraging a Carbon Advantage: Impacts of a Border Carbon Adjustment and Carbon Fee on the US Steel Industry

For Climate Leadership Council

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

All $ values are expressed in United States dollars unless specified otherwise.

1. Executive summary

- **A domestic carbon fee and border carbon adjustment (BCA) is a key potential enabler of future US climate leadership and economic growth.**
- **The US steel industry has a major carbon advantage. Steel exporters to the US emit 50-100+% more CO_2 emissions per tonne than US producers on average.**
- **A carbon fee and BCA policy, applied in the context of the 2019 steel market, could increase the US steel industry margin by 32-41% and value add by 45-52%, driven by higher US steel sales and a moderate increase in steel prices, well within the range of historical price volatility.**
- **This policy package also has the potential to reduce imports by around 50%, reflecting the higher carbon emissions from imported steel.**
- **The economic benefits to the US steel industry and are likely to be broad based, with mills in the South Central and Great Lakes regions being notable beneficiaries. Western mills become newly competitive and benefit as well but to a lesser extent.**

1.1. Introduction

An economy-wide climate policy is required to deliver new US emissions reduction goals. The US government recently re-joined the Paris Agreement, setting an ambitious goal to achieve a 50-52% reduction in economy-wide net greenhouse gas pollution from 2005 levels by 2030. While considerable progress has been made in reducing the carbon intensity of the US economy in recent decades, achieving this goal will require a significant intensification of policy implementation to begin decarbonising all sectors of the economy in the coming years.

Carbon pricing is key to achieving these objectives at least cost, but the potential impacts on industrial sectors need to be considered carefully. Carbon pricing creates efficient market-based incentives for households and firms to reduce their emission. However, its implementation varies widely across countries and regions. This exposes energy-intensive and trade-exposed (EITE) sectors, such as steel, in countries with relatively high carbon prices to competitive disadvantages. This in turn risks displacing industrial production, investment and jobs to countries with zero or lower carbon prices.

A border carbon adjustment (BCA) is a key potential enabler of future US climate leadership and economic growth. At a conceptual level, a BCA is a specific levy charged on the carbon embodied in imported products and a corresponding rebate on any domestic carbon charges associated with the manufacture of goods which are exported. A BCA thus has the potential to ensure a level playing field for US industries under a carbon price – so that all competitors face the same carbon fee. It may also unlock additional competitive advantage of some industrial producers resulting from their early deployment of low carbon production technologies and higher carbon efficiency.

In this context, the Climate Leadership Council proposes implementation of a carbon price and BCA policy with the following core design features:

a) a $43/t$CO_2$ economy wide carbon fee;

b) a border carbon adjustment (BCA) of $43/t$CO_2$ on the emissions associated with the manufacture of products entering the US;

c) a full rebate of domestic carbon fees paid to US exports; and,

d) all revenue is recycled as "carbon dividends" to households on an equal basis per capita.

The economic impacts and implications of this policy proposal are explored below.

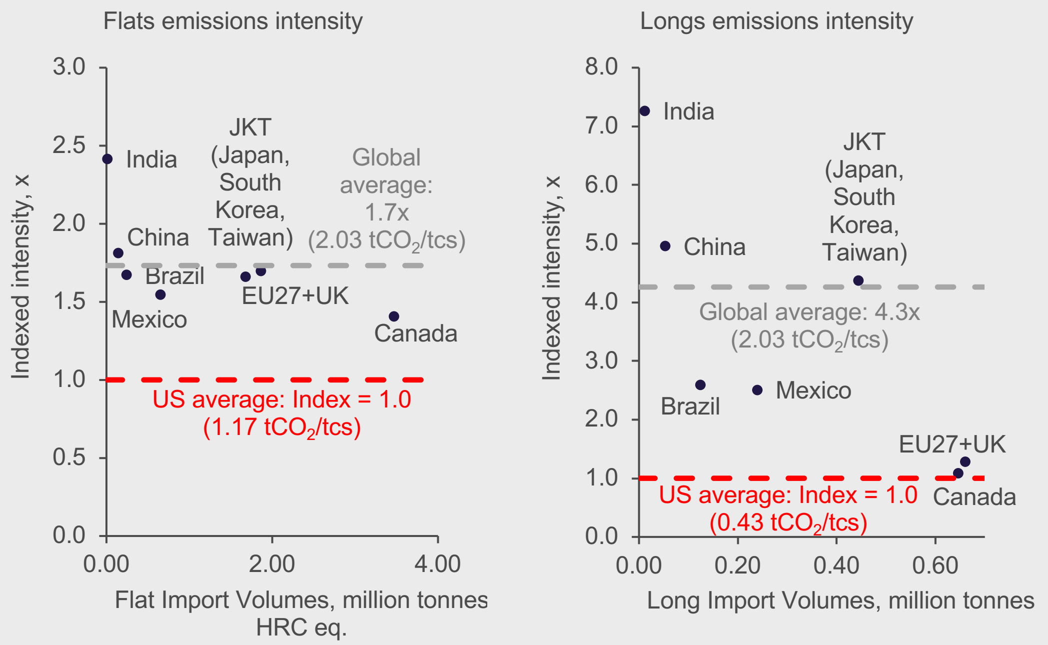
1.2. Impacts of CLC policy proposals on US Steel industry

Many US industries are highly energy efficient compared to global producers. Steel producers in the US, for example, have some of the lowest CO_2 emissions intensities anywhere in the world: CRU's analysis shows, for example, that leading exporters of flat steel products (used, for example in the manufacture of automotive body sheets) to the US such as Canada, Mexico, Japan, South Korea and China emit 50-100% more CO_2 emissions per tonne of output than US producers on average. In the case of long steel products (widely used in many construction applications), of the regions studied, only Canada and Europe are close to the US in terms of carbon intensity which is 4 times less than the global average (see Box 1).

Box 1: Carbon competitiveness of the US steel industry

According to CRU, production of steel flat products in the US generates ~1.2 tonnes of CO_2 per tonne of crude steel (tcs) and US long products manufacturing generates around 0.4 t CO_2/tcs. The US average is half of the global average emissions intensity for flat products and just a quarter in the case of long products (see Figure i). This significant carbon advantage reflects the high share of scrap-based electric arc furnaces (EAF) – which are less emissions-intensive than blast furnace-based manufacture (that converts new iron units into steel using coal) – compared to other trading partners.

Figure i Indexed average scope 1 and 2 emissions intensity for flat and long products by region (Index: US average = 1.0)



DATA: CRU.

A BCA thus presents substantial economic opportunities for the US steel industry. The imposition of a US domestic carbon price, in conjunction with a BCA, has the potential to increase the cost of imported steel products relative to domestic producers due to the higher carbon embodied in their manufacture. This in turn creates opportunities for US steel producers to take greater market share, displacing imports and fuelling domestic economic growth and employment. Drawing on CRUs cutting edge data and market evaluation methodologies (outlined in Box 2), this white paper quantifies these potential impacts.

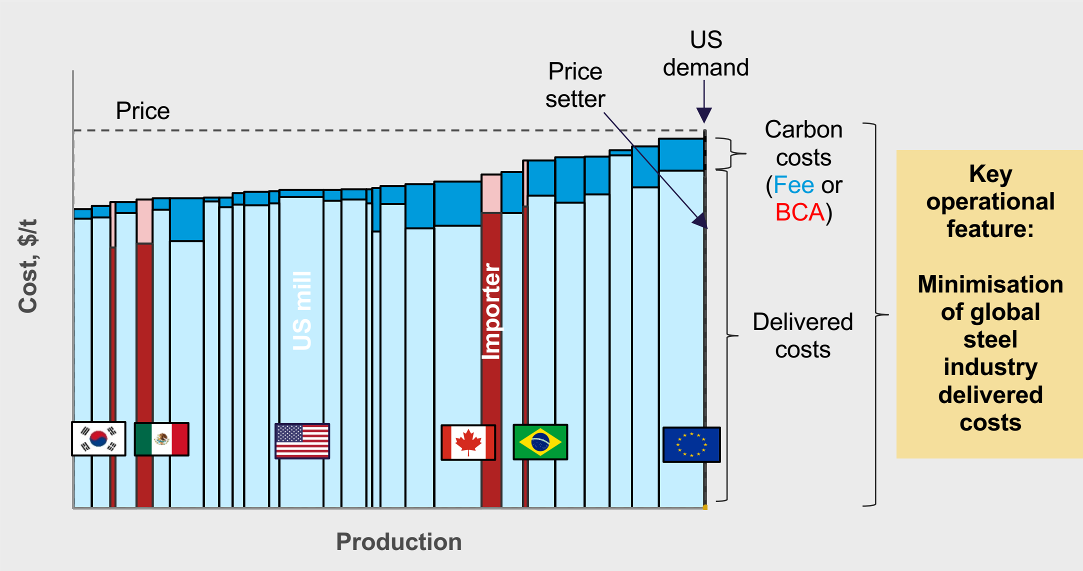
Box 2: CRU's BCA scenario impact assessment methodology

CRU simulated the impact of BCA policy implementation on steel production and trade responses based on a ranking of the implications for steel production costs (inclusive of BCA and domestic carbon prices). The impact on future US market access assumes that US steel demand is fulfilled from the global market on the basis of minimising total delivered costs (reflecting the commoditised nature of these industries).

Inputs to the model include US demand and supply, steel production costs,[1] transport costs, scope 1 and 2 carbon emissions and associated policy costs, and trade duties (current trade measures on steel imports are assumed to remain in place). These inputs are principally drawn from CRU's market leading data on steel demand, trade, production costs and CO_2 emissions for US and global steel mills.

Output metrics for US mills and major importer regions (including the EU, Japan, China, Mexico, Brazil and Canada) are generated to assess the impact of the BCA, e.g. US sales, capacity utilization, mill costs, product price, margins and value add. These outputs are tested, validated and sensitised as part of a robust evaluation process. A graphical representation of CRU's approach is shown in Figure ii.

Figure ii Ilustration of CRU's behavioural model of Carbon cost impacts (fee or BCA)



In particular, CRU's simulations suggest that BCA implementation increases US steel industry value add, and corresponding reduces imports, by around 50%. US steel industry profitability rises by 32% and 41% across flat and long products respectively, which, coupled with a 7-9% increase in domestic sales, and an almost halving of steel imports, yields an overall increase in industry value add of up to 50% (see Table i). Lower relative costs of domestic steel manufacture under the BCA reduce steel imports from both developed economies (such as Canada and Japan) as well as major emerging markets such as China, Mexico and Brazil.

[1] We assume importers sell into the US market at variable costs, i.e. at a discount to full costs, in order to remain competitive. All other things being equal, this may imply long term import displacement could be higher than is simulated under the assumption that importer investment costs are ultimately recovered.

Table i Summary of impacts of a BCA and carbon fee on the US steel market:

Output metric	Unit	Base Case		BCA policy simulation		*% change vs Base Case*	
Product		Flats	Longs	Flats	Longs	*Flats*	*Longs*
Importer sales	Mt	9.2	2.7	4.5	1.29	*(51.2%)*	*(51.8%)*
Importer market share	%	15.3%	12.9%	7.5%	6.2%	*(51.2%)*	*(51.8%)*
US sales	Mt	50.6	18.1	55.2	19.4	*9.3%*	*7.7%*
US mill value add	$m	3,375	2,569	4,899	3,905	*45.1%*	*52.0%*
US mill unit margin	$/t	67	142	89	201	*32.8%*	*41.2%*
Product price	$/t	616	705	690	790	*12.0%*	*12.1%*

DATA: CRU.

As with any simulation, these conclusions are subject to a number of key risks and dependencies, including the precise design of the BCA and the prevailing market and broader policy conditions when it applies. Importantly, this paper only simulates the short term impacts of introducing a BCA and carbon fee in the 2019 market (of which the trade measures like Section 232 tariffs and quotas are a key feature since implemented in 2018). These impacts are likely to depend on: i) the level of carbon prices, ii) the relative carbon intensity of US compared to imported steel producers,[2] and, iii) the policy rules determining the basis of any BCA (some core sensitivities are explored in the full analysis that supports this summary). However, trade and technology adoption has the potential to shape longer term outcomes for both domestic and importers. For example, a BCA could ultimately restrict access to the US steel market for carbon-intensive importers or incentivize importers to heavily decarbonize to mitigate the burden of the BCA. These longer-term trends may limit the uplift in US domestic value add but will nonetheless create potential benefits for global decarbonization efforts.

