



Future of steel: market trends and new technologies

13th Iranian Steel and Iron Ore Market
Conference and Expo

May 8

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¹ McKinsey & Company, Boston Consulting Group, Bain & Company

Agenda

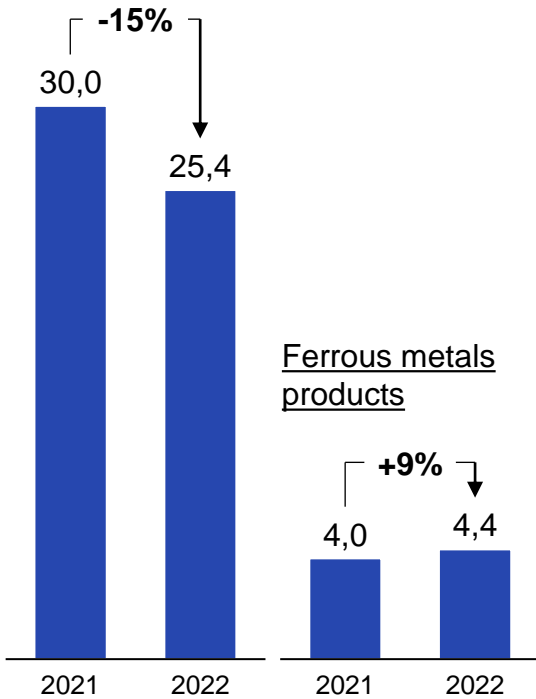
01 Market context and outlook

02 Future of metallurgy industry

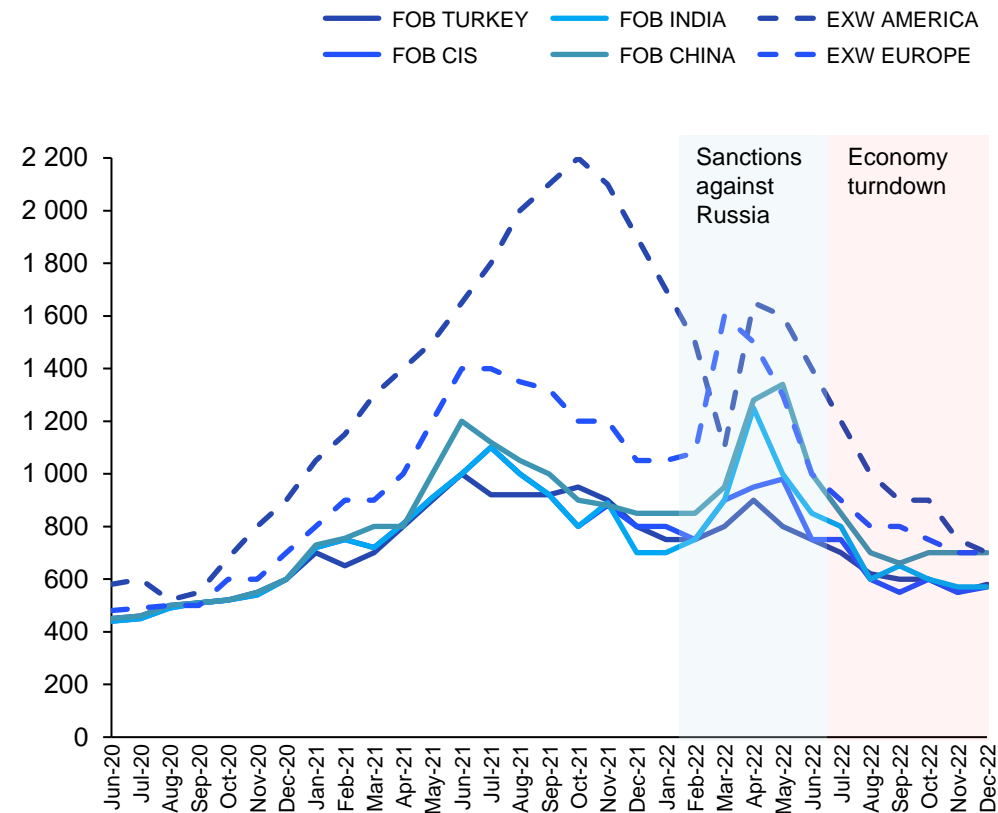
2022 market dynamics was mainly driven by European sanctions against Russia that significantly affected global demand and supply chains

Russian export, bln \$

Ferrous metals



Global HRC Price Trend 2020-2022, USD/T



Russian export of ferrous metals in 2022 **decreased by 15% to \$25 bln** mainly due to European sanctions, but exports of **ferrous metal products increased 8,8% to \$4,4 bln**

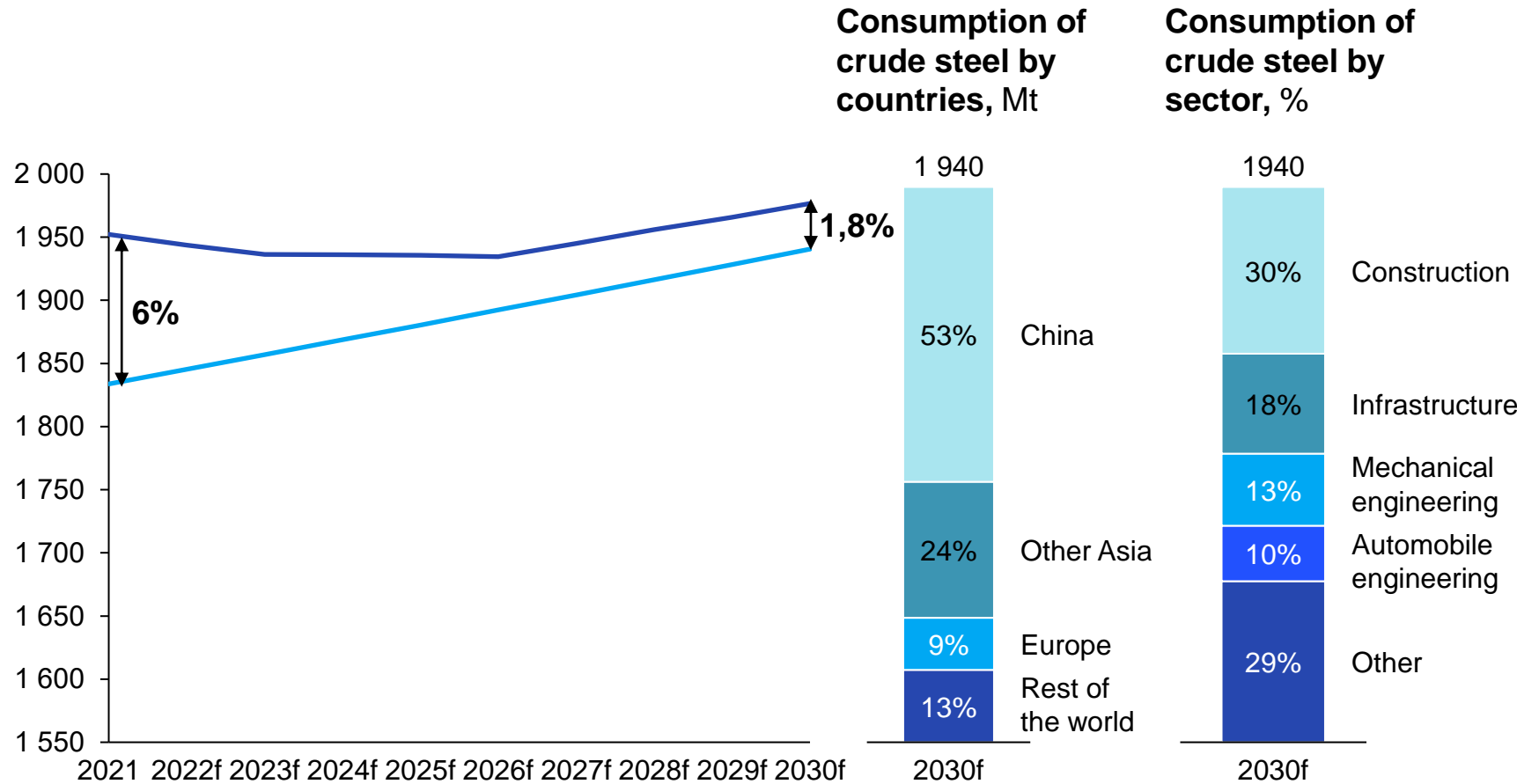
Russian smelters have managed to diversify their export **redirecting sales to Asia, Middle East** and other regions and **increasing share of value added products**

In April'22 the steel market saw an **upswing in prices driven by panic** surrounding the halt of Russian exports, but these prices eventually stabilized and have gone below 2021 as a result of sanctions and economy turnaround

In 2021 on the back of COVID-19 the surplus of supply of steel was 6%, the situation will gradually improve

xx% Surplus of supply — Production — Consumption

Production and consumption of crude steel on global market, Mt



Key observations

The surplus of supply in 2021 was 6%, the gap is expected to gradually decrease to 1,8% in 2030

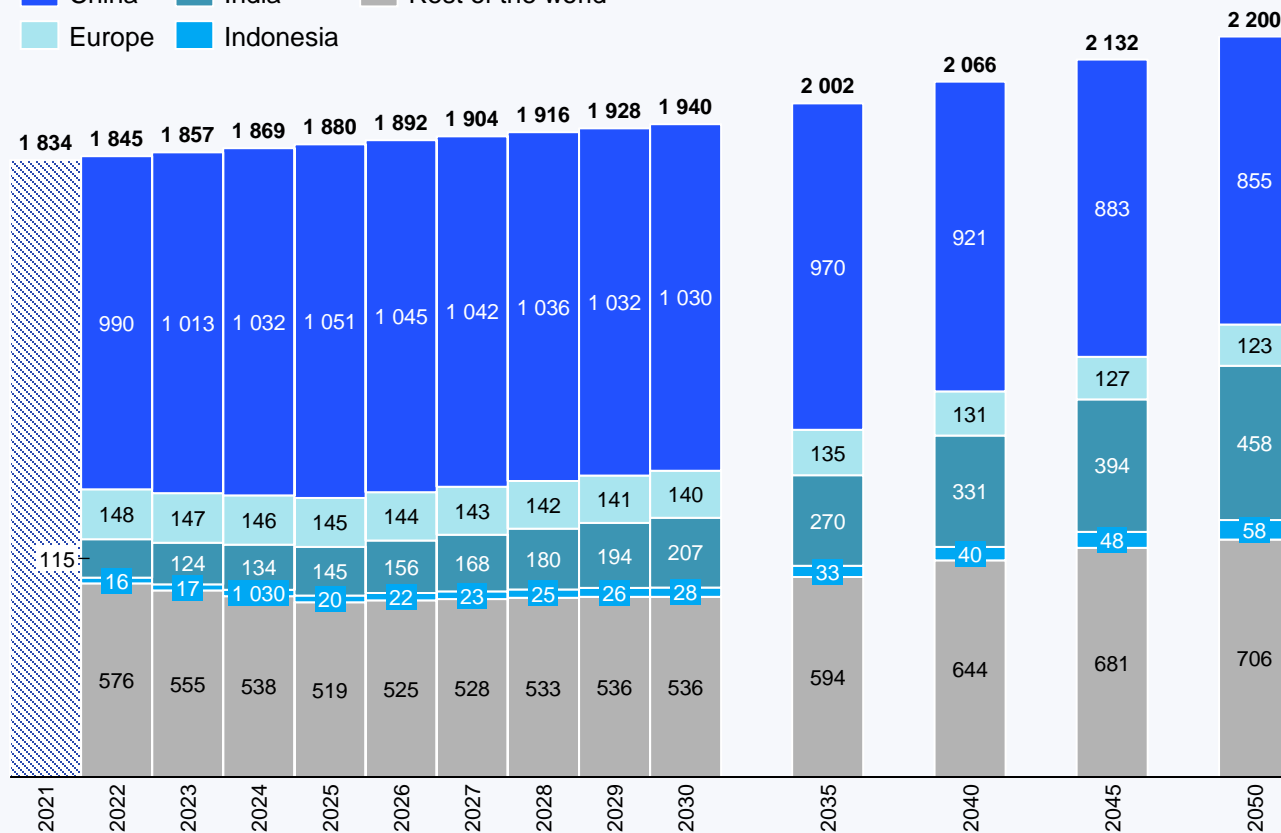
China is the main consumer of steel in the world (53% of total consumption)

The main growth in production and consumption is concentrated in Asian countries (India, Indonesia)

Decline of steel consumption in China and Europe will be offset by rapidly growing demand from India and Indonesia

The dynamics of steel consumption by sectors and net steel exports, Mt

■ China⁴
■ India
 ■ Rest of the world
■ Europe
 ■ Indonesia



2022-2030
CAGR

2030-2050
CAGR

0,5%

-0,9%

-0,7%

-0,6%

7,7%

4,0%

6,8%

3,8%

-0,9%

1,4%

After steady growth **China demand for steel is expected to decline after 2025** mainly due to decrease in housing and infrastructure construction

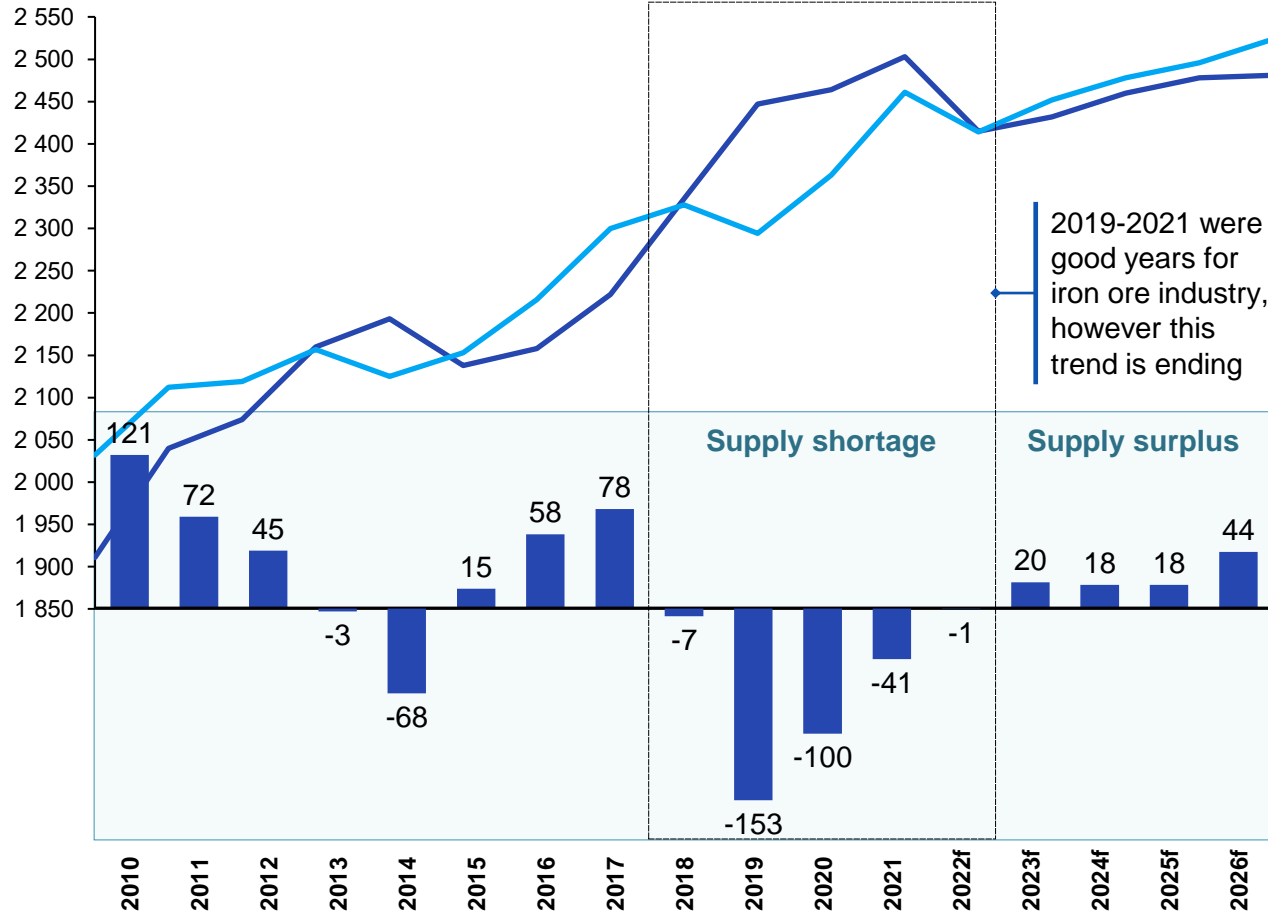
India and Indonesia are the most growing consumers of steel with **~7% CAGR in 2022-30** and **~4% CAGR in 2030-50**

