Project REFYHNE at the Shell Rhineland Refinery - Building the world largest PEM electrolyser

Green Hydrogen Webinar

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The German “Energiewende”

Climate Protection Plan 2050 with targets set for 2030

Area of action	1990 (in million tonnes of CO_2-equivalent)	2014 (in million tonnes of CO_2-equivalent)	2030 (in million tonnes of CO_2-equivalent)	2030 (reduction in % compared to1990)
Energy Sector	466	358	175 - 183	62 - 61 %
Buildings	209	119	70 - 72	67 - 66 %
Transport	163	160	95 - 98	42 - 40 %
Industry	283	181	140 - 143	51 - 49 %
Agriculture	88	72	58 - 61	34 - 31 %
Subtotal	1.209	890	538 - 557	56 - 54 %
Other	39	12	5	87 %
TOTAL	**1.248**	**902**	**543 - 562**	**56 - 55 %**

Source: Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit, Klimaschutzplan 2050, 14. November 2016, S.4.

New Energy Transition Opportunity:

The REFHYNE Project embedded in the Shell Rhineland Refinery

10 MW PEM Electrolyser

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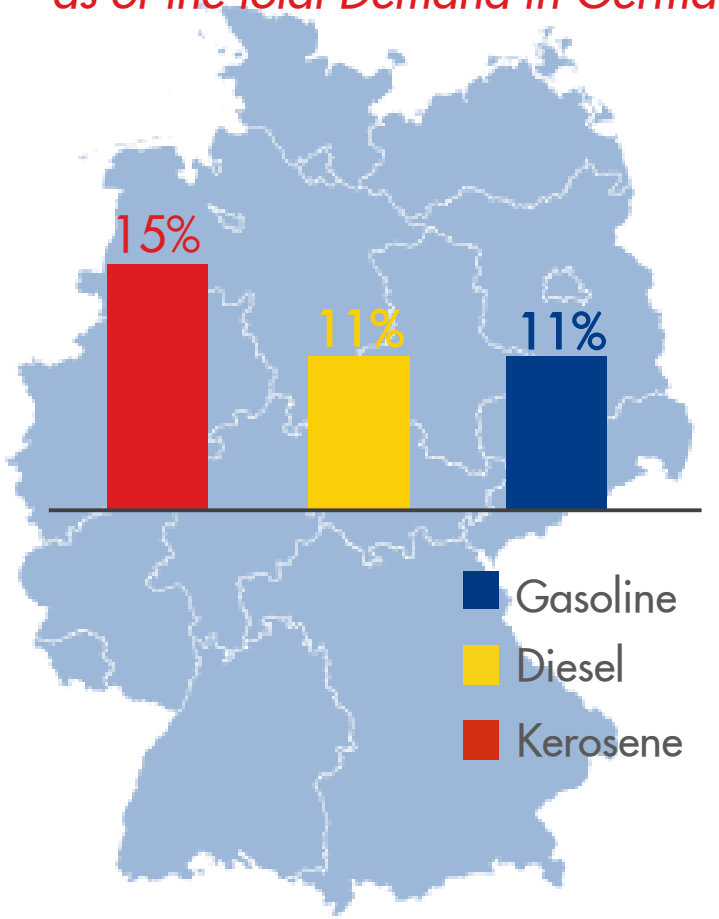
Shell Rhineland Refinery – Major Energy Supply Hub

- Crude Oil throughput of more than 17 million tons per year
  - Largest refinery in Germany
  - Crude arrives via pipeline from Rotterdam and Wilhelmshaven

- Supply Channels from Rhineland:
  - 34 percent via ship and own harbours
  - 28 percent via road
  - 22 percent via pipelines
  - 11 percent via pipelines to neighbour industries
  - 5 percent via rail

Percentage of the Rhineland Refinery Supply as of the total Demand in Germany



About 180,000 tons of annual hydrogen demand in the Rhineland Refinery

Used for:
- De-Sulphurisation (Gasoil, Naphtha)
- Cracking (Hydrocracker)

Produced by:
- Platformers (Mogas Upgrading)
- Steam Cracker
- Gasifiers
- Steam Methane Reformer (SMR)

About 20-30% is produced through SMRs based on natural gas:

=> This could be potentially replaced by hydrogen from electrolysers based on renewable power

=> GREEN HYDROGEN reducing the refinery CO_2 footprint

REFHYNE – Building the world-wide largest PEM-Electrolyser

Investing in the future

- Construction of the world's largest PEM hydrogen electrolysis with ITM
- Completion in 2021
- 10 megawatts
- 1,300 tons of production capacity
- Connection to the existing electricity and water network

Why lighthouse project?

