Global Iron & Steel Technology Roadmap

Simone Landolina and Araceli Fernandez

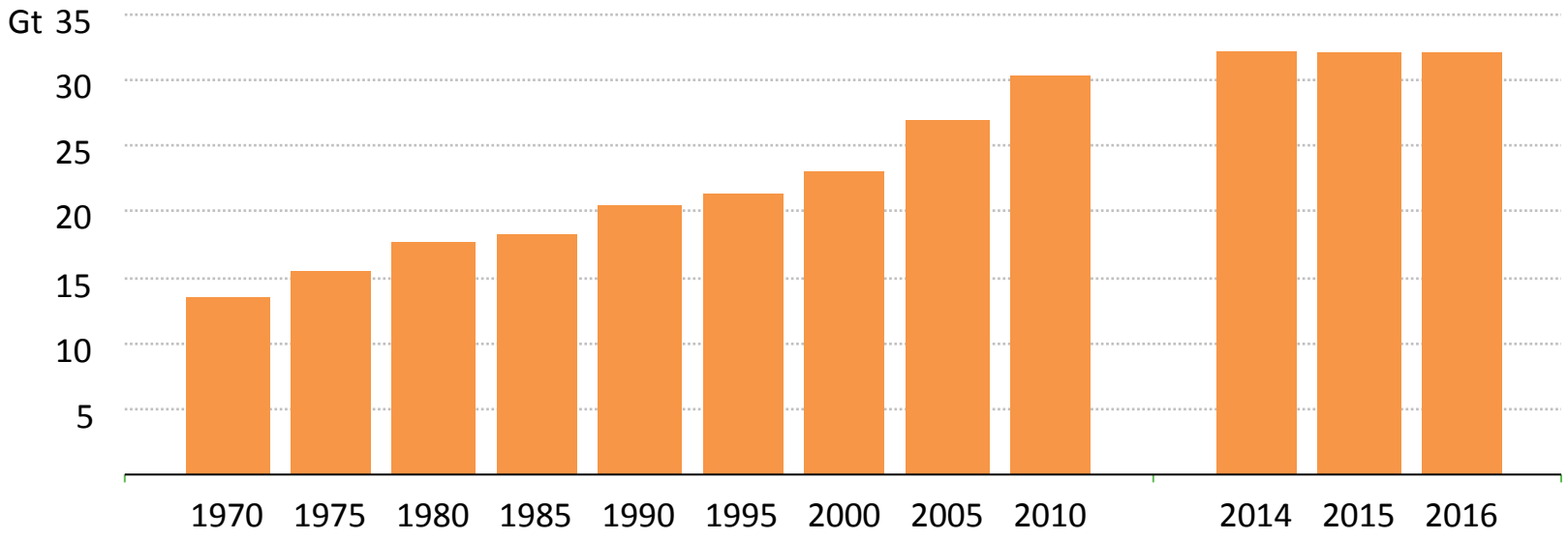
Kick-off workshop, 20 November 2017

The global energy context today

- Global energy markets are changing rapidly
  - *Solar at records highs, driven by policy support & cost reductions*
  - *Electric car sales are growing exponentially*
  - *Global energy intensity fell by 1.8% in 2016*
- Digitalization is having profound impacts on the energy sector
- Local air pollution remains a key driver of energy policy
- Current climate pledges fall short of meeting mitigation goals

Global CO_2 emissions flat for 3 years – an emerging trend?