Infrastructure projects in India and construction will grow at a rate of **7–10% through 2030** and **3–5% through 2050**

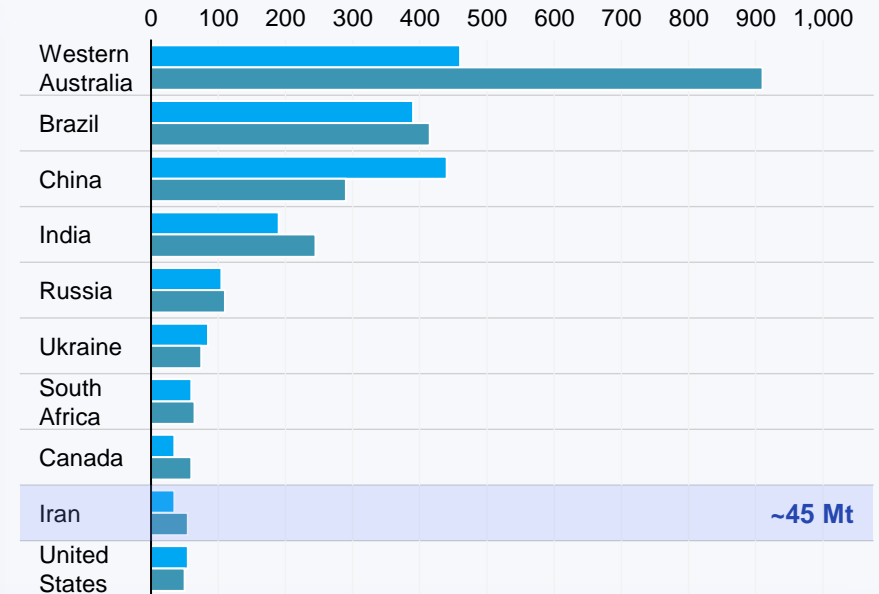
After 5 years of supply shortage it is expected that production of iron ore will exceed consumption

■ Market balance (Supply-Demand) — Global iron ore demand — Global iron ore supply ■ 2011 ■ 2022

Balance of supply and demand on global iron ore market, Mt



Major global iron ore suppliers, Mt



Key observations

Stable growth both in iron ore production and consumption with CAGR ~2% from 2010 to 2021

Supply shortage of iron ore in 2018-2021

Production of iron ore is forecasted to exceed consumption during the next 4 years

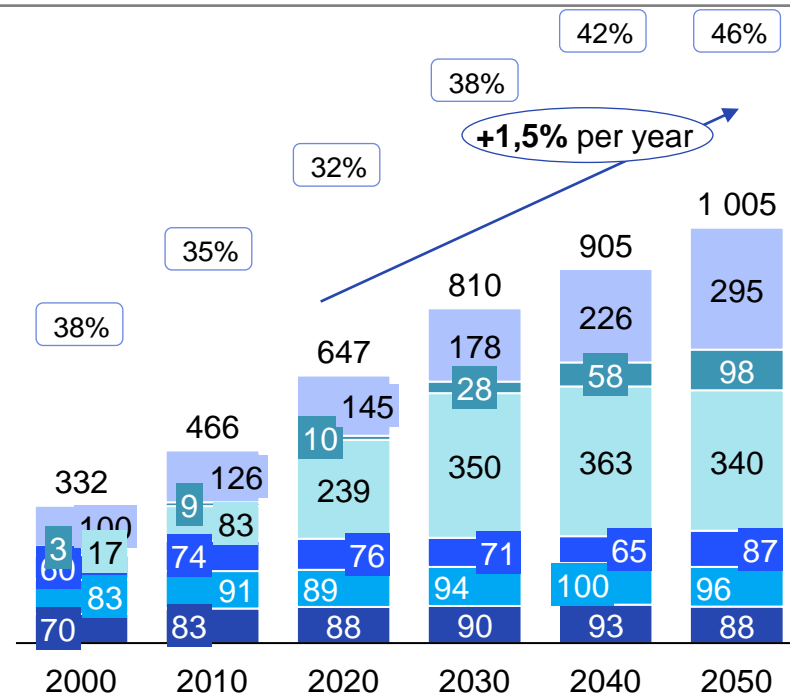
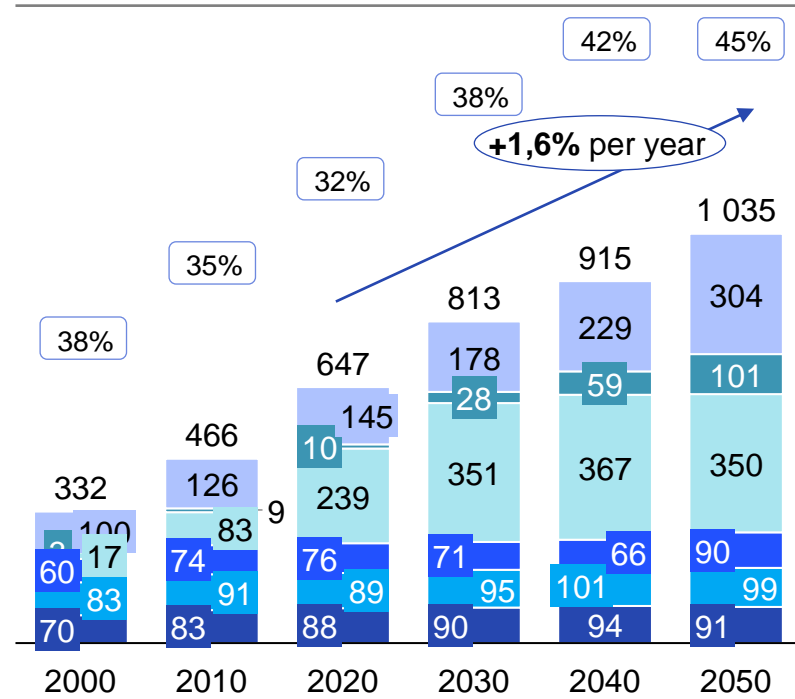
Growth of scrap usage in metallurgy will put extra pressure on ore producers

x Share of scrap in the total demand for iron, %

Other India China Developed Asia Western Europe North America

Sustainable development scenarios:
scrap metal production, Mt

Net-zero scenario:
scrap metal production, Mt



Policy efforts speed up innovation timelines for new energy technologies so that innovation happens at least as fast as it has ever done before

Net zero CO2 emissions by 2050, with advanced economies reaching net zero emissions in advance of others

By 2030 scrap production is expected to increase to ~0,8 bln tones or 38% of the total iron demand in both outlook scenarios

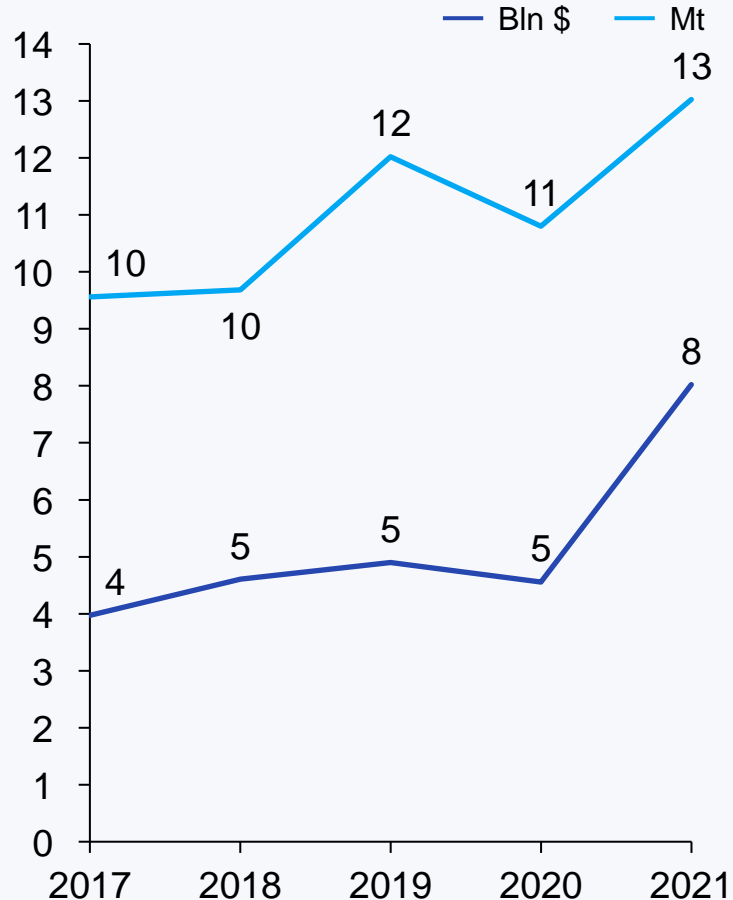
The growth is mainly driven by China and India

By 2030 China will be the largest consumer of scrap with 40% share

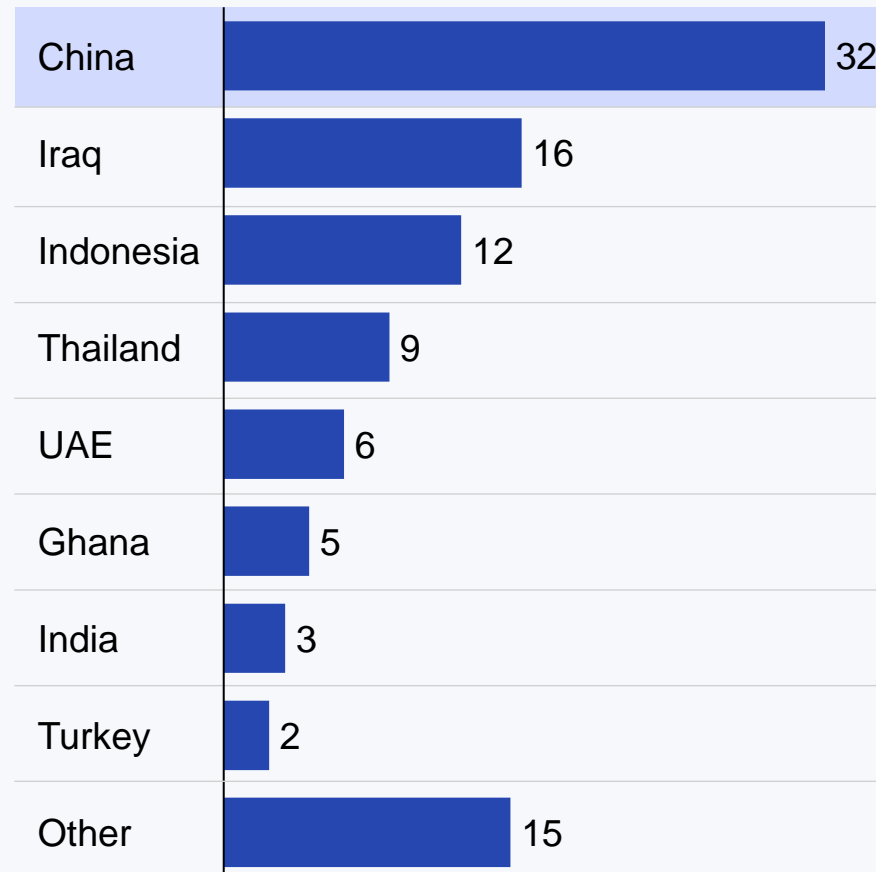
Source: IEA

While now China is the main consumer of Iranian iron ore and steel, growing markets like India and Indonesia might be priority going forward

Export of iron, steel and products from Iran



Export directions of iron and steel from Iran in 2021, %



Key observations

Iran is the second largest supplier of steel and iron ore in the Middle East (after Turkey)

Export volumes of iron, steel and products from Iran showed stable growth except covid-19 recession in 2020

China is the main importer of Iranian steel and iron (28% of total export from Iran in 2021), main volumes fall on iron ore

Australia is the cheapest iron ore producer in the region; priority is to be cost competitive on new markets

Cost Curve: Total Cash Cost Cargo and Freight (China Basis) 4Q2022, \$



Western Australia ore is more competitive on the key Asian markets as a result of low cash cost: 50% lower vs North and South America

Western Australia's major iron ore ports are close to the largest iron ore markets in Asia, reducing shipping costs relative to some of its competitors

Companies should focus on efficiency leveraging new technologies and innovations, specifically in greenfield projects

Source: Refinitiv

Agenda

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02 Future of metallurgy industry

Future of metallurgy industry: key areas of transformation

Product innovations

Focus on improving steel properties:

- Automotive – growing demand for high-strength steel (e.g., dual-phase steels, boron-or manganese-alloyed) and hot stamping technology to reduce vehicle weight
- Demand for materials with better insulation properties, such as zinc-based alloy sheet steel

Extending products line and service portfolio:

- Non-core products with a focus on future trends and potential substitutes for steel (other metals, graphene, carbon plastics)
- Adding products and services for end users to the product line (e.g., offering a turnkey construction project services)

New technologies

Decarbonization commitments pushing demand for green steel mainly in transport and construction industries

- Regulators in 50+ countries have introduced or plan to introduce trading in quotas for carbon dioxide emissions and / or special taxes

European smelters have already started to invest in green steel production

- More than half of European green steel supply in 2030 (18 mt) will use carbon capture and storage (CCS) technology
- Mass usage of H2 technology for steelmaking by 2040 (H2 Green Steel, Sweden plans to launch the production of 5 mt per year of green steel in 2023-24)

Process innovations

4 key technological trends help leading companies to unleash full potential

- Advanced analytics for process planning, control, and optimization
- Big data collection and a unified digital environment
- Automation, robotization, and digitalization
- Establishment of a **digital competence center**

Full Potential Asset Development program allows companies to prioritize and implement innovations and improve efficiency

Automotive: total share of steel in a vehicle body will decrease from 67% to 50% by 2030; 75% of the steel will be of advanced high-strength grades

Carbon fiber Magnesium Plastic Aluminum AHSS¹ Steel (<550 MPa) Other non-lightweight materials

Significant industry trends



Advanced materials

Striving to produce lightweight vehicles, growing demand for advanced **high-strength/ ultra-strength steel**, lower demand for **low-strength steel**

Growing demand for steel with high relative elongation (**DX, DC3**) to satisfy design requirements



Advanced production techniques

Some of the parts currently made from steel will be produced by 3D printing from powder

