Wuppertal Institute
for Climate, Environment
and Energy

Reindustrialisation and low carbon economy– can they go together?

Results from transdisciplinary scenarios for energy intensive industries

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panel 4: „energy intensive industries II“

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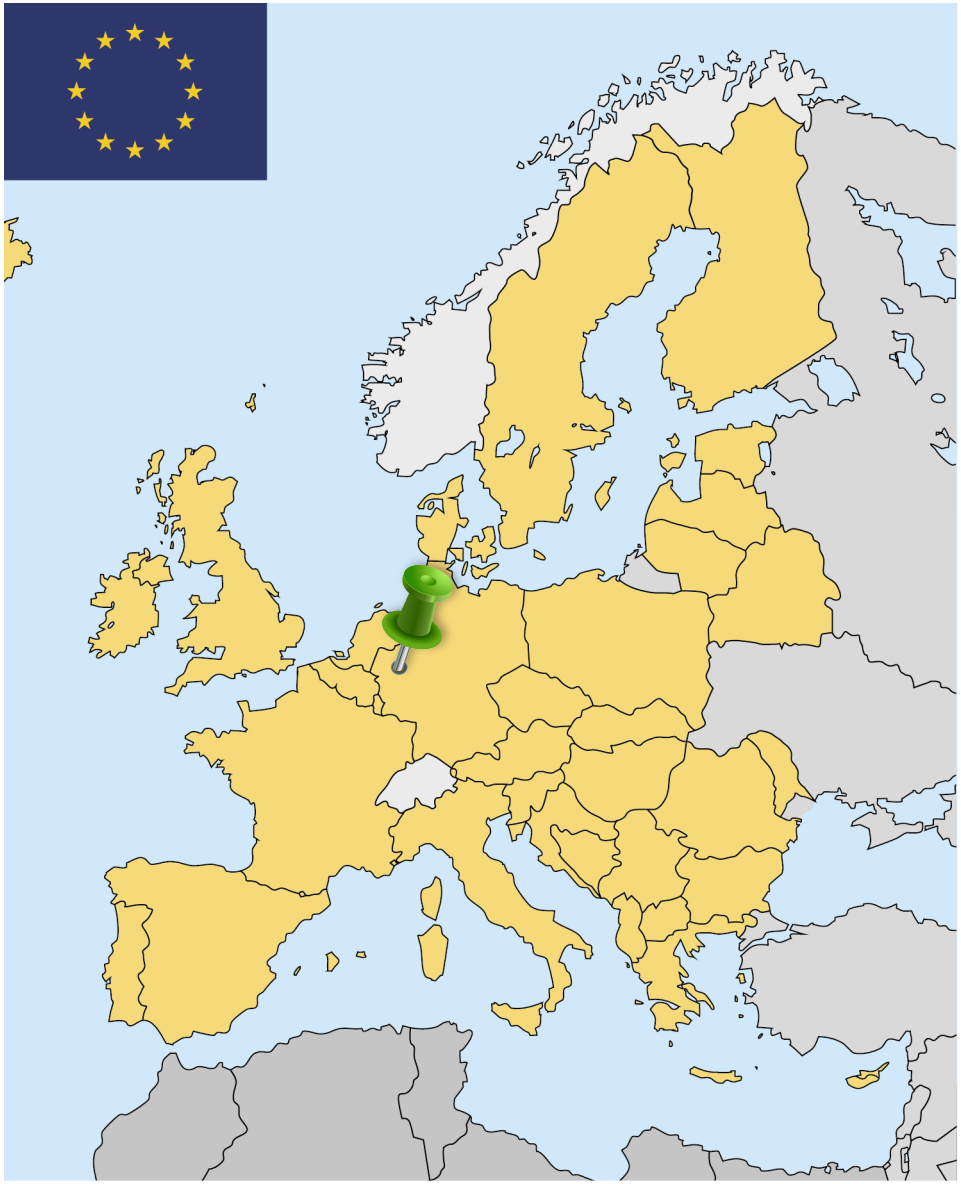
The German state North Rhine-Westphalia (NRW)

