



Industrial electrification and the electricity system – sector coupling and flexibility

Alla Toktarova

Chalmers tekniska högskola



Energy-intensive industries decarbonization

Industry is a major emitter of CO₂

20% of carbon emissions in the EU

“Fit for 55” package

climate neutrality

Deep CO₂ emissions reduction

- Electrification
- CCS
- Biomass

European industry is at a crossroads

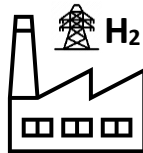
Before 2035, existing industrial facilities will reach the end of lifetimes

Decline in the cost of renewable energy technologies



Implications of electrification

Cement +120 TWh
Plastics +240 - 400 TWh
Steel +200 TWh



+36 - 46 %

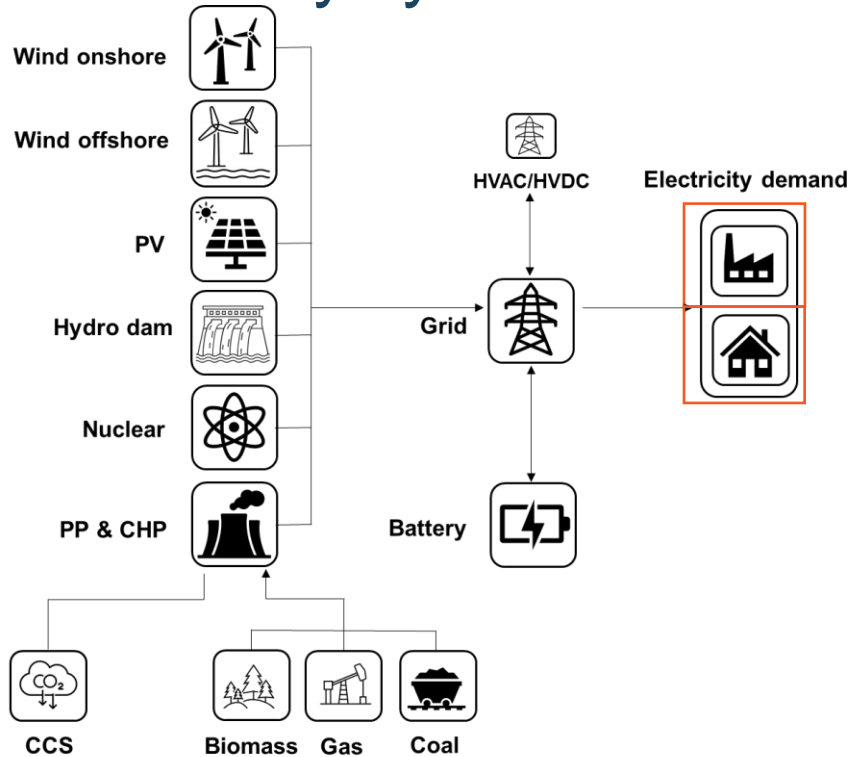


Electricity demand in Northern Europe in 2021 – 1570 TWh



CHALMERS

Electricity system model



Cost-minimized electricity supply and commodities (steel, cement, plastics etc.) production