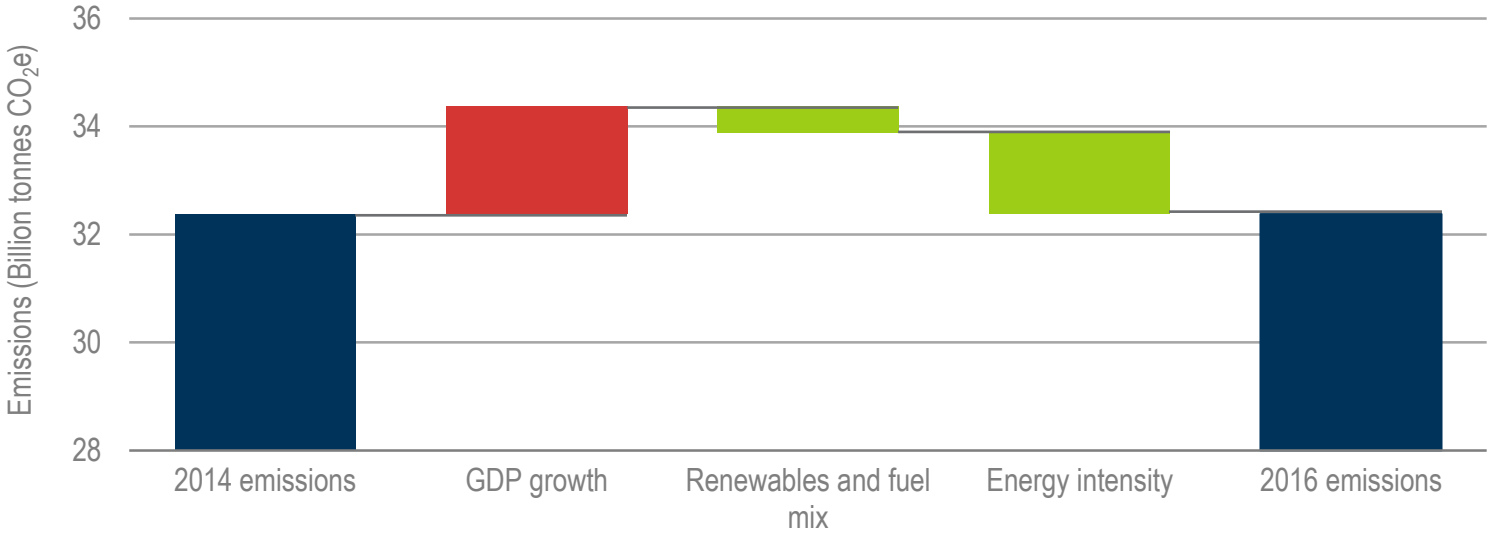
Global energy-related CO_2 emissions



IEA analysis shows that global CO_2 emissions remained flat in 2016 for a third consecutive year, although the global economy grew; changes to the fuel mix and energy efficiency played key roles

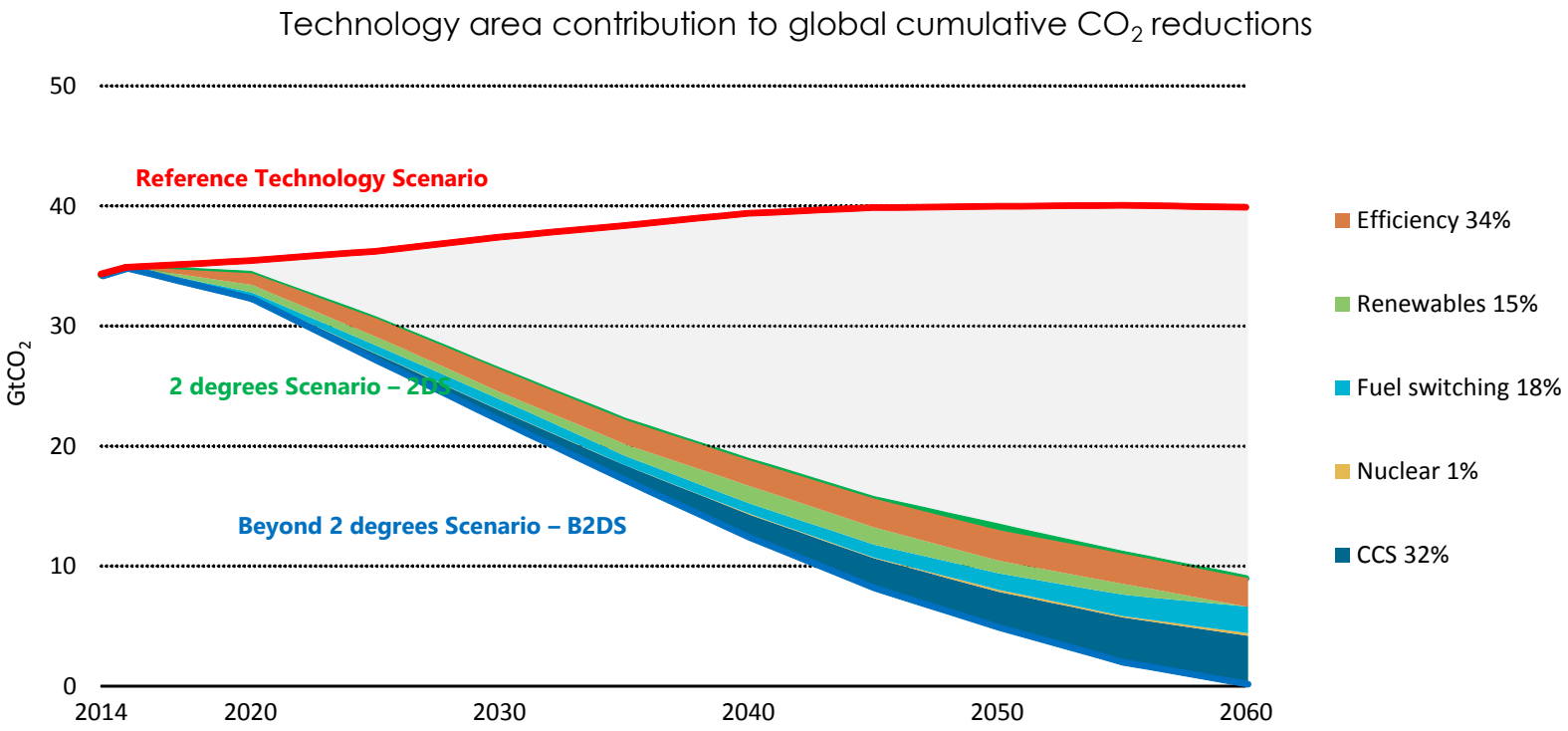
Energy efficiency improvements are keeping emissions down