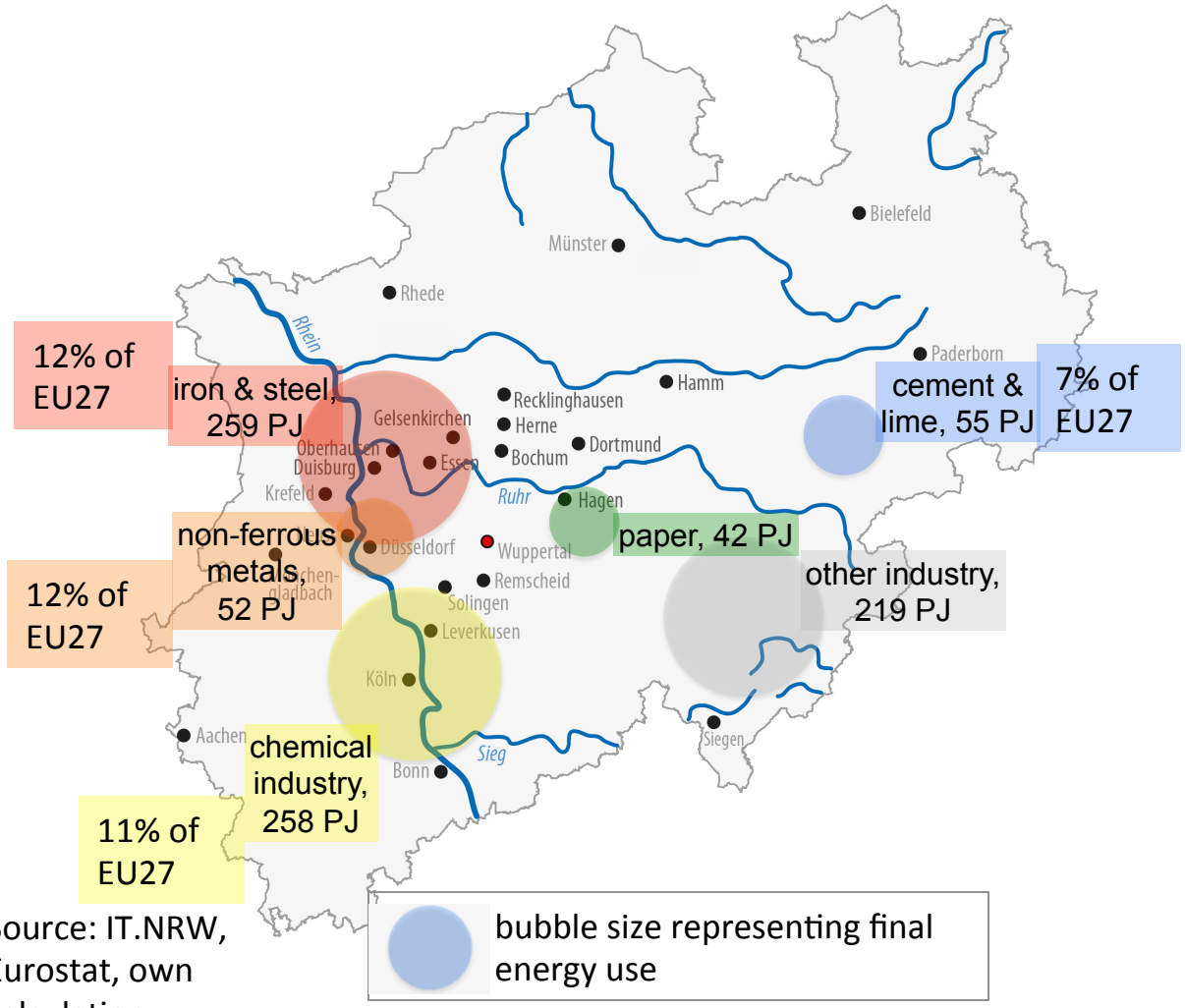
Industrial heart of Germany

- German federal state with a population of 18 Mill. (4% of EU, 22% of Germany)
- Share of industry in gross value added (GVA) is 27% (German average: 26% ,
  EU average: 20%)
- Share of NRW in EU28's industry GVA: 6% (2007)



NRW‘s industry today

Energy intensive industry’s prominent role within Europe



- NRW consists of urban areas (at the rivers Rhine and Ruhr with heavy industry clusters) and more rural areas
- NRW has significant shares in EU’s heavy industry energy use (esp. primary steel and aluminium production and base chemicals)

Source: IT.NRW, Eurostat, own calculation

NRW's climate protection policy

Regulatory framework and target

- **Climate protection act** of North Rhine-Westphalia
  - Greenhouse gas reduction in North Rhine-Westphalia:
    at least 25% by 2020
    at least 80% by 2050 (vs. 1990)
- The **climate protection plan** specifies the necessary steps to accomplish these goals. Central elements of the plan are
  - comprehensive participation of all social groups as wells as local authorities
  - identification of sectoral potentials of climate protection (industry is only one of six sectors) via scenario development
  - strategies and measures for the achievement of climate protection goals

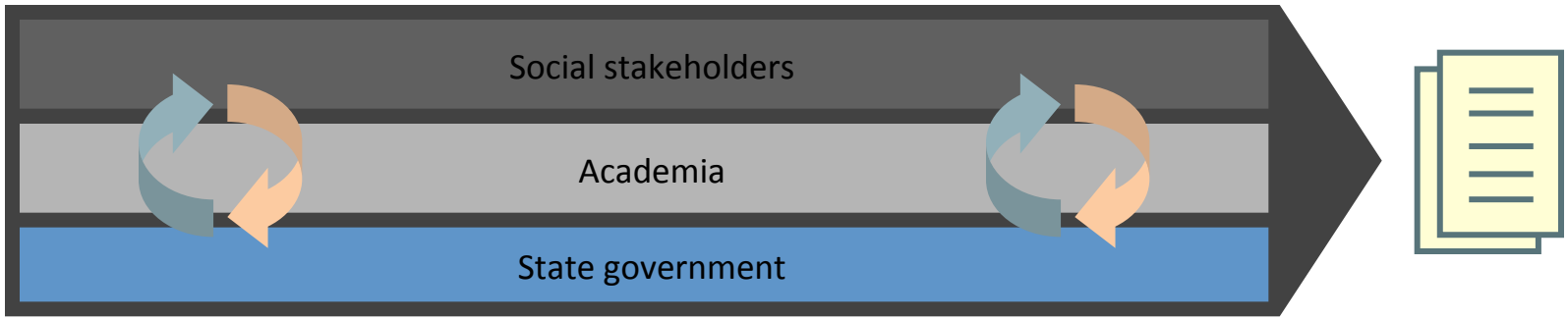
➢ Strong legal framework + wide participation process

