Digitalization as an Enabler of a Green Hydrogen Value Chain

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Agenda

- Why SAP?
- Supply
- Transport
- Demand
- Regulation
- Bringing all needed layers together
- Digitalization

Why SAP?

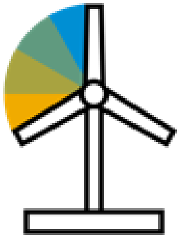
1. SAP Mission: **Help the world run better and improve people‘s lives.**
2. SAP is part of the **CEO Alliance for Europe‘s Recovery, Reform and Resilience working on the following workstreams:**
    1. *Cross-EU charging infrastructure for heavy duty trucks*
    2. *Integration of EU Power systems, in particular grids*
    3. *Digital carbon footprint tracking*
    4. *Sustainable healthy buildings for the future of work and living*
    5. *E-buses for Europe*
    6. ***Green hydrogen value chain***
    7. *Rapid build-up of battery production*
3. SAP serves all the relevant industries: **Utilities; Oil and Gas; Chemicals; Engineering, Construction, and Operations; Cargo Transportation and Logistics; Aerospace and Defense; Automotive; Industrial Machinery and Components; Building Products; Future Cities; Agribusiness; Consumer Products; Retail; Banking; Insurance.**

Supply

Natural gas

Cracking and steam reformation produces H_2 and CO_2. The CO_2 is stored away safely and for a long time. The result is blue hydrogen. (Transitional solution to support the balancing of green hydrogen demand and supply).

Supporting companies: Project planners, service providers, operators, auditors.



Renewables generation

+

Water

Electrolysis:
1. PEM (Proton Exchange Membrane)
2. Siemens Alkali (chemical)
3. Thyssen Krupp solid oxide (high temperature, e.g. use of the sun)

The result is green hydrogen.

Preparation and processing for **transportation** in agreement with the demand side and the prerequisites of the production location:
1. Liquified / pressured H_2
2. H_2 packed in LOHC
3. H_2 transformed to ammonia (NH_3) via the Haber-Bosch process
4. H_2 transformed to methanol (CH_4O)

Production of end products (if the prerequisites allow it):
1. Renewable based fuels (e.g. kerosene, gasoline, diesel)
2. Renewable based olefins (as the basis for renewable based plastics)
3. Renewable based gas (e.g. methan (CH_4))

Intermediate **storage** facilities.

- What **quantities** in which **form** and what **timeframe** are needed on the demand side?
- What **price** will be paid and how does it change over time?
- What are the best **locations** and **technologies** to produce green hydrogen and resulting products?
- What is the best mix out of **lowest overall CO_2 footprint** and **lowest overall cost** from renewable energy production to the final end consumer product or service?