Factors influencing greenhouse gas emissions, 2014-16



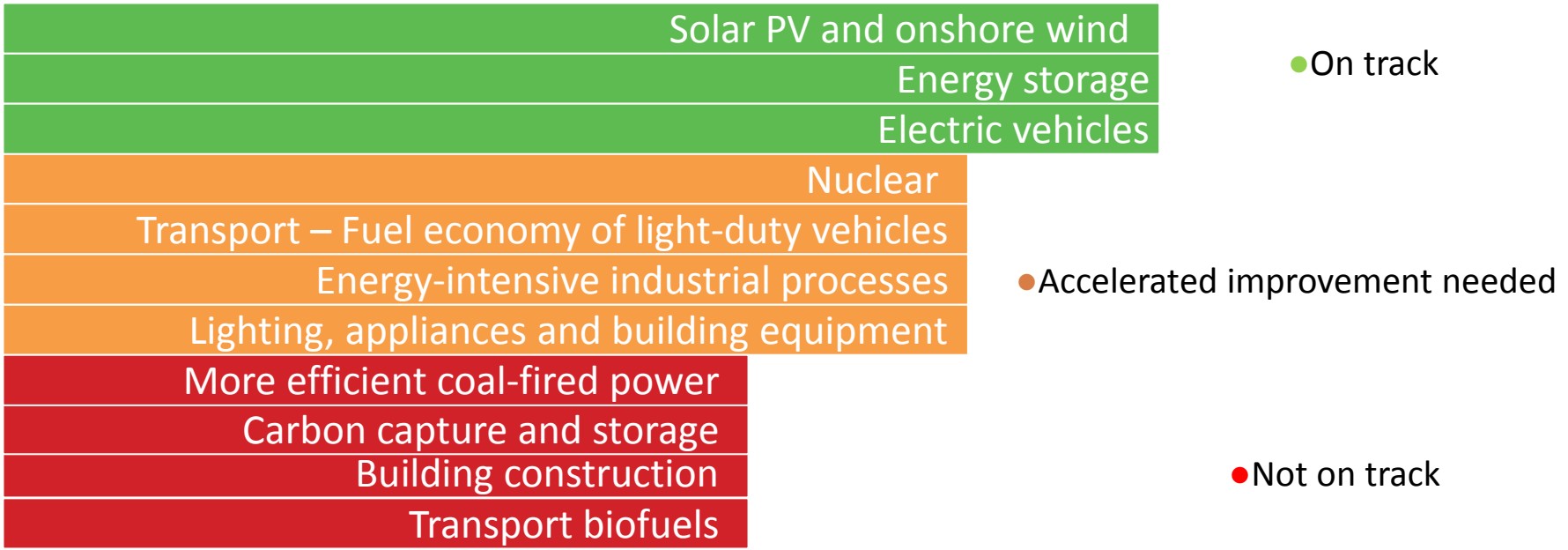
The combination of energy efficiency improvement and the move towards renewables and cleaner fuels has been key to avoiding 2 billion tonnes of additional greenhouse gas emissions

Climate goals require early emissions peak and technology innovation



CO_2 emissions would need to fall to 1960 levels by 2050, with an economy that is over 20 times larger

The potential of clean energy technology remains under-utilised



Recent progress in some clean energy areas is promising, but many technologies still need a strong push to achieve their full potential and deliver a sustainable energy future.

