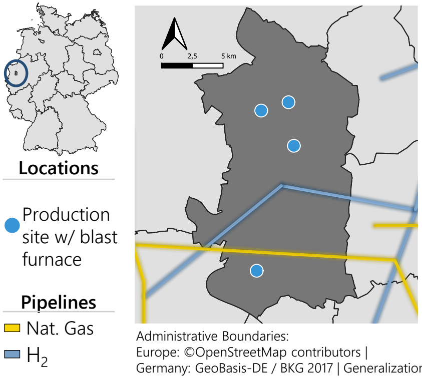


Administrative Boundaries:
Europe: ©OpenStreetMap contributors |
Germany: GeoBasis-DE / BKG 2017 | Generalization: FfE

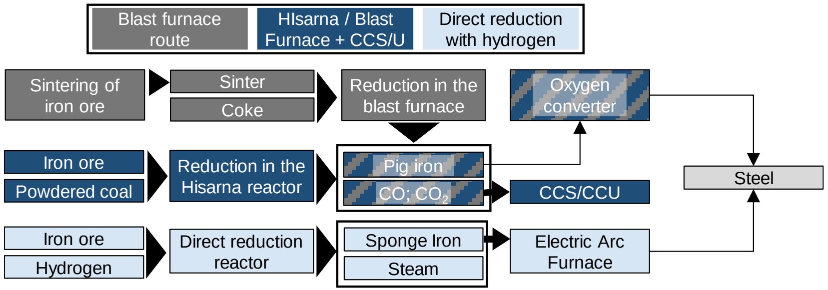
Duisburg (DE)

Scope

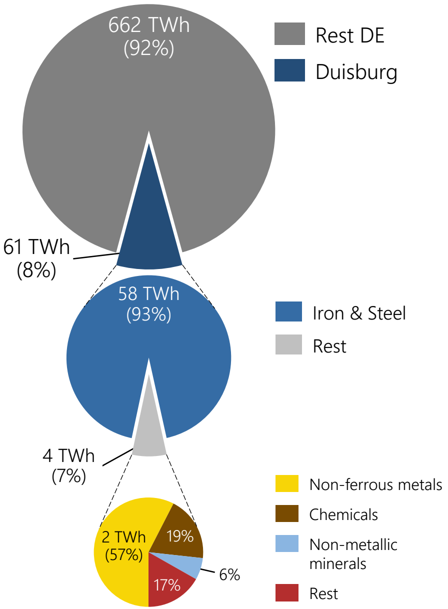
Four production sites with **blast furnaces** within the city of **Duisburg** are considered

In the imagined transformation described here, each blast furnace is replaced by the **new process route** of hydrogen-based **direct reduction** and **electric arc furnace**

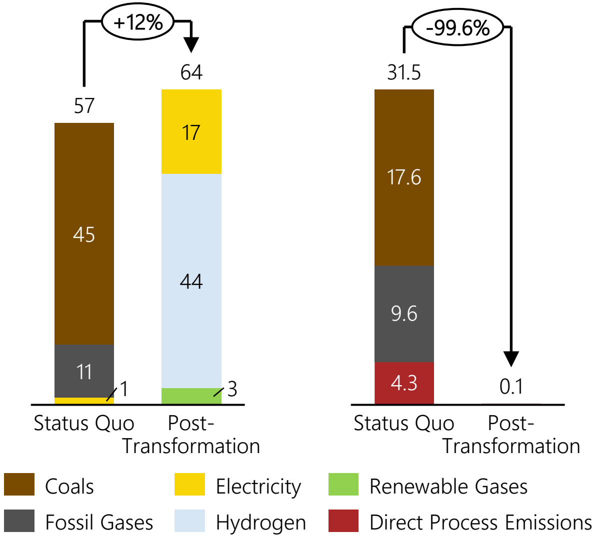
Schematic Comparison of Production Routes:



Top-Down Modeling: German Industrial Final Energy Consumption 2019: 723 TWh



Bottom-Up Calculations:
Effects of the considered production route shifts



*Blast furnace gas partially allocated to the energy sector

** Scope 1 Emissions

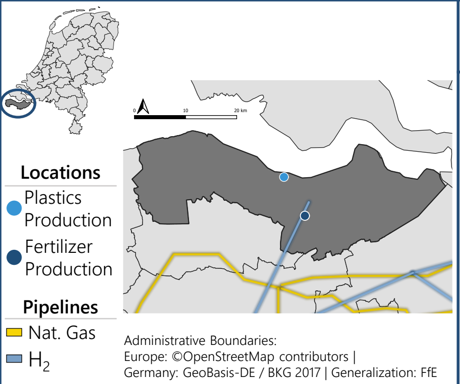
Industrial transformation put into practice:

Thyssenkrupp has begun testing the use of **hydrogen in existing blast furnaces** as a first step for reducing emissions at their Duisburg-Hamborn site. In the long term, further deep emissions reductions are possible through a production route shift via the replacement of blast furnaces with **direct reduction reactors**. Thyssenkrupp plans to bring their first such reactor online in 2026.

