



**DURATION & TYPE**  
**TYPE: Demonstration**

# DEMO4GRID

## FUNDED BY



**FUEL CELLS AND HYDROGEN  
 JOINT UNDERTAKING**

Schweizerische Eidgenossenschaft  
 Confédération suisse  
 Confederazione Svizzera  
 Confederaziun svizra  
 State Secretariat for Education,  
 Research and Innovation SIK

## CONSORTIUM MEMBERS



FUNDACIÓN PARA EL  
 DESARROLLO DE LAS NUEVAS  
 TECNOLOGÍAS DEL HIDRÓGENO  
 EN ARAGÓN

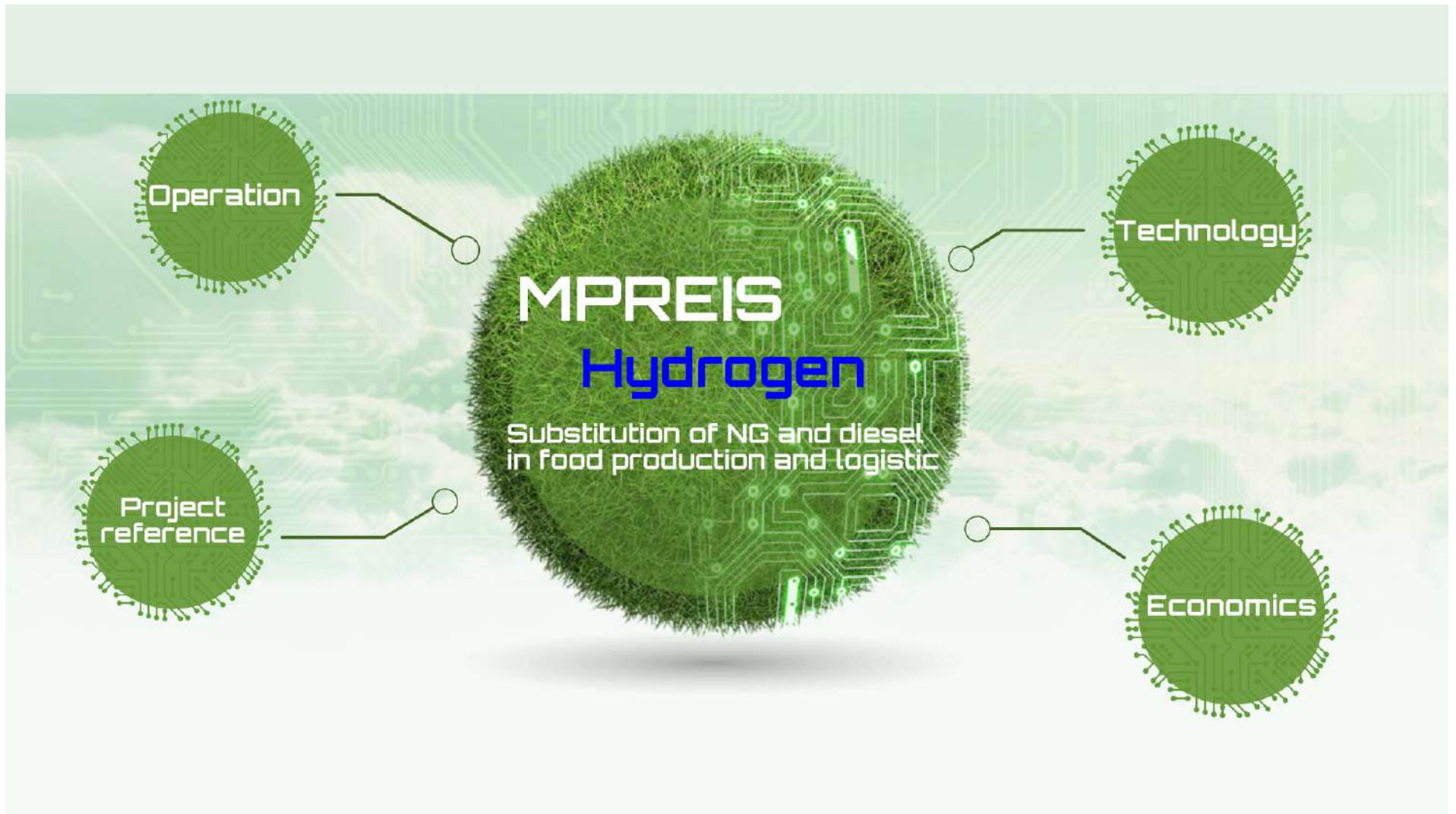


## FCH-02-7-2016:

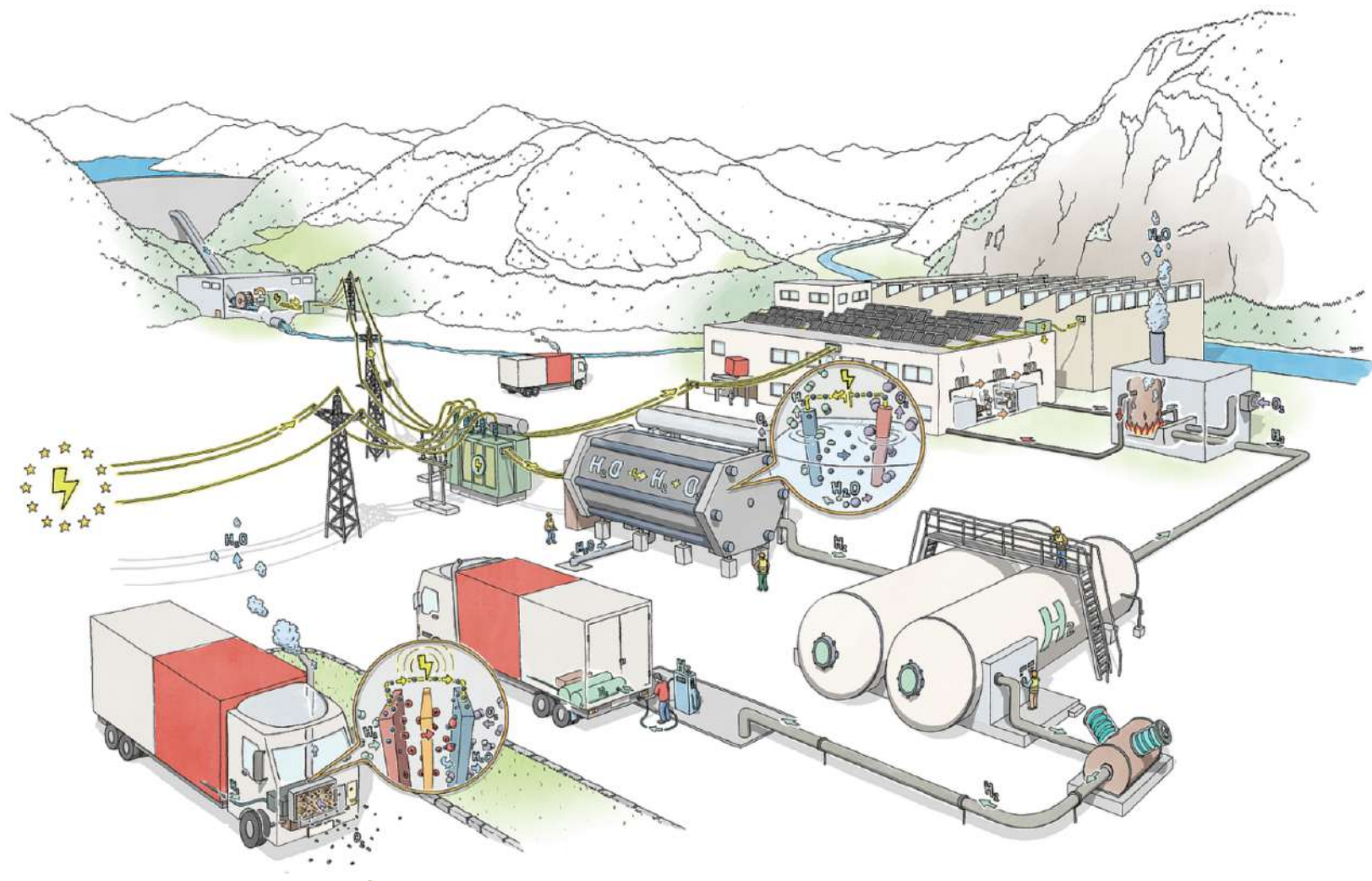
Demonstration of large-scale rapid response electrolysis to provide grid balancing services and to supply hydrogen markets