1.3. Distributional effects of BCA implementation

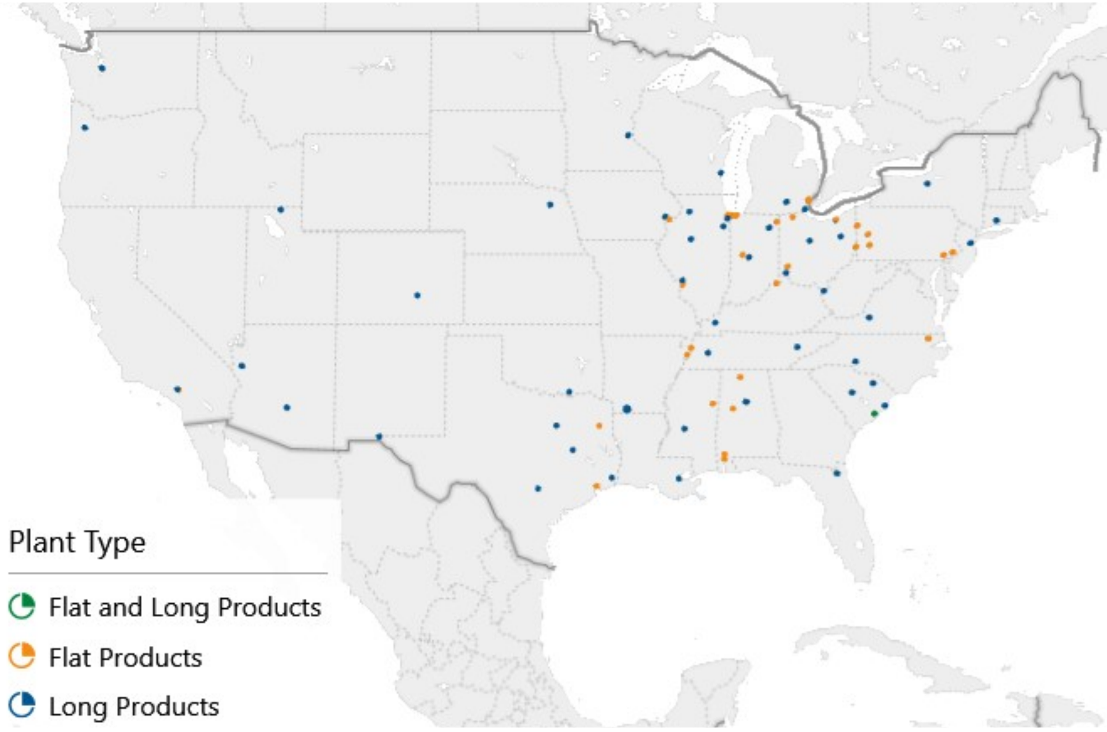
The net benefits of BCA implementation are likely to accrue most to carbon-efficient producers. Among steel producers, some industrial segments are better placed than others to benefit from a BCA: EAF-based producers, for example, generally have more to gain under a BCA scenario than those using blast furnace technologies. EAF-based flats producers that typically compete against imported product using more carbon-intensive blast furnace technologies, are particularly well positioned to benefit from the fee and BCA policy.

The economic benefits to the US steel industry are likely to be relatively broad based, with mills in the South Central and Great Lakes region expected to be notable beneficiaries. In CRU's BCA policy simulations, the value adds of South Central and Great Lakes' mills both increase by nearly one billion dollars across product segments. Value add gains are driven by low-cost production and increased margins for the South Central mills, while the Great Lakes' mills which enjoy a 2.6 Mt increase, for example, in domestic sales of flat products (equivalent to a 7% uptick). This is due to the concentration of installed capacity in this Great Lakes region (see Figure iv) and the fact that some of these mills act as "swing producers" given their relatively high production costs. Other US regions, such as the West, also see significant growth in production and value add (albeit from a much lower

[2] For example, significant increases in US steel industry value in part depend on the continued penetration of carbon intensive (particularly high cost) importers into the US steel market.

base). In particular, some of these Western mills become newly competitive under a BCA given their carbon advantage relative to international steel producers.

Figure iv Distribution of US steel producing facilities



DATA: CRU.

Purchasers of steel (and ultimately the US consumer) are projected to see moderately higher steel prices. However, these effects fall well within the range of typical steel price volatility and are smaller in magnitude than existing trade measures: the simulated price increases from a BCA and carbon fee are roughly one-third less than the current Section 232 levies. Moreover, the impacts on final consumers are likely to be limited, in part, by the modest share of steel compared to total production costs or final product prices. For example, CRU's BCA scenario implies a roughly $65 increase in the cost of the steel required to produce a standard sized car[3], which – while not inconsequential – is nonetheless a relatively small fraction of the overall sales price. **Critically a carbon fee could also generate billions of dollars in carbon dividends to help mitigate such impacts on the US consumer.**

1.4. Conclusions

A domestic carbon fee and BCA may yield significant economic benefits and increase US steel industry competitiveness. Carbon pricing is key to low-cost delivery of US emissions reduction targets, but raises competitiveness and carbon leakage issues particularly in EITE sectors. A BCA is a key means to level the playing field and has the potential to confer significant benefits in the case of US steel producers.

CRU's analysis suggests that BCA implementation both increases US steel industry value add and correspondingly reduces imports by around 50%. US steel industry profitability rises by 32-41% across flat and long products respectively, which, coupled with a 7-9% increase in domestic sales, and an almost halving of steel imports, yields an overall increase in industry value add of up to 50%. Lower relative costs of domestic steel

[3] This estimate assumes 0.9 tonnes of steel is used for a standard sized car and looks at a differential in flats price of $74/t (between Base Case $616/t and BCA policy's $690/t as displayed in Figure iv).

manufacture reduce steel imports from both developed economies (such as Canada and Japan) as well as major emerging markets such as China, Mexico and Brazil. Importantly, this paper simulates the short-term impacts of the implementation or a BCA and carbon fee. Maintaining the current US carbon advantage in the long term will be key to sustaining these benefits and will depend, in part, on the relative pace and associated productive efficiencies of decarbonisation domestically and in importing regions.

2. Overview of US steel market

2.1. US steel market fundamentals

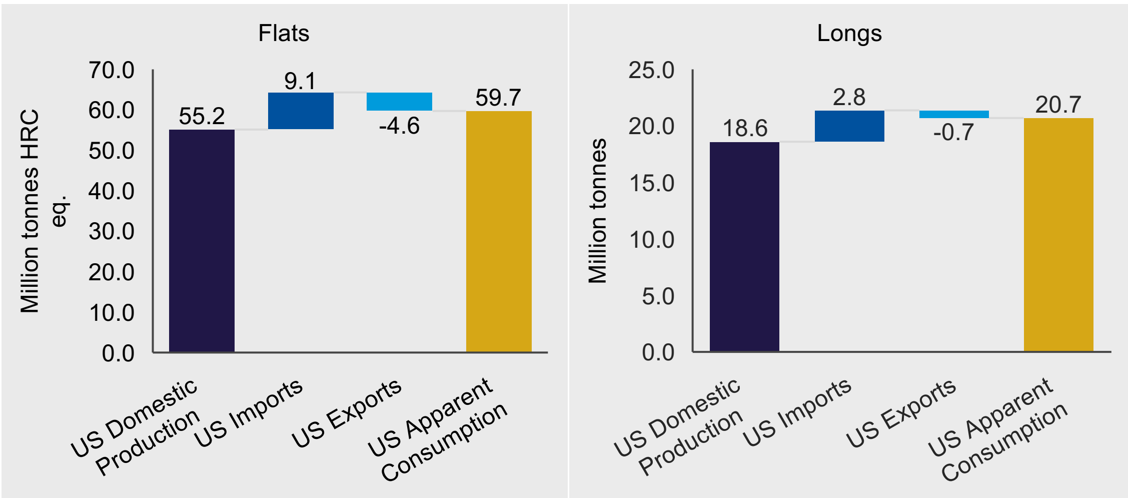
Steelmaking is a $100-billion industry for the US. US carbon steel demand amounted to 95 Mt in 2019, equivalent to around 5% of the global market. The sector is broadly segmented into two product classes: (i) flat products ("flats") such as steel sheets and plate (used for a range of consumer and industrial applications in auto manufacture and construction), accounting for 65% of the US production in 2019; and (ii) long products ("longs") such as bars, rods and beams (used principally for construction and other industrial applications), accounting for 35% of the market in 2019.

In this report, we will focus on flats such as hot rolled coil ("HRC"), and cold rolled coil ("CRC"), coil plate, tinplate and galvanized products (plate products are not included) and light longs such as rebar, wire rod and merchant bar (sections, rail and seamless pipe are not included).

In aggregate, the US has sufficient steelmaking capacity to satisfy domestic steel demand. However, the global steel market is highly competitive and interregional trade is widely observed. The key trading partners for the US are Canada, South Korea, Japan, Mexico, Brazil, and some EU countries. Globally, the largest producers of steel are China, the EU, India and Japan; together these countries represent for nearly 75% of global production.

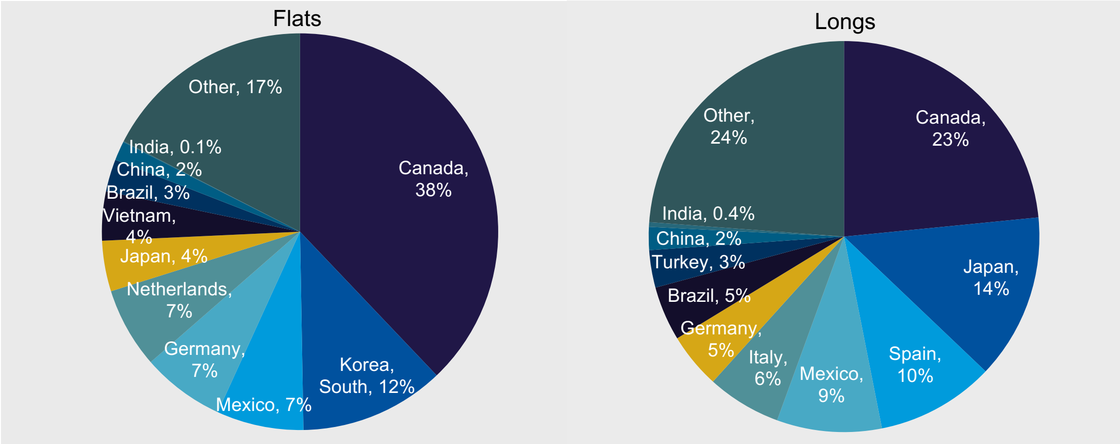
In 2019, 9.1 Mt of flats were imported into the US, amounting to 16% of US consumption. Half of the flats volumes were supplied by Canada and South Korea. The 2.8 Mt of longs imports met 13% of US demand with key importers being Canada, Japan, Spain and Mexico. China and India typically represented a small portion of total imports into the US that year (Figure 1 and Figure 2), but account for 12% and 5% of global finished steel trade, respectively. Canada and Mexico receive 90% of flats and longs steel exports from US steel producers.

Figure 1 US flats and longs apparent consumption, 2019



DATA: CRU.

Figure 2 Share of US imports for steel flats and longs, respectively, 2019



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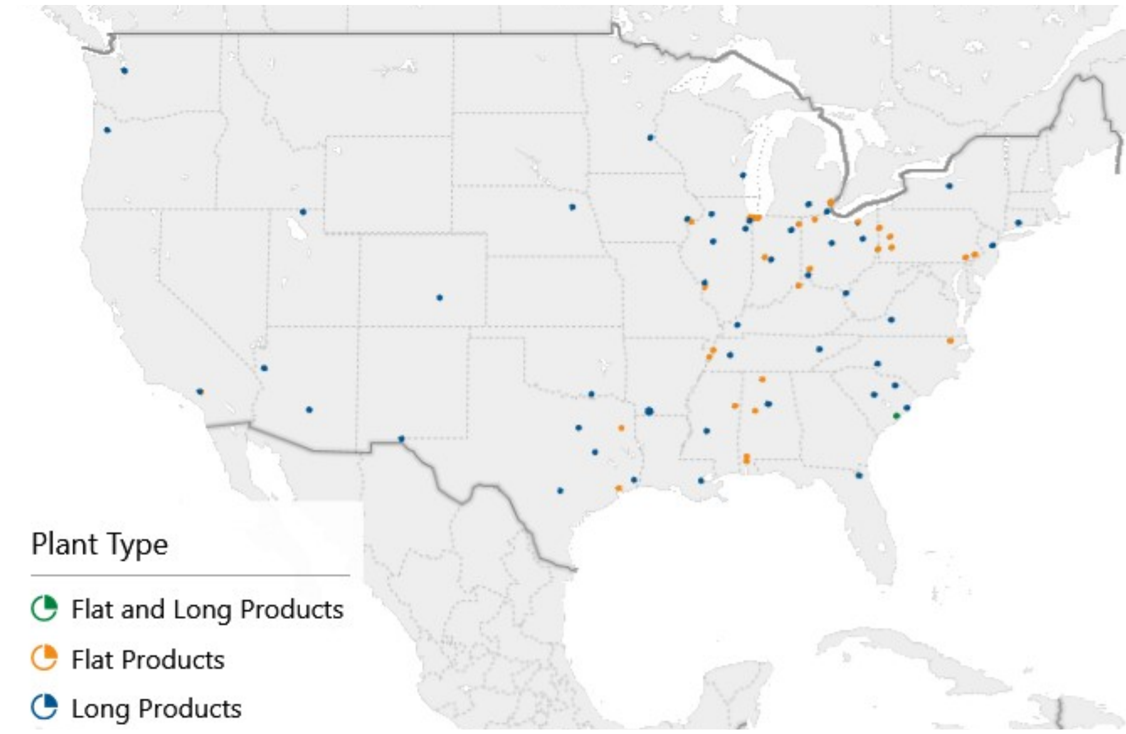
The Eastern half of the US has most of the steel mills in the country, with the West Coast relying on imports to a greater extent. The Great Lakes blast furnaces steelmakers traditionally supplies flats to nearby major automakers such as Ford, General Motors and Stellantis (formerly Fiat Chrysler Group). Blast furnaces have traditionally held a monopoly on automotive end-uses due to the quality requirements for exposed autobody sheet that electric arc furnace ("EAF") technologies have been unable to match. The Great Lakes region has the highest concentration of Blast Furnace-Basic Oxygen Furnaces ("BF-BOF") in the U.S and U.S-Canada steel trade is also generally for automotive end-uses from the Great Lakes region.

The largest US domestic producers of flats in 2019 were US Steel's Gary Works (4.5Mt), ArcelorMittal's Burns Harbor (4.2 Mt) and ArcelorMittal's Indiana Harbor East (3.2 Mt). The largest domestic producers of long products in 2019 were Steel Dynamics Inc.'s Columbia City (1.7 Mt), Gerdau AmeriSteel's Midlothian (1.2 Mt), and Nucor Steel's Jewett (1.0 Mt) (Figure 2).