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"

G7 Kitakyushu Energy Ministerial Meeting

G7 2017 ITALIA

A new cycle of Roadmaps for a stronger bridge to implementation

- Long-term vision (2060), near term action (2020 / 2030)
- Regional relevance and partnerships for implementation (TCPs, MI, CEM,…)
- 2DS and beyond…
- Metrics and Tracking

UPDATES (2017 -2018)	NEW TITLES (2018-2019)
- **Smart Energy Systems**	- **Iron and Steel**
- **Bioenergy**	- Cooling and refrigeration
- **Cement** (Q1 2018)	- How2Guide for Solar Energy

How do we get there?

CONTEXT AND ANALYSIS

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

IMPLEMENTABLE PATHWAY

- 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

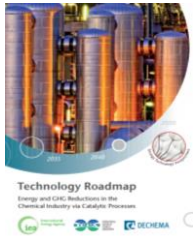
PRIORITISING ACTION

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

STAKEHOLDERS' ENGAGEMENT

Industry-related IEA Technology Roadmaps

GLOBAL CHEMICALS

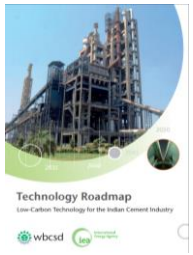


GLOBAL CEMENT UPDATE

GLOBAL IRON & STEEL

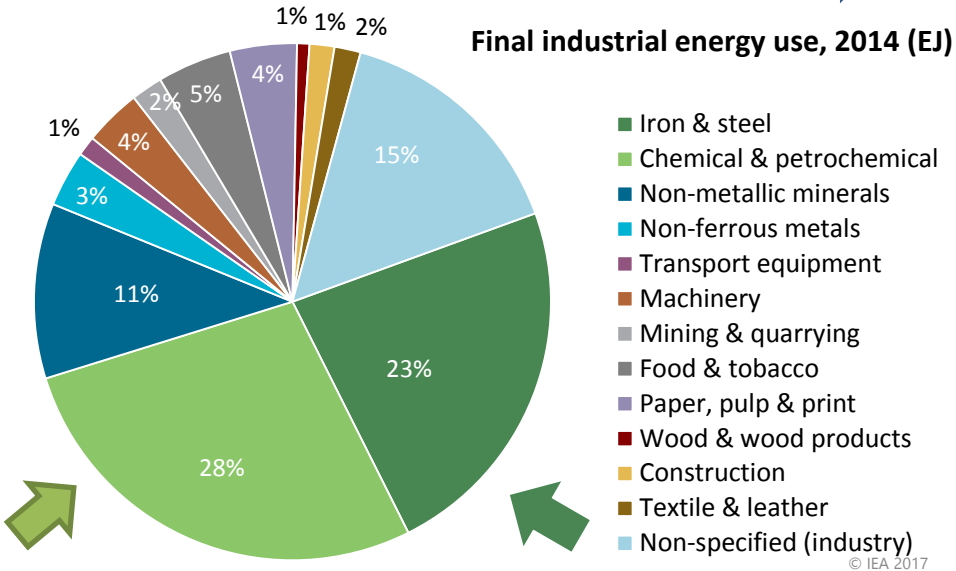
2009 — 2013 — 2018 — 2019

GLOBAL CEMENT



REGIONAL CEMENT

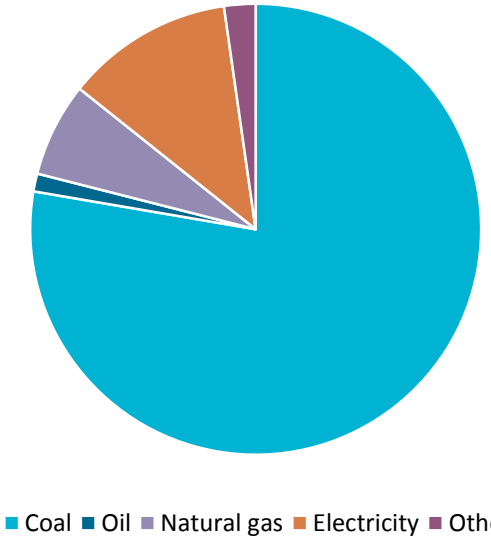
Final industrial energy use, 2014 (EJ)



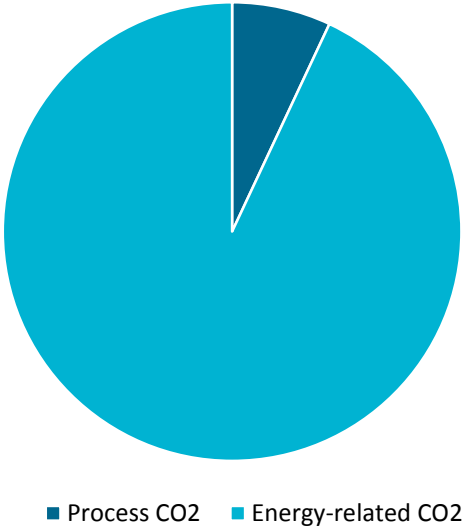
Iron and steel sector opportunities and challenges

