Nerves of steel

Who's ready to get tough on emissions?

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CDP's sector research for investors provides the best and most tailored environmental data in the market. CDP's team of analysts, voted no. 1 climate change research provider in 2015 by institutional investors, takes an in-depth look at high emitting industries one-by-one, starting with the automotive industry, electric utilities, diversified chemicals, metals & mining, cement, and now steel. Forthcoming is research on the oil & gas industry.

The report is available to CDP investor signatories and includes detailed analysis, methodology and recommended areas of engagement for investors to raise with company management teams. In addition, a separate engagement booklet providing further detail on company specific engagement ideas is available to CDP signatories on request.

For more information see:
https://www.cdp.net/en/investor/sector-research

Linking emissions-related metrics to earnings for steel companies

- With governments globally agreeing to limit climate change to 2 degrees Celsius at COP21, the global steel industry will face increasing pressure to reduce its significant emissions profile. The steel industry contributes 6-7% of global anthropogenic greenhouse gas emissions, and has limited potential to reduce its emissions based on currently available technology.

- This report introduces CDP's League Table for steel, highlighting company performance across a range of emissions and water-related metrics which in aggregate could have a material impact on company performance.

- Highest ranked companies are POSCO, SSAB, ThyssenKrupp, and Hyundai Steel.

- Lowest ranked companies are United States Steel, Tata Steel, Evraz, and CSN.

Overview

This report, covering steelmaking companies, is the latest in a series of investor-focused reports covering high emitting sectors. CDP has previously published reports on auto manufacturers (February 2015 and March 2016), European electric utilities (May 2015), chemicals companies (August 2015), diversified miners (November 2015), and cement companies (June 2016). The oil & gas sector will be the next in CDP's sector research series. Each report features a CDP League Table that ranks companies in an industry grouping on a number of emissions and water-related metrics relevant to that industry. When taken in aggregate, we believe these metrics could have a material impact on company's earnings and therefore investment decisions. In this report, we launch a CDP League Table for steel companies that ranks 14 of the largest and highest emitting steelmakers.

Scope of report: key areas

There are six key areas in our League Table:

- **Emissions and energy management:** steel companies report that energy costs can represent over 40% of operating costs. Using company emissions and energy intensity profiles, this key area assesses which steelmakers are currently the most efficient and which may be least exposed to potential rises in energy and carbon costs.

- **Emissions targets and pathways:** we examine companies' forward-looking emissions reduction targets, comparing companies' targets and their progress against them with science-based targets under the Sectoral Decarbonization Approach[1].

- **Carbon cost exposure:** examines the potential earnings impacts on the companies in our study under different carbon pricing regulation scenarios including emissions allowances allocated under intensity benchmarking, and under full global auctioning. We also assess whether companies make use of an internal carbon price.

- **Low carbon technology development:** to meet global goals to limit global warming to 2 degrees Celsius, emissions intensive steelmaking processes will have to undergo a technology transformation. This key area identifies company involvement and progress in breakthrough emissions reduction projects, and compares the level of focus on research and development between companies.

- **Water resilience:** we assess steel companies' exposure to risks from water stress, undertaking facility-level analysis to assess which companies are at greater risk of business interruption due to water stress. We also compare their respective levels of water consumption and water recycling.

- **Climate governance:** we use proprietary analysis by InfluenceMap[2] to assess each company's actions in supporting or opposing meaningful carbon regulation, and information on the alignment of executive and employee remuneration with climate risk management actions.

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1. The Sectoral Decarbonization Approach is a method for setting corporate emissions reduction targets in line with climate science. See the chapter "Emissions targets and pathways" for more details.
2. A UK-based not-for-profit whose remit is to map, analyse and score the extent to which corporations are influencing climate policy and legislation. http://influencemap.org/

Condensed summary of the League Table for steel companies

League table rank	Company	Country	Market cap 2015 average (US$m)	2015 steel production (m tonnes)	League Table score	Emissions & energy management	Emissions pathways & targets	Carbon cost exposure	Low carbon technology development	Water resilience	Climate governance
1	POSCO	South Korea	16,984	42	4.6	A	C	B	A	A	B
2	SSAB	Sweden	2,437	8	4.9	B	A	B	A	B	C
3	ThyssenKrupp	Germany	13,570	17	5.2	C	B	A	C	A	B
4	Hyundai Steel	South Korea	6,841	20	5.4	A	A	A	D	D	C
5	ArcelorMittal	Luxembourg	14,115	97	5.7	A	C	C	A	B	E
6	Nippon Steel & Sumitomo Metal Corp (NSSMC)	Japan	22,272	46	6.1	B	B	C	B	C	E
7	China Steel	Taiwan	11,314	15	6.4	B	C	D	B	C	A
8	JFE Holdings	Japan	12,097	30	7.1	C	C	D	B	D	D
9	Kobe Steel	Japan	5,713	8	7.8	D	E	C	B	C	C
10	JSW Steel	India	3,506	12	8.2	C	D	D	D	E	A
11	CSN	Brazil	2,222	5	8.6	D	E	C	E	A	B
12	Evraz	United Kingdom	2,890	14	9.0	D	E	C	E	D	C
13	Tata Steel	India	4,517	26	10.1	E	D	E	C	E	C
14	US Steel	USA	2,715	15	10.3	E	E	E	E	C	D
Weighting for each key area						**30%**	**17.5%**	**10%**	**17.5%**	**15%**	**10%**

The summary League Table above initiates CDP investor coverage on the steel industry. It is based on detailed analysis across a range of carbon and water-related metrics, which are aggregated to assign an A to E-grade to each company across each key area.

We also highlight the largest non-responding steelmakers to CDP's 2016 climate change questionnaire in the following table, which has resulted in them not being included in this report. We encourage investors to raise this lack of transparency over reporting practices in discussions with company management.

We note that United States Steel has also not responded to CDP's 2016 climate change questionnaire, but has replied for previous years, on the basis of which we have included it in this report.

Key findings

▼ Progress in reducing emissions and energy use is limited and uneven across the industry. In our sample, more companies increased their emissions intensity and energy intensity than reduced them in the past seven years. Based on figures reported by the World Steel Association covering a wider sample and longer period, there has been no industry-wide progress in improving emissions and energy efficiency levels in a decade (Graph A overleaf).

▼ The steel industry will need to make sharp reductions in emissions levels to achieve science-based targets for a 2 degree transition. The sectoral decarbonization approach (SDA) suggests the need for an emissions intensity reduction of over 70% by the steel industry by 2050 to achieve 2 degrees (Graph B overleaf). While several steel companies have emissions reduction targets that track or better the 2 degrees SDA pathway in coming years, all

Non-responders to CDP

Company	Country	Market cap 2015 average (US$m)	2015 crude steel production (million tonnes)	First year approached by CDP	Public disclosure of carbon emissions
Wuhan Iron and Steel (A)	China	7,477	26	2009	No quantitative data
Nucor Corporation	USA	14,247	20	2006	No quantitative data
Novolipetsk Steel OJSC	Russia	7,410	16	2010	Partial (emissions intensity)
Steel Authority of India	India	3,968	14	2007	Partial (emissions intensity)
Inner Mongolian Baotou Steel Union (A)	China	19,845	12	2009	None
SeverStal PAO	Russia	9,019	12	2009	No quantitative data

Source: CDP, Bloomberg, World Steel Association

these targets expire by 2020. Six out of fourteen companies in our sample have not published forward looking targets, or have targets that expire in 2016.

▼ A range of projects are underway to develop technologies that could provide the deep decarbonization needed by the industry to achieve a 2 degree transition. However, most are at feasibility or piloting stages and not technically or commercially proven. With current low industry profitability, research and development expenses have been cut in recent years. With the timeframe for most technology transitions spanning multiple decades, slow progress now puts at risk efforts toward long-term global and country targets for decarbonization.

▼ Adequate levels of funding for incremental and breakthrough emissions reduction needs to be a priority by companies and governments to ensure long term decarbonization targets are not missed. In particular, progress has been slow in realising the potential for carbon capture and sequestration (CCS), with no CCS pilots underway in the steel industry and little signs of near term progress. Recent investment announcements suggest several steelmakers currently see more potential in carbon capture and utilization (CCU) for steelmaking, though the scale of its emissions reduction potential remains unproven.

▼ Over 70% of world steel production will be subject to a carbon price by end 2017, including from emissions trading schemes, carbon taxes or climate-focused coal taxes. Without success in realizing the potential of breakthrough low emissions technologies, steelmakers could face a continuously rising burden of carbon permit obligations.

▼ Debate between industry and regulators over 'carbon leakage' will enter a new phase in coming years as more countries introduce carbon prices. The steel industry, while generally supportive of climate change regulation in principle, has sometimes obstructed it in practice, arguing it could create distortions in production decisions between regions with and without carbon prices. The largest steelmakers in developed countries and their trade associations have been active in demanding free permit allocations and other concessions, which some have argued blunt the effectiveness of carbon prices in their current form.

▼ Steelmakers are projected to face increasing water stress that could cause future localised disruption to operations. In 2015, 3% of steelmaking sites assessed were based in high water stress areas according to our analysis using WRI Aqueduct. By 2030, 20% of sites assessed are projected to be in high risk areas and 8% in extremely high risk areas.

▼ Most Chinese steelmakers provide much less transparency on climate change strategies and greenhouse gas emissions than their global peers. Only one of China's largest fifteen steelmakers, which represent 40% of Chinese production, discloses emissions. Steelmaking in China now accounts for 50% of global production, and steelmakers there face growing carbon risks, with a national emissions trading scheme to be introduced in 2017, and indications that environmental factors could frame regulator's decisions on how to reduce China's steel overcapacity. Investors currently lack adequate climate-related disclosures to assess individual company risk and preparedness, and make informed investment decisions.

Graph A: Steel industry emissions and energy use
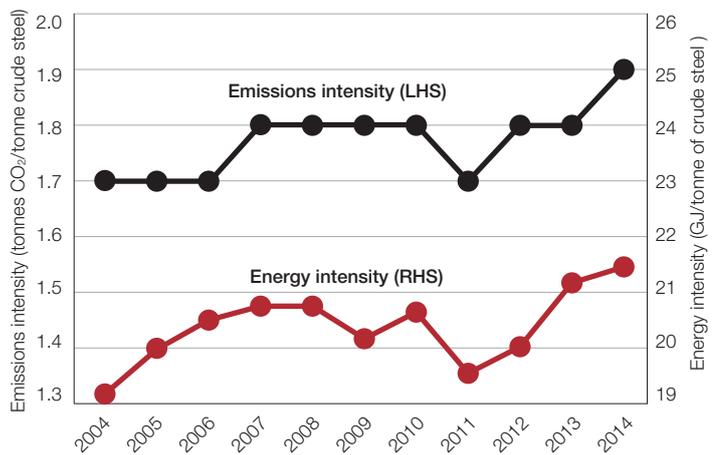
Source: World Steel Association

Graph B: Steel industry 2 degree transition pathway
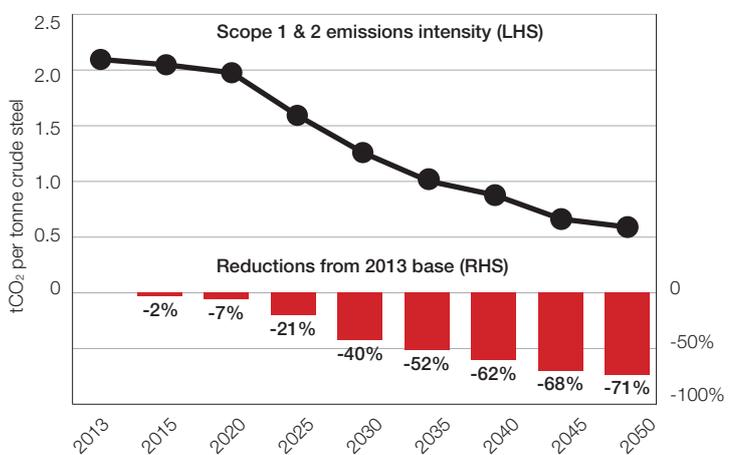
Source: Aligning corporate greenhouse-gas emissions targets with climate goals' in Nature Climate Change (2015), updated using IEA Energy Technology Perspectives 2016

Company findings

Top-ranked companies

▼ **POSCO** is ranked first and performs strongly across most key areas. It has a below average emissions intensity, and unlike several other steelmakers has demonstrated an ability to reduce its emissions intensity significantly in recent years. Its targets are consistent with a 2-degree sectoral decarbonization pathway as far as its target expiry in 2020. It has developed and commercialized a technology FINEX, providing incremental emissions reductions from steelmaking by eliminating sintering and coke oven processes. The technology has potential to be combined with CCS due to high concentrations of CO_2 in waste gases. It also has other active projects to separate and capture CO_2, and has undertaken early stage work on CCU and hydrogen-based steelmaking.

▼ **SSAB** ranks second. Its emissions intensity is low, driven by significant electric arc furnace (EAF) operations, and Europe-based blast furnace-basic oxygen furnace (BF-BOF) plants that it states benchmark as among the most carbon efficient globally. SSAB's emissions reduction target is among the strongest of companies assessed. It recently announced a long term breakthrough emissions reduction project, HYBRIT, working toward a hydrogen-based steelmaking process using renewable energy that envisages elimination of almost all the process emissions of steelmaking. It is aiming for a working demonstration plant around 2025, with potential for commercialisation envisaged a further one to two decades after that.

▼ **ThyssenKrupp** is ranked third. Its emissions intensity is the lowest of companies we assessed that focus on the blast furnace steelmaking route – only Hyundai Steel and SSAB with significant electric arc furnace operations have lower emissions intensities. Its water consumption intensity and water stress risk are also among the lowest we observed. It is pursuing a CCU project, Carbon2Chems, seeking to create usable chemicals from CO and CO_2 waste gases from steelmaking, and has also participated in other collaborative breakthrough emissions technology initiatives. ThyssenKrupp's executive remuneration framework shows the greatest alignment with low carbon goals among companies in our sample.

▼ **Hyundai Steel** ranks fourth. It is the least emissions and energy intensive steelmaker assessed, driven by around half of its production being from the EAF route. Helped by these factors it also performs strongly on benchmarking of carbon pricing scenarios, and its emissions reduction target is proactive relative to peers. Limiting its overall ranking though, it does not disclose details of research into breakthrough emissions reduction technologies, and faces higher exposure to water stress than many others.

Bottom-ranked companies

▼ **US Steel** ranks last, driven by a high emissions intensity relative to peers, as well as the lack of any emissions reduction target, or recent progress in reducing its emissions intensity. Unlike most companies assessed, it lacks transparency on energy and water consumption, resulting in poor rankings on those factors. It was one of only a few steelmakers assessed not to provide evidence of actively pursuing research or pilot programs for breakthrough emissions reduction technologies.

▼ **Tata Steel** ranks second last. It provides limited transparency relative to other companies, only providing substantive environmental data for its India-based operations, representing only one-third of its operations by tonnes of steel produced globally. This lack of fully consolidated environmental disclosure provides investors with limited perspective of its environmental risks and performance and resulted in its omission from several quantitative benchmarking exercises. If it were included, its disclosed India-only emissions and energy intensities rank worse than average. It is also subject to a higher level of water stress than most companies assessed. Positively influencing its ranking, it has piloted a new bath smelting steelmaking technology, HIsarna, stated as capable of reducing steelmaking emissions by 20%, or up to 80% if able to be combined with CCS in future. However, significant additional funding will be required to achieve commercialization.

▼ **Evraz** ranks third last. It performs among the bottom companies on our emissions and energy benchmarking, and does not disclose forward-looking reduction targets, or any participation in research toward breakthrough emissions reduction technologies.

▼ **CSN** ranks fourth from last. It has the highest emissions intensity among companies assessed, and does not disclose any emissions reduction target. It has not participated in major announced breakthrough emissions reduction research projects. However, it performs strongly on water resilience benchmarking, with low water consumption per tonne of steel produced relative to peers.

Mid-ranked companies

ArcelorMittal ranks fifth. Its emissions and energy intensities are better than average and most other quantitative KPIs are in the average range overall, reflecting a diverse spread of operations worldwide. It ranks highly on breakthrough emissions reduction technology development, with a demonstration sized Lanzatech CCU plant to start operating in 2017 to convert steel waste gases into usable by-products. It also made some progress toward a CCS pilot, before putting plans on hiatus and withdrawing its application for EU funding in late 2012, but emphasizes that work continues toward realising this ambition. Analysis by InfluenceMap indicates that ArcelorMittal has been the most active in opposing unilateral carbon pricing in countries where it operates, including lobbying against strengthening the carbon price signal in Europe.

Nippon Steel & Sumitomo Metal Corp (NSSMC) ranks sixth. Its emissions intensity is slightly better than average and it has a relatively strong emissions reduction target, though it is demonstrating little progress in reducing actual emissions. Like other Japanese steelmakers it is part of the COURSE50 consortium to develop breakthrough technologies involving hydrogen-based reduction and carbon capture. InfluenceMap analysis identifies it as among the companies most obstructive to incremental carbon regulation and pricing in the steel industry.

China Steel ranks seventh. It ranks poorly on emissions transparency, failing to disclose consolidated environmental data based on its full operational footprint, excluding a key 100% owned steelmaking subsidiary that accounts one-third of its steel production. Once manually consolidated, its environmental efficiency metrics generally fall in the mid-range for companies assessed. It is an early adopter of CCU technology, building one of the first demonstration sized Lanzatech plants.

JFE Holdings ranks eighth. Its environmental efficiency metrics fall within the average range relative to its industry. With other Japanese steelmakers it is part of the COURSE50 consortium to develop breakthrough technologies involving hydrogen-based reduction and carbon capture.

Kobe Steel ranks ninth. Its emissions and energy intensities are above average and higher than other Japanese steelmakers. It does not have a public emissions reduction target. With other Japanese steelmakers it is part of the COURSE50 consortium to develop breakthrough technologies involving hydrogen-based reduction and carbon capture.

JSW Steel ranks tenth. It has high emissions and energy intensities, though has demonstrated progress in reducing them in recent years. Its emissions reduction target runs only to 2016, and it does not appear to be involved in significant breakthrough emissions reduction technology research.

Scope of report: Company selection

We selected the group of companies for our study as follows:

▼ Started with the 31 steel companies that responded to CDP's 2016 climate change questionnaire.

▼ Reviewed the ownership and nature of business activities of these companies.

▼ Excluded subsidiaries and privately owned companies.

▼ Excluded remaining companies whose primary business activity is iron ore mining or steel recycling not steelmaking – these companies had much lower emissions and emissions intensities than steelmakers. One company, Vale, with primarily mining operations was also already included in CDP's sector report on diversified miners.

▼ Excluded the steel companies that focused on downstream processing and value-added products, without significant crude steelmaking operations.

▼ Excluded one remaining company, Salzgitter AG, which provided its first full response to the CDP climate change questionnaire during the course of our research process.

▼ Added US Steel which did not respond in 2016 but did so for 2015 and many years prior.

Following this process we were left with a set of 14 companies, which together represent approximately US$118 billion in market capitalization and account for 92% of the combined operational (Scope 1 and 2) emissions of the 31 steel companies that responded to CDP. The activities of the 14 companies are all significantly focused on steelmaking using the blast furnace-basic oxygen furnace (BF-BOF) or electric arc furnace (EAF) routes of production.

Linking our findings to investment choices

We recognise that investment decisions are based on a multitude of different factors and that some of these can be misaligned with emissions reduction efforts.

Our League Table is not intended as definitive winners and losers for investment purposes, but more as a proxy for business-readiness in an industry likely to be impacted by more stringent carbon regulations needed to meet long-term climate objectives.

We would flag that companies towards the bottom of our League Table may be higher risk investments from a sustainability perspective than those towards the top.

Methodology

We score each steel company based on a number of different metrics which are first ranked and then weighted within each key area (see table overleaf for metric weightings within each key area) to give a weighted rank for each area. We then grade each area from A to E based on these weighted ranks. We calculate the overall League Table score by weighting the weighted ranks for each key area.

Each of the key areas has a separate chapter within this report. We disclose the precise methodology for how we rank and grade each metric in an appendix.

