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Tsunami, spring tide, or high tide? The growing importance of steel scrap in China

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Executive summary

The global share of scrap in metallics consumption has been declining in recent years, driven largely by China's growing role in the steel industry. As a developing economy, China has had limited amounts of obsolete (or postconsumer) scrap to use as a material in steel-making. However, as the country's products and infrastructure enter the replacement phase, the growing availability of obsolete scrap is likely to fuel a shift from steelmaking based on basic oxygen furnace (BOF) technology to electric arc furnace (EAF) technology that relies more heavily on scrap. In time, this shift will have a significant impact on scrap consumption trends both in China and globally.

Today, scrap recycling in China is a highly fragmented industry that lacks vertical integration and mainly operates under the authorities' radar. In order to handle growing volumes of scrap, the sector will need to gain scale and efficiency. To date, it has been challenged by the uncertainties surrounding the government's plans to restructure the domestic steel industry, declines in scrap prices relative to raw materials, and lack of market regulation. Additionally, the government has provided little support for the industry in recent years, despite voicing high ambitions for its future.

How rapidly China's scrap recycling industry develops will depend on the evolving economics of the industry, government policies, and the pace of the shift in Chinese steel production from BOF to EAF technology or the use of new technologies to increase the amount of scrap used in BOF. In this article, we lay out a scenario for China's scrap recycling industry over the next 15 years, based on our projections of China's steel production and consumption, its scrap supply and how much of its processors will be able to profitably recycle, and the relative production shares of BOF and EAF. Failing to use the recycled scrap locally will push extra scrap volumes onto the export market and potentially distort overall trade dynamics.

The below analysis is based on a specific set of assumptions with respect to future steel demand/production, life cycles of steel products, scrap recycling rates and scrap intensities in both BOF and EAF to come to a future view on the supply demand balance for scrap. Although these assumptions might have a high likelihood, how the actual future scrap balance turns out will largely depend on the economics for the scrap recycling business as well as for the steel companies.

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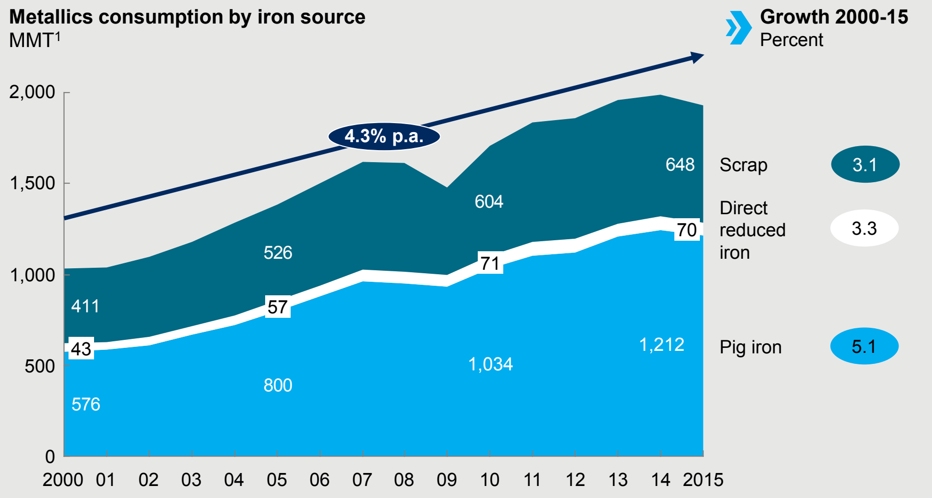
The global scrap industry – an overview

After more than a decade of consistent growth, global demand for steel scrap has been declining since 2014 (Exhibit 1). This is due to both the slowdown in overall steel demand and a drop in the global production share of the EAF route – the primary destination for scrap – in steelmaking. In 2015, the steel industry used about 650 million metric tons (MMT) of scrap, down from a peak of 680 MMT in 2013 (see "Scrap consumption estimates: McKinsey methodology"). While steel production grew 4.3 percent per year since 2000, scrap annual growth has averaged 3.1 percent.

The slower global growth of steel scrap is due to a large extent to China's rising share of the global steelmaking sector. In 2000, China accounted for 15 percent of global crude steel production, while in 2015 it represented 50 percent. Over the past decade, the country has dominated both steel demand and production. As a developing economy, it has had limited domestic supply of obsolete scrap. Additionally, with most of the installed assets using BOF technology, producers have largely relied on primary raw materials – namely iron ore and coking coal. As the country's share of global steel production grew, its low dependence on scrap pushed down scrap's overall share in global steel production from 40 percent in 2000 to 34 percent in 2015. Nevertheless, annual steel scrap consumption in China has continued to grow, amounting to an increase of 155 MMT over the past 15 years.