Figure 3 Distribution of US flats and longs producing facilities, 2019



DATA: CRU

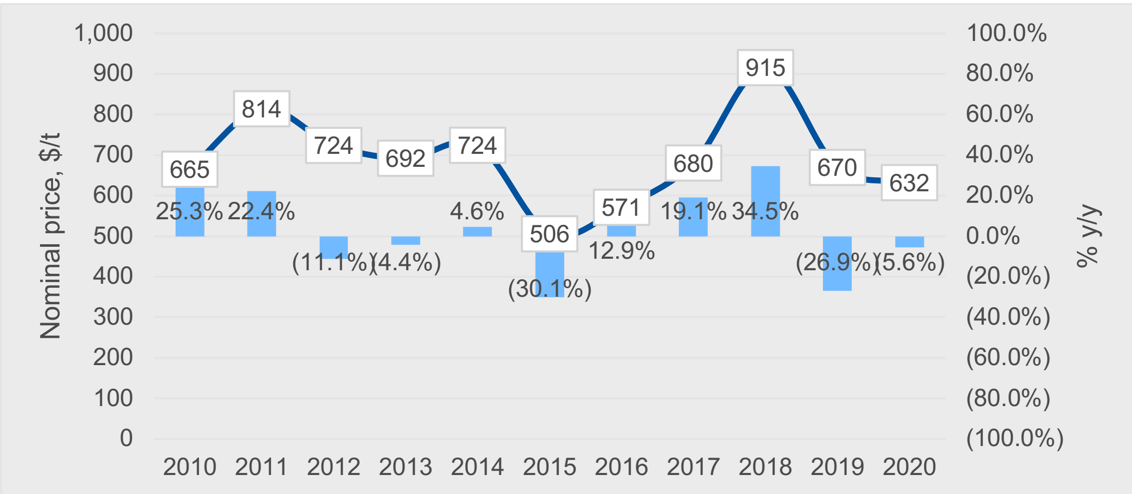
2.2. Steel prices

Steel prices are cyclical and key economic metrics for the steel producers as it directly impacts profits. Prices vary by region and even countries as the local fundamentals and costs competitiveness differ. CRU tracks prices for USA Midwest, Germany, Italy, EU export, Asia, China, CIS export, Brazil export, India (Mumbai).

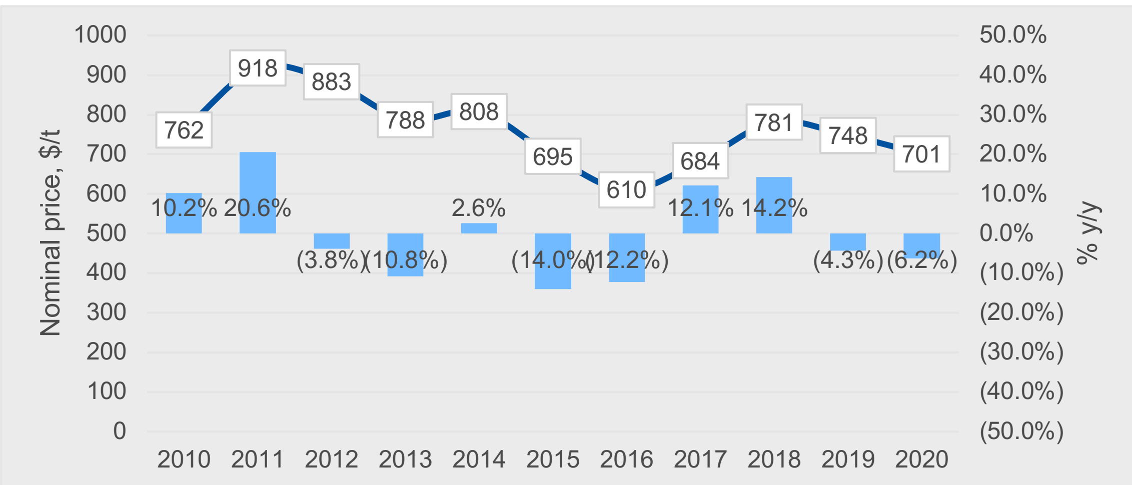
Focussing on the US market, Figure 4 shows the history of the USA Midwest price for flats and longs from 2010 to 2020[1,2]. Both prices have fluctuated over the last decade with year-on-year changes as large as ±30-35% for flats and ±15-20% for longs. 2018 was a local peak for prices while 2015-2016 were 10-year lows. 2020 saw relatively depressed prices as the sector was impacted by the Covid-19 crisis. 2019 prices are close from 5-year average prices (i.e. around $662/t for flats and $708/t for longs) for both product segments, indicative of a mid-cycle year in terms of prices.

Figure 4: USA Midwest flats and longs nominal prices and year on year changes, 2010-2020

a) Flats price[4]



b) Longs price[5]



DATA: CRU

[4] Flats price refers to the FOB USA Midwest Hot Rolled Coil price.
[5] Longs price refers the weighted average basket price of FOB USA Midwest prices for rebar, wire rods and merchant bars.

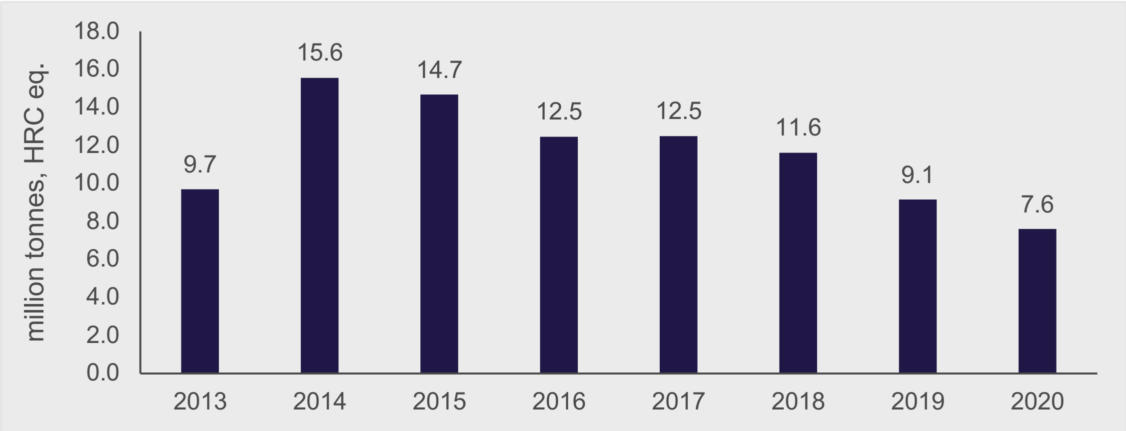
2.3. US trade policy

The US government introduced the Section 232 ad valorem tariffs and quotas on steel and aluminum imports in two waves in March and July 2018, and have so far remained a key feature of US trade policy. Tariffs of 25% on steel and 10% on aluminum were applied to metal imports from nearly every country in the world (including China and Japan). Argentina, Brazil, and South Korea agreed to quotas instead of tariffs; uniquely, Australia received a full exemption. Tariffs were only dropped in the case of Canada and Mexico in May 2019. Following the implementation of the 232 tariffs, imports into the US saw a reduction of 15 to 20% year on year in 2019 as shown in Figure 5.

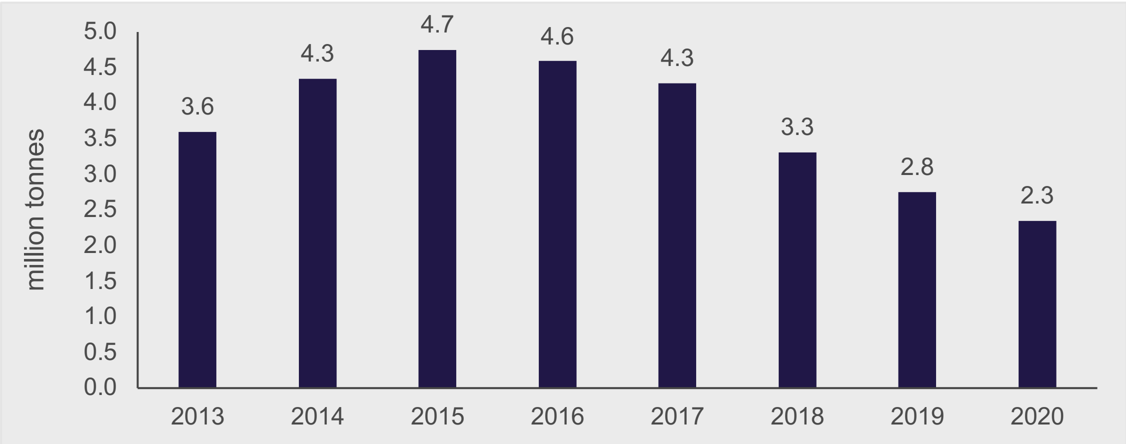
Outside the tariffs, stringent anti-dumping duties on hot rolled and cold rolled coils imports from China and Brazil apply, but galvanized products are exempt. Some derogations may also exist in special cases, most likely HRC from Brazil to feed some US re-rolling mills.

Figure 5 Total imports of flats and longs into the US, 2013-2020

a) Flats imports



b) Longs imports



3. Steel emissions

3.1. Emissions benchmarking of US production

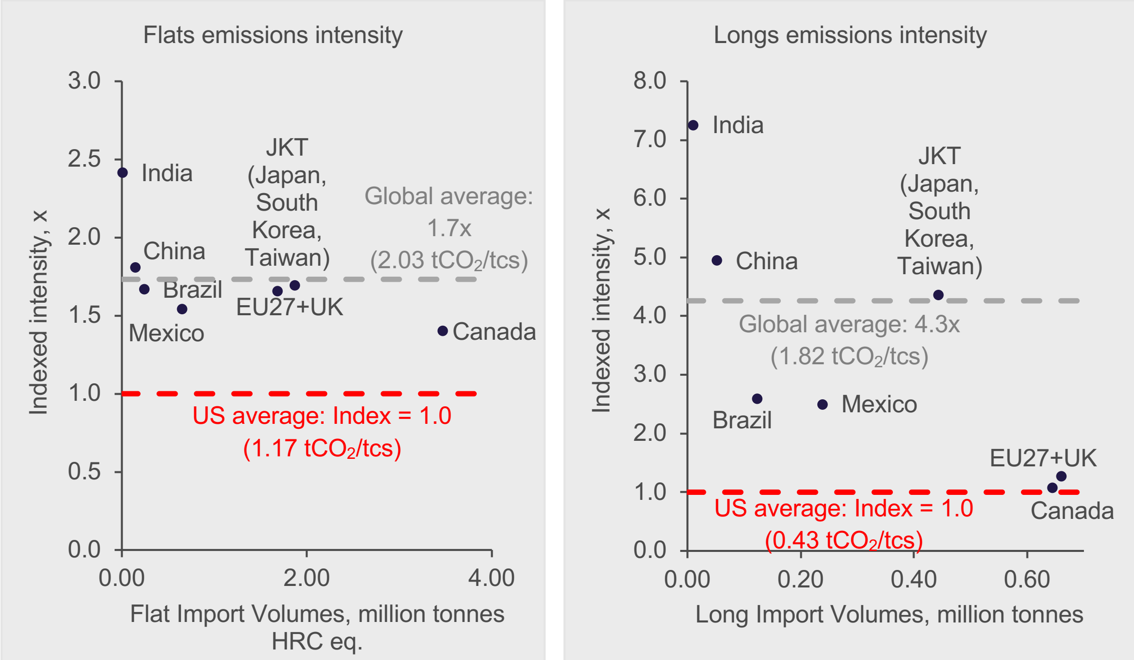
The choice of process route has critical implications for the carbon intensity of steel manufacture. Most of the flats products from the Great Lakes area, which are required to be of high quality (i.e. with low levels of impurities), are produced using the BF-BOF process, with virgin iron ore units and coal as the primary raw materials. By contrast, the lower quality requirements of the long products means that production via the mini-mill EAF process, using scrap as the major feedstock, is adequate. The EAF process dominates the production of longs and represents half of the production of flats, the remainder being from BF-BOFs.

EAF technologies generally have lower scope 1 emissions compared to an average BF-BOF plant but trade off with higher electricity consumption. Overall, EAF-based production in the US is around 65% less carbon intensive than BF-BOF based manufacture. As such, flat products are typically more carbon intensive than longs, reflecting their manufacture via BF-BOF process. On average, for example, flats production in the US generates ~1.17 tonnes of CO_2 per tonne of crude steel (tcs) and longs production generates ~0.43 t CO_2/tcs. As a point of comparison, global flats production generates 2.03 tCO_2/tcs and global longs production generates around 1.82 tCO_2/tcs, on average, reflecting both the higher share of BF-BOF steelmaking in flats and longs production outside the US and the lower carbon efficiency of many overseas producers.

The mix of EAF-based and BF-BOF-based flats in the country means the US average flats emissions intensity is typically lower than its main trading partners, but US mill intensities display a large spread from ~2.0 tCO_2/tcs for BF-BOF mills down to 0.4-0.5 tCO_2/tcs for EAF mills. Domestic BF-BOF (and Canadian) producers generally have lower scope 1 intensities than foreign thanks to higher utilisation of BF-grade pellets as opposed to sinter fines, which reduces coke consumption (Figure 6).

US average longs emissions intensity is on par with key trading partners like Canada and European countries (EU), although still significantly lower than many others such as China, Japan and India. Longs production is EAF-based only in the US (apart from re-rolling capacity), meaning the observed spread in mill carbon intensities is tight compared to flats, ranging from 0.37 to 0.48 tCO_2/tcs (Figure 6). Countries with higher intensities typically will have a higher proportion of their longs production manufactured via BF-BOF steelmaking or, sometimes, Direct Reduced Iron process (DRI). This is the case, for example, in China, India, Brazil and Malaysia.

Figure 6 Indexed average scope 1 and 2 emissions intensity for flats and longs by region (Index: US average = 1.0), 2019, x-axis: imports, million tonnes; y-axis: tCO_2/tcs



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3.2. Relevant foreign emissions-related policies

3.2.1. Overview

Globally, the World Bank identifies 64 carbon pricing initiatives which are implemented or scheduled to be implemented, covering 46 national jurisdictions. In 2020, these initiatives would cover 12 $GtCO_2e$, representing 22% of global greenhouse gas ("GHG") emissions.

