Hydrogen in Steel Making for decarbonization

Your speaker

Jens Hundrieser

Dipl. Ing. Elektrotechnik

European Industry Manager

jens.hundrieser@endress.com

Jens Hundrieser

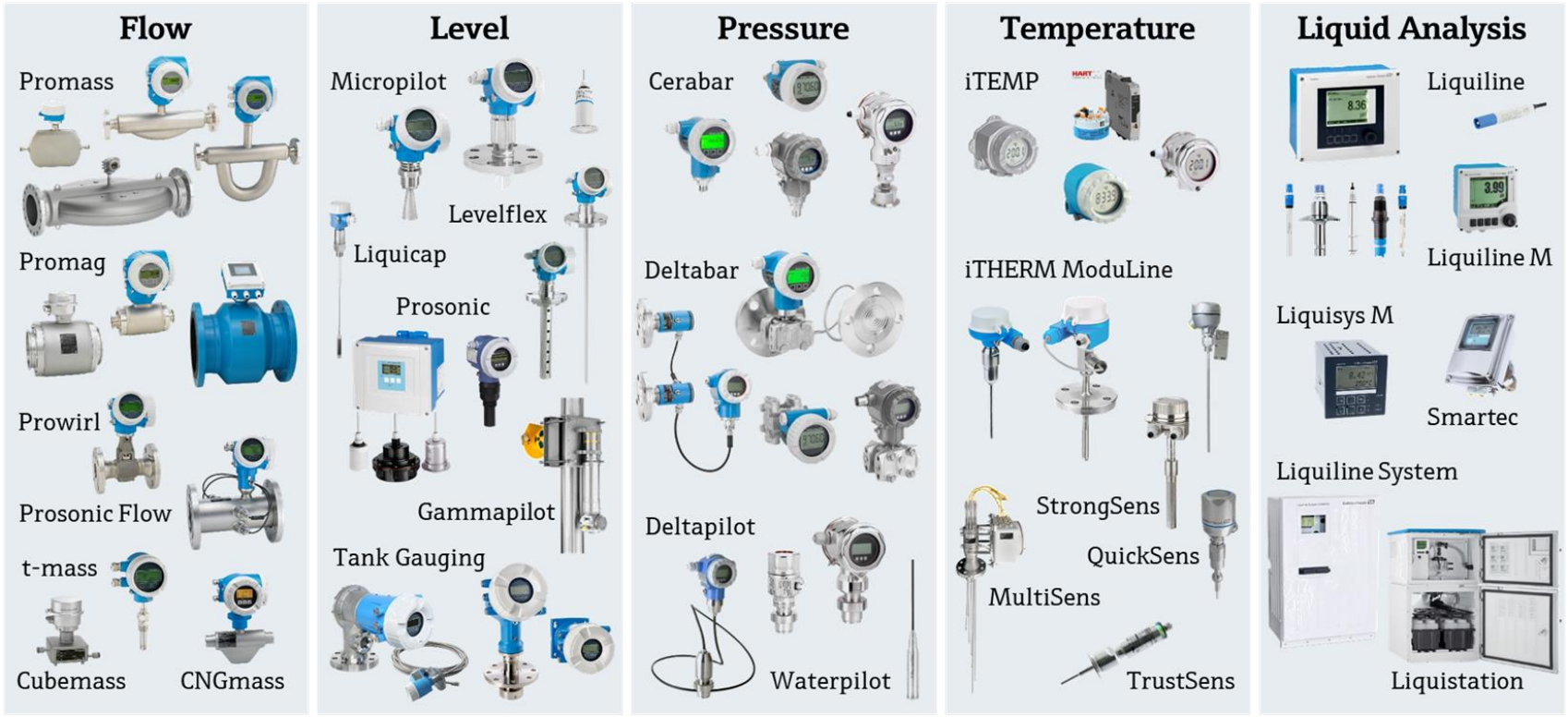
Scan and save my contact data

- worked in product and industry management in a wide variety of process industries at Endress+Hauser for almost 34 years
- Member of the Endress+Hauser core team for the global energy transition with hydrogen as a key element with a clear focus on implementing sustainable goals for decarbonization and defossilization
- Member for Endress+Hauser at the European Clean Hydrogen Alliance

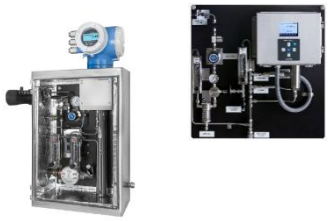
Endress+Hauser (Deutschland) GmbH+Co. KG , Colmarer Str. 6,
79576 Weil am Rhein

Facts & Figures 2023

The Portfolio in Process Measurement



SIL 3
IEC 61508 / IEC 61511
Safety Integrity Level
SIL 2
IEC 61508 / IEC 61511



+ Gas Analysis
Global Service & Compliance

Decarbonization of industrial sectors

McKinsey&Company

Decarbonization of industrial sectors: the next frontier

June 2018

Decarbonization options

Decarbonization options for the four focus sectors can be grouped into the following categories: (Exhibit 6)

- **Demand-side measures.** Decreasing the demand for an industrial product should lead to lower production and CO_2 emissions. For example, light-weighting can reduce the demand for steel, and cement could be replaced by materials such as wood. In addition, increasing the circularity of products, e.g., by increasing recycling or reuse of plastics and steel, would lessen CO_2 emissions by reducing the production of virgin materials.