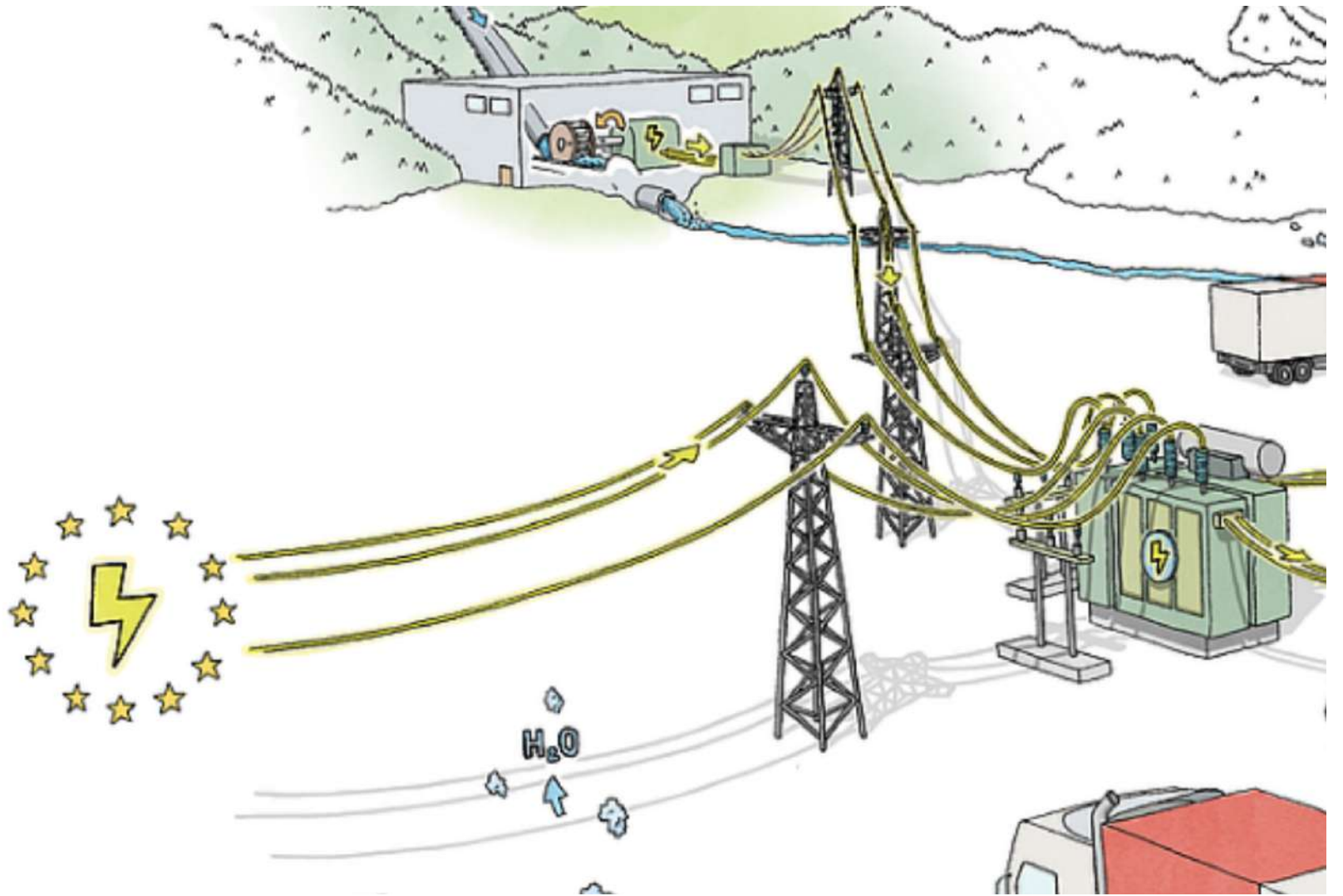
## OBJECTIVE:

to deploy and monitor improved electrolyser systems configured to attract revenues from grid services and leveraging timely power price opportunities, in addition to providing hydrogen (and potentially oxygen) for high value markets.