➢ High level of transparency

Target of participatory discussion with heavy industry in NRW

- Development of scenarios (to be regarded in a GHG model)
  - Industrial growth and industry structure
  - Joint strategies and technology pathways (to be implemented in the model)

- Policies and measures (time horizon 2020)



Industry Working Group

Collaborative scenarios together with stakeholders

companies and associations

steel

- Stahlinstitut VDEh
- ThyssenKrupp Steel Europe

aluminium

- TRIMET Aluminium SE
- Rheinwerk Neuss (Norsk Hydro ASA)

chemicals

- Verband der Chemischen Industrie e.V. Nordrhein-Westfalen
- several companies (Bayer, Evonik, LANXESS)

cement

- Verein Deutscher Zementwerke e.V. / European Cement Research Academy GmbH

paper

- Gebr. Grünewald GmbH & Co. KG
- Stora Enso Germany GmbH

NGOs

environment & climate protection

- WWF Germany
- Naturschutzbund Deutschland
- Bund fuer Umwelt und Naturschutz Nordrhein-Westfalen

trade unions

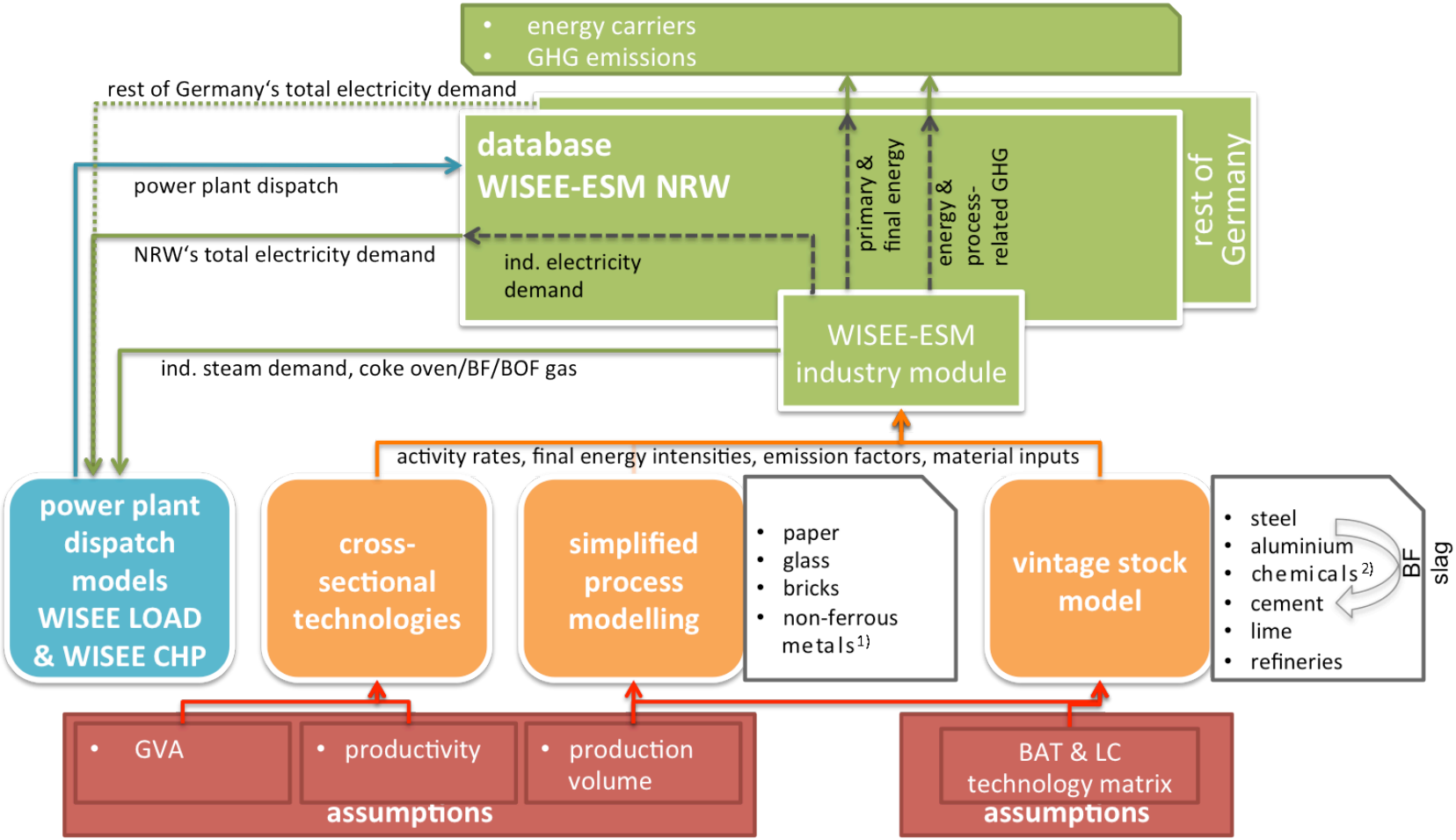
- DGB Nordrhein-Westfalen (umbrella organization of German trade unions)

churches

- Institut fuer Kirche und Gesellschaft der Evangelischen Kirche von Westfalen

The Model

Bottom-up integrated energy system simulation model: detailed representation of energy system technologies and low degree of endogenization



