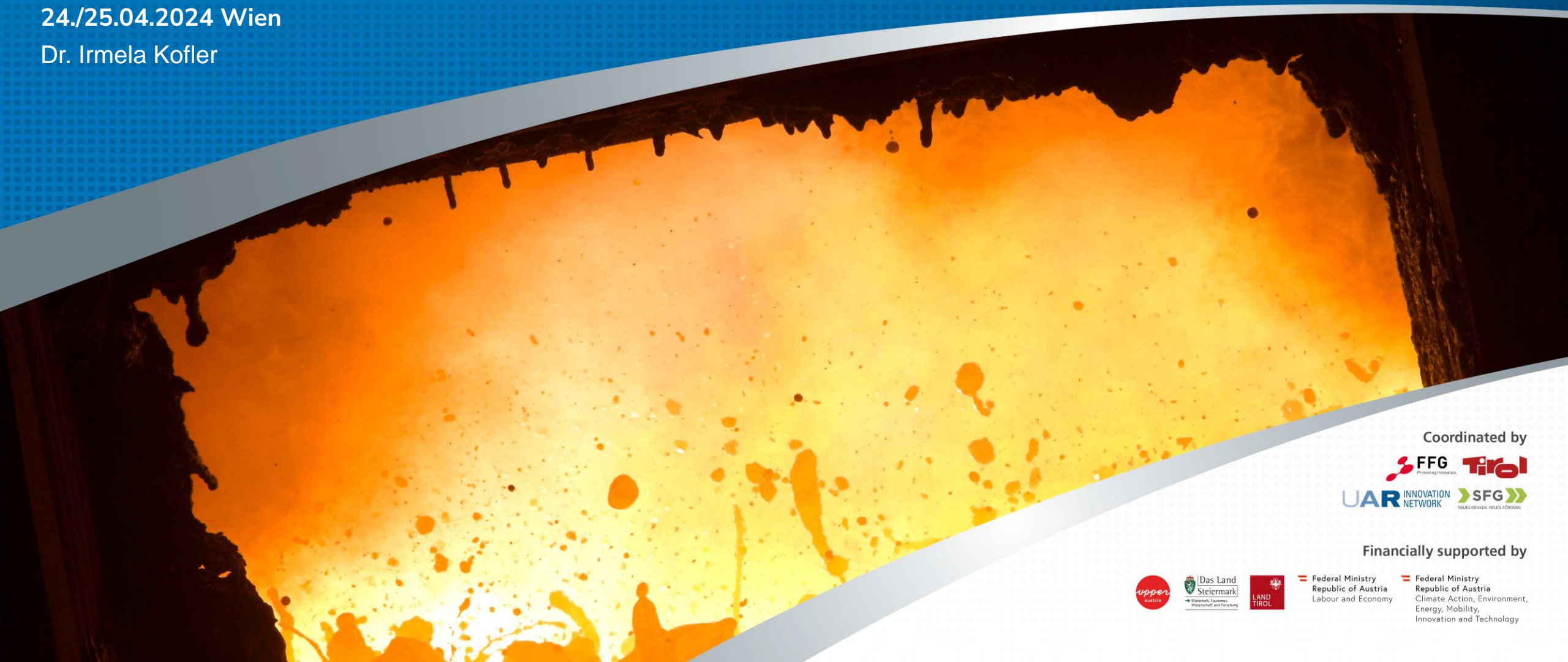


ZEUS – Zero Emissions throUgh Sectorcoupling

6. Branchentag Wasserstoff

24./25.04.2024 Wien

Dr. Irmela Kofler



Coordinated by



Financially supported by



K1-MET is one of the leading international **metallurgical research competence centers** for ferrous and nonferrous metallurgy located in Austria.