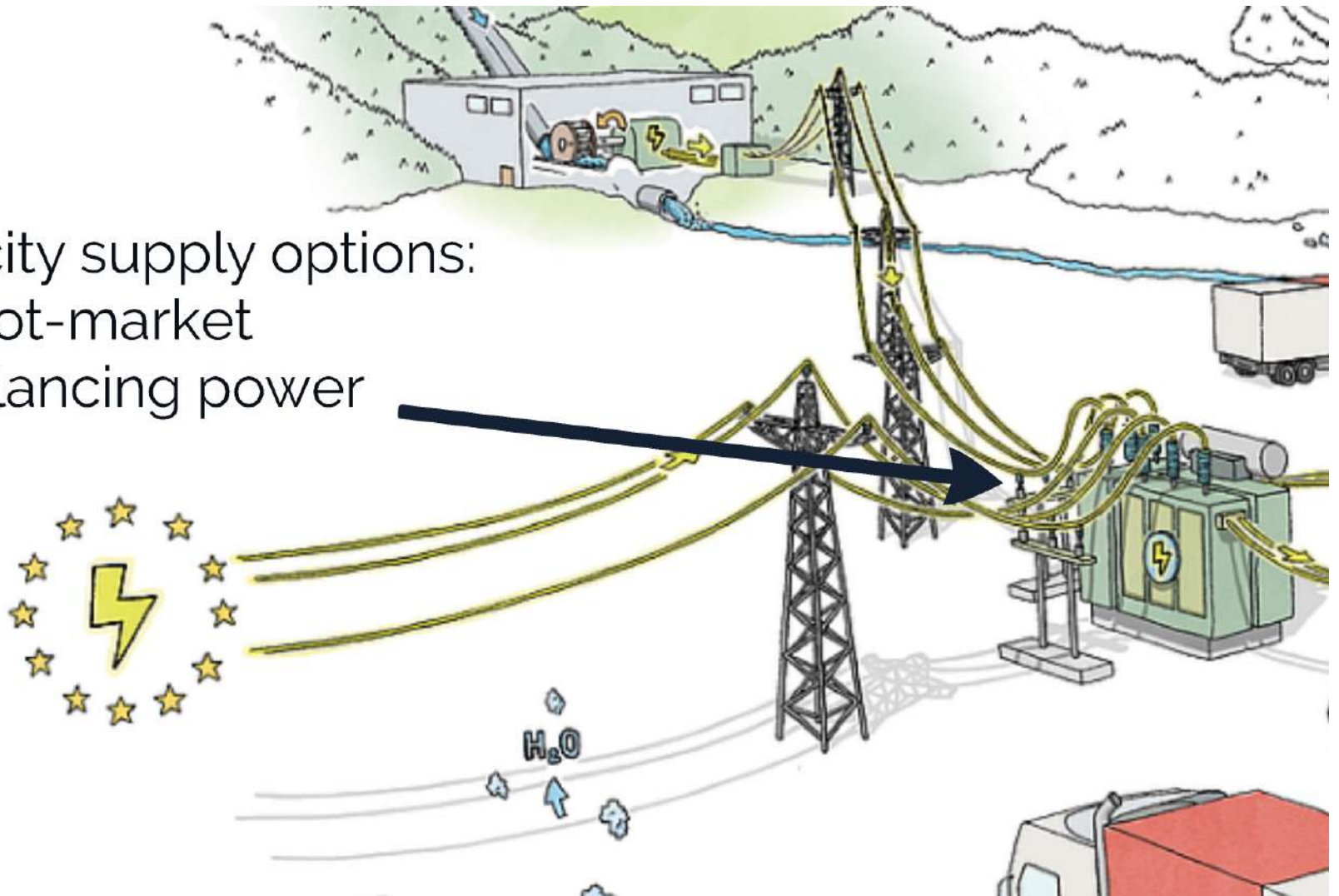






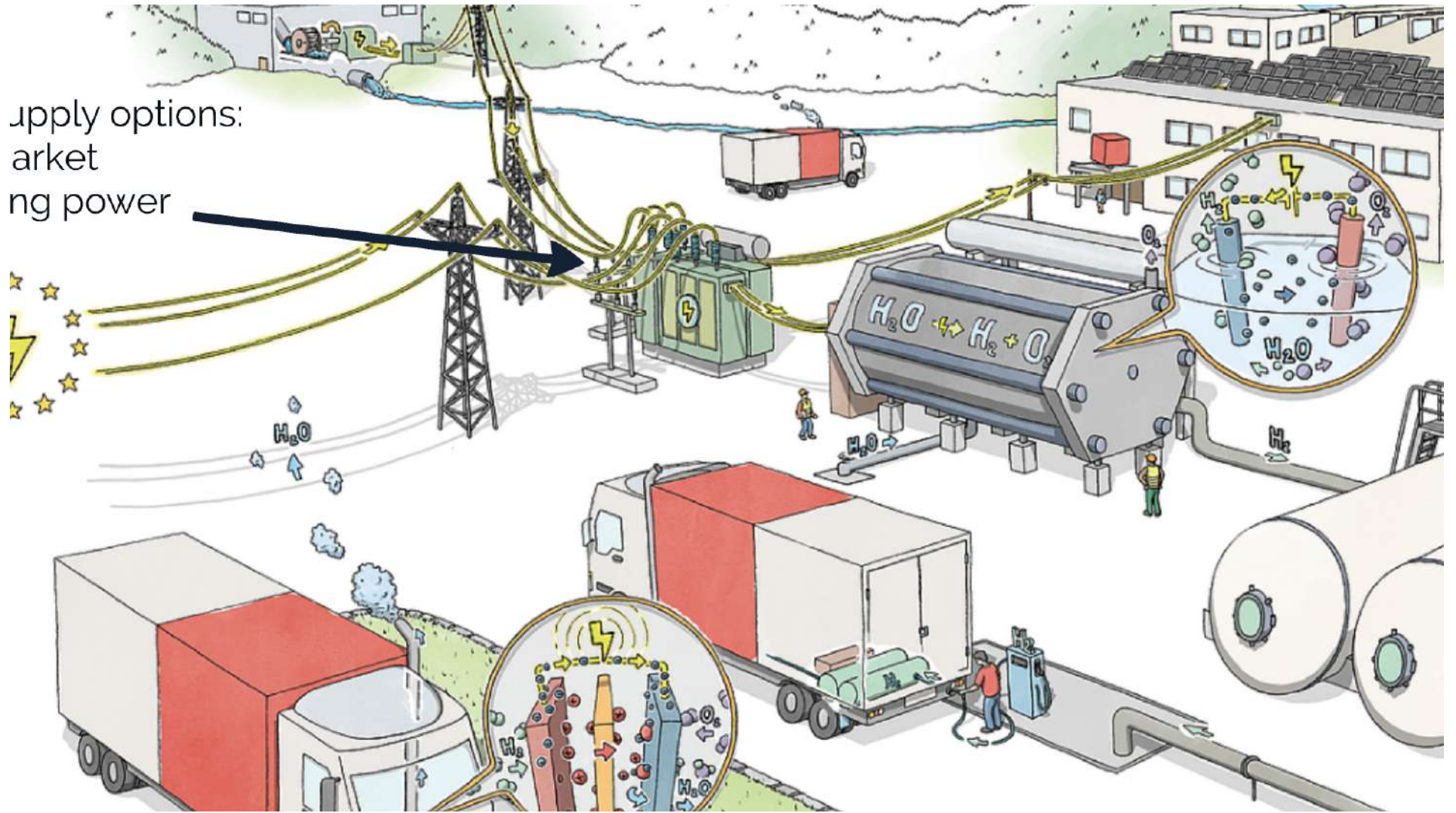
## Electricity supply options:

- Spot-market
- Balancing power

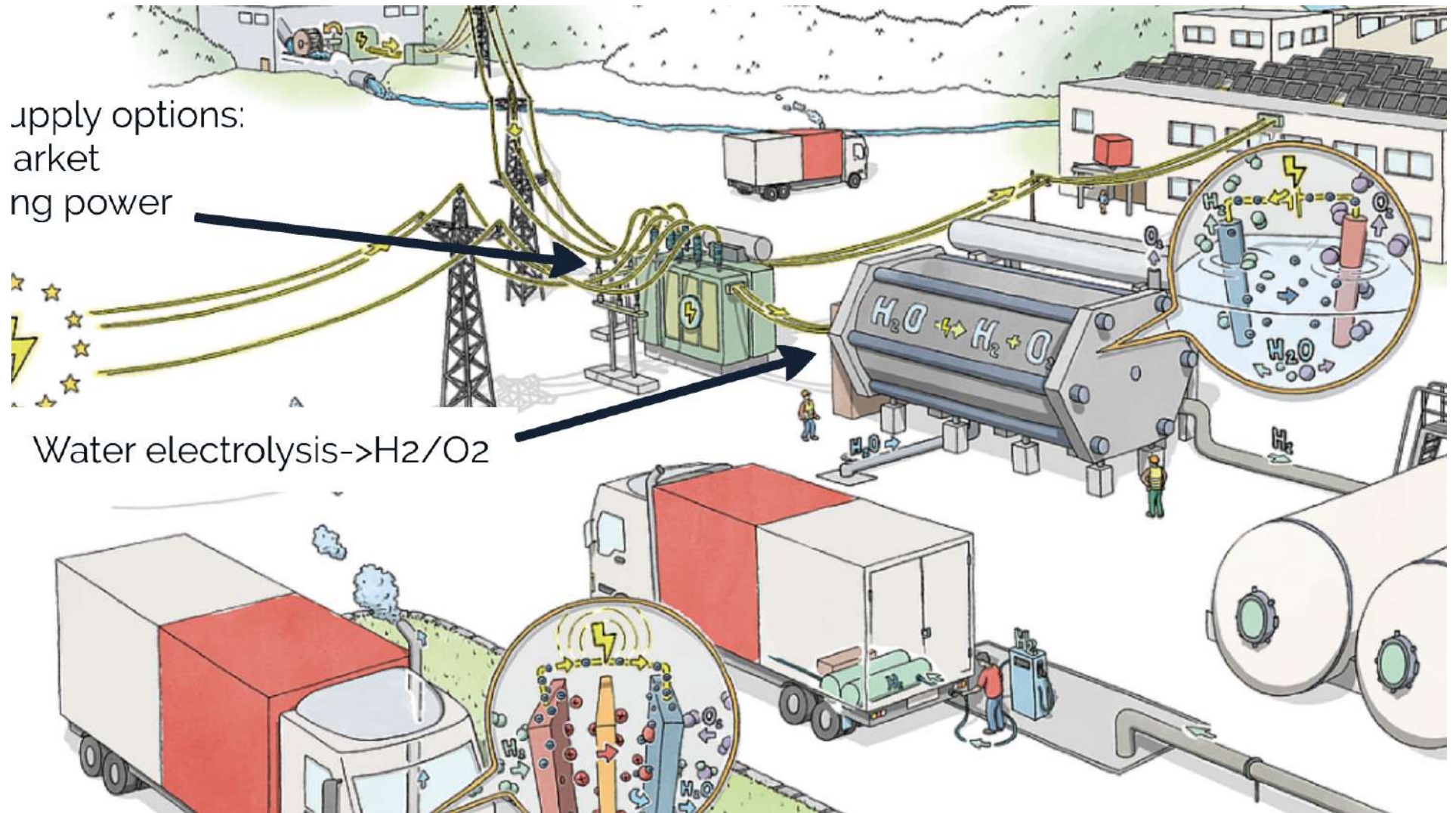




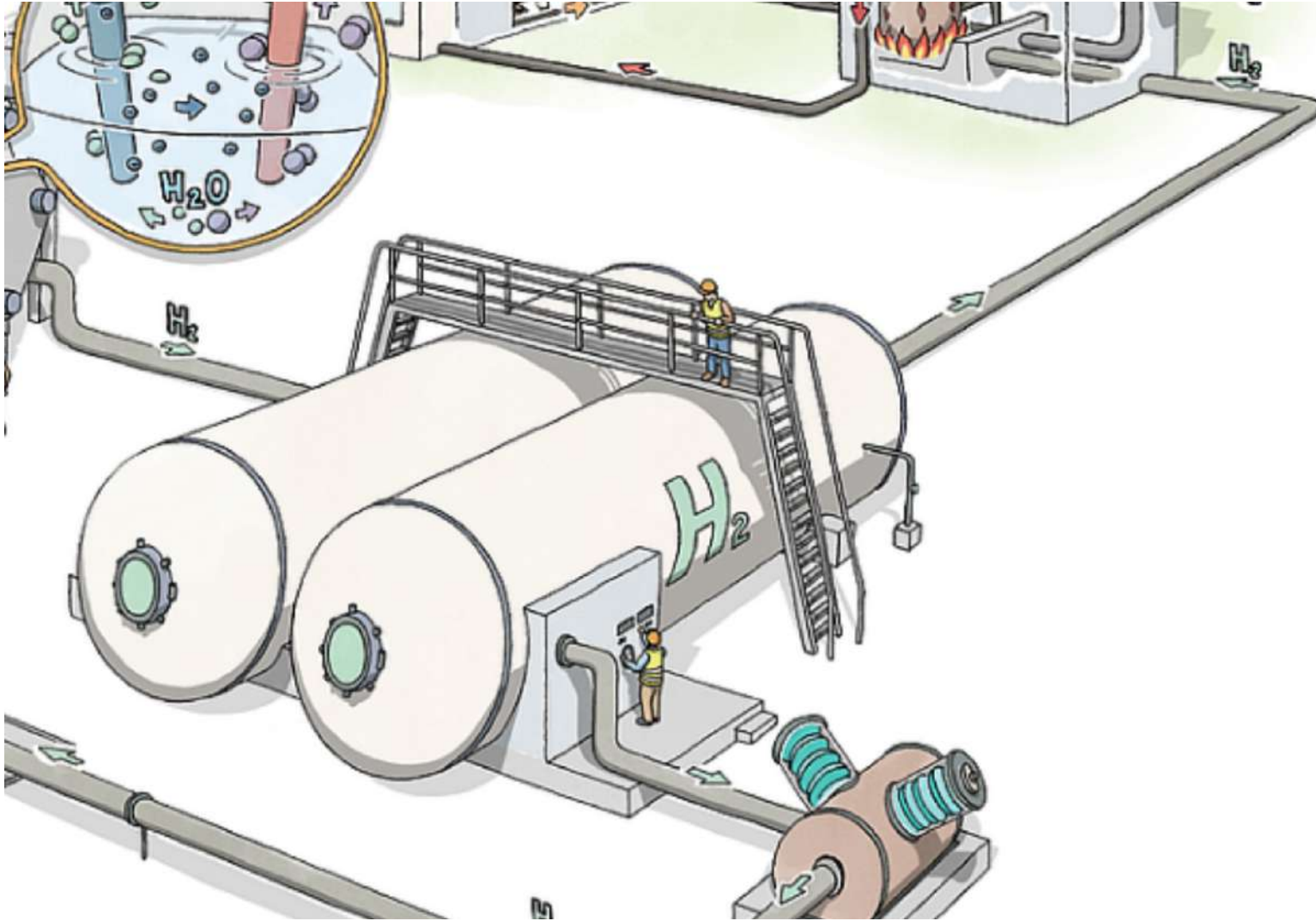
Supply options:  
Market  
Generating power