Source: Wuppertal Institute

Comparison of three industry scenarios

Framework for discussion

- Focus on **five basic industrial production** processes
- Focus on **one** Industry GVA growth of 1.2% p.a. (middle path)
- Diverse inner industry development over time with partly significant increase in physical production
  - *primary* steel: 0.7% p.a.
  - aluminium: 2.2% p.a. (with primary aluminium constant!)
  - olefine: -0.9% p.a.
  - cement (constant production)
  - paper (constant production)

Industry pathways to 2050 (1 & 2)

Two accepted pathways: BAT and Low Carbon Technologies

best available technologies pathway (BAT)

- based on best available technologies and improved „operational excellence taking into account usual re-investment cycles
- fuel shift from hard coal and lignite to natural gas or biomass
  - ➢ BAT pathway and the underlying assumptions have been accepted by all stakeholders within the process, especially by the involved industrial sectors

low carbon technology pathway (LC)

- Improvements in energy efficiency beyond BAT and slight shift to electricity-based
- Implementation of new breakthrough and low-carbon technologies for energy-intensive processes; backbone: hydrogen infrastructure NRW linked to excess renewable electricity.
  - ➢ The industry stakeholders within the working group approved most assumptions, although classified them as very ambitious.

Industry pathways to 2050 (3)

Industry-CCS not regarded in the process

carbon capture and storage pathway (CCS)

→ not regarded in the climate protection plan process but displayed in the following due to scientific interest

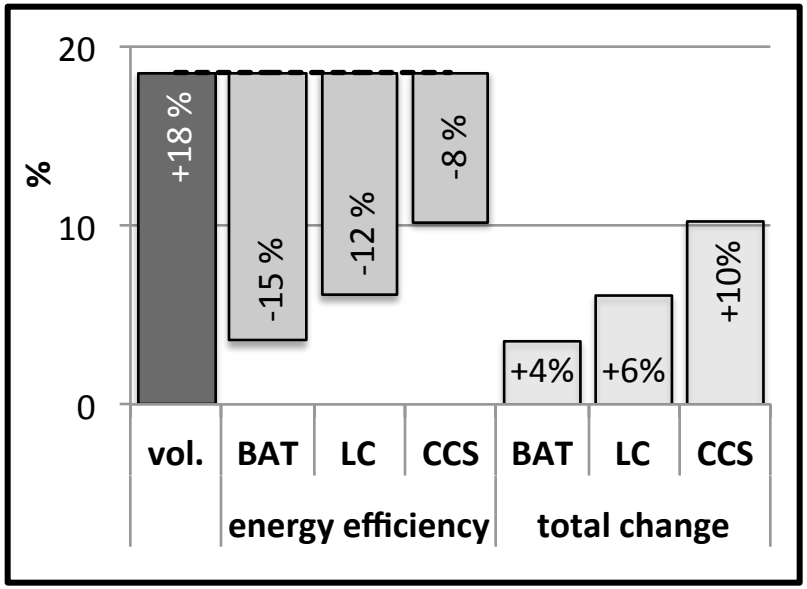
- keeps the assumptions taken for the LC path and adds the implementation of CO_2 capture and storage (CCS) in large industrial facilities.
- Applied in iron and steel making as well as in olefine production (steam crackers) and cement production.
  - **High costs** and the **lack of available storage facilities** in the region as well as the **perceived lack of acceptance** have been major criticisms for regarding the CCS pathway in the process.

The role of energy efficiency in the scenarios

Overall results for all five selected processes

Energy demand change in selected industrial production processes; % change in 2050 compared to energy demand level in 2010

- Total volume effects lead to a total increase of final energy demand (and CO_2 emissions).
- Increase in final energy demand will only partly be compensated by improved technology
  - In the LC scenario even higher increase in energy use than in BAT as energy efficiency gains in aluminium, ethylene, cement and paper production are overcompensated by less energy efficient steel making
  - CCS scenario achieves lowest improvements in energy efficiency.