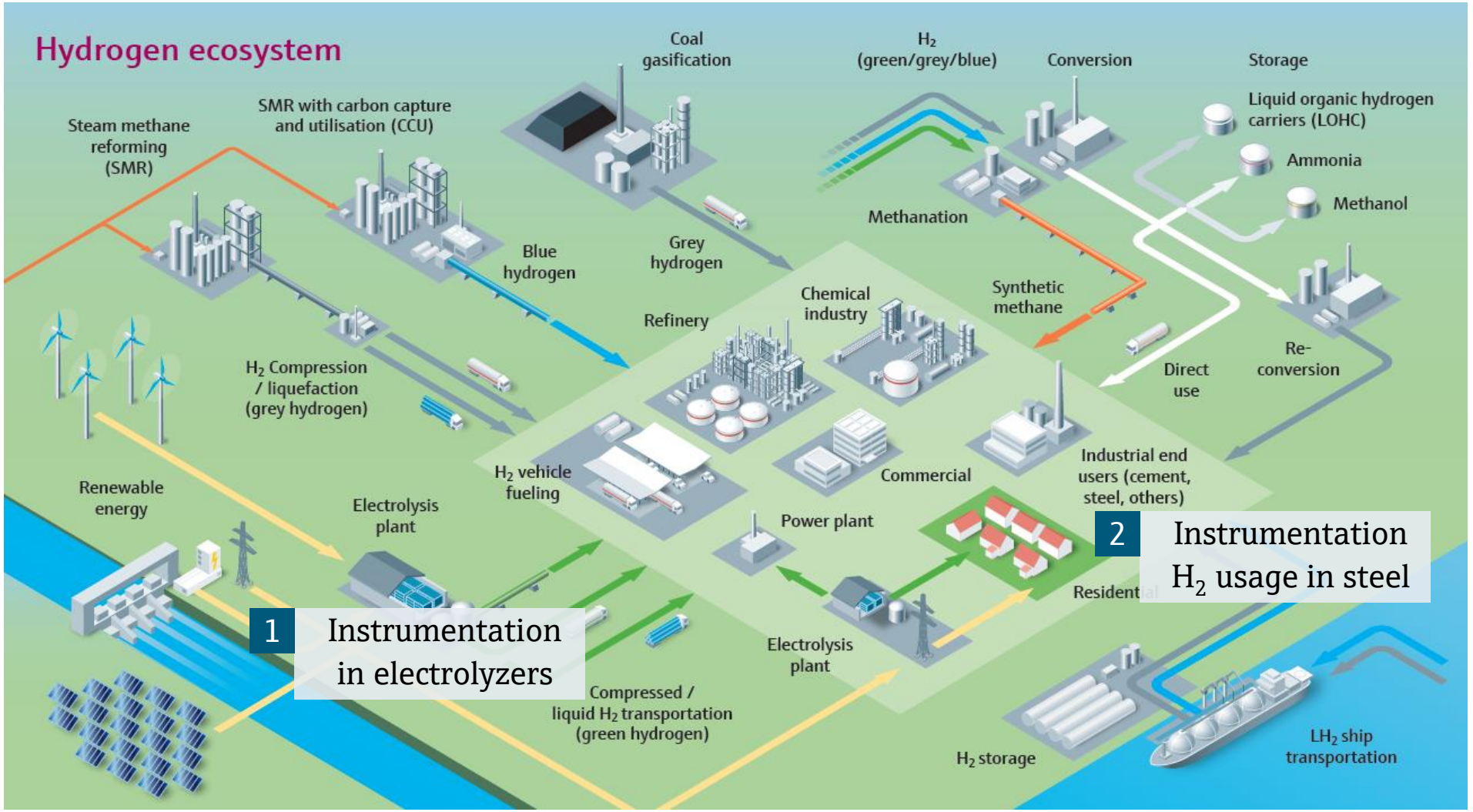
- **Energy-efficiency improvements.** Increases in energy efficiency can economically cut fuel consumption for energy use by 15 to 20 percent across sectors.[17] Potential gains in energy efficiency will differ between sectors and facilities. Generally speaking, developed regions will tend to be closer to the low end of that range, and developing regions closer to the high end. Using less fossil energy to make industrial products will lower CO_2 emissions.

- **Electrification of heat.** Emissions from the use of fossil fuels to generate heat can be abated by switching to furnaces, boilers, and heat pumps that run on zero-carbon electricity. Electrifying heat can involve a change in the production processes. For example, to electrify ethylene production, companies need to install both electric furnaces and electrically driven compressors.

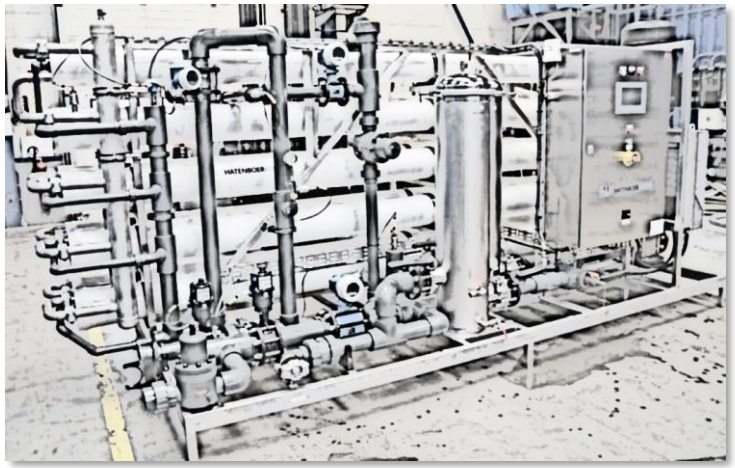
- **Hydrogen usage.** Emissions from the consumption of fossil fuel for heat and emissions from certain feedstocks can be abated by changing them for zero-carbon hydrogen. In this report it is assumed that hydrogen is generated by using zero-carbon electricity for the electrolysis of water. For example, ammonia production can be decarbonized by replacing the natural gas feedstock with zero-carbon hydrogen.