Global iron and steel sector indicators, 2014

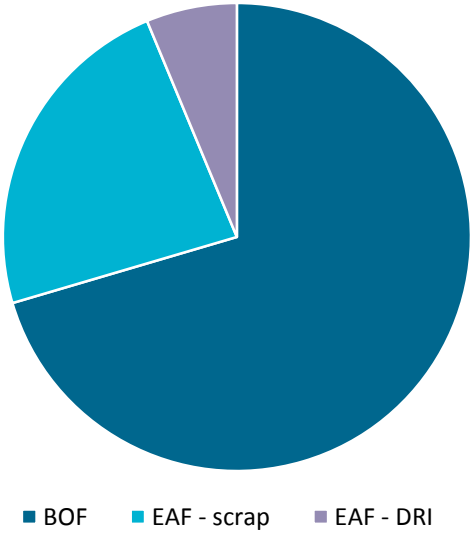
Final energy use
(2nd industrial energy user)
(1st industrial coal use)



Direct CO_2 emissions
(1st industrial CO_2 emitter)



Liquid steel production by route

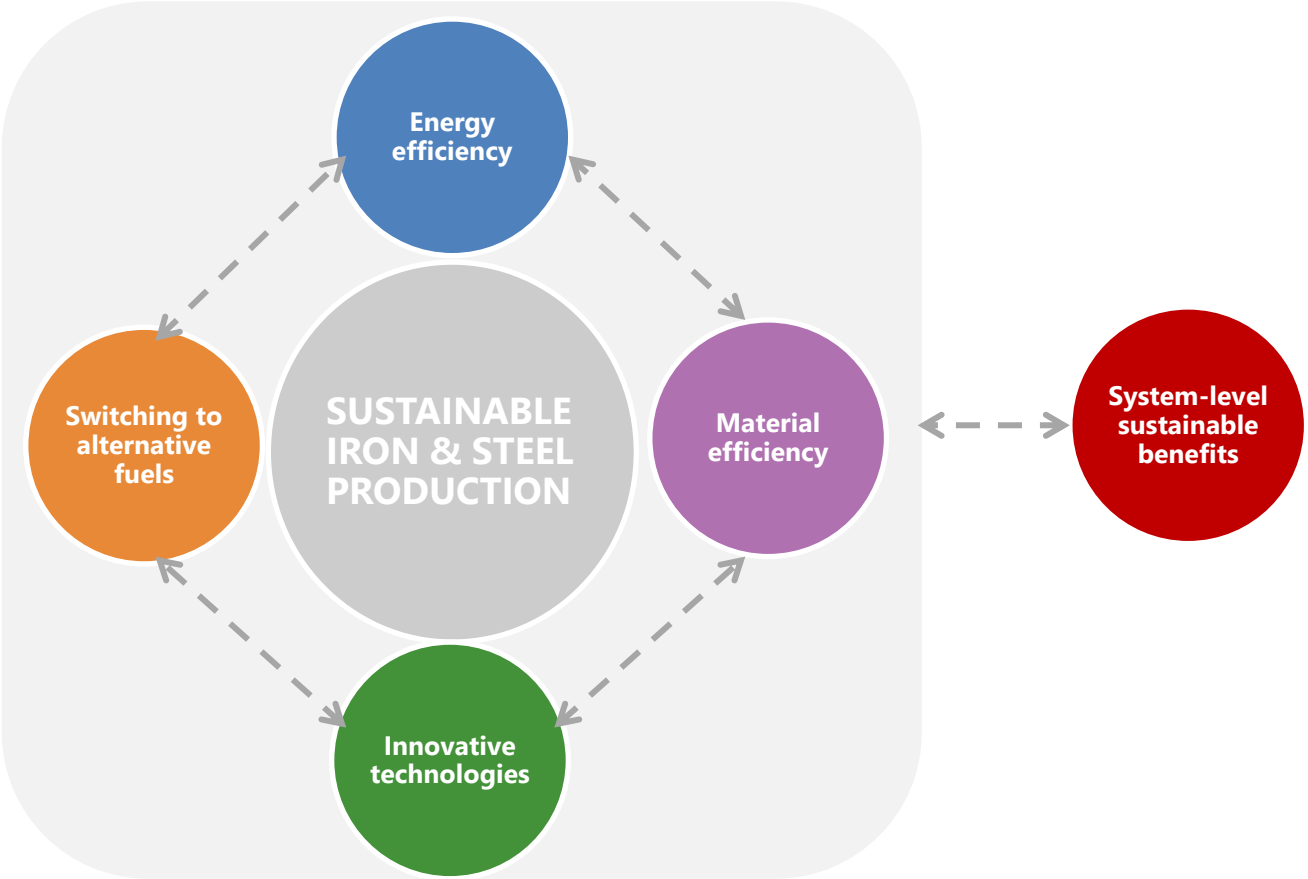


Note: blast furnaces and coke ovens are included

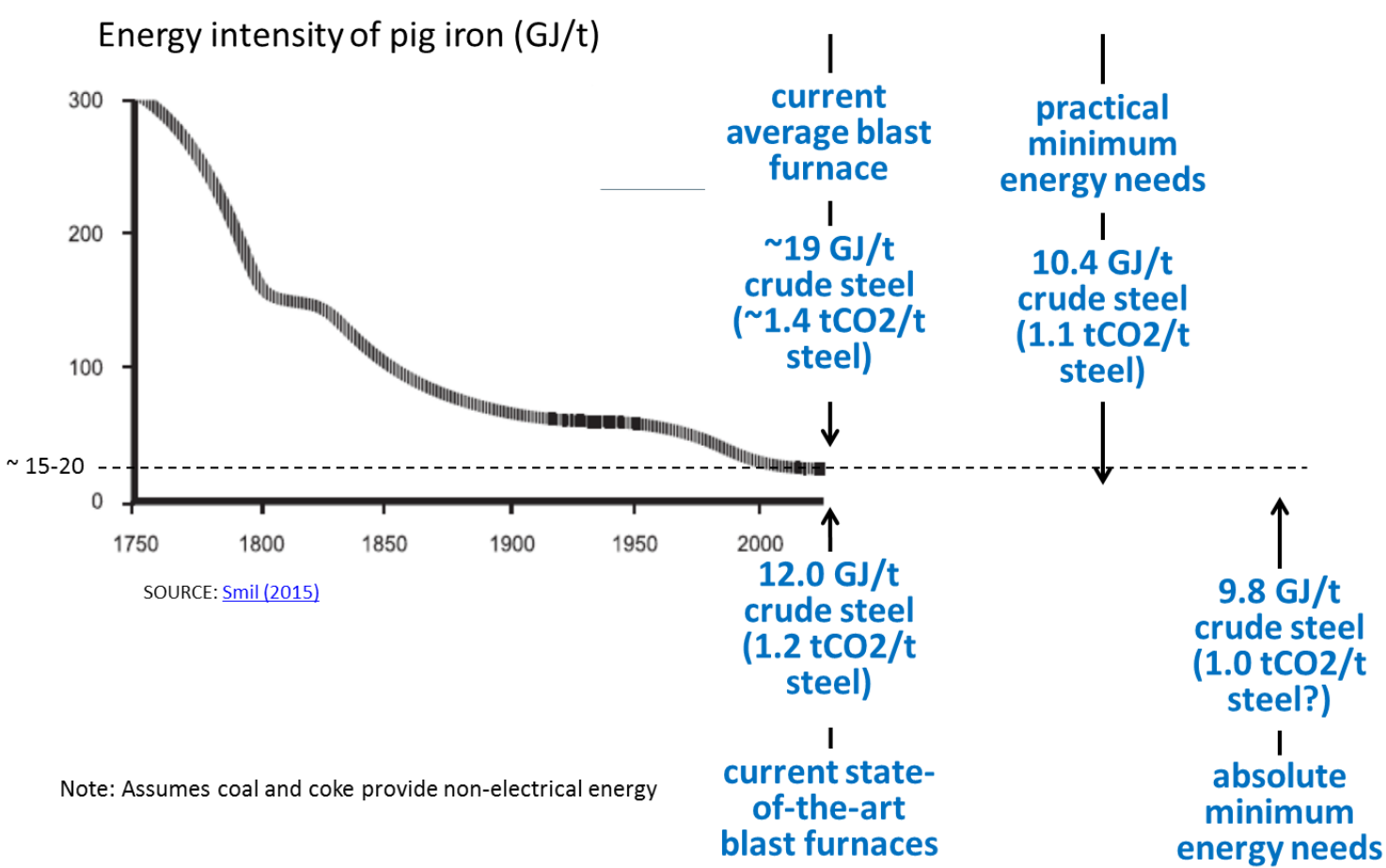
Enabling strategies of sustainable iron & steel production

SUSTAINABLE TRANSITION GOALS:

- ENVIRONMENTAL SUSTAINABILITY
- ENERGY SECURITY
- LEAST-COST TRANSITION PATHWAYS
- SYNERGIES BETWEEN IRON & STEEL PRODUCTION AND OTHER SECTORS



Diminishing returns from energy efficiency improvements



SOURCE: Smil (2015)

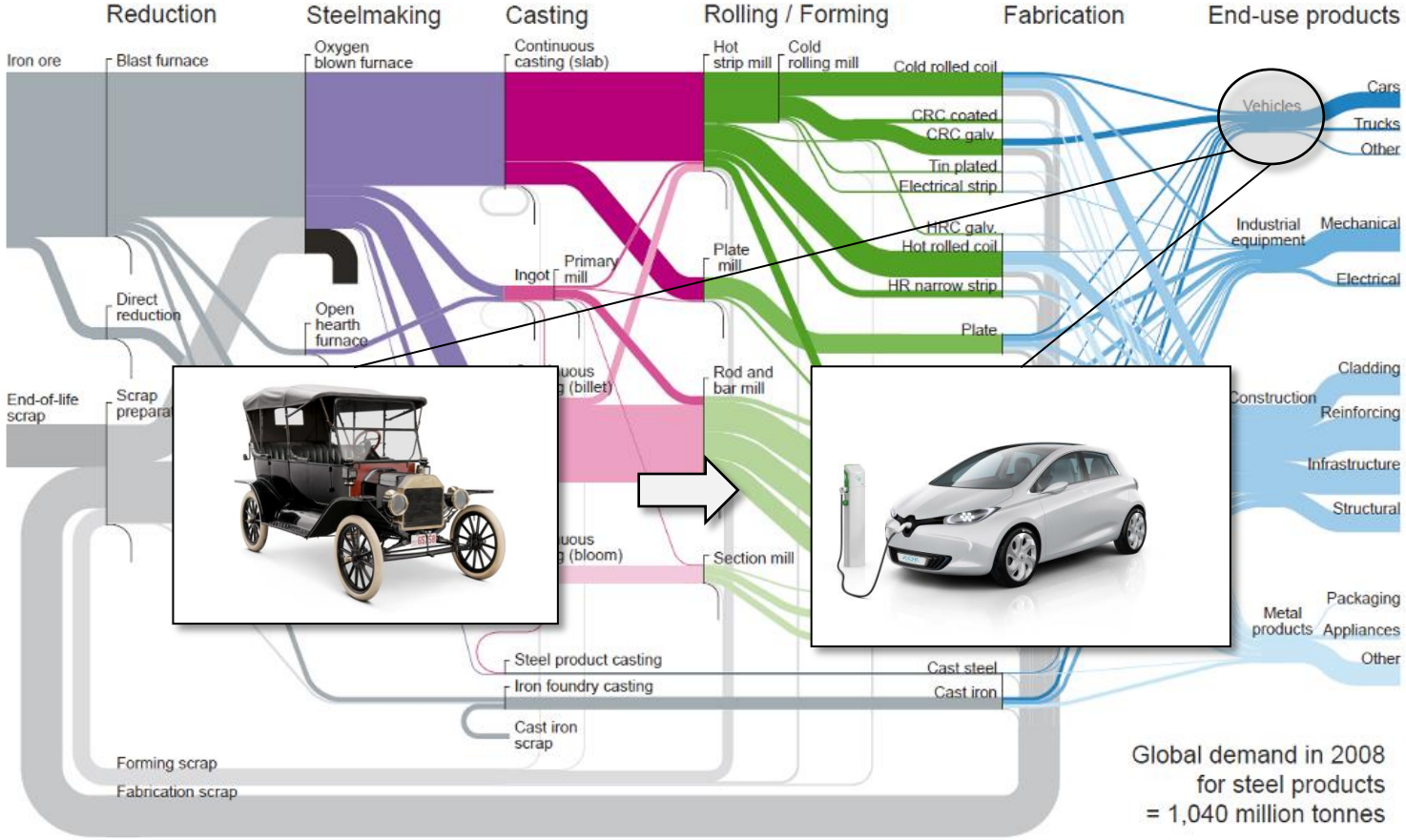
Note: Assumes coal and coke provide non-electrical energy

Exploring alternative low-carbon steel technologies

Innovative 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 enhanced CO_2 capture. [Paper studies]
- **Hydrogen from renewable-electricity for DRI production** [Pre-feasibility]
- **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.
- **Direct use of electricity to reduce iron ore** relying on renewable electricity. [intermediate TRLs]