Adverse impact on the **steel industry value chain**



Network connection

Compact cars for sharing with relatively low performance characteristics

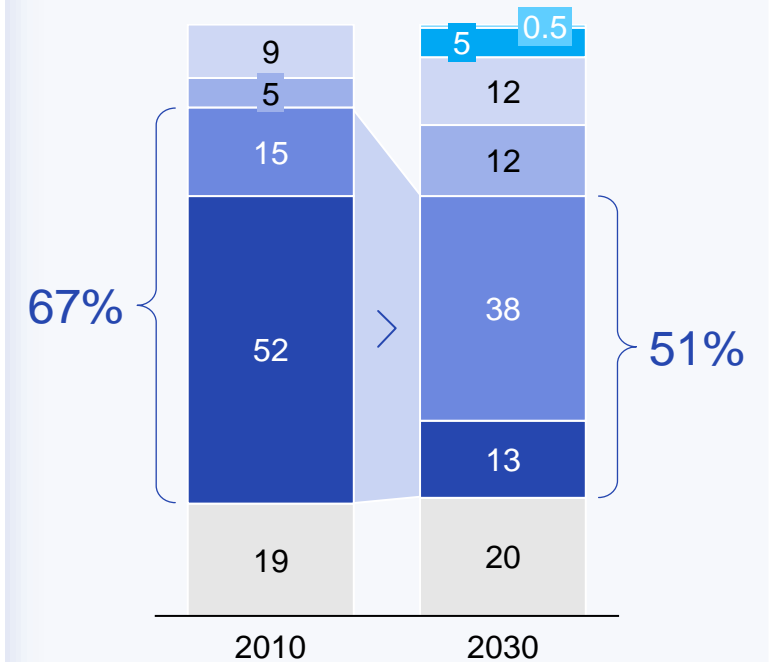
Lower accident rates

Decreasing demand for common flat steel



Autonomous driving

Car body materials breakdown², percent



Significant (by 16 pp.) reduction of the share of steel and replacement of conventional steel with high-strength grades

1. Advanced High-Strength Steel (>550 MPa)
2. European manufacturers
3. Deep-drawing steels

Construction: strong drive to boost productivity and erect taller buildings

Fast-track construction

Growing demand for housing and the need for fast and efficient implementation of projects is driven by innovative technologies, such as modular construction and 3D printing, which can reduce construction time by 30–50%, significantly reduce construction costs and improve project cost-efficiency

Increased scope of construction using **structural steel**, with the steel frame of the building designed and fabricated from computer models off-site and steel components ready for immediate erection on arrival at the site

Polymer-coated thin steel sheets are used in wall cladding not only because of their high specifications, but also because of the wide range of 30 available colors, high quality paints and aesthetic appeal of the exterior design

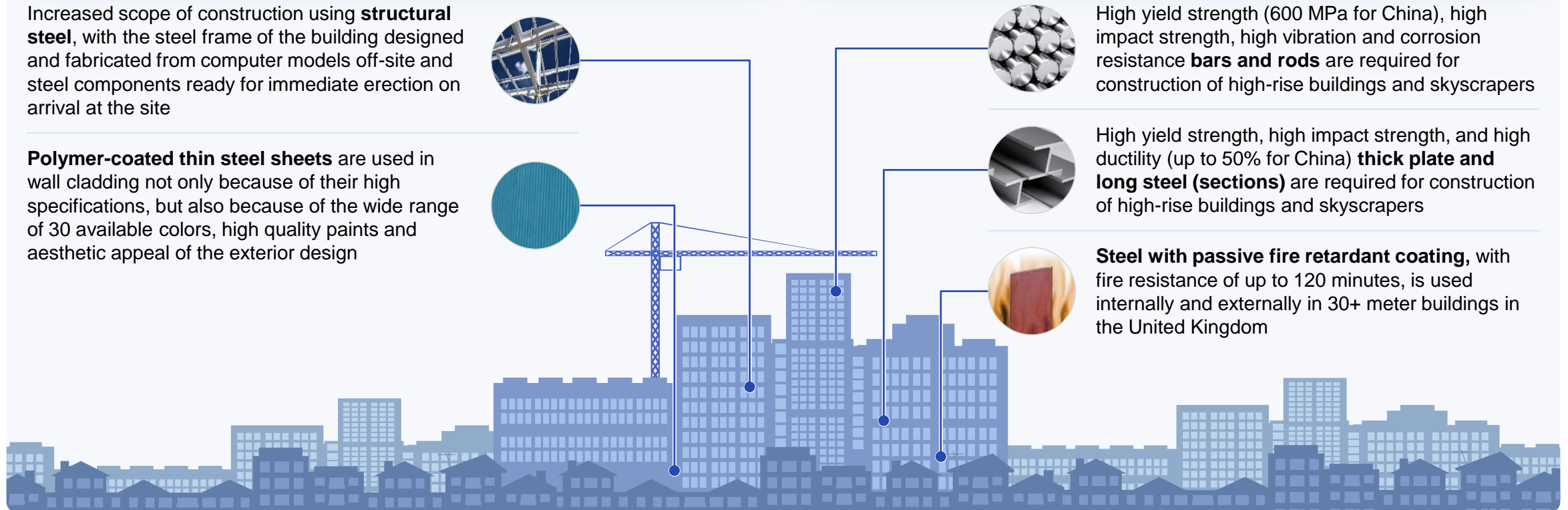
Complex and high-rise buildings

Urbanization and overpopulation of cities lead to high-rise and complex constructions and as a result demand for high quality steel and technologies including computer control of construction, use of automation and robotics systems, innovative materials

High yield strength (600 MPa for China), high impact strength, high vibration and corrosion resistance **bars and rods** are required for construction of high-rise buildings and skyscrapers

High yield strength, high impact strength, and high ductility (up to 50% for China) **thick plate and long steel (sections)** are required for construction of high-rise buildings and skyscrapers

Steel with passive fire retardant coating, with fire resistance of up to 120 minutes, is used internally and externally in 30+ meter buildings in the United Kingdom



Companies are expanding into products that are outside of the traditional steelmaking portfolio

Product

Prefabricated buildings and structures made of metal structures

Thin sheet steel with polymer coating

Thin sheet steel with coating

Sandwich panels

Producer



Description

Prefabricated buildings are a modern solution for construction in a short time. Their distinctive feature is the use of metal frames, which are protected by sandwich panels or profiled sheets

The offer of roofing solutions under the Rooftop brand based on rolled metal with a polymer coating. The company introduced new products Rooftop Drain for drainage systems that are designed to protect the facade, basement and blind area of buildings from the negative effects of precipitation and meltwater

A metal surface coated with layers of a special passivating solution and resin

The coating alloy consists of 55% aluminum, 43.5% zinc, and 1.5% silicon
The solar reflectance coefficient is 57

A coating applied by hot-dip method consisting of 95% zinc and 5% aluminum

Application areas

- Industrial and industrial buildings
- Warehouses and hangars
- Shops and commercial buildings
- Buildings for transport
- Agricultural buildings



- Industrial and industrial buildings
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- Agricultural buildings



- Roof and wall cladding



- Non-combustible roof element, partitions

Decarbonization commitments of customers become steel companies' commitments

Sectors of metals companies' key customers

Automotive manufacturers set ambitious lifecycle decarbonization goals; the related CO₂ reduction strategies mainly cover steel, aluminum, and battery production



Construction companies participating in public tenders are required to use low-carbon materials, including steel, because national and local authorities in developed countries support **green public procurement**



Metals companies

Customer commitments become commitments of metals companies

For BOF steel players, meeting these commitments is difficult in the short term due to the sheer variety of possible technology solutions and the high financial requirements to create new assets

The EAF players have offers that are already focused on meeting the growing market demand, but for them it is essential to secure a supply of high-quality scrap



Equipment vendors

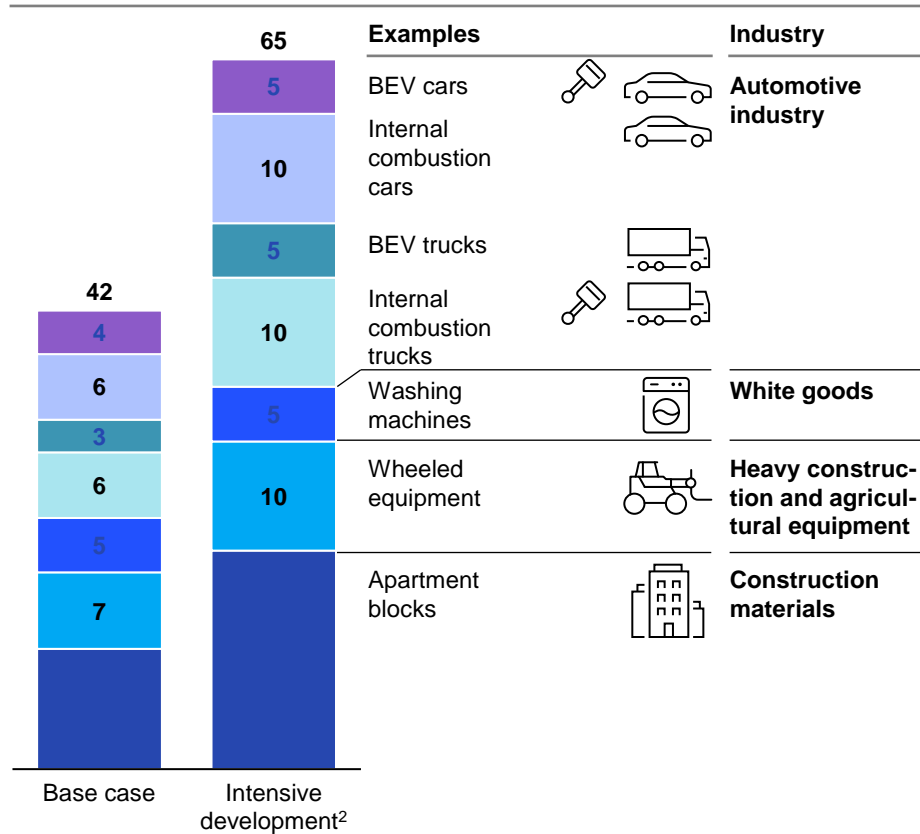
It is critical for equipment vendors to develop technical solutions for metals companies to assist them in meeting their decarbonization goals

A portfolio of competitive solutions is needed, including possible prioritization of some of the solutions

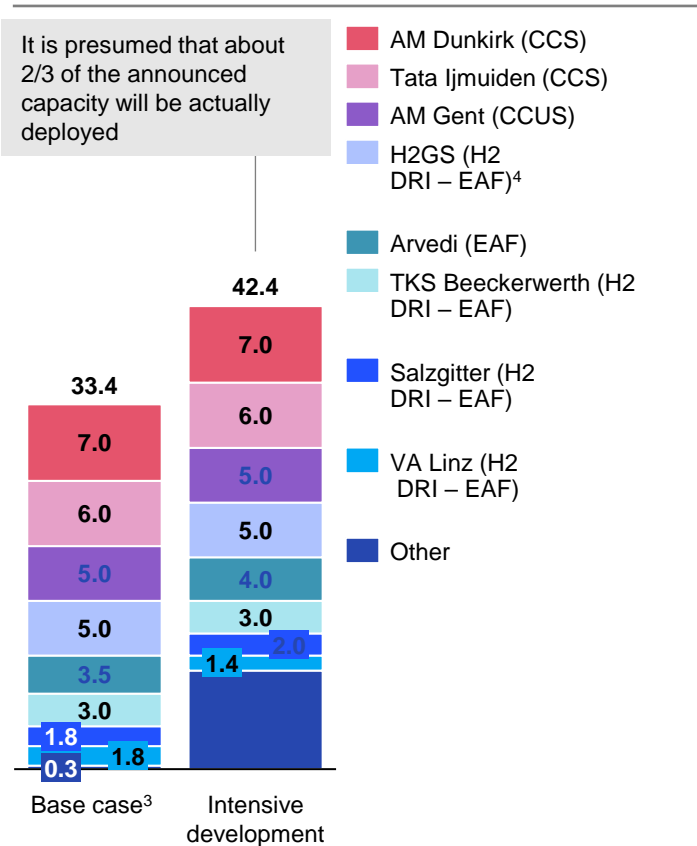


Green steel is a new fast-growing niche metallurgy companies are already fight for

Scenarios of demand for green steel¹ in 2030 considering the announced target reduction of CO₂ emissions, mln tonnes



Scenario of green flat steel production in 2030 in Europe¹, mln tonnes / year



Demand in Europe in 2030 is expected to reach **42 mln tonnes** in “Base case” and **65 mln tonnes** in “Intensive development” scenario

Up until 2030, it is expected to be **shortage of capacity** of green steel production in Europe in both scenarios

More than half of European green steel supply in 2030 or 18 mln tonnes in “Base case” scenario will use carbon capture and storage (CCS) technology

Mass usage of H2 technology for steelmaking is expected by 2030-2040

1. No change in demand for steel in Europe; 2. Considering the announced reduction of emissions by 50%; 3. Includes projects with reduction of emissions by more than 70%; 4. Construction of H2 Green Steel production pays back without subsidies already

Full Potential asset development program is an effective tool to prioritize and implement innovations and improve efficiency

Program update (every 2–3 years)

Diagnostics

8–10 weeks (from mid-2019)

Development

8–10 weeks

Rollout

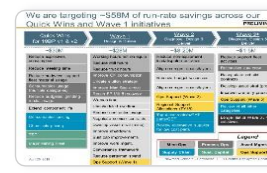
2 years (by the end of 2021)

Stage activities

- Analysis of challenges and strategies
- Finding bottlenecks
- Utilization and costs



- Workshops on initiatives (including assessment of new technologies implementation)
- Prioritization by impact
- Target, KPIs, and owners



- Implementation of program initiatives
- Monitoring the implementation of KPIs, e.g.



Project team

Full Potential Program Coordination Team

Program launch on the asset and project team formation

Asset CEO

Program Manager from the Asset (permanent position for 2–3 years)

Deputy for Mining

Deputy for Mill

Asset team (works on the asset for 3–4 months)

Technical services in the MC

10 senior experts in key disciplines (mining, metallurgy, maintenance)

External consultants

8–10 consultants to support diagnostics and program development

Asset technical staff

- Processing output growth
- Recovery increase
- Drill spacing optimization
- Hauler throughput growth
- Digger throughput growth
- Downtime of flotation cells reduction
- Mill downtime reduction
- OEM equipment costs reduction

+5-10%
effect on EBITDA

4 key technological trends help leading companies to unleash full potential

1 Big data collection and a single digital environment

All processes are integrated into a **single digital environment**, which supports a consistent data model and end-to-end data exchange between related streams – increasing transparency in decision-making, as well as the speed of handling information

IoT sensors are used extensively on all equipment, making it possible to collect the maximum amount of data

Single repositories of unstructured data (lakes) are used to improve the efficiency of analytical systems



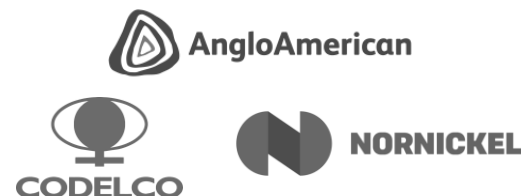
2 Advanced analytics for process planning, control and optimization

Machine learning and artificial intelligence methods

- Build predictive models, plan resources, and optimize their use
- Improve existing processes (e.g., optimizing ore movement, increasing the accuracy of grade estimation)
- Produce technology foresight and facilitate technology scouting

Advanced IT solutions are actively used

- Simulation modeling (digital twins)
- Spatial visualization (3D, AR, VR, Geoinformation Systems)
- Process Mining



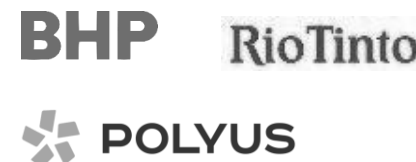
3 Automation, robotization and digitalization

Unmanned aerial and ground vehicles (drones) are used to track current processes and prospecting tasks)

Remote-controlled equipment and automated transport systems for enhancement of employee safety

Smart mobile devices:

- Digital headsets (glasses)
- Environmental sensors on clothing
- Fatigue and attention sensors
- Pocket measuring devices
- Geo-positioning devices, etc.