- focus on ferrous and nonferrous metallurgy
- founded in July 2015 as a limited liability company
- 84 employees (as of 1 July 2023)
- partially funded by an Austrian competence center programme
- annual revenue of 10 million €
- 100 projects and associated partners from industry and science
- 28 Company Partners
- 13 Scientific Partners

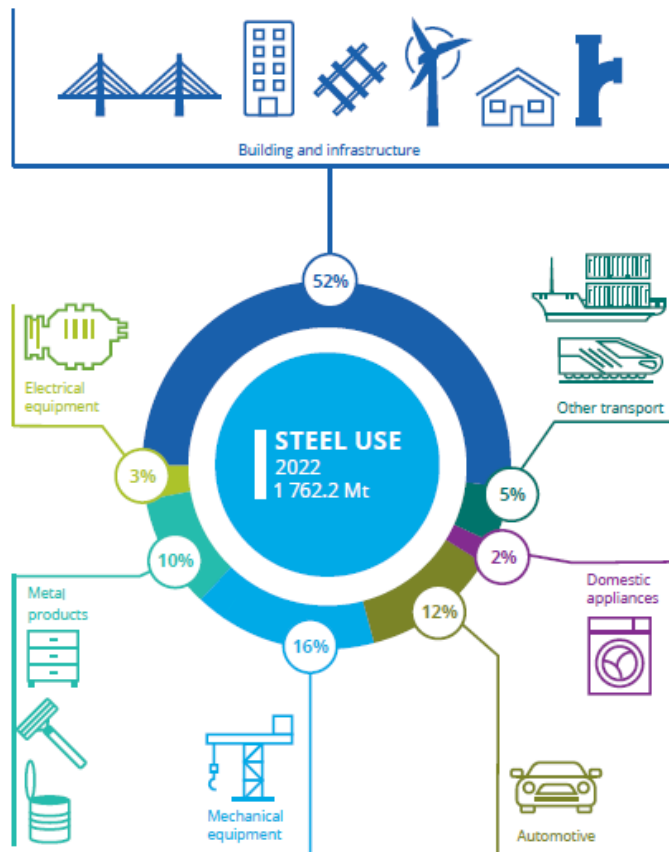
Area 2: Decarbonisation and Sector Coupling



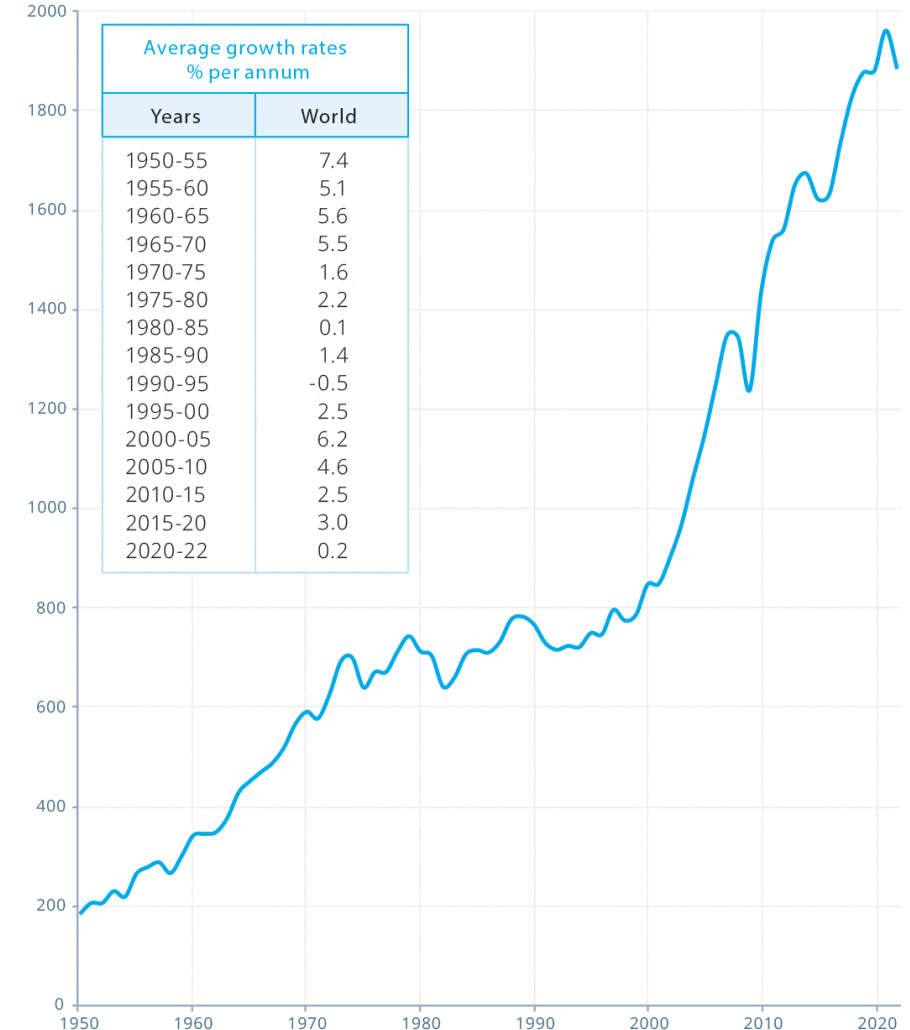
Steel? Do we even need this anymore?