A summary of key areas, associated metrics and relative weightings within the League Table

Key area in League Table	Link to company earnings	Metrics	Metric weighting within key area	Key area weighting
Emissions and energy management	Measures to reduce emissions deliver cost benefits, and are a proxy for wider operational efficiency measures. Energy costs account for a significant share of total steel manufacturing costs. Energy efficiency efforts can yield significant cost savings and higher profit margins.	i) Emissions intensity per tonne of crude steel produced (2013-15) ii) Reduction in emissions intensity per tonne crude steel (2009-15) iii) Emissions data transparency iv) Energy intensity per tonne crude steel (2013-15) v) Reduction in energy intensity per tonne crude steel (2010-15)	35% 10% 15% 30% 10%	30%
Emissions targets and pathways	Announced emissions reductions targets and companies' progress toward them provide a forward-looking indicator of progress and commitment to lowering climate change-related risks.	i) Quality of emissions reduction target (vs. science-based levels) ii) Company performance against own target	75% 25%	17.5%
Carbon cost exposure	The financial exposure of meeting costs of carbon pricing schemes across a number of simplified scenarios. This is a direct financial cost to companies and thus impacts earnings.	i) Carbon cost exposure under intensity benchmarking ii) Potential carbon cost exposure under full emissions allowance auctioning iii) Company use of internal carbon price	50% 30% 20%	10%
Low carbon technology development	Parts of the steel industry operate close to theoretical maximum efficiency and large emissions reductions are infeasible without technological breakthroughs. Focus on R&D and participation in announced new low emissions technology development is an indicator of which companies may gain future competitive advantage through technological breakthroughs.	i) Participation in announced breakthrough emissions reduction technology projects. Projects' expected potential to reduce emissions, projected timing of commercialisation of technologies, announced dollar investments ii) Research & development expense / Sales	75% 25%	17.5%
Water resilience	Localised water issues at steel production sites can pose risks to operational continuity.	i) Water stress risk exposure (using WRI Aqueduct) ii) Water consumption intensity iii) Water recycling rate	50% 40% 10%	15%
Climate governance	Companies that are supportive of regulation which facilitates a low-carbon transition are likely to be better placed to benefit from it. Remuneration structures incentivizing management of climate change issues contribute to their priority versus other corporate goals.	i) InfluenceMap score ii) Remuneration structures providing incentives for the management of climate change issues	75% 25%	10%

Source: CDP

For further study

Areas for further research include:

▼ Analysis of the potential for production route substitution opportunities, from blast furnace to electric arc furnace-based steelmaking, and market and regulatory dynamics that may create opportunities for greater use of scrap steel.

▼ Advanced carbon price modeling, developing and integrating exposure factors currently analyzed under separate scenarios. Analyzing potential for carbon cost pass-through to end product prices as further countries adopt carbon pricing.

▼ Enhanced analysis of company innovation activities, including R&D expenditures specific to emissions and energy reduction activities, and more detailed analysis of technological progress and prospects.

▼ Extending innovation analysis from process innovation to also include product innovation, such as sales of high strength, lightweight steel, and life cycle analysis of products.

▼ Investigate if the concept of 'stranded assets' could apply to the steel industry – in particular if the timing of refurbishment or replacement of steel facilities based on a need to lower emissions could result in significant asset writedowns.

Emissions and energy management

▼ As a group, the assessed steelmakers show little overall improvement in emissions or energy performance in recent years. More companies have increased their emissions and energy intensities than have reduced them over the period assessed.

▼ Hyundai Steel is a leader on emissions and energy management. It has the largest share of production from the electric arc furnace (EAF) production route, which offers significant emissions reduction potential versus the traditional blast furnace-basic oxygen furnace (BF-BOF) route which uses coking coal. ArcelorMittal and POSCO also perform strongly overall versus peers.

▼ US Steel and CSN are poor performers. They each have among the highest emissions and energy intensities of steel production and have not shown progress in reducing them in recent years.

▼ Several companies' ranking is weighed down by a lack of transparency in emissions disclosures. Tata Steel and China Steel omit significant wholly-owned steelmaking subsidiaries from their emissions disclosures, hampering efforts to accurately benchmark performance on a company-wide basis.

Overview

The World Steel Association calls climate change "the biggest issue for the steel industry in the twenty-first century". Steelmaking is one of the most emissions intensive activities in the global economy, and represents approximately 6-7% of global anthropogenic greenhouse gas emissions[3]. Additionally, steel companies report to CDP that energy represents as much as 40-45% of their operational costs.

Steel is in widespread use in numerous industrial and consumer applications, many of them with limited substitutes for less emissions and energy intensive materials. Steel production and use has grown dramatically in the past decade, driven by high rates of economic growth and urbanisation in emerging markets. With this, steel industry emissions have also grown considerably. The steel industry claims to operate at high levels of efficiency, with very limited ability to improve its emissions profile or energy efficiency based on available technology and production processes.

Steel production occurs using the following processes, or routes:

▼ Blast furnace-basic oxygen furnace (BF-BOF) route. This entails first preparing iron ore in sintering plants, and coke by baking coal without oxygen at high temperatures in coke oven plants. The iron ore is then reduced using coke in the blast furnace to produce hot metal, then transformed into liquid steel in a basic oxygen furnace, before further processing into finished steel products. This is also referred to as the integrated route and 74% of steel is produced in this manner globally.

▼ Scrap-based electric arc furnace (scrap-EAF) route. This route uses primarily scrap (recycled) steel, re-melted using electricity, to produce new steel products.

▼ Direct reduction iron EAF (DRI-EAF) route. Iron ore is reduced using natural gas or coal to produce sponge iron, before being transformed into liquid steel using EAF. Natural gas-based DRI only occurs in small volumes in regions where cheap natural gas prices make production cost effective.

Total EAF based production accounts for 25% of world steel production.

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3.   Kim and Worrell in Energy Policy (2002), IPCC (2007)

Steel production by route

Hyundai Steel	
SSAB	
ArcelorMittal	
NSSMC	
Kobe Steel	
US Steel Corp	
Global	
Asia	
China	
European Union (28)	
NAFTA	

0%　20%　40%　60%　80%　100%

- ■ Blast furnace-Basic oxygen furnace
- ■ Electric arc furnace
- ■ Other
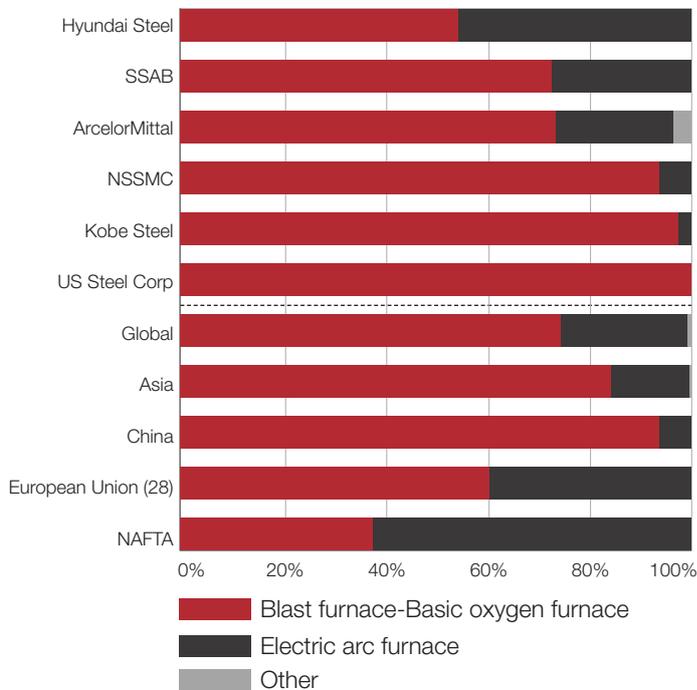
Source: Company reports, World Steel Association

A large share of steel industry emissions originate from the use of coal to reduce iron ore in the BF-BOF route. Incremental emissions reductions are possible throughout the steelmaking process by applying a number of best available techniques. We highlight some of those key available emissions and energy reduction measures in the table below. Steel produced through the scrap-EAF route can also provide very significant emissions reductions relative to the BF-BOF route, though wider adoption is limited by a number of factors, discussed in the accompanying box.

However, a large part of steel industry emissions cannot be significantly reduced based on current technologies and fuel feedstock. The limited current technological options to reduce the emissions profile of steelmaking creates challenges in achieving global and country climate targets, such as the 2 degree ambition agreed at COP21. In this section, we examine companies' current emissions and energy intensities, and what incremental progress they are demonstrating in reducing them. We identify five key metrics across three different areas to assess steel companies' emissions and energy performance.

Key incremental emissions reduction opportunities

Best available technique	Steelmaking process	Description
Coke Dry Quenching (CDQ)	Coke Oven	Dry quenching of the coke, in place of wet quenching, reduces dust emissions and is used to recover sensible heat that would otherwise be lost from the coke. Treating coke by CDQ also enhances its quality, reducing coke consumption in the blast furnace.
Waste Gas Recirculation	Sinter Plant	Sensible heat from waste gases emitted in the sintering process are recirculated back to the sinter bed. This technique reduces emissions from waste gas flow and can lead to a decrease in energy consumption.
Pulverised Coal Injection (PCI)	Blast Furnace	PCI is used as a supplement or replacement of coke in the blast furnace to speed up the conversion of iron ore to iron. This reduces coke production, thus reducing emissions and energy consumption from coke making.
Top Pressure Recovery Turbine (TRT)	Blast Furnace	TRTs recover the large volume of gases in the blast furnace. These top gases are used to drive a turbine and generate electrical power or used as a fuel in the iron and steel manufacturing processes.
BOF Gas and Heat Recovery	Basic Oxygen Furnace (BOF)	BOF gas produced during oxygen blowing is recovered in a waste heat boiler and used to generate high pressure steam.The exhaust gas from the BOF reaches temperatures of 1900°C. The recovery of this gas is the single most energy-saving improvement in the BOF process.
EAF Scrap Preheating	Electric Arc Furnace	Preheating scrap reduces the power consumption of the EAF by using waste heat as the energy source to preheat the charge.
Thin Strip Casting (TSC)	Downstream Processing	In TSC, steel is cast directly to slabs with a thickness between 30 and 60 mm, instead of slabs with a thickness of 120-300mm. The process integrates casting and hot rolling, thereby reducing energy consumption.

Source: European Commission (2010). Best Available Techniques (BAT) Reference Document For Iron and Steel Production, Industrial Emissions Directive 2010/75/EU
United States Environmental Protection Agency (2012). Available and Emerging Technologies for Reducing Greenhouse Gas Emissions from the Iron and Steel Industry
Energy Efficiency Improvement and Cost Saving Opportunities for the U.S. Iron and Steel Industry, An ENERGY STAR® Guide for Energy and Plant Managers

Emissions intensity performance

We analyze the historic profile and trends in operational emissions from steel production from 2009-2015, including Scope 1 and Scope 2 emissions. We use emissions-intensity metrics, normalized per tonne of crude steel rather than absolute emission levels to avoid penalizing companies that grow faster than others.

▟ **Metric 1) Current steel production emissions intensity:** This metric identifies the companies with the lowest current emissions intensity from steel production. Though several companies assessed also have activities in non-steelmaking business segments, it is difficult and potentially misleading to compare companies varying exposures to other heterogeneous business segments, which is why we assess companies' steel production efficiency only. This is the dominant source of emissions for all the companies we assessed.

▟ **Metric 2) Reduction in steel production emissions intensity:** This metric identifies the extent to which companies have reduced their emissions intensity over the period 2009-2015. As cumulative carbon emissions matter from a global warming perspective, instead of using a compound annual growth rate (CAGR) calculation, which only looks at the first and final year's data points, we apply a proprietary function which accounts for a company's emissions-intensity profile over each of the years 2009-2015 and adjusts for anomalies.

Data transparency

We undertake a review of the quality, transparency and level of sophistication of the companies' responses to CDP on Scope 1 and 2 emissions. Investors require this transparency to reduce uncertainty and ensure company-by-company comparisons occur on a reasonable basis.

▟ **Metric 3) Emissions data transparency:** We form a scorecard that assesses the companies' emissions accounting procedures. The scorecard includes: method of consolidation for emissions (the reporting boundary), level of third party verification and assurance, scope of verification and any exclusions or uncertainties relative to the reporting boundary.

Energy intensity performance

Managing efficient use of energy is a substantial opportunity to deliver cost savings for companies.

▟ **Metric 4) Current steel production energy intensity:** This metric identifies the companies with the lowest current energy intensity per tonne of crude steel production.

▟ **Metric 5) Reduction in steel production energy intensity:** This metric identifies the extent to which companies have reduced their energy intensity over the period 2010-2015. Instead of using a compound annual growth rate (CAGR) calculation, which only looks at the first and final year's data points, we apply a proprietary function which accounts for a company's energy intensity profile over each of the years of 2010-2015.

Opportunities and limitations of EAF

The EAF steelmaking route provides a tantalising opportunity to reduce emissions, at face value offering emissions reductions of up to 75% versus the BF-BOF route. Besides this it offers some other advantages, including low up front capital costs and greater ability to adapt to peaks and troughs in steel demand, without the same need for constant operation to maintain efficiency as BF-BOF. However, its ability to make inroads versus production from the BF-BOF route is limited by a number of factors:

▟ Limited supplies of scrap. The current demand for steel products vastly outpaces the supply of scrap, meaning the balance needs to be produced using the BF-BOF route. A much higher share of EAF steel would require much higher scrap supplies from the recycling economy, or a much lower demand for steel, or more likely both. Some forecasts suggest scrap could make up a large share of steel production toward the end of this century. Regulatory reforms could help to achieve a higher share of recycling of scrap and accelerate this transition.

▟ Quality issues. EAF tends to be used to produce steel products that have a greater tolerance for impurities that may be introduced from alloys in the scrap. This means that some high value steel products are almost exclusively produced using BF-BOF. This situation could be helped in future by technological advances to more readily separate impurities, in line with processes that remove impurities in recycled aluminium.

▟ EAF is not always cost competitive. Dependent on key costs like the price of electricity and the price of scrap steel at a given location and time, EAF production may not be attractive to steelmakers.

Emissions of steelmaking production routes

Source: Ecofys
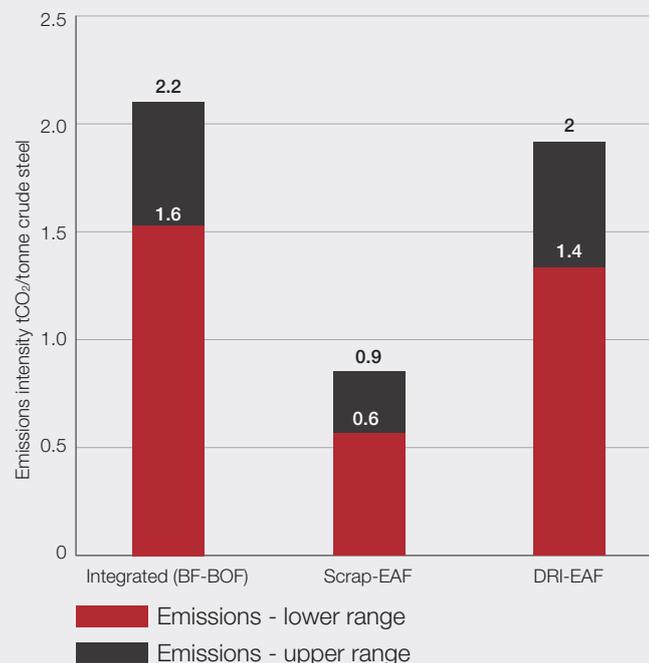
Highlights

▼ Hyundai Steel excels in this key area, having both the lowest emissions and energy intensity of steel production, driven by a high EAF production share.

▼ The largest three steelmakers assessed, ArcelorMittal, Nippon Steel & Sumitomo Metal, and POSCO all performed consistently above average across the metrics assessed, though rarely stand out as the very top performers on individual metrics.

▼ CSN, US Steel and Tata Steel consistently performed among the worst on emissions and energy benchmarking.

▼ Seven companies reported emissions intensities lower than science-based levels for 2015, while six companies had emissions intensities above 2015 science-based levels[4].

Emissions and energy management performance summary

Company	Emissions management rank	Emissions data transparency rank	Energy management rank	Overall weighted rank	Emissions & energy management rank	Emissions & energy management grade
Hyundai Steel	2	6	1	3.5	1	A
ArcelorMittal	3	2	6	4.2	2	A
POSCO	4	7	3	4.3	3	A
Nippon Steel & Sumitomo Metal Corp (NSSMC)	6	3	5	5.0	4	B
SSAB	1	10	10	6.3	5	B
China Steel	9	9	2	6.5	6	B
ThyssenKrupp	5	4	10	6.9	7	C
JFE Holdings	7	14	4	6.9	8	C
JSW Steel	10	5	7	7.5	9	C
Evraz	8	12	9	7.9	10	D
Kobe Steel	11	12	8	8.9	11	D
CSN	13	1	10	10.0	12	D
US Steel	12	8	10	10.5	13	E
Tata Steel	14	11	10	12.0	14	E

| **Weighting** | **45%** | **15%** | **40%** | | | |

Source: CDP

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4. The levels defined by the decarbonization trajectory for the steel industry in order to meet the global agreement of limiting global temperature increase to below 2 degrees compared to pre-industrial levels. See the next chapter "Emissions targets and pathways" for more details.

Emissions intensity performance

▼ SSAB, Hyundai Steel and ArcelorMittal lead on emissions intensity. Key contributors to this result were their significant proportions of steel production using the EAF route. SSAB and ArcelorMittal were also among a minority of companies to show a reduction in emissions intensity over the period assessed.

▼ CSN and US Steel are poor performers, with the highest emissions intensities as well as having those efficiency levels worsen over the period assessed.

▼ Only five companies demonstrated a reduction in emissions intensity since 2009, while eight saw an increased intensity. Accounting for this, in part, are overcapacity issues that have plagued the steel industry in recent years – steelmaking plants tend to operate at less efficient levels when not producing at or near full capacity.

Emissions intensity performance summary

Company	Current emissions intensity rank	Reduction in emissions intensity rank	Overall weighted rank	Emissions intensity rank
SSAB	2	1	1.8	1
Hyundai Steel	1	10	3.0	2
ArcelorMittal	4	4	4.0	3
POSCO	5	2	4.3	4
ThyssenKrupp	3	12	5.0	5
Nippon Steel & Sumitomo Metal Corp (NSSMC)	5	8	5.7	6
JFE Holdings	7	6	6.8	7
Evraz	8	5	7.3	8
China Steel	9	7	8.6	9
JSW Steel	11	3	9.2	10
Kobe Steel	10	9	9.8	11
US Steel	12	11	11.8	12
CSN	13	13	13.0	13
Tata Steel	14	14	14.0	14
Weighting	**78%**	**22%**		

Source: CDP

Current emissions intensity (median 2013-2015)

Bar chart: tCO₂e / tonne crude steel

- Hyundai Steel: 0.97
- SSAB: 1.40
- ThyssenKrupp: 1.86
- ArcelorMittal: 1.97
- NSSMC: 1.99
- POSCO: 1.99
- JFE Holdings: 2.00
- Average: 2.03
- Evraz: 2.17
- China Steel: 2.18
- Kobe Steel: 2.36
- JSW Steel: 2.45
- US Steel: 2.51
- CSN: 2.61
- Tata Steel (India only): 2.43

2015 sectoral line value: 2.08

Legend:
- Emissions intensity (Scope 1 & 2)
- 2015 sectoral emissions intensity consistent with 2-degree decarbonization trajectory

Source: CDP

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Change in emissions intensity p.a. (2009-2015)

Change in emissions intensity 2009-2015

Company	Value
SSAB	-1.8%
POSCO	-1.8%
JSW Steel	-1.7%
ArcelorMittal	-1.2%
Evraz	-0.5%
JFE Holdings	0.1%
China Steel	0.2%
Average	0.3%
NSSMC	0.3%
Kobe Steel	0.5%
Hyundai Steel	2.3%
US Steel	2.4%
ThyssenKrupp	2.5%
CSN	2.8%
Tata Steel (India only)	-0.3%

Source: CDP, company reports

Data transparency

- CSN is ranked top with 100% of its Scope 1 and 2 emissions verified with reasonable assurance.

- Evraz, JFE Holdings, and Kobe Steel report that they do not have external assurance of any of their CO_2 emissions, and rank bottom.

- The rankings of Tata Steel and China Steel are negatively impacted by their decisions not to include key high emitting, 100% owned, steelmaking

subsidiaries in their public emissions and other environmental disclosures. For the purposes of our other analysis in this report, we have sought to consolidate these based on other sources to enable like-for-like comparisons. This was possible for China Steel based on separate Chinese language-only reporting by its subsidiary Dragon Steel, but insufficient information was available for Tata Steel Europe for us to provide a consolidated view of Tata Steel emissions as a whole.