Transport

Shipping

On the road

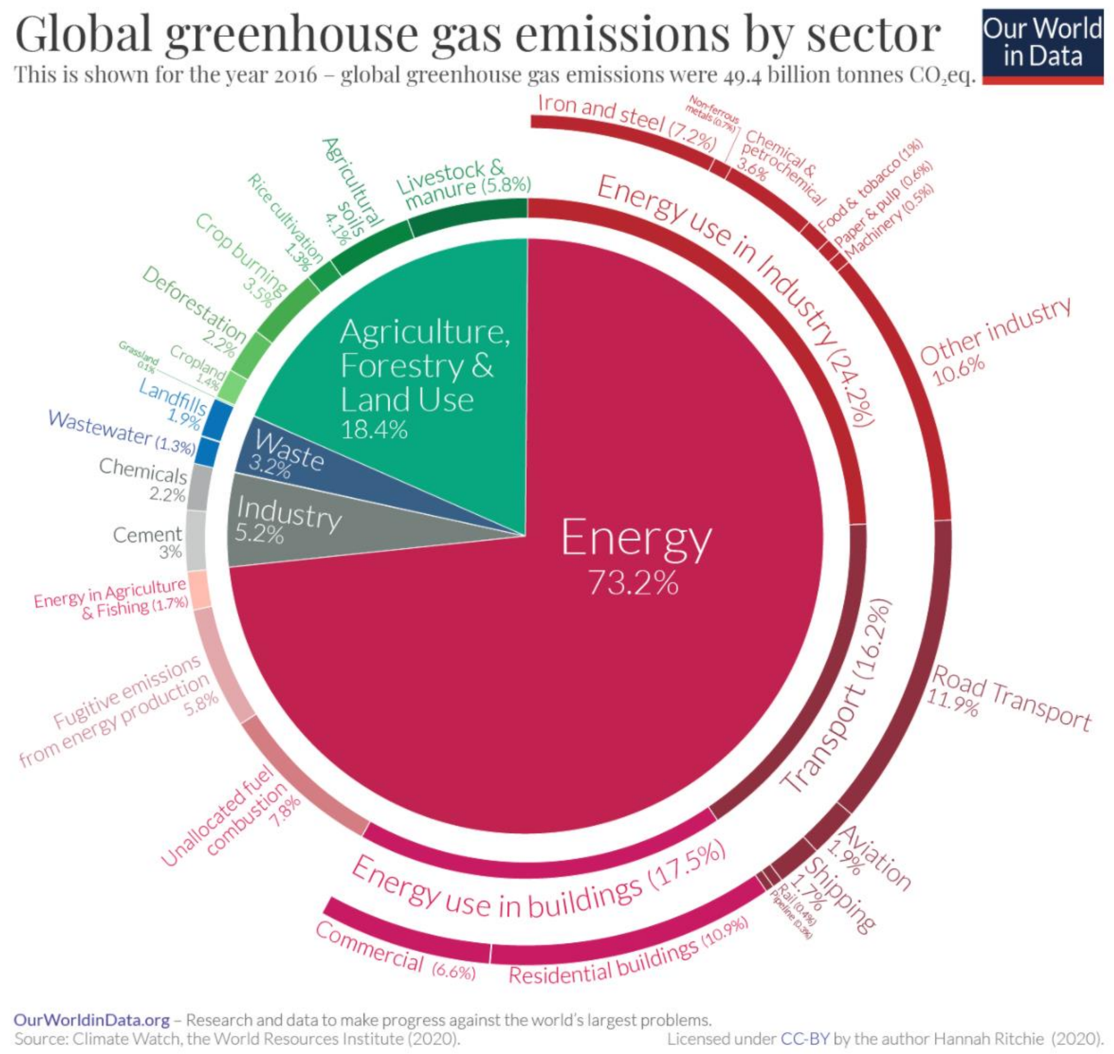
Via train

Via pipeline

Creation of **new or additional pure H_2 infrastructure** consisting e.g. of caverns, pipelines, pressure and liquid tanks plus the needed logistics (e.g. in harbors etc.). **For** products like **ammonia, methan, methanol and LOHC mainly existing infrastructure can be used**. That reduces the overall costs and speeds up mass adoption.

- What is the **best transport method** depending on the specific green hydrogen value chain?
- What are the **critical investment needs** to have a full functioning supply chain?
- **How can the green H_2 based products be tracked** when they are mixed with conventionally produced products of the same kind?
- **How can the CO_2 footprint be measured** from the source to the final end consumer product or service?

Demand



- What **investments** and which **technologies** are needed to extract the H_2 out of the carrier products if the demand side requires it?
- What are the **sectors** where green house gas emissions can be reduced with the least effort and the highest speed?
- How can the **mass balancing problem** be solved when there is green H_2 based and fossil fuel based input at the same time?
- What are **new business models** that help to fasten up the acceptance of green H_2 based products and services?

Source of picture: https://ourworldindata.org/emissions-by-sector

Regulation

CO_2 taxes

Analysis of existing barriers

Research

Introduction of common standards, terminology and certification

Improved consumer information

Financial support

Phasing out of fossil fuel subsidies

Deployment of new technologies and digital tools

Fiscal measures

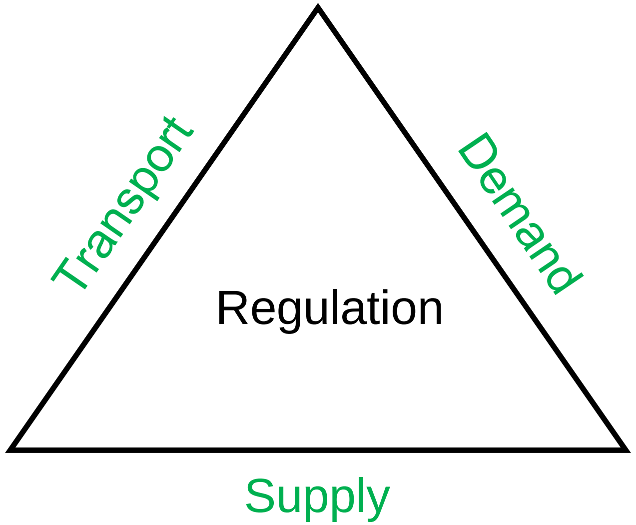
Market governance

Infrastructure planning

- How do regulators, governments and institutions get the **transparency** about what is going on at the supply, transport and demand side?
- How must the green H_2 based products be **subsidized** to make them competitive and/or the **price for CO_2 be increased**?
- How can the **critical investments** to have a fully functioning supply chain be subsidized in the most efficient way?
- What are the right instruments and market rules to support the **energy transition** from first pilots to a full functioning market?