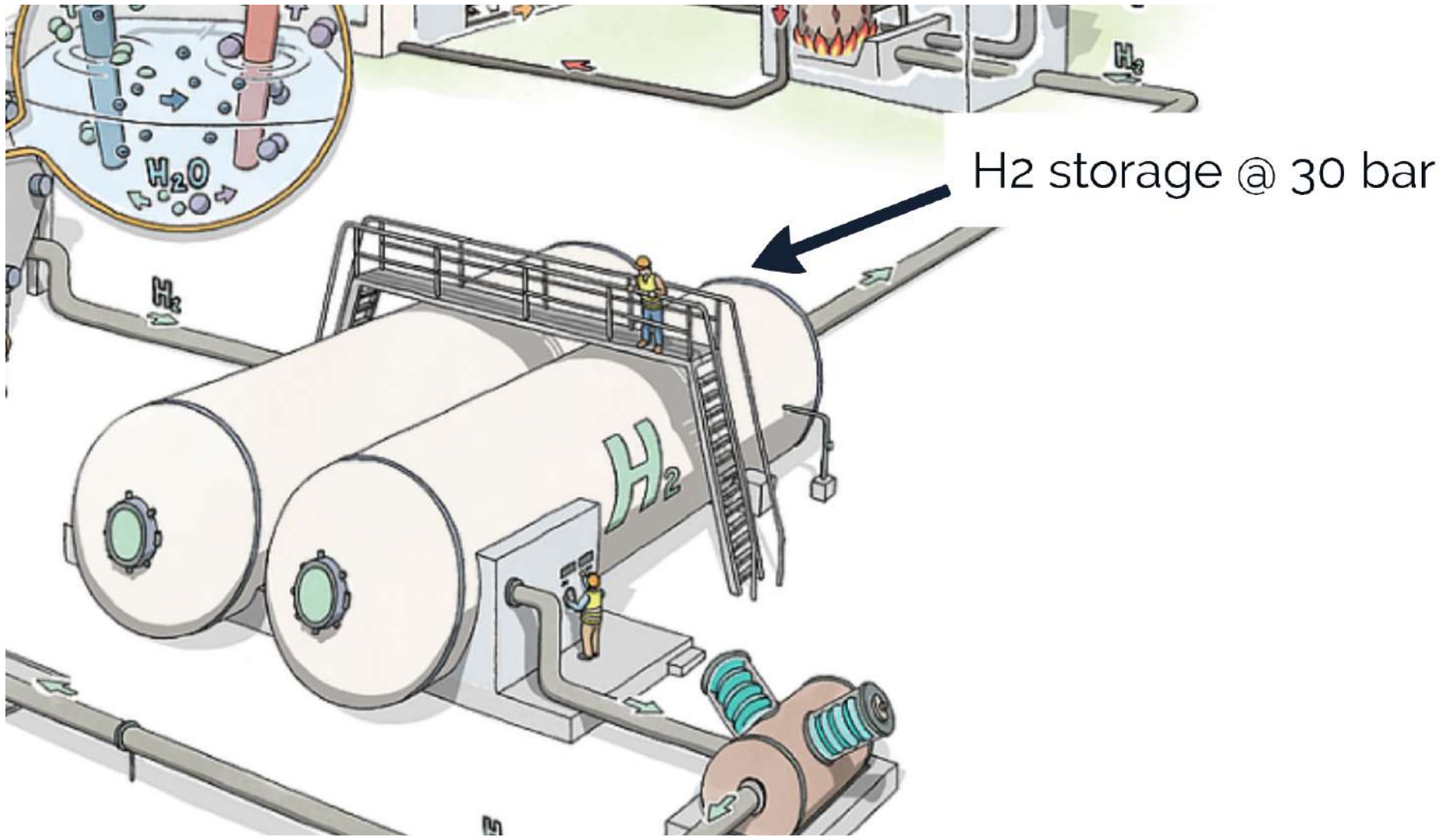


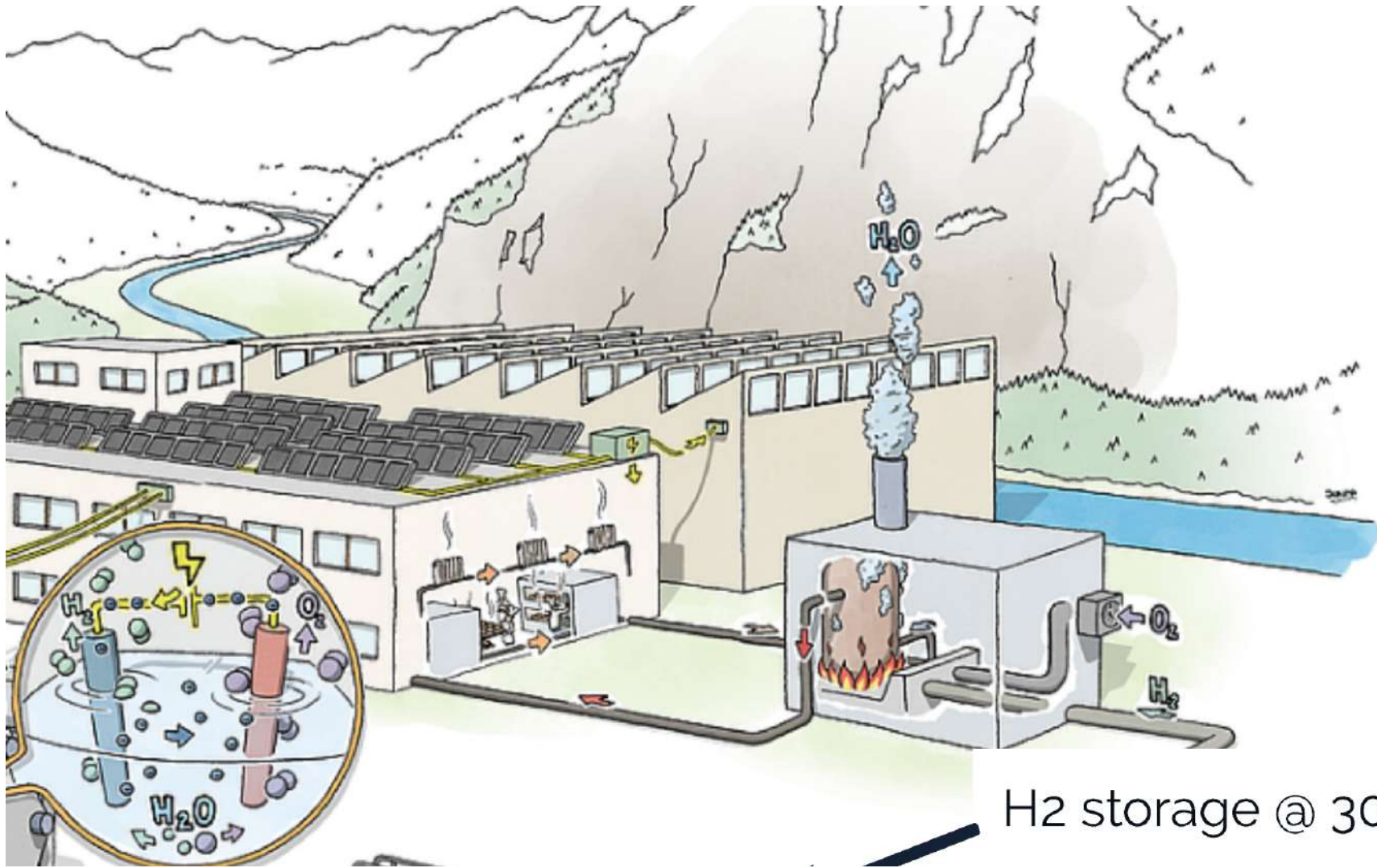
Supply options:  
Market  
Generating power