Source : McKinsey 2018

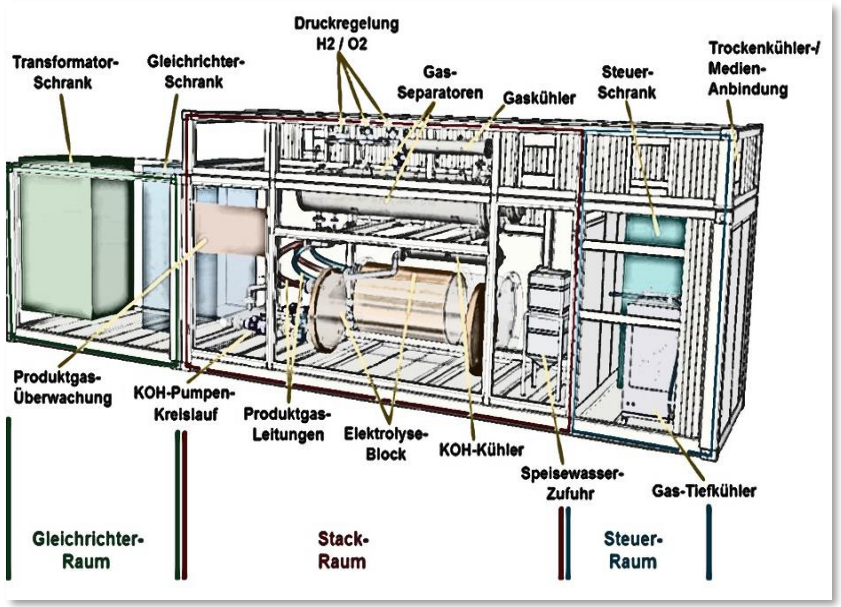
Hydrogen production route



1. Green hydrogen production from electrolyser – e.g. Alkali



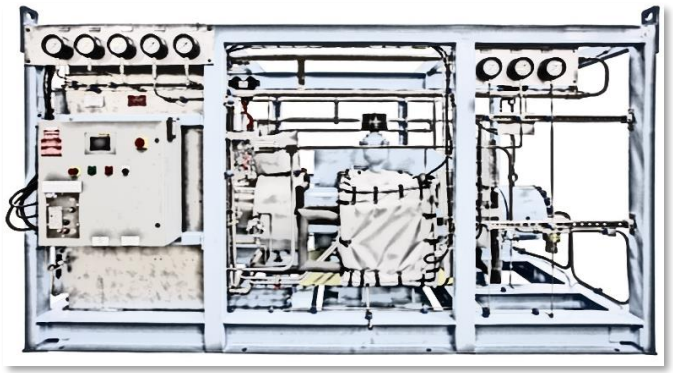
Water purification / demineralization



Electrolysis

Green Hydrogen

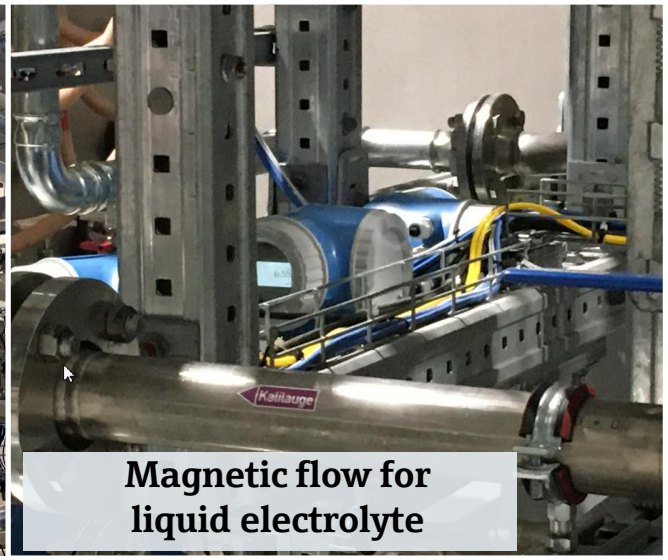
Green H_2 refers to hydrogen produced by the electrolysis of water, with the electricity used in the process coming from renewable sources such as sun, water and wind



Hydrogen compression

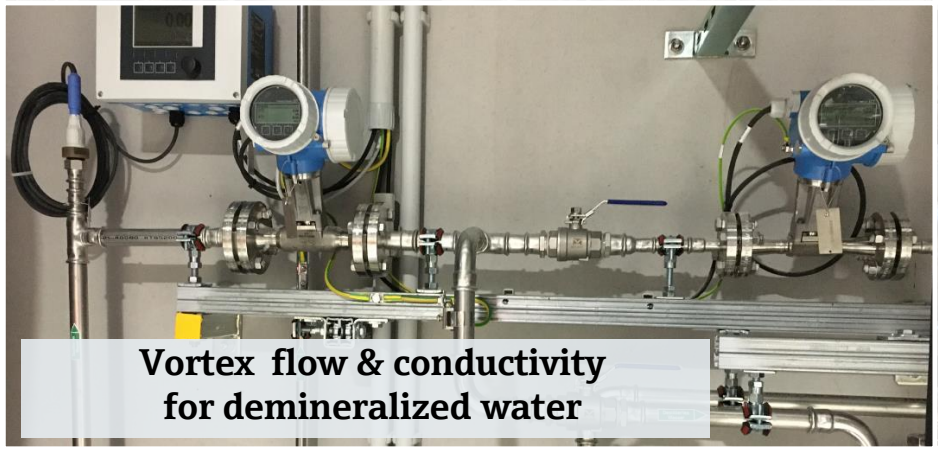
1. Reference installation in alkaline electrolyser – “Whylen – Germany”