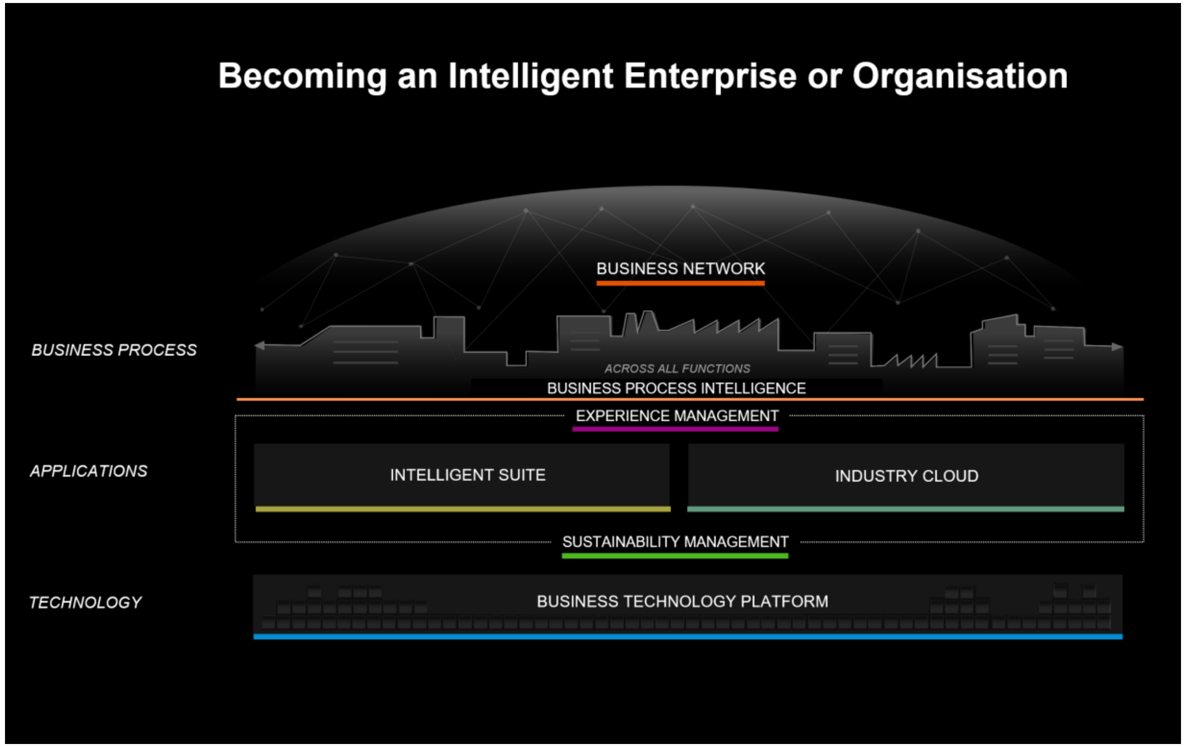
Bringing all needed layers together

- **Transparency** of the specific H_2 green value chain
- What are the **roadmaps** on the supply, transport, demand and regulation side?
- How can we best **work together** to scale up fast with the lowest risk?



Digitalization

Individual excellence



Working together as a team

- Using **one digital platform** to exchange information, align on plans and come to the right decisions.
- Each participant of the green H_2 value chain registers to speed up the process for everybody else:
  - Which parts of the specific value chain are covered?
  - What are the products and services they offer?
  - References
  - Contact persons
- What supply is needed in what timeframe?
- What subsidies are available for what?
- What are the actual and future market rules?