4 Setup of a digital competence center

Designation of a dedicated **unit responsible for digitalization**

Establishment of **practices to develop digital competencies** across the entire workforce

Facilitating digitalization through the development of a digital corporate culture:

- Setup of a corporate internal innovation center
- Launch of corporate startups
- Creation and development of an internal digital environment for employees



1 Case study: BHP's remote operations center enables the involvement of highly qualified specialists to collect and integrate all data from the mine to the plant and provides significant cost reduction

24/7 remote operating center



Specialists with deep expertise (e.g. planners, geotechnics, etc.) can be **involved** in the project without relocation to the asset

Fully integrated operations from mine to ship

- Integrated Production and maintenance planning
- Pro-active monitoring and adjusting (e.g., port scheduling)
- Continuous control of safety issues

collecting and integrating all of the data in real-time

Performance and safety management



Displays information on physical availability, safety indicators, utilization and productivity by vehicle, operator and overall shift

Equipment management



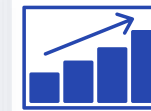
Displays standby time, delay and runtime by vehicle, queuing at loading point and activity assignment details

Mine management



View fleet information real-time and manage ongoing & upcoming allocation and maintenance schedules

and enabling a unit cost reduction of 25%



Increased availability, utilization and production rate of assets



Synergies in the supply chain unlocked by system-wide management



Improved safety record: Less people exposed to hazards, better risk management

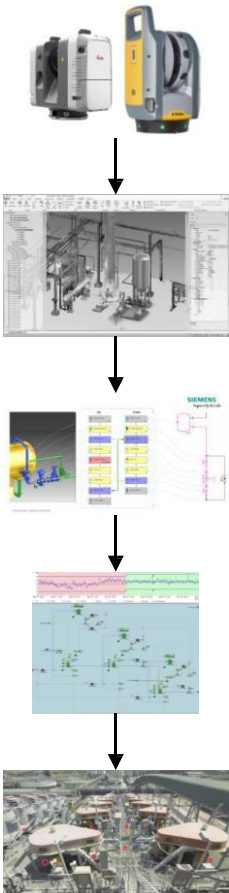


Access to deeper pool of talent in city location and close to universities

2 Case study: AngloAmerican got \$170 mln impact from introducing Advanced Process Control system



Digital twins are integrated with APC, making it possible to create a digital model of the entire plant



1. Creating a 3D point cloud using scanners

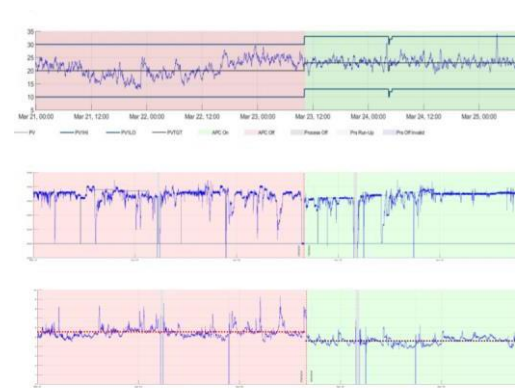
2. Creating a detailed CAD model

3. Creating a digital twin from equipment drawings

4. Connecting the plant's APC model (controlled by AI¹)

5. Creating a digital model of the entire plant

By 2020, APC generated an impact of USD 170 mln, and by 2024, APC is expected to oversee all available processes



48%

Current **stability** was improved by 48%, which increased **productivity** by 4%

32%

Mill **stability** increased by 32%

17%

Energy consumption reduced by 17% per 1 ton of milled feedstock

- 4% **decrease in water consumption** by the mills at Los Bronces
- 4–12% **reduction in power consumption** by SAG mills
- 80% **reduction in minor plant shutdowns** in South Africa and Brazil

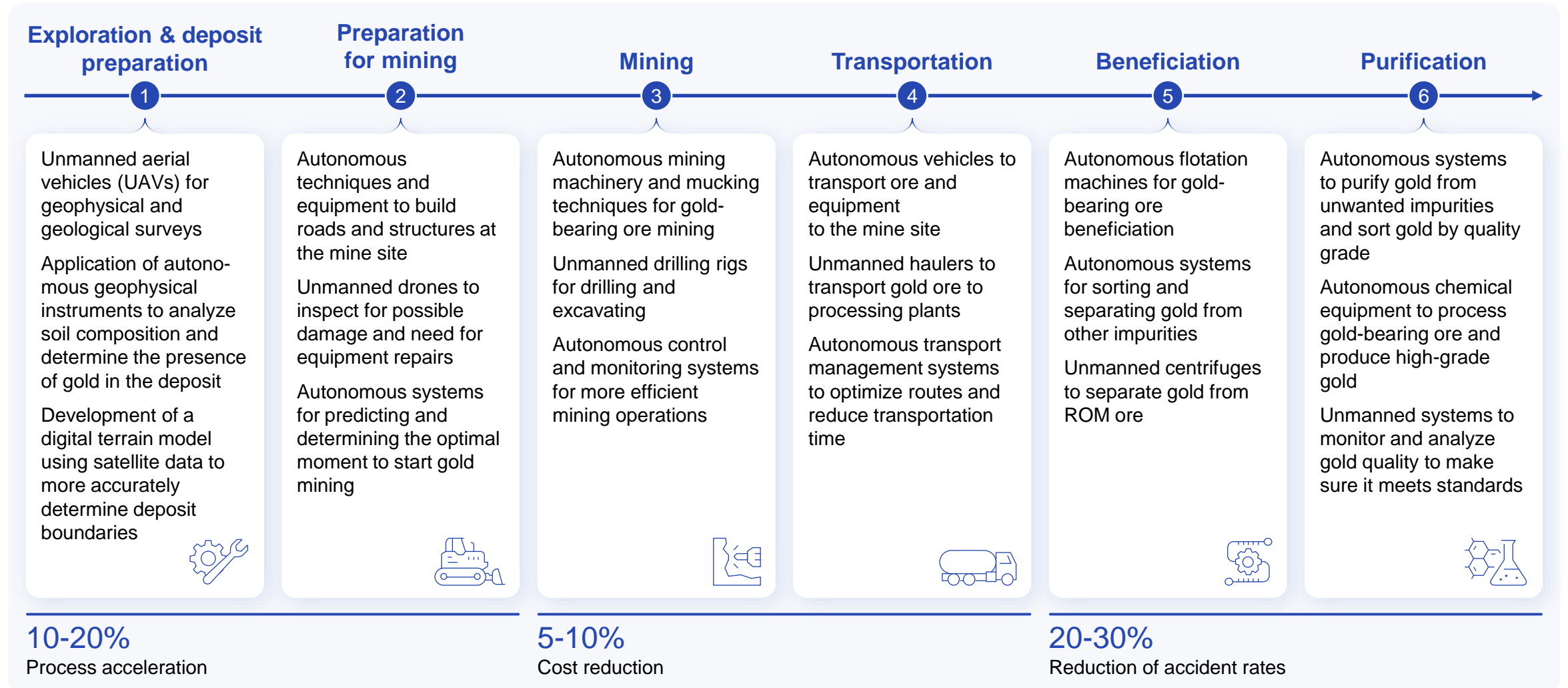
Provides a real-time view of equipment performance, operational data, and asset visualization

¹ APC uses machine learning and artificial intelligence: The APC at Los Bronces includes more than 100 virtual operators, each responsible for optimizing a different part of the process (e.g., mill rotation)
Source: AngloAmerican Technical and Innovation Update (11 May 2021)

3 Autonomous/unmanned technologies and smart systems can be used at all stages of mining and production

Examples of technologies at each stage

XX% Expected impact



Appendix

01 Market context and outlook

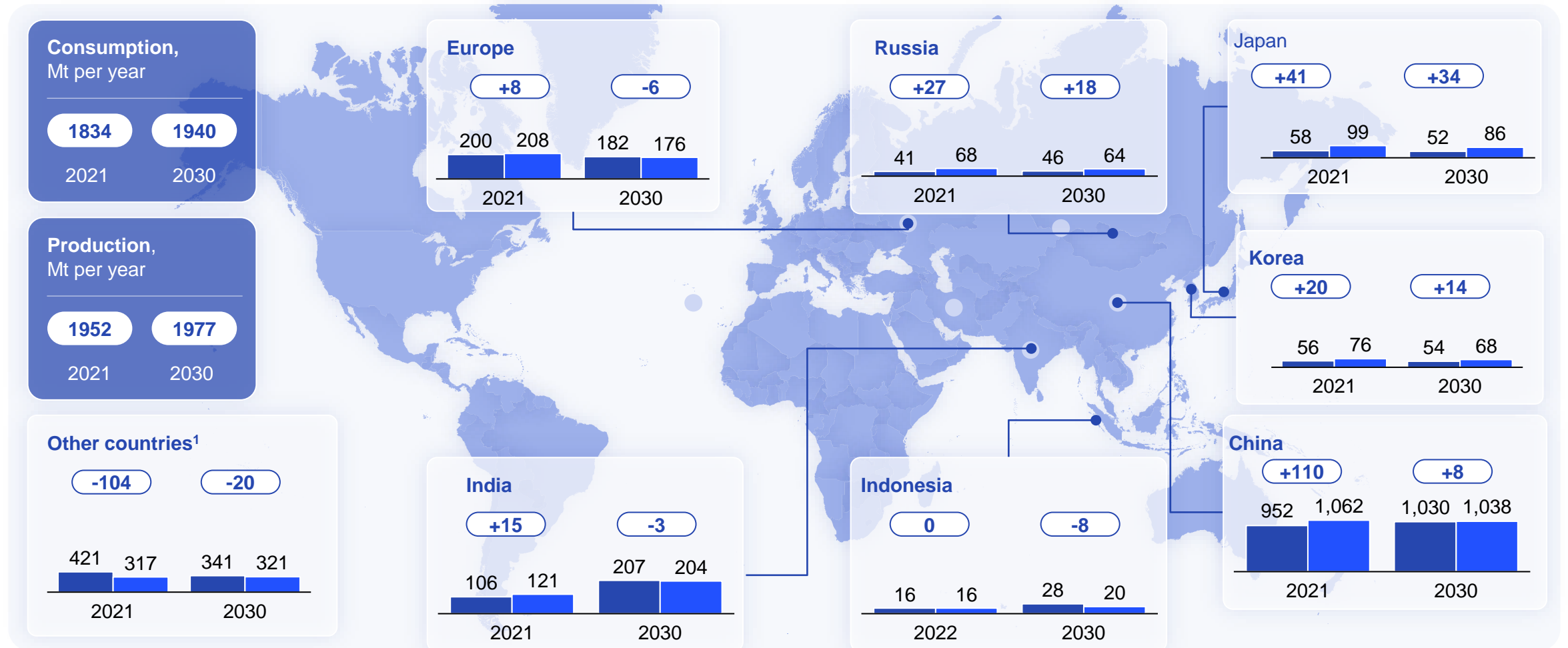
02 Future of metallurgy industry

Global steel market 2030: China still the largest consumer with 50% share, India takes 2nd place

BASE SCENARIO

Consumption and production, 2021–2030, Mt

+XX Balance Production Consumption

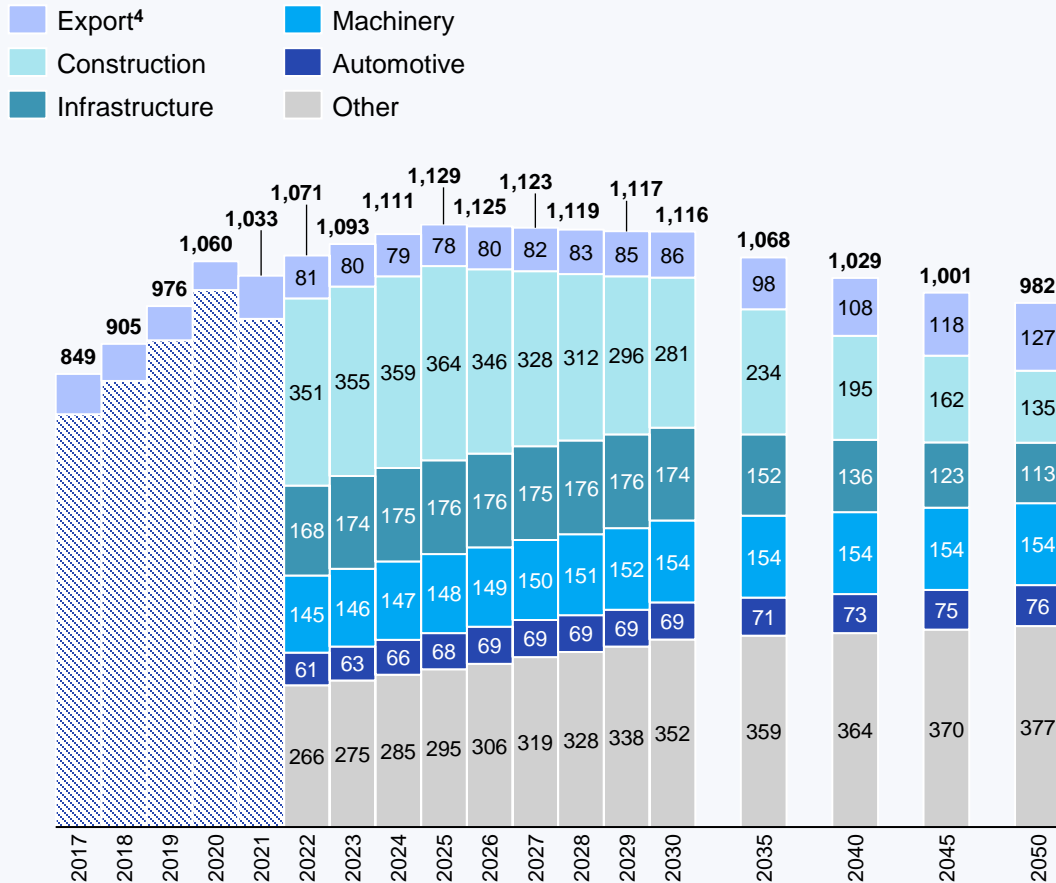


1. Countries and regions: North America, Central and South America, Africa, Middle East, Asia (excluding East Asia and South Asia), Australia and New Zealand



After 2025, Chinese demand for steel will decline primarily due to construction and infrastructure sectors; by 2050, consumption will decrease to ~90% of the current level