International systems of relevance to the US as trading partners are the European Union's Emissions Trading System ("EU ETS"), South Korea's Emissions Trading System ("KETS") and Canada's Output-Based Pricing System ("OBPS").[6] The carbon prices in those systems in 2019 were: $28/$tCO_2$ for EU ETS, $26 /$tCO_2$ for KETS and $15 /$tCO_2$ for OBPS.

There is no federal carbon price in the US, only state- and regional-level Emissions Trading Systems ("ETS"). California and Washington ETS cover three steel facilities representing less than 4% of total US capacity. Eleven states participate in the Regional Greenhouse Gas Initiative, which is a regional ETS market covering emissions from the power sector. Massachusetts participates in RGGI and implemented an additional power-sector-only ETS in 2018.

3.2.2. European Union's Emissions Trading System ("EU ETS")

The EU Emissions Trading System ("EU ETS") is a cornerstone policy to achieve the goal of climate neutrality by 2050, including the intermediate target of an at least 55% net reduction

[6] N.B.: After piloting carbon markets in eight regions (Shenzhen, Shanghai, Beijing, Guangdong, Hubei, Fujian, Chongqing, Tianjin), which averaged a carbon price of $4/$tCO_2$, China implemented a national Emissions Trading System in 2021 which only applies to emissions from the domestic power sector initially. Approved in March 2021, the 14th Year Plan include emissions reduction goals for emissions of energy intensive industrial sectors like iron and steel, cement, aluminum and chemicals. It is possible that the implementation for those goals will mean the inclusion of those sectors under the China ETS umbrella.

in GHGs by 2030. It covers GHG emissions from the industry (including the iron and steel sector), power, chemical and aviation sectors responsible for 45% of the European total GHG emissions.

It has been in effect since 2005, with the Phase I, pilot phase running during the period 2005-2008, Phase II running from end-2008 to 201 and Phase III running from 2013 to 2020. It is currently in its Phase IV which commenced in 2021 and will have two stages: Stage 1 will be in effect during the period 2021–2025 and Stage 2 will be in effect during the period 2026–2030.

The EU ETS works on the 'cap and trade' principle. GHG emissions of all participants in the system are capped to specific amount in tonnes of CO_2 equivalent every year. The cap is reduced annually so that total emissions fall.

Installations participating in the EU ETS buy or receive emissions allowances, with 1 allowance giving the right to emit 1 tonne of CO_2 equivalent. Allowances are distributed within the limits of the cap via a combination of auctioning or free allocation. EU ETS participants can also freely trade allowances amongst themselves. After each year, an installation must surrender enough allowances and/or eligible offset credits (up to a limit) to cover fully its annual emissions, otherwise heavy fines are imposed. Surplus allowances can cover future needs or else be sold to another installation.

The cap on the total number of allowances distributed available ensures that they have a value, which sets the carbon price for the EU. Trading of allowances encourages the achievement of emission reductions at the least cost and a carbon price promotes investments in low-carbon technologies.

Industry and aviation sectors receive free allocation based on EU-wide benchmarks and historical production levels. The free allocation to industry sectors also depends on their emission and/or trade intensity and is corrected to ensure the total free allowances does not exceed the available allowances for free allocation.

For steel production, allocations are split according to the products produced onsite. The relevant benchmarks relate to all forms of upstream and downstream industrial scale steelmaking processes. These include coke, sintered ore (n.b. also covers BF pellet), hot metal (i.e. blast furnace output), EAF carbon steel, heat benchmarks (n.b. applicable to steam generation), fuel benchmarks (n.b. covers all processes not incorporated into the benchmarks above, for example, reheat furnaces at the hot strip mill).

The power sector does not receive any free allocation since 2013, translating into higher electricity prices. Some EU countries provides partial compensation for indirect carbon costs (i.e. the embedded cost of scope 2 emissions in the electricity price) paid by industrial facilities. Across the EU ETS, hundreds of millions of euros in compensation are provided to the EU industry every year.

For the year 2019, during EU ETS Phase III, CRU estimates that emissions allowances received by EU steel producers covered 75% to 93% of their emissions on average depending on process and product manufactured. We also estimate compensation for scope 2 emissions to be up to $6/t for electricity intensive EAFs and around $0.5-1.0/t for blast furnaces. **Overall, because of the policy measures described above, average carbon costs for European steel mills ranged from $1/t to $14/t depending on the mill and products manufactured.**

3.2.3. South Korea's Emissions Trading System ("KETS")

The South Korean ETS ("KETS") is a national "cap-and-trade" system playing an essential role in meeting Korea's 2030 target of 37% GHG emission reductions below business-asusual emissions. It covers he industry, power, buildings, domestic aviation, public sector and waste sectors responsible for 70% of the country's total GHG emissions.

Phase I of KETS was in effect during the period 2015–2017, Phase II ran from 2018 to 2020 and Phase III will be in effect from 2021 to 2025.

Similarly to EU ETS, a Korean emissions allowance covers 1 tonne of CO_2e and enough allowances must be surrendered on an annual basis to cover emitted GHGs. Allowances required in excess of any allocation must be purchased at auction.

Allocation of Korean emissions allowances in KETS Phase I is based on a grandfathering method. It means that for most sectors, 100% of allowances were allocated based on an emissions level baseline that covered average annual emissions during the period 2011-2013.

In Phase II, only energy-intensive and trade-exposed ("EITE") sectors, like iron and steel, received 100% of allowances based on an emissions level baseline that covers annual average emissions during the period 2011-2013. The other sectors received 97% of allowances based on this baseline; the remaining 3% of allocation were subject to auctioning.

Allocation of allowances in the KETS Phase III is similar to that in Phase II. EITE sectors retained 100% allocation while other sectors received 90% of allowances (still based on the annual average emissions during the period 2011-2013).

For the year 2019, during KETS Phase II, CRU estimates Korean BF-BOF and EAF mills received allowances that, on average, covered their emissions up to 95% and 75% respectively. **This translates into average carbon costs for Korean steel mills of $3/t to $7/t that year depending on the mill and product manufactured.**

3.2.4. Canada's Output-Based Pricing System ("OBPS")

Carbon pricing is a central component of the Pan-Canadian Framework on Clean Growth and Climate Change (PCF), the plan established in 2018 by the Canadian federal government to meet its emissions reduction targets in a sustainable way. The carbon pricing strategy consists in two elements, implemented in 2019:

- a charge on fossil fuels that is generally payable by fuel producers or distributors, and
- an Output-Based Pricing System ("OBPS") for industrial facilities, covering among other sectors, the Canadian steel industry.

Each OBPS industrial facility is subject to a set carbon price on the portion of emissions that exceed an annual output-based emissions standard. Facilities with emissions above their standard can meet their compliance obligations through surrendering an equivalent amount of earned credits from facilities that outperform their standards, pay a carbon price in line with the federal fuel charge – CAN$20/t$CO_2e$ in 2019, rising CAN$10//t$CO_2e$ per annum to CAN$50/t$CO_2e$ in 2022 – and/or submit eligible offset credits.

The guidance for output-based standards distinguishes the production through the BF-BOF and EAF process. BF-BOF standard can be calculated based on standards for individual process units (coke oven, blast furnace, basic oxygen furnace) and energy consumption. EAF standard is set at 95% of the average emissions intensity of Canadian EAF mills. CRU estimates the 2019 standards are respectively 1.50 tCO_2/t BF steel 0.29 tCO_2/t EAF steel. **At CAN$20/t$CO_2e$ carbon price in 2019, this translates into average carbon costs of $2/t to $10/t steel depending on the mill and products manufactured.**

4. Implementing a BCA in the context of the US steel market

4.1. BCA policy simulation: policy parameters

The United States government recently re-joined the Paris Agreement and set an ambitious goal to achieve a 50-52% reduction in economy-wide net greenhouse gas pollution from 2005 levels by 2030. A significant intensification of carbon policy implementation needs to occur in the coming years to achieve the US emissions reduction goals.

At present, steel products can be imported into the US without being penalised for the carbon emissions embedded into their products. Similarly, there is no economy-wide carbon price implemented in the US. This study simulates the Climate Leadership Council's ("CLC") "Carbon Dividends" policy that aims to level the playing field in terms of carbon emissions generated by US domestic steel mills and non-US steel mills importing into the US.

The policy consists in putting a domestic price on carbon and levying a border carbon adjustment ("BCA") on the carbon embodied in steel products entering the US parallel to the domestic carbon price imposed on carbon emissions from US mills. It is a clear departure from the recent market policies and may bring transformations to the steel market as it affects the relative competitiveness of the market participants in the US market.

Key carbon and trade aspects from CLC's policy relevant to the steel industry and industry assumptions in this analysis include:

- Carbon policy
  - Price on carbon: A US domestic carbon price of $43/t$CO_2$ is applied across the economy. The same $43/t$CO_2$ is levied on importers in the form of a BCA. The $43/t$CO_2$ price will rise at 5% above the inflation rate each year.
  - Benchmark: The carbon price and BCA are applied to the respective market participants' scope 1 and 2 emissions intensities.
  - Export: A full rebate of the domestic carbon fees paid is provided for US exports destined to foreign countries.
- Trade policy
  - Tariffs: Section 232 ad valorem tariffs and quotas as described in section 2.3 remain in place.
- Carbon dividends / Revenue recycling
  - All revenue is recycled as "carbon dividends" to households on an equal basis per capita.

In this report, CRU simulates the financial and economic changes on the 2019 US steel market resulting from CLC's BCA policy (CRU's "BCA policy simulation") and analyses the key impact drivers. CRU's impact assessment methodology is detailed in Appendix.

4.2. Key factors driving the impact of a BCA

There are various factors that affect the behaviours of the market participants on the cost curve and hence have an impact on the resulting metrics. Among the main ones to be considered for results interpretation are:

- Carbon pricing levels and application on mills

  The costs related to the BCA policy simulation for importers will depend on the level of the BCA and on the precise basis on which the BCA is calculated, e.g. importers' emissions intensity, global or US average emissions intensity, for all products or by product segment, etc.

  The US domestic carbon price and the carbon intensity of individual producers will define the carbon fee costs paid by US mills.

- Market conditions

  Market conditions such as demand levels or raw materials prices are important parameters to understand as a BCA can have a different impact in magnitude, but also direction, depending on which point of the business cycle – high, mid, low point of cycle –is considered.

  The 2019 market is the base year for this study to avoid the Covid-related distortions from economic global slowdown and the uneven regional rebound observed from March 2020 to today.

- The relative cost competitiveness of the market participants

  There are two aspects to the relative cost competitiveness to account for:

  - Baseline delivered costs – Variation in delivered costs will shape the structure of the cost curve and guide the relative position of importers against US mills in the absence of US policy-related carbon costs.
  - Emissions intensity – Variation in carbon intensity have a significant impact on carbon costs for US mills and importers. For example, differences in emissions intensity between US mills and importers will shape the behavioural response when a BCA is applied on importers' intensities. Also, if the carbon intensity of the marginal producer is different than the average intensity of the other mills, it will have a direct noticeable impact (positive or negative) on margins and value add for other players.

- Steepness of the curve

  The flatter the cost curve, the more easily the relative cost competitiveness of various market participants can change because of cost changes from a US carbon price and a BCA. Indeed, as market evolves and relative cost competitiveness shift, a flat curve favours movement of participants as it makes positional re-ordering easier.

  For the US market, the technological homogeneity of EAF mills producing longs translates into a flatter cost curve than for the flats segment where both EAF-based and BF-BOF-based volumes compete. The major differentiators for EAF mills in the US are raw materials, labour and electricity costs which vary by state.

- Marginal producer on the curve

  Under some circumstances, the BCA policy may prompt reshuffling of the cost curve and hence the identity of the marginal producer that sets the steel price. In these instances, price increase can be below or above the BCA charge (i.e. non-linear relationship between carbon price and steel price increase).

- Alternative markets

  The propensity of both importers and US mills to sell to the non-US market, which is mostly driven by relative logistics costs, affects the sensitivity of volume allocation between markets and the easiness of sales being shifted in and out of the US.

- Regional differentiation

  The location and type – EAF or BF-BOF – of US mills will influence the state-level and regional market dynamics. A BCA will have a different impact depending on the steel technology mix of the US region being considered.

4.3. Impact of the BCA policy simulation

US domestic sales, imports volumes, steel product prices, costs, value add[7], margins are the metrics that will help measure the magnitude and direction of the BCA policy impact. The basis of the comparison will be a modelled Base Case which reflects as closely as possible the characteristics of the 2019 market described in sections 2 and 3.

4.3.1. Impact of the BCA policy simulation on flats

The implementation of a BCA results in significant changes compared the Base Case. As importers' costs ramp up, 51% of imports are squeezed out of the market and only 4.5 Mt of foreign steel supplies the US market. Some higher-cost domestic mills gain ground over importers. This is despite a 10% increase in US mill average cost from $548/t to $601/t. The implementation of the BCA raises the price to $690/t, a 12% increase vs the Base Case, well within the range of typical flats price volatility. The US domestic producers clearly benefit from the BCA element of the policy as value add jumps by 45% vs the Base Case to reach $4.9 bn due the higher US sales and higher margins.

We summarise the flats market metrics from the BCA simulation compared to the Base Case in **Error! Reference source not found.**.

Table 1 Flats market metrics summary for the Base Case and BCA policy simulation

Output metric	Unit	Base Case	BCA policy simulation	*% change vs Base Case*
Product price	$/t	616	690	*12.0%*
Marginal producer	-	Middletown	EU BF/BOF	*n/a*
US sales	Mt	50.6	55.2	*9.3%*
US mill value add	$m	3,375	4,899	*45.1%*
US mill unit margin	$/t	67	89	*32.8%*
US mill % margin	%	10.8%	12.8%	*18.5%*
US mill capacity utilization (effective)	%	92.2%	100.0%	*8.5%*
Importer sales	Mt	9.2	4.5	*(51.2%)*

[7] Defined as mill unit margin multiplied by volumes sales in the US market.