Data transparency summary

Company	Rank	Total score^	Boundaries	Scope 1 verification	Scope 1 assurance type	Proportion of scope 1 verified	Uncertainty scope 1 verified	Scope 2 verification	Scope 2 assurance type	Proportion of scope 2 verified	Uncertainty Scope 2 verified
CSN	1	17.1	OC	Complete	Reasonable	100%	2%<X<5%	Complete	Reasonable	100%	2%<X<5%
ArcelorMittal	2	13.3	OC	Complete	Limited	100%	2%<X<5%	Complete	Limited	100%	2%<X<5%
NSSMC	3	12.3	OC	Complete	Limited	90%	0%<X<2%	Complete	Limited	90%	0%<X<2%
Thyssenkrupp	4	10.3	FC	Complete	Limited	100%	0%<X<2%	Complete	Limited	100%	0%<X<2%
JSW Steel	5	10.0	OC	Underway	Limited	100%	2%<X<5%	Underway	Limited	100%	2%<X<5%
Hyundai Steel	6	8.1	OC	Complete	Reasonable	100%	2%<X<5%	Complete	Reasonable	NR	2%<X<5%
POSCO	7	6.7	OC	Complete	Limited	100%	0%<X<2%	Complete	Limited	NR	0%<X<2%
US Steel	8	6.4	FC	Complete	Reasonable	100%	2%<X<5%	NR	NR	NR	2%<X<5%
China Steel	9	5.1	Other*	Complete	Reasonable	67%*	5%<X<10%	Complete	Reasonable	67%*	5%<X<10%
SSAB	10	3.0	OC	Underway	High	42%	0%<X<2%	NR	NR	NR	0%<X<2%
Tata Steel	11	2.2	Other*	Complete	Limited	34%*	0%<X<2%	Complete	Limited	34%*	0%<X<2%
Evraz	12	0.0	OC	Complete	None	NR	No assesment of uncertainty	NR	NR	NR	NR
Kobe Steel	12	0.0	Other	Complete	None	NR	2%<X<5%	NR	NR	NR	0%<X<2%
JFE Holdings	14	-0.1	OC	Complete	Limited	NR	0%<X<2%	NR	NR	NR	0%<X<2%

^ Refer to the methodology section for steps used to calculate the total score.
OC = Operational control, FC = Financial control, NR = No reply
* These fields have been modified from company disclosed values based on identified 100% owned steelmaking subsidiaries that are outside the scope of the company's public emissions reporting. Modified values for proportion verified for China Steel are based on consolidation of Dragon Steel which is approximately 33% of the consolidated entity's GHG emissions. Modified values for proportion verified for Tata Steel are based on the 34% share of steel production capacity of Tata Steel India within the consolidated Tata Steel entity.

Source: CDP, company reports

Non-consolidated emissions disclosures

	Tata Steel	China Steel
Disclosed emissions (tCO$_2$)	24,708,159	21,112,730
Disclosed emissions intensity (tCO$_2$/tonnes crude steel)	2.54	2.291
(a) Steel production - unconsolidated (million tonnes crude steel)	9.96	9.68
(b) Steel production - consolidated (million tonnes crude steel)	26.31	14.67
Difference between consolidated & unconsolidated production	164%	52%
Unconsolidated but relevant emissions sources	Tata Steel Europe, NatSteel Singapore, Natsteel Thailand (100% owned subsidiaries)	Dragon Steel (100% owned subsidiary)
Identified unconsolidated emissions	15,000,000	9,745,448
Total identified emissions	39,800,000 (not comprehensive)	30,858,178 (comprehensive)
Difference to disclosed emissions	>60%	46%
Consolidated emissions intensity (tCO$_2$/tonnes crude steel)	Unknown	2.18

Source: CDP, company reports, EU ETS transaction logs

Energy intensity performance

▼ Hyundai Steel has the lowest energy intensity per ton of crude steel produced, with an intensity of nearly half of the most energy intensive company, Evraz. Contributing to this result is Hyundai Steel's high proportion of crude steel production from the EAF route, 45% of total production, where energy consumption is around a third of the BF-BOF route.

▼ Evraz has the greatest energy intensity reduction rate but also has the highest intensity level. In contrast, Hyundai Steel's intensity increased the most but its current intensity is one of the lowest.

▼ Five companies rank equal last in this analysis due to lack of comparable data. The energy data disclosed by CSN, SSAB and US Steel appears to exclude energy content in raw materials used; ThyssenKrupp does not disclose energy consumption specific to its steel production segments. Tata Steel's disclosed data only covers its operations in India but not the larger portion of its operations elsewhere.

Energy intensity performance

Company	Current energy intensity	Reduction in energy intensity (2010-2015)	Overall weighted rank	Energy intensity rank
Hyundai Steel	1	9	3.0	1
POSCO	2	7	3.3	2
China Steel	3	4	3.3	2
JFE Holdings	4	5	4.3	4
Nippon Steel & Sumitomo Metal Corp (NSSMC)	4	8	5.0	5
ArcelorMittal	6	3	5.3	6
JSW Steel	8	2	6.5	7
Kobe Steel	7	6	6.8	8
Evraz	9	1	7.0	9
CSN	10	10	10.0	10
US Steel	10	10	10.0	10
SSAB	10	10	10.0	10
Tata Steel	10	10	10.0	10
ThyssenKrupp	10	10	10.0	10
Weighting	**75%**	**25%**		

Source: CDP

Energy intensity of crude steel production (median 2013-2015)

Company	Energy intensity (GJ/tonne of crude steel)
Hyundai Steel	15.2
POSCO	21.3
China Steel	22.6
JFE Holdings	22.8
NSSMC	22.8
Average	23.7
ArcelorMittal	23.8
Kobe Steel	26.9
JSW Steel	28.1
Evraz	30.0
Tata Steel (India only)	25.2
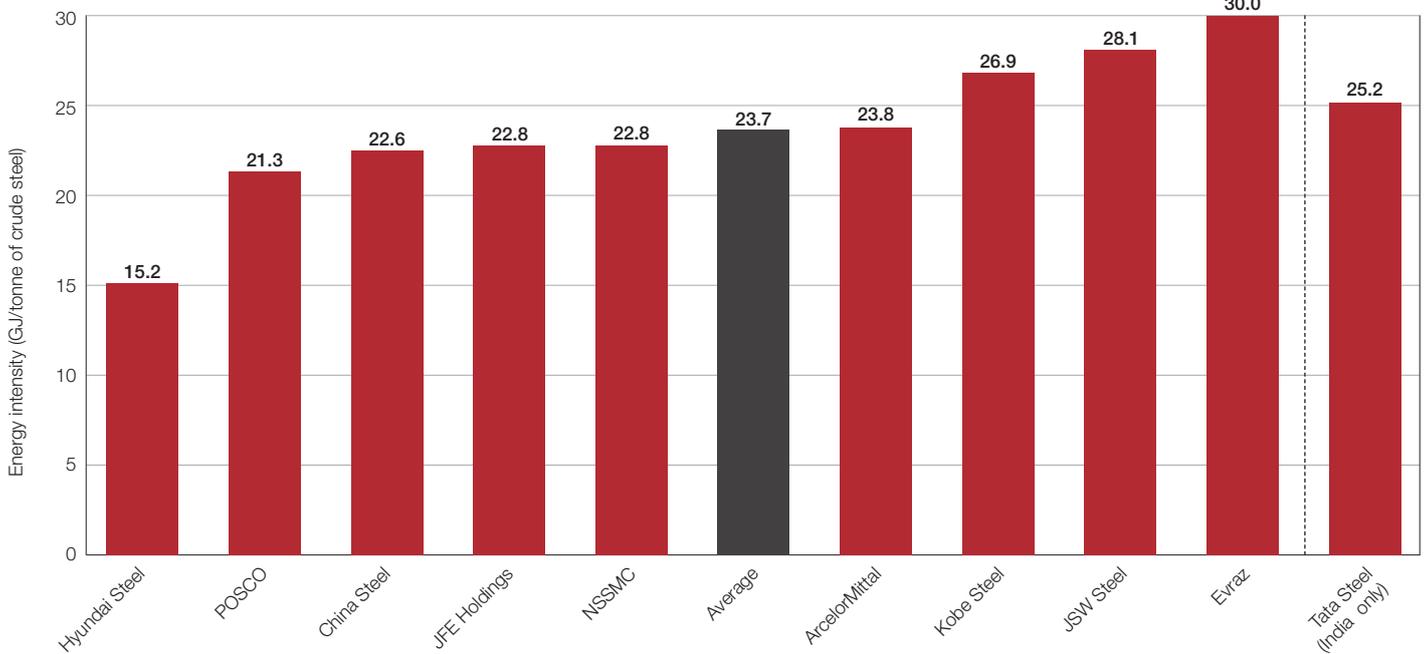
Source: CDP, company data

Reduction in crude steel energy intensity (2010-2015)

Company	Change in energy intensity per annum
Evraz	-5.3%
JSW Steel	-1.2%
ArcelorMittal	-0.1%
Average	0%
China Steel	0.4%
JFE Holdings	0.5%
Kobe Steel	0.5%
POSCO	0.5%
NSSMC	0.7%
Hyundai Steel	3.9%
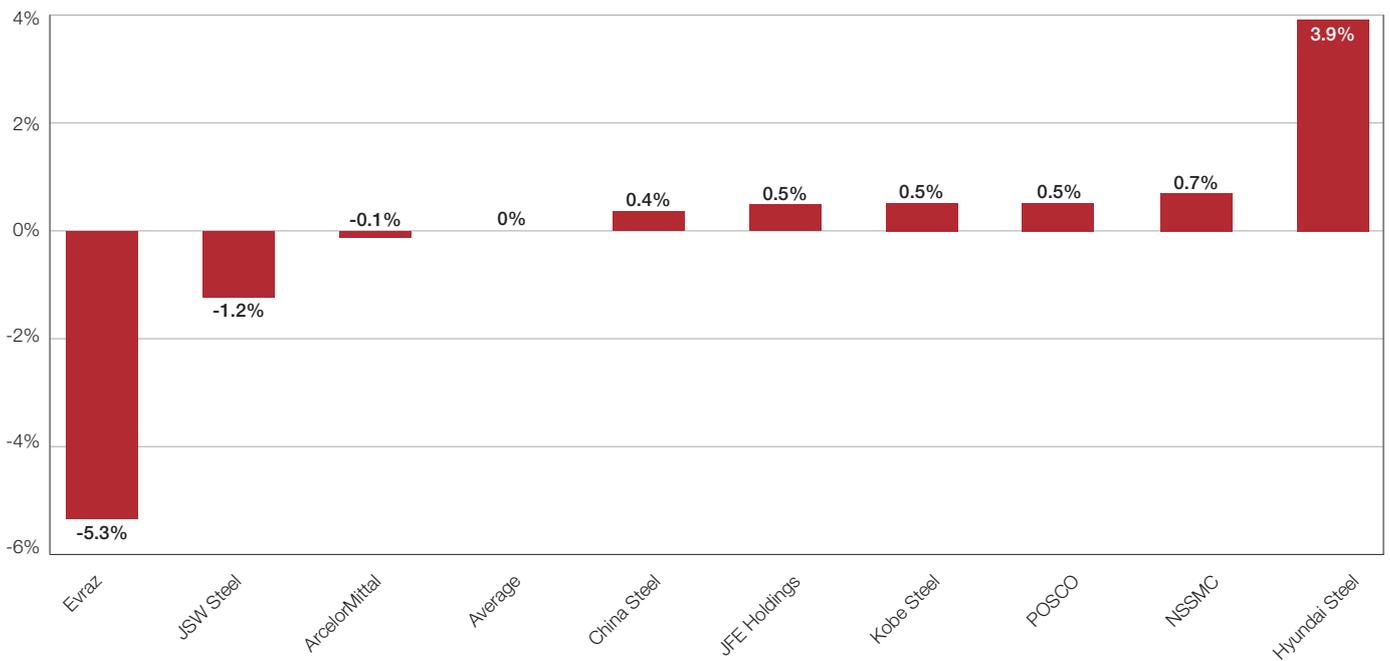
Source: CDP, company reports

Change in energy intensity per annum

Emissions targets and pathways

▜ In our analysis of company emissions reduction targets, SSAB, Hyundai Steel and ThyssenKrupp show the strongest combination of ambition and progress consistent with a science-based target approach.

▜ Four out of the fourteen companies assessed have not set any public emissions reduction targets, while a further two have targets that expire in 2016.

▜ All announced company targets expire by 2020 or earlier. Given the industry will need to achieve considerable further emissions reduction beyond 2020 to remain consistent with a 2 degree transition, investors may wish to engage with companies to encourage the setting of new and long term science-based targets, and monitor progress toward their achievement.

Overview

With global agreement to limit warming to 2 degrees in the Paris Agreement at COP21, and carbon pricing becoming an increasingly common feature globally, steelmakers will come under increasing pressure to reduce their high process emissions. Companies are increasingly subject to the expectation from investors and other stakeholders that they have transparent and ambitious emissions reduction targets in place as part of a comprehensive strategy to reduce emissions and associated risks.

In this section, we assess companies' emissions reduction targets against a decarbonization pathway for the steel sector consistent with the goal of limiting the global temperature increase to below 2 degrees Celsius compared to pre-industrial levels. We use the Sectoral Decarbonization Approach (SDA)[5], a science-based target setting methodology developed by the Science Based Targets (SBT) initiative[6], and projections of sectoral emissions and activity levels taken from the International Energy Agency's Energy Technology Perspectives 2016 report.

Emissions reduction targets

We assess companies' emissions reduction targets in terms of the ambition of the target as well as the performance of each company against its own target. We believe these factors can be used as a proxy for a company's intentions on future emissions management measures and the robustness of its strategy to manage climate-related risks.

Our proprietary analysis also assesses companies' performance against their own emissions reduction targets on a yearly basis to recognize the cumulative effect of greenhouse gas emissions in the context of a global carbon budget.

▜ **Metric 1) Quality of emissions reduction target:** This forward-looking metric determines whether each company target is weaker or stronger than the steel industry's science-based 2 degree sectoral decarbonization pathway as determined using the SDA[7]. We only consider targets that are active in 2015, and only consider Scope 1 and Scope 2 emissions.

▜ **Metric 2) Performance against target:** This metric analyses each company's performance against its own target. Our proprietary modelling enables us to assess the profile of companies' historic emissions annually against their respective targets. This method highlights those companies whose emissions trajectory consistently outperforms what is required to meet their target. The benefits of this are twofold: First, from a climate change perspective, reducing emissions on a cumulative basis is crucial, rather than reducing emissions aggressively only in the final year of a target's lifetime. Second, companies that consistently outperform their emissions reduction targets are those that consistently benefit from reduced carbon risk.

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5. Sectoral Decarbonization Approach (SDA): A method for setting corporate emission reduction targets in line with climate science, Science Based Targets initiative, Version 1, May 2015 (http://sciencebasedtargets.org/SDA/)
6. The Science Based Targets initiative is a joint collaboration between CDP, UN Global Compact, World Resources Institute (WRI) and WWF. The initiative encourages companies to set ambitious and meaningful emissions reduction targets that are aligned with what the latest climate science says is required to meet the long-term temperature goals adopted in the Paris Agreement.
7. While we adopt a metric based on the SDA methodology developed by the SBT initiative, our assessment of the quality of companies' emissions reduction targets should not be interpreted as an indication that any individual company's target would be approved as being 'science-based' by the SBT initiative. In its target assessments, the SBT initiative applies additional eligibility criteria concerning the boundary and timeframe of the target; use of intensity and absolute targets; annual reporting requirements; and inclusion of scope 3 emissions, which are not considered in this report.

Highlights

▼ Hyundai Steel is a clear leader in the ambition of its target, although its performance against its own target is ranked mid-range, whereas SSAB's target is ambitious and it also performs well against it.

▼ Four companies – CSN, Evraz, Kobe Steel and US Steel – have not disclosed any GHG emissions reduction targets that are active in 2015. Evraz specifically explains that its absence of an emissions reduction target is due to lack of regulatory pressure in jurisdictions in which it operates, e.g. Russia, Ukraine and the US, whereas Kobe Steel explains that its action is dependent on confirmation of the energy policy set by the Japanese government.

▼ JSW Steel and Tata Steel both have one-year targets expiring in 2016, which we consider too short-sighted to be meaningful. JSW Steel states that it has carbon emissions intensity targets for 2020 and 2030 communicated to the Indian government as an input for India's Intended Nationally Determined Contributions (INDC). However, those targets are less stringent than its targets for 2016 so are excluded from this analysis.

▼ China Steel's target is also less stringent than science-based levels. However, we note that it has committed via the SBT initiative to set a science-based target in future.

▼ JSW Steel and Nippon Steel & Sumitomo Metal are off-track to meet their own emissions reduction targets.

▼ All targets analysed expire in 2019 or 2020. This represents an opportunity for companies to set forthcoming targets that are both long-term and ambitious, and outline how they intend to achieve such reductions.

▼ We note that the steel industry 2 degree decarbonization pathway does not dictate aggressive abatement until after 2020. As such, even if companies meet or better the pathway to 2020, it is important for companies and their investors not to be complacent as much more rapid abatement is required beyond 2020.

Emissions targets and pathways summary

Company	Quality of target - average annual emissions intensity beat/(miss) 2DS pathway (tCO$_2$/tcs)	Rank	Average annual emissions intensity beat/(miss) company target pathway (tCO$_2$/tcs)	Rank	Overall weighted rank	Emissions targets and pathways rank	Emissions targets and pathways grade
SSAB	0.42	2	0.25	1	1.8	1	A
Hyundai Steel	1.11	1	0.01	5	2.0	2	A
ThyssenKrupp	0.09	4	0.10	2	3.5	3	B
NSSMC	0.10	3	-0.01	7	4.0	4	B
ArcelorMittal	0.07	5	0.00	6	5.3	5	C
JFE Holdings	0.02	6	0.06	4	5.5	6	C
POSCO	-0.01	7	0.10	3	6.0	7	C
China Steel (exc. Dragon Steel)	-0.04	8	0.11	8	8.0	8	C
JSW Steel	-0.32	9	-0.11	10	9.3	9	D
Tata Steel (India only)	-0.48	10	0.04	9	9.8	10	D
CSN	N/A	11	N/A	11	11.0	11	E
Evraz	N/A	11	N/A	11	11.0	11	E
Kobe Steel	N/A	11	N/A	11	11.0	11	E
US Steel	N/A	11	N/A	11	11.0	11	E

Weighting   **75%**   **25%**

Source: CDP, company data

Science-based steel industry decarbonization pathway and company target pathway
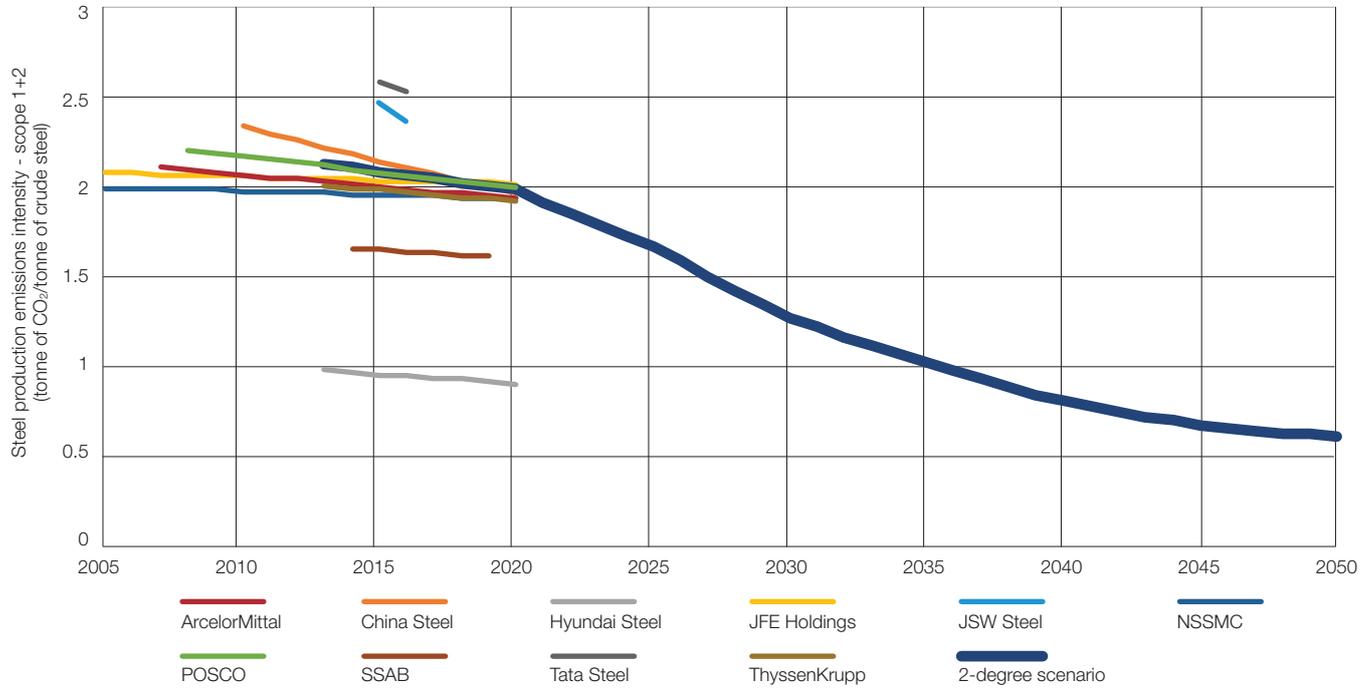
Source: IEA Energy Technology Perspectives 2016, CDP, company data

Carbon cost exposure

▼ US Steel, Tata Steel and JSW Steel are ranked in the last three. US Steel has significant proportions of EBIT at risk under carbon price scenarios that involve intensity benchmarking or full auctioning of allowances. It also does not have an internal price on carbon and does not plan to introduce one in the next two years. JSW Steel and Tata Steel have high emissions intensities and are subject to a rising tax on coal use.