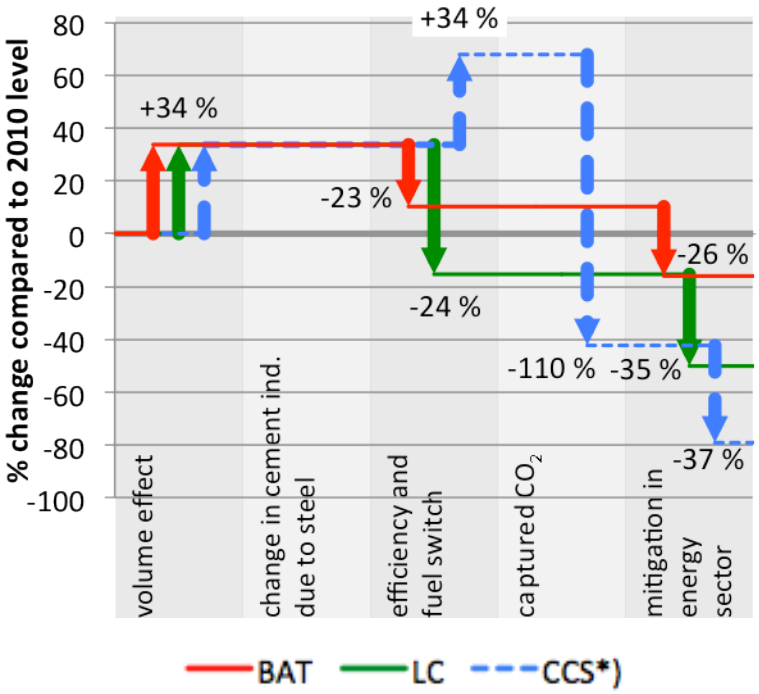
Source: own calculations

Decarbonization of the industry in the scenarios

Overall results for all five selected processes

CO_2 mitigation in all (five) selected industrial production processes; % change in 2050 compared to emission level in 2010

all selected processes



Source: own calculations

- Both LC and CCS scenario achieve higher CO_2 reductions than BAT:
  - LC scenario's reduction due to an increased use of renewable energies (hydrogen and electricity)
  - CCS scenario reaches a 79% reduction relying on fossil fuels and on the long term storage of captured CO_2.

Conclusions

- A policy of "**re-industrialization**" (basic industries) would come with significant pressure on energy demand.
- Analysis of BAT and further technology options makes clear that this trend cannot be fully compensated by more efficient technology, partly because **in very energy intensive productions possible improvements become increasingly incremental**.
- In order to significantly reduce greenhouse gas emissions from heavy industry the development and implementation of **new breakthrough technologies** such as electrification, hydrogen based processes, alternative cements or CCS becomes necessary.
- "**Low carbon technologies**", however, often are no longer linked to improved energy efficiency but are **often using more energy than conventional BAT** (most pronounced for CCS).
- Thus low carbon technologies for heavy industry have to **rely on the supply of sustainable renewable energy** via electricity or hydrogen, or on the long-term storage of CO_2.
- Decarbonising basic industries is a huge **challenge and a chance** for the EU's energy intensive industries to maintain their already pronounced profile of high tech and high value added producers as compared to global production.

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Thank you for your attention !

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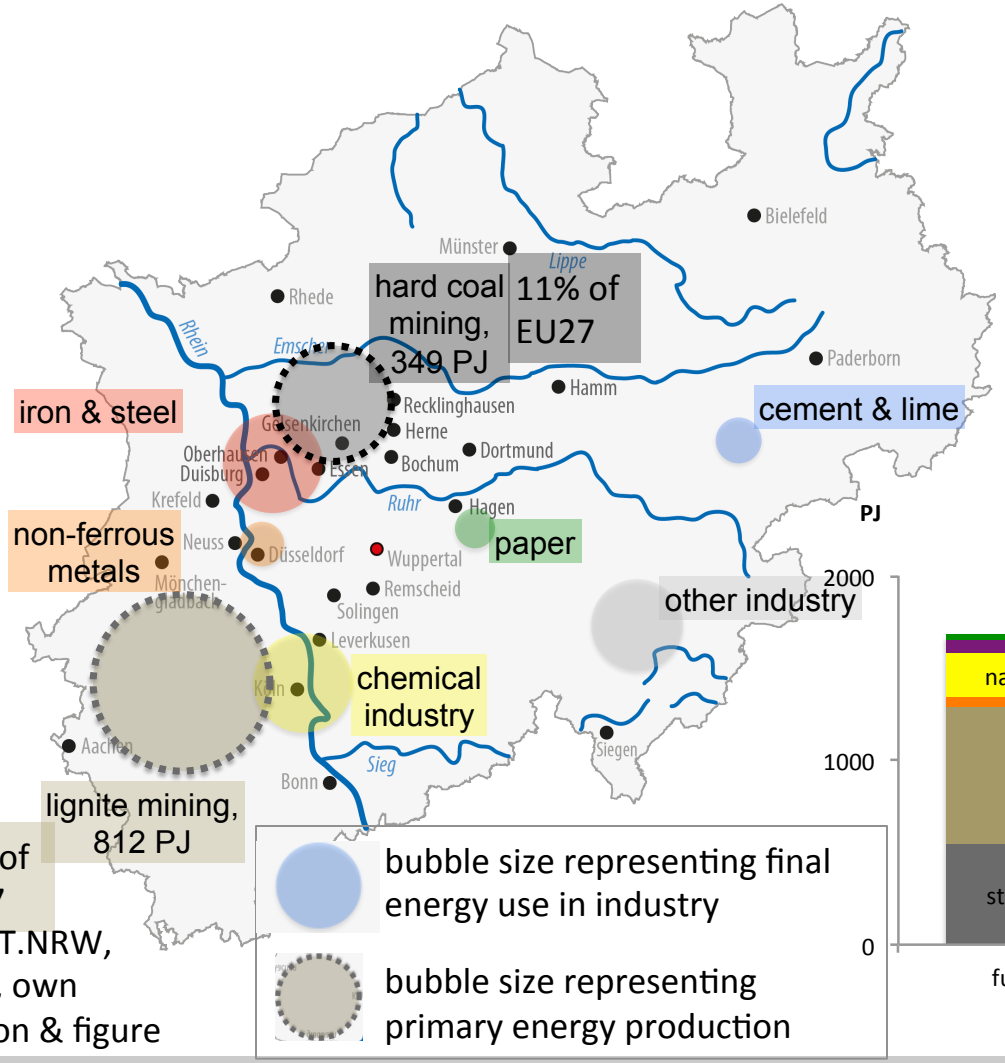
The energy system behind