- First large-scale water electrolyser integrated in a refinery
- Green hydrogen production for the refining process
- Reduction of CO2 footprint of the refinery
- Build experience in grid balancing services
- Stepping stone to and reference for the 100 MW class

REFHYNE
CLEAN REFINERY HYDROGEN FOR EUROPE

ITM POWER
Energy Storage | Clean Fuel

SINTEF

elementenergy

sphera™

REFHYNE Ground Breaking Event: June 25th 2019

Brussels/Cologne, June 25th, 2019

Construction starts on the world's largest PEM electrolyser at Shell's Rheinland Refinery

Ground-breaking ceremony for a new hydrogen electrolysis plant at the Shell Rheinland refinery in Wesseling, Germany, that will help contribute to a cleaner, lower-carbon energy future.

The total investment is at 16 million euros, of which the European Fuel Cell Hydrogen Joint Undertaking contributes 10 million euros, 6 million euros will be contributed by the REFHYNE consortium with Shell, ITM Power, SINTEF, thinkstep and Element Energy.

Construction of the new plant, which features advanced polymer electrolyte membrane (PEM) technology, is expected to be completed in the second half of 2020. The plant will produce up to 1,300 tons of hydrogen per year when operating at peak rates.

Hydrogen will be produced using electricity instead of natural gas. Producing hydrogen with electricity generated from renewable power sources could help significantly reduce CO2 emissions from the Shell Rheinland refinery.