Exhibit 1

Global scrap consumption has been growing at ~3.1% per year during the last 15 years, which is significantly lower than pig iron (~5.1%)



1 Absolute value of metallics consumption based on crude steel output, taking into account (i) typical Fe content in metallic and (ii) Fe losses in the steel making process

SOURCE: worldsteel; Midrex; McKinsey analysis

Differences in regional scrap consumption

Scrap usage rates in steelmaking differ significantly around the world depending on the production process used in each market and its domestic scrap availability. In regions that rely heavily on EAF technology to produce crude steel, scrap's share of the total metallic input can be as high as 85 percent. Some markets have a high EAF share but low scrap usage because they favor direct reduced iron (DRI) as the main metallic input. These are typically countries with cheap access to natural gas.

Three main factors affect the amount of scrap used in steelmaking. Firstly, domestic scrap availability and the volume of metallics needed to support steel production influence the choice between EAF and BOF, and thus scrap demand. Secondly, the quality and volume of steel products a given market needs to support its economic development play a role: typically, a developing economy invests in infrastructure first, relying on long steel products that have lower quality criteria and can be made from scrap. Finally, capital costs and cash availability factor into steelmakers' choice between EAF and BOF.

Sources of steel scrap

Steel scrap is generated in three ways:

1. **Home (or return) scrap.** This scrap comes from waste generated during the steelmaking process due to rolling, conditioning, cutting, and trimming. As such, home scrap's availability is directly linked to steel production volumes. Typically, home scrap is fully and immediately recycled in the mill.

2. **Prompt (or industrial) scrap.** Generated in the downstream manufacturing process, prompt scrap rates tend to track finished steel consumption. Like home scrap, prompt scrap is usually fully recycled. Once collected, it is typically transported back to the steelmaker within the year.

3. **Obsolete (or postconsumer) scrap.** This form of scrap is collected once products containing steel reach the end of their life. The historical steel use by various sectors and length of those products' lifecycles determines the volumes of available obsolete scrap. The recovery rate depends on the local recycling business.

Scrap pricing dynamics

The supply of obsolete, or postconsumer, scrap (see “Sources of steel scrap”), depends largely on the economics of scrap collection and processing. The scrap recycling industry has a similar structure around the world: a pyramid with numerous small, private entities at the bottom. An analysis based on the US market shows that scrap supply is inelastic below a certain price (Exhibit 2): when prices drop below that threshold, collectors only recover scrap that can be easily extracted and total scrap supply remains relatively constant while scrap sellers await better prices. Above that threshold, the supply tends to increase in line with rising scrap price.

Exhibit 2

Scrap price becomes more elastic to supply or vice versa once it hits values of >USD 250-300 MT

US EXAMPLE

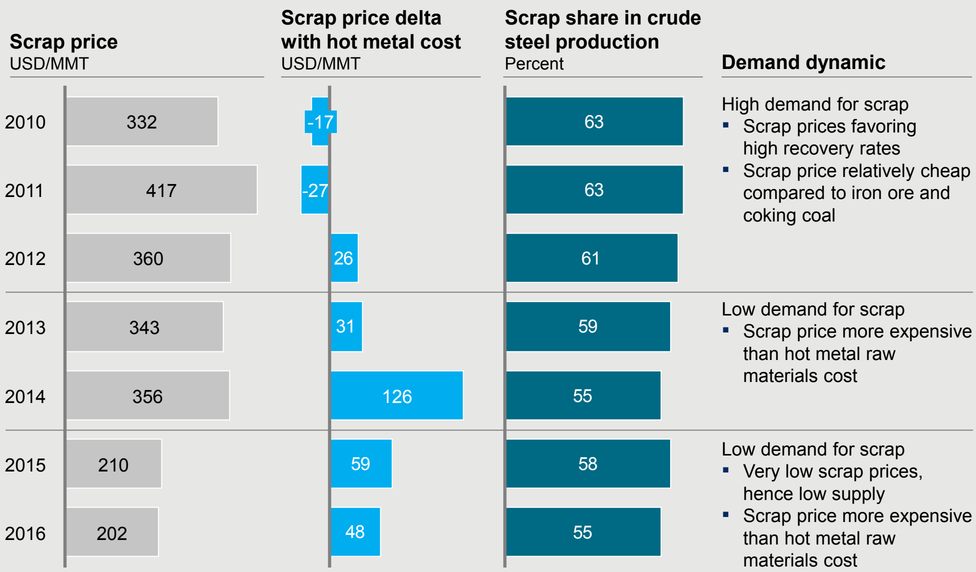
SOURCE: United States Geological Survey; McKinsey analysis

Scrap consumption, on the other hand, is driven by the price differential between scrap and the hot metal raw materials basket (Exhibit 3). Scrap prices tend to correlate closely with the prices of iron ore and coking coal used (to produce hot metal (pig iron)) as scrap is essentially a substitute for them. Steelmakers make trade-offs based on these inputs' relative prices and the value-in-use (VIU) models that take into account the quality and full cost of the metallic input to reach the optimal balance. Producers also factor in capacity utilization of all their assets. As integrated (BOF) mills have higher fixed costs than EAF facilities, steelmakers tend to maximize hot metal production at the expense of using scrap.