Steel demand and applications

Tell me about **one thing** on **your person** that is not **made of steel** or produced by **using steel!**



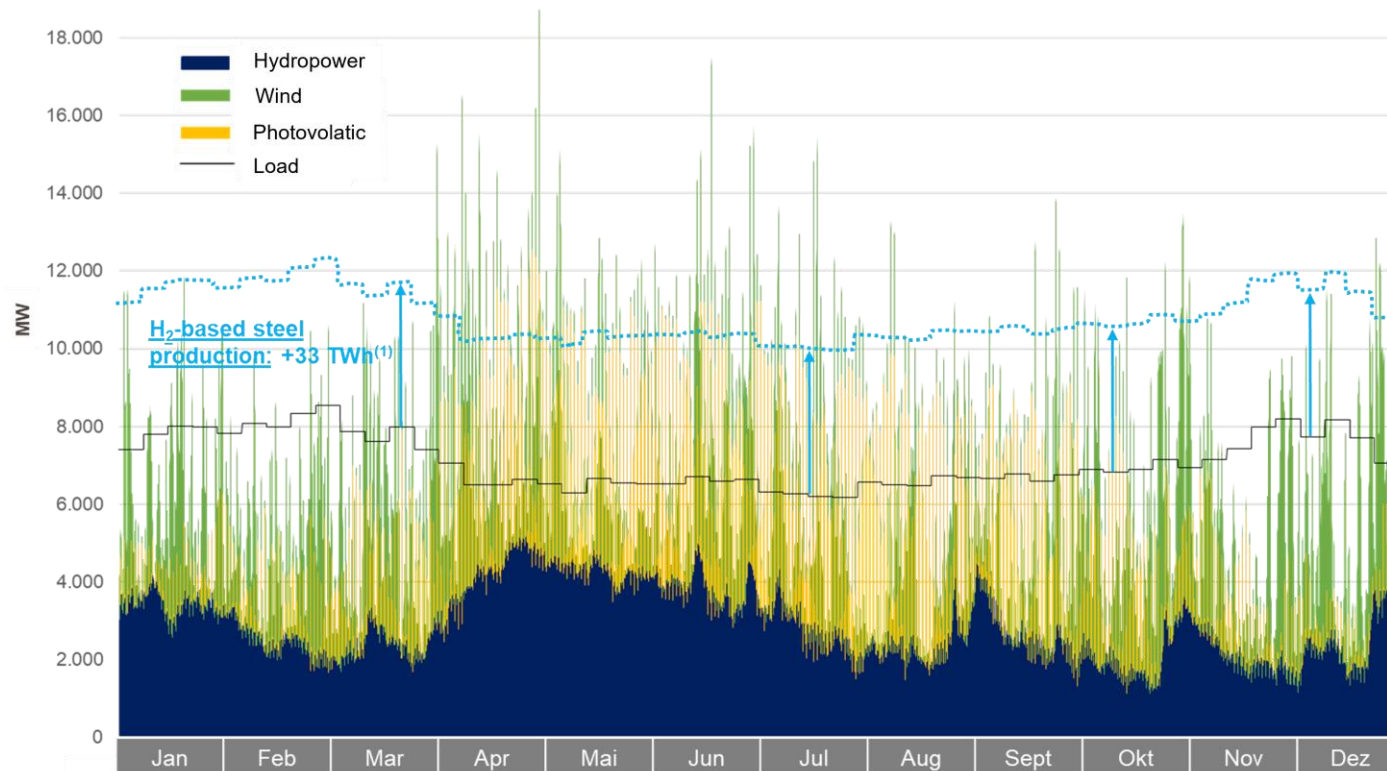
[https://unesid.org/descargas_files/World-Steel-in-Figures-2023.pdf]



[<https://worldsteel.org/steel-topics/statistics/world-steel-in-figures-2023/>]

Motivation

Renewable energy meets future steelmaking



[Christiner, Die zentrale Bedeutung der Netze beim Umbau des Energiesystems, Presentation at the renewable energy conference, Klagenfurt (AT), 2017]

Scenario 2030+

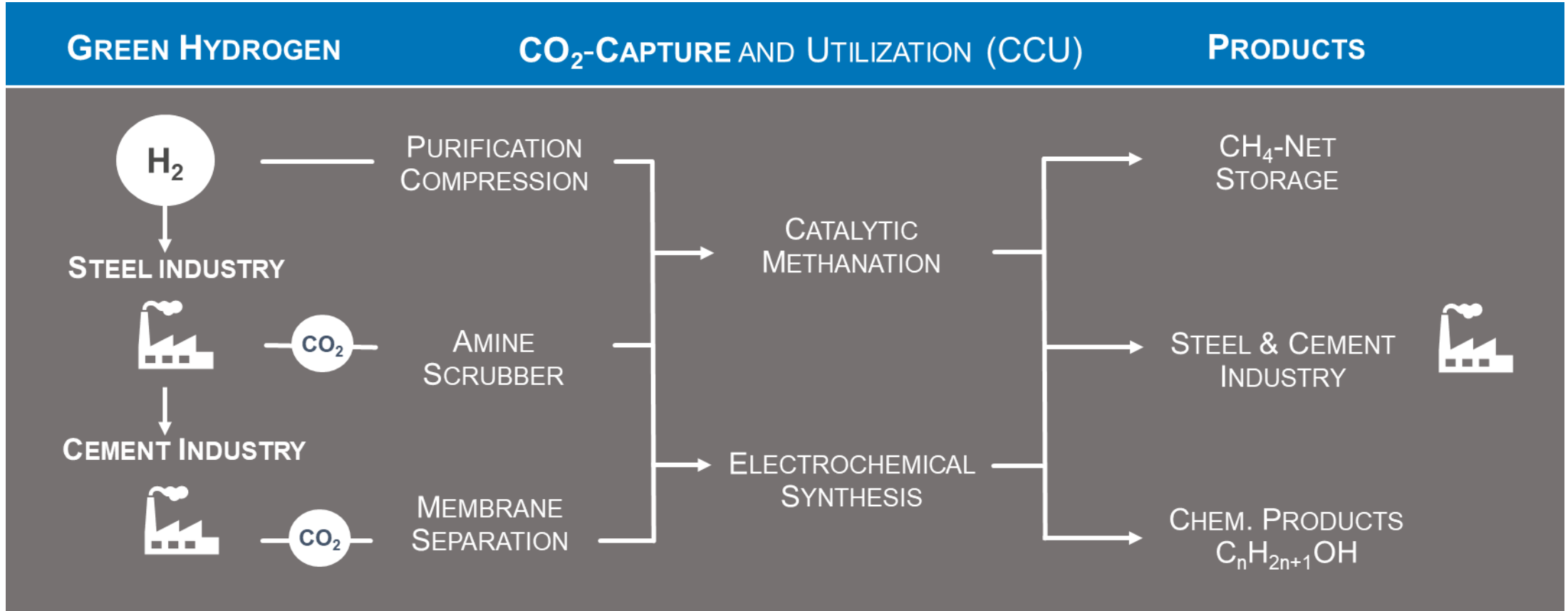
- 100% renewable energy in Austria (basis: demand 2022)
- Strong **seasonal fluctuations** of renewable energy
- **Sector coupling** as key for **stabilising the renewable energy system and chemical storage**

Goals

- Cross-sectoral demonstration of a **climate-neutral process** chain at TRL 7 to accelerate the technology transfer into practice!
- Stabilising the electric energy system through grid balancing and **cost optimised green hydrogen production**
- Demonstrate **CCU-technologies** under dynamic/real conditions in energy intensive industries
- Investigate **techno-economics** of process chains

Cost:	16.7 M€
Funding:	7.6 M€
Nation funding agency:	Climate and Energy funds
Duration:	10/2023-09/2027 (4 years)

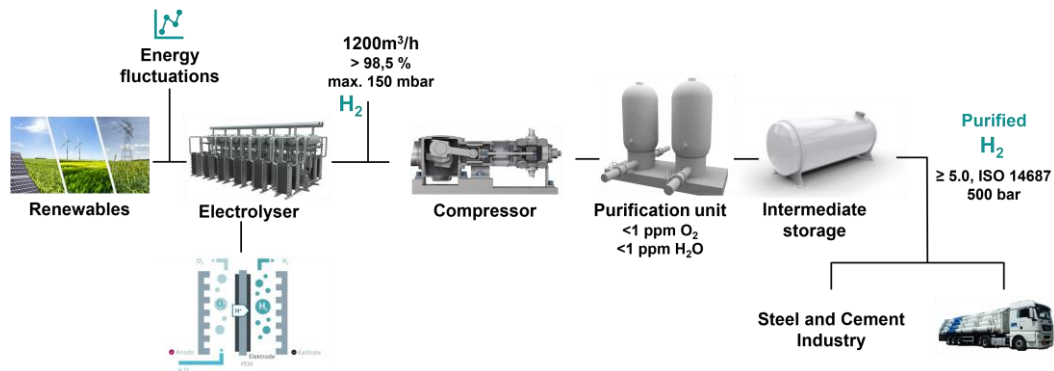






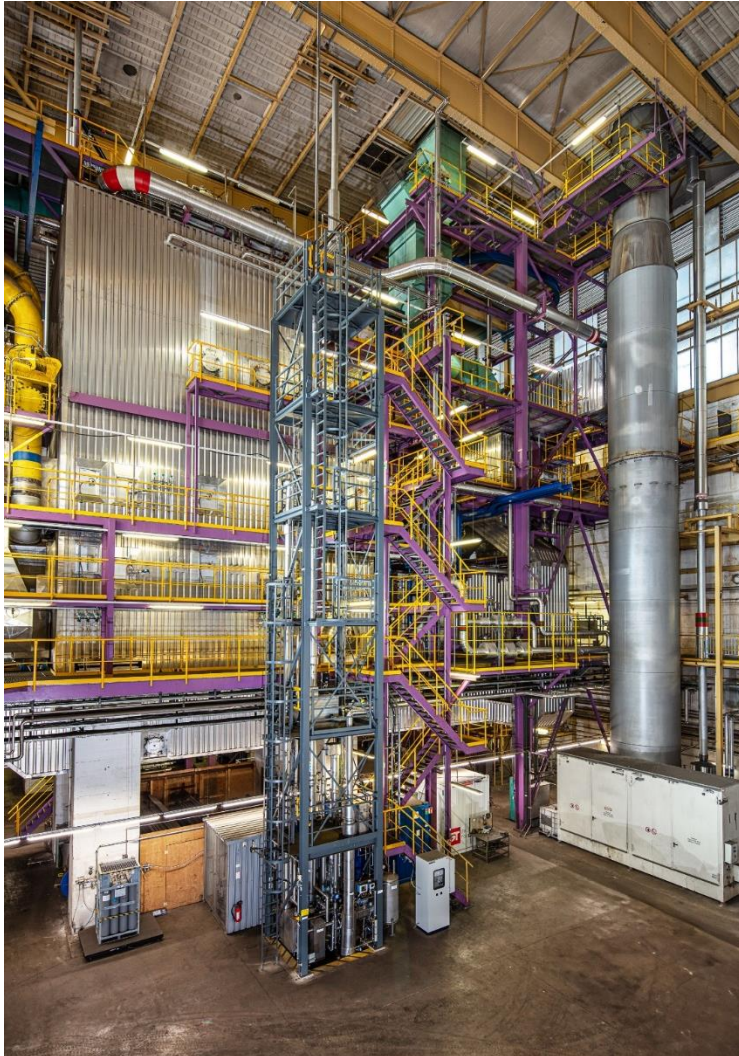
6 MW PEM Electrolyser voestalpine Linz

- Grid services to enable **sector coupling**
- **Reduce H₂ production costs**
- 1200 Nm³/h **green hydrogen**
- **Compression (500 bar) and trailer filling**
- Purification to **hydrogen 5.0**
- Use for **CCU-technologies** and **H₂-based steelmaking**



Carbon Capture

Amine Scrubber pilot plant



Key facts

- Commissioned Q1/23 at **voestalpine Linz power plant**
(C-CED project, <https://www.wiva.at/project/c-ced/?lang=en>)
- Power plant off-gas (**20-25 vol.% CO₂**)
- **Capacity up to 800 kg CO₂/day**
- **Compression / liquefaction** of CO₂ into bottles
- Provide the **downstream carbon utilisation** process
(e.g. methanation)

Sector coupling in the near future (2023-2027)

What's on the Agenda?



Demonstrate **CO₂-neutral process** chains in industrial environment (TRL=7)



Develop **business cases** and **roll-out scenarios** (efficiency vs. costs)



Accelerate the **technology scale-up** in green steel production processes



Develop and demonstrate **sector coupling mechanisms**



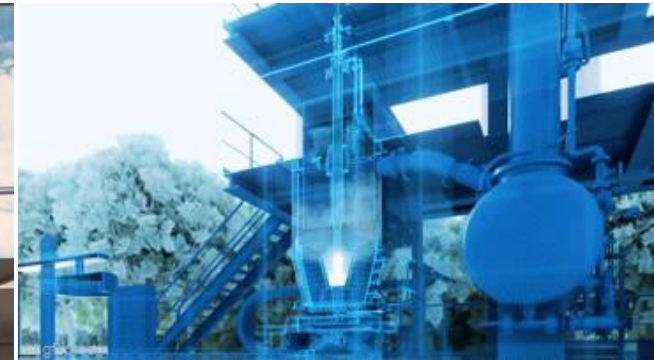
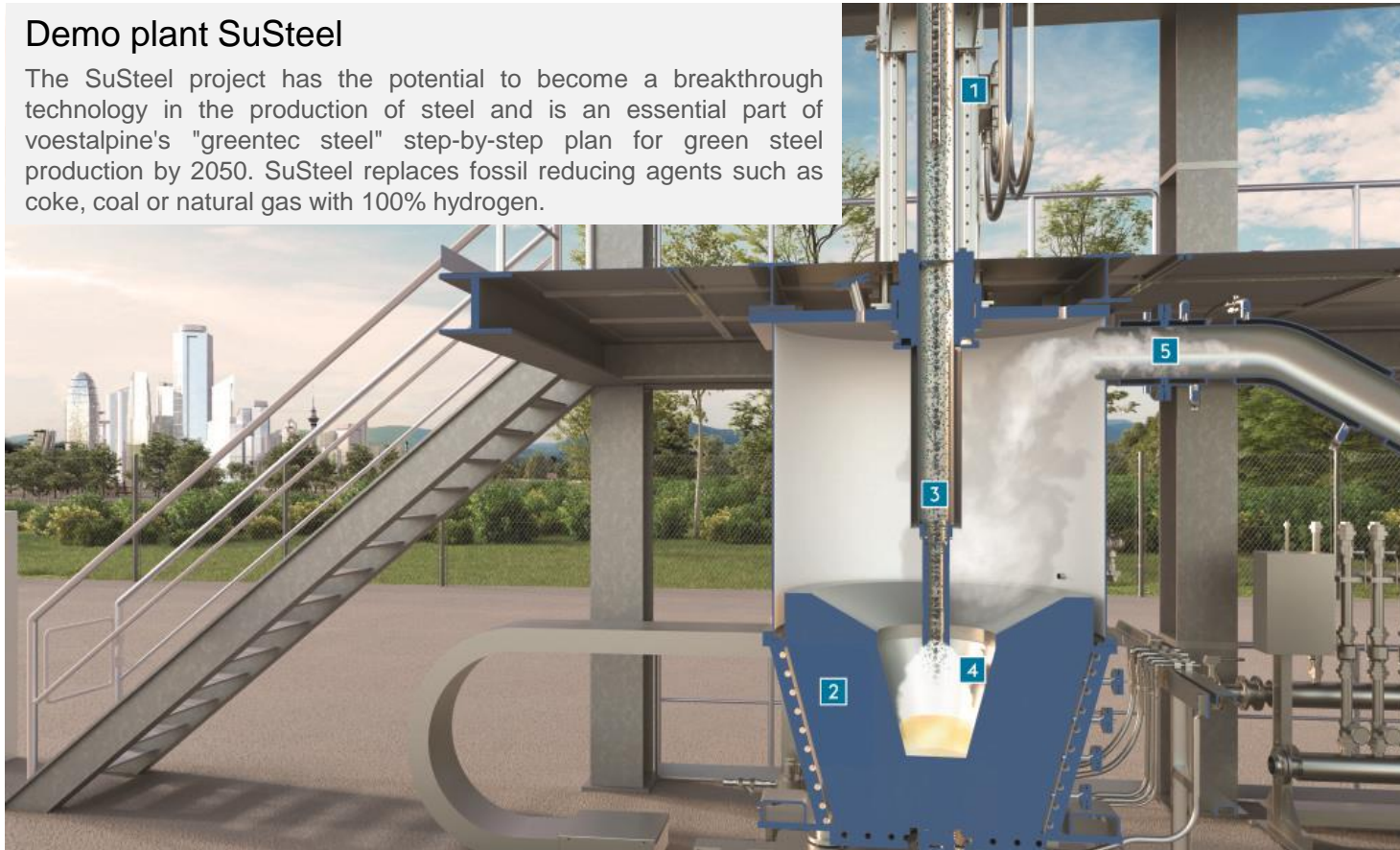
This project is funded by the “Klima- und Energiefonds” and is carried out within the framework of the “Energieforschungsprogramm 2022”

