



# Industrial flexibility is part of the solution

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# Agenda

1. Background
2. Industrial flexibility options
3. Results
4. Key messages



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# Basic materials industries electrification

## **The production of steel, ammonia, cement and plastics**

70% of the EU industrial CO<sub>2</sub> emissions

## **Inflation Reduction Act, REPowerEU plan and Net Zero Industry Act**

## **Decline in the cost of renewable energy technologies**

Direct and indirect (via H<sub>2</sub>) electrification is attractive option to decarbonize industry

## **Flexibility from the industry is likely to play an important role**

# Agenda



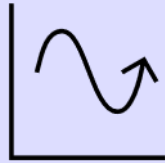
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# Flexibility



# Flexibility options

Flexibility in  
time



Flexibility in  
CO<sub>2</sub> utilisation



Flexibility in  
location

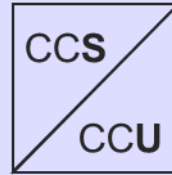


# Flexibility options

Flexibility in  
time



Flexibility in  
**CO<sub>2</sub> utilisation**



Flexibility in  
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# Flexibility options

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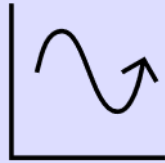
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# Flexibility options

Flexibility in  
**time**



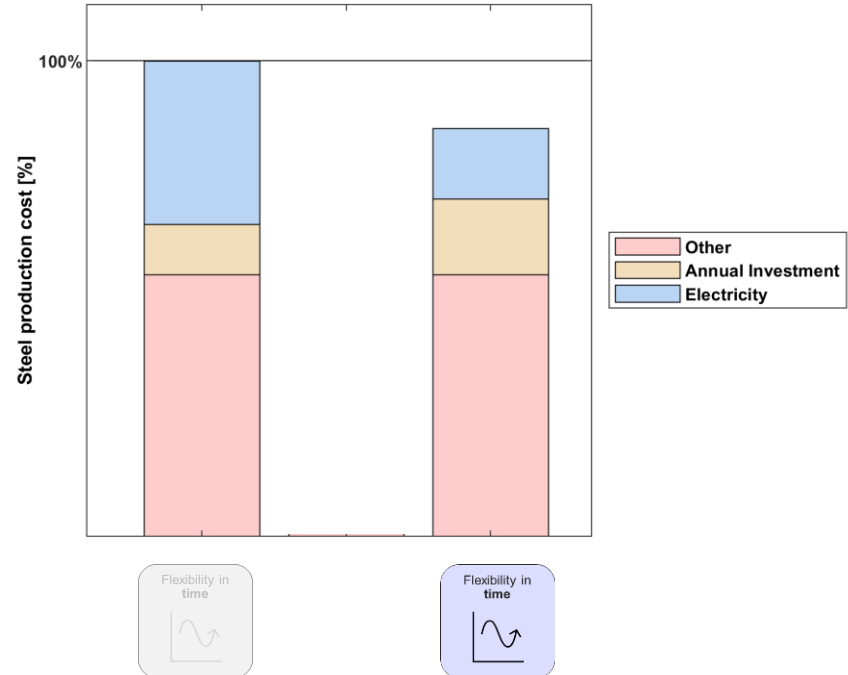
Flexibility in  
**CO<sub>2</sub> utilisation**



Flexibility in  
**location**

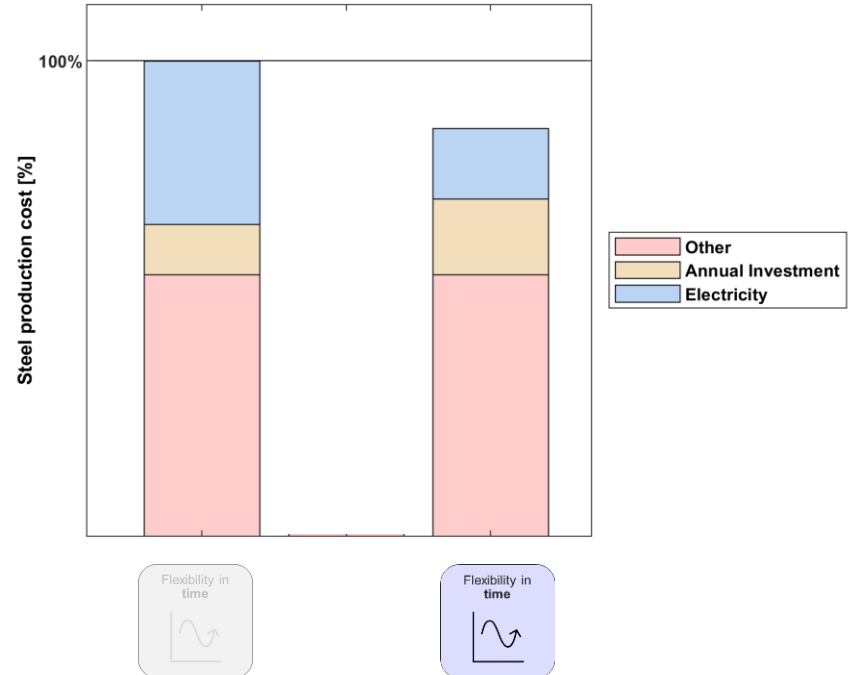


# Results: Steel production cost



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It is cost-efficient  
to invest in  
overcapacity of  
the industrial units  
and in storage to  
follow the  
variations in  
electricity price