Exhibit 3

Scrap demand is, apart from the absolute price level, primarily driven by the difference between scrap price and hot metal raw materials cost

US EXAMPLE



SOURCE: United States Geological Survey; McKinsey analysis

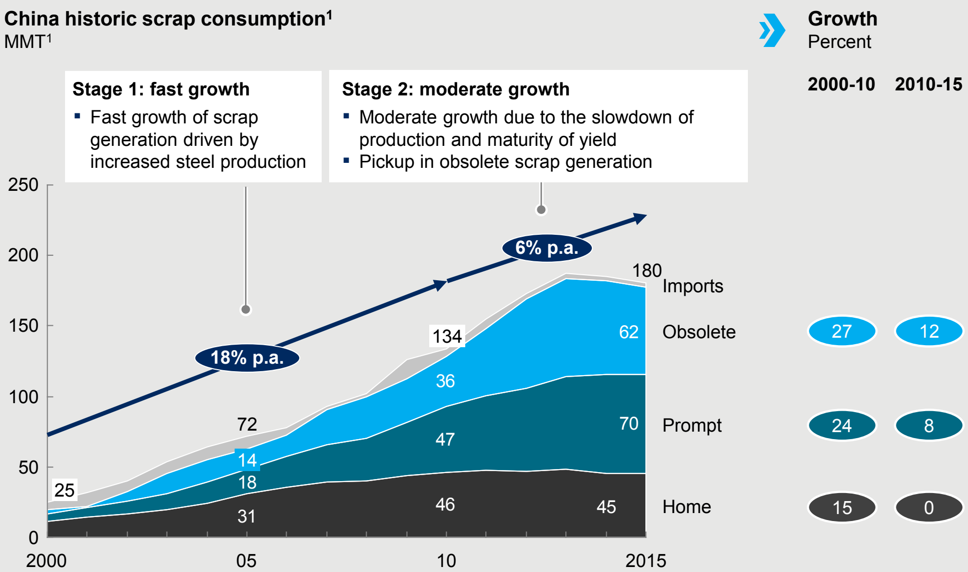
The scrap recycling industry in China

After more than a decade of remarkable economic development and industrialization, China has emerged as both the biggest producer and top consumer of steel in the world, accounting for about 47 percent of global steel consumption. However, the country's demand for steel peaked in 2013 at 735 MMT, or about 540 kg per capita. We expect it to stabilize at roughly 400 to 450 kg per capita – a level in line with developed economies – in 15 to 20 years, as the country's economic growth continues to level off.

As China's steel industry expanded, the country's scrap consumption rose at 14 percent per year; today, it leads the world in both scrap supply and usage. In 2015, scrap consumption amounted to 180 MMT – about 27 percent of the global total (see "Scrap consumption in China: McKinsey methodology"). For much of the past decade and a half, the bulk of this volume came from home and prompt scrap, generated in increasing amounts during steel production and manufacturing. However, the share of obsolete scrap has been rising recently as more steel products reach the end of their life and are recycled, and as the drop-off in steel production reduces the volumes of home and prompt scrap (Exhibit 4). In 2015, obsolete scrap accounted for about 35 percent of total scrap consumed in China, and that share will keep growing.

Exhibit 4

Obsolete scrap consumption in China is gaining importance as steel production is slowing down and end-of-life steel is growing



1 Calculated by closing the Fe-loop using pig iron/DRI consumption and crude steel production including Fe% and yield assumption

SOURCE: Worldsteel; BMI McKinsey

In the last five years (2011-2015), scrap represented only one-fifth of the total metallics China used for crude steel production. On average, Chinese steelmakers use about 100-150 kg of scrap per ton of crude steel produced in BOF operations and 550-600 kg in EAF operations – significantly lower quantities than typically observed as they rely heavily on pig iron, especially in EAF operations. Currently, EAF represents only 6 percent of China's steel production. In addition to the EAF and BOF crude steel production, it was recently reported that around 40 MMT of crude steel in China is produced using induction furnaces (IF). These typically rely fully on scrap as metallic charge.[1]

As in many parts of the world, China's recycling sector is very fragmented. Minimal technology requirements, limited government regulation, and low labor and operating costs have brought a large number of players into the industry, with little vertical integration along the value chain. The players comprise three main categories: scrap collectors, basic processors (or distributors), and secondary processors (professional scrap companies). Small collectors gather discarded items containing steel from neighborhoods and local industry. Distributors sort, dismantle, and bale this scrap using simple processing equipment. Professional scrap companies then sort and process the scrap into standardized products for sale to steel mills. (For some specialized obsolete goods, such as cars and ships, only licensed scrap companies can conduct collection and processing.)