Another transformation option is the **capture and use of CO_2 emissions** from the steelmaking process. Potential usage of these emissions as a **raw material for the chemical industry (methanol)** are being explored in the project Carbon2Chem. This would transform the emissions from a waste product into a valuable commodity. The industrial cluster of Duisburg, with companies from both the steel- and chemical branches nearby, is an ideal location for these experiments.

Arcelor Mittal plans to transport sponge iron from their production site in Hamburg for further processing in Duisburg.

Zeelandic Flanders (NL)

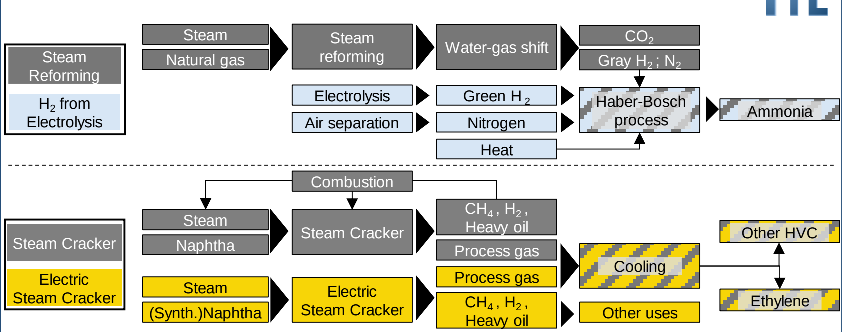


Scope

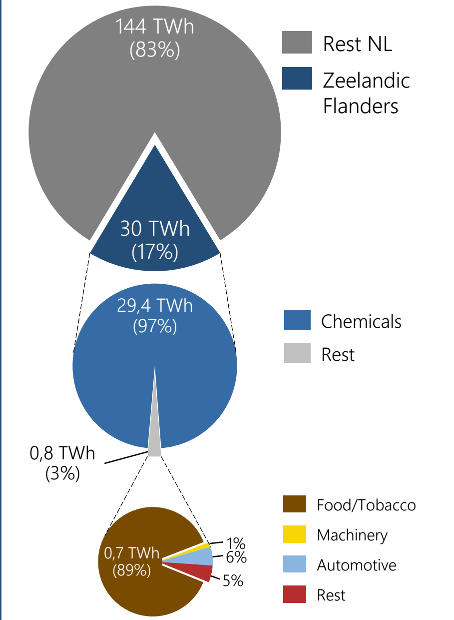
Two production sites in the region are considered – one site producing fertilizers and one site producing plastics

In the imagined transformation described here, the effects of shifts to production via **Power-to-Ammonia** and via an **electric Steamcracker** are considered

Schematic Comparison of Production Routes:

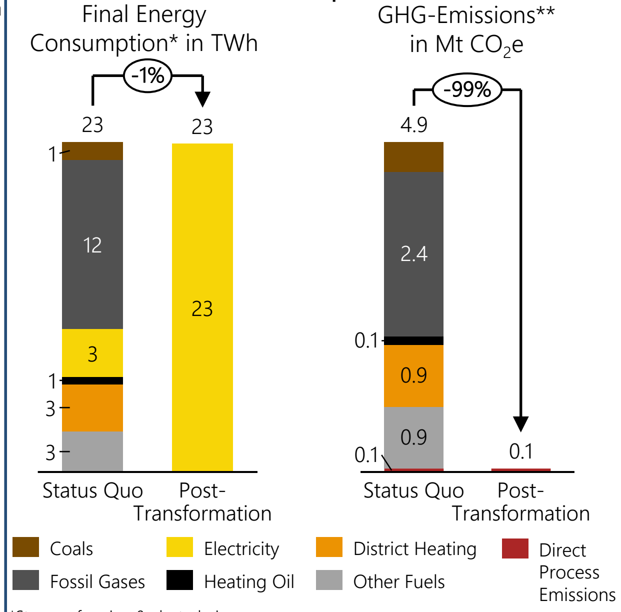


Top-Down Modeling: Industrial Final Energy Consumption of the Netherlands 2019: 174 TWh



Bottom-Up Calculations:

Effects of the considered production route shifts



*Steam reforming & electrolysis are allocated to the energy sector

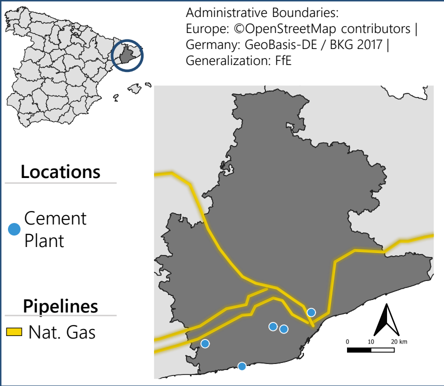
** Scope 1 Emissions

Industrial transformation put into practice:

Companies in the chemical industry can take advantage of **synergies between production sites** to reduce their emissions.