Imports share	%	15.3%	7.5%	*(51.2%)*
US mill average delivered cost	$/t	548	601	*9.7%*
Importer mill average delivered cost	$/t	564	593	*5.1%*

DATA: CRU

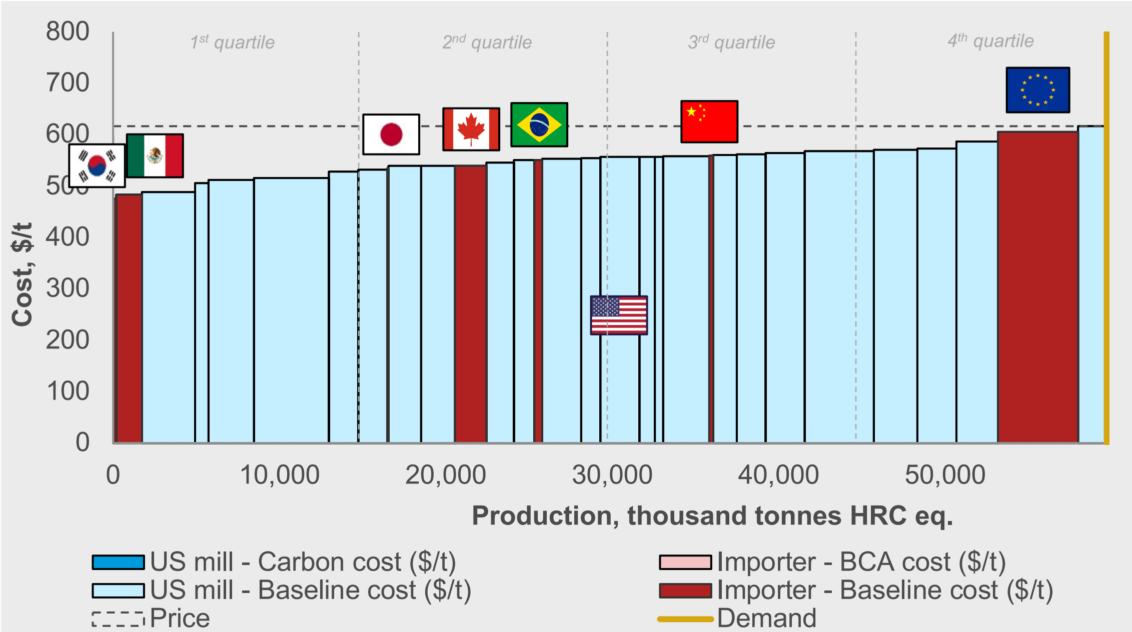
The BCA policy impact on flats described above can be visualised in Figure 7 by the cost curves representing the US flats market for the Base Case and the BCA policy simulation. We observe the flats cost curve is relatively flat despite the fact that US mills use both the BF-BOF and EAF processes to produce flats. As explained in section 4.2, this will favour movements and postion reshuffling of the market particpants.

In the Base Case, the product price is set by the marginal producer, a US mill, at $616. Flats imports into the US are assumed to be BF-BOF-based only. High-cost European blast furnaces are close to the margin. Asian importers are spread across the curves due to intrinsic variation in delivered costs and differential treatment vis-à-vis the 232 section. The tariffs apply to both Chinese and Japanese volumes, the former being slightly higher cost due to higher logistics costs. Steel imports from South Korea are only limited by quotas and, with Mexican imports, are the lowest cost players located at the bottom of the curve. Canadian, Brazilian and Japanese flats imports are concentrated in the second quartile of the curve.

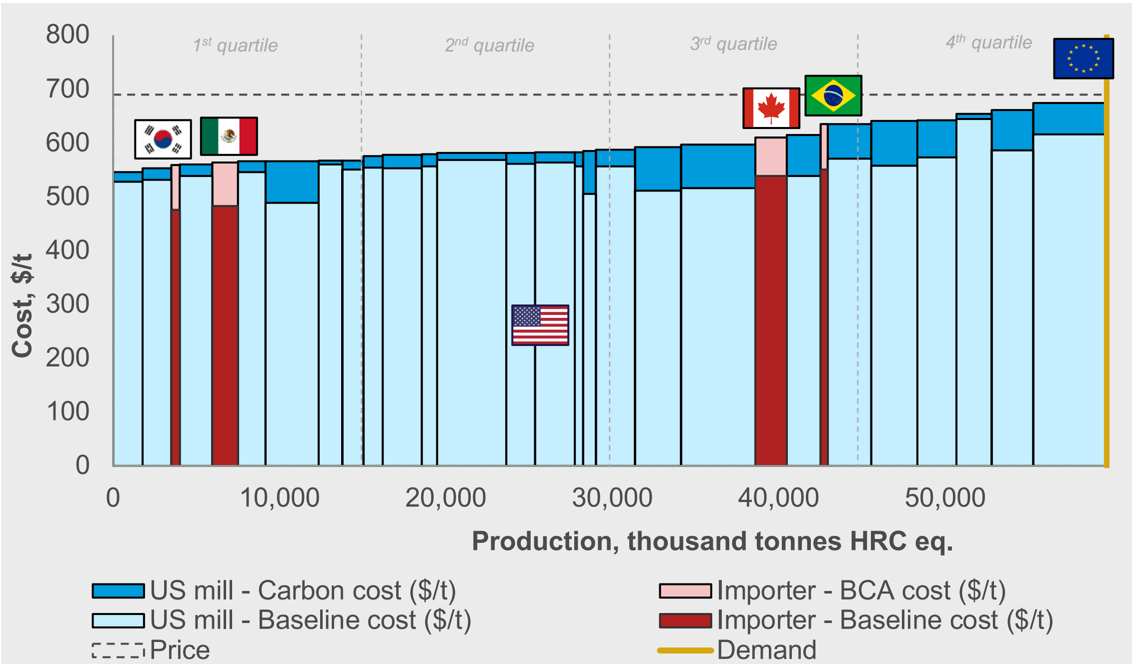
As explained above, imports are squeezed out from the US market under the BCA policy simulation. The US market become less attractive for China and Japan, both which are displaced entirely from the US market. European flats also lose market share although a fraction of volumes seen in the Base Case remain in the market as marginal tonnes. Canadian and Brazilian volumes move from the second to the third quartile, while the low-cost South Korean and Mexican steel are resilient and remain close from bottom of the curve. Interestingly most EAF-based flats producers are advantaged by lower emissions intensities and move towards the bottom half of the curve, making greater gains in value add their BF counterparts.

Figure 7 US flats market cost curves for Base Case and BCA policy simulation

a) Base Case (No US carbon price)



b) BCA policy simulation



DATA: CRU

4.3.2. Impact of the BCA policy simulation on longs

As with flats, implementing a BCA alongside the domestic carbon price is effective in reducing longs imports into the US, which decrease by over 51% to 1.3 Mt, from 2.7 Mt in the Base Case. The displaced imports are replaced by US domestic production with average cost of $587/t, i.e. 4% higher than the Base Case ($563/t). Price jumps to $790/t, a 12% increase compared to the Base Case but, as with flats, well within the historical volatility range of longs prices. Value add increases by 52% vs the Base Case to $3.9 bn thanks to higher US sales and margins.

We summarise the flats market metrics from the BCA simulation compared to the Base Case in **Error! Reference source not found.**.

Table 2 Longs market metrics summary for the Base Case and BCA policy simulation

Output metric	**Unit**	**Base Case**	**BCA policy simulation**	***% change vs Base Case***
Product price	$/t	705	790	*12.1%*
Marginal producer	-	EU BF/BOF	EU BF/BOF	*n/a*
US sales	Mt	18.1	19.4	*7.7%*
US mill value add	$m	2,569	3,905	*52.0%*
US mill unit margin	$/t	142	201	*41.2%*
US mill % margin	%	20.2%	25.4%	*26.0%*
US mill capacity utilization (effective)	%	90.2%	96.9%	*7.4%*
Importer sales	Mt	2.7	1.29	*(51.8%)*
Imports share	%	12.9%	6.2%	*(51.8%)*
US mill average delivered cost	$/t	563	587	*4.3%*
Importer mill average delivered cost	$/t	587	608	*3.7%*

DATA: CRU

The BCA policy impact on longs described above can be visualised in Figure 8 by the cost curves representing the US longs market for the Base Case and the BCA policy simulation. The longs cost curve is steeper than the flats cost curve in th US market, particularly at the bottom and top of the curve. Imported longs volumes are either BF-BOF-based or EAF-based and we represent importers by process type on the cost curve. BF volumes are more affected by a BCA due to their higher emissions intensity and tend to be displaced out of the market more easily due to higher emissions intensities.

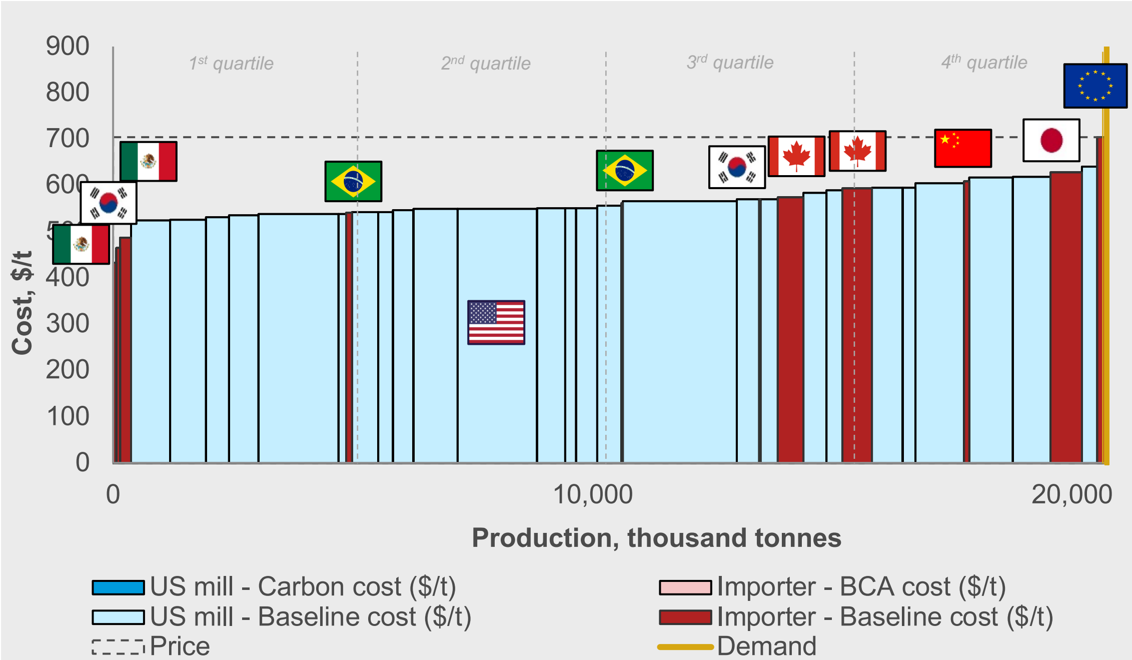
The marginal player in the Base Case are European BF-BOF volumes that set the price at $705/t. Some of this EU steel is higher quality wire rod grades of blast furnace quality only for tyre cord production which cannot be made by the US EAF mills. In CRU's view, those type of imports are therefore sticky in the US market.

Similarly to flats, the section 232 tariffs impact the relative postion of Asian producers. China and Japan steel imports are high cost and located in the fourth quartile as they are penalised by the tariff. South Korea imports are limited by quotas but at BF volumes are the base of the curve alongside cheap Mexican steel. South Korean EAFs are higher costs and located between the second and third quartile, like Brazilian and Canadian imports.

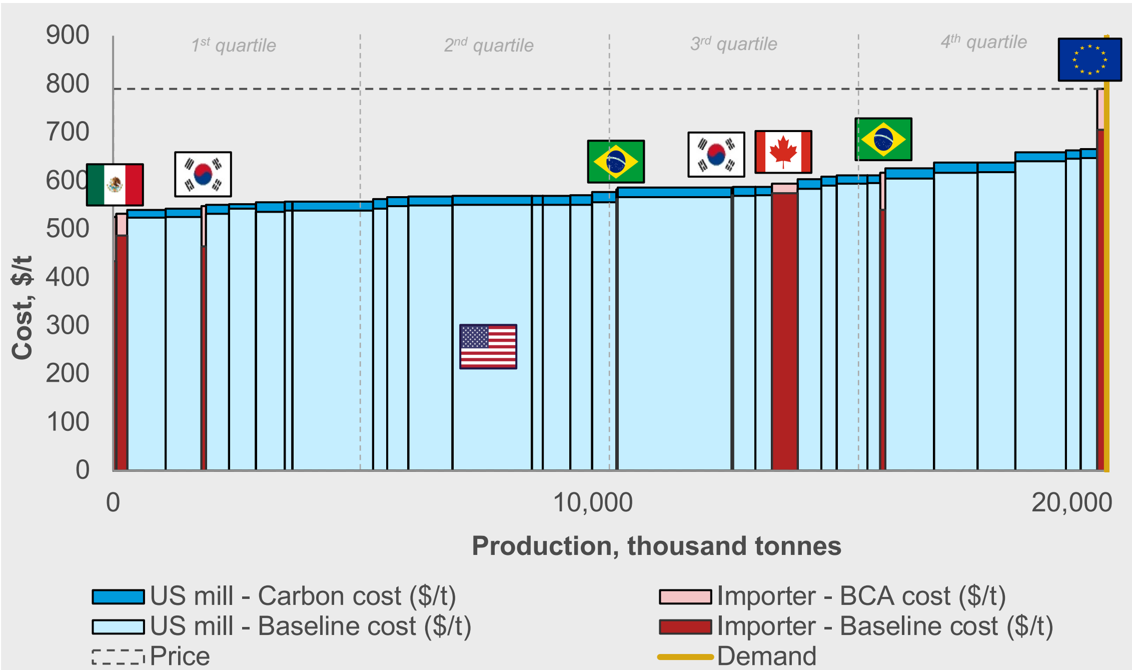
Under the BCA policy simulation, European BF imports are still the marginal volumes in the market. Canadian and Japanese BF volumes are displaced from the market as higher margin can be found in alternative markets like other Asian countries, India or Europe. All Brazilian volumes and South Korean BF-BOF volumes move up the curves but the latter remains in the first quartile. Mexican BF-BOF and EAF-based steel retain their position at the bottom of the cost curve but closer in costs to the next US mill than in the Base Case.