The collector and distributor tiers largely operate under the radar of taxation authorities. China has more than 20,000 scrap collectors – mostly individuals or very small businesses – each handling less than 2 kilo metric tons per year (KMTPY), and the 10 biggest companies make up just 2 percent of the market. Of the 2,000 plus distributors, the 10 biggest generate less than 5 percent of the output, processing about 30 KMTPY each. Both groups tend to operate without licenses and rely on unofficially hired staff.

Secondary scrap processors face higher barriers to entry, and must comply with regulations regarding safety, handling capacity, waste disposal, and other criteria. Roughly 200 companies are registered with the government, with average annual output of about 150 KMTPY. More than two-thirds of them are located in the eastern and coastal regions, which are relatively more developed. Even in this more professionalized section of the industry, fragmentation is high, with the 10 largest players accounting for roughly 15 percent of the market. Gross margins also range widely: between 4 and 12 percent in 2015.

Professional scrap companies have evolved different business models. Some focus on premium scrap from end-of-life ships and cars and foster relationships with those suppliers. Another strategy is to add value by customizing the scrap quality and density to the needs of steel mill clients. (Some take this model further by developing cross-regional supply networks and diversifying into other materials, such as stainless steel scrap, plastics, and paper.) Others still strive to be low-cost suppliers by ensuring high plant utilization and minimal logistics costs.

[1] In 2015, China official statistics reported 804 MMT of crude steel production: 49 MMT of EAF production, ~40 MMT of induction furnace (IF) production and 715 MMT of BOF production. IF steel, called "ditiaogang" – literally ground bar steel – in Chinese, is made through melting scrap in induction furnaces, according to the definition employed by China's central government since 2002.

As the availability of obsolete scrap continues to grow, the recycling industry will need to expand to handle the larger volumes and become more efficient to improve profitability. Three challenges make achieving these goals difficult.

Deteriorating steel industry economics. Many Chinese steel companies are struggling financially amidst declining domestic demand and industry overcapacity. As a result, steel mills are taking longer to pay suppliers, putting cash flow pressure on scrap companies. In 2015, some steel mills breached payment contracts altogether, forcing several professional scrap companies into bankruptcy.

Declining scrap prices. As noted above, prices for scrap strongly correlate with those for iron ore and coking coal. Recent declines in price for these primary materials have led mills to prioritize them at the expense of scrap, affecting scrap demand. Additionally, the time lag between scrap collection and delivery to steel mills squeezes scrap companies' revenues and profits at a time when scrap prices continue to drop. As a result, recyclers have less incentive to collect scrap.

Grey-economy impact. There are numerous small operators in the scrap recycling industry whose roughly 60 MMT of supply are not included in official statistics. Some small EAF mills strike exclusive deals with these unofficial scrap companies and negotiate secret profit sharing agreements with local governments to avoid paying tax. This enables them to gain an edge over legal players, distorting market dynamics.

To date, the scrap recycling sector's small size, combined with its lack of transparency, has made it a low-priority industry for the Chinese government. Only 150 companies have registered since the country introduced licensing in 2012 – a small fraction of the total number of players. Additionally, Beijing's efforts to boost the use of scrap in domestic steel-making have been ineffective so far. In its 12th Five-Year Plan, the government targeted an increase in scrap's share of raw material from 13 percent in 2010 to 20 percent by 2015, and a rise in EAF penetration to 20 percent by 2020 from 10 percent in 2010. Instead, the 2015 EAF share stood at only 6 percent.

That said, the government is increasingly concerned about the environmental impact of its industrial economy, with "green development" set out as a priority in the 13th Five-Year Plan. This new focus may lead Beijing to put more and better incentives in place for scrap-intensive EAF, which has a potentially lower environmental footprint.

Scrap supply and demand in China – 2020-30

Whether China can benefit from the rising volume of obsolete scrap that will become available will largely depend on the evolving economics of the recycling industry, government policies, and the progress in shifting Chinese steel production from BOF to EAF. In the following analysis, we make our projections based on assumptions regarding the future steel demand for domestic use and export, raw materials prices, sustainable margins for scrap companies, and scrap intensities in the different steel production routes.