Still highly coal based

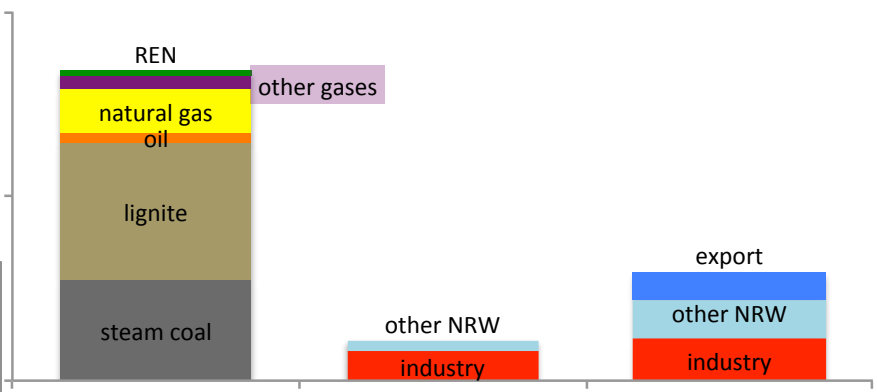


Source: IT.NRW, Eurostat, own calculation & figure

Some location factors of NRW energy intensive industries:

- coal mining areas and large fossil power plants nearby
- River Rhine and other European traffic infrastructure
- Historical regional value added chains in steel and chemical industry

NRW power plants



The role of energy efficiency in the scenarios

Necessary but not sufficient for a low carbon economy

Energy demand change in selected industrial production processes; % change in 2050 compared to energy demand level in 2010