Steel consumption by sector and net export¹, mln tonnes



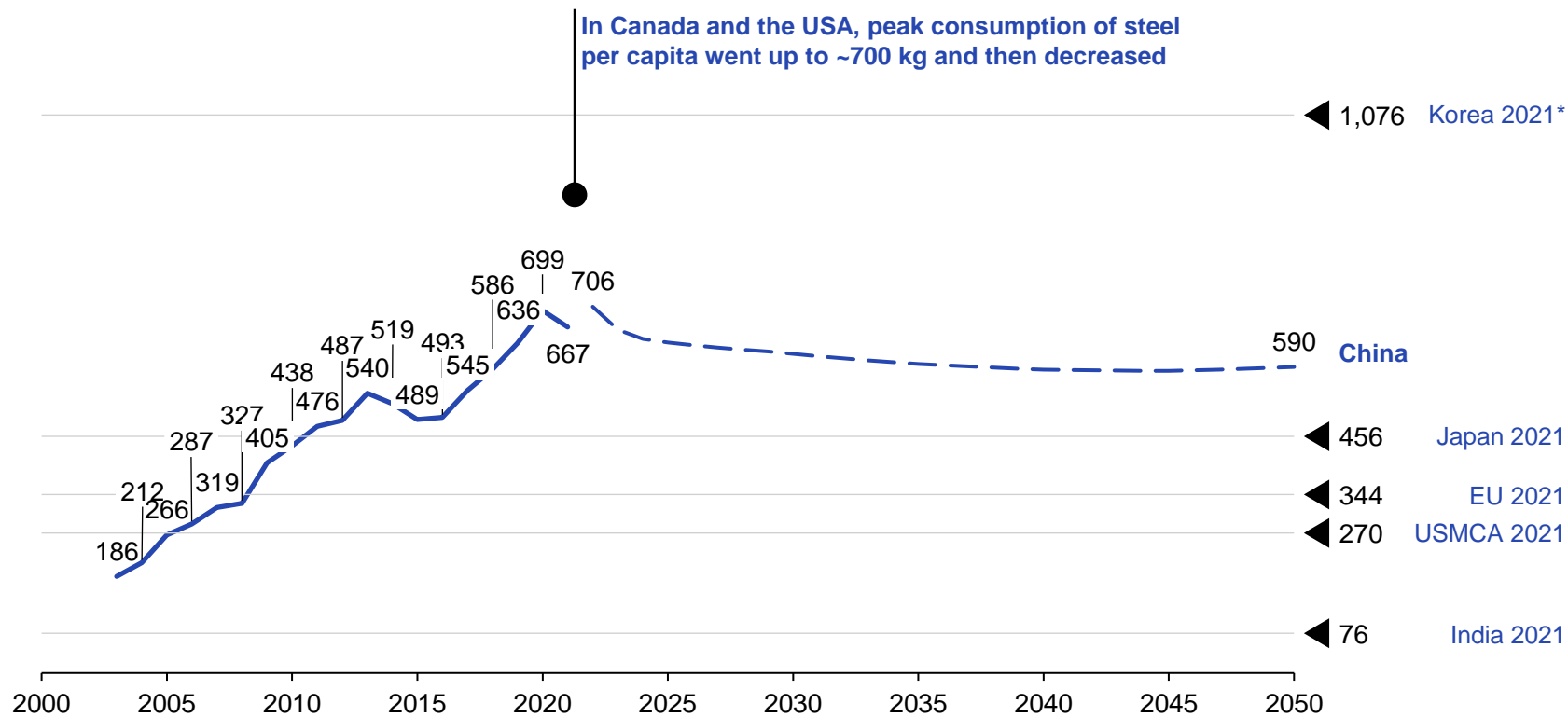
Consumption breakdown ²	CAGR ¹	Drivers	Reasons
A 16% Construction	2022-25: 2% 2026-50: -4%	Construction sector growth rates	Decreasing population Excess supply
B 13% Infrastructure	2022-30: 1% 2031-50: -2%	Changing scope of infrastructure projects	Peaking urbanization
C 18% Machinery	2022-30: 1% 2031-50: 0%	Machinery sector growth rates	Completed industrialization
D 9% Automotive	2022-30: 2% 2031-50: 0.5%	Automotive sector growth rates	Growing demand for electric vehicles
E 44% Other	2022-30: 3.5% 2031-50: 0.3%	Other industry growth rates ³	Stable industrial growth Demand for shipbuilding

1. World Steel Association, Statistics and Forecast of China Iron and Steel Industry Association, China Statistical Yearbook, National Bureau of Statistics, OECD, expert interviews, YnP forecast, IEA
 2. Lead Leo Consulting
 3. A combined metric that includes growth of the production sector and other industries
 4. The export has a dynamic relationship with global consumption of steel except for consumption in China



Steel consumption per capita will peak around 2022 at 706 kg/person

Steel consumption per capita in China – vs. countries¹, kg



Comments

Per-capita steel consumption will grow until 2022 in our forecast. By 2022, the figure will reach the peak value for developed economies and then decrease gradually

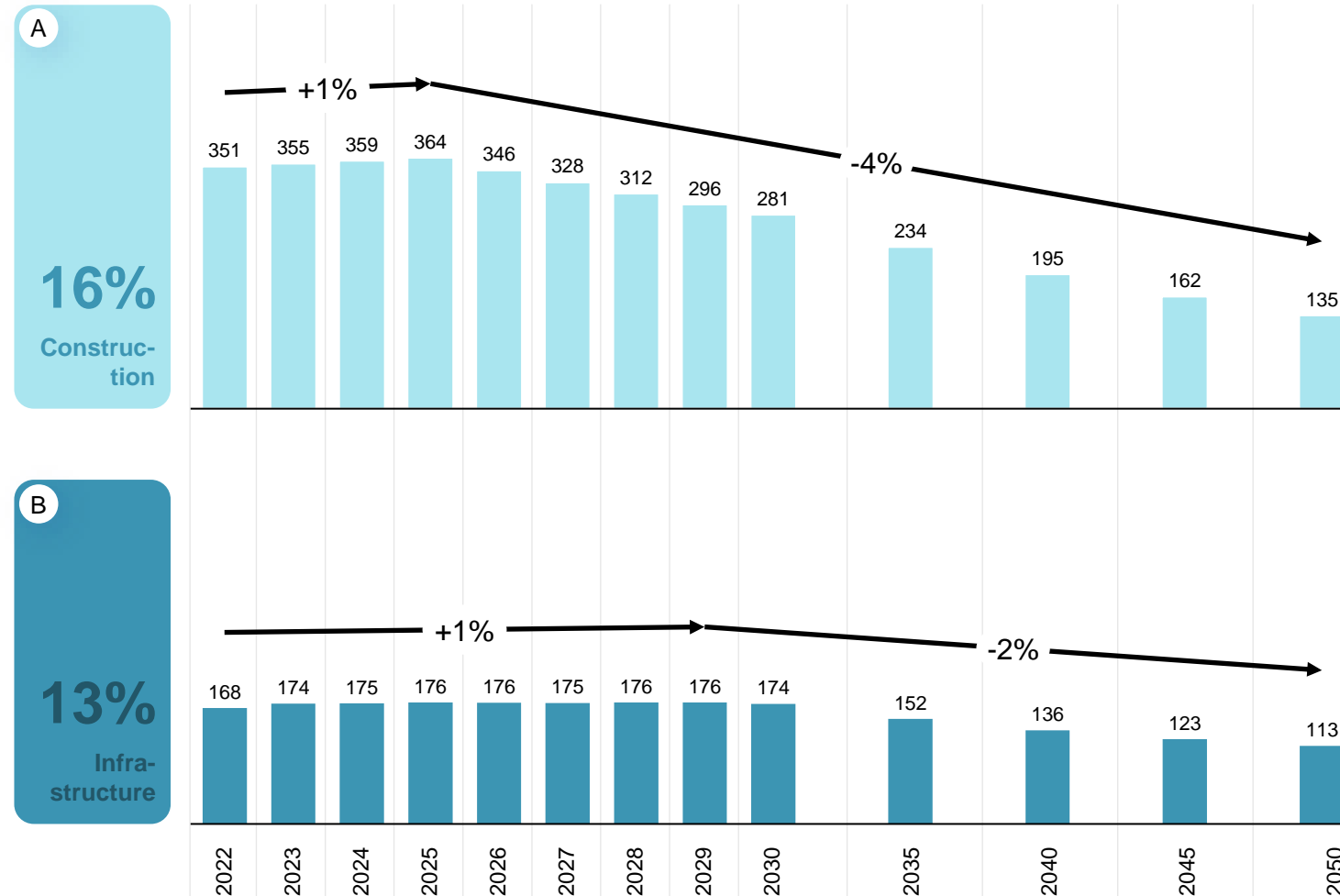
* Spike in per-capita steel consumption in Korea is caused by increased demand in the advanced machinery and shipbuilding industries

1. World Steel Association, McKinsey, YnP forecast



Construction sector will decline by 2–4% per year after 2025–2030s, which will later drive shrinking demand for steel

Long-term forecast for steel consumption by sector through 2050¹, mln tonnes



Comments

- A Housing construction will decline after 2025**
- After 2021, Chinese population will decrease by 1.1% per year on average
 - By 2030, China's total birth rate will go down from 1.15 to 1.1
 - **90%** of Chinese population already own real estate
 - 30% of 50 largest Chinese real estate companies went bankrupt in 2021
 - Current living space per person in Chinese urban areas is 42 m² and no further growth is expected

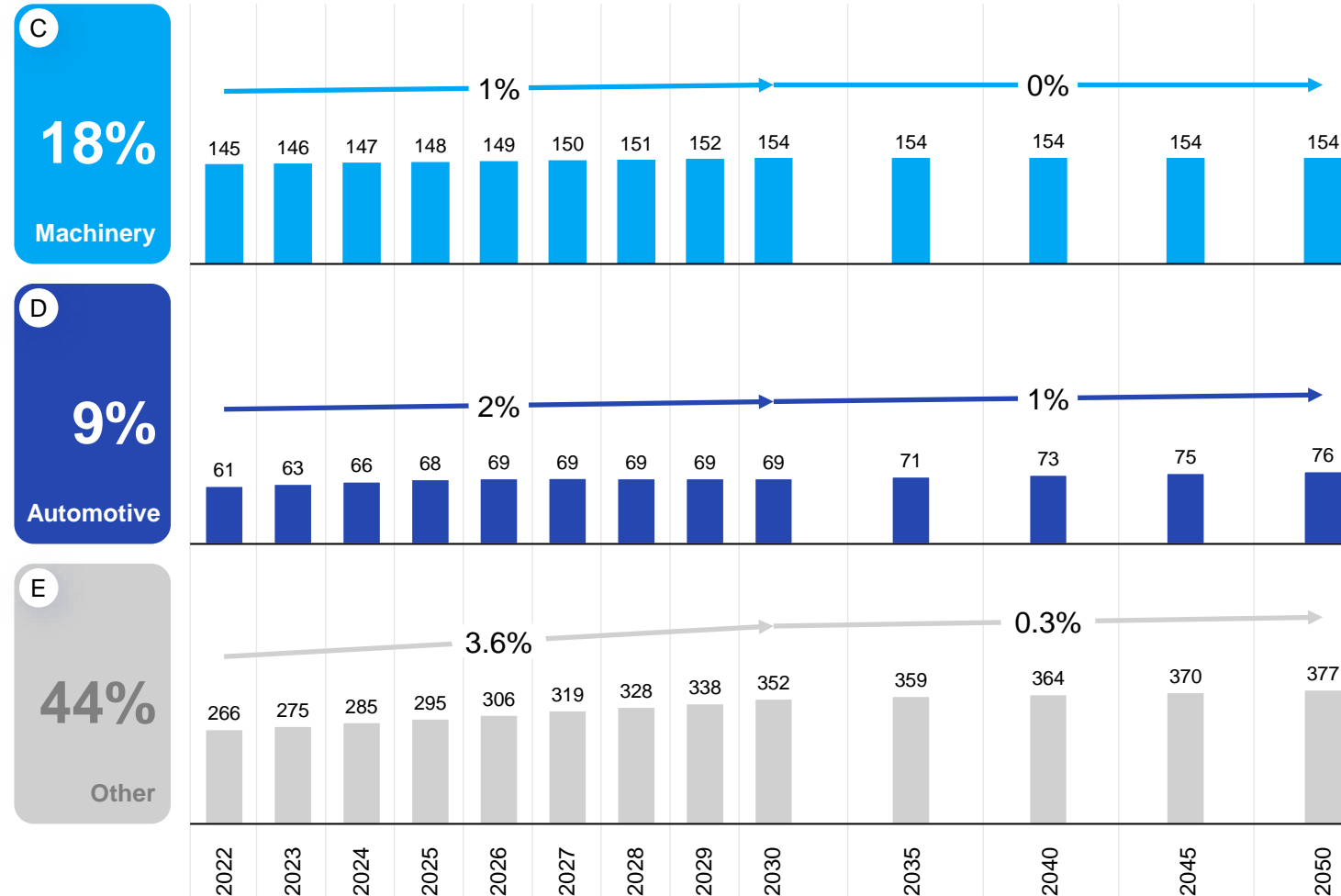
- B Infrastructure construction will slow down**
- China's urbanization is coming to an end. The official level of urbanization is 65% (2021) but the required infrastructure has approached or even exceeded the required scale
 - As far back as 2015, China's urban built-up area has exceeded 100,000 km² – this is enough to accommodate 1 billion people
 - The built-up area is currently capable of housing 70–80% of Chinese population
 - Thanks to ongoing government investments in the infrastructure, the growth will be sustained in the next 10 years

1. Statistics and Forecast of China Iron and Steel Industry Association, China Statistical Yearbook, National Bureau of Statistics, OECD, expert interviews, YnP forecast



Other steel consuming industries will keep growing at a moderate rate

Long-term forecast for steel consumption by sector through 2050¹, mln tonnes



Comments

C Mechanical equipment service life is longer and the replacement cost is higher. As the Chinese industrialization process has entered the second half of its development, we expect the growth of demand for mechanical equipment to decrease after 2030.

D Cars are consumer goods. On the back of national economic incentives, the rate of car renewal is high. Besides, vehicles on new sources of energy will take 10–15 years to replace fuel cars in China, so growth in the automotive industry will be higher vs. machinery.

E “Other” includes the production sector, manufacturing of containers, electric appliances, railway, marine, aerospace sectors, etc.

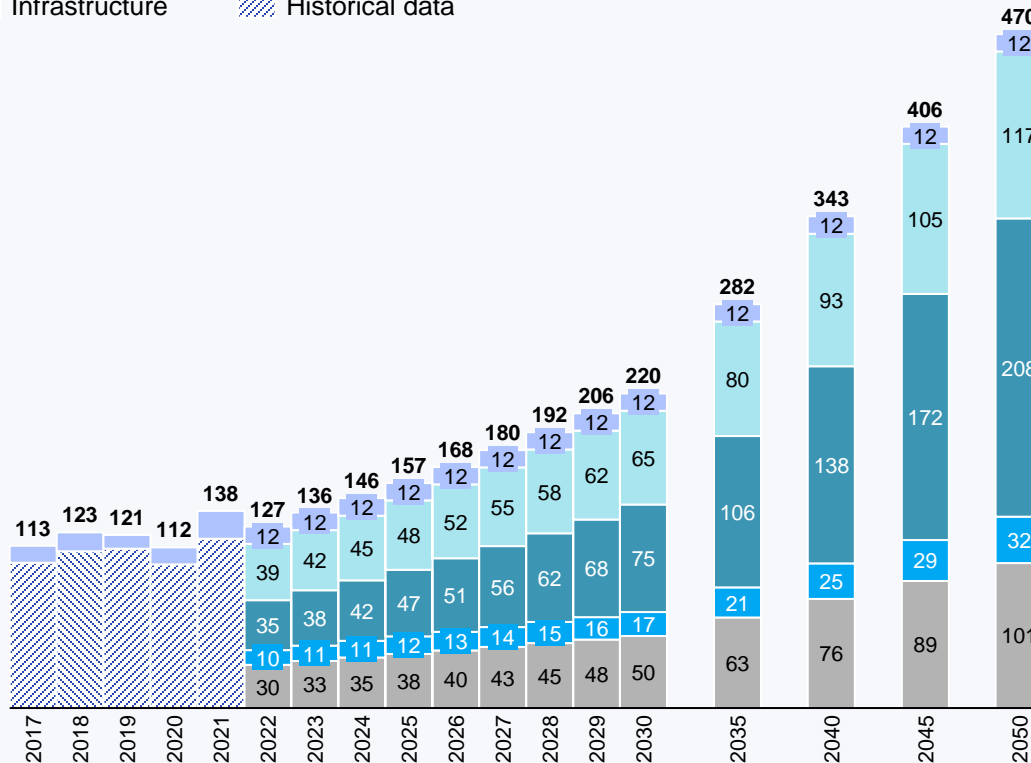
1. Statistics and Forecast of China Iron and Steel Industry Association, China Statistical Yearbook, National Bureau of Statistics, OECD, expert interviews, YnP forecast

India could become a large consumer of Iranian steel products supported by the rapid growth of consumption