▼ The two South Korean companies, Hyundai Steel and POSCO, are ranked first and fourth. They have amongst the lowest earnings exposures to carbon pricing in our full allowance auctioning scenario, although they have the highest portion of emissions exposed to carbon pricing schemes as all their steelmaking-related emissions are covered by the ETS in South Korea.

▼ Only four companies use an internal carbon price yet none of them disclose the levels of price used. Half of the companies in our study do not foresee using an internal carbon price within two years.

Overview

Carbon pricing is becoming an increasingly common part of regulation facing steelmakers globally. South Korea, the sixth largest steel producing country, put in place an emissions trading scheme (ETS) in 2015. China, which now has in place several regional ETS pilots, has announced it will introduce a national ETS in 2017. China today represents over 50% of world steel production. With it, a combined 70% of world steelmaking will face a carbon price by end of 2017, including national ETS, carbon taxes and climate-linked coal taxes.

At present, within the company sample for this report approximately 37% of companies' direct emissions are covered by existing or announced carbon pricing schemes. However, there is significant variation between companies: this ranges from CSN and China Steel operating almost exclusively in Brazil and Taiwan, respectively, with minimal carbon-related regulations, to Hyundai Steel and POSCO whose steelmaking operations are in South Korea and have their direct emissions subject to the South Korean ETS.

Until now, steelmakers facing carbon pricing have generally also received significant transitional assistance to account for their status as an emissions intensive but trade exposed industry, for which key international competitors do not always face an equivalent carbon price. Regulators in countries early to introduce carbon prices have been conscious of dual aims to encourage emissions reduction but also not encourage high emitting industry to simply relocate offshore, entailing 'carbon leakage'. Looking at disclosures to CDP from steelmakers with EU operations, transitional assistance levels in the form of free permit allocations under the EU ETS have often been higher than their direct EU emissions until now. As more countries put in place carbon prices though, it is likely that these high levels of assistance will be re-examined and reduced.

Allocation of EU ETS emissions allowances

Y-axis: Millions of tonnes of CO_2e

- Verified emissions
- Allowances allocated
- Allowances purchased
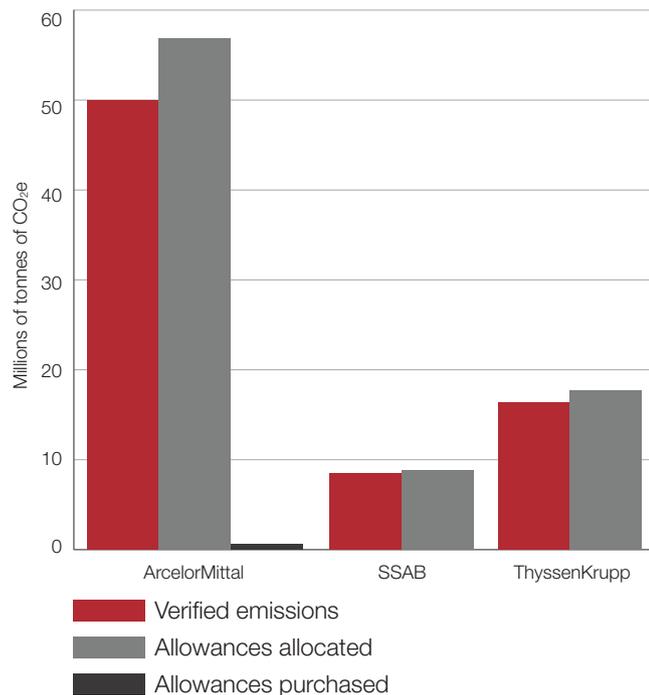
Source: CDP CC13.1a, owned and operated facilities

In this chapter, we use three metrics to assess companies' potential earnings exposure to carbon pricing. We make use of two simplified carbon pricing scenarios, one based on intensity benchmarking and another on full auctioning of all emissions allowances, and we identify which companies use an internal or shadow carbon price for internal planning purposes in anticipation of more widespread carbon pricing in future:

▼ **Metric 1) Carbon cost exposure under intensity benchmarking:** This is calculated according to the difference between a company's emissions intensity and the level consistent with the industry science-based decarbonization trajectory that acts as a benchmark. This approach is a simplified version of the approach that is used in existing ETS which allocates emissions allowances to each facility up to a certain benchmark level, but requires purchases of further emissions allowances for any emissions above that level. It favours companies with the most carbon efficient steel production. We calculate each company's carbon cost exposure using an illustrative carbon price of US$1 per tonne of carbon.

▼ **Metric 2) Carbon cost exposure under full auctioning:** In this illustrative scenario companies are required to pay for all direct emissions. We apply a price of US$1 per tonne of carbon to companies' global Scope 1 emissions.

Both Metric 1 and Metric 2 represent significant simplifications of carbon pricing as it presently exists. They show illustrative potential earnings risks based on scenarios for future pricing, rather than dollar estimates of earnings impacts of carbon pricing today. Aside from assuming a global coverage of carbon pricing and uniform carbon price which does not exist today, the scenarios ignore the potential for flow on effects on the traded price of steel products that might occur from more widespread global carbon pricing, or the changes in company emissions abatement activity that a widespread price on carbon may entail.

▼ **Metric 3) Company use of internal carbon price:** This metric assesses whether companies incorporate an internal carbon price into capital planning and investment decision-making.

Emissions split by geography and % exposure to key carbon pricing schemes
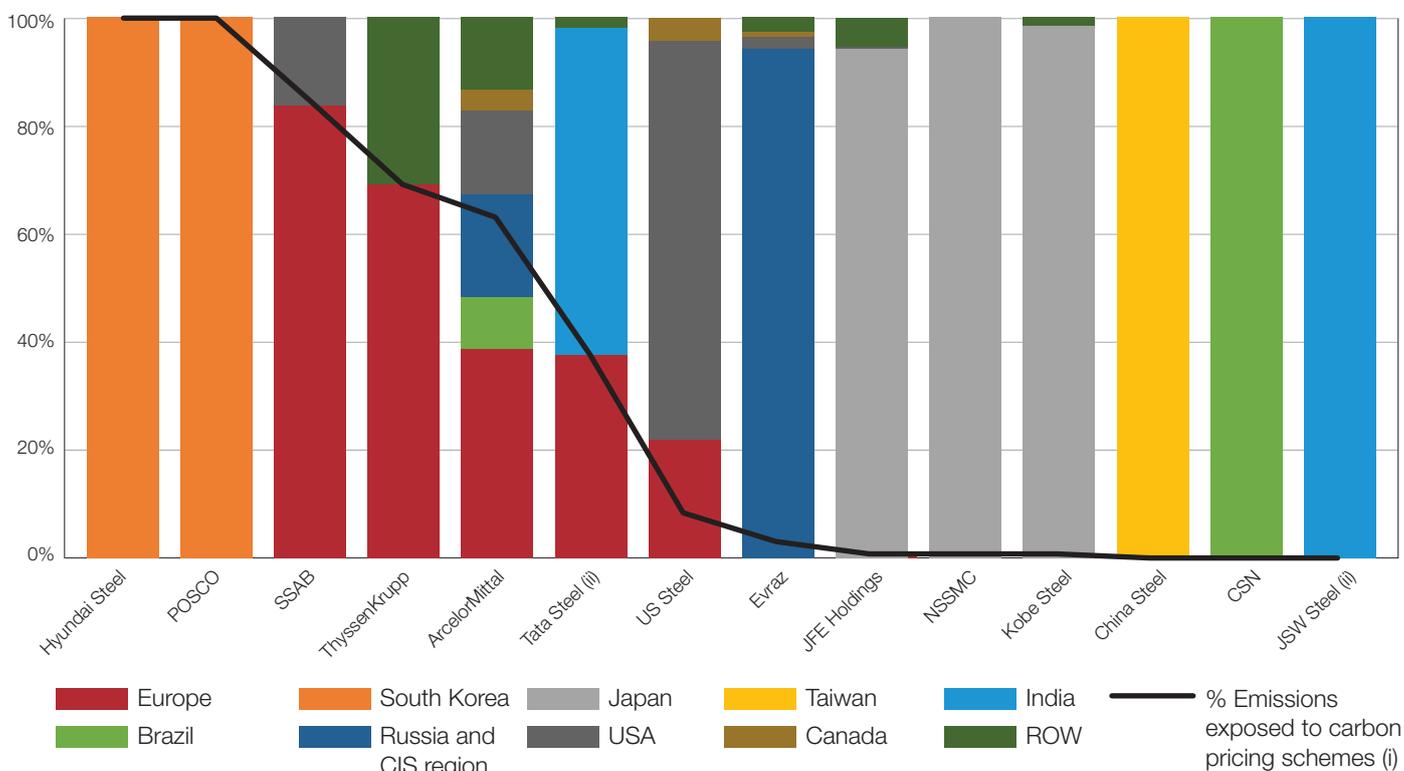
(i) % emissions exposed assumes 100% of emissions in Europe, South Korea, South Africa, Mexico and Kazakhstan exposed to carbon pricing schemes; when facility locations in Canada, US and Japan are unknown, we assume 52%, 7% and 1% of the emissions in the respective jurisdictions are exposed to carbon pricing schemes based on geographical coverage of the scheme in the country.
(ii) The company's operation in India may exposed to the Clean Energy Cess levied on coal, but the related carbon emissions in India are not included in this chart.

Source: CDP, company data

Highlights

▼ Hyundai Steel ranks top as it performs well in both scenarios of carbon cost exposure, with only 1% of its EBIT at risk per US$1 carbon price under a full auctioning scenario.

▼ US Steel is ranked bottom and has one of the highest potential EBIT at risk were it to face comprehensive carbon pricing: 2% of EBIT under intensity benchmarking and 10% of EBIT under full auctioning per US$1 carbon price. It also reported in its 2015 response to CDP, the latest available, that it does not expect to make use of an internal carbon price within two years.

▼ SSAB achieves the top rank in an intensity-based benchmarking scenario but close to the bottom in a full auctioning scenario. This is because SSAB has one of the lowest emissions intensities but very low EBIT in recent years.

▼ On average, 3% of company EBIT is at risk under full emissions allowance auctioning per US$1 carbon price, though this has a wide range from 1% (CSN) to 11% (ArcelorMittal).

▼ Half of the companies do not incur any carbon cost in our simplified intensity-based benchmarking scenario as their current crude steel production emissions intensity level is lower than the science-based level we have used in our calculations for 2015. Real world benchmarks used for carbon allowance allocations have more complex allocation rules, and multiple benchmarks for activities like sintering, coke making, iron making, and so on, at a level of granularity for which we lack data to reproduce. However, such benchmarks will tighten over time and make them increasingly difficult for companies to meet.

Carbon cost exposure summary

Company	Intensity-based carbon cost rank	Auctioning carbon cost rank	Internal carbon price rank	Overall weighted rank	Carbon cost exposure rank	Carbon cost exposure grade
Hyundai Steel	2	2	5	2.6	1	A
ThyssenKrupp	4	4	1	3.4	2	A
SSAB	1	12	1	4.3	3	B
POSCO	6	6	1	5	4	B
Nippon Steel & Sumitomo Metal	5	9	8	6.8	5	C
ArcelorMittal	3	14	8	7.3	6	C
CSN	11	1	8	7.4	7	C
Kobe Steel	10	3	8	7.5	8	C
Evraz	8	7	8	7.7	9	C
JFE Holdings	7	11	8	8.4	10	D
China Steel	9	10	5	8.5	11	D
JSW Steel	12	8	1	8.6	12	D
Tata Steel	14	5	5	9.5	13	E
US Steel	13	13	8	12	14	E
Weighting	**50%**	**30%**	**20%**			

Source: CDP

Carbon cost exposure under different scenarios

Legend:
- Metric 1) Carbon cost exposure under intensity benchmarking per US$1, % of EBIT
- Metric 2) Carbon cost exposure under auctioning per US$1, % of EBIT
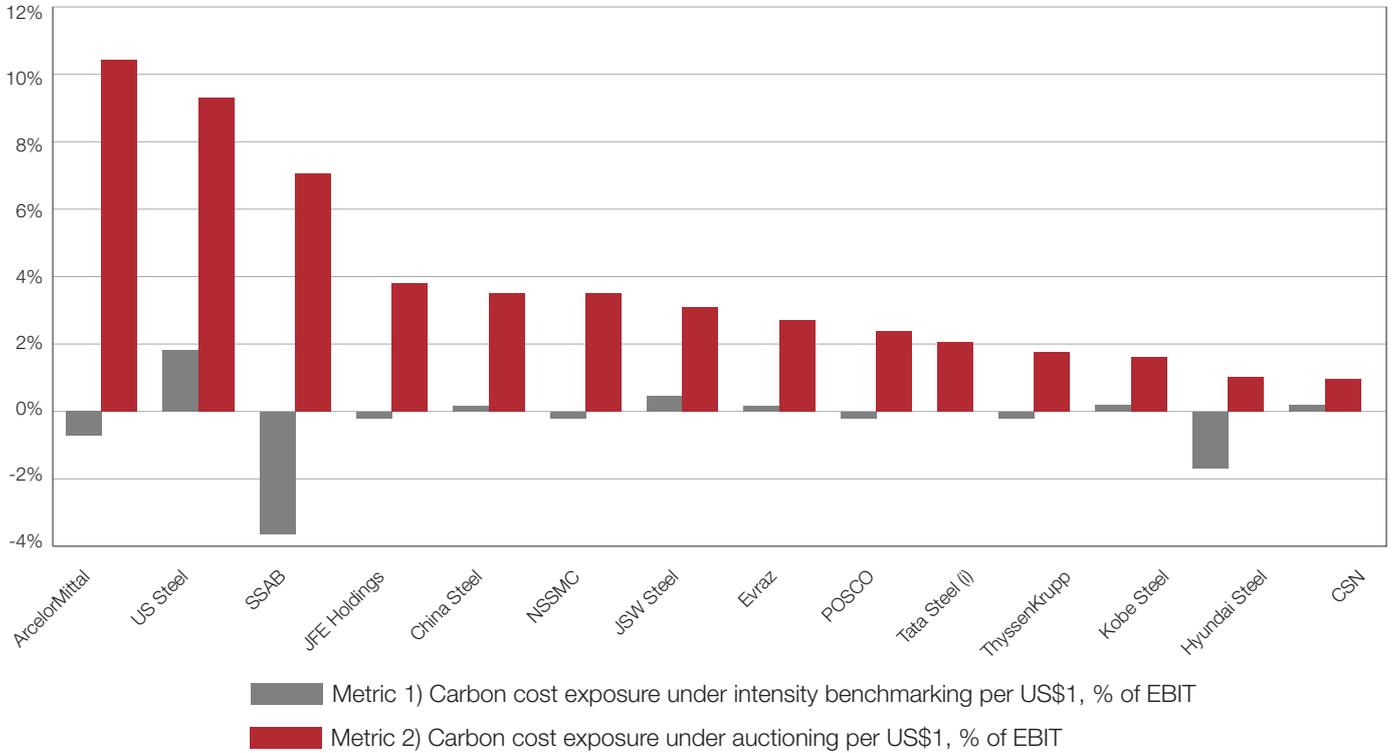
(i) Tata Steel is omitted on Metric 1 due to no consolidated emissions intensity figure available. Its Metric 2 value also likely underestimates its true exposure due to our inability to identify its full emissions.

Source: CDP

Metric 3) Company use of internal carbon price

Company	Current use of internal carbon price	Internal carbon price disclosed
JSW Steel	Yes	No
POSCO	Yes	No
SSAB	Yes	No
ThyssenKrupp	Yes	No
China Steel	Not currently but expected within 2 years	
Hyundai Steel	Not currently but expected within 2 years	
Tata Steel	Not currently but expected within 2 years	
ArcelorMittal	Not expected within 2 years	
CSN	Not expected within 2 years	
Evraz	Not expected within 2 years	
JFE Holdings	Not expected within 2 years	
Kobe Steel	Not expected within 2 years	
Nippon Steel & Sumitomo Metal	Not expected within 2 years	
US Steel	Not expected within 2 years	

Source: CDP

Latest developments in key carbon pricing schemes

◣ China

China is set to introduce a national trading scheme in 2017 to price greenhouse gas emissions which will cover approximately 4bn tonnes of CO_2, making it the largest carbon market globally. China's current pilot carbon trading system covers five cities and two provinces with steel being one of the industries included. Carbon allowances are expected to trade at around RMB39 (US$6) in 2017 and RMB56 (US$8.5) per tonne of carbon-equivalent in 2020 [8]. China currently produces approximately 50% of the world's steel and is suffering from chronic overcapacity.

◣ EU ETS

Five companies in our study have exposure to the EU ETS where currently around 55% of allowances are auctioned with an uneven distribution across industries covered. The system is set to reduce its emissions cap by 2.2% annually post-2020 and introduce price support measures such as auction 'back-loading' and the Market Stability Reserve to manage the number of allowances in the market and avoid oversupply.

◣ North America

In 2015 the Canadian province of Alberta announced a carbon tax of CA$20 (US$15.5) per tonne effective from 2017 and rising to CA$30 (US$23) per tonne in 2018. Large industrial manufacturers are set to join the scheme in 2018. The province of British Columbia already has a revenue-neutral carbon tax on fossil fuel purchases and Quebec an existing ETS (which is linked to that of California in the USA). The province of Ontario plans to introduce an ETS in 2017.

◣ India

In 2016 India has doubled its tax on coal consumption to INR400 (US$6) per tonne of coal.

8. According to a survey conducted by the China Carbon Forum in 2015.

Chinese steelmakers and climate-related disclosure

The Chinese steel industry underwent explosive growth in the past two decades. Crude steel production in China climbed from 13% of global production in 1995 to 50% in 2015, with 800 million tonnes of production. Over that time, China has become the world's largest greenhouse gas emitter, and steel is one of the key sources of that emissions growth. However, most Chinese steelmakers currently fall outside the scope of CDP's annual disclosure requests for several reasons. First, there is a high proportion of Chinese state ownership. Second, for those companies with public stockmarket listings, a number fall outside of the key benchmark indexes used by global investors which are a driver of which companies are requested to disclose by CDP. Depending on the global benchmark, China A shares are generally excluded or included only at small weights due to accessibility issues for international investors, including the need to attain licenses to invest, quotas on foreign ownership, and limits on repatriation.

CDP's sector research series and its League Tables only include companies that have disclosed through the CDP disclosure platform, something that provides a baseline level of comparability on some of the key points of analysis. Despite this, given the scale of China's role in world steelmaking and the fact it will soon come under a nationwide carbon price which will create new costs and risks for steelmakers, we have undertaken separate analysis of their climate-related disclosures to provide insight into how their transparency compares to global peers.