Crude steel production

We expect Chinese steel production to continue to decline at about 1 percent per year, driven by decreasing domestic demand, a moderate decline in exports, and government efforts to consolidate and rationalize the steel industry. These production declines will affect both the supply of and demand for scrap and will lower the volumes of home and prompt scrap available for recycling into the value chain. Production decreases, meanwhile, will cut into demand for raw materials.

As stated earlier, we expect steel demand in China to drop to the levels of developed regions over the next 10 to 15 years, reaching roughly 400 to 450 kg per capita. About 90 percent of that volume will be used for finished goods for China, while the remaining 10 percent will go into manufacturing products for foreign markets. China's share of the global steel export market is also likely to decline. The country's steel exports in 2015 reached a record 112 MMT, making it a net exporter of about 100 MMT of steel. Nevertheless, the government's efforts to reduce steelmaking capacity and restructure the industry – combined with growing trade barriers imposed by importing countries – will lead to declining net exports, which we expect to level off at roughly 75 to 80 MMT.

As a result of these developments, we estimate that crude steel production will decline to approximately 650 to 700 MMT by 2025, down by about 100 to 150 MMT from 2015 levels. The amount of home and prompt scrap will decline accordingly – by around 15% in our base scenario. In a more optimistic scenario, if the direct exports of steel stay on the same peak level achieved in 2015 while the indirect exports continue to rise due to increasing exports of metal-intensive goods, steel production in China may decline only marginally.

Obsolete scrap supply

The supply of obsolete scrap is determined by both availability – that is, the theoretical volume that can be collected from the system – and scrap return rates: how much of the available scrap companies can profitably collect and process. While the former is driven by the amount of steel historically used in the economy, the latter largely depends on the economics of collecting, processing, and transporting scrap.

As we stated earlier, China's scrap will increasingly take the form of steel recovered from old products, buildings, infrastructure, and machinery, while the amount of home and prompt scrap produced in steelmaking and manufacturing will decline. Taking into account typical lifecycles of steel in different industries, we project total availability of obsolete scrap to grow by about 9 percent per year over the next 15 years. That would make roughly 250 MMT of additional obsolete scrap available by 2030. The expected slowdown of China's construction growth may affect those estimates by extending the life span of existing steel infrastructure and thus cutting into scrap availability. Nevertheless, there should be sufficient volumes of obsolete scrap to offset the declines in home and prompt scrap.

However, it is the economics of the scrap recycling business that will determine how much of this obsolete scrap will actually be delivered to market (both domestic or for export). As noted earlier, markets with excess blast furnace capacity such as China tend to favor hot metal over scrap. Hence, scrap remains less attractive than the alternatives and its price continues to be determined by the price of iron ore and coking coal.[2]

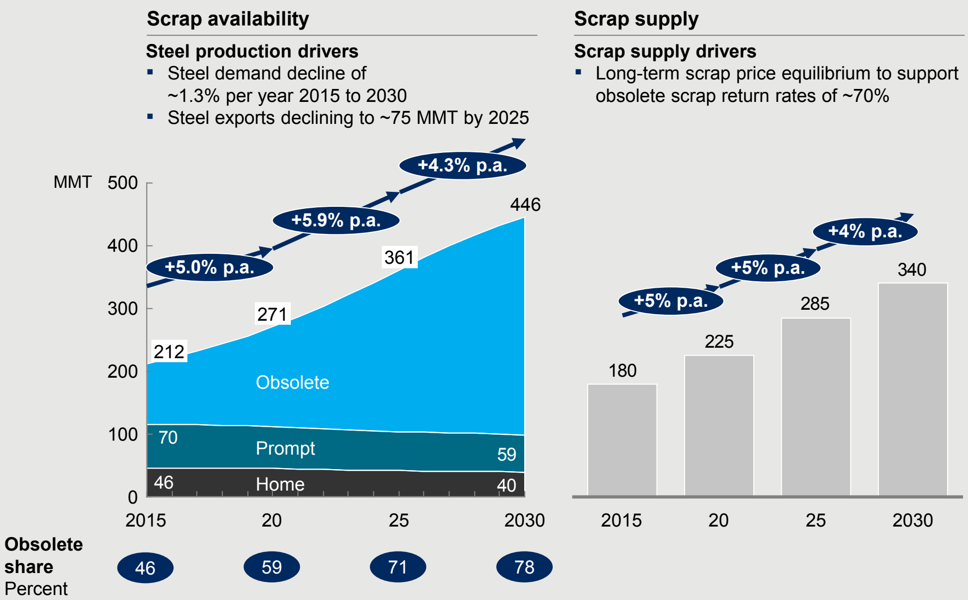
The main costs involved in recycling obsolete scrap are labor and the energy used in processing. Businesses also incur considerable expense from the transport of scrap from consumers to collection and processing sites and then to steel mills. The combined tally determines the minimum scrap price the recycling industry needs for viability. We believe this floor price in China currently ranges between USD 200 and USD 250 per MT.