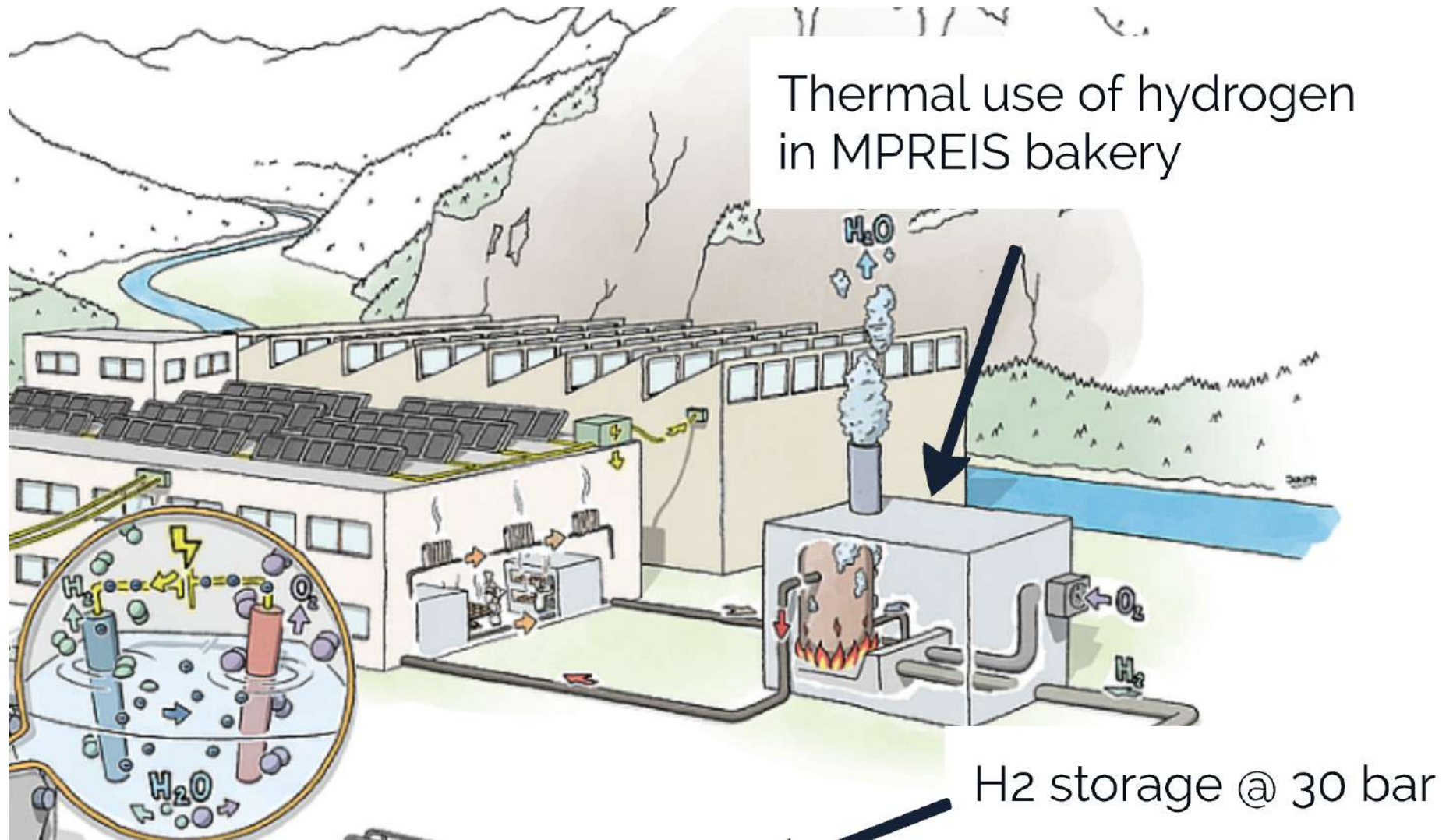


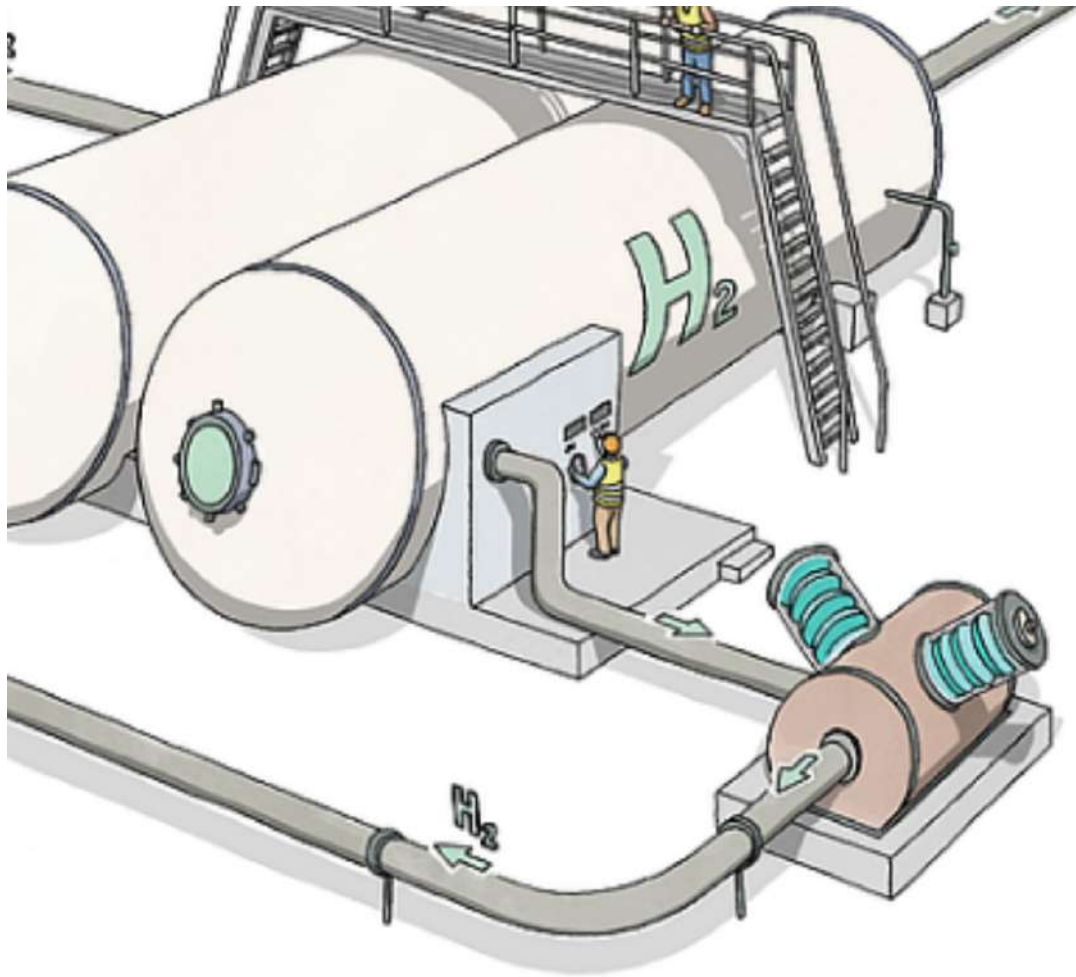


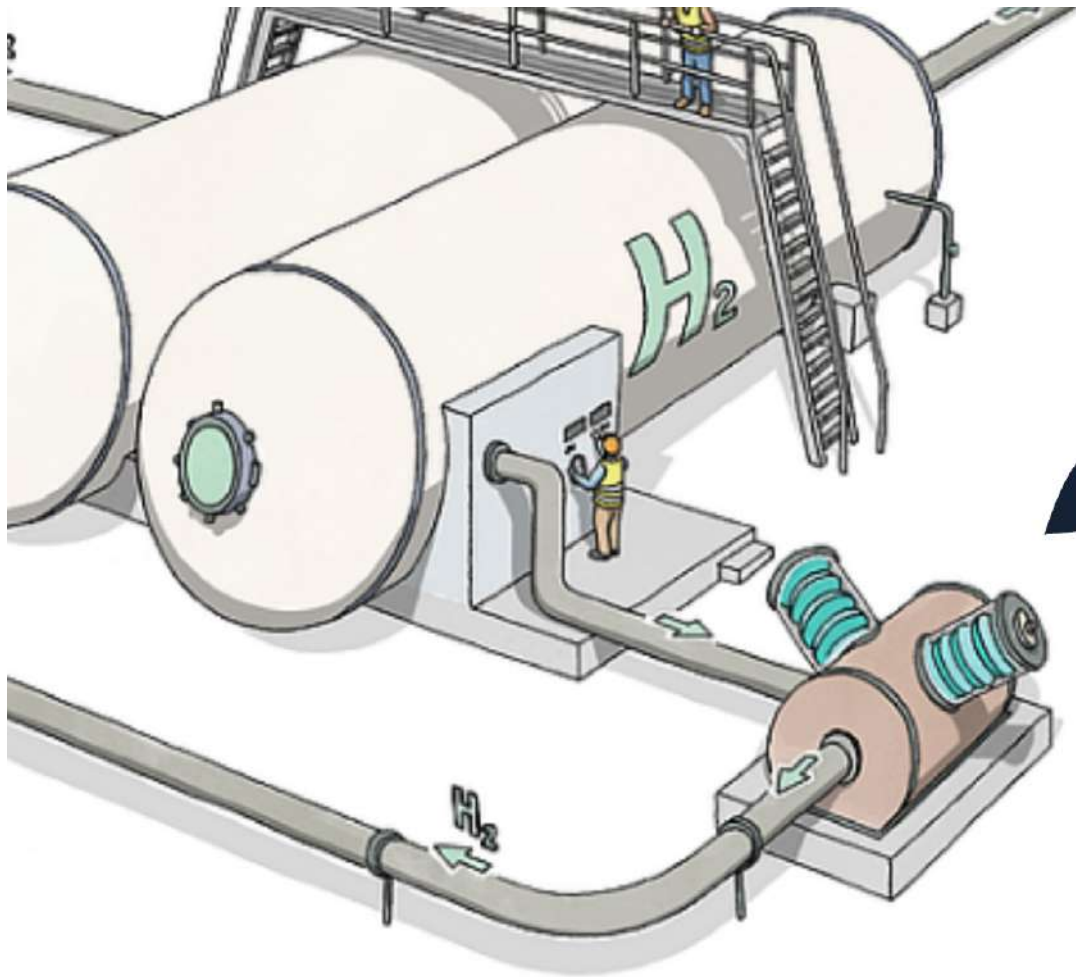


H2 storage @ 30 bar