Figure 8 US longs market cost curves for Base Case and BCA policy simulation

a) Base Case (No US carbon price)



c) BCA policy simulation



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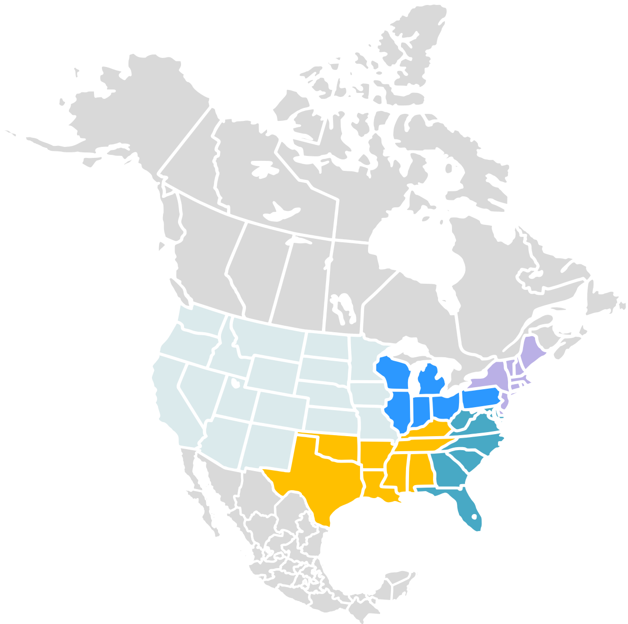
4.4. "Winners and losers" at regional level

The impact of a BCA on US regions will differ depending on the geographical spread of US steel hubs and clusters. We consider the regional breakdown outlined in Figure 9 for the Base Case and the BCA policy simulation. The marginal producer and the product price and are assumed to be the same for all regions and the focus is on value add to understand the differentiation in response to a BCA.

Figure 9 Colour coded map of US regional breakdown



US region	States
Great Lakes	WI, IL, IN, OH, MI, PA
Northeast	NY, NJ, CT, RI, MA, VT, NH, ME
South Atlantic	WV, VA, MD, DC, DE, NC, SC, GA, FL
South Central	KY, TN, MS, AL, AR, LA, OK, TX
West + Other Midwest	MN, IA, MO, ND, SD, NE, KS, MT, WY, CO, NM, AZ, UT, ID, NV, WA, OR, CA

4.4.1. Flats

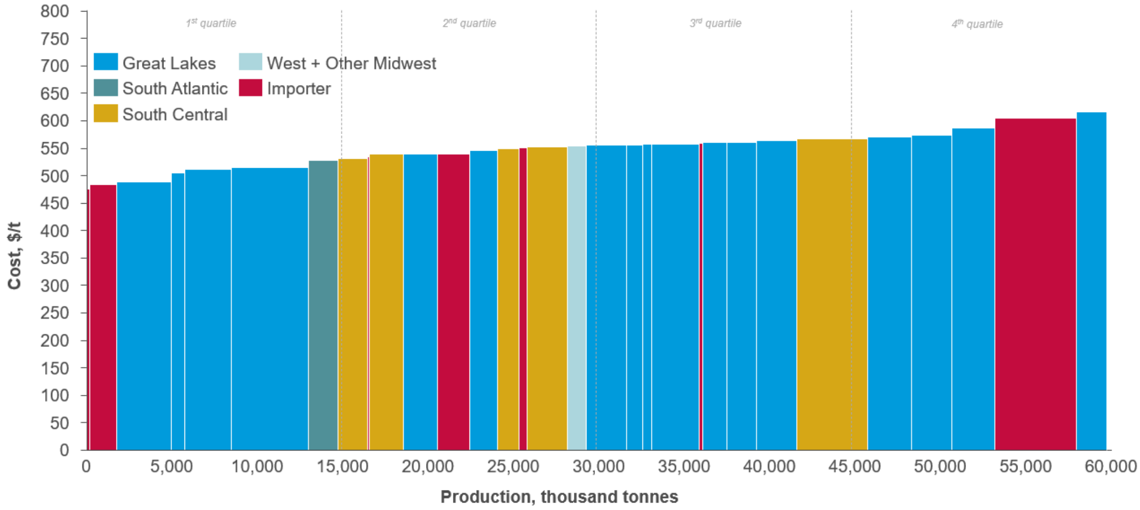
The position on the cost curves of US flats producers by US region is highlighted in Figure 10. The response from flats producers to a BCA in terms of value add is heterogenous across regions and displayed in Figure 11 (n.b. no flat producing plants are in the Northeast region).

In the Base Case, the Great Lakes mills dominate flats production in the US and are dispersed throughout the cost curve, with a skew towards the second half of the curve. Southern mills are mostly located in the first half of the cost curve. For the West + Other Midwest region, Arizona plants are in the middle of the curve, but California re-rolling mills are uncompetitive (and likely turned towards the export market) against imports in this relatively protected market west of the Rockies. This translates into a low regional value add as California mills are loss-making in the US market.

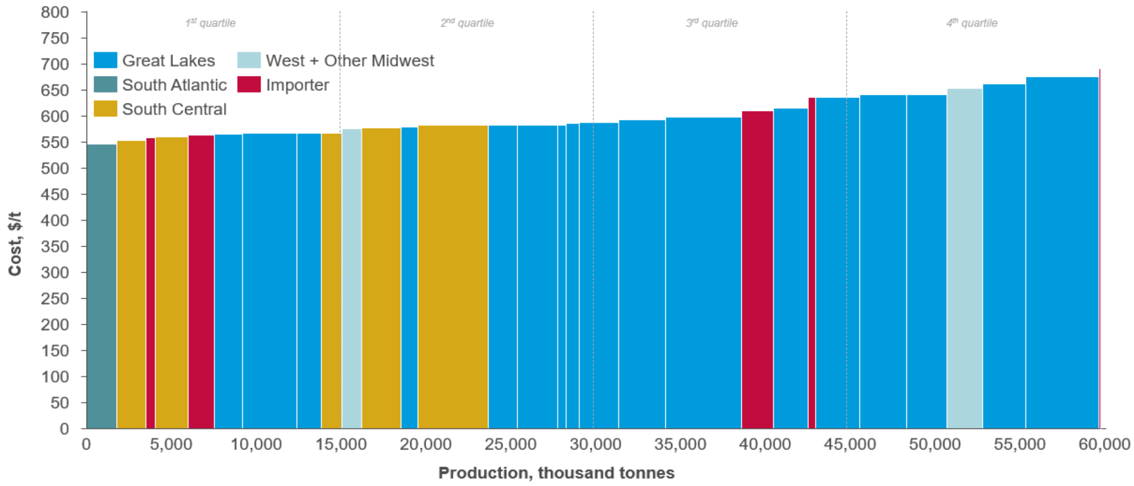
In the BCA policy simulation, the Great Lakes mills enjoy higher domestic sales by 2.6 Mt (+7%), and their production act as swing volumes mostly filling the void from high-cost EU imports – they net a 24% increase in value add vs Base Case from $2.5 bn to $3.1 bn. Southern mills (from Central and Atlantic regions) slide down the curve, but US sales do not change; market prices increase more than mill costs resulting in value add increasing by nearly 85% in aggregate from $0.9 bn to $1.6bn. Value add in the West + Other Midwest region is low in the Base Case as California high-cost production does not supply the US market and is out of the cost curve. However, they become competitive under a BCA and move into the cost curve, translating in a decent value add of around $0.2 bn.

Figure 10 Regional breakdown of US flats market cost curves for Base Case and BCA policy simulation

a) Base Case

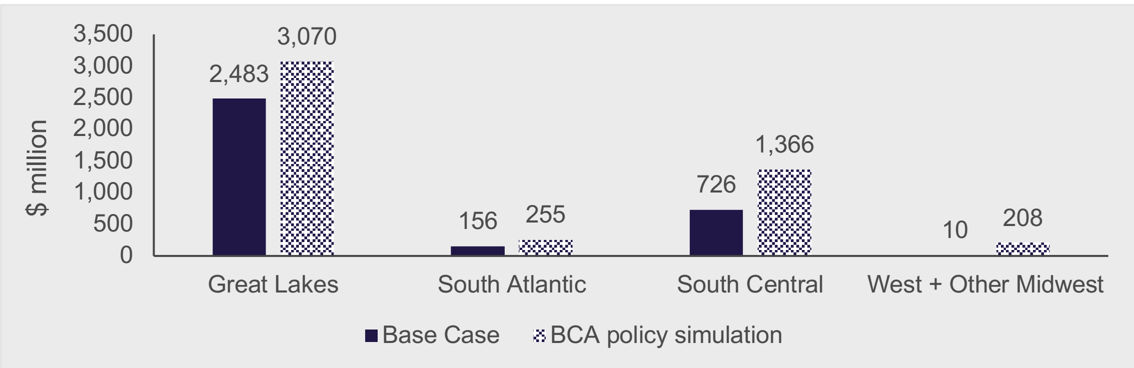


b) BCA policy simulation



DATA: CRU

Figure 11 Flats value add for BCA policy simulation by US region



DATA: CRU

4.4.2. Longs

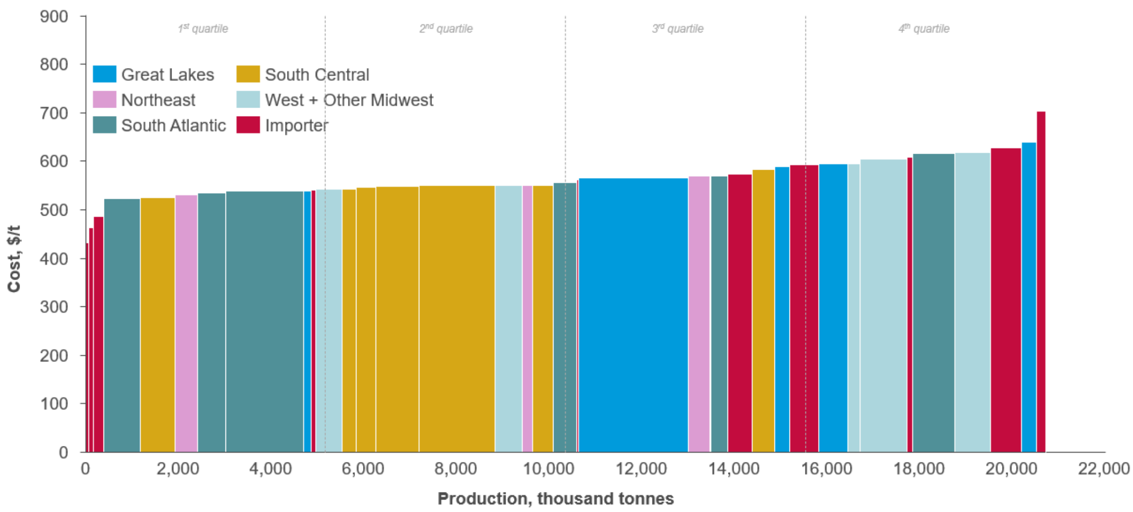
The position on the cost curves of US longs producers by US region is highlighted in Figure 12. The response from longs producers to a BCA in terms of value add is more homogenous across US regions than for flats producers due to the technological similarities of the EAF plants in the segment (see Figure 13).

In the Base Case, Great Lakes and the West + Other Midwest region are located in the upper half of the cost curve while Southern mills are mostly in the bottom half. Northeast plants are spread from the first to the third quartile.

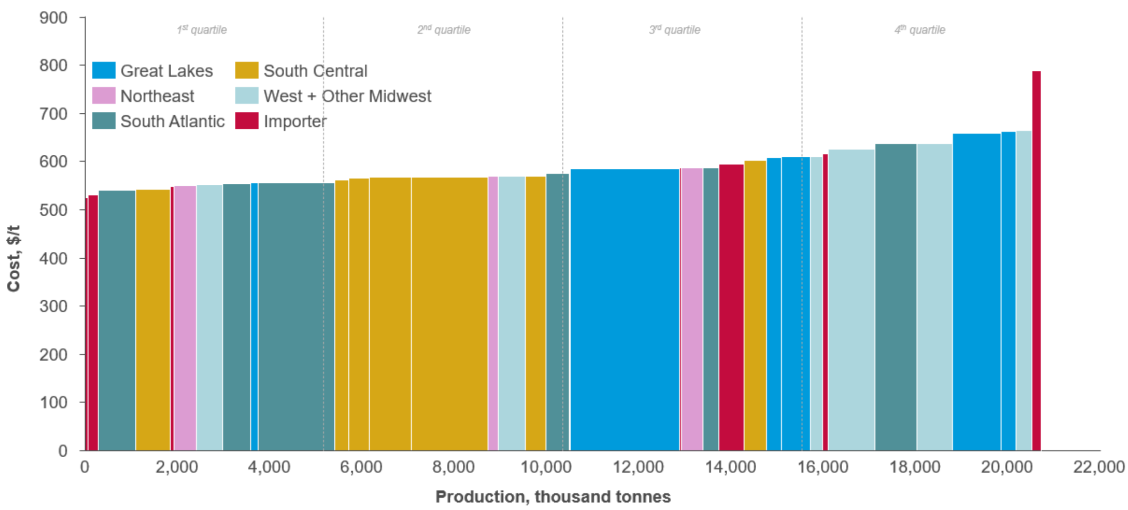
In the BCA policy simulation, volumes from Great Lakes replace high-cost Japanese, Chinese and Canadian volumes and increase sales by 1.0 Mt (+27%). Sales in other regions do not change. With the price increment being the cost increment for all regions, it translates into higher value add across regions thanks to higher sales; the Great Lakes leads the way with a 75% rise in value add while other regions see a 40% to 60% increase.