Assuming a long-term iron ore price of USD 60-80 per MT and coking coal price of USD 110-130 per MT, the equilibrium price for scrap delivered to the steel mill[3] would fall to between USD 210 and USD 240 per metric ton. That price, we believe, is high enough to sustain and further increase the current estimated collection rates of about 65 percent.

Consequently, we anticipate that China's total scrap supply will grow at 4 to 5 percent per year, yielding about 340 MMT by 2030, or 160 MMT more scrap than in 2015 (Exhibit 5).

Exhibit 5

Obsolete scrap will drive the growth of available scrap in China as its share will reach levels >70% from 2025, from only ~45% in 2015



SOURCE: McKinsey analysis

2 For scrap to drive the prices of steelmaking raw materials, demand for scrap must be high relative to supply, and total recycling costs need to be competitive with the prices of iron ore and coking coal. Even in countries with excess scrap availability and a well-organized scrap recycling industry like the US, scrap prices have always followed a hot metal cost-substitution logic.

3 Heavy melting scrap, domestically delivered to mills in China.

Obsolete scrap demand

To assess how much steel scrap Chinese mills will buy, we have to consider the scrap intensity of the EAF and BOF routes, and the share of each in China's steel market. Given that China's central government has set the plan to eliminate the induction furnace-based steel making in 2017, IF crude steel production is no longer considered in our analysis. The analysis below assumes that the full supply will be used for domestic steel production, as the Chinese government is unlikely to support the export of scrap.[4]

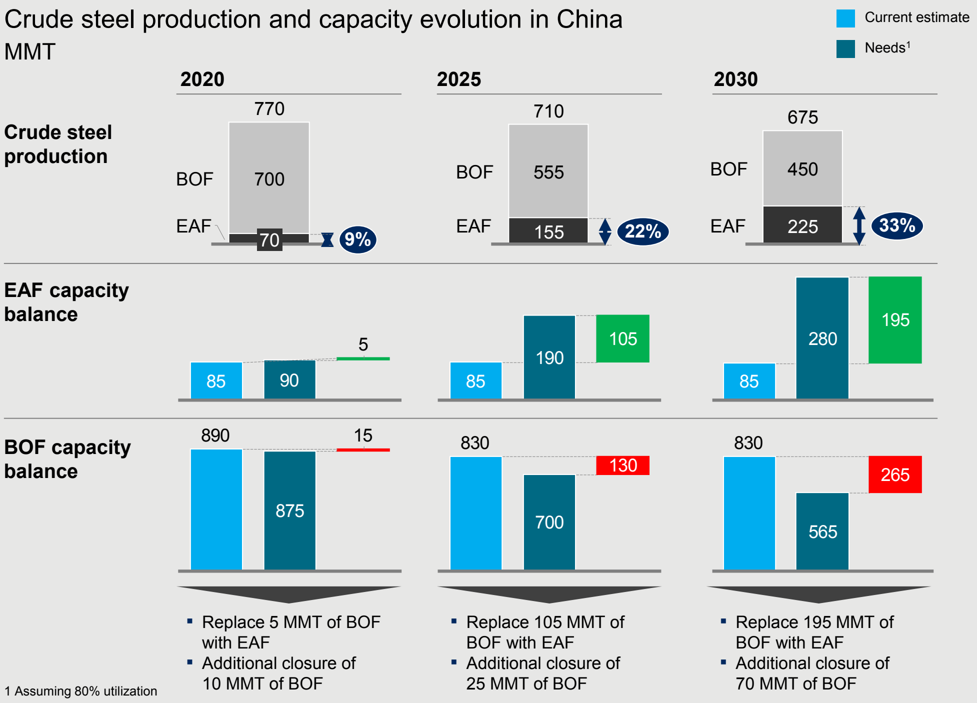
Scrap intensity. We estimate that because of a high share of pig iron fed directly into furnaces in China, on average only about 550-600 kg of scrap is loaded into an EAF per ton of crude steel produced, and 100-150 kg into a BOF. This is a much lower scrap intensity than we see in more developed regions that enjoy ample scrap availability; there, typical figures are 900-1,100 kg of scrap per ton of crude steel for EAF and 180-220 kg for BOF. We have used these figures for calculating future scrap use in China's EAF and BOF routes, in the expectation that in the coming years the country's scrap intensity will mirror that of the developed world. These values set the expected EAF production share in China and can be used to assess future investment needs. However, we can also theorize that the intensity of scrap use at existing BOFs may increase beyond the global average, through scrap preheating and coal addition into the furnace: this may somewhat lower the need for additional EAF capacity.