We assessed the public reporting of the largest fifteen Chinese steelmakers by production volume, both in Chinese and English languages. These fifteen account for over 40% of China's crude steel production. Among them only Baosteel disclosed a portion of its carbon emissions, that which has been subject to ETS pilots. A few other companies disclosed data on energy and water consumption, and disclosed qualitative information on climate and other environmental issues. As such, while companies that have operations covered by the 7 pilot ETS are required to report the relevant carbon emissions data to the regulator, our research shows that such data is usually not publicly available.

World crude steel production

Source: World Steel Association
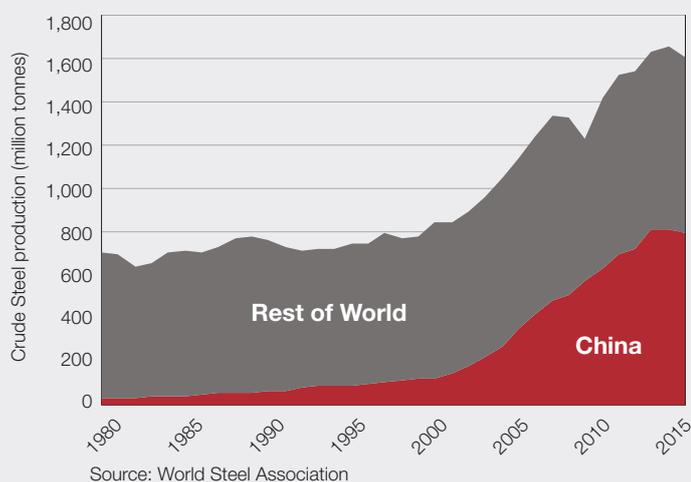
This lack of transparency significantly limits the extent to which investors and other stakeholders, in China and internationally, can assess company risk and preparedness for new climate regulation. Disclosing greenhouse gas emissions data would not add significant reporting burden to companies given it is already required by regulators, and together with information on climate-related strategy would help investors and other stakeholders to assess their risk exposures. Among these exposures are to the existing pilot ETS and the planned national ETS in which the steel industry is one of the six industries covered. Chinese regulators have also stated that they will more strictly enforce environmental regulations as a tool to reduce current overcapacity in steelmaking and other industries. The government aims to reduce steel capacity by 100-150 million tonnes between 2016-2020.

Largest Chinese steelmakers and climate-related disclosure

Company	Steel production 2015 (mt)	Main operation covered by pilot ETS?	Greenhouse gases	Energy	Water	Sustainability report in English and/or Chinese
Hebei Steel Group	48	No	No	Total consumption	Total consumption	Chinese only
Baosteel Group	35	Yes, Shanghai	Yes, but only data on 9 subsidiaries covered by pilot ETS in 2013.	Indexed on 2010	Indexed on 2010	English and Chinese
Shagang Group	34	No	No	No	No	None
Ansteel Group	33	No	No	Indexed on 2011	Indexed on 2011	Chinese only
Shougang Group	29	Yes, Beijing	No, but mentioned 7 subsidiaries' operations are covered by pilot ETS.	No	No	Chinese only (most recently 2013)
Wuhan Iron and Steel Group	26	Yes, Hubei province	No, but states that past 3 years' emissions data was verified and submitted to the regulator.	Absolute and intensity data	Absolute and intensity data	English and Chinese
Shandong Steel Group	22	No	No	No	No	None
Ma Steel	19	No	No	No	No	None
Tianjin Bohai Steel	16	Yes, Tianjin	No	No	No	None
Jianlong Group	15	No	No	No	No	None
Benxi Steel	15	No	No	No	No	Chinese sustainability website, no full report
Valin Group	15	No	No	No	No	Chinese sustainability website, no full report
Rizhao Steel	14	No	No	No	No	None
Fangda Steel	13	No	No	Yes	No	None
Inner Mongolia Baotou Steel	12	No	No	No	No	None

Source: CDP, company reports

Low carbon technology development

◥ No technologies are yet to emerge as technically and economically feasible to reduce steelmaking emissions in line with a 2-degree pathway.

◥ Greater diversity is evident in breakthrough emissions reduction projects underway than was the case several years ago. New project announcements in 2015 and 2016 include a hydrogen-based steelmaking project by SSAB, and carbon capture and utilisation (CCU) projects involving ArcelorMittal, China Steel, and ThyssenKrupp.

◥ Progress on carbon capture and sequestration (CCS) has been slow to be realised. No CCS pilot plants are operating in the steel industry, and we have not identified significant signs of progress. Uncertain prospects for CCS may also limit progress and uptake of a number of technologies that could pair with CCS if it were technically and commercially proven, like HIsarna, FINEX, and Top Gas Recycling.

◥ Five of the steelmakers assessed - CSN, Evraz, Hyundai Steel, JSW Steel and US Steel - have not disclosed involvement in major breakthrough emission reduction projects.

Overview

There is substantial pressure building for the steel industry to achieve a technological breakthrough in reducing its high process emissions. This is driven by the combination of an industry operating close to current technical limits, together with a societal need for deep emissions reductions to achieve a 2-degree transition, and carbon prices being enacted in more and more key steelmaking countries.

However, the industry has a number of hurdles to overcome in development of low carbon technology. Steel prices and industry profitability have been low in recent years, driven in large part by overcapacity issues. This has contributed to reduced research and development expenditures. Over the past five years, R&D expenditure is down 14% in US dollar terms across the 14 companies assessed. A number of technologies show promise for deep emissions reduction, but most are at feasibility or pilot stages and far from commercialisation.

A number of stakeholders see CCS as critical for the achievement of low carbon objectives for steel. For example, to meet its 2-degree scenario the IEA estimates that CCS will be required to avoid 40% of the industry's direct CO_2 emissions by 2050. However, developments in realising CCS for steelmaking have been slow, with no pilots operational today. We have not identified substantive new initiatives, announcements or investment decisions since the cancellation of a planned top gas recycling (TGR) with CCS pilot in late 2012 that had been expected to be built at an ArcelorMittal plant in France. This initiative has been quiet since, but ArcelorMittal states that it has not abandoned the project and may proceed with it in future. Japanese steelmakers also continue to work on capture technology. If CCS is proven technically and economically feasible in future, it could sharply increase the emissions reduction potential of several other emissions reduction technologies, such as HIsarna, FINEX, and TGR.

CCU projects are gaining traction among steelmakers, with potential to capture emissions and utilise them in producing new products like chemicals and biofuels. In this way it has the potential to both avoid greenhouse gas emissions and create new revenue streams. Lanzatech and Carbon2Chems are two prominent CCU initiatives for steel. Questions remain over the emissions reduction potential of such projects, which are dependent on the scale of the CCU plants built. Our calculations based on figures disclosed by ArcelorMittal's Steelanol initiative at what it states as its expectation for full scale operation in Europe suggest a reduction of less than 2 percent of its European emissions profile. However, if able to be realised at a larger scale, emissions reductions could be much greater.

Several steelmakers are also working on projects that do not require capture of emissions, but instead have potential to largely eliminate process emissions. In 2016 SSAB announced a pre-feasibility study to develop hydrogen-based steelmaking using renewable energy, though it doesn't expect to have a demonstration plant before 2025, and potential for full commercialisation only after 2040. The Japanese steelmakers are also investigating use of hydrogen in steelmaking, though as an enhancement for, not full replacement of, existing BF-BOF processes. Projects have also investigated the application of electrolysis in steelmaking, which could also use renewable energy sources. ArcelorMittal has an early laboratory stage project investigating electrolysis in steelmaking, and other research is taking place at MIT. Application of fully hydrogen-based or electrolysis-based steelmaking could enable potential reductions of over 90% in process emissions, though would rely on the availability and cost-effectiveness of clean energy.

Government co-funding can be key to unlocking emissions reduction projects. Recently, ThyssenKrupp's Carbon2Chems CCU project is aided by EUR60m German government financing, while ArcelorMittal's EUR87m CCU project received EUR10m in EU Horizon 2020

funding. Progress on Tata Steel's HIsarna pilot project in the Netherlands, employing an alternative smelting reduction process, will need to access significantly expanded funding to move toward commercialisation following its recent pilot stage.

Technology development initiatives have sometimes been active through collaborative regional groups. The Japanese steelmakers work primarily as a group to pool resources and knowledge on low carbon innovation, through industry innovation initiatives like COURSE50. ULCOS (the Ultra Low Carbon Dioxide Steelmaking) has been the primary EU collaborative low carbon research body, funded with EUR75m for its first two phases between 2004-2015, though today appears to be largely in hiatus and EU steelmakers pursuing more unilateral technological projects. US steelmakers worked on an industry-wide collaborative technology initiative with the US Department for Energy through to 2008, but have demonstrated limited activity since.

In this section we assess progress on low carbon technology development using the following metrics:

▼ **Metric 1) Technology development scorecard:** We undertook a scorecard-based approach to provide a simple ranking of technological progress and prospects, seeking to identify and score the following elements for each technology:
   a) Stated emissions reduction potential
   b) Stated emissions reduction potential if combined with CCS
   c) Level of committed funding
   d) Timeline for potential commercialisation

▼ **Metric 2) Ratio of research & development expenses to sales:** We rank companies on their average R&D expense to sales ratio over the period 2013-2015. This provides an indicator of companies' capabilities and focus on innovation.

Highlights

▼ No technological solution to reduce steelmaking process emissions so far shows a clear path toward a 2-degree outcome. Technologies like HIsarna, FINEX and TGR show promise if able to be paired with CCS in future. However, alone they cannot provide deep emissions reductions unless CCS is also proven to be technically and economically feasible. CCU, though dominating recent project announcements, appears to provide only small incremental emissions reductions unless able to be scaled up dramatically.

▼ Other potential solutions that do not involve carbon capture – such as hydrogen-based and electrolysis-based steelmaking – have potential for deep emissions reduction but could be decades away from proven technical or economic feasibility.

▼ ArcelorMittal ranks equal first on low carbon technological development. It is constructing a demonstration CCU plant in France and has undertaken laboratory scale work on electrolysis-based steelmaking. It also made progress toward a TGR-BF with CCS pilot in 2012 before putting the project on hold due to unresolved technical challenges.

▼ POSCO ranks equal first, having developed through to commercialisation FINEX, which provides incremental emissions reduction through eliminating sintering and coke-making stages of steelmaking, and which provides a high concentration CO_2 gas stream suitable for pairing with CCS. POSCO also has a memorandum of understanding in place to develop CCU with Lanzatech in South Korea, and has one of the highest R&D to sales ratios.

▼ SSAB ranks highly, being one of a small number of steelmakers working on an announced emissions reduction project that envisages elimination, not simply storage or utilisation of steelmaking process emissions.

▼ The three Japanese steelmakers, Nippon Steel & Sumitomo Metals, JFE Holdings and Kobe Steel all rank highly. They have among the highest R&D to sales ratios in the industry and are working together collaboratively on hydrogen-based enhancements to current steelmaking and on carbon capture technology.

▼ ThyssenKrupp has a high R&D to sales ratio but so far has demonstrated less progress in low carbon technology development for steelmaking than some peers. Its Carbon2Chems CCU initiative announced in 2016 appears to be some years behind the progress of the Lanzatech CCU process that ArcelorMittal, China Steel and POSCO have committed to developing.

▼ Tata Steel's ranking is driven down by a low R&D to sales ratio. It has undertaken significant activity to develop HIsarna, which if able to be paired with CCS could provide emissions reductions of 80% versus current BF-BOF processes. HIsarna will however require significant new funding to move onward from its pilot activities and achieve commercialization.

▼ CSN, Evraz, JSW Steel, and US Steel rank among the bottom. They have not announced significant low carbon technology development projects, and have low R&D to sales ratios. Hyundai Steel ranks slightly above them based on a higher R&D to sales ratio.

Low carbon technology development summary

Company	Technology development scorecard rank	Research & development rank	Weighted rank	Low carbon technology development rank	Grade
ArcelorMittal	1	9	3.0	1	A
POSCO	3	3	3.0	1	A
SSAB	2	7	3.3	3	A
Kobe Steel	5	1	4.0	4	B
Nippon Steel & Sumitomo Metal Corp (NSSMC)	5	2	4.3	5	B
China Steel	4	6	4.5	6	B
JFE Holdings	5	4	4.8	7	B
ThyssenKrupp	9	5	8.0	8	C
Tata Steel	8	11	8.8	9	C
Hyundai Steel	10	8	9.5	10	D
JSW Steel	10	10	10.0	11	D
CSN	10	12	10.5	12	E
Evraz	10	13	10.8	13	E
US Steel	10	13	10.8	13	E

Weighting	**75%**	**25%**			

Source: CDP

Claimed emissions reduction potential by technology
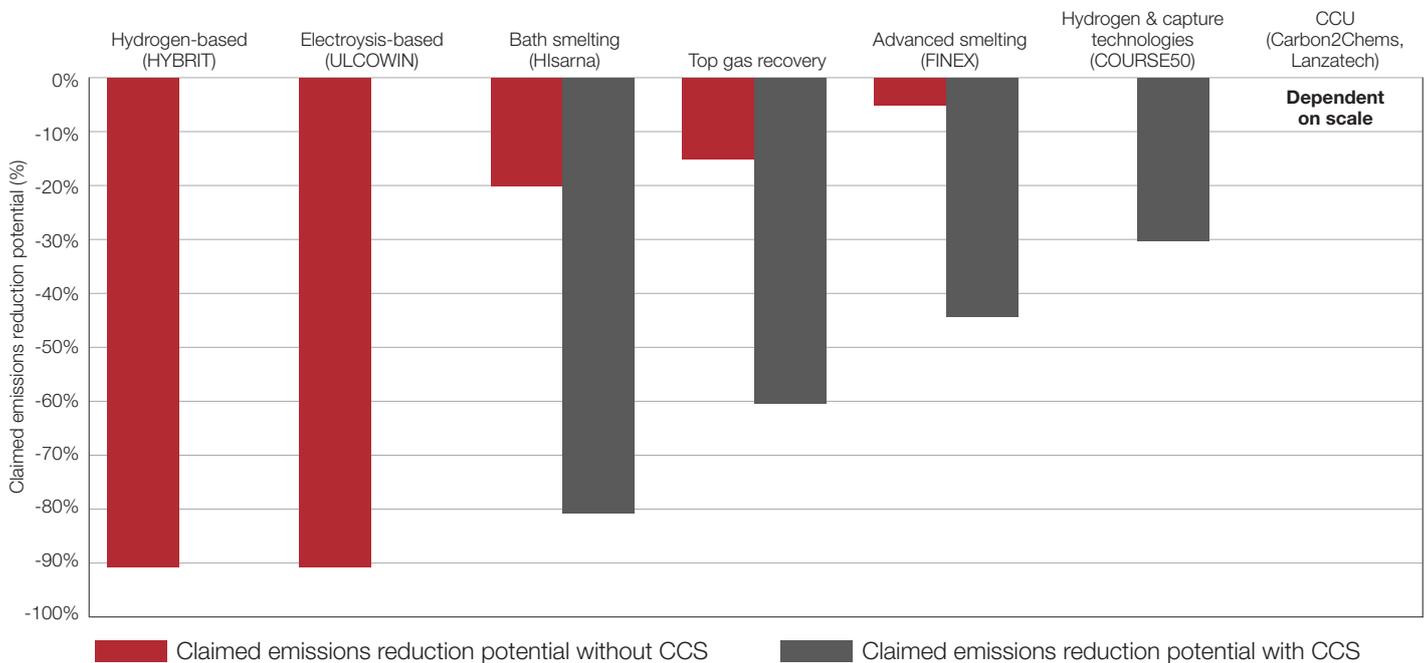
Source: Wyns & Axelson, EUROFER, company reports

Key emissions reduction technology projects

Key features	Alternative reduction technologies and CCS enablers				Carbon Capture & Utilization		Elimination of process emissions	
	Top Gas Recycling Blast Furnace (TGR-BF)	HIsarna	FINEX	COURSE50	Lanzatech	Carbon2Chems	HYBRIT	ULCOWIN*
Key features	Increases CO_2 concentrations in off-gas, which may then be captured if CCS technology can also be realised.	Combines smelting and cyclone converter furnace technologies and uses pure oxygen instead of air, resulting in a top gas with high CO_2 concentration suitable for capture.	Advanced smelting technology that eliminates sintering and coking phases of steel production. Part of the CO_2 is removed from recirculation gas and could be captured with little efficiency penalty.	Multiple projects focusing on suppression of CO_2 emissions from blast furnaces using hydrogen and capture of CO_2 from blast furnace gas.	Biofuel production using steelmaking waste gases.	Chemicals and biofuel production using steelmaking waste gases.	Hydrogen-based steelmaking using renewable energy.	Electrolysis-based steelmaking using renewable energy.
Companies involved	ArcelorMittal	Tata Steel	POSCO	NSSMC, JFE Holdings, Kobe Steel	ArcelorMittal, China Steel (demonstration plants), POSCO (MoU)	ThyssenKrupp	SSAB	ArcelorMittal
Claimed emissions reduction potential	-15%	-20%	-5%	n/d	Dependent on scale	Dependent on scale	-90%+	-90%+
Claimed emissions reduction potential with CCS	-60%	-80%	-44%	-30%	-	-	-	-
Funding	Not disclosed	>EUR50 million	KRW 554.1b (US$550m) in R&D costs incurred	26 billion yen (2008-2017) [approximately US$300m]	US$198m VC financing, ArcelorMittal plant EUR87m, China Steel plant US$46m	>EUR60m German government funding	Not disclosed	Not disclosed
Timeline	Not disclosed	Targeting full size demonstration operational 2020-2025	Commercialised 2007	Industrial scale application targeted for 2030s	Demonstration plants operating	Approx 2030 for industrial scale	2016-2017 pre-feasibility, 2018-2024 feasibility & pilot, 2025-2035 demonstration	Not disclosed
Status	Pre feasibility (on hold)	Pilot	Commercial	Pilot	Demonstration	Feasibility	Pre-feasibility	Laboratory

* Not scored due to limited information available
Source: Wyns & Axelson, EUROFER, Company reports

Research and development expense as a proportion of sales (2013-2015)

Source: Company reports
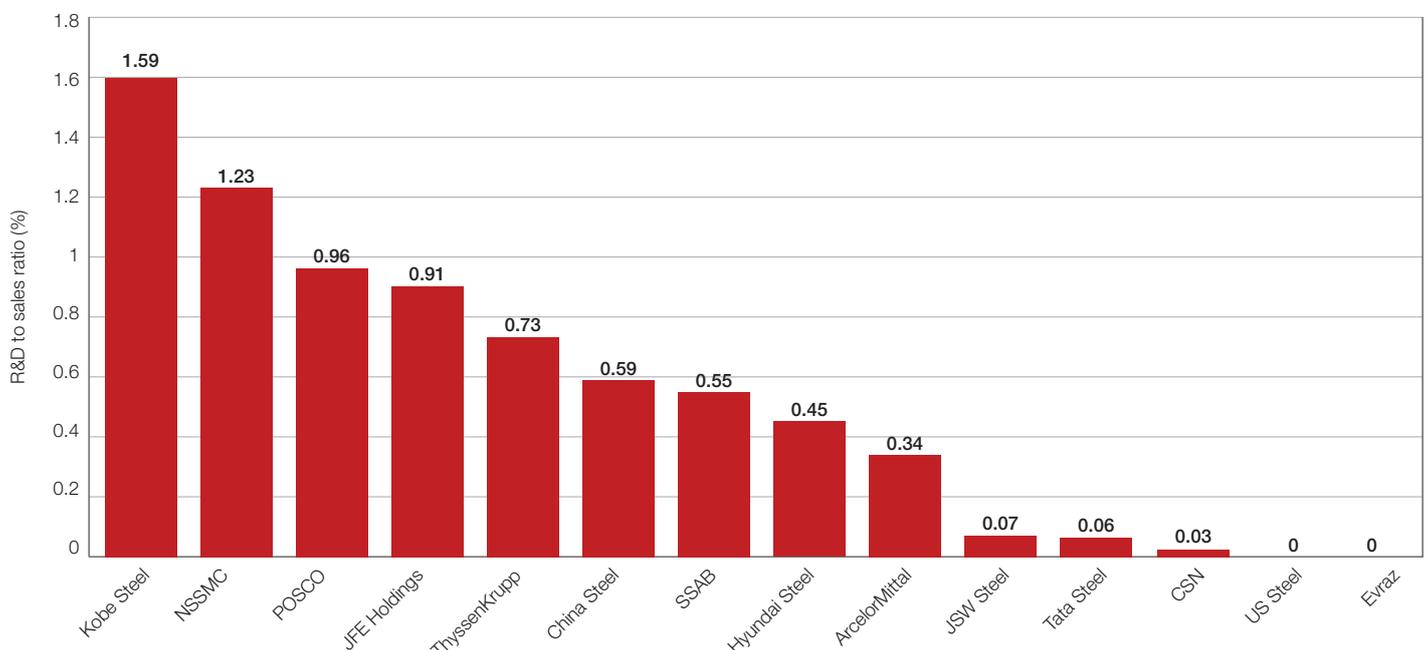
Water Resilience

- ◥ ThyssenKrupp ranks first on water resilience. It has among the lowest water consumption intensity and water stress exposure, with all its key steelmaking facilities currently located in low to medium risk areas.