Carbon direct avoidance

Smelting reduction with hydrogen plasma

Demo plant SuSteel

The SuSteel project has the potential to become a breakthrough technology in the production of steel and is an essential part of voestalpine's "greentec steel" step-by-step plan for green steel production by 2050. SuSteel replaces fossil reducing agents such as coke, coal or natural gas with 100% hydrogen.



HYDROGEN AND IRON ORE SUPPLY
Hydrogen and iron ore are fed to the plant.

ELECTRIC ARC FURNACE
The DC electric arc furnace is the heart of the plant. The reactions take place in the transferred arc.

ELECTRODE
Iron ore and hydrogen enter the reaction zone of the arc via a hollow electrode.

REACTION ZONE
Hydrogen is ionised into plasma and the iron ore is melted and reduced in one step. Crude steel is produced.

END PRODUCT: WATER VAPOUR
At the end of the process, only water vapour escapes. CO₂ emissions are fully avoided.

Carbon direct avoidance

Smelting reduction with hydrogen plasma

Sustainable Steel | [SuSteel, Austria](#)

Direct production of crude steel by reduction of fine ores with ionized hydrogen

Fundamental research project in bench scale at voestalpine Stahl Donawitz site

Project partners

K1-MET GmbH, voestalpine and Montanuniversitaet Leoben

Timeline

- 2016 – 2020 (1st phase) – TRL 4
- 2019-2023 (2nd phase) – TRL 5
- 2023++(3rd phase) – TRL 6 to 7



Technology development

HYFOR DR process



- » Test the performance of the **HYFOR reactor** and the **preheating/oxidation cyclone** under real operating conditions
- » Direct reduction of **magnetite/hematite iron ore fines** with H_2 in fluidized bed reactor up to a **metallization degree of 97 %**
- » Typical grain size: **100% < 150 μm**
Max. grain size: **< 500 μm (up to 2 mm possible)**
- » **Batch operation** with 800 kg ultrafine iron ore is equal to **200 kg DRI per hour**
- » **Pilot plant at voestalpine Donawitz site** as technical basis for next development phase



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