EAF/BOF share. The pace of China's evolution from BOF to EAF steelmaking will be crucial in shaping future scrap consumption. As of 2015, EAF's share of steel production was about 6 percent, with utilization levels at roughly 50 percent (compared to 80 percent for BOF). For China to use the future scrap supply in its domestic industry, we estimate that the EAF share will have to rise to 9 percent by 2020, 22 percent by 2025, and 33 percent by 2030. Based on the typical rate of EAF adoption in mature regions, this is a feasible trajectory; however, as mentioned above, the actual rate of adoption could be slower, if the existing players prefer to invest in options allowing the increase of scrap usage in BOF. The average global EAF production share in 2015 was 25 percent, compared to 35 percent at the beginning of the century, a drop caused, naturally, by the surge in BOF-based steel production in China.

Although the current installed EAF capacity in China of roughly 85 MMT (if in a good state) may be sufficient for the next five years, by 2025 that capacity has to double – and, by 2030, triple – to keep pace with scrap supply (assuming average utilization levels of 80 percent). The government currently intends to focus steel capacity cuts on the BOF route – a reduction we estimate at 120 MMT over the next decade, or 13 percent of current BOF capacity. But we believe these cuts will not be enough to set the steelmaking industry on the right footing. That will require both replacing BOF mills with EAF facilities and closing noncompetitive BOF plants. By 2025, China should target replacing 105 MMT of BOF production with EAF, as well as eliminating an additional 25 MMT in inefficient BOF capacity in our base case scenario. By 2030, we believe those numbers may need to rise to 195 MMT and 70 MMT respectively (Exhibit 6). If this cannot be achieved, the excess scrap will have to be exported.

[4] The assessment assumes that both EAF and BOF routes maximize scrap intensity. Based on that calculation, we can establish the EAF and BOF volumes and shares of total steel production in China. This enables us to then evaluate the EAF and BOF capacity needs and compare them to the current rationalization targets set out by the government in the 13th Five-Year Plan.

Exhibit 6



1 Assuming 80% utilization

SOURCE: McKinsey analysis

Toward a thriving scrap industry

With proper government support and regulation, the scrap recycling industry in China has huge potential to benefit the economy and create opportunities for all stakeholders involved in the steel value chain. Under optimal conditions, scrap recycling could represent a USD 60 billion market by 2030 – or about 30 percent of China's overall steel market. To realize this opportunity, however, the government will need to actively shape the industry through incentives such as low-cost financing and tax exemptions for new EAF assets, and a CO_2 tax that would make BOF producers less competitive.

There are several reasons to believe that future government policies will be favorable to the steel scrap industry. Unlike iron ore and coking coal, which are largely imported, scrap recycling would feed domestic economic activity. Additionally, higher scrap usage is in line with the government's growing focus on building a cleaner economy. China has already introduced regulations limiting emissions of CO_2, SO_2, and dust, and its ratification of the 2016 Paris Agreement on climate change raises the likelihood of a tax on carbon emissions. Beijing has expressed strong concerns about the steel sector's contribution to dust generation, greenhouse gas emissions, and poor air quality. This suggests that future policies may encourage or even force the closure of polluting cokemaking plants, sinter plants, and blast furnaces, and provide further incentives for the transition from BOF to EAF, which has a lower environmental impact. That said, most of the electricity that powers EAF plants currently comes from coal burning, which is also harmful to the environment. By making a significant shift toward cleaner energy can China credibly defend an increase in EAF capacity as an environmental benefit.

The scrap industry's evolution will be greatly affected by how China copes with its current steelmaking overcapacity and the effects of closures already realized or planned for the future. Closing and restructuring plants will cause significant unemployment and require large-scale environmental cleanup. To bring the industry back to health, China will need a clear strategic plan along the lines of the Davignon Plan that Europe implemented in the 1970s and 1980s to restore the region's steel sector to profitability. In the short term, production quotas and compulsory minimum price levels could be necessary to squeeze out underperforming producers, while longer-term solutions will require labor redeployment and government funding assistance.

