The Future of Global Steel Production
An Energy and Climate Modelling Exercise using ETSAP-TIAM and SAAM

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Steel production increasing globally
Global major energy users in the steel sector

![Bar chart showing energy use by country and source.](chart.png)
Challenges for the European Iron and Steel Sector

- Ensuring **competitiveness** in a context of stringent climate change mitigation requirements.
- **Carbon leakage** is a concern of European producers
- Understanding steel **demand patterns** + increasing use of **scrap** as feedstock
- Use of **excess heat** for energy production / district heating
- Use of **by-products** in other industries (e.g. slag can be used in ceramic industries)
- According to A. Mordashov (Severstal) three biggest global challenges are 1. China slowdown and chronic **overcapacity**. 2. **saturation of demand** in developed countries. 3. **cost** inflation (source: world steel association twitter #steeldebate, 18th January)
Need for new technologies and new thinking...

An integrated approach – cost-optimizing energy production and steel production simultaneously.

- Extension of steel production technology detail inside ETSAP-TIAM.

ETSAP-TIAM highlights technology development at a global scale based on cost-optimization modelling of technology options up until 2100.
Need for new technologies and new thinking…

An unbound availability of scrap would result in a global shift towards electric arc furnaces based on scrap as feedstock.

-> Development of Scrap Availability Assessment Model (SAAM).

SAAM estimates scrap availability at each point in time, taking into account the different residence time of steel in different societal sectors and for various products.
Need for an integrated approach
Theoretical need for virgin materials in the 2050...
...and in 2100!

![Graph showing primary production requirement vs. long-term demand growth (2150)]
In-use stock per capita for industrialization...

Cumulative in-use stock [tonnes per capita]

- Demand stagnation in 2100
- Stock stagnation in 2150

2000 2050 2100 2150
In-use stock per capita for industrialization...

Demand stagnation in 2050

Stock stagnation in 2100
Reaching the limits of the iron resource...

- **Resource**
  - **Reserve**: 80 Gt
  - **Resource**: 230 Gt

- **In-use**: 18 Gt
Reaching the limits of the iron resource...

![Graph showing the cumulative in-use stock of iron over time, with labels for resource, reserve, and in-use stock. The graph predicts demand stagnation in 2100.](image-url)
Reaching the limits of iron available as a resource...

Total cumulative in-use stock [billion tonnes]

- Resource
- Reserve
- In-use stock

Demand stagnation in 2050
ETSAP-TIAM output:
Future technology choices for steel primary production

*Demand stagnation in 2100*

*Demand stagnation in 2050*

Climate ambition: Radiative forcing 3.5 W/m² and no availability of CCS
ETSAP-TIAM output:
Scrap use and total steel production

Demand stagnation in 2100

Demand stagnation in 2050

Scrap Use and Crude Steel Production [billion tonnes]

Scrap Use - Basic oxygen  Scrap Use - Electric Arc  Total Crude Steel Production

Climate ambition: Radiative forcing 3.5 W/m² and no availability of CCS
ETSAP-TIAM output:
Cost break-down per tonne
Western Europe, 2060, Demand stagnation in 2050

Climate ambition: Radiative forcing 3.5 W/m² and no availability of CCS
Conclusions

• 90% recycling of scrap is theoretically possible – resulting in low energy demand and CO₂ emissions from steel production.

• Due to late demand growth stagnation (both scenarios), scrap availability is not enough – at global level, recycling is limited to 50% in 2050 under the assumed growth.

• Steel production from scrap is competitive in all scenarios.

• **Need for cleaner primary production routes, and working towards reducing steel demand.**
Conclusions

• Technology choices show that energy efficiency increments in current processes will not be enough.

• Hence, innovative approaches such as new processes, use of low-CO₂ reduction agents and/or carbon capture and storage (CCS) are needed.
Conclusions

- Climate change mitigation policies would make such technologies competitive.

- **CCS** is the technology of choice, combined with blast furnace extended with top gas recycling.

- **Hydrogen based direct reduction** of iron ore would be competitive in all climate policy scenarios, but only a major contributor if CCS is made unavailable.
Thank you!

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