Steel consumption by sector and export¹, mln tonnes

■ Export
■ Construction
■ Infrastructure
■ Automotive
■ Other
 Historical data



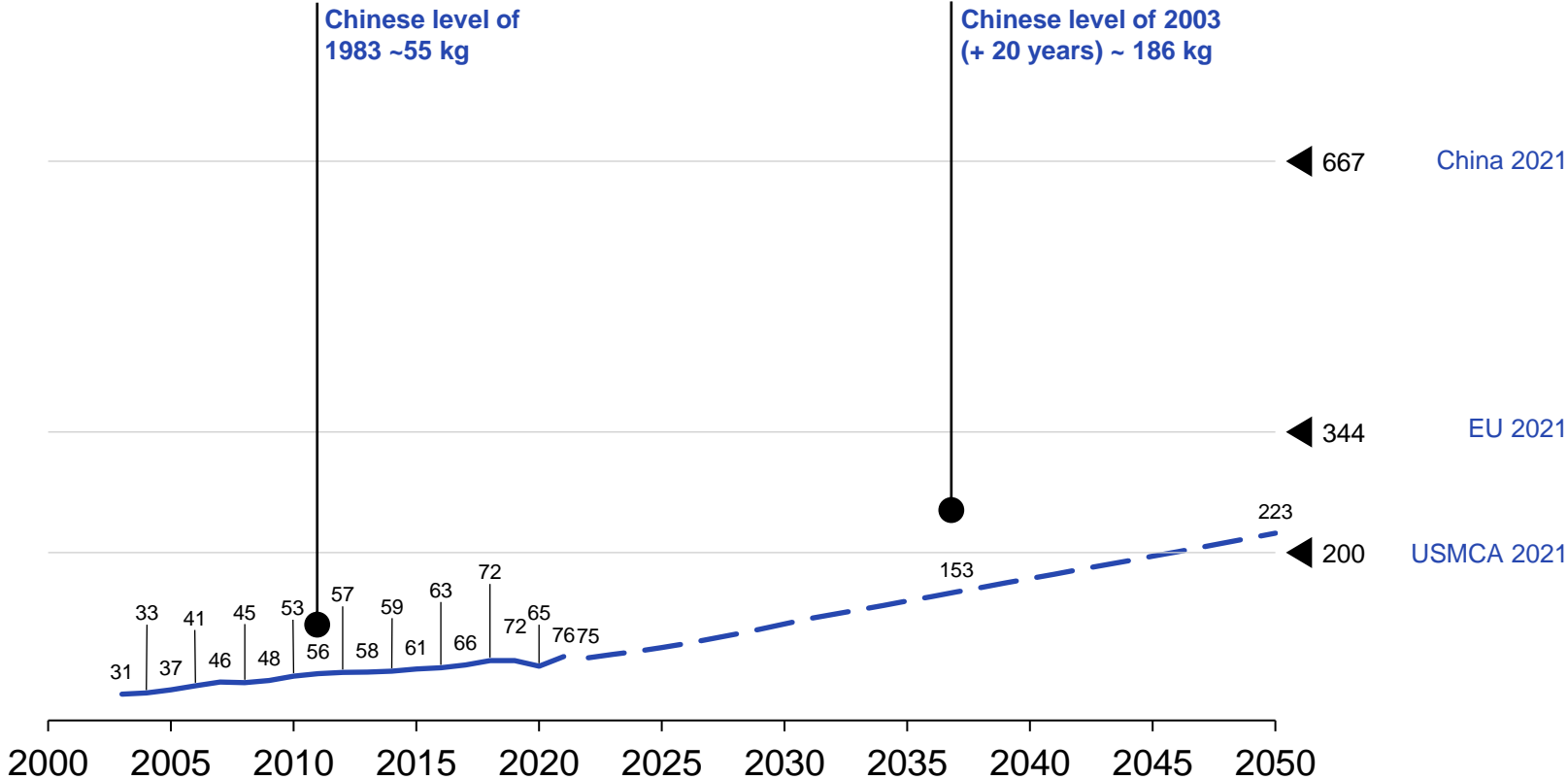
Consumption breakdown ²	CAGR ¹	Drivers	Reasons
A 25% Construction	2022–30: 7% 2031–50: 3%	Construction sector growth rates	Urbanization
B 45% Infrastructure	2022–30: 10% 2031–50: 5%	Changing scope of infrastructure projects	Government investments
C 7% Automotive	2022–30: 6% 2031–50: 3%	Automotive sector growth rates	Industry development due to growing demand
E 22% Other	2022–30: 6.9% 2031–50: 3.6%	GDP growth rates	Rapid economic development

1. World Steel Association, IBEF, OECD, Oxford Economics, Invest India, YnP forecast, expert interviews
 2. World Steel, ISA



Per-capita steel consumption in India will grow to approach the EU level by 2050

Steel consumption per capita in India – vs. countries¹, kg



Comments

Per-capita steel consumption will keep growing to approach the EU level by 2050

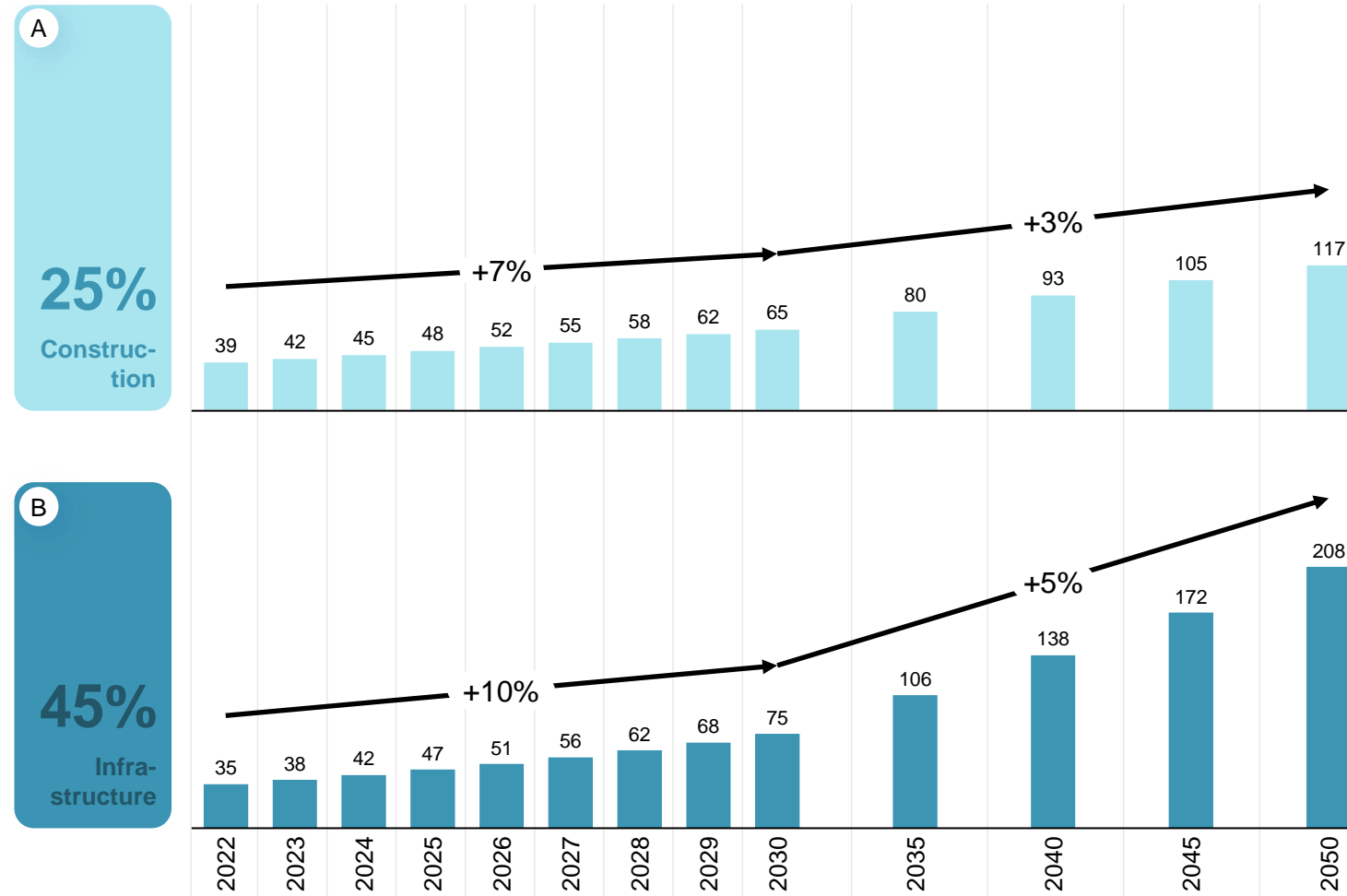
The growth rates will be close to those in China since 1980s when the figures were at approximately the same levels

1. World Steel Association, European Commission, YnP forecast, expert interviews



Infrastructure projects and construction will grow at a rate of 7–10% through 2030 and 3–5% through 2050

Long-term forecast for steel consumption by sector through 2050¹, mln tonnes

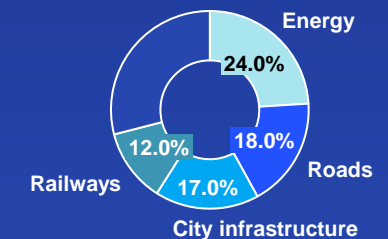


Comments

B 70% of Indian infrastructure is still to be constructed

- The government has planned investments in the roads, railways, connection to the subway, industrial parks, production corridors, water, oil and gas transportation, and affordable housing
- The Government of India has allocated USD 1.4 tn under the National Infrastructure Pipeline (NIP) for FY 2019–25
- The sectors affecting steel consumption will get ~71% of forecasted infrastructure investments in India

Government investments by sector

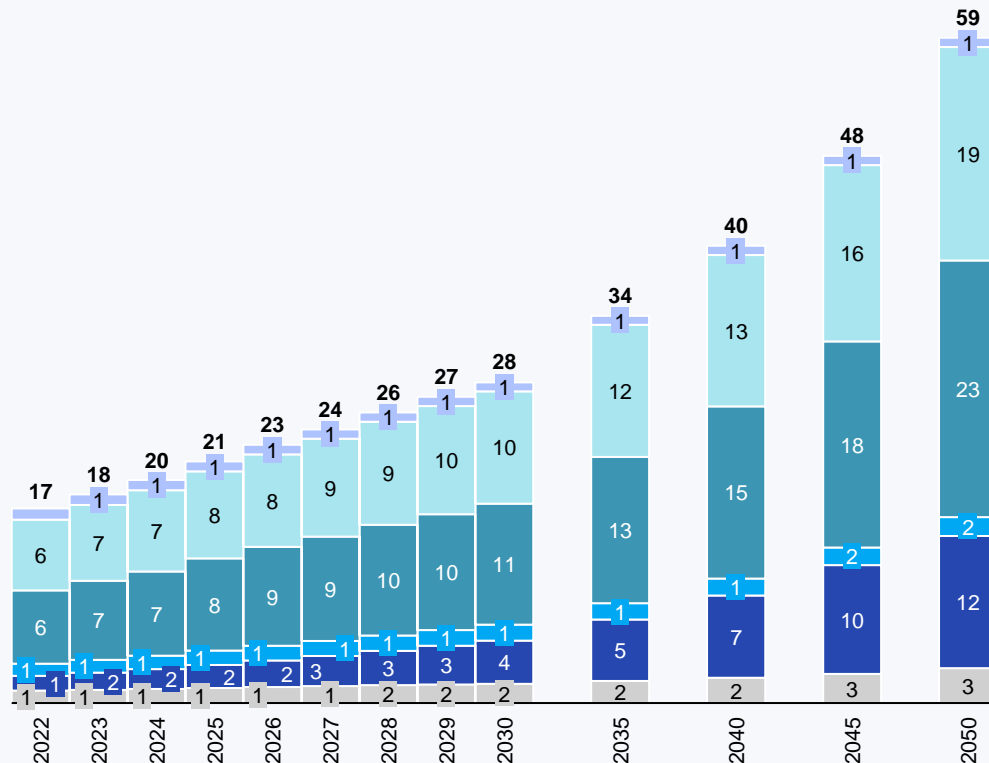


1. IBEF, OECD, Oxford Economics, Invest India, YnP forecast, expert interviews

Steel consumption in Indonesia is actively growing due to rapid economic development, that opens opportunities for steel producers



The dynamics of steel consumption by sectors and net steel exports, Mt



Consumption structure ²	CAGR ¹	Drivers	Reasons
A 38% Construction	2022-30: 6% 2031-50: 3%	Growth rate of the construction sector	Economic growth Population growth Indonesian capital relocation
B 40% Infrastructure	2022-30: 6% 2031-50: 4%	The dynamics of infrastructure project volumes	Increase in investment in infrastructure projects
C 7% Pipes and Energy	2022-30: 3% 2031-50: 1%	Growth rate of pipe production and energy development	Gradual transition to renewable energy sources
D 8% Automobile Industry	2022-30: 15% 2031-50: 6%	Growth rate of the automobile manufacturing sector	Increase in demand for cars

1. World Steel Association, Statistics and Forecast of China Iron and Steel Industry Association, China Statistical Yearbook, National Bureau of Statistics, OECD, Interview with experts, YnP forecast
 2. Lead Leo Consulting
 3. A combined metric that takes into account the growth of production and other industries
 4. The export has a dynamic relationship with the world's consumption of steel

Appendix

01 Market context and outlook

02 Future of metallurgy industry

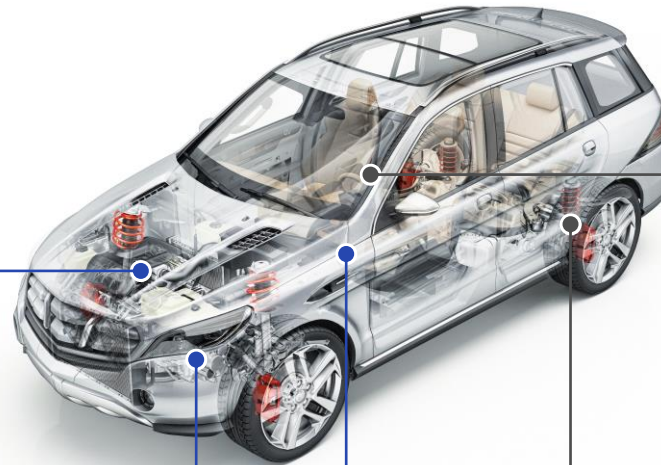
Proliferation of electric vehicles affects consumption of special steel: Special Bar Quality (SBQ)

Key car components with substantial use of SBQ steel, use of special steel for car manufacturing, %

■ Bulk of the systems affected by new technology solutions ■ Other parts

25-35% Engine

Special steel is used mostly to make a camshaft, crankshaft, injectors, connecting rods, and valves



1-5% Steering

Pinion, ball pins and joints, steering racks

15-25% Gearbox

Used to make cog wheels/gears, shifter shafts, input and output shafts

20-30% Transmission

Special steel is widely used to make side shafts, swivel members, joints, differentials, and cog wheels

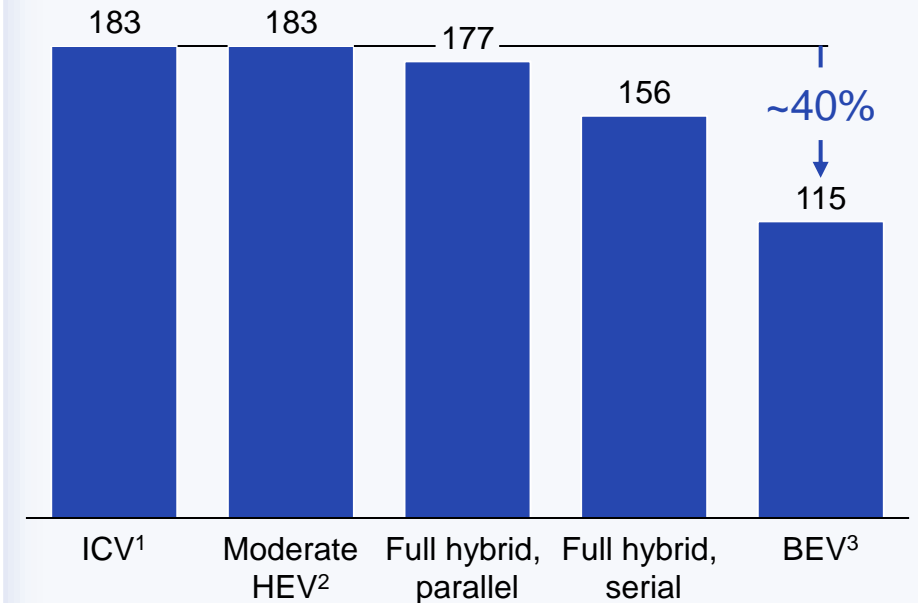
5-15% Suspension

SBQ steel is mainly used to make coil springs, leaf springs, and suspension arms

10-20% Other

Fastening parts, bearings, differential, etc.