Appendix

Energy Transition across Mills, Utilities and Oil, Gas and Energy

Project partners: EDF, FH Westküste ITE, Holcim, OGE, Ørsted, Raffinerie Heide, Region Heide, Stadtwerke Heide, thyssenkrupp, Thüga

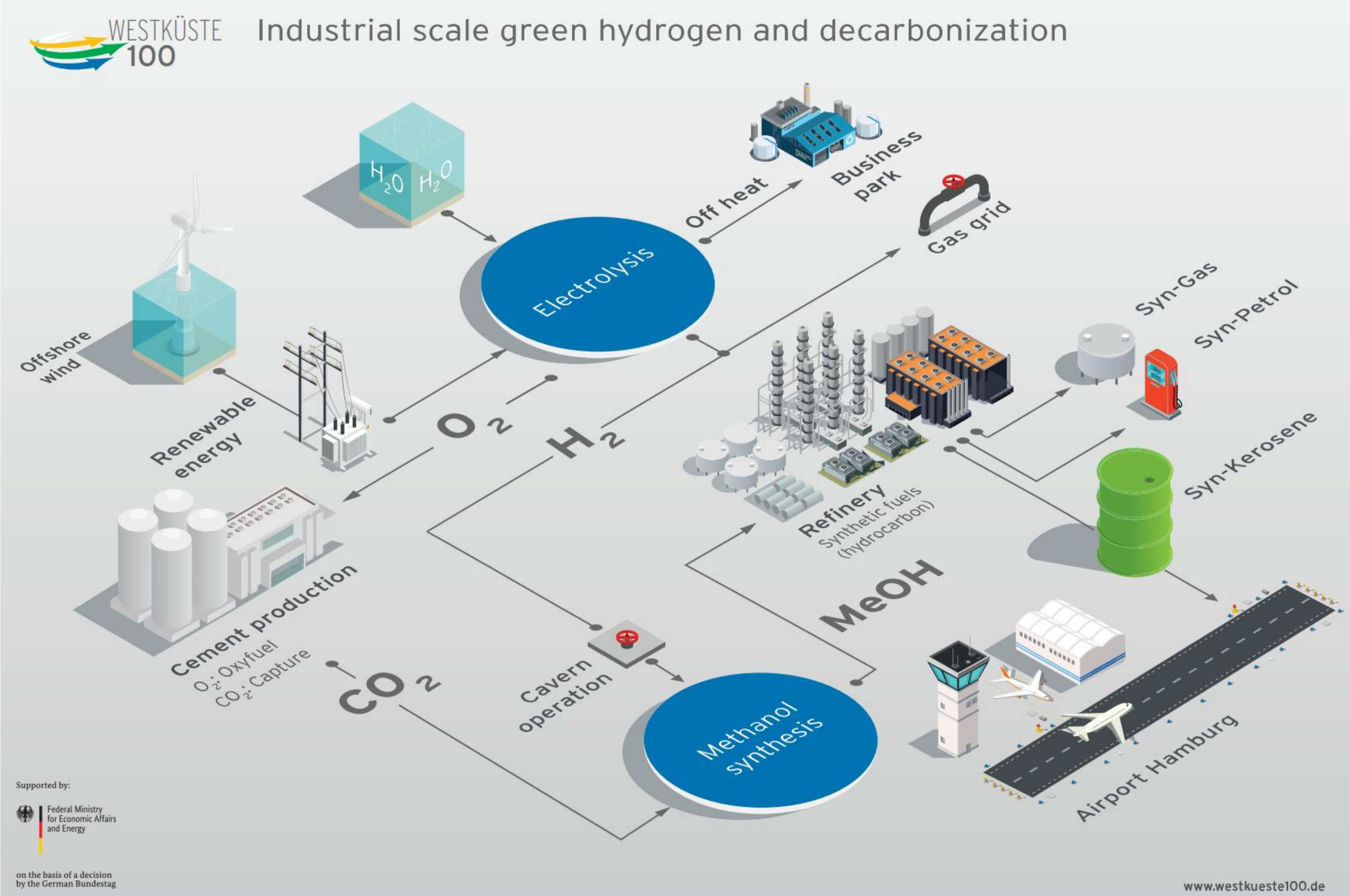
Project lead: Jürgen Wollschläger, managing director of Raffinerie Heide and the project’s coordinator.

This project is in a **pilot stage**.

It is a **great example how different industries work together** to massively reduce the input of fossil fuels, reduce CO^2 through the whole process and come up with products that are requested by their customers.

The part **regulation** has to play is to make this set up competitive compared to the existing practice to motivate mass adoption.

Our part will be to **understand the new business processes in detail** that arise from this new collaboration and **provide the existing and new software solutions** that are needed.