Perhaps the biggest challenge for the scrap industry lies in China's ability and willingness to make the shift to EAF technology. As we noted above, the shift from BOF to EAF will require not only continued capacity reductions of BOF to improve utilization levels, but also new investments in EAF capacity. A clampdown on pollution may motivate BOF producers to convert existing BOF mills to EAF rather than investing a similar amount in the periodic relining of their blast furnaces. In addition, EAF mills create higher production flexibility and have typically lower maintenance capex. As an alternative, BOF mills could apply new technologies to increase the amount scrap used in the convertor by injecting additional thermal or chemical energy into the furnace. The choice between these two alternatives is quite individual, different players will most likely take different paths, in part dependent on where they stand in their investment cycles. As more investment shifts to either EAF or an increase of scrap use in BOF, the scrap industry will benefit from both the increase in demand and growing government attention.

The recycling industry itself will need to become more efficient through consolidation and joint ventures that create bigger supply networks. Given Chinese urbanization trends, most of the scrap will continue to be concentrated around big cities, providing large volumes of material within a short radius. Scrap companies need to maximize and diversify their revenue streams and gain higher operational efficiency through more sophisticated technology, higher labor productivity, and more streamlined logistics. As operating costs come down and revenues grow, the threshold price for economical scrap collection should drop, putting the scrap industry in a better position to compete with iron ore and coking coal.

We anticipate that new business models will begin to emerge among China's steel players as they strive to secure their own scrap supply; vertical integration of scrap recycling with (new) EAF steel production facilities. This will also create new opportunities for manufacturers of EAF and BOF furnaces and scrap processing equipment. An increase in scrap availability in China and an efficient collection system could even raise the liquidity of the global scrap market and lead to a more profound role of scrap futures and related trading on the financial markets, in turn leading to a new pricing mechanism for iron ore and coking coal.

If the pace of the transition to EAF and the growth in scrap consumption fails to keep up with the rising scrap supply, China is likely to turn increasingly to exporting its obsolete scrap. Adding approximately 100 MMT of scrap to the export market will more than double currently traded scrap volumes. This would put pressure on scrap prices and affect global trade in scrap. We believe that this surplus scenario is more likely than a scrap shortage in China caused by the recycling industry's failure to modernize. Consequently, global scrap players will create more value from entering the scrap recycling business in China through joint ventures with locally experienced firms than in exporting scrap to China. The scrap recycling market in China has high potential and would greatly benefit from the injection of best practices from established global players.

How the scrap dynamics in China will turn out in the medium to long term will depend on Chinese steel players' ability to accumulate more scrap:

- Will current BOF players be able to use more scrap (up to the standards typically observed in developed regions or above) by applying new technologies to preheat or melt scrap prior to charging into the convertor?

- To what extent is the country ready to allow the steel industry to make the switch from BOF to EAF?

- If not all scrap collected can be consumed locally, what measures will be put in place to support or discourage the exports of scrap from China?

Appendix

Scrap consumption estimates: McKinsey methodology

Our scrap consumption figures differ from those published by the Bureau of International Recycling (BIR) because we employed an Fe-balance formula to arrive at what we believe is a more accurate estimate. The scrap industry's fragmented nature, especially in developing regions, makes it difficult to collect comprehensive statistical data. Our model assesses the historical scrap consumption on a regional basis, relying on the more robust statistics available for DRI and pig iron, and the steel produced from them.

The Fe-balance model covers three main components:

1. Fe inputs from pig iron and DRI production as reported by the World Steel Association (WSA) and Midrex, combined with the typical iron content in each

2. Fe outputs from crude and foundry iron castings as reported by the WSA and the World Foundry Organization (WFO), combined with the typical Fe content in each

3. Typical Fe losses in the production process due to dust generation, slag formation, oxidation, and cutting

Scrap consumption in China: McKinsey methodology

Our 180 MMT scrap consumption figure differs significantly from the 83 MMT reported by the China Association of Metal Scrap Utilization (CAMU). The reason is our reliance on the Fe-balance calculation (see "Scrap consumption estimates: McKinsey methodology"), in combination with a correction of the pig iron production statistics that we believe under-report the true volumes since 2014. The 97 MMT difference stems from three different contributions not taken into account in official statistics:

1. **25 to 30 MMT from small steel plants.** The reported 83 MMT takes into account the member plants of the China Iron and Steel Association (CISA), which represent only about 75% of the total industry.

2. **Approximately 15 MMT from foundries.** China's scrap statistics do not include the scrap used to generate 30 MMT to 35 MMT of the country's iron and steel foundry products.

3. **Approximately 55 MMT from the grey economy.** There are a significant number of small scrap suppliers that China is unable to track in official statistics.

Additional sources

Bureau of International Recycling (BIR)

Chinese Iron and Steel Association (CISA)

China Association of Metal Scrap Utilization (CAMU)

Midrex

United States Geological Survey (USGS)

World Foundry Organization (WFO)

World Steel Association

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