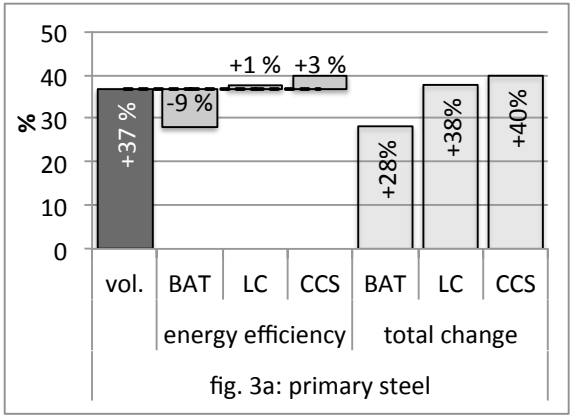


fig. 3a: primary steel

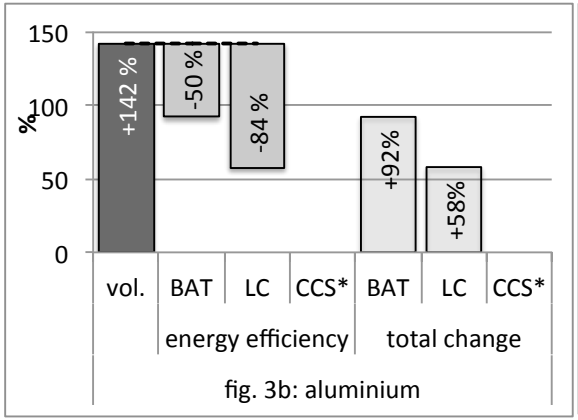


fig. 3b: aluminium

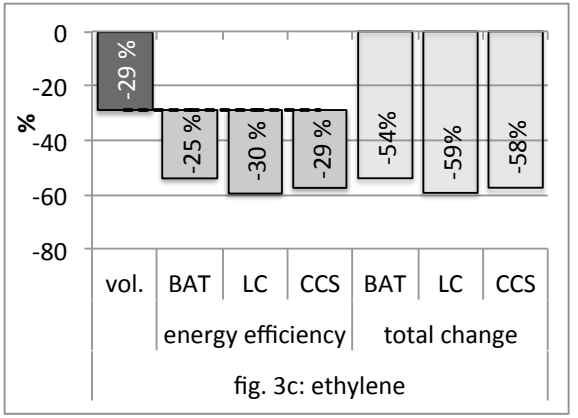


fig. 3c: ethylene

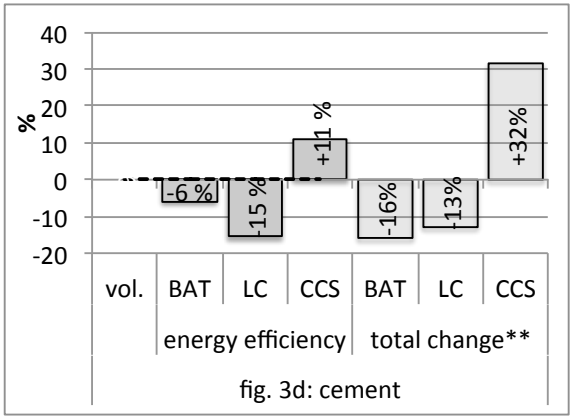


fig. 3d: cement

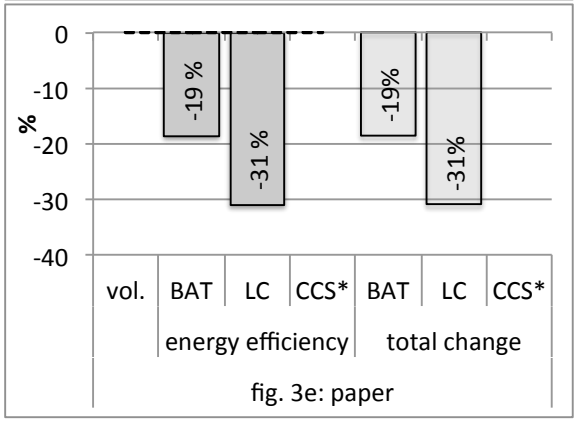


fig. 3e: paper

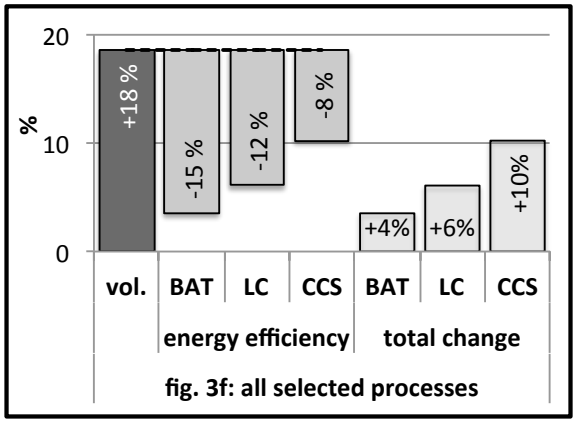
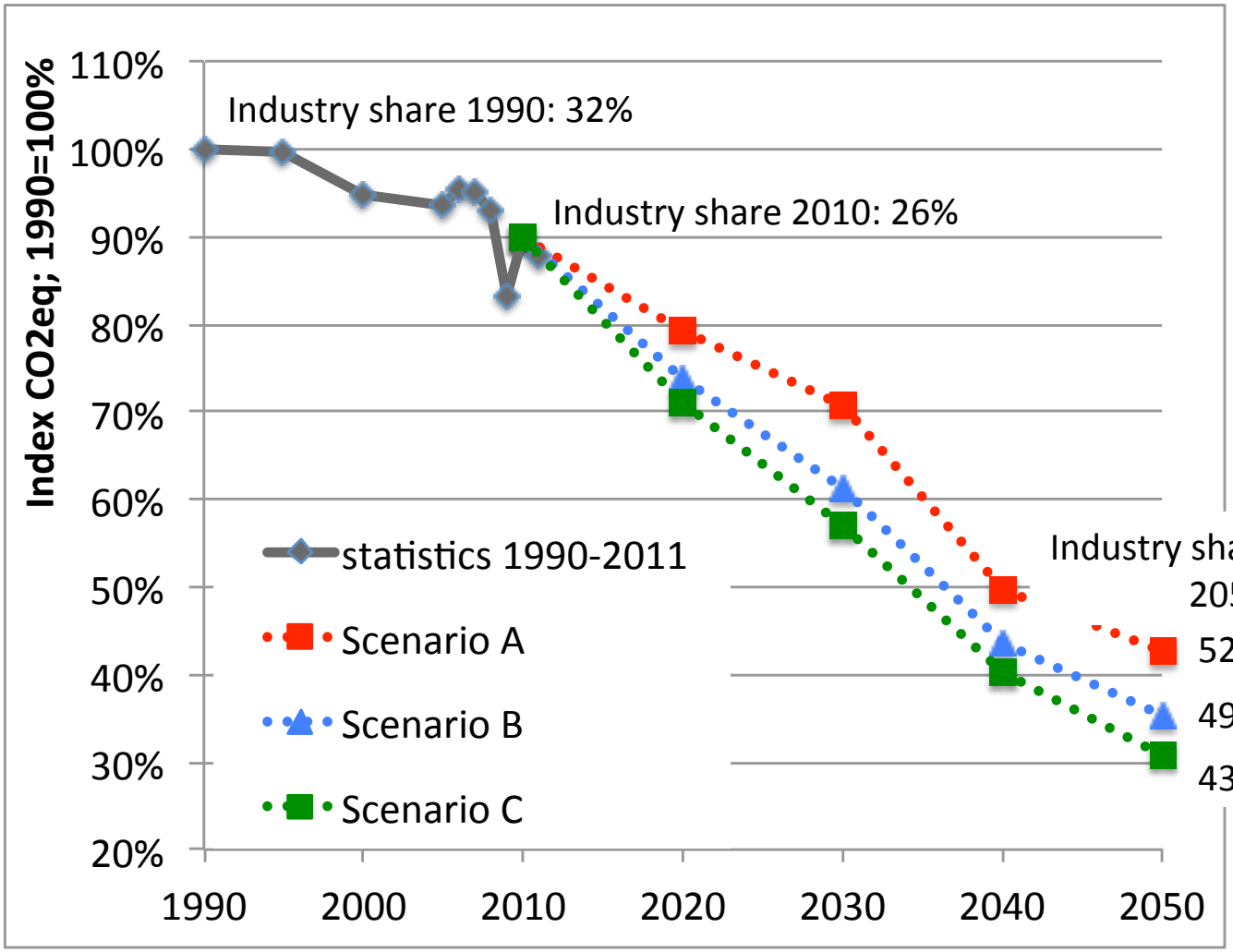