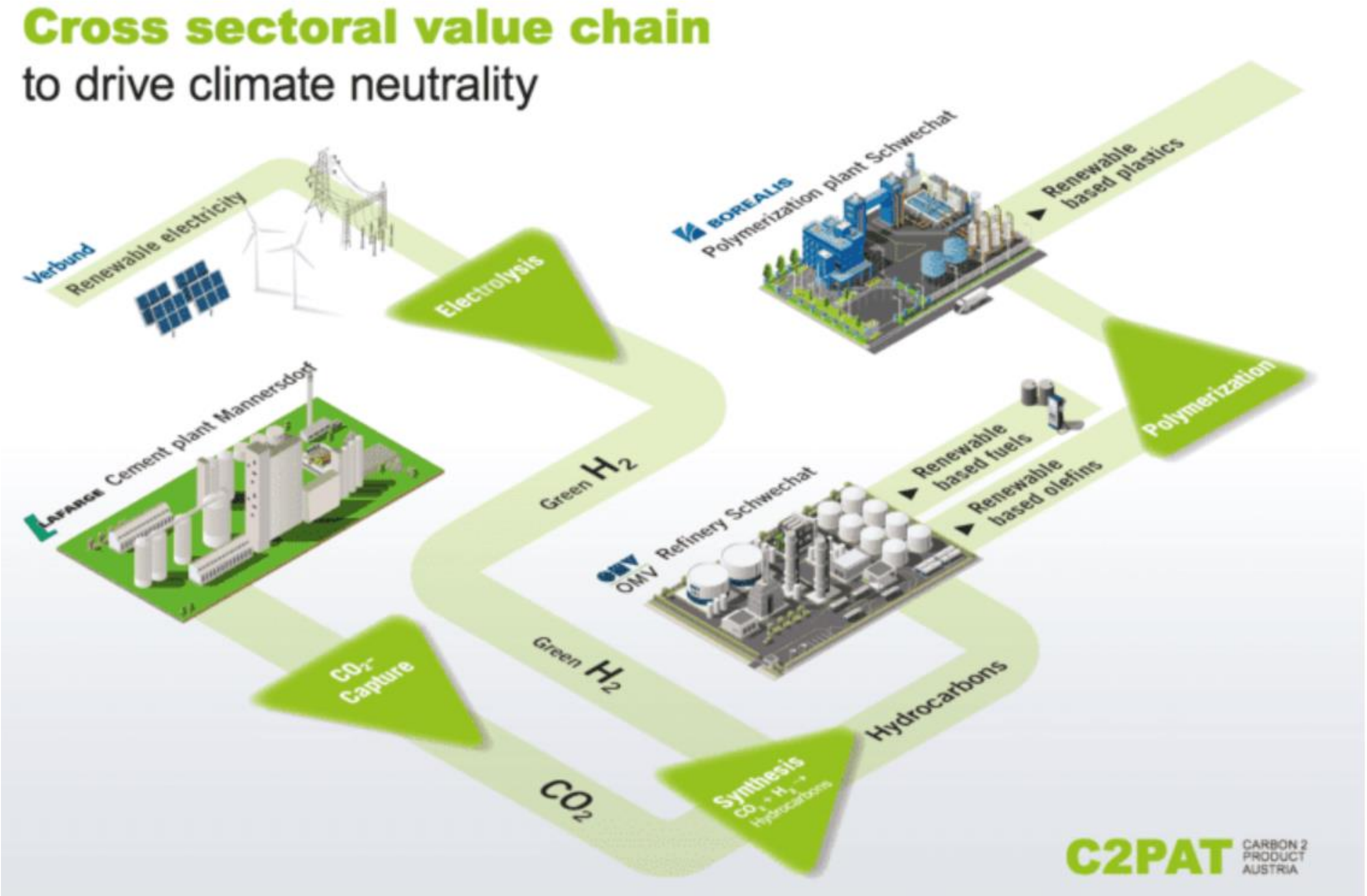
Source: https://www.westkueste100.de/en/#ProjectHome/

Energy Transition across Mills, Utilities, Chemicals and Oil, Gas and Energy

Project partners:

Here another example from Austria that also **includes the chemical industry** which is also in the pilot phase.