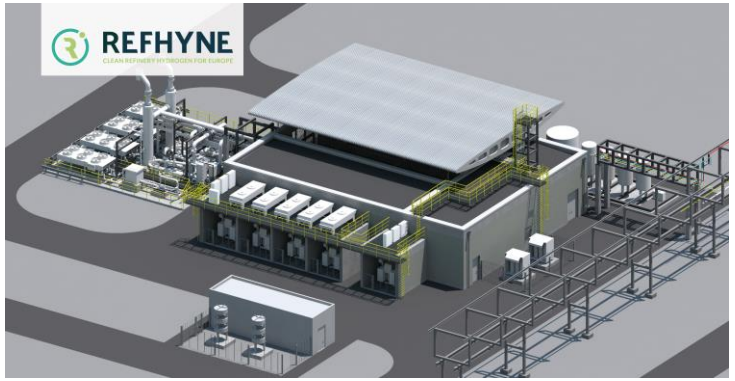
ITM POWER Energy Storage | Clean Fuel

SINTEF

thinkstep

elementenergy

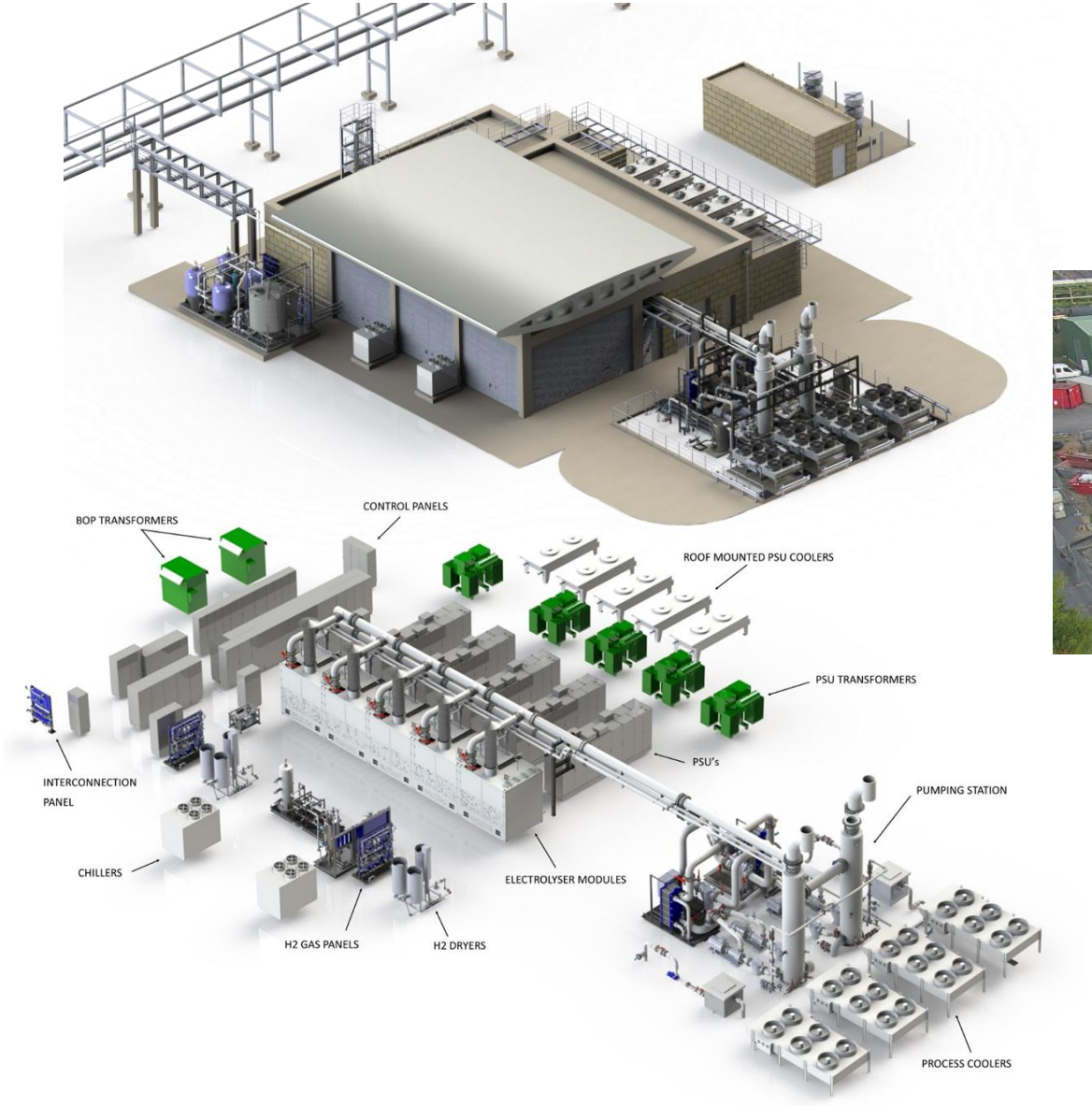
REFHYNE 10 MW Electrolyser – Design



Visit by the EU Commissioner Kadri Simson and the NRW Minister of Economic Affairs Prof. Andreas Pinkwart on July 6th, 2020

Welcome in the Shell Refinery in Corona times visiting the REFHYNE construction site and the inauguration of the first hydrogen car for the refinery

From Design to Implementation (today)



Today

- So far in the construction more than 25,000 hours were spent with more than 2,500 tons of concrete and more than 110 tons of steel reinforcements.

- Around 30 staff on site for the ongoing installation

- On target for Shell's Goal Zero target, with no HSE incidents.

REFHYNE – Platform for New Opportunities

Rheinland Refinery
-> Industrial Use for Hydrogen
-> EU RED II Opportunities

Hydrogen for Mobility (HRSs)
-> cars, buses, trucks, trains, ships

REFHYNE – 10 MW Electrolyser

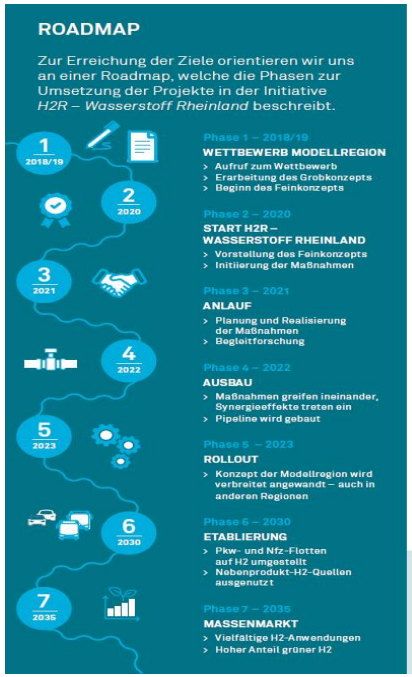
RVK Cologne (local bus comp.)
-> 50 H2 buses operat. by end '20

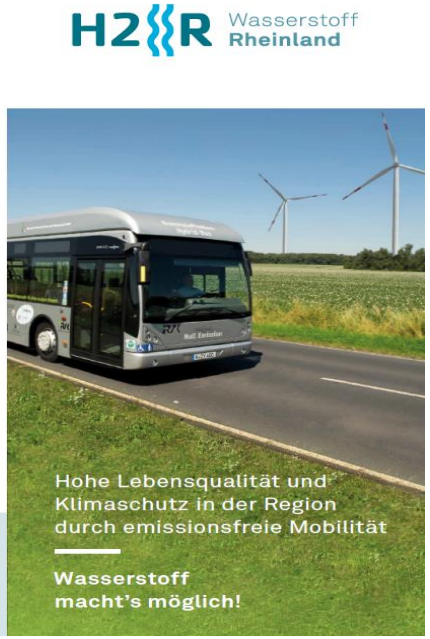
Power Market
-> Primary/Secondary Grid Balancing

Lighthouse Project for the EU FCHJU

Platform for synthetic
e-fuels for aviation

Target: Development of an innovative H_2 Supply Chain for large H_2 consumers like buses, trucks, trains, ships for the H_2 Model Region Rheinland (H2R) and along the river Rhine





To be implemented as of the H_2 Rheinland Region Concept, developed by the consortium, supported by the State of NRW and submitted in September 2020

see also:
https://www.wasserstoff-rheinland.de/