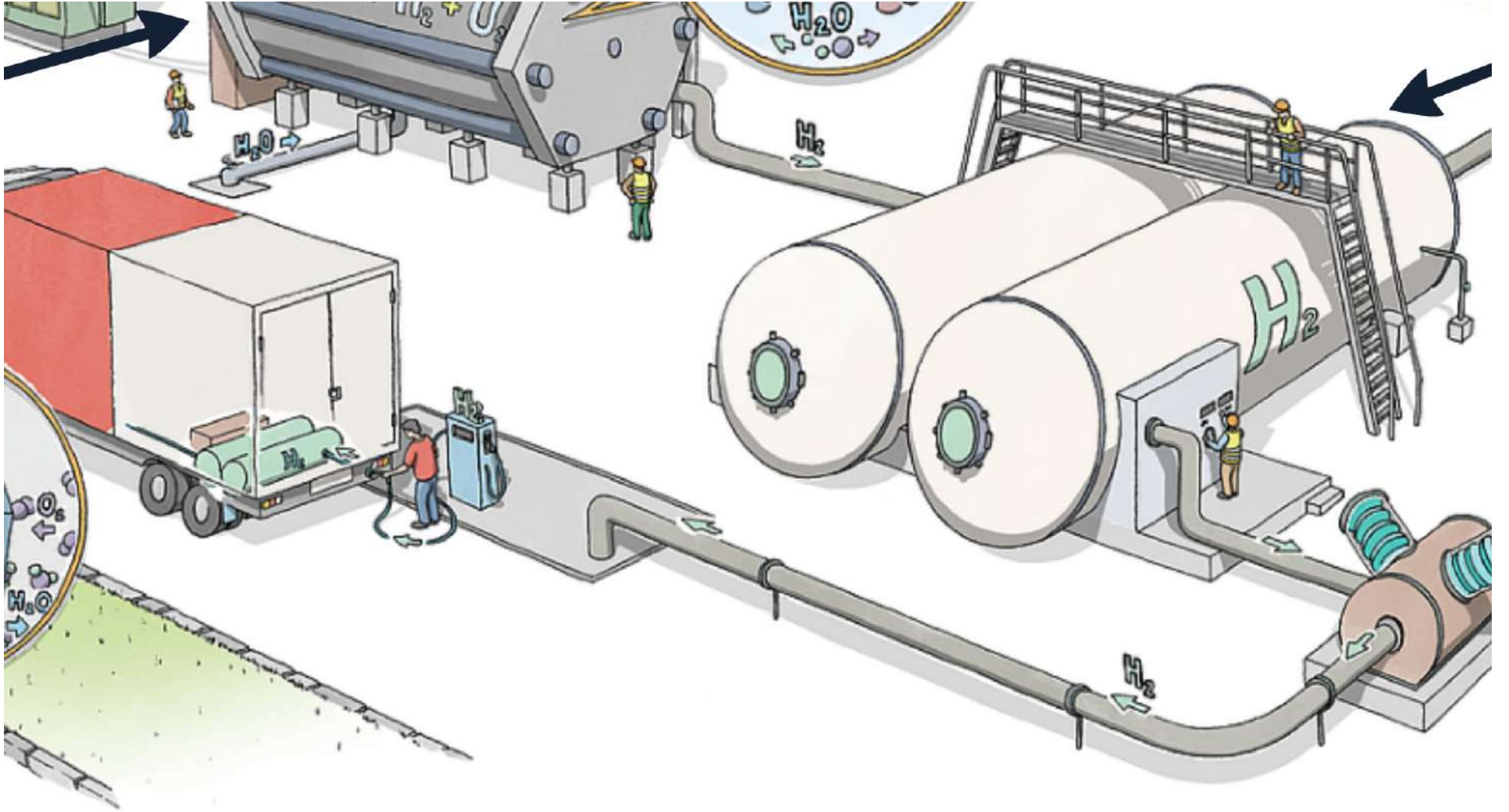


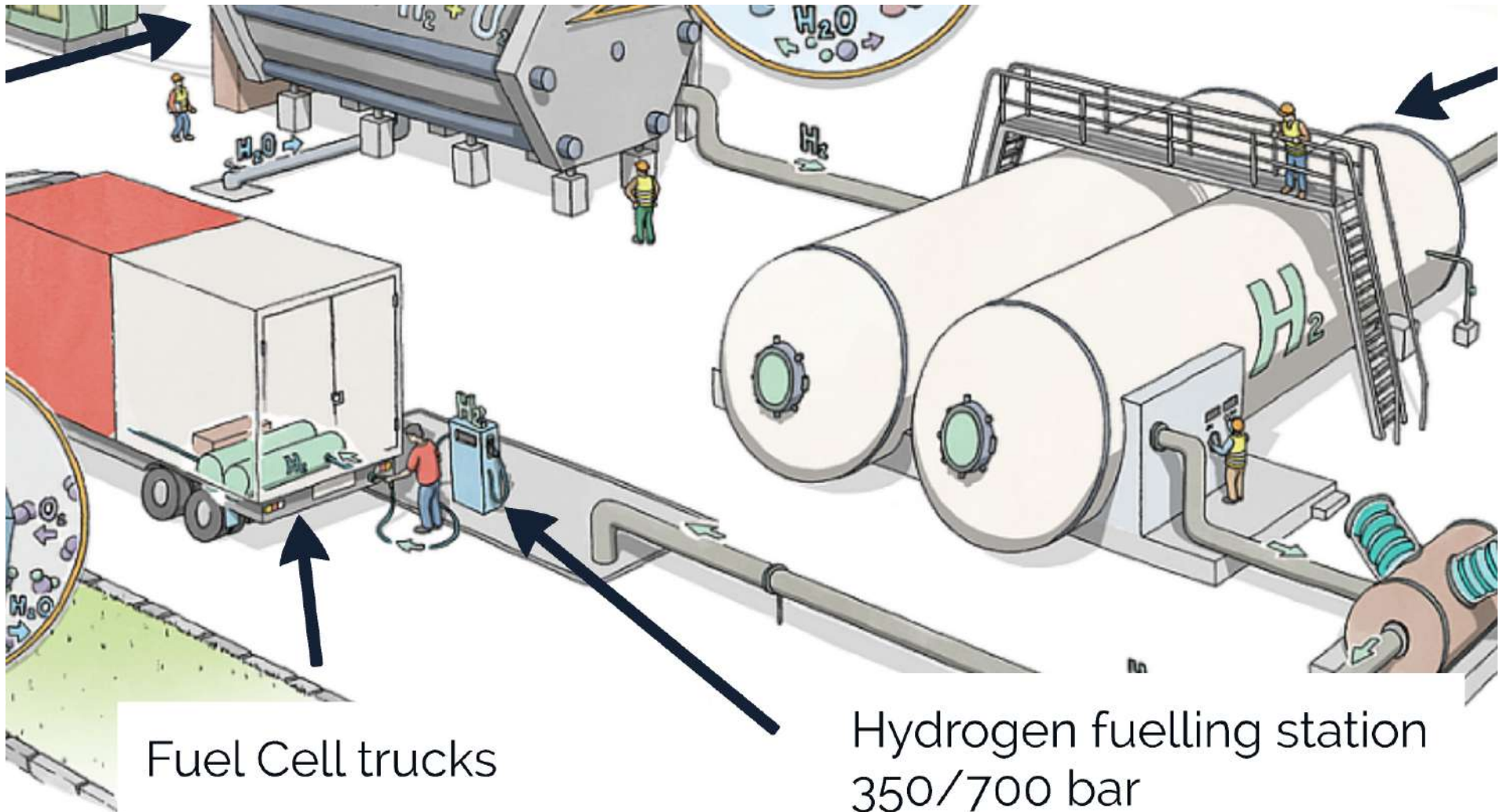


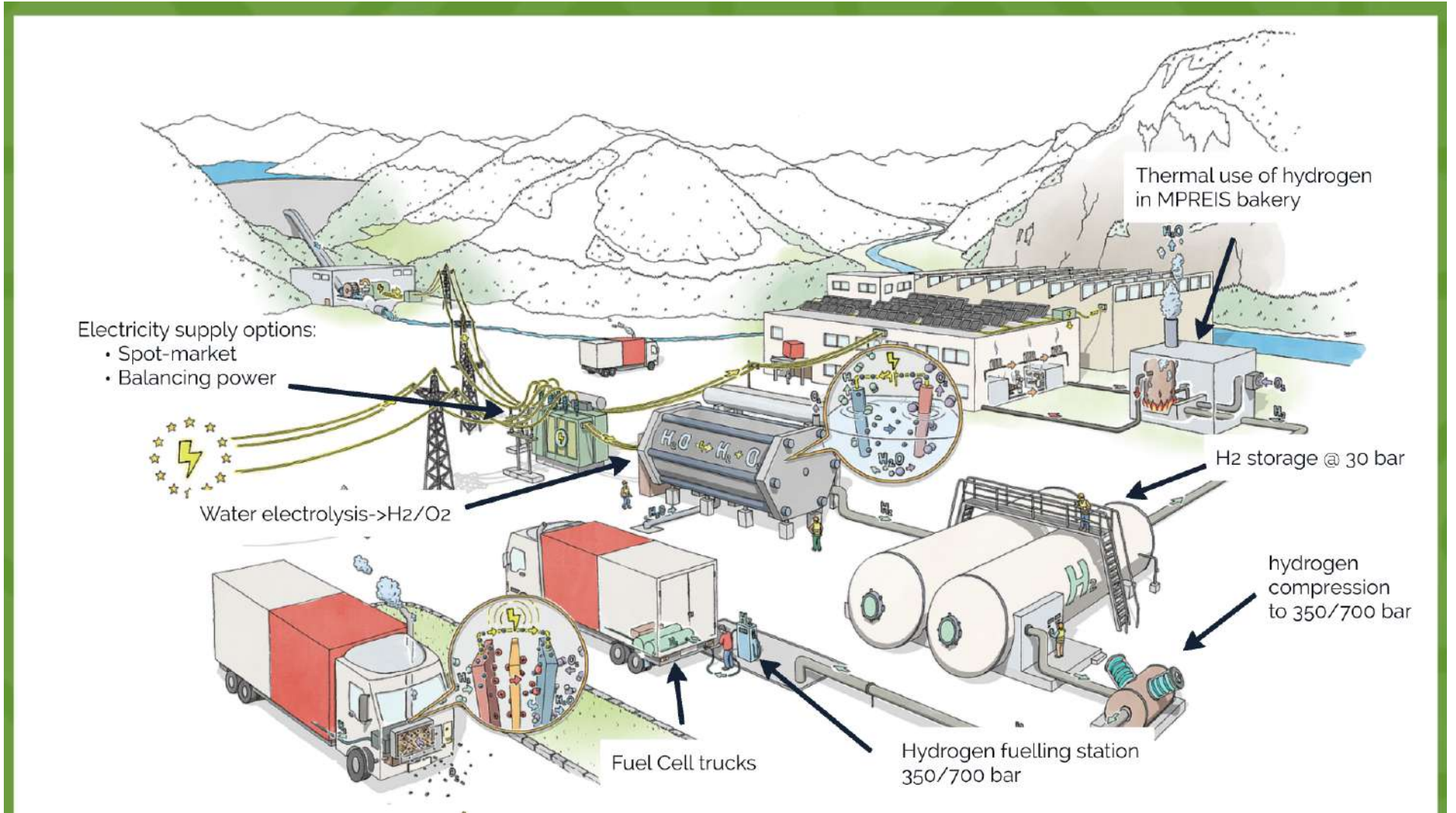
hydrogen  
compression  
to 350/700 bar