Electrolyser Plant
–in operation since 2019

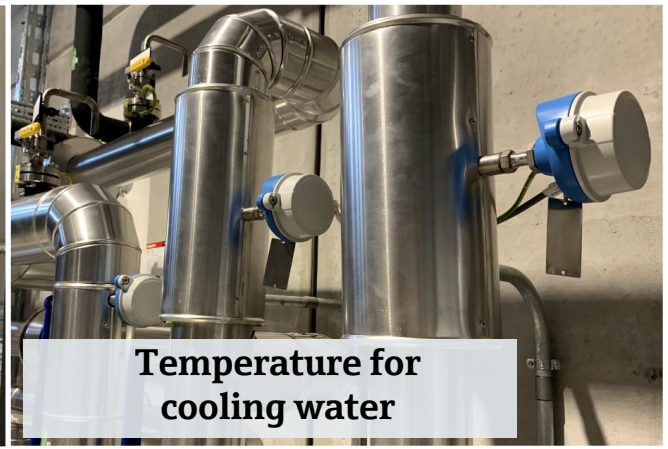


Magnetic flow for
liquid electrolyte

Pressure for
hydrogen cyclinder



Vortex flow & conductivity
for demineralized water



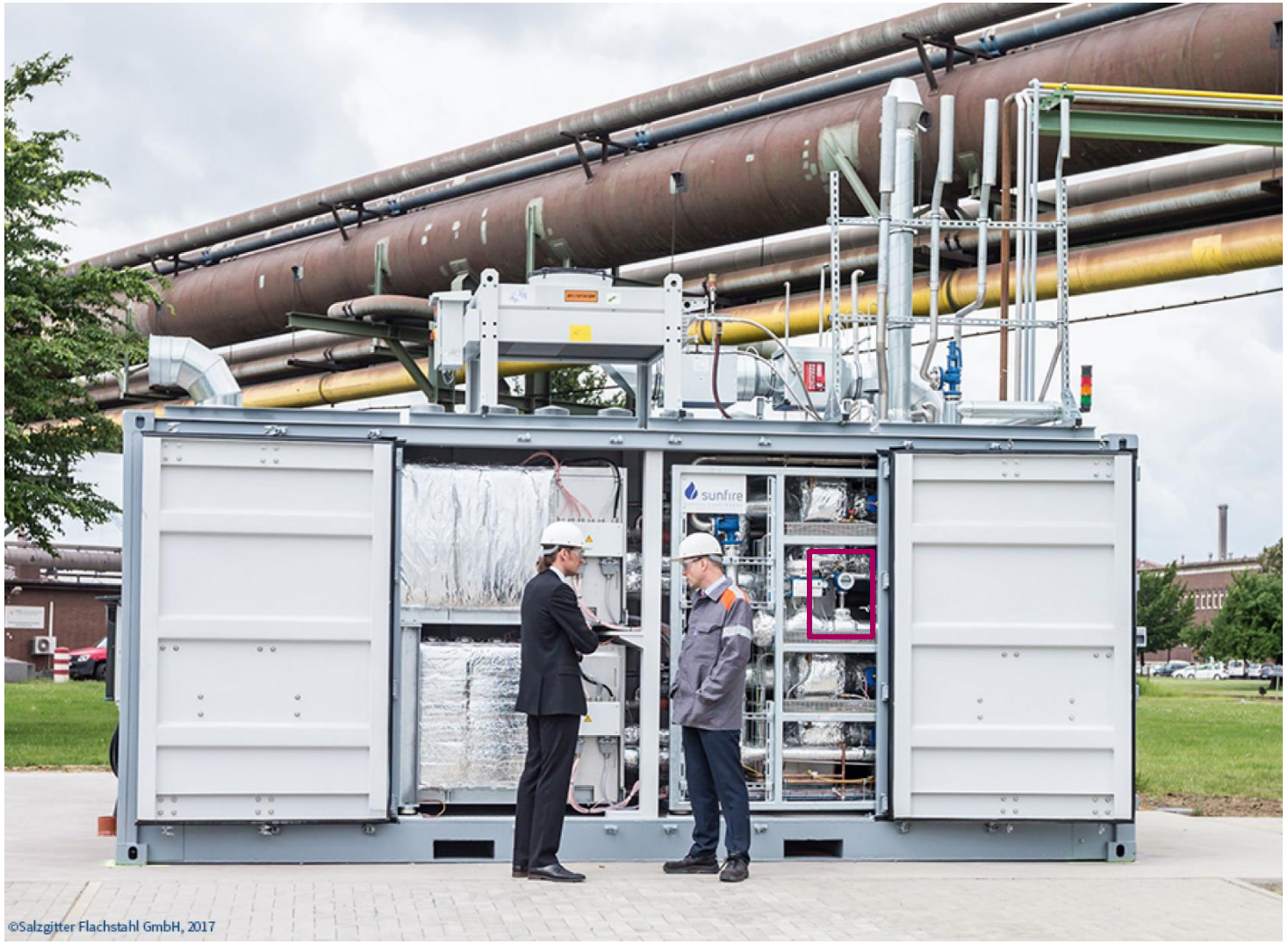
Temperature for
cooling water

1. Reference installation in another alkaline electrolyser

1. Reference installation in PEM electrolyzer

https://changes.endress.com/en/hitting-gas-hydrogen

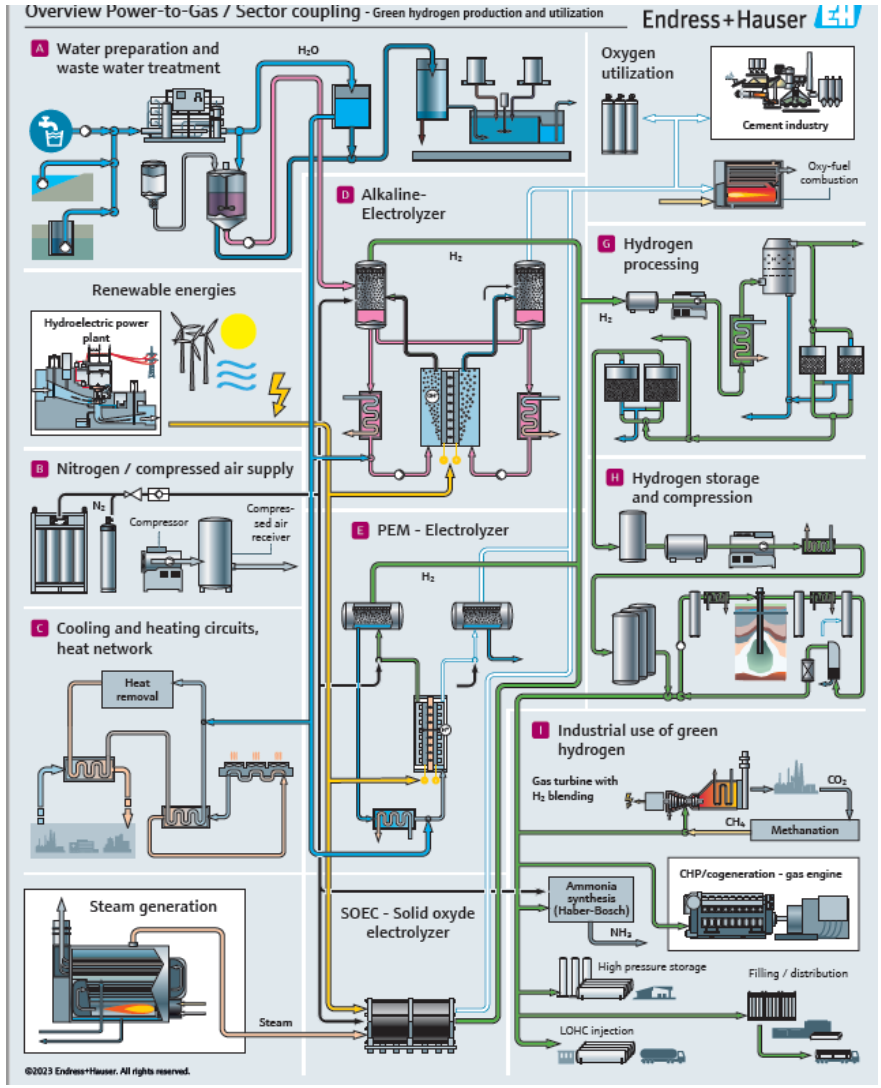
1. Reference installation in SOEC electrolyzer

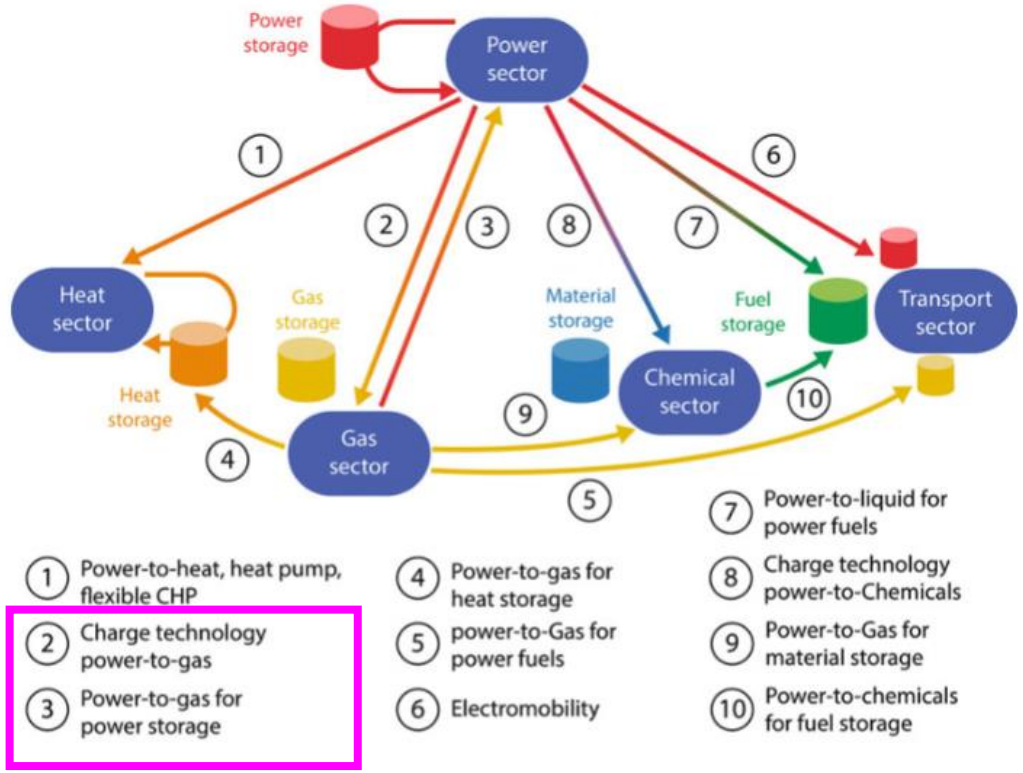


with thermal mass flow meter t-mass 150 measurement

and Coriolis mass flow meter in DN04 for small quantities of steam in kg/h (overheated)