In the Netherlands, Yara Sluiskil added a hydrogen pipeline **to their existing ammonia plant**. This **delivers hydrogen**, a byproduct of ethylene production in the nearby **steamcracker** belonging to Dow, to the ammonia plant and reduces the direct dependence on fossil fuels on site. This project provided Yara Sluiskil with a yearly CO_2-savings of approximately 10,000 t, as well as lowering energy consumption by roughly 0.15 Petajoule per year.

In the medium run, Dow plans to **use byproducts of current processes to produce hydrogen and useful CO_2**, as well as transitioning to the use of hydrogen as a fuel source. In the long run, the steamcracker, which is currently powered by fossil fuels, will be electrified. This could occur via retrofitting, or through the complete replacement of the current unit with an **electric steamcracker**.



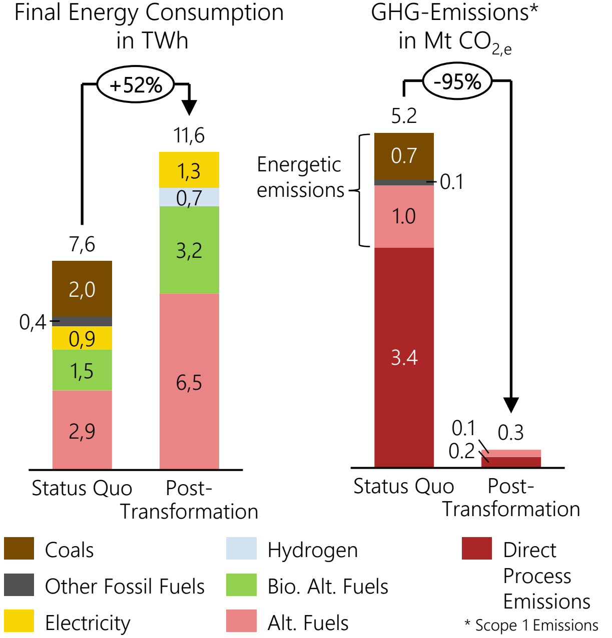
Barcelona (ES)

Scope

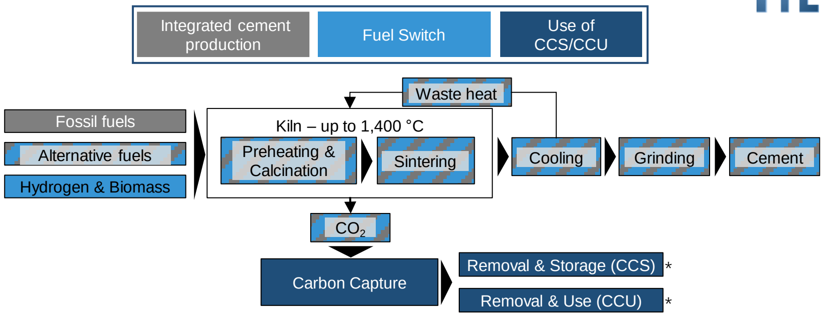
Five cement plants located in the region are considered

In the imagined transformation described here, the effects of increasing the share of **secondary fuels**, a 10 % admixture of green **hydrogen**, and **carbon capture of remaining emissions** are considered.

Bottom-Up Calculations: Effects of the considered measures

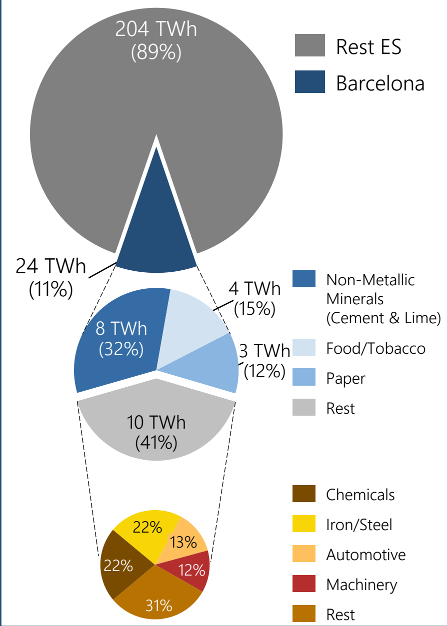


Schematic Comparison of Production Routes:



*Consumption not included in these calculations

Top-Down Modeling: Spanish Industrial Final Energy Consumption 2019: 228 TWh



Industrial transformation put into practice:

Today's cement industry already covers significant portions of the energy demand for clinker production via **alternative fuels** (for example, treated sewage). This share can be further increased in the future, in turn continuing to reduce the use of fossil fuels. In addition, limited **amounts of hydrogen** can be included in the fuel mix for further emissions reductions.

A significant proportion of the **emissions** from clinker production **result from chemical reactions** in the raw materials. These direct process emissions are not affected by changes to fuel mix, and can therefore only be abated via **carbon capture and utilization or storage**. An example of this can be found in the Bavarian municipality of Rohrdorf, where a **carbon capture unit** is currently in development. This pilot project aims to reduce the emissions of the local cement plant and provide the captured CO_2 as feedstock for the **chemical industry**.

If the captured CO_2 was released via the use of biomass, stable storage can lead to a negative emissions balance. If it is used as a feedstock, at best a neutral balance can be achieved.