fig. 3f: all selected processes

Source: own calculations & figures

Scenario results for NRW

Mitigation of 57% to 69% in the main scenarios



- three main scenarios do not achieve the governments target of 80% GHG reduction
- rise of industry's GHG share from 26% in (direct) emissions to ca. 50% in 2050
- industry as a underperformer in GHG mitigation

Source: Lanuv NRW, own calculation & figure

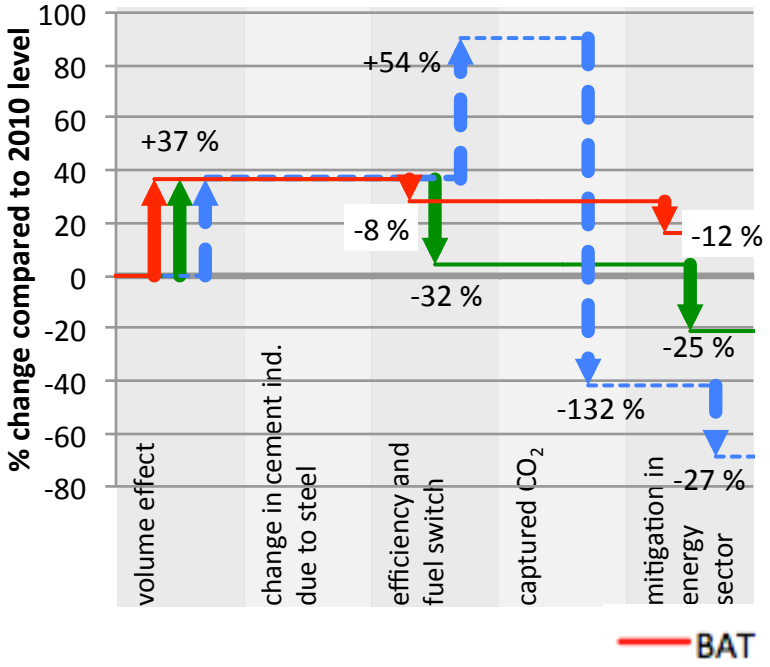
The role of "low carbon technologies" in the scenarios

The examples of iron & steel and cement

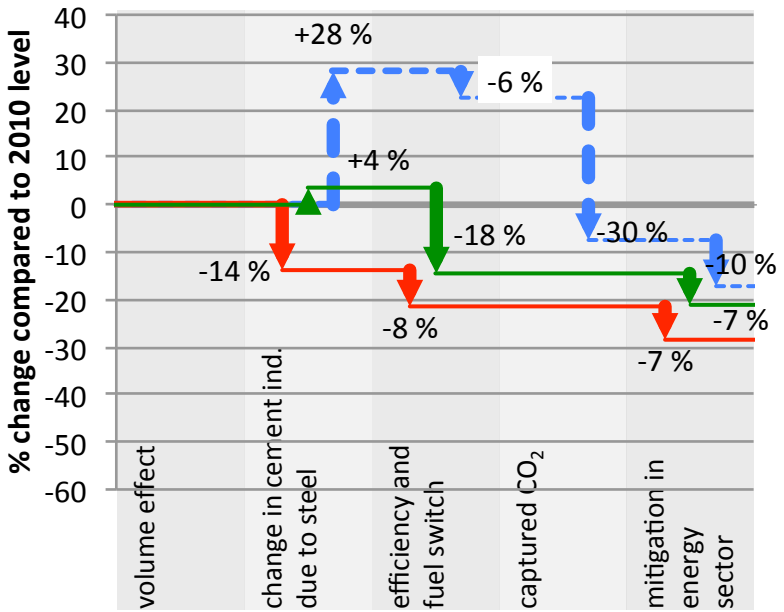
CO_2 mitigation in two selected industrial production processes; % change in 2050 compared to emission level in 2010

Source: own calculations & figures

primary steel



cement



BAT LC CCS*)

Technologies:

BAT: Blast Furnace, Basic Oxygen Furnace

LC: Direct Reduction with hydrogen phase in

CCS: smelting reduction & CCS

Technologies:

BAT: BAT kilns and high share of biogen waste fuel use

LC: Low Carbon cements phase in

CCS: CCS retrofit (no new oyxfuel kilns)