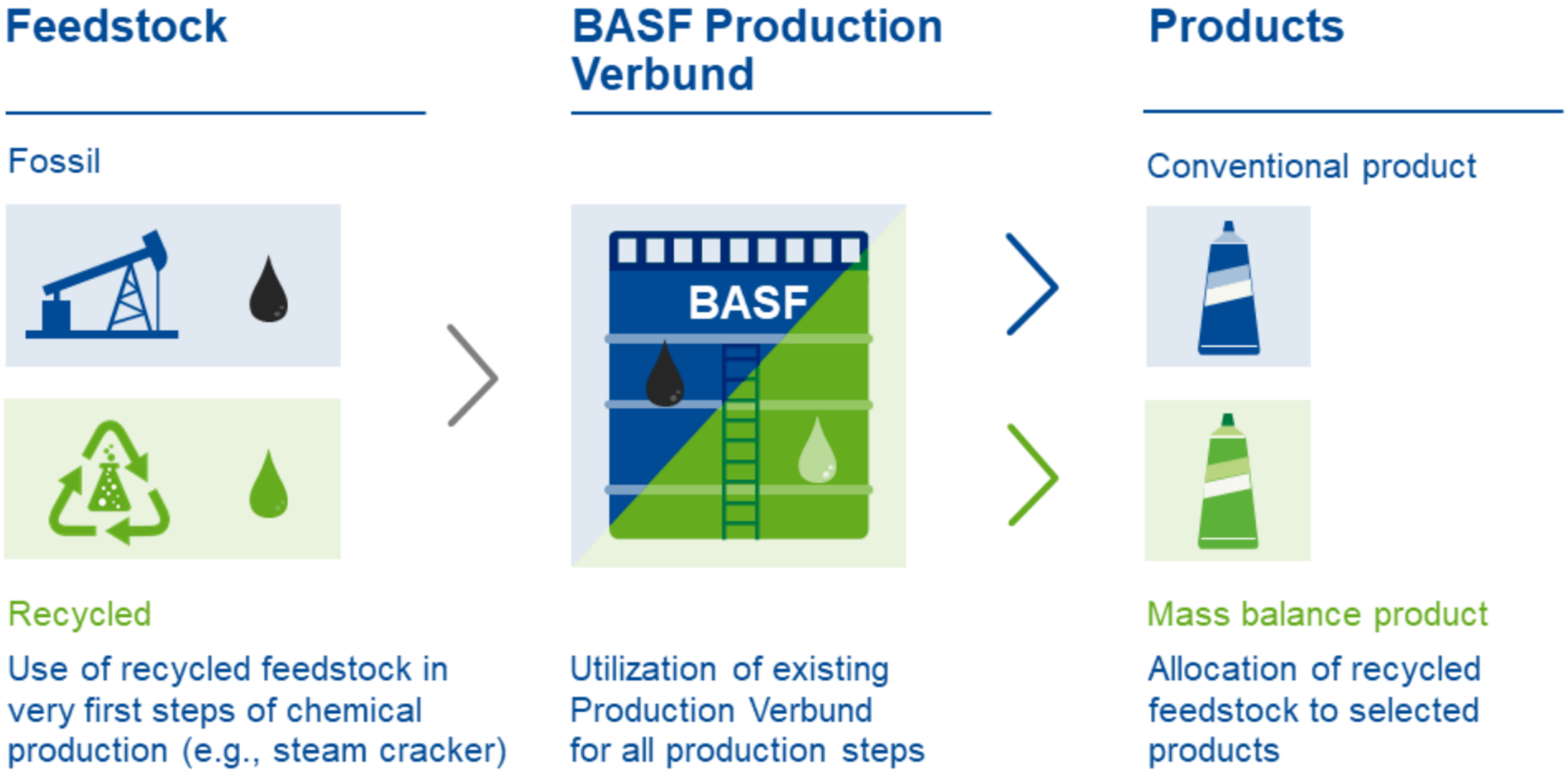
If we do not have the setup of an industrial park then there are additional aspects like trading of the different commodities, transport, supply chain and further regulatory aspects.



Picture: https://fuelcellsworks.com/news/lafarge-omv-verbund-and-borealis-to-collaborate-on-major-decarbonization-project-focused-on-co2-capture-green-hydrogen/

The Mass Balancing Approach

The same mass balancing approach that has been proven successful in the utilities industry is used for the chemical industry. Here the example of BASF. However, this also is relevant for refineries and a lot of other use cases.



  Source: https://www.basf.com/global/en/who-we-are/sustainability/we-drive-sustainable-solutions/circular-economy/mass-balance-approach.html

Thank you.

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