- ◥ Tata Steel ranks poorly on all three metrics, while JSW Steel has the highest exposure to water-stressed areas. These companies rank lowest.

- ◥ In 2015, 3% of all steel sites within the sample were in high water stress areas. By 2030, exposure to high water stressed regions increases significantly, with 20% of steel sites projected to be in high risk areas and 8% in extremely high risk areas.

Overview

In 2016 the World Economic Forum ranked water crises among the top 3 global risks to society[9]. Population growth, urbanisation and an increasingly unpredictable climate are likely to exacerbate pressure on water resources and increase water scarcity. In light of this, competition for such a vital and non-substitutable resource puts a greater emphasis on heavy industries to consider the implications of water consumption.

Water is used throughout the steelmaking process, predominately for cooling at the blast furnace and electric arc furnace, in coke quenching, dust scrubbing and cleaning. Steel companies are major consumers of water in absolute terms, and consumption can vary considerably depending on site location, access to water resources and mill configuration. Water can be reused multiple times and returned to source, though recycled water, especially seawater, must be treated and filtered in order to be used continually and so a trade-off ensues between the advantages of recycling water and the additional environmental costs that the process incurs.

Steel mills are capital intensive, long term fixed assets with lifecycles of several decades. This poses a particular problem for steel companies', as localised water stress is likely to fluctuate over time. Of the 14 companies analyzed, all but two already have steel plants in medium to high water stress locations (as identified by the World Resources Institute's [WRI] Aqueduct tool)[10] and by 2030, 28% of all sites will be located in high or extremely high risk areas. With little scope for substitution of water from the steelmaking process, and with increasing pressure on water supplies it is imperative that water withdrawal, consumption and discharge continues to be monitored and managed effectively.

In this chapter we assess companies' water resilience based on publicly available resources and company responses to the CDP 2016 water questionnaire. Companies are ranked based on their current water stress exposure and water stress exposure risk in 2030, water consumption intensity and recycling rate. The key metrics are:

- ◥ **Metric 1) Water stress exposure:** We assess water stress on a plant by plant basis using the Aqueduct global water stress risk mapping tool developed by the WRI. This evaluates localized water stress using industry specific indicators, water quantity, water quality and regulatory and reputational risks. We analyse current water stress exposure (2015) and projected water stress in the year 2030.

- ◥ **Metric 2a) Water Consumption Intensity:** We examine companies' current water consumption intensity for steel production. Using intensity figures allows for a direct comparison between companies regardless of their size of production.

- ◥ **Metric 2b) Water Recycling Rate:** Companies' water recycling rates are assessed as a percentage of total uptake.

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9. World Economic Forum – Global Risks Report 2016
10. World Resources Institute Aqueduct tool: http://www.wri.org/our-work/project/aqueduct

Highlights

- ThyssenKrupp is ranked first in overall water resilience. It has a low water consumption intensity and the second lowest exposure to water stress risk. By 2030, 75% of ThyssenKrupp's steel sites have reduced water risk and move into the low water risk category.

- CSN is placed second overall, with the lowest water consumption intensity of 1.3m$_3$/tcs. POSCO ranks third with high water consumption efficiency and low water stress exposure in 2015 and 2030.

- Tata Steel and JSW Steel rank bottom and second from bottom. Tata Steel has a high proportion of steelmaking facilities in medium to high risk and high risk areas (85%). By 2030, 43% of Tata's steel-making sites move into the high and extremely high water stress region categories, while JSW Steel's site in Vijayanagar, India has the second highest overall water stress indicator score.

- SSAB has the lowest water risk exposure for both 2015 and 2030. Five of its six sites are based in low to medium risk areas, and its Lulea site in Sweden is in the low risk category. By 2030, one site has an increased water stress exposure and four drop into the low risk category.

- Nippon Steel and Sumitomo Metal recycles 90% of its water yet has the highest water consumption of 13.37m$_3$/tcs. SSAB, Evraz and Tata Steel publish non-comparable water data, while US Steel does not disclose any water-related data.

- Hyundai Steel is a highly efficient water user, yet ranks eleventh due to high water stress exposure and a low recycling rate. All its sites are within medium to high risk areas in 2015 yet by 2030, 75% of those sites are projected to be in high and extremely high water stress categories.

- ArcelorMittal has steel plants in the highest and lowest overall water stressed regions. The integrated steel mill in Kazakhstan is in the most water stressed, while the EAF mini-mill in Georgetown, USA is the least.

Water resilience summary

Company	Water stress risk exposure	Water consumption Intensity	Recycling rate	Overall weighted rank	Water resilience rank	Water resilience grade
ThyssenKrupp	2	2	10	2.8	1	A
CSN	8	1	5	4.9	2	A
POSCO	4	5	10	5.0	3	A
ArcelorMittal	5	8	2	5.9	4	B
SSAB	1	11	10	5.9	4	B
China Steel	9	7	1	7.4	6	C
Kobe Steel	11	4	3	7.4	6	C
NSSMC	7	10	6	8.1	8	C
US Steel	3	14	10	8.1	8	C
Evraz	6	11	10	8.4	10	D
Hyundai Steel	13	3	9	8.6	11	D
JFE Holdings	10	9	4	9.0	12	D
JSW Steel	14	6	7	10.1	13	E
Tata Steel	12	11	8	11.2	14	E
Weighting	**50%**	**40%**	**10%**			

Source: CDP

2015 Water stress exposure by risk category (LHS) and average water stress exposure (RHS)

Legend:
- Medium to high risk (2-3)
- High risk (3-4)
- 2015 water stress score (0-5)
- (Range high)
- (Range low)
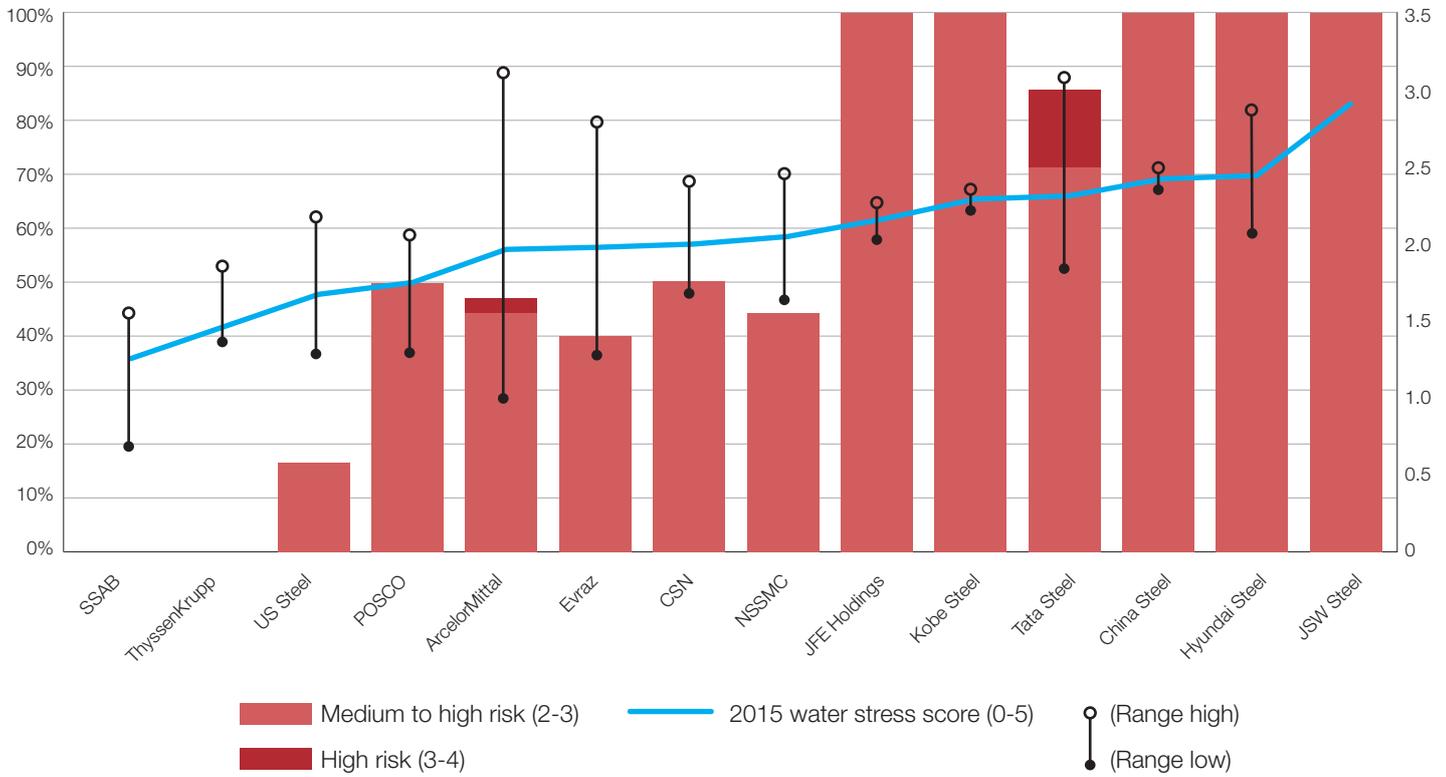
Source: CDP, WRI, company data

2030 Water stress exposure by risk category (LHS) and water stress index (RHS)

Legend:
- Medium to high risk
- High risk
- Extremely high risk
- 2030 Water Stress Index
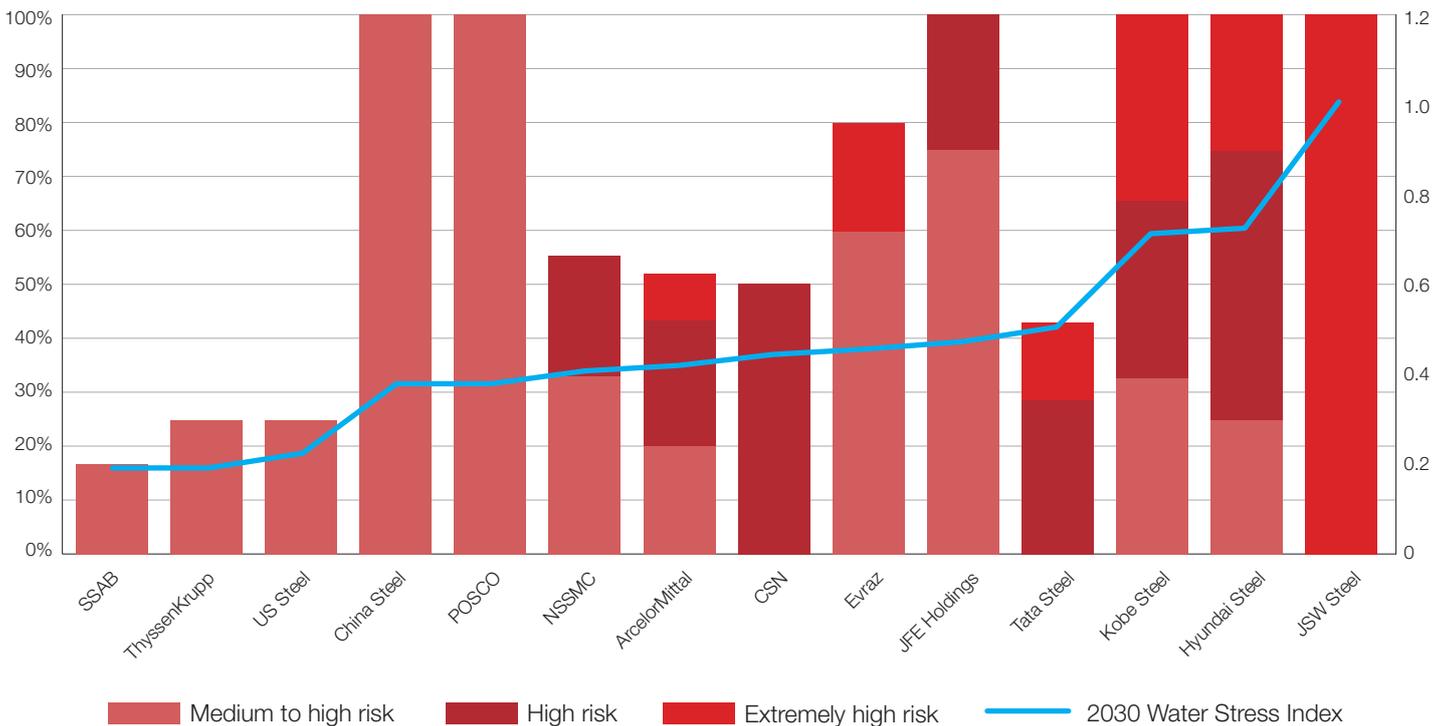
Source: CDP, WRI, company data

Water consumption intensity (LHS) and water recycling rate (RHS)

Legend
■ 2015 water consumption intensity (m³/tonne crude steel)
● 2015 water recycling rate (%)
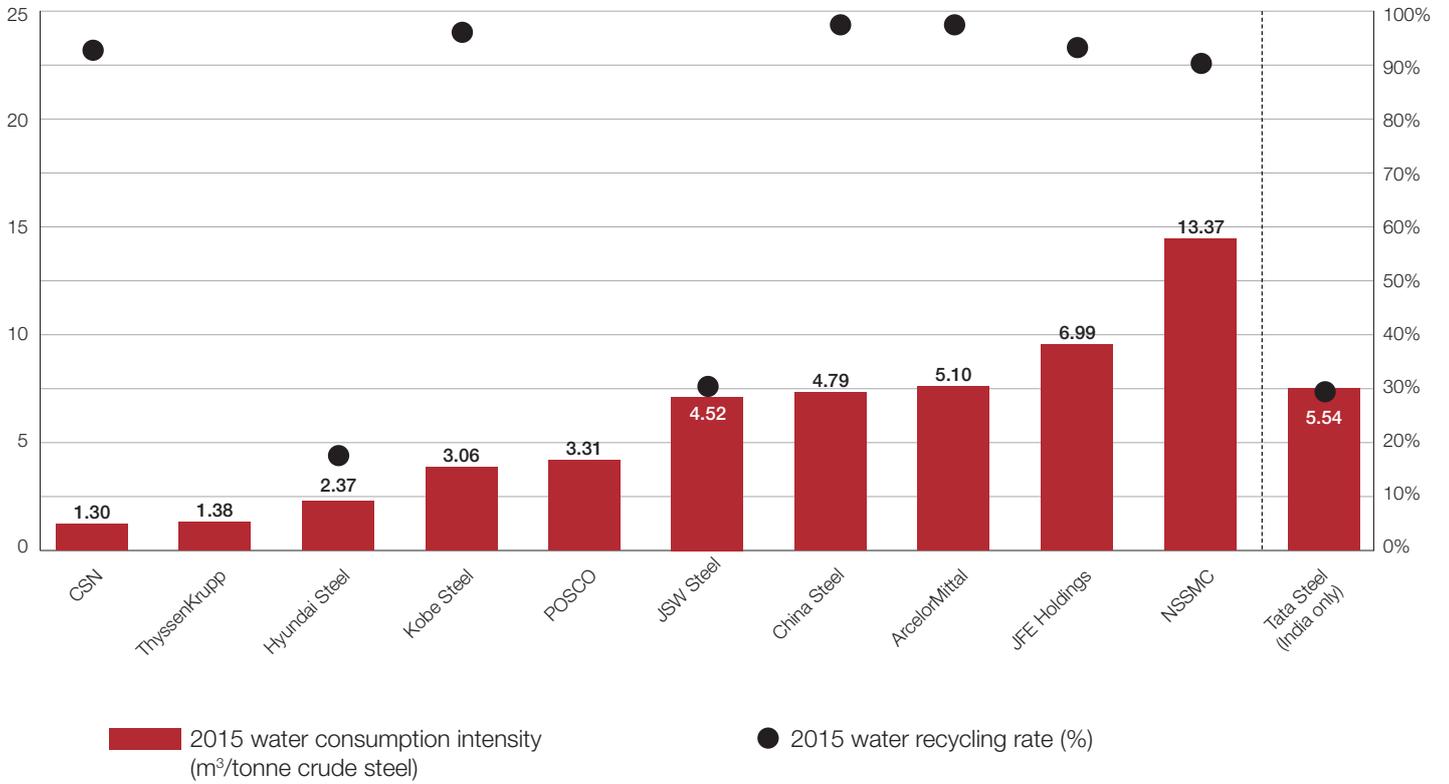
Source: CDP, company data

Climate governance

▼ All companies assessed provided mixed messages on their level of support for climate legislation. JSW Steel, CSN and China Steel were assessed as overall most supportive of incremental climate legislation.

▼ Most companies lacked disclosure of substantive remuneration incentives that aligned pay with management of climate change-related risks, at executive or other organizational levels. ThyssenKrupp disclosed the most meaningful alignment between executive pay and climate goals.

▼ ArcelorMittal and Nippon Steel & Sumitomo Metal appear to be the most obstructive in lobbying against progressive carbon regulation. They also lack any substantive disclosed remuneration incentives aligned with managing climate change risks, as did Evraz.

Overview

The steel industry is increasingly subject to climate-related regulation and carbon prices across a number of jurisdictions. It is therefore important to understand how steelmakers are preparing themselves for a transition to a low-carbon regulatory regime. We believe that companies that are supportive of low-carbon regulatory measures, and are strategically aligning themselves accordingly, are more likely to be better placed should regulations tighten. Conversely, companies engaged in overt or covert obstruction of climate change policies may be less likely to be strategically shifting their activities and thus could be at a higher risk from regulatory shocks. However, we recognize that some companies may be lobbying against climate regulation for short-term gain yet simultaneously preparing for a longer-term shift towards a low-carbon economy.

In this chapter, we adopt InfluenceMap's[11] proprietary analysis to assess companies' supportiveness of a shift to a low-carbon regulatory framework. InfluenceMap analyses the behaviour of companies concerning key regulatory items affecting their business, including carbon cap and trade schemes, clean energy targets and energy efficiency measures.

The steel industry will also need proactive leadership from the top and effective incentives throughout organizations in order to reinvent its production processes for a low carbon future. We also consider in this chapter the level of alignment between company remuneration structures and the management of climate-related risks. We consider such incentives as a marker of companies placing a high priority on climate objectives among other company priorities.

▼ **Metric 1) Carbon regulation supportiveness (InfluenceMap total score)**
InfluenceMap scores companies in two ways:
  ▼ **Organizational score:** represents the stance a company takes in influencing climate policy and legislation as well as its transparency of positions on key climate issues.

  ▼ **Relationship score:** represents the strength of a company's relationships with trade bodies or other entities and its ability to influence climate policy and legislation.

The two scores for each company are combined[12] along with other factors in InfluenceMap's algorithmic calculation to produce a total score (InfluenceMap score), expressed as a percentage. A score of 60% or more indicates that the company is actively supporting policies and regulations towards a low-carbon future. Conversely, scores lower than 40% indicate obstructing behavior. This score determines our carbon regulation supportiveness rank.

The InfluenceMap score is overlaid with a company's 'Engagement intensity'[13] value in the graph overleaf to display how active each company is in their climate policy engagement alongside their position on such issues.

▼ **Metric 2) Alignment of remuneration policy with climate risk management**
This indicator identifies company remuneration incentives for the management of climate change risks. It adopts a scorecard approach, identifying and scoring remuneration incentives for climate risk management at top executive level, at key divisional levels, and for general employees.

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11. A UK-based non-for profit whose remit is to map, analyze and score the extent to which corporations are influencing climate policy and legislation. http://www.influencemap.org/
12. The scores are combined in varying proportions on a company by company basis.
13. Engagement intensity is another metric calculated by InfluenceMap, representing the extent to which the company is engaging on climate change policy matters, whether positively or negatively. It is a number from 0 (no engagement at all) to 100 (full engagement on all data points). Each total score should be looked at in conjunction with this metric to gauge the amount of evidence used in each case as a basis for scoring.