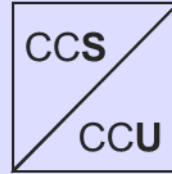


# Flexibility options

Flexibility in  
time



Flexibility in  
**CO<sub>2</sub> utilisation**

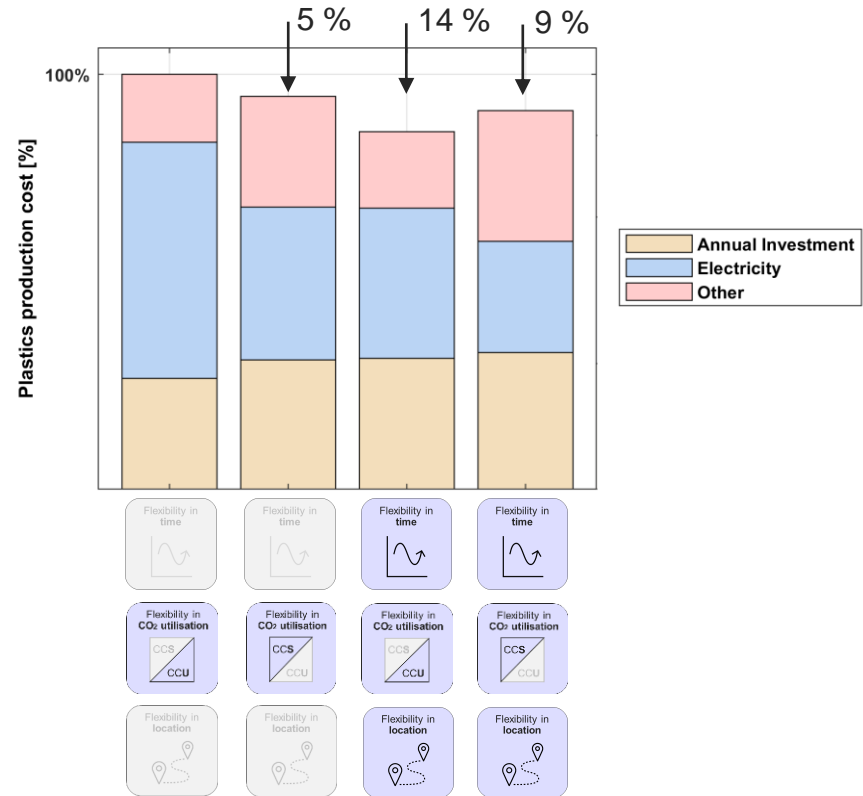


Flexibility in  
location



# Results: Plastic production cost

Without industrial flexibility options, results indicate that CCS is more cost-effective than CCU even though this requires more waste input. However, with flexibility in time and location, CCU becomes the cheaper option



# Flexibility options

Flexibility in  
time



Flexibility in  
CO<sub>2</sub> utilisation



Flexibility in  
location





# Results: Ammonia plants location



Present – day location of the ammonia production

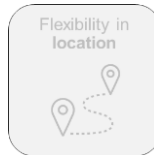
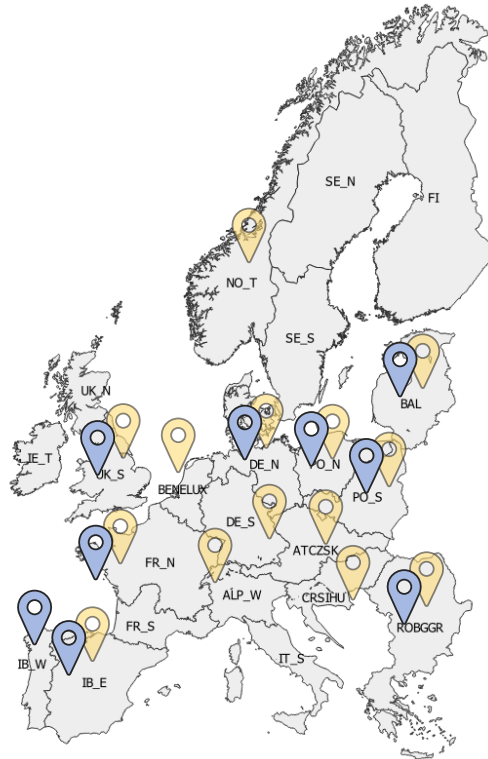
*Locational determinants:*

Proximity to raw material

Proximity to market

Transportation cost

# Results: Ammonia plants location



Present – day location of the ammonia production

*Locational determinants:*

Proximity to raw material

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Future possible location of the ammonia production

# Results:

## Ammonia plants location

The availability of  
low-cost  
electricity can  
affect  
geographical  
location of  
industry



Present – day location of the ammonia production

*Locational determinants:*

- Proximity to raw material
- Proximity to market
- Transportation cost



Future possible location of the ammonia production

*Locational determinant:*

- Availability of low-cost electricity generation

# The renewables pull effect

Relocation of some industrial production as a consequence of regional differences in the marginal cost of renewable energy sources

The energy-intensive production (HBI and ammonia) is going to be affected by renewable pull in the future

Skilled labor force, the availability of key input materials, demand-side preferences and transport infrastructure remain relevant

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# Key messages

## *Industrial flexibility options:*

- The lowest cost for basic materials production;
- The highest rate of carbon recovery from the feedstock;
- The lowest capacity utilisation rate, i.e., overcapacity.

# Key messages

*Historical determinants:*

- Proximity to raw material
- Proximity to market
- Transportation cost

*New determinant:*

- Availability of low-cost electricity generation

# Future work

The electrification of industry – how fast and how far?

Centralized and decentralized electrolysis-based hydrogen supply systems for industry sector

Electrofuels demand and supply and its impact on the electricity system





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