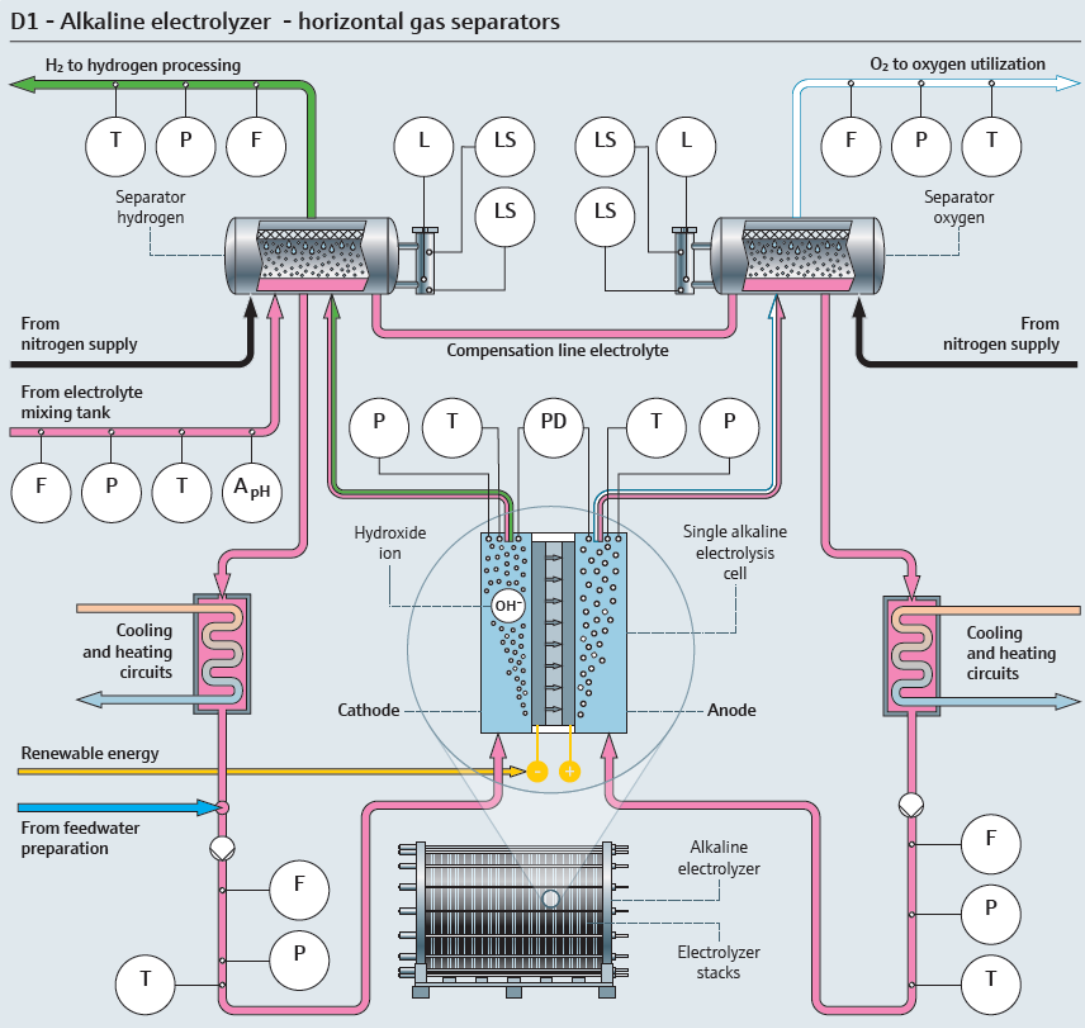
1. Power-to-Gas –Green H2 production and utilization– APPLICATOR (in prep.)