Consumption of special steel for new hybrid/electric vehicles will decrease significantly, kg of special steel per car



Demand is growing for electric steel with high magnetic permeability and good ductility, which is used to make EV motors

1. Internal combustion vehicles
2. Hybrid electric vehicles
3. Battery electric vehicles

Trends in environmentally responsible construction and energy conservation affect steel consumption in housing construction

Premium and eco-friendly building materials

Growing interest in **sustainability and high quality construction** is based on the use of materials that provide high strength, durability, energy efficiency and safety for construction projects. The use of premium and sustainable materials **can increase construction costs, but reduce operating costs and improve livability**

Zinc/aluminum or zinc/magnesium alloy steel sheets are used in roofing systems because of their high corrosion and weather resistance and 4 times longer service life

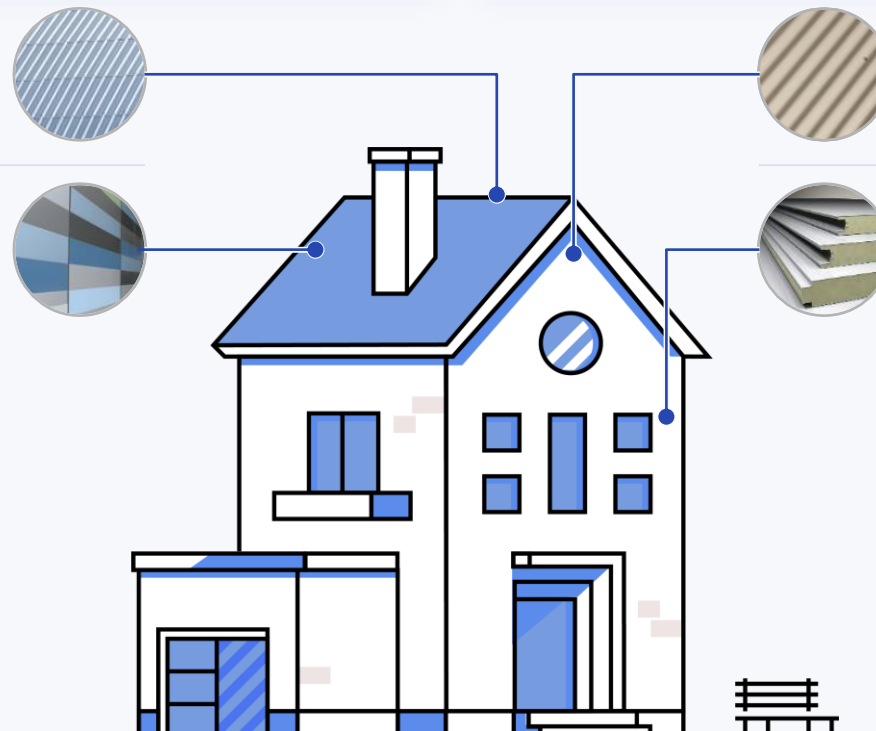
Premium coated steel sheets are used in interior and facade design thanks to a palette of more than 400 colors, exclusive finishes and customization

New energy efficiency and energy saving standards


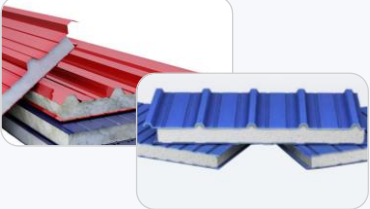



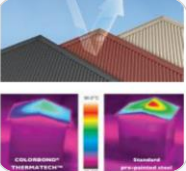
Consumers' **growing awareness of the need for sustainable use of resources and mitigation of adverse impact on the environment** is driven by Government regulations and incentives, as well as technology innovations. The new standards application can increase the cost of construction, but reduce operating costs and make a significant contribution to improving urban environments

High thermal insulation steel sheets are used in roofing systems with a 5% higher solar reflection, 6°C lower roof temperature and optimized thermal performance

Sandwich panels with a wide range of available interior materials provide optimal insulation, making them suitable for use on facades



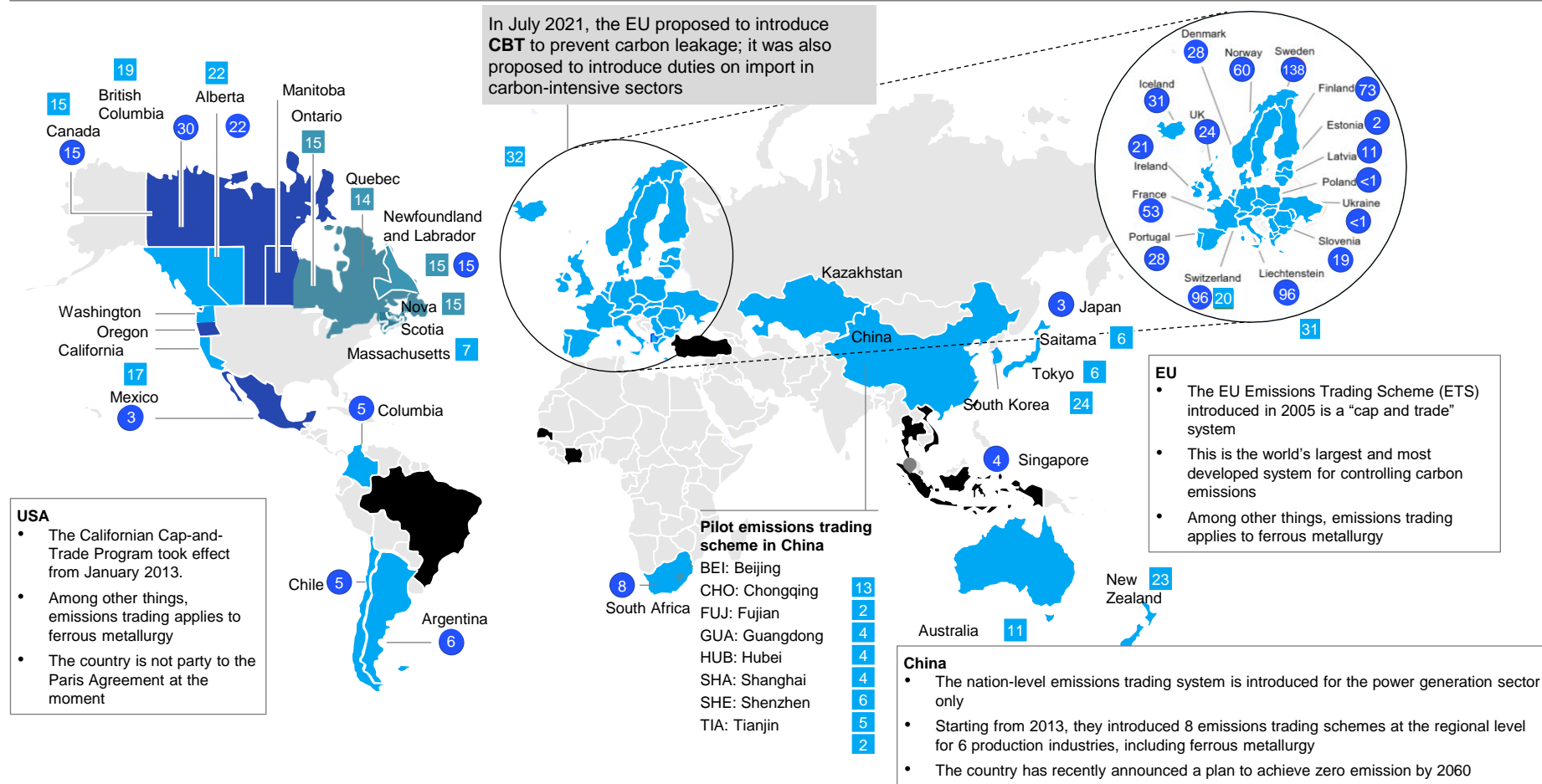
Companies are expanding into products that are outside the traditional steelmaking portfolio – additional examples

Product	Producer	Description	Application areas
<p>Sandwich panels</p>	 <p>MAGNITOGORSK IRON & STEEL WORKS</p>	<p>Classic glued sandwich panels with a core of non-combustible mineral wool slabs of high density are actively used as one of the modern options for building thermal circuit devices</p>	<ul style="list-style-type: none"> • Agriculture and animal husbandry • Industrial facilities • Storage and logistics • Trade, commercial sector • Auto business • Modular buildings • Administrative and other complexes 
<p>Thin sheet steel with polymer coating</p>	 <p>thyssenkrupp</p>	<p>A metal surface with layers of protective lacquer and decorative matte coating The ZM EcoProtect metal layer is a special composition containing no less than 1% aluminum and 1% magnesium</p>	<ul style="list-style-type: none"> • Facade and roofing materials 
<p>Thin steel sheet with improved insulating coating</p>	 <p>TATA</p>	<p>A solar reflectance technology embedded in COLORBOND® steel The solar reflectance coefficient ranges from 25 to 82 depending on the paint color</p>	<ul style="list-style-type: none"> • Roofing systems 

Regulators in 50+ countries have introduced or plan to introduce trading in quotas for carbon dioxide emissions and/or special taxes

■ Emissions trading scheme is introduced ■ Emissions trading scheme is planned to be introduced ● Carbon emission tax is introduced¹ ● Carbon emission tax is planned to be introduced¹

Global prices for carbon emissions by country, 2020, USD for a tonne of CO₂ equivalent



Globally, there is a total of **64** planned and already implemented initiatives for taxing carbon emissions in **46** countries and **35** subnational jurisdictions

In some jurisdictions, the carbon tax rate is set at about USD 100 for a tonne of CO₂ (e.g., in Switzerland and Sweden)

According to IEA, to ensure compliance with the Paris Agreement, the tax rate should go up to **about USD 300 for a tonne by 2050** after a stepwise increase to USD 75–100 for a tonne by 2030 and USD 125–140 for a tonne by 2040

The EU's Carbon Border Tax (CBT) mechanism will require payment for carbon dioxide emissions from importers of the steel that does not meet green requirements

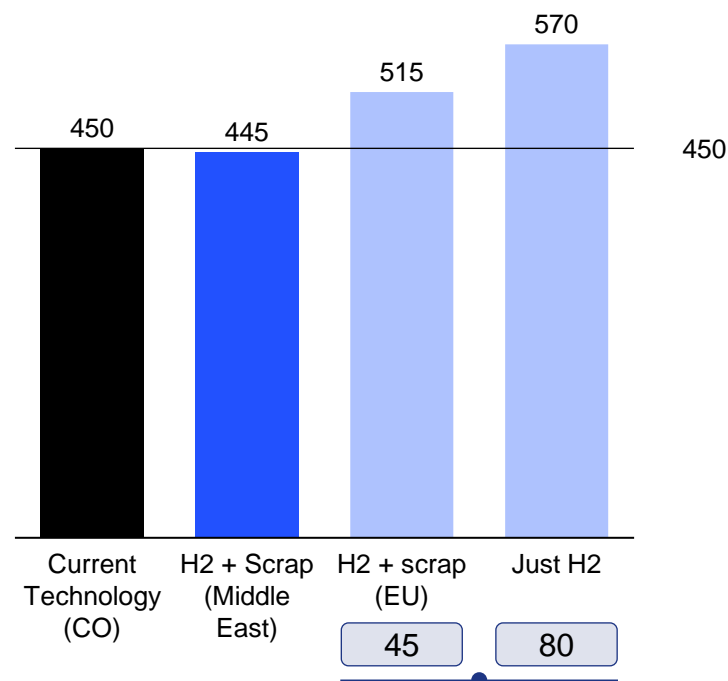
1. The taxes do not always apply to the same sectors as the emissions trading schemes

Mass usage of H2 technology for steelmaking is expected by 2030-2040

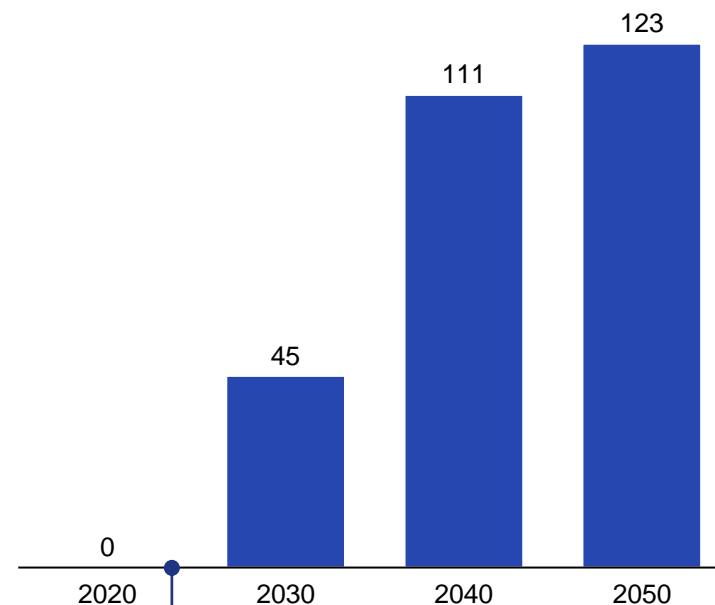
Hydrogen avoids carbon dioxide emissions during iron ore recovery

The technology becomes cost-effective as the cost of H2 decreases and the CO2 tax increases

Cost of steel production, USD/t



Demand for hydrogen for steel, TWh



14 projects in Europe for the modernization/construction of steel plants are already planned

H2 Green Steel (Boden, Sweden) plans to launch the production of **5 million tons** per year of "green" steel **by 2023** based on hydrogen technology, which can **reduce carbon emissions by 95%** compared to conventional production.

Baowu Steel Group: started the construction of a hydrogen-based furnace in 2022. **Commissioning** is scheduled for **2023**

HBIS study to build the world's first showpiece **1.2 million tons hydrogen steel making plant**

ArcelorMittal Hamburg: is planned to launch a plant for the **production of DRI** with a capacity of **100 thousand tons** per year based on hydrogen technology by the end of **2025**. The company also announced the launch of hydrogen projects at plants in Bremen, Dunkirk, Asturias

POSCO has announced plans to build EAF, slated to **start up in 2027**.