Figure 12 Regional breakdown of US longs market cost curves for Base Case and BCA policy simulation

a) Base Case

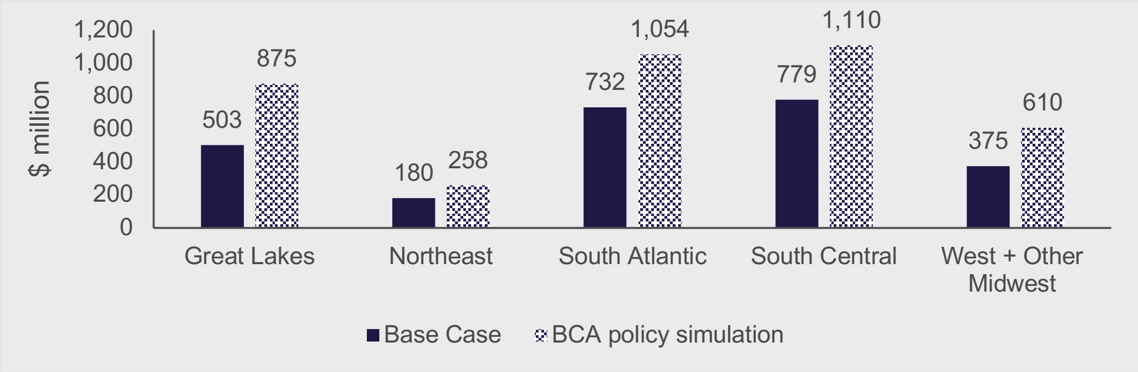


b) BCA policy simulation



DATA: CRU

Figure 13 Longs value add for BCA policy simulation by US region, % change vs Base Case



DATA: CRU

5. Market sensitivity to BCA policy design

5.1. Changes in BCA design: sensitivity cases

To assess the sensitivity of the output metrics to the assumptions underlying the BCA policy simulation, we examine four alternative / sensitivity cases:

1. **Global average benchmark:** Rather than the facility's specific emissions, the BCA costs are calculated based on the global average scope 1 and 2 emissions intensity by process route (BF-BOF or EAF).

   For flats, the BF-BOF global average intensity is estimated at 1.84 tCO_2/tcs. For longs, the BF-BOF and EAF global average intensities are estimated at 2.04 tCO_2/tcs and 0.49 tCO_2/tcs.

2. **US average benchmark:** Rather than the facility's specific emissions, the BCA costs are calculated based on the US average scope 1 and 2 emissions intensity by process route (BF-BOF or EAF).

   For US BF-BOF flats volumes, average intensity is estimated at 1.73 tCO_2/tcs. For US BF-BOF-based and EAF-based longs volumes, global average intensities are estimated at 2.04 tCO_2/tcs[8] and 0.43 tCO_2/tcs.

3. **Deduction for Pre-Existing Carbon Prices:** ETS and OBPS costs are deducted from the BCA costs for the relevant regions, i.e. EU, South Korea and Canada.

4. **Replacement of Section 232 with BCA:** Section 232 tariffs and quotas are replaced by the BCA policy simulation with the BCA applying on importers' emissions intensities. In other words, it is the BCA policy simulation without the Section 232 tariffs and quotas.

5.2. Impact of changes to BCA design

We summarise the output metrics for BCA sensitivity cases described above against the BCA policy simulation in Table 3. The detailed outputs are compiled in Table 4.

Applying a BCA on global or US average benchmarks is detrimental to flats and favourable to longs in terms of value add. In the case of flats, the new benchmarks are more punitive for importers as average costs rise but not on the emissions-intensive European mills. The result is lower product prices, unchanged US sales and lower value add. Value add for longs only marginally increases by 1.5% because average costs decrease (pushed down by reduced costs at Mexico EAFs mills located at the bottom the curve) and higher prices as the costs European BF-BOF-based longs volumes increase. Overall, since flats dominate the markets in size, alternative benchmarks do not appear as beneficial to the US domestic steel market on balance as the importer-specific benchmark used under the BCA policy simulation.

The deduction of pre-existing carbon prices results in lower prices for flats and longs as the marginal producer, European BF-BOF volumes, see their total costs reduced by their ETS costs. A diminished US value add is the result. Based on this metric, and given the disparity we highlight between headline and actual ETS cost impacts, this approach does not seem as attractive as the BCA policy simulation. It would also create potential WTO "Most Favored Nation" treatment issues.

[8] Proxied with the global average as there is no BF-BOF mills producing longs in the US.

Replacing Section 232 tariffs and quotas by a BCA more than doubles the imports and hurts the value add for both product segments, restoring importer sales to base case levels. A BCA as a standalone policy therefore is not as efficient as Section 232 to reduce imports into the US market. The co-existence of both policies under CLC's BCA policy simulation yields more favourable results for the US steel industry.

Table 3 Summary of directional impact of the sensitivity cases compared to the BCA policy simulation

Sensitivity case vs BCA policy simulation by output metric	Global Average Benchmark		US Average Benchmark		Deduction for Existing Carbon Prices		Replacement of Section 232 with BCA	
Product	Flats	Longs	Flats	Longs	Flats	Longs	Flats	Longs
Product price	↓	↑	↓	↑	↓	↓	↓	↓
US sales	=	=	=	=	=	=	↓	↓
US mill value add	↓	↑	↓	↑	↓	↓	↓	↓
Importer sales	=	=	=	=	=	=	↑	↑
US mill average delivered cost	=	=	=	=	=	=	↓	↓
Importer mill average delivered cost	↑	↓	↑	↓	↓	↓	↑	↑

Table 4 Flats and Longs market metrics summary for the BCA sensitivity cases compared to the Base Case

a) Flats

Output metric	Unit	Base Case	BCA policy simulation	*% change vs Base Case*	Global Average Benchmark	*% change vs Base Case*	US Average Benchmark	*% change vs Base Case*	Deduction for Existing Carbon Prices	*% change vs Base Case*	Replacement of Section 232 with BCA	*% change vs Base Case*
Product price	$/t	616	690	*12.0%*	684	*11.1%*	679	*10.3%*	679	*10.2%*	661	*7.4%*
Marginal producer	-	Middletown	EU BF/BOF	-	EU BF/BOF	-	EU BF/BOF	-	EU BF/BOF	-	Granite City	-
US sales	Mt	50.6	55.2	*9.3%*	55.2	*9.3%*	55.2	*9.3%*	55.2	*9.3%*	50.6	*0.0%*
US mill value add	$m	3,375	4,899	*45.1%*	4,564	*35.2%*	4,306	*27.6%*	4,283	*26.9%*	3,313	*(1.8%)*
US mill unit margin	$/t	67	89	*32.8%*	83	*23.7%*	78	*16.7%*	78	*16.1%*	66	*(1.8%)*
US mill % margin	%	10.8%	12.8%	*18.5%*	12.1%	*11.4%*	11.5%	*5.8%*	11.4%	*5.4%*	9.9%	*(8.6%)*
US mill capacity utilization (effective)	%	92.2%	100.0%	*8.5%*	100.0%	*8.5%*	100.0%	*8.5%*	100.0%	*8.5%*	92.2%	*(0.0%)*
Importer sales	Mt	9.2	4.5	*(51.2%)*	4.5	*(51.2%)*	4.5	*(51.2%)*	4.5	*(51.2%)*	9.2	*0.0%*
Imports share	%	15.3%	7.5%	*(51.2%)*	7.5%	*(51.2%)*	7.5%	*(51.2%)*	7.5%	*(51.2%)*	15.3%	*0.0%*
US mill average delivered cost	$/t	548	601	*9.7%*	601	*9.7%*	601	*9.7%*	601	*9.7%*	595	*8.5%*
Importer mill average delivered cost	$/t	564	593	*5.1%*	604	*7.2%*	600	*6.3%*	591	*4.8%*	633	*12.3%*

DATA: CRU

b) Longs

Output metric	Unit	Base Case	BCA policy simulation	*% change vs Base Case*	Global Average Benchmark	*% change vs Base Case*	US Average Benchmark	*% change vs Base Case*	Deduction for Existing Carbon Prices	*% change vs Base Case*	Replacement of Section 232 with BCA	*% change vs Base Case*
Product price	$/t	705	790	*12.1%*	792	*12.5%*	792	*12.5%*	775	*10.0%*	707	*0.3%*
Marginal producer	-	EU BF/BOF	EU BF/BOF	*n/a*	EU BF/BOF		EU BF/BOF		EU BF/BOF		EU BF/BOF	-
US sales	Mt	18.1	19.4	*7.7%*	19.4	*7.7%*	19.4	*7.7%*	19.4	*7.7%*	17.8	*(1.6%)*
US mill value add	$m	2,569	3,905	*52.0%*	3,960	*54.2%*	3,960	*54.2%*	3,622	*41.0%*	2,241	*(12.8%)*
US mill unit margin	$/t	142	201	*41.2%*	204	*43.2%*	204	*43.2%*	186	*30.9%*	126	*(11.3%)*
US mill % margin	%	20.2%	25.4%	*26.0%*	25.7%	*27.3%*	25.7%	*27.3%*	24.0%	*19.0%*	17.8%	*(11.6%)*
US mill capacity utilization (effective)	%	90.2%	96.9%	*7.4%*	96.9%	*7.4%*	96.9%	*7.4%*	96.9%	*7.4%*	88.8%	*(1.6%)*
Importer sales	Mt	2.7	1.29	*(51.8%)*	1.29	*(51.8%)*	1.29	*(51.8%)*	1.29	*(51.8%)*	2.97	*10.9%*
Imports share	%	12.9%	6.2%	*(51.8%)*	6.2%	*(51.8%)*	6.2%	*(51.8%)*	6.2%	*(51.8%)*	14.3%	*10.9%*
US mill average delivered cost	$/t	563	587	*4.3%*	587	*4.3%*	587	*4.3%*	587	*4.3%*	580	*3.1%*
Importer mill average delivered cost	$/t	587	608	*3.7%*	607	*3.3%*	605	*3.1%*	605	*3.0%*	614	*4.5%*

6. Conclusions

Carbon pricing is likely to be an important policy tool to deliver the ambitious 50% emissions reduction goal recently set out by the US government. This target will require a significant intensification of policy implementation in the coming years.

In this context, the Climate Leadership Council proposes a BCA policy to level the playing field for all market participants by imposing a US domestic carbon price and levying a BCA on imports. The core design features of the policy relevant to the steel industry are:

a) a $43/tCO_2$ economy wide carbon fee, rising at 5% above the inflation rate each year;

b) a border carbon adjustment (BCA) of $43/tCO_2$ on the emissions associated with the manufacture of products entering the US;

c) a full rebate of domestic carbon fees paid to US exports; and,

d) all revenue is recycled as “carbon dividends” to households on an equal basis per capita.

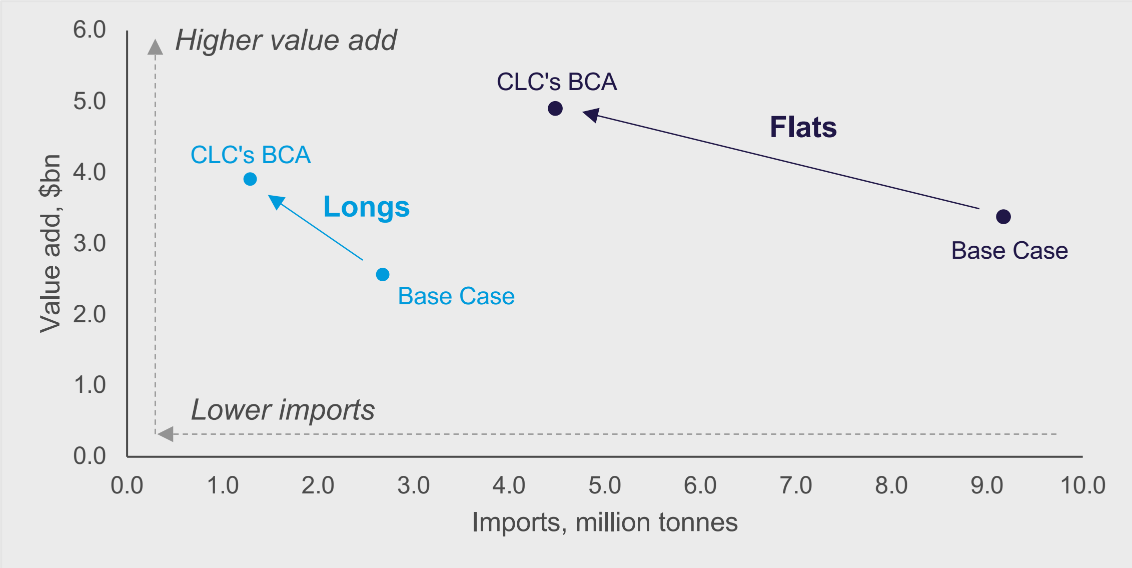
Energy-intensive and trade-exposed (EITE) sectors, such the steel sector, are particularly exposed to such policy. The variability in steel emissions by mill along technology mix and mill carbon intensity is bound to create asymmetrical responses depending on producers. However, US mills have the advantage of being less polluting than the average mills on a global basis; flats exporters to the US are 50-100% more emissions-intensive while longs exporters other than the EU and Canada, are one-to-five-fold more emissions intensive. This suggests a BCA could provide economic opportunities for the US steel industry.