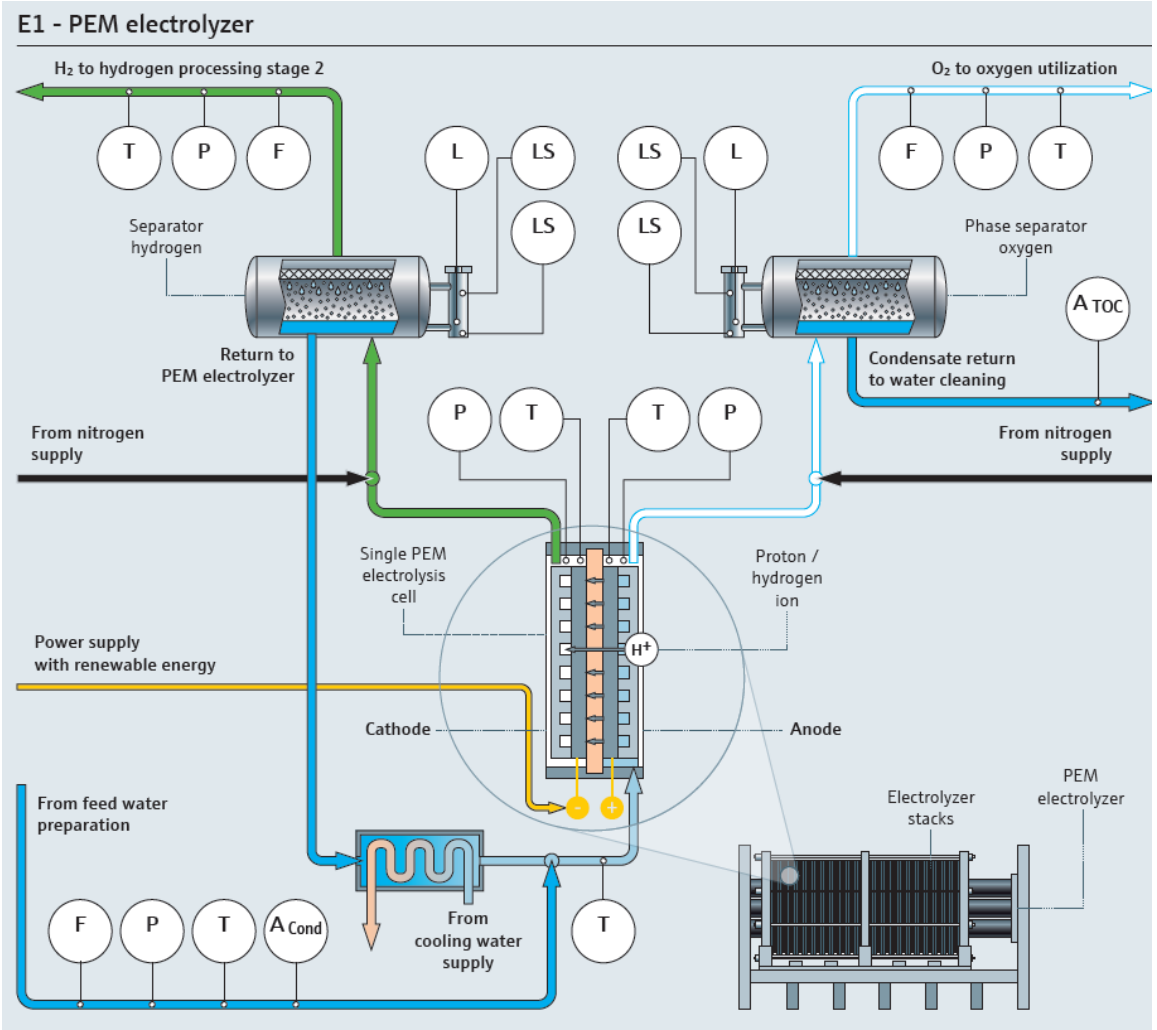




Source: Michael Sterner · Ingo Stadler Handbook of Energy Storage

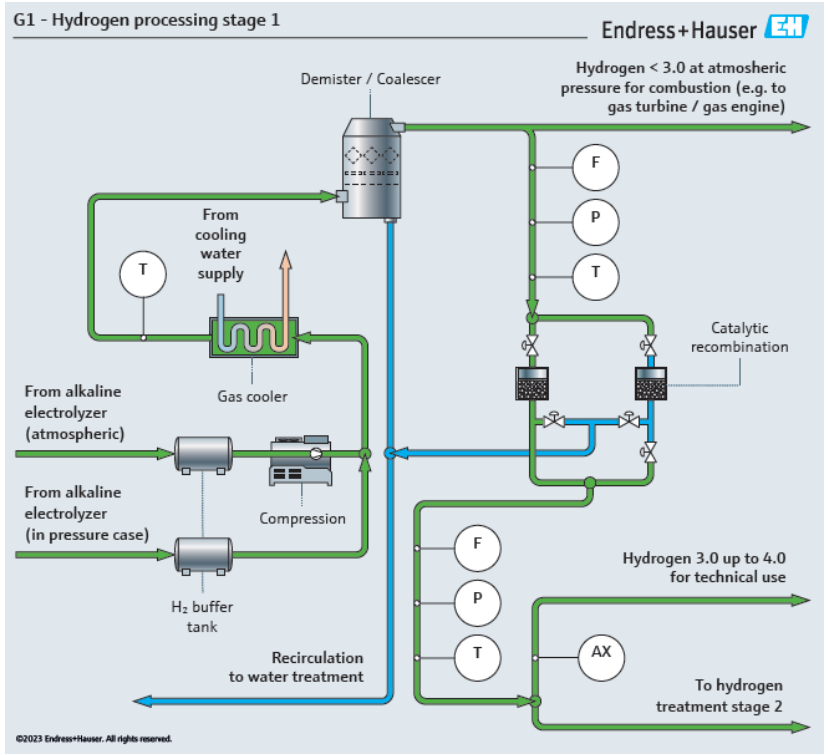
1. Alkaline & PEM Electrolyzers: Instrumentation

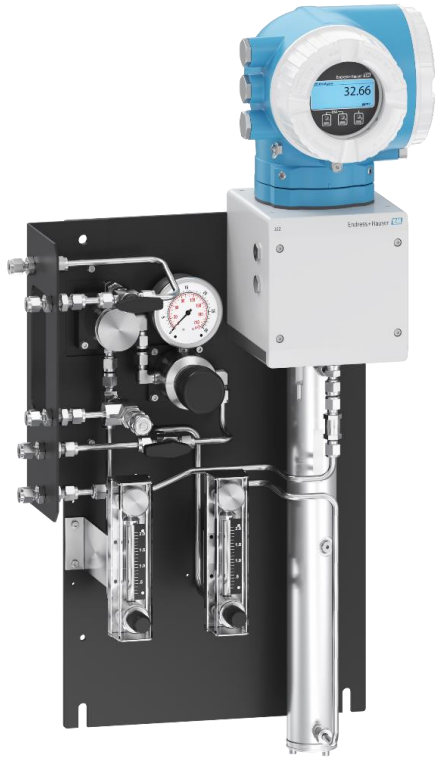




1. Hydrogen processing - optical Analysis solution for purity and quality 5.0

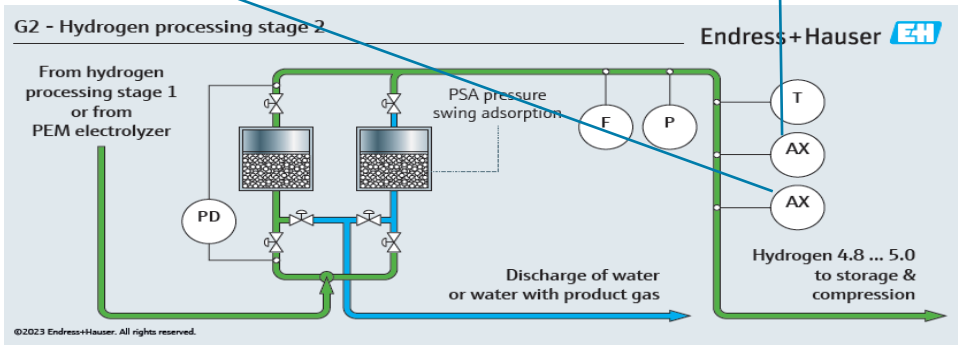
- Gas Analysis of trace oxygen and moisture in a gas stream, e.g. Hydrogen
- 2 analysis techniques: TDLAS + fluorescence spectroscopy
- 1 common system for gas sample preparation





0-5ppm
O_2 in H_2

0-5ppm
H_2O in H_2



1. First reference to the multi-component solution plus other measuring devices

1. Product portfolio for green hydrogen production

Flow (electrolyte + hydrogen)

Pressure and Temperature

Limit detection and level

Liquid analysis: conductivity ..

Gas analysis and composition

1. What Heartbeat Technology can do for you

Increase your plant availability and ...