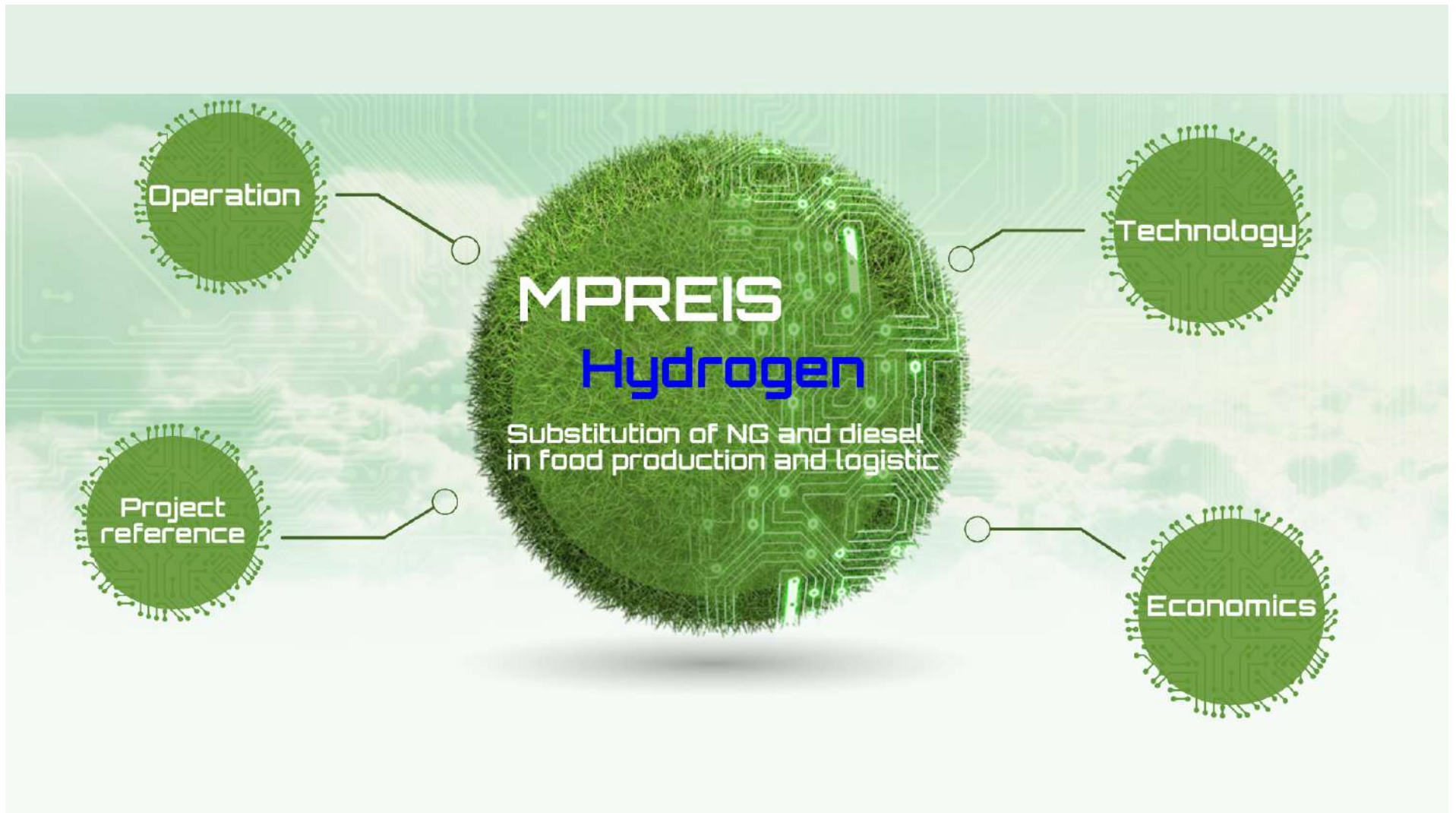














# Hydrogen production: location

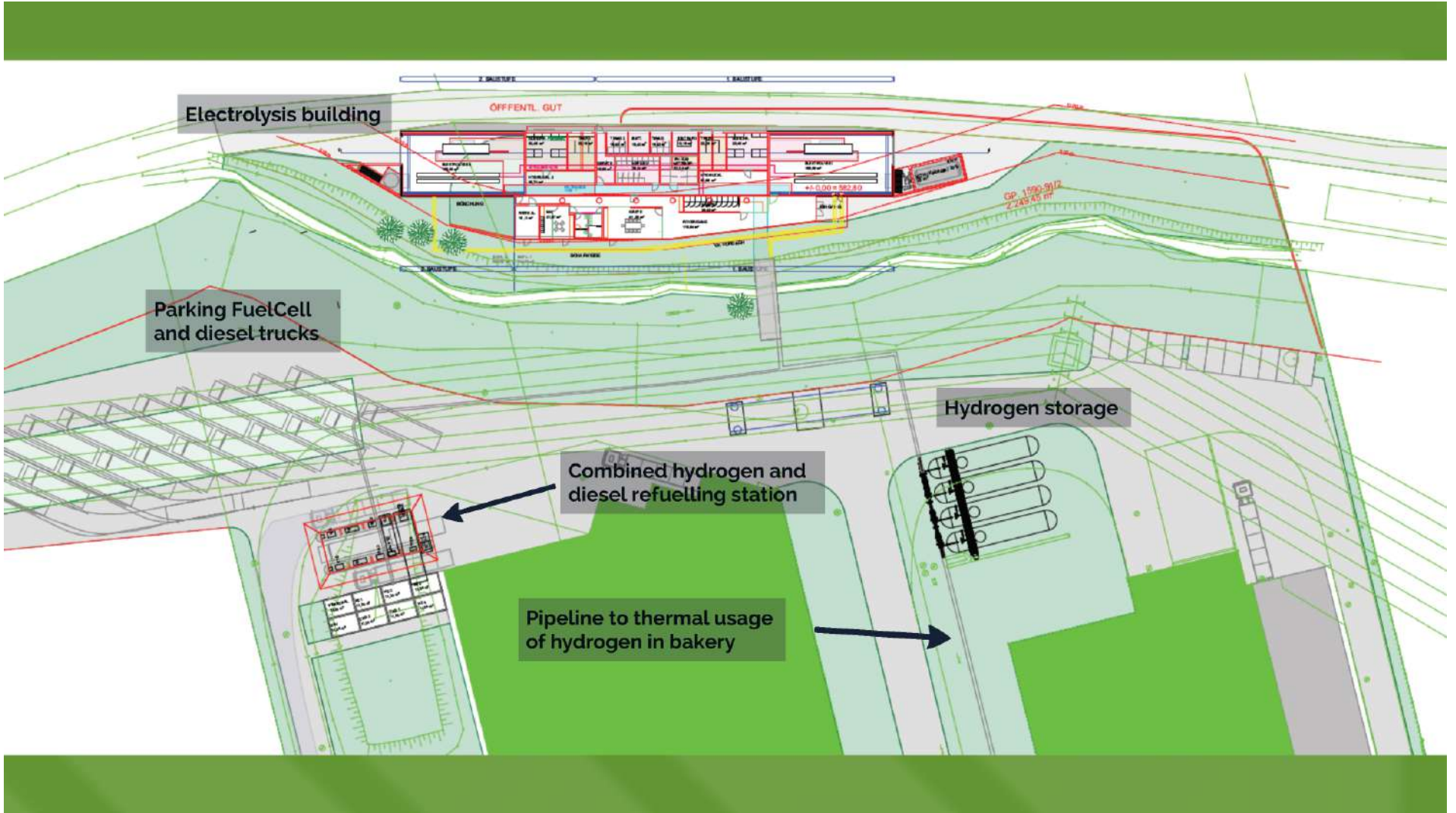












# Pressurized alkaline electrolysis:



**TECHNOLOGY : LