IEA Technology Roadmap
The global iron and steel sector

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Introduction

Background and broader context
The IEA works around the world to support accelerated clean energy transitions with unparalleled data, rigorous analysis and real-world solutions.
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After remaining flat for 3 years, global CO$_2$ emissions rose again in 2017, to an all-time high.
A wide variety of technologies are necessary to meet carbon emission reduction goals, notably energy efficiency, renewables and CCUS.

The global climate challenge: Where do we need to go?

Contribution of various levers to global cumulative CO₂ reductions

Global CO₂ reductions by technology area

- Efficiency 40%
- Renewables 35%
- Fuel switching 5%
- Nuclear 6%
- CCS 14%

GtCO₂ cumulative reductions in 2060

2 degrees Scenario – 2DS

Reference Technology Scenario – RTS
Are clean energy technologies on track?

Some technologies have made tremendous progress in 2017 – particularly solar PV, LEDs and EVs – but most are not on track. Energy efficiency improvements have slowed and progress on key technologies like carbon capture and storage remains stalled.

The IEA tracks the progress of various technologies critical to a successful clean energy transition.
IEA Technology Roadmaps

Low-carbon pathways for key technologies
IEA Technology Roadmaps

- Since 2009, 22 Technology Roadmaps and How2Guides (33 publications)
- Re-endorsed at G7 Energy Ministerial Meetings in 2016 (Japan) and 2017 (Italy) “(G7 Ministers) welcomed the progress report on the Second Phase of IEA’s Technology Roadmaps, focused on viable and high impact technologies”
- Close engagement with key industry stakeholders
How do we get there?

- What is the status of the technology today?
- What alternative technology options may be available in the long-run?
- What data are available, and what data are needed?

- Assessment of technology performance and innovation challenges
- Consideration of barriers to market deployment and enabling factors
- Evaluation of cost-competitiveness across technology options and routes

- How policies and regulation can support the clean energy transition?
- How to accelerate technology adoption with the private sector?
- How collaborative mechanisms can boost technology innovation?
Industry-related IEA Technology Roadmaps

- **Global Chemicals**
- **Global Cement update**
- **Global Iron and Steel**

- **2009**
  - Global Cement
- **2013**
  - Regional Cement (India)
- **2018**
  - Status review Cement (India)
- **2019**

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Why steel?

Steel production accounts for around a fifth of industrial energy consumption and about a quarter of direct industrial CO₂ emissions.

Note: Data are estimates for 2017; industrial emissions include process emissions.
India’s crude steel production is projected to grow by more than 400% between 2015 and 2050, compared to global growth of 30% over the same period.
Iron and steel sector Technology Roadmap

Aims, scope and methodological overview
Enabling strategies for sustainable iron and steel production

Sustainable transition goals:

• Environmental sustainability
• Energy security
• Least-cost transition pathways
• Synergies between Iron and Steel and other sectors
Enabling strategies for sustainable iron and steel production

Exploring alternative low-CO$_2$ steel technologies

- **Upgraded smelting reduction.** Maximises the CO$_2$ content of the off-gases through pure oxygen operation, facilitating CO$_2$ capture. Pilot trials currently underway. Avoids the need for coke or sinter. [Large pilot demonstration TRL 6-7]

- **Oxy blast furnace and top gas recycle:** The CO$_2$ content of the top gas is raised by replacing the air in the blast furnace with oxygen and recycling the top gas. Lowers coke requirements. [Large pilot demonstration TRL 6]

- **Upgraded DRI process** (based on natural gas) that reuses off-gases from the shaft as a reducing agent after CO$_2$ capture. [Paper studies]

- **Coke oven gas (COG) reforming:** Increasing the hydrogen concentration of COG through reforming tar to reduce net energy consumption. Through integration with oxy blast furnaces, CO$_2$ capture can be added.

- **Hydrogen from renewable-electricity for DRI production** [Pre-feasibility]

- **Direct use of electricity to reduce iron ore** relying on renewable electricity. [Intermediate TRLs]

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Exploring alternative low-CO₂ steel technologies

Slide content courtesy of the World Steel Association.
Material efficiency from cradle to grave

DESIGN STAGE
- Lightweighting, reduced over-design and optimised design
- Design for use, long-life, and reuse

FABRICATION STAGE
- Reducing materials losses and over-use when manufacturing materials/products and in construction

USE STAGE
- Life-time extension and repair
- More intensive use

END OF LIFE
- Re-manufacturing, re-purposing, and reuse
- Recycling

incorporation of reuse and recycled materials
Understanding current and future supply value chains is critical.

Exploring further sustainability opportunities

Source: Adapted from Tata Steel presentation from kick-off workshop for the IEA Global Iron & Steel Technology Roadmap, 2017
ETP modelling: the engines behind the analysis

Bottom-up, technology-rich modelling to yield sector-specific insight
ETP Industry sub-sector model structure

**MACRO ECONOMIC INPUTS**
- GDP projections
- Population projections

**MARKET DYNAMICS**
- Bulk material production
- Historic dynamics of material demand

**MATERIAL EFFICIENCY STRATEGIES**
- Post-consumer scrap recycling and reuse
- Manufacturing yield improvement
- Clinker substitution

**PRODUCTION MODULE**

**MATERIAL PRODUCTION PROJECTIONS**
- Average plant life times
- Installed capacities
- Actual technology energy performance
- BAT energy performance
- CAPEX and fixed OPEX
- Energy prices
- Feedstock and raw materials availability
- Material yields
- CO₂ intensity factors
- Water use and air pollution factors

**MATERIAL PRODUCTION PROJECTIONS**
- Energy use (feedstock and fuel)
- CO₂ emissions (energy and process)
- Technology investments
- Generation of industrial by-products
- Other environmental implications

**TIMES TECHNOLOGY MODEL**

**Scenario results**
Key milestones for the Iron and Steel Roadmap

Timeline

• Project kick-off – November 2017, Paris
• Materials demand trends in Transportation and Construction – March 2018, Paris
• Asian Steel Experts Dialogue – May 2018, Shanghai
• American Steel Experts Dialogue – August 2018, São Paulo
• Indian Steel Experts Dialogue – February 2019, New Delhi
• Enabling policies and mechanisms workshop – this Friday 29th March, Paris
• Modelling and analysis commences – April 2019
• Tentative launch – Q4 2019
High-level overview of the core Iron and Steel modelling structure