... boost reliability as well as safety levels	... reduce your verification efforts	... improve your process performance

Heartbeat Technology

for diagnostics

Permanent process and device diagnostics

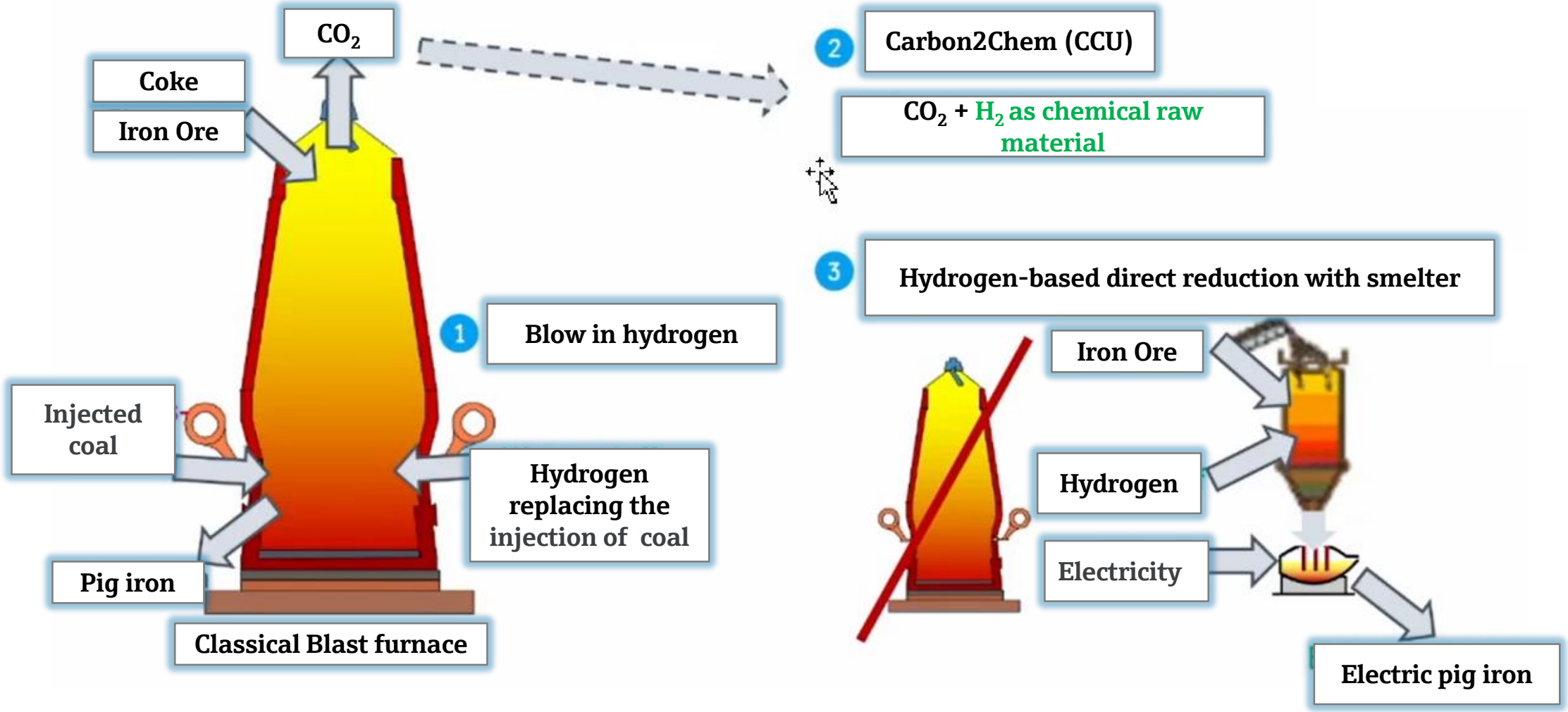
for verification

Documented device functionality without process interruption

for monitoring

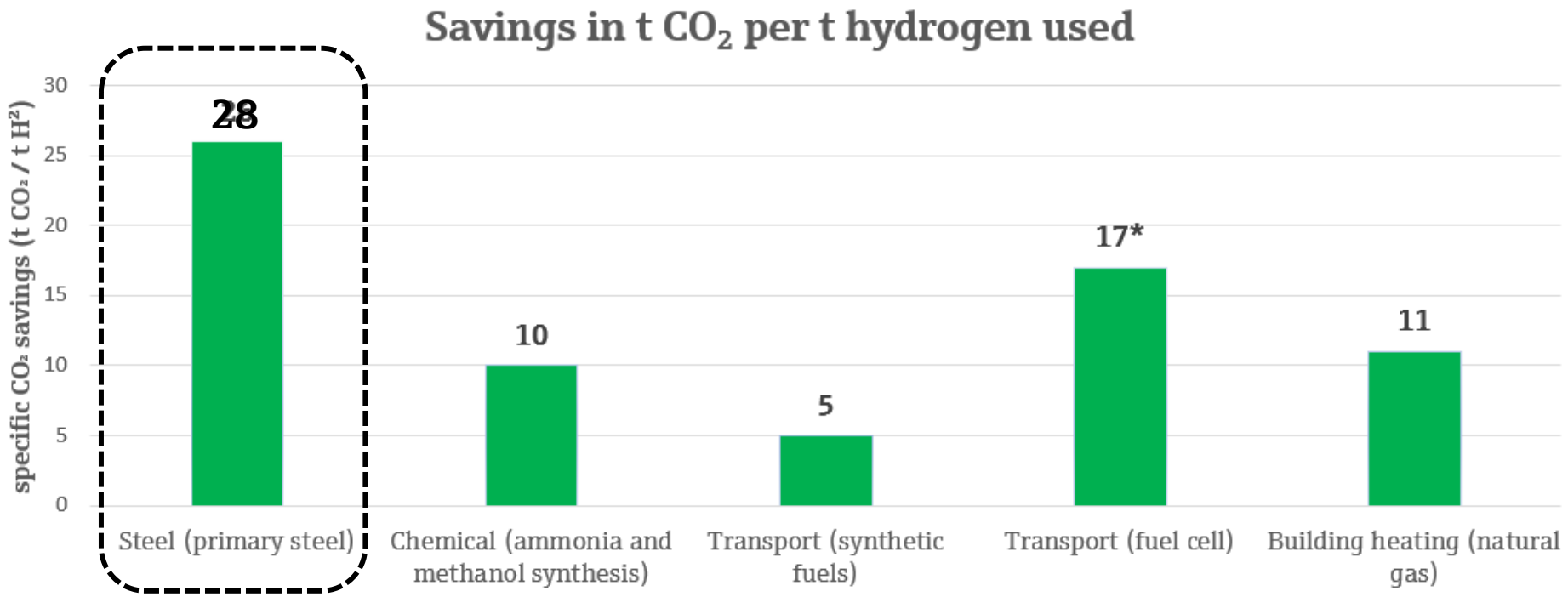
Information for process optimization and predictive maintenance

2. Schematic for climate-friendly steel production with hydrogen



Source : https://www.thyssenkrupp-steel.com/en/company/sustainability/climate-strategy/

2. Use of hydrogen: CO_2 reduction potential in an industry comparison



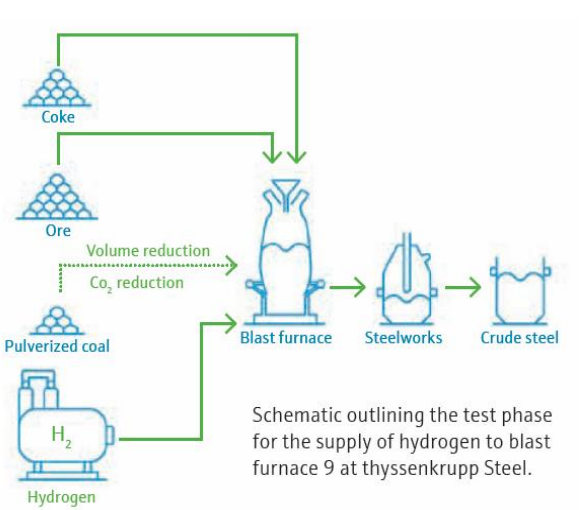
*** Average potential today and 2050**

Source: Calculations by WV Stahl, after obtaining a statement from the Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT

2. Thyssenkrupp: Hydrogen metallurgy in Blast Furnace

Groundbreaking use of hydrogen in a blast furnace

Steel production is resource-intensive and is one of the industries with the highest CO_2 emissions. In terms of reducing CO_2 emissions, the classic carbon-based methods used in the production of steel constrained by limits imposed by the process. thyssenkrupp Steel is currently conducting a series of tests at blast furnace 9, with the aim of reducing CO_2 emissions through the use of hydrogen.