Carbon regulation supportiveness summary

Company	InfluenceMap total score	Carbon regulation supportiveness rank	Engagement intensity
JSW Steel	65.1	1	6%
CSN	59.5	2	8%
China Steel	51.9	3	10%
POSCO	51.5	4	11%
Thyssenkrupp	45.1	5	14%
Kobe Steel	41.7	6	2%
Evraz	40.6	7	7%
Tata Steel	39.8	8	12%
Hyundai Steel	37.8	9	6%
SSAB	35.8	10	16%
US Steel	34.1	11	13%
JFE Holdings	31.3	12	5%
Nippon Steel & Sumitomo Metal	28.6	13	7%
ArcelorMittal	28.5	14	26%

Weighting	100%

Source: CDP, company data

InfluenceMap score and engagement intensity
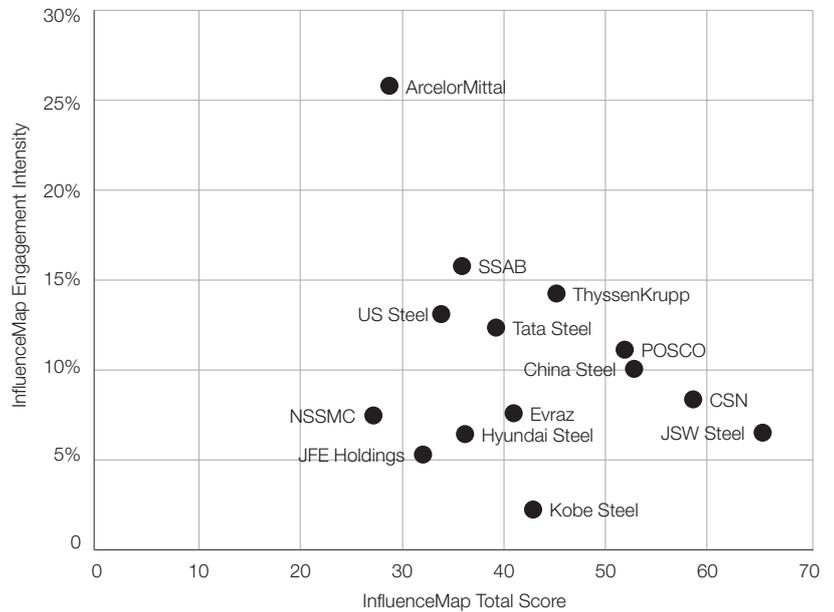
Source: CDP, InfluenceMap

Highlights

Climate regulation supportiveness

◤ The InfluenceMap analysis shows a routine disparity between companies' low carbon ambitions and their approach to climate policy in practice. All companies showed at least some resistance to climate policies such as trading schemes, carbon taxes and GHG emissions reduction targets, citing high risks and costs and the loss of competitiveness brought about through such regulations. Many companies also have close links with cross-sector trade associations that consistently obstruct ambitious climate change policy.

◤ JSW Steel, CSN and China Steel rank as the top 3 for climate regulation supportiveness. All three companies show low levels of direct engagement with climate change policy. JSW steel show support for a number of policies including India's Perform Achieve and Trade energy efficiency scheme and CEO Sjjan Jindal signed a letter from the World Economic Forum encouraging leaders to reach an ambitious climate deal at COP21. Similarly, CSN were part of an industry group advocating for climate change policies, including emissions trading, and renewable energy targets in the run up to the UN Climate Treaty, while China Steel signed CDP's 'Science Based Targets' commitment and aligned itself with the World Bank's statement calling for countries to put a price on carbon. It must be noted however that all three companies also show some other resistance to climate change policy, either by opposing specific aspects of national climate policies or through membership in trade groups opposed to climate legislation.

◤ Hyundai Steel, SSAB, ThyssenKrupp and US Steel appear to have a predominantly negative engagement with climate change legislation. ThyssenKrupp are against the EU unilateral action on climate change and believe that steel production is already at the physical limit of carbon reduction. Hyundai Steel opposes the Korean Emissions Trading Scheme introduced in 2015 and has taken legal action against it, preferring technological improvements over regulation, while SSAB has criticised Europe's 2030 climate change targets, citing the high cost such regulations will have on even the best industry performers. In 2015 US Steel appeared to oppose any regulation on GHG emissions that might constitute a tax on carbon, stating support for a piece of legislation that would limit the powers of US policymakers to advance ambitious climate change policy in the future.

◤ Nippon Steel & Sumitomo Metal and JFE Holdings rank second and third from bottom respectively. Both companies show limited direct engagement with climate policy but hold key positions in trade associations that actively oppose key regulations in Japan. Nippon Steel's president, Kosei Shindo is the current Chairman of the Japan Iron and Steel Federation, while the President of JFE Holdings Koji Kakigi is a vice-chairman. Other key executives within both companies also hold co-chairmanships on the board of Keidanren, the Japan Business Federation. Between them, these two associations have actively opposed nearly all climate regulation in Japan, including a carbon tax, an emissions trading scheme, renewable energy legislation and Japan's long term GHG emission reduction targets.

- ArcelorMittal ranks bottom. It has recently opposed measures to increase the traded price of carbon in the EU through the Cross Sectoral Correction Factor and Market Stability Reserve reforms, and lobbied against climate legislation across several regions. Its CEO has called for EU policymakers to reduce 'overregulation' on climate change which he considers a threat to European manufacturing. ArcelorMittal is also a member of trade associations that have negatively influenced climate change policy, including the American Petroleum Institute and National Association of Manufacturers in the US and the European Roundtable of Industrialists and BusinessEurope.

Remuneration

- We identified relatively little direct alignment between company remuneration and climate targets. In particular, at the executive level, remuneration was only directly linked to climate or energy efficiency goals in two out of 14 companies.

- ThyssenKrupp is the only company assessed that demonstrates a degree of alignment between remuneration systems and climate objectives at top executive, divisional and general employee levels. Its executive level remuneration in particular stands out as having the clearest alignment with climate objectives. In addition to financial performance targets, there is what it calls a multiplicative correction factor that operates in a range of +/-20%. This correction factor is equally weighted based on a sustainability multiplier that includes achievement of its public energy efficiency improvement target of 3.5 TWh efficiency gains by 2020, and a discretionary factor.

- China Steel and Tata Steel also perform strongly in aligning incentives with climate objectives. They have remuneration incentives for energy and emissions reductions in place for key divisional and management staff, as well as monetary rewards linked to emissions savings that can be accessed by all employees.

Climate governance summary

Company	Carbon regulation supportiveness rank	Remuneration incentives rank	Overall weighted rank	Climate governance rank	Climate governance grade
JSW Steel	1	4	1.8	1	A
China Steel	3	2	2.8	2	A
CSN	2	7	3.3	3	B
ThyssenKrupp	5	1	4.0	4	B
POSCO	4	7	4.8	5	B
Kobe Steel	6	7	6.3	6	C
Tata Steel	8	2	6.5	7	C
Evraz	7	12	8.3	8	C
Hyundai Steel	9	7	8.5	9	C
SSAB	10	4	8.5	9	C
US Steel	11	4	9.3	11	D
JFE Holdings	12	7	10.8	12	D
Nippon Steel & Sumitomo Metal Corp (NSSMC)	13	12	12.8	13	E
ArcelorMittal	14	12	13.5	14	E

| **Weighting** | **75%** | **25%** | | | |

Source: CDP

- JSW Steel also ranks highly on this metric, stating that it has rewards at the Chief Executive Officer and Chief Operating Officer level for achieving emissions and energy goals. However, we ranked it below the three companies noted above as JSW Steel did not provide any details of the policies – such as how they were weighted among other incentives, or the specific targets or thresholds that these officers would need to attain to access these rewards.

- The two largest companies assessed, ArcelorMittal and Nippon Steel & Sumitomo Metals, as well as Evraz, did not demonstrate any direct alignment between remuneration systems and climate goals. ArcelorMittal argued that its financial performance-based short and long term incentives, based on EBITDA and operating free cash flow, encourage energy and emissions reduction because emissions and energy reductions reduce costs. However, we have not recognized this as having sufficient direct alignment with climate outcomes.

Remuneration for climate risk management

Company	Score: Incentives for top executives	Score: Incentives for key divisional responsibilities	Score: Incentives for general employees	Total score	Rank
ThyssenKrupp	10	10	5	25	1
China Steel	0	10	10	20	2
Tata Steel	0	10	10	20	2
JSW Steel	5	0	5	10	4
SSAB	0	10	0	10	4
US Steel	0	0	10	10	4
CSN	0	0	5	5	7
Hyundai Steel	0	0	5	5	7
JFE Holdings	0	0	5	5	7
Kobe Steel	0	5	0	5	7
POSCO	0	0	5	5	7
ArcelorMittal	0	0	0	0	12
Evraz	0	0	0	0	12
Nippon Steel & Sumitomo Metal	0	0	0	0	12

Source: CDP

Appendix: Investor engagement themes for steelmakers

In order to ensure robust and resilient business strategies and encourage a smooth transition to a low-carbon economy, we are recommending some areas of engagement for investors to raise in their discussions with steelmakers' boards and management. These are intended as to help 'stress test' business strategy to prepare for the medium and long term. CDP is actively supporting institutional investors in their discussions with steelmakers and will provide additional information, support and coordination when needed.

A) Emissions and energy management

◤ Fully exploit currently available emissions and energy reduction levers, including production route substitution to lower emitting EAF where feasible, and use of best available technologies for emissions reduction across all production routes.

◤ Supplement existing public emissions and emissions intensity per tonne of crude steel disclosures with additional emissions insights benchmarkable to peers. Consider publicly disclosing Scope 1-3 intensity according to World Steel Association (WSA) guidelines. These are already reported privately to WSA by many steelmakers. Consider publicly disclosing route specific emissions intensities where feasible.

◤ Work collaboratively with others in the steel industry and with outside stakeholders to improve the consistency and usability of emissions and energy reporting to enable benchmarking by investors and other stakeholders. Companies can disclose their emissions intensities in CDP Climate Change questionnaire question CC12.3.

◤ Report publicly on energy consumption and energy consumption per tonne of crude steel produced. Work collaboratively within the steel industry and with outside stakeholders to improve the consistency and comparability of energy consumption data, particularly so that it includes the energy content of resources used including coal on a consistent basis between companies. Companies can disclose information on their energy use and fuel choices in CDP Climate Change questionnaire question CC11.

B) Emissions targets

◤ Set clear, ambitious, long term emissions reduction targets in line with the methodology of the Science-Based Targets' Sector-based Decarbonization Approach (SDA) and track and report on performance against them. The SDA targets are industry-specific emissions reduction pathways to 2050 which are consistent with a transition to a 2-degree world. It is important that steelmakers set targets post 2025 when more aggressive abatement action is required for the industry to decarbonize. Companies can disclose their emissions reduction targets in CDP Climate Change questionnaire questions CC3.1a – 3.1f.

C) Carbon cost exposure

◤ Provide detailed emissions information at country and facility level so that investors can make an accurate assessment of companies' financial exposure to local carbon regulations. Where the company participates in emissions trading, disclose free allocations and purchases of emissions allowances, and obligations to remit allowances.

◤ Disclose an internal carbon price and describe how it is used in capital planning and other company decision making.

◤ Companies can disclose their use of an internal carbon price, facility level emissions, and emissions trading activity in CDP Climate Change questionnaire questions CC2.2c, CC9.2, CC10.2, and CC13.1.

D) Low carbon technology development

◤ Disclose transparently on progress on low carbon technology development, providing regular periodic updates on progress. Provide clear expected timelines for development phases, and clear disclosure of expected emissions reduction potential of each technology.

◤ Disclose a breakdown of research and development expenditure that identifies expenditure on low carbon technology development. Disclose long term funding commitments as well as annual expenditure.

E) Water resilience

◤ Provide data on water withdrawal and water consumption in absolute terms and per tonne of crude steel produced, including historical data and reduction targets.

◤ Improve the granularity of water data reporting at facility level and use a consistent reporting framework. Information on production levels for each facility will allow investors to more accurately assess the materiality of water risks at a company level. Companies can disclose their facility level water information in CDP Water questionnaire questions W3.2 and W5.

F) Climate governance

◤ Provide a clear and supportive stance on climate policy consistent with actions and provide greater disclosure on engagement with policy makers. Companies can disclose their climate policy position in CDP Climate Change questionnaire question CC2.3.

◤ Set long term executive remuneration incentives that reward achievement of ambitious emissions reduction targets consistent with the SDA.

Company engagement: traffic light system

We use a traffic light system for each metric to highlight areas of engagement focus for each steelmaker:

Green = good performance

Amber = monitor performance, possible concern

Red = area of concern, engage with company

We have not assigned a uniform number of green, amber and red across the metrics according to rank. Instead, we have reviewed the results of each metric in detail and assigned the above colours according to the underlying values for each metric.

Engagement area:

League Table rank	Company	Country	Emissions and energy management rank	Current emissions intensity	Reduction in emissions intensity	Emissions data transparency	Current energy intensity	Reduction in energy intensity	Emissions targets and pathways rank	Quality of emissions reduction target	Performance against targets	Carbon cost exposure rank	Intensity-based carbon cost	Auctioning carbon cost	Internal carbon price	Low carbon technology development rank	Technology development scorecard	Research and development	Water resilience rank	Water stress exposure	Water consumption intensity	Water recycling rate	Climate governance rank	Carbon regulation supportiveness	Remuneration	Green	Amber	Red
1	POSCO	South Korea	3	5	2	7	2	7	7	7	3	4	6	6	1	1	3	3	3	4	5	10	5	4	7	8	8	1
2	SSAB	Sweden	5	2	1	10	10	10	1	2	1	3	1	12	1	3	2	7	4	1	11	10	9	10	4	9	2	6
3	ThyssenKrupp	Germany	7	3	12	4	10	10	3	4	2	2	4	4	1	8	9	5	1	2	2	10	4	5	1	8	5	4
4	Hyundai Steel	South Korea	1	1	10	6	1	9	2	1	5	1	2	2	5	10	10	8	11	13	3	9	9	9	7	6	8	3
5	ArcelorMittal	Luxembourg	2	4	4	2	6	3	5	5	6	6	3	14	8	1	1	9	4	5	8	2	14	14	12	6	7	4
6	NSSMC	Japan	4	5	8	3	4	8	4	3	7	5	5	9	8	5	5	2	8	7	10	6	13	13	12	3	10	4
7	China Steel	Taiwan	6	9	7	9	3	4	8	8	8	11	9	10	5	6	4	6	6	9	7	1	2	3	2	4	12	1
8	JFE Holdings	Japan	8	7	6	14	4	5	6	6	4	10	7	11	8	7	5	4	12	10	9	4	12	12	7	3	10	4
9	Kobe Steel	Japan	11	10	9	12	7	6	11	11	11	8	10	3	8	4	5	1	6	11	4	3	6	6	7	4	7	6
10	JSW Steel	India	9	11	3	5	8	2	9	9	10	12	12	8	1	11	10	10	13	14	6	7	1	1	4	6	6	5
11	CSN	Brazil	12	13	13	1	10	10	11	11	11	7	11	1	8	12	10	12	2	8	1	5	3	2	7	5	4	8
12	Evraz	UK	10	8	5	12	9	1	11	11	11	9	8	7	8	13	10	13	10	6	11	10	8	7	12	2	6	9
13	Tata Steel	India	14	14	14	11	10	10	10	10	9	13	14	5	5	9	8	11	14	12	11	8	7	8	2	2	6	9
14	US Steel	US	13	12	11	8	10	10	11	11	11	14	13	13	8	13	10	13	8	3	14	10	11	11	4	2	2	13

Weighting:

| Metric | 30% | | 35% | 10% | 15% | 30% | 10% | 17.5% | 75% | 25% | 10% | 50% | 30% | 20% | 17.5% | 75% | 25% | 15% | 50% | 40% | 10% | 10% | 75% | 25% | 100% | | | |

Area: 30%

Engagement area groupings:
- Emissions and Energy Management
- Emissions Targets and Pathways
- Carbon Cost Exposure
- Low Carbon Technology Development
- Water Resilience
- Climate Governance
- Total

Emissions and energy management summary

League Table rank	Company	Country	Emissions & energy management rank	Current emissions intensity	Reduction in emissions intensity	Emissions data transparency	Current energy intensity	Reduction in energy intensity
4	Hyundai Steel	South Korea	1	1	10	6	1	9
5	ArcelorMittal	Luxembourg	2	4	4	2	6	3
1	POSCO	South Korea	3	5	2	7	2	7
6	NSSMC	Japan	4	5	8	3	4	8
2	SSAB	Sweden	5	2	1	10	10	10
7	China Steel	Taiwan	6	9	7	9	3	4
3	ThyssenKrupp	Germany	7	3	12	4	10	10
8	JFE Holdings	Japan	8	7	6	14	4	5
10	JSW Steel	India	9	11	3	5	8	2
12	Evraz	UK	10	8	5	12	9	1
9	Kobe Steel	Japan	11	10	9	12	7	6
11	CSN	Brazil	12	13	13	1	10	10
14	US Steel	US	13	12	11	8	10	10
13	Tata Steel	India	14	14	14	11	10	10
		Weighting:		35%	10%	15%	30%	10%

Source: CDP

Emissions targets and pathways summary

League Table rank	Company	Country	Emissions targets & pathways rank	Quality of target	Performance against target
2	SSAB	Sweden	1	2	1
4	Hyundai Steel	South Korea	2	1	5
3	ThyssenKrupp	Germany	3	4	2
6	NSSMC	Japan	4	3	7
5	ArcelorMittal	Luxembourg	5	5	6
8	JFE Holdings	Japan	6	6	4
1	POSCO	South Korea	7	7	3
7	China Steel	Taiwan	8	8	8
10	JSW Steel	India	9	9	10
13	Tata Steel	India	10	10	9
11	CSN	Brazil	11	11	11
12	Evraz	UK	11	11	11
9	Kobe Steel	Japan	11	11	11
14	US Steel	US	11	11	11
		Weighting:		75%	25%

Source: CDP

Carbon cost exposure summary

League Table rank	Company	Country	Carbon cost exposure rank	Intensity-based carbon cost	Auctioning carbon cost	Internal carbon price
4	Hyundai Steel	South Korea	1	2	2	5
3	ThyssenKrupp	Germany	2	4	4	1
2	SSAB	Sweden	3	1	12	1
1	POSCO	South Korea	4	6	6	1
6	NSSMC	Japan	5	5	9	8
5	ArcelorMittal	Luxembourg	6	3	14	8
11	CSN	Brazil	7	11	1	8
9	Kobe Steel	Japan	8	10	3	8
12	Evraz	UK	9	8	7	8
8	JFE Holdings	Japan	10	7	11	8
7	China Steel	Taiwan	11	9	10	5
10	JSW Steel	India	12	12	8	1
13	Tata Steel	India	13	14	5	5
14	US Steel	US	14	13	13	8
			Weighting:	**50%**	**30%**	**20%**

Source: CDP

Low carbon technology development summary

League Table rank	Company	Country	Low carbon technology development rank	Technology development scorecard	Research and development
5	ArcelorMittal	Luxembourg	1	1	9
1	POSCO	South Korea	1	3	3
2	SSAB	Sweden	3	2	7
9	Kobe Steel	Japan	4	5	1
6	NSSMC	Japan	5	5	2
7	China Steel	Taiwan	6	4	6
8	JFE Holdings	Japan	7	5	4
3	ThyssenKrupp	Germany	8	9	5
13	Tata Steel	India	9	8	11
4	Hyundai Steel	South Korea	10	10	8
10	JSW Steel	India	11	10	10
11	CSN	Brazil	12	10	12
12	Evraz	UK	13	10	13
14	US Steel	US	13	10	13
			Weighting:	**75%**	**25%**

Source: CDP

Water resilience summary

League Table rank	Company	Country	Water resilience rank	Water stress exposure	Water consumption intensity	Water recycling rate
3	ThyssenKrupp	Germany	1	2	2	10
11	CSN	Brazil	2	8	1	5
1	POSCO	South Korea	3	4	5	10
5	ArcelorMittal	Luxembourg	4	5	8	2
2	SSAB	Sweden	4	1	11	10
7	China Steel	Taiwan	6	9	7	1
9	Kobe Steel	Japan	6	11	4	3
6	NSSMC	Japan	8	7	10	6
14	US Steel	US	8	3	14	10
12	Evraz	UK	10	6	11	10
4	Hyundai Steel	South Korea	11	13	3	9
8	JFE Holdings	Japan	12	10	9	4
10	JSW Steel	India	13	14	6	7
13	Tata Steel	India	14	12	11	8
			Weighting:	50%	40%	10%

Source: CDP

Climate governance summary

League Table rank	Company	Country	Climate governance rank	Carbon regulation supportiveness	Remuneration
10	JSW Steel	India	1	1	4
7	China Steel	Taiwan	2	3	2
11	CSN	Brazil	3	2	7
3	ThyssenKrupp	Germany	4	5	1
1	POSCO	South Korea	5	4	7
9	Kobe Steel	Japan	6	6	7
13	Tata Steel	India	7	8	2
12	Evraz	UK	8	7	12
2	SSAB	Sweden	9	10	4
4	Hyundai Steel	South Korea	9	9	7
14	US Steel	US	11	11	4
8	JFE Holdings	Japan	12	12	7
6	NSSMC	Japan	13	13	12
5	ArcelorMittal	Luxembourg	14	14	12
			Weighting:	75%	25%

Source: CDP

Appendix: Methodology and limitations

Emissions and energy management

We apply the following methodologies to determine the weighted rank for each area:

Emissions intensity performance

Data collection:
We apply the following steps to ensure the data is as consistent and credible as possible for our intensity analysis:

◥ Collate Scope 1 and 2 steel production emissions intensities for 2009-15 from CDP questionnaire responses and company reports.