CRU undertook an impact assessment of the BCA policy simulation on the steel industry based on cutting edge data methodology. As with any simulation, these conclusions are subject to a number of key risks and dependencies, including the design of any future BCA and the market conditions to which it applies. In particular, the impacts of carbon pricing reform are likely to depend on i) the level of carbon prices, ii) the relative carbon intensity of US compared to imported steel producers, iii) the policy rules determining the basis of the BCA, iv) the nature and extent of any competitive responses of importers.

CRU’s simulations suggest that BCA implementation increases US steel industry value add and reduces imports by around 50% for both the flats and longs product segments (Figure 14). Steel prices are expected to increase by 12%, remaining well within the historical volatility range of 20-30%, and pushing US steel industry margins up (+32-41%). Higher costs on imported steel displace volumes from the US market from both developed economies (such as Canada and Japan) as well as major emerging markets such as China, Mexico and Brazil.

Under the CLC’s proposed BCA policy, the carbon fee could generate around $4.5 billion in additional revenue annually from the US steel sector alone. If recycled to US consumers as carbon dividends, it is equivalent to around $15 per person. This recycling mechanism would help mitigate the impacts of higher steel prices on consumers.

Figure 14: Imports vs value add for steel products under the Base Case and CLC's BCA policy.



CRU identified that the benefits of the BCA on the US steel sector will be uneven depending upon steelmaking technologies and US region, though no region sees curtailed production. The low carbon intensity of EAF mills is best placed to reap the benefits of a BCA policy as it increases their competitiveness against blast furnaces – this is particularly the case for flats producers. At the regional level, the economic benefits to the US steel industry are likely to be relatively broad based across regions, with mills in the South Central and Great Lakes regions expected to be notable beneficiaries. The South Central are low-cost mills and their value add increase the most in dollar terms (+$970 million) across product segments thanks to increased prices since their sales to the US market remain unchanged. They are closely followed by the Great Lakes' mills in terms of value gains (+$958 million). The concentration of installed capacity in this region means some of the mills act as "swing volumes" and can replace imports displaced by the BCA. Other US regions, such as the West, also see significant growth in production and value add (albeit from a much lower base). In particular, some of these Western mills become newly competitive under a BCA, boosting the regional value add (+$421 million).

Overall, CRU's analysis uncovered CLC's BCA policy is likely to yield positive outcomes on the US steel industry, in part thanks to the industry's low carbon intensity relative to trading partners. Maintaining this advantage in the long term to sustain such impact will depend on the relative pace and associated productive efficiencies of decarbonisation domestically compared to importing regions.

It is also important to note that the analysis presented above, undertaken by CRU, is at the frontier of current policy research, given its grounding in high quality data and behavioural modelling approach. However, as with any research, it is subject to limitations and simplifying assumptions. In particular, analysis of the impacts of long-term shifts in technology adoption, both in steel, power and key end use markets under real world policy parameters is required for a fuller understanding of the potential impacts.

7. Appendix: CRU's impact assessment methodology

7.1. General parameters

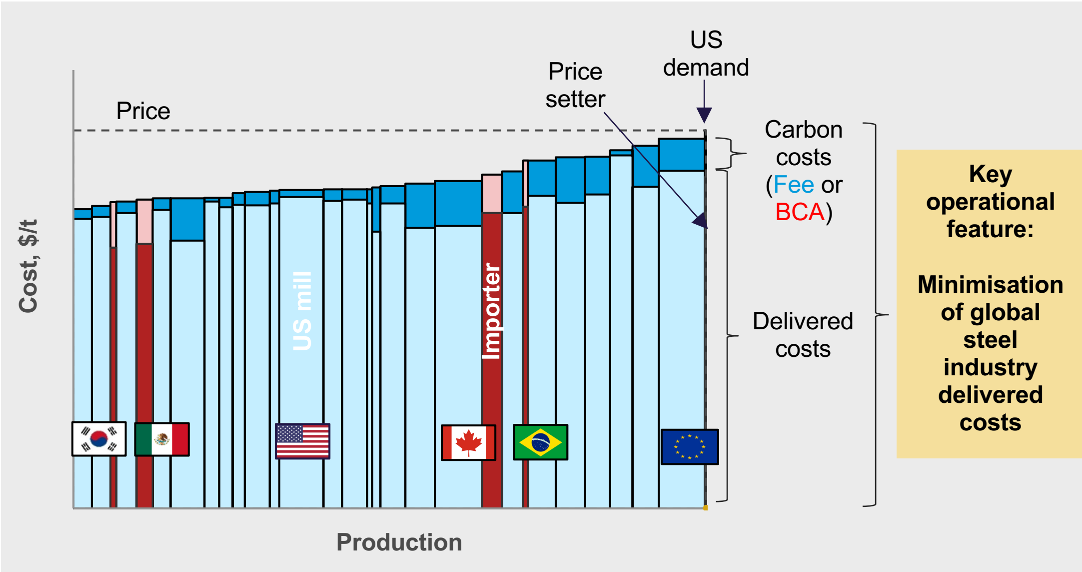
Product categories	• Flats: hot rolled coil ("HRC"), and cold rolled coil ("CRC"), coil plate, tinplate and galvanized products for flats (plate products are not included). Flats volumes are rebased in HRC equivalent using product yields from hot rolled coil. • Longs: light products, including rebar, wire rod and merchant bar (sections, rail and seamless pipe are not included)
Emissions	• Scope 1 (direct) & scope 2 (indirect) for all products.
Players	• US mills and non-US importer mills.
Markets	• The US market and "other" or "alternative" markets representing markets of non-US countries

7.2. Modelling approach

Overview	• **CRU's model uses a dynamic approach based on a linear programming optimisation with Excel Solver, which seeks to minimise total delivered costs on a global basis by flexing US production and volumes imported into the US.** • For simplification, four trade flows are considered: ○ US mills to US market, ○ US mills to alternative non-US markets (US exports), ○ Importers to US market, and ○ Importers to alternative non-US markets
US physical capacity utilisation	• CRU has an internal view of nominal capacity in the US market. • US mills physical capacity utilization is determined by both domestic production and exports to other markets. • The physical utilization rate of the nominal capacity by product is assumed to be 85% for flats and 77% for longs.
Production volumes	• Volumes can fluctuate to meet demand (supply = demand), but within certain constraints to ensure the uniqueness of the solution. • The constraints on the trade flows are the following: ○ US mills to US market – between 0 and effective capacity (nominal mill capacity * physical capacity utilization rate). ○ US mills to alternative non-US markets – between certain designated minimum levels based on total US exports and effective capacity (nominal mill capacity * physical capacity utilization rate).

	○ Importers to US market – between 0 (unless minimum volumes specified) and maximum designated volumes derived from historical peak sales to the US market. ○ Importers to alternative non-US markets – between 0 and maximum designated 'capacity' derived from total historical exports.

Illustration of CRU's modelling approach



7.3. Model inputs

7.3.1. US demand and supply

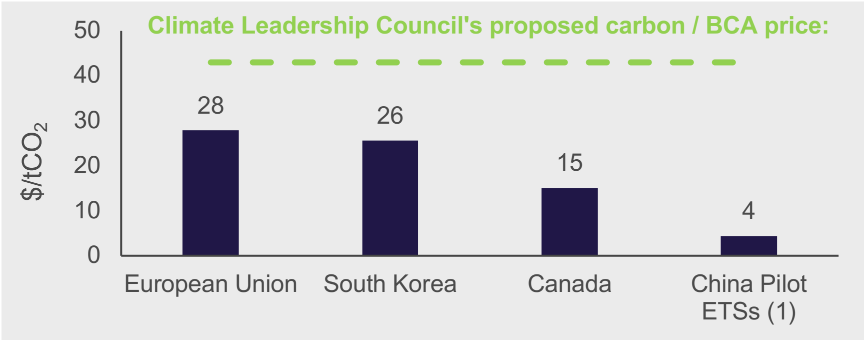
US demand	• Apparent consumption in the US region in 2019, as determined by CRU's Steel Analysis team. • Apparent consumption is defined as US production minus net exports. • **US demand is a fixed parameter in CRU's model.**
US supply	• US supply is the total potential capacity available to the US market from domestic and importing mills. • Importers mills are in a shortlist of countries representing 85-90% of total US imports: Canada, Mexico, China, Taiwan, Japan, South Korea, Brazil and the European Union • To approximate 100% of domestic and import supply, CRU's model uses a sample of representative US and non-US importer mills to proxy volumes (and corresponding costs) to meet US demand. • **US modelled supply volumes will flex according to the examined scenario to equal US demand.**

7.3.2. Baseline costs

Steel production costs	• Steel production costs represent the delivered costs of US and non-US importer mills, excluding carbon costs.

	• Delivered costs for US mills are defined as: *Raw material costs + Conversion costs + Transportation costs.* • Delivered costs for importers are defined as: *Raw material costs + Conversion costs + Transportation costs + ETS or OBPS costs (if applicable)* [9] • **Steel production costs are calculated on a 2019 basis, using 2019 input prices and production volumes.**
Variable costs for importers	• The tariffs from Section 232 (a key feature of the US trade policy since implementation in 2018) rendered some imports effectively non-competitive in the US market. As a response to the tariffs, CRU believes importers have been absorbing part of the additional costs imposed on them by lowering their selling price into the US market. At full costs, we estimate half of the 2019 actual US imports would out of the cost curve otherwise. • In practice, it means marginal volumes from importers targeted by the 232 tariffs are destined to the export market and sold at variable costs, i.e. at a discount to full costs. Importers make their margins selling into markets where they are more competitive. • This is broadly consistent with observed behaviours among exporters to other major regional markets, e.g. in the EU, in response to trade policy and other market-related margin pressure. • Variable costs exclude fixed/quasi fixed items such as overheads, sustaining capital, financing of working capital, labour, and part of energy and rolls and spares costs. • Variable costs are only applied to countries hit by the 232 tariffs like the EU, China, Japan and Taiwan. South Korea and Brazil are treated at full costs because they are impacted by quotas, not tariffs. Canada and Mexico are treated at full costs. • **CRU's Base Case assumes variable costs equal 86% and 90% of full costs for flats and longs respectively, after calibration of the model against the 2019 market.**
ETS costs	• **ETS costs are part of the baseline costs for European Union and South Korea volumes imported to the US.** • ETS costs for steel products consist of: *Scope 1 costs + Scope 2 costs – Compensation for indirect carbon costs (if applicable).* • Scope 1 costs are calculated as: *Scope 1 carbon intensity * (1- % coverage of free allocation) * EU or South Korea carbon price.* • Scope 2 costs are calculated as: *Scope 2 carbon intensity * or South Korea carbon price.* • Compensation for indirect carbon costs is only included in the carbon costs for European imports. • CRU model has the capacity to deduct ETS costs from BCA costs.
Output-Based Pricing	• **OBPS costs are part of the baseline costs for Canadian volumes imported to the US.**

[9] Anti-dumping duties are not included for imports into the US are not considered as they targeted on specific products only, not on whole product segments.

System (OBPS) costs	• OBPS costs for steel products consist of: *Scope 1 costs* + *Scope 2 costs*. • Scope 1 costs are calculated as: (*Scope 1 carbon intensity – OBPS standard for EAF-based or BF-BOF-based steel) * Canada carbon price*. • Scope 2 costs are calculated as: *Scope 2 carbon intensity * Canada carbon price.* • CRU model has the capacity to deduct OBPS costs from BCA costs
Carbon prices in considered international systems	• **The headline carbon prices used are the average 2019 carbon prices in each system.** We compare them in the graph below in $ per tonne:  Note: (1) Prices in China relate to regional pilot carbon markets spanning eight regions (Shenzhen, Shanghai, Beijing, Guangdong, Hubei, Fujian, Chongqing, Tianjin) and are added for comparison. A federal scheme currently covering power was implemented in 2021. • However, note that the true comparability of carbon prices across countries is more challenging to assess given the extensive relief that is provided, in all cases, but particularly to EITE industries in an effort to shield them from potential competitive pressures. In the case of the EU ETS, for example, the effective carbon price on a typical steel producer is only around 20% of the headline rate given most emissions allowances are given (rather than sold) to producers.

7.3.3. Carbon costs from US policy

US carbon price & BCA	• If a scenario with a BCA is considered, a US domestic carbon price is applied on US mills and a BCA is applied to importers. • **A $43/t value is applied to both the US carbon price and the BCA.**

Emissions intensity	• **Carbon intensity is a key input of the BCA model.**
	• Scope 1 emissions intensities are estimated by mill in CRU's Steel Cost Model based on detailed operating data. CO_2 emitted from the combustion of all carbon-containing inputs used in the iron and steel production process are accounted for. These include, but are not limited, to:
	  ○ Coals (i.e. metallurgical, PCI, anthracite, coke and thermal, where used in a captive power plant),
	  ○ Natural gas,

	○ By-product gases (i.e. coke oven gas, blast furnace gas, steelmaking gas or Corex gas), ○ Ferroalloys ○ Pig iron & DRI/HBI. • Scope 2 emissions intensities are estimated by mill in CRU's Steel Cost Model based on electricity and heat consumption. Average country grid emissions intensities are used to derived scope 2 intensities.
Scope	• Carbon fee costs for all steel products consist of scope 1 costs + scope 2 costs.
Carbon fee costs – US mills	• For US mills, scope 1 costs are calculated as: *Scope 1 carbon intensity * US carbon price*. • For US mills, scope 2 costs are calculated as: *Scope 2 carbon intensity * US carbon price*.
BCA costs – Importers	• For importers, BCA costs are calculated as: *Benchmark * BCA*. • The benchmark is scope 1+2 intensity and can be defined as either the importer-specific emissions intensity or the global average intensity or the US average intensity.

7.4. Model outputs

Outputs – Production and cost	• Sales of US mills and importers into the US market • US mill effective capacity utilisation
Outputs – Financial & economic	• US and importers average mill costs • US steel price • US average mill margin • Total value add for US mills