Schematic outlining the test phase for the supply of hydrogen to blast furnace 9 at thyssenkrupp Steel.

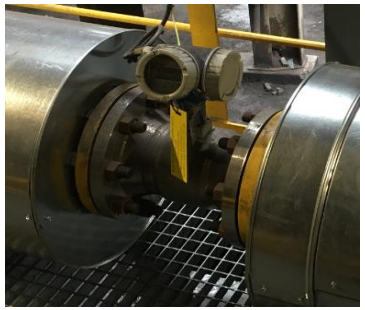
Valve station at blast furnace with vortex flowmeter plus pressure and temperature compensation for hydrogen measurement.

Instrumentation for Hydrogen :

- 1 x flow Prowirl Vortex
- 1 x pressure Cerabar
- 1 x temperature Moduline

Source : https://www.thyssenkrupp-steel.com/en/company/sustainability/climate-strategy/

2. Dillinger steel works: coke oven gas usage



Products Solutions Services

Startklar für die grüne Transformation

Dillinger und Saarstahl kochen jetzt mit Wasserstoff

DILLINGER

Die Grobblechproduktion bei der Dillinger Hütte in Dillingen

Die Dillinger Gruppe bietet für ihre Kunden höchste Qualität und beste Serviceleistungen im Bereich Grobblech. Dies umfasst sowohl die Tätigkeiten eines integrierten Hüttenwerkes wie die Koks- und Roheisenerzeugung über die gemeinsam mit der Saarstahl AG gehaltenen Tochtergesellschaften, als auch das Herstellen von Flüssigstahl und Halbzeugen. Die Grobblechproduktion erfolgt an zwei Standorten, zum einen bei der Dillinger Hütte in Dillingen, zum anderen bei Dillinger France in Dünkirchen.

Die erste Anlage deutschlandweit zur wasserstoffbasierten Stahlproduktion über die Hochofenroute ging am 21. August 2020 in Dillingen in Betrieb. Damit verringern Dillinger und Saarstahl weiter ihre CO_2-Emissionen und schaffen die Voraussetzung, grünen Wasserstoff in der Praxis einzusetzen.

Die Herausforderung Die Stahlindustrie in Deutschland soll eine Vorreiterbranche in der Arbeit mit Wasserstoff werden. Das Ziel ist „grüner", CO_2-freier Stahl. Es geht darum, wasserstoffreiches Kuppelgas in den Hochofen einzubringen. Ganz vereinfacht gesagt wird dadurch Kohlenstoff durch Wasserstoff ersetzt und so am Ende weniger CO_2 in die Luft geblasen. In der tatsächlichen Praxisanwendung ist dieses Verfahren nach Unternehmensangaben eine Premiere in Deutschland. Die Stahlbranche steht aktuell unter Druck, weiter CO_2 einzusparen, auch um Vorgaben der EU einzuhalten.

Unsere Lösung Dank der neuen Koksgas-Eindüsungssysteme der Firma Paul Wurth wird Koksgas zu einem metallurgischen Prozessgas, anstatt es bei niedrigem Wirkungsgrad für die Energieerzeugung zu nutzen. In dieser neuen Rolle wird das Koksgas als Reduktionsmittel sowohl Staubkohle als auch metallurgischen Koks im Hochofenprozess teilweise ersetzen. Somit wird es dazu beitragen, die Kohlenstoffintensität im Hochofen sowie den Kohlenstoff-Fußabdruck der Eisenerzeugung im Ganzen zu verringern. Im Rahmen der Strategie von Paul Wurth zu einer kohlenstoffneutralen Primärmetallurgie zu gelangen, ist das Konzept der Koksgaseindüsung in die Blasform eine der sofort verfügbaren Lösungen zur schrittweisen Reduzierung der CO_2-Emissionen in bestehenden integrierten Hüttenwerken. Auf Grund der langjährigen, partnerschaftlichen Kundenbeziehungen zu beiden Unternehmen, wurde die Anlage mit Endress+Hauser Messtechnik ausgerüstet.

Endress+Hauser
People for Process Automation

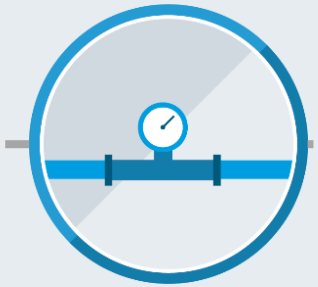
Source : https://www.dillinger.de/d/en/news/press-releases/it-s-all-systems-go-for-the-green-transformation-94472.shtml

Our Offering across the Hydrogen Value Chain

Production

Storage

Transport



Utilization

Quality measurement

Quantity measurement

Composition measurement

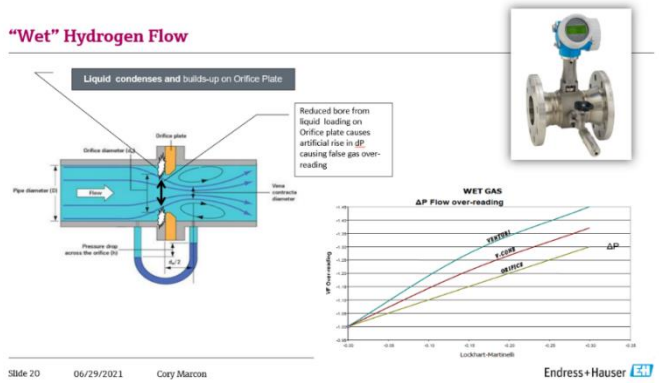
Hydrogen: installed base and project examples

LH_2 Level

0-5ppm H_2O in H_2

0-5ppm O_2 in H_2

Wet H_2 Flow



PEM / Alkali-Instrumentation

H_2% in NG CCGT power plant

Our Contribution towards a Green and Sustainable Future

We are committed and support decarbonization and climate goal initiatives.

We are investing in people, products, solutions and services to support the development of hydrogen industry.

Our products are developed with highest standards of process and environmental safety.

Our product portfolio supports online measurement of quantity and quality parameters in the hydrogen production, storage, transportation and end use processes.

Thanks for your attention and do you have any questions?