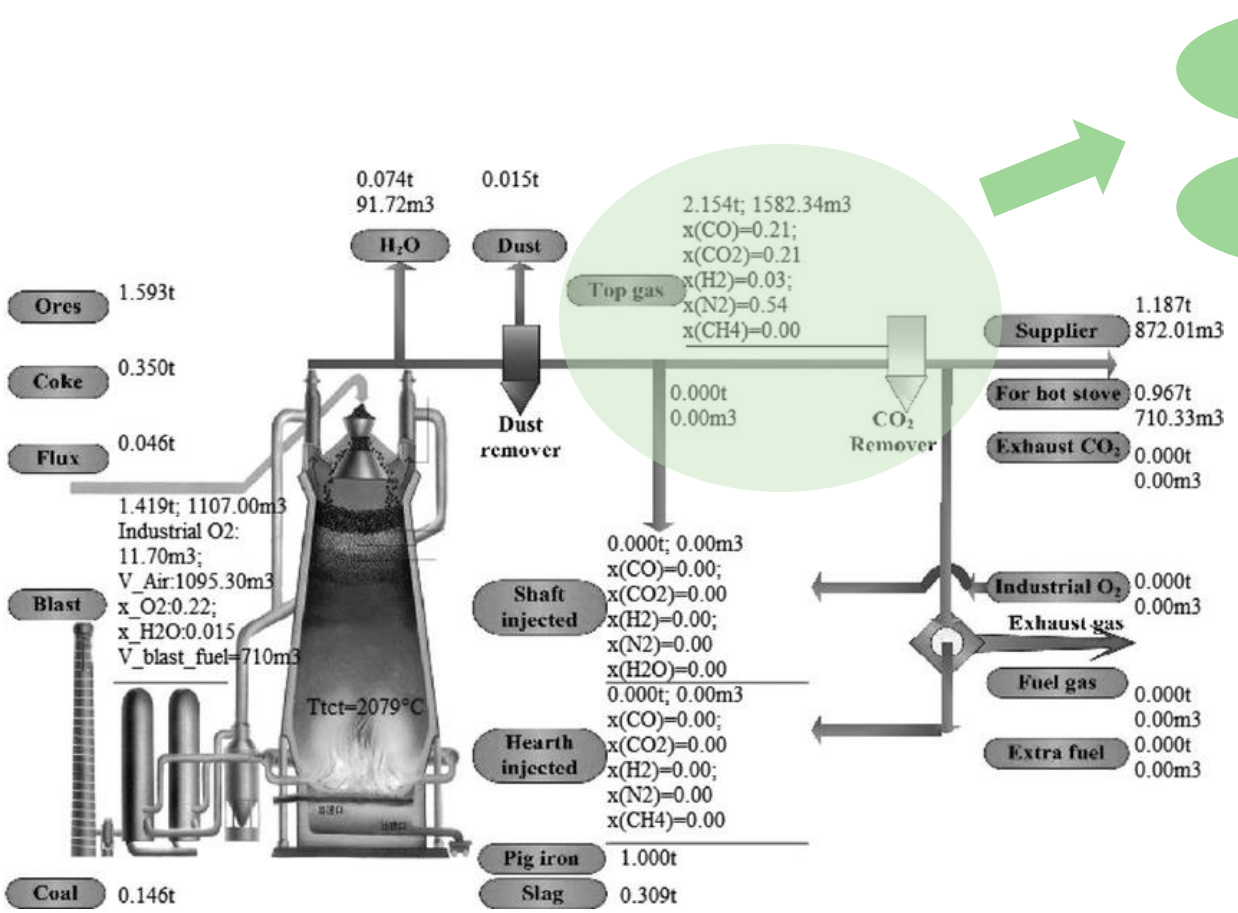
Understanding current and future supply value chains is critical



Material efficiency

Source: Sustainable Materials – Both eyes open web pres., p.7

Exploring further sustainable opportunities beyond the iron and steel sector



CHEMICALS

FUELS

System-level sustainable benefits

PROJECT FEATURES AND ENCOMPASSING ACTIVITIES

- Global coverage but building on regional specific analysis
- Strong engagement with international stakeholders and research institutions
- Expected launch Q2 2019

Encompassing activities

- Regional workshops:
  - Firming plans for an Asia-based experts' workshop – Q2 2018
  - Further regional workshops subject to available funds
- Series of topical experts' meetings: (web access)
  - Materials demand trends in transportation and construction – late Feb/early March 2018
  - Low-carbon alternative iron & steel making technologies: techno-economic characterisation and further development/demonstration priorities
  - Enabling regulatory and financial mechanisms in the sustainable iron & steel transition

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