H2Green Steel is building a new plant to make green steel with a capacity of 5 mln tonnes per year

Status

Up until 2030, we expect **short capacity of green steel production**

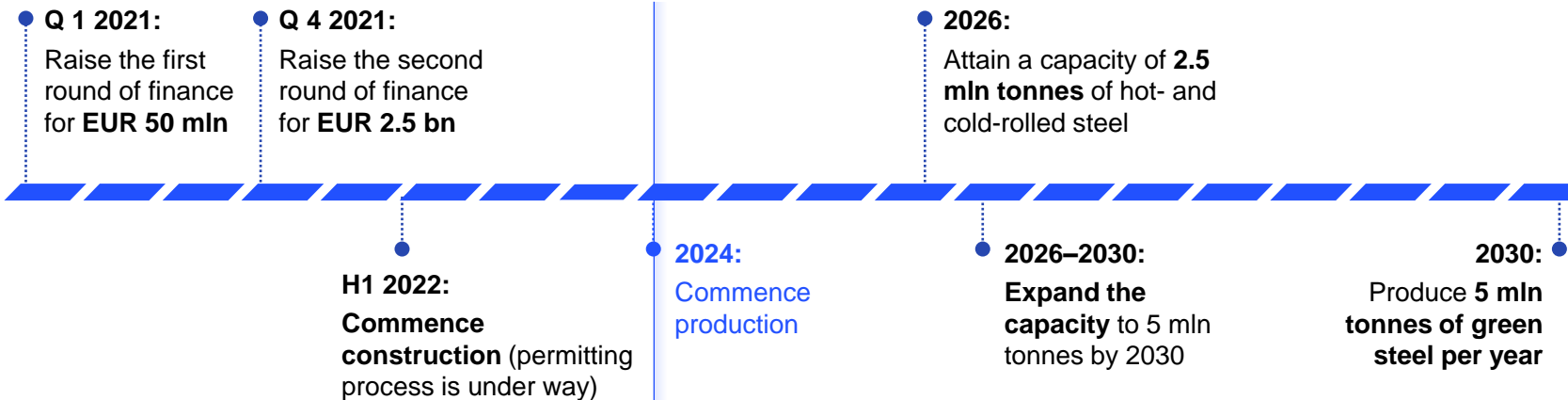
Demand for green steel by 2030 in the EU will go up to:

42–65
mln tonnes

Potential supply of green steel in the EU

33–42
mln tonnes

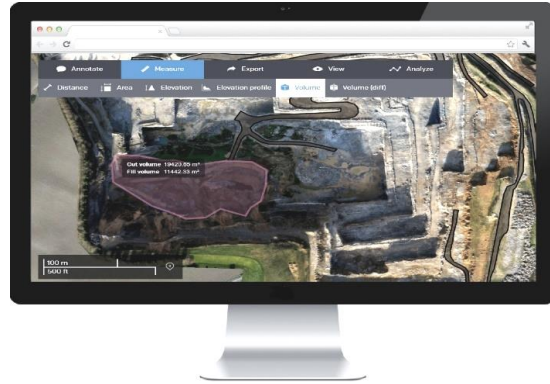
Phased project development plan through 2030



H2green steel

1 Data collected by drones can be deployed through a web-based platform and allows for better and location-independent decision-making

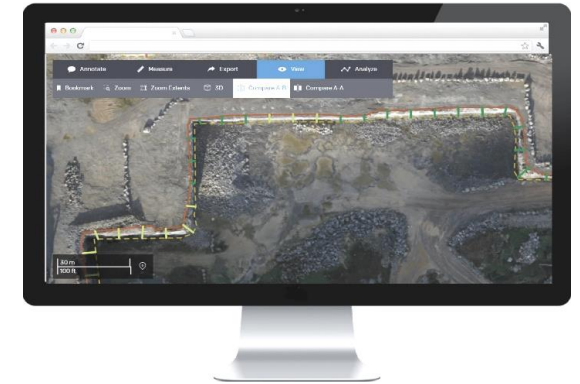
Spatial plan compliance



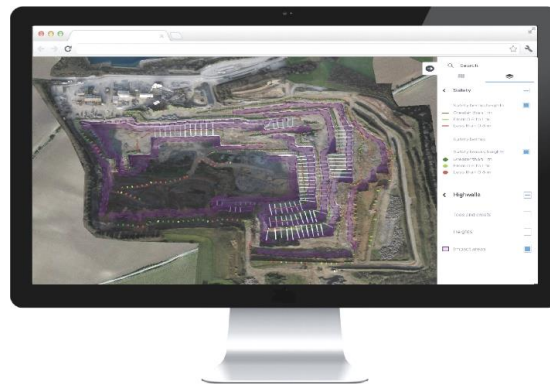
Road profile measurement



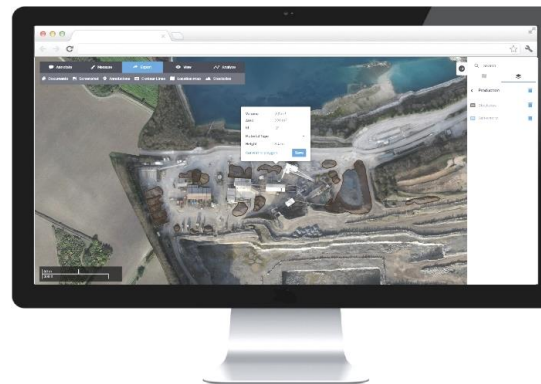
Highwall assessment



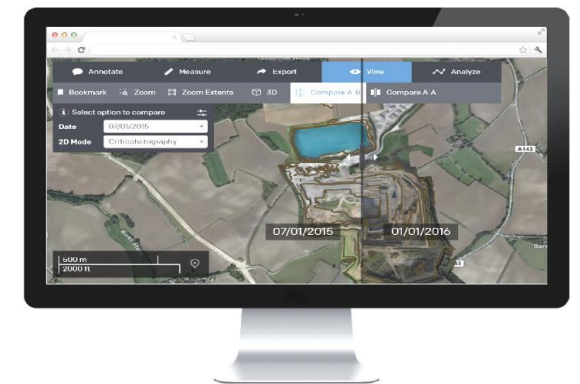
Wall stability monitoring



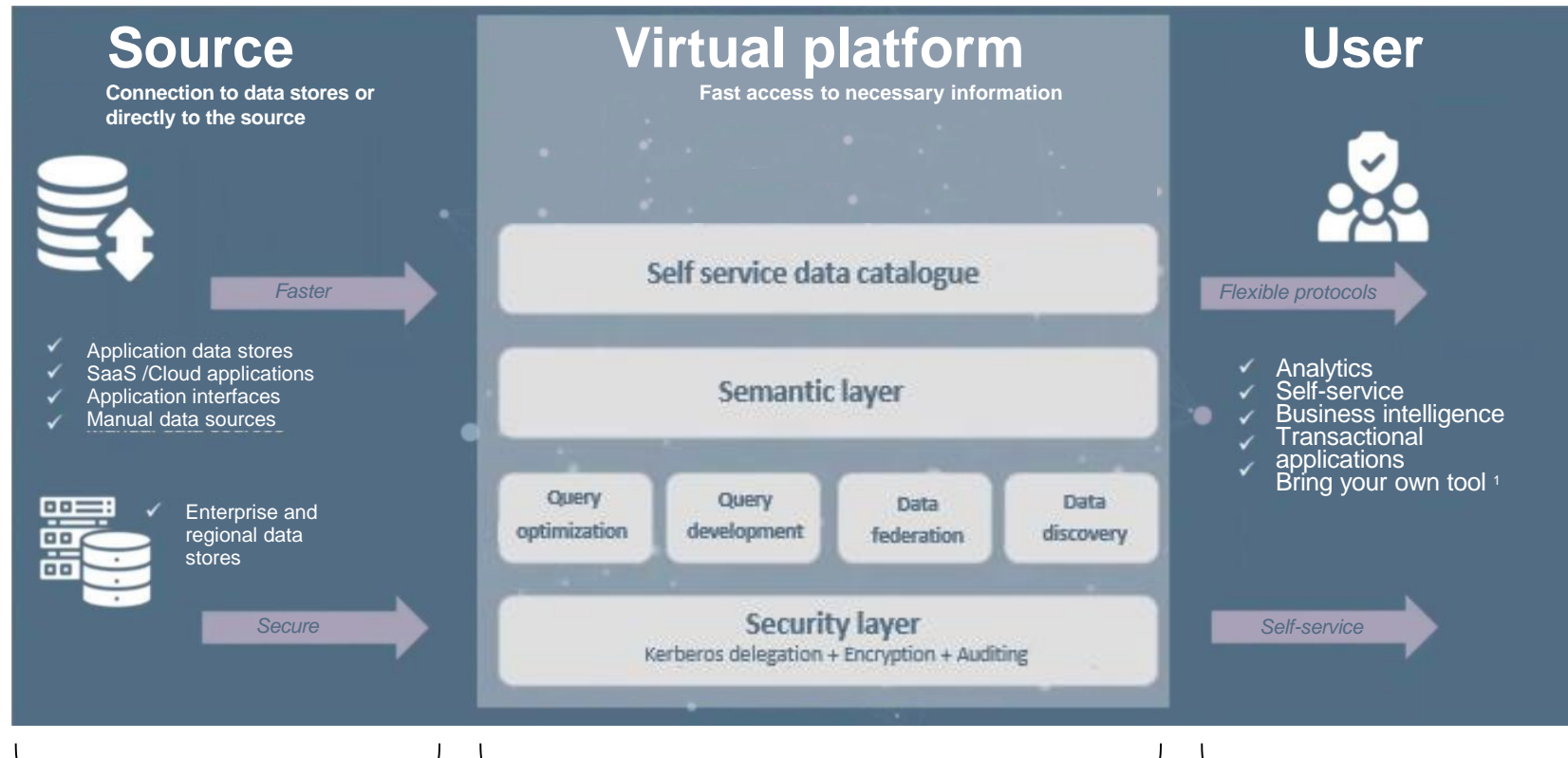
Stockpiles surveys



Mine development tracking



1 Case study: a virtual platform that integrates local stores boosts data speed and reduces TCO



1 Each asset collects data in **local stores** (clusters) integrated into a common cloud platform

2 The platform establishes **real-time communication between clusters** and allows local clusters to link to data in other clusters

3 Employees are **able to work with data located at any of the assets**

Remote access combined with relational system ² can optimize data handling:

- No need to copy data
- Less load on the system and, consequently, lower TCO³
- Higher speed and relevance of data used

3 Case study: robotization helps minimize risks during mining and increase efficiency



Drone surveying an open pit to create a digital model (3d mapping)



Controlling the steadiness of the open pits slope



Problem Monitoring and Control Center



Robotic platforms for geodetic research



Tablets with drilling diagrams



The use of automatic dump trucks, bulldozers, excavators on deep horizons and the most dangerous areas



Improving production safety and reducing human error

Up to 20%

Increasing the productivity of mining equipment

Up to 10%

Reduction of mining OPEX

3 In-Pit crushing and conveying (IPCC) systems allow to significantly reduce operating costs for deep high productivity open pits with a long life of mine

Main prerequisites for the use the IPCC

Steep – falling deposits

The transportation distance is more than 3-4 km

The depth of the open pit is more than 100-200 meters

The volume of transportation is more than from 5 Mtpa

Steep – falling deposits

IPCC Pros

Simplification of dispatching by dump trucks

Reducing of operating costs due to

- The number of dump trucks
- The staff of drivers and repair personnel
- Fuel consumption
- CO₂ and dust emissions

IPCC Cons

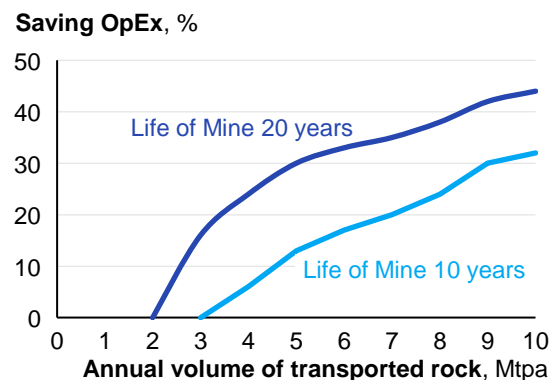
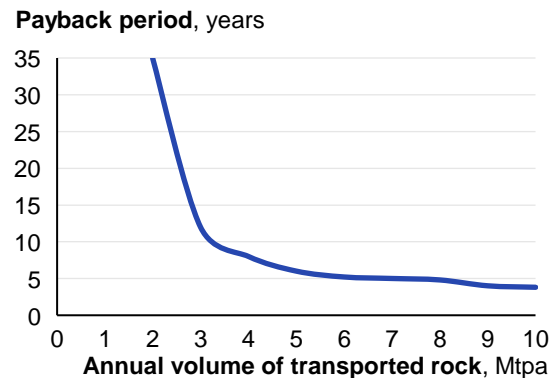
Significant CapEx

The need to disperse the slope of the open pit for IPCC

The need to put the side of the open pit in the final position ahead of time or freeze it for a long period for IPCC

Necessary to fix the station of crushing and loading on the conveyor for 5-10 years

Example of the dependence of the payback period IPCC on its capacity




IPCC results for Muruntau mine (Au, Uzbekistan)

Dump trucks, units	-22
The volume of transportation by one dump truck, m ³ per year	490,000
The mileage of dump trucks, 000 km	-20,000
Fuel consumption, t	-10,700
Tire consumption, units	-420
Drivers, people	37
CapEx for stripping, M\$	-45
OpEx, M\$/year	-20

IPCC transports 15 mln m³ of ore and 20 mln m³ of strip per year. The lifting height is 180 m.

3 Technology of in-pit crushing and conveying at iron ore mines are widely spread across former Soviet Union countries

Head company	Deposit	Ore/Waste	Capacity, tpa	Capex/Payback	Specifications
 Metalloinvest	Mikhaylovsky	Ore	35 M	180 M\$/n d	The angle of inclination is 37 degrees, the lifting height is 215 m.
	Lebedinsky	Ore	55 M	250 M\$/4 years	2 conveyor lines, 3 km each. Steeply inclined conveyor. The project implementation period is 5 years
 EUROCHEM	Kovdorsky	Stripping/ overburden	Corresponds to 15 Mtpy ore	Operation for more than 20 years	Lifting height 150 m. The 4 conveyors are arranged in an underground gallery. The length of the conveyors is 1700 meters. Reduction of cargo turnover by motor transport by 30 million ton-kilometers per year
 Severstal	Olenegorsky	Ore	12 M	Operation for more than 20 years	The conveyor is 530 meters long, 500 of which are underground. Tilt angle of 36 degrees
	Karelsky Okatysh	Ore and Stripping/ overburden	Waste 50 M Ore 20 M	180 M\$/n d	Lifting height 200 m. The length of the conveyors is 2500 meters. Ore is loaded into railway wagons after delivery by conveyors. Reduction of CO ₂ emissions by 9,500 tons/year
 METINVEST	Inguletsky	Ore	18 M	Operation since the 1970s	Lifting height 180 m. Tilt angle of 16 degrees
	Severny	Ore	18 M	Operation since the 1970s	Lifting height 165 m. Tilt angle of 15 degrees
 NLMK	Stoylensky	Ore	21 M	The system was dismantled in 2006	Lifting height 200 m. Tilt angle of 15 degrees. Work is underway to restore IPCC

3 Case study: significant increase in operational efficiency due to implementing automation of drilling rigs



Impact

~140

of drill rig operators
on site in 2016

~30

operators in a
remote operations
center by early 2020

↑ 20%

increasing the
number of cycles

↑ 30%

optimization of time
for underground
ventilation

↑ 25%

drill rig
productivity

Up to
↓ 25%

maintenance
costs



Key success factors

- Prioritization based on value created and tangible quick wins: Initial test results were very impressive, leading to increased demand from other mines
- Rigorous vendor selection: pilot projects were conducted with 3 vendors before Epiroc was selected (the winner)
- Support of the HQ leadership and enthusiasm of the mine director during testing
- Dedicated mine site with sufficient resources and a focus on successful implementation

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