◥ Replace this with restated emissions data where available.

We urge companies to provide:

◥ Total company wide emissions levels as well as calculated emissions intensities, to avoid errors in manually calculating these intensities.

◥ Clear disclosure of the scope and units of their disclosures.

◥ Consider making available multiple measures of emissions intensity where available. Many steelmakers report Scope Scope 1-3 intensities to World Steel Association, but do not make these publicly available. These intensities would provide a more comprehensive company boundary and would likely make emissions intensities more consistent and comparable between different companies.

◥ Making restated emissions data publicly available where relevant

◥ Ensure that intensities are available for all years back to a target's base year.

Metric 1) Current emissions intensity:
◥ We collate steel production emissions per tonne of crude steel for the three-year period 2013-2015 from the CDP questionnaire or company sources.

◥ We calculate the median emissions intensity over the three-year period of 2013-2015.

Metric 2) Reduction in emissions intensity:
◥ We collate steel production emissions per tonne of crude steel for the seven-year period 2009-2015 from the CDP questionnaire and company sources.

Once we have a complete emissions intensity dataset we apply the following steps:

◥ We use our proprietary function to assess the companies' emissions reduction performance for each of the following periods: 2009-2015, 2010-2015 and 2011-2015. Our function takes into account the full emissions profile of each of the three periods.

◥ The function measures the total emissions intensity over a period and calculates the implied constant reduction rate per annum required to create the same aggregate emission profile (over the same period) starting from the base year for the period.

◥ The function is therefore independent of end date for the period (i.e. 2015) but dependent on start date. This is why we apply the function to three periods with differing start dates.

◥ We calculate the implied constant reduction rate for each of the three periods.

◥ We take the median of the results in order to exclude any anomalies (e.g. temporarily altered production and efficiency levels, or a material acquisition with a significantly different emissions intensity).

◥ We rank the companies based on the median implied constant reduction rate with the companies who have reduced their emissions more aggressively favoured.

Transparency on emissions

We adopt a scorecard approach to analyze companies in terms of their emissions data transparency on a scale of 0-20 (10 for transparency on Scope 1, and 10 for transparency on Scope 2). We rank companies according to their score.

Metric 3) Data transparency:
◥ We use the following approach to score companies according to their Scope 1 data transparency. The procedure is exactly the same for Scope 2.

◥ The start point in the analysis is the proportion of emissions verified by a third party. We score this out of 10. If 100% are verified, this achieves 10 points. Then, points are awarded according to the proportion verified, i.e. a company with 86% of emissions verification is awarded 8.6 points.

◥ We then adjust the score (max 10) according to the uncertainty of the scope verified. If the uncertainty is 5%, we deduct 0.5 points, if the uncertainty is 2%, we deduct 0.2 points, and so on.

◥ We multiply the remaining score according to the level of assurance as follows: high assurance = 100%; reasonable = 90%; moderate = 80%; limited = 70%; don't know yet = 50%; none = 0%.

- We then multiply the remaining score (still max 10) according to the status of the verification: complete = 100%; underway = 75%; none = 0%.

- We apply the above steps to transparency on both Scope 1 emissions and Scope 2 emissions. We then combine the score (max 10 each).

- Finally, we multiply the combined score (out of 20) according to the boundary of the emissions reported as follows: operational control = 100%; financial control = 75%.

- Operational control is the most comprehensive boundary. It reflects accounting consolidation, i.e. 100% of emissions for all subsidiaries controlled by the group regardless of ownership share and % owned (or controlled) of JVs and associated companies.

- Financial control requires consolidation of 100% of emissions for subsidiaries controlled by the group (regardless of ownership share) but does not require emissions from JVs or associated companies to be included.

Energy intensity performance

Data collection:
- We collate energy intensity for crude steel production over 2010-2015 from companies' publicly available sources. If such data is not available, we calculate the energy intensity by dividing the energy consumption related to steel making by the volume of crude steel produced.

- We note that not all denominators of energy intensity figures provided by companies are crude steel (e.g. sometimes it is liquid steel or simply "steel"). However, the difference between crude steel and other type of steel at the remaining stage of the production process is negligible.

- Since China Steel and its subsidiary Dragon Steel report their energy intensity separately, we obtain the weighted energy intensity in order to compare China Steel fairly with other companies.

- The energy intensity data disclosed by Evraz covers three plants representing around three quarters of the company's total production (comparing to one-third for Tata Steel), concluding it was significant enough to be included in our analysis.

Metric 4) Current steel production energy intensity:
- We calculate the median energy intensity over the three-year period of 2013-2015 and rank the company with the lowest intensity first.

- We use median instead of the latest year's data to avoid anomalies.

Metric 5) Reduction in steel production energy intensity:
- We use our proprietary function to assess companies' energy intensity reduction performance for the six-year period of 2010-2015.

- Our function takes into account each year's energy intensity within the six-year period and calculate the implied constant rate of change per annum required to create the same aggregate energy intensity profile (over the same period) starting from the base year of the period.

- We rank the company with the greatest reduction rate first.

Limitations:
Companies in a number of cases disclosed emissions intensities with unclear scope, or disclosed in ways subtly different from other companies.

- Some companies disclosed in units of CO_2 where others disclosed in CO_2e.

- All Japanese companies appear to disclose emissions intensities excluding 'non-energy derived emissions', excluding emissions from lime and dolomite, whereas other companies appear to include these.

- In other cases, companies disclosed in some publications or in some years Scope 1+2 intensities, while other times Scope 1+2+3 intensities (as per WSA guidelines), without always differentiating between them.

- We sought to clarify the nature of unclear or inconsistent disclosures and raised concerns over consistency with many companies.

- In most cases it was not possible to adjust remaining inconsistencies, due to lack of availability of transparent conversion factors. In several cases, companies stated that the magnitude of differences between company emissions data based on these inconsistencies was very small. However, we have not been able to independently verify the magnitude of inconsistencies that differences in disclosure practices might create, and not all companies responded to our requests for clarifications.

Our research also highlighted the potential for some artificial differences in disclosed emissions intensities to arise based on different business models and ownership of key facilities:

▼ Steelmakers whose end products require a high degree of processing might have higher emissions than those that produced simple steel products, or whose crude steel output then underwent final processing by another party.

▼ One steelmaker argued that emissions disclosures using the GHG Protocol created data suitable for footprinting, but of limited use in benchmarking, partly due to ownership of power plants that produce energy using steel waste gases. All emissions of power plants owned by steelmakers would be classified as Scope 1 emissions, whereas the portion of power used in steelmaking from non-owned, external power plants would be recorded as Scope 2 emissions. Excess power plant energy that uses steel waste gas would also not be within the Scope 1+2 boundary if not owned by the steelmaker, but would be included in its Scope 1 emissions if owned. Though this was pointed out as a concern, it is unclear to us how substantial its impact is. Several companies told us specifically that they included power generated from steelmaking gases as part of their Scope 1 emissions whether or not the power plant was owned by them.

Emissions reduction targets

▼ Six companies set intensity targets and four set absolute emissions reduction targets. To convert the absolute targets into intensity targets in order to have a fair comparison across all companies, and unless the company provided transparent disclosure otherwise, we assume that a company's production levels in its target years' business-as-usual scenario are the same as its base year (which is a methodology adopted by at least one reporting company). We recognise that such an assumption might not best reflect the situation in the target years, yet this is a reasonable assumption in the absence of intensity targets.

▼ We collect companies' GHG emissions reduction targets from their responses to CDP and other publicly available sources.

▼ We include targets in our analysis only if they cover a minimum of five years and 80% of the company's total emissions, so as to represent meaningful, comprehensive, and comparable targets across companies

▼ While we adopt a metric based on the SDA methodology developed by the SBT initiative, our assessment of the quality of companies' emissions reduction targets should not be interpreted as an indication that any individual company's target would be approved as being 'science-based' by the SBT initiative. In its target assessments, the SBT initiative applies additional eligibility criteria concerning the boundary and timeframe of the target; use of intensity and absolute targets; annual reporting requirements; and inclusion of scope 3 emissions, that are not considered in this report.

Metric 1) Quality of emissions reduction target:

▼ We start by modelling companies' emissions trajectory using the details of their emissions reduction targets, assuming a compound annual growth rate (CAGR) over the lifetime of their targets. The CAGR is derived from the base year, target year, base year intensity and the percentage of reduction targeted by companies (for intensity targets converted from absolute targets, such percentage of reduction is calculated from the difference of base year's and target year's emissions intensity).

▼ We collate the Scope 1 & 2 emissions and activity level, i.e. crude steel production, of the steel industry from the IEA's Energy Technology Perspectives 2016 (ETP 2016) dataset in order to construct the 2-degree scenario (2DS) emissions intensity pathway for the steel industry for 2013-2050.

▼ We compare company targets' pathway against the 2DS pathway by calculating the average annual difference between the two pathways, and rank the company beating the 2DS the most first.

▼ We rank companies without targets joint bottom, and companies with unqualified targets, i.e. JEF Steel's and Tata Steel's targets have only one-year lifetime, second-last.

▼ We recognise that China Steel's target does not cover its fully-owned Dragon Steel which has a significant production; similarly, Tata Steel's target overs its operation in India only. Investors should ask these companies to revise their targets to cover the majority of their operations.

Metric 2) Performance against target:

▼ Similar to the methodology used in the previous metric, we compare company targets' pathway against their actual emissions intensity performance between 2009 and 2015.

▼ The actual emissions intensity performance data is obtained from the calculation of metric 1 and metric 2.

Carbon Cost Exposure

We apply the following methodologies to determine the weighted rank for each metric:

Metric 1) Carbon cost exposure under intensity benchmarking:

◤ See the methodology of emissions intensity metrics in emissions and energy management chapter for details of data collection/calculation of emissions intensity of crude steel production for the three-year period 2013-2015.

◤ Using the average of 2013-2015 emissions intensity and the sectoral decarbonisation approach (SDA) crude steel emissions intensity benchmark for 2015 (2.082 tonne CO_2 / tonne of crude steel), we calculate each company's carbon credit (deficit) per tonne of crude steel.

◤ We use the average of 2013-15 crude steel production to calculate the total carbon cost by multiplying the production by the carbon credit (deficit) and a price of US$1 per tonne of carbon.

◤ We calculate the carbon cost exposure by dividing the carbon cost by the company's 2013-15 median recurring EBIT. For SSAB and US Steel, we take the only year that has a positive recurring EBIT.

◤ Tata Steel is ranked bottom in this metric due to no consolidated emissions intensity figure available.

Metric 3) Company use of internal CO_2 price:

◤ We collect data on the use of internal carbon prices from companies' responses to question CC2.2c-d from the 2016 CDP climate change questionnaire.

◤ We adopt a scorecard approach to assess companies based on their application of an internal price and the level of the price. However, since none of the companies in our study discloses their internal carbon price, this metric effectively is composed of one component only.

Limitations:

◤ We acknowledge that applying a uniform carbon price on emissions originating in various jurisdictions has its limitations. Greater company disclosure of emissions data at country and facility level would allow a more accurate measurement.

◤ The SDA benchmark is not part of any current regulations which use an industry benchmark to allocate free CO_2 allowances. Some schemes allocate allowances linked to a 'best available technology' practises or top emission intensity performers. The EU ETS's industry benchmark for steel is made up of multiple individual benchmarks, for example covering sintering, coke making, and iron making stages. As we do not have input or output data at each of these interim stages, such a granular approach could not be employed.

◤ We recognise that as carbon pricing is more effectively enforced, companies are likely to take abatement action which will alter their emission profiles and thus carbon cost in a non-liner manner and potentially pass on some of the costs in the form of price rises. However, such analysis is not undertaken in this study due to lack of data.

Low carbon technology development

Metric 1) Technology development scorecard

◤ We started by undertaking a review of company and steel industry literature on low emissions technology for steelmaking, and developing a database of technologies the industry had identified with breakthrough emissions reduction potential.

◤ We narrowed this to a shortlist based on technologies that had identifiable involvement by steelmakers, been active within the past five years, some information available on emissions reduction potential, committed funding and had information on expected timeframes for the project and the level of technological progress achieved.

◤ We undertook a scorecard based approach to provide a simple ranking of technological progress and prospects, seeking to identify the following details for each technology:

  ◤ What is its stated emissions reduction potential? (0-10 points, for example with 1 representing a potential 10% emissions reduction and 10 representing a 100% emissions reduction versus the BF-BOF route)

  ◤ What is its stated emissions reduction potential if it were to be combined with CCS? (0-5 points, scored the same way as above then divided by 2, to account for the more difficult prospects of achieving commercialisation of both the core technology and CCS)

  ◤ What is its level of committed funding? (3= less than US$100m or unidentified, 5 = US$101-200m, 7 = US$201-500m, 10 = US$501m+

  ◤ What is its projected timeline for potential commercialisation? (3=around 2040 or later, 5=around 2030, 7=around 2020, 10=now)

- Total scores for each technology are then aggregated on a 35 point scale and then attributed to any companies with involvement. Technology scores are additive in cases where one company is involved in development of multiple key technologies.

- We recognise the inherent limitations of such an approach and the high level of simplification it entails.

Metric 2) Ratio of research & development expenses to sales:
- We rank companies on their average R&D expense to sales ratio over the period 2013-2015. This provides an indication of companies' innovation capability and level of focus on innovation.

Water Resilience

We apply the following methodologies to determine the weighted rank for each metric:

Metric 1.) Water Stress Exposure
We combine the ranks of both components using the following weightings: Current (2015) water stress exposure 60% and projected (2030) water stress exposure 40%.

We apply the following steps

- Site information on geographical coordinates and equity stakes are collated for more than 380 steel facilities. These facilities are filtered down to crude steel producing sites only.

- We apply WRI Aqueduct's water stress risk classifications to the remaining facilities according to their geographical location using five categories: low, low to medium, medium to high, high and extremely high. These are based on three risks areas weighted for the construction industry: physical water quality (77.9%), physical water quantity (10.2%) and regulatory and reputational risks (11.9%).

Current water stress (2015)

- At the facility level we identify the level of water stress risk exposure using the WRI water risk indicator score, ranging from 0 to 5 (the higher the score the greater the overall water stress). The score is based on physical water quality and quantity, regulatory and reputational risks and further metrics such as flood occurrence, drought severity and baseline water stress.

- The score is averaged for all sites in each company to produce a single overall score. The range of the lowest and highest scoring sites within a company are also presented

- We also calculate the number of each company's facilities in each WRI risk category and present the medium to high risk and high risk facilities as a percentage of the total sites.

Current water stress (2015)

- At the facility level we identify the level of water stress risk exposure weighting the three scenarios: 25:50:25 (optimistic: business as usual: pessimistic) as defined by WRI.

- We calculate the number of each company's facilities in each WRI risk category based on this aggregate, presenting the medium to high risk, high risk and extremely high risk categories as percentages. We then scale the number of facilities according to the following weights 0:5:15:35:45 (low: low to medium: medium to high: high: extremely high) and divide by the total number of facilities. This approach assigns greater weight to facilities facing higher water stress risks.

- Finally, we normalize this number to produce a water stress exposure index ranging from 0 (all facilities exposed to low water stress risk) to 1 (all facilities exposed to extremely high water stress risk). Therefore, the higher the index value the more exposed a company is to water stress risk.

Metric 2a.) Water Consumption Intensity and 2b.) Water Recycling Rate:
- Water consumption intensity figures for 2015 are collected from company filings and the 2016 CDP water questionnaire. Where intensity figures were not available intensity figures were calculated using total water consumption and crude steel production figures. Units were standardised where appropriate to give an intensity figure in m3/tonne of crude steel production.

- Several companies could not be included in this comparison: US Steel does not disclose any water data, while Tata Steel only discloses its India operations. SSAB only discloses withdrawals, and Evraz does not separate water consumption for its mining and steelmaking operations.

- Water data for Dragon Steel, a 100%-owned subsidiary of China Steel is incorporated into the China Steel figure. Water intensities for Kobe Steel and JFE Holdings are calculated based on total water consumption and steel production.

- Recycling rates were collected from company filings and expressed as a percentage.

Limitations:

▾ Water accounting practices differ across companies. For example, some companies report only water withdrawal instead of consumption, others report intensity figures instead of absolute figures, while others omit water usage figures of any kind. Without consistently reported or verified data it is a challenge to effectively benchmark and compare water consumption between companies. Further metrics of water use such as water withdrawal and discharge, which may give a more complete indication of water resilience are infrequently reported and so cannot be compared.

▾ Some companies have more sites than others and therefore, an average water stress score can be seen as a limitation. A more effective method would be to weight facilities by annual production or capacity, to give a more representative value of water stress. However, due to a lack of site production or capacity data available for many companies this was not possible.

▾ Water recycling data was not accessible for all companies. Furthermore, without establishing additional environmental costs of increased energy consumption accrued in the filtering and cleaning process and waste discharge levels, the efficacy of recycling water is unclear.

Climate governance

Metric 1) Carbon regulation supportiveness:
Our CDP carbon regulation supportiveness metric uses InfluenceMap's total score which combines the company organization score and relationship score according to their proprietary algorithm. From this, we determine the carbon regulation supportiveness rank.

A full description of InfluenceMap's detailed methodology can be found on its website. Its methodology comprises three stages: (a) aggregation of suitable data sources (SEC disclosures, legislative consultations, CDP responses etc.); (b) assessment (via raw scores) of those data sources using suitable queries; and (c) input of the raw scores and other factors into its algorithm to arrive at comparable metrics of regulatory supportiveness for corporations. It analyzes these data sources with a series of 12 queries relating to various aspects of climate change policy and legislation. It then scores each data source/query intersection (or cell) on a 5-point scale, with clearly consistent evidence and guidelines.

▾ Organizational score: is computed over 96 scoring cells by InfluenceMap's proprietary algorithm that accounts for weightings and irrelevant data sources/ queries. The organizational score is expressed as a percentage, with 100% representing very supportive influence on climate policy.

▾ Relationship score: is a reflection of a corporation's climate influencing activities through its influencers (i.e. trade association etc.). The relationship score is also expressed as a percentage, with 100% representing very supportive influence over climate policy.

Metric 2) Alignment of remuneration policy with climate risk management:
We developed a scorecard based on responses to CDP climate change questionnaire CC1.2 and CC1.2a on incentives for the management of climate change issues, including the attainment of targets.
Based on our assessment of responses, we identified three key organisation levels at which remuneration incentives were being applied to climate change-related objectives – at executive level, in key divisions and departments (eg. those with responsibility for energy management or research and innovation), and rewards that were available to general employees.
We scored companies based on these responses, and sought further information from the company's own public reporting where answers were unclear. Scoring was out of a maximum 30 points as follows:

▾ Incentives for top executives (maximum score of 10 for clear alignment of remuneration policy with carbon risk management, score 5 for some limited alignment or disclosure of lesser detail, score 0 for none)

▾ Incentives for key divisional responsibilities (maximum score of 10 for a clear alignment at one or more key divisional levels, 5 for some limited alignment or disclosure of lesser detail, score 0 for none)

▾ Incentives for general employees (maximum score of 10 for carbon related incentives that can be attained by many or all employees, 5 for some but less widespread incentives, score 0 for none)

Notes

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