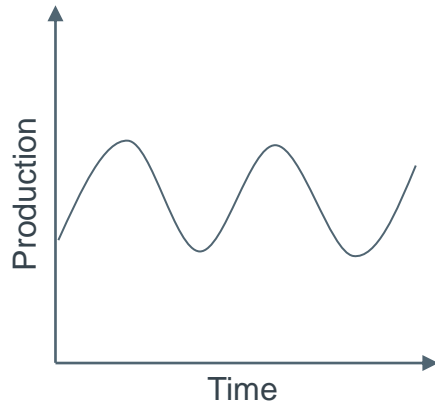
Net-zero CO₂ emissions

Green-field model

The **transmission network and hydro** power

Flexibility options

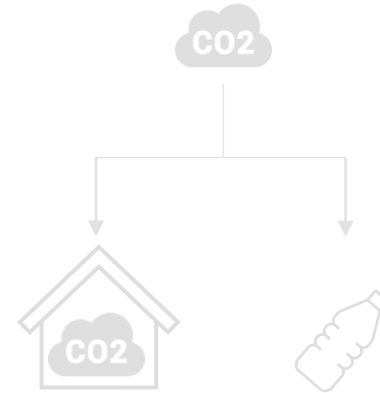
Flexibility in time



Flexibility in location

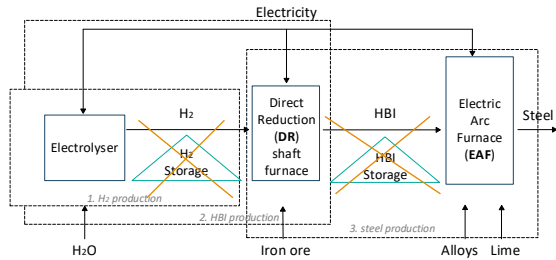


Flexibility in CO₂ utilization

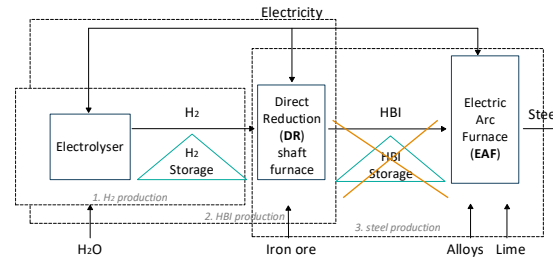


Flexible operation of the industrial consumers – steel production

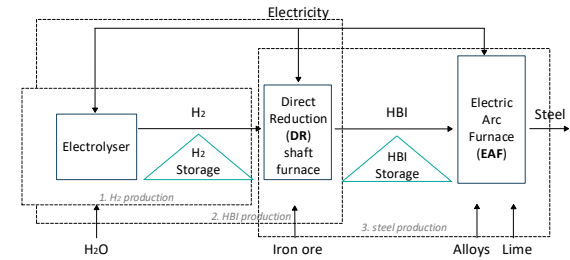
Inflexible



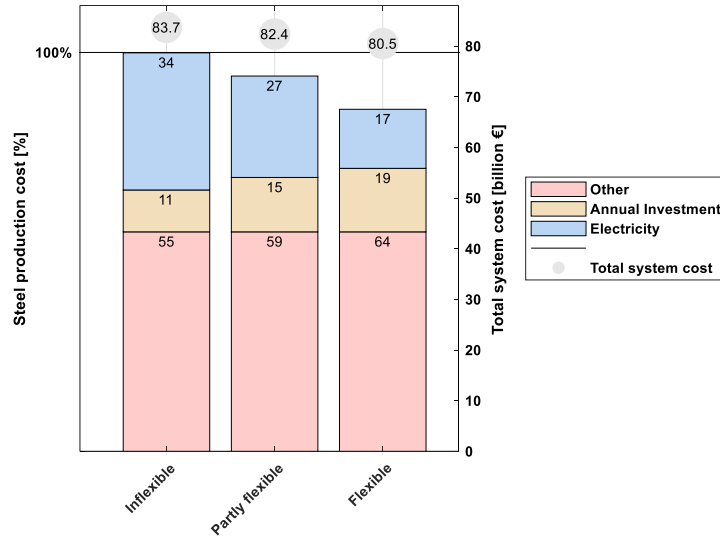
Partly flexible



Flexible



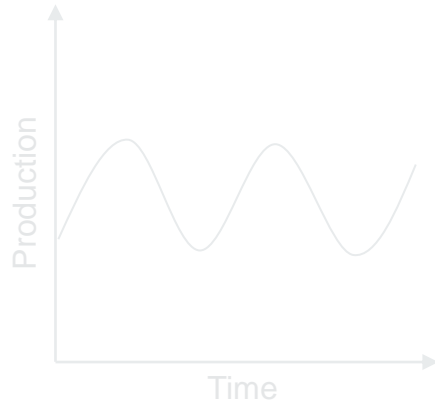
Results: Steel production cost



	Partly flexible	Flexible
Steel production cost	↓ 6%	14%
Investment cost	↑ 30%	48%
Total system cost	↓ 2%	4%

Flexibility options

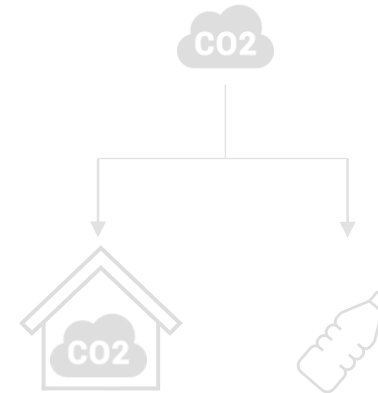
Flexibility in time



Flexibility in location



Flexibility in CO₂ utilization



Results: Steel plants allocation



Current location of the steel production

Locational determinants:

Proximity to raw material

Proximity to market

Transportation cost



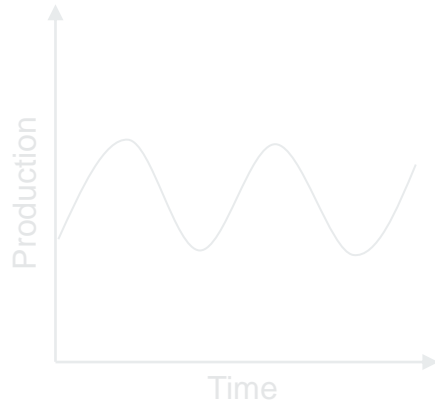
Future possible location of the steel production

Locational determinant:

Availability of low-cost electricity generation

Flexibility options

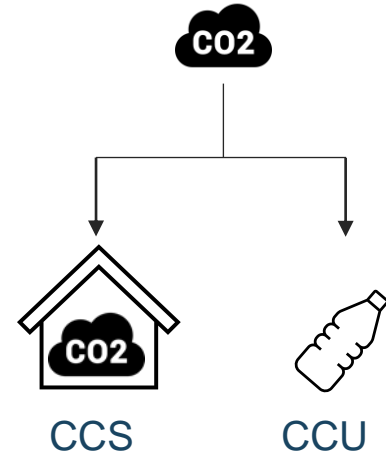
Flexibility in time



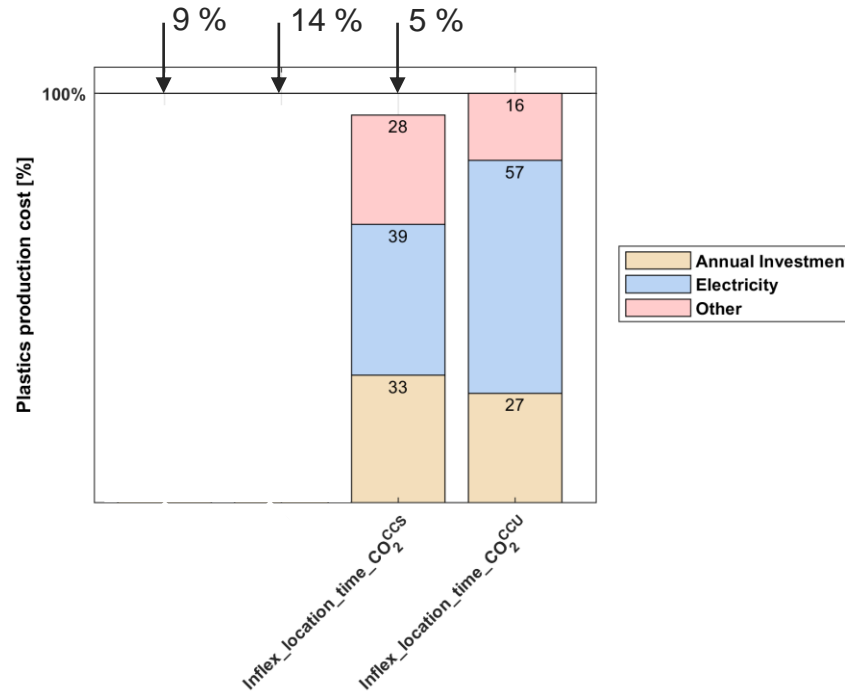
Flexibility in location



Flexibility in CO₂ utilization



Results: Plastic production cost





Opportunities

- Emissions reductions
- Develop new 'green' markets
- Inter-firm collaboration

Challenges

- Security of supply in the electricity grid
- Upscaling of hydrogen production, distribution, and storage infrastructure
- Organizational changes across whole material value chains
- New climate and industrial policies



CHALMERS

Industry: Steel production



Other press releases

HYBRIT: SSAB, LKAB and Vattenfall to start up the world's first pilot plant for fossil-free steel

AUGUST 31, 2020 13:30 CET

7 MIN READ

Today, SSAB, LKAB and Vattenfall are taking a decisive step toward fossil-free steelmaking with the start-up of HYBRIT's globally unique pilot plant for the production of fossil-free sponge iron. Swedish Prime Minister Stefan Löfven started up the plant together with Isabella Lövin, Minister for Environment and Climate and Deputy Prime Minister, Martin Lindqvist, President and CEO of SSAB, Jan Moström, President and CEO of LKAB and Magnus Hall, President and CEO of Vattenfall. SSAB, LKAB and Vattenfall aim to create a complete value chain for fossil-free steel.



Other press releases

SSAB to be first to market with fossil-free steel

NOVEMBER 14, 2019 11:00 CET

5 MIN READ

Global steel company SSAB plans to be the first company in the world to get fossil-free steel onto the market. The plan for transitioning to iron-ore based fossil-free steel production was presented to more than 400 customers and key players in the industry, in conjunction with SSAB's Swedish Steel Prize seminars this week in Stockholm.



Other news

SSAB to deliver fossil-free steel to Volvo Trucks

MAY 24, 2022 8:10 CET

3 MIN READ

Volvo Trucks will, as the world's first truck manufacturer, introduce SSAB fossil-free steel in its trucks. Small scale introduction of the steel in Volvo's heavy electric trucks will start already in the third quarter of 2022.



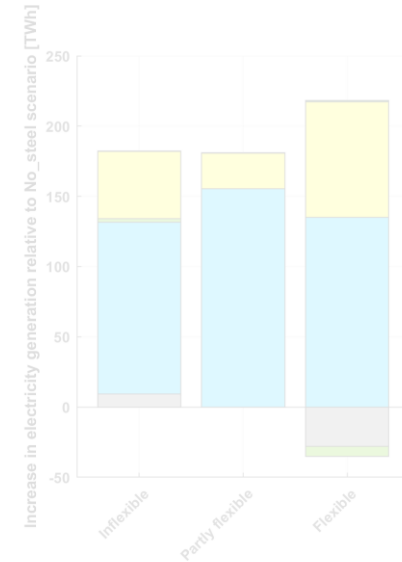
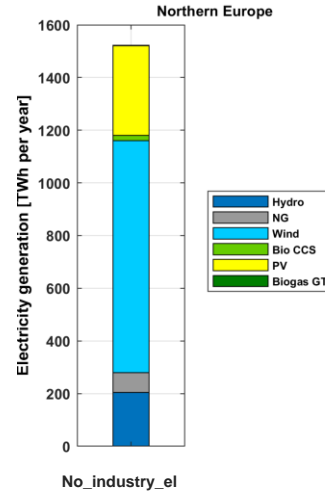
Results:

Electricity system composition – electrified steel industry

Cement +120 TWh
 Plastics +240 - 400 TWh
 Steel +200 TWh



+36 - 46 %



Electricity demand in Northern Europe in net-zero emissions Year – 1570 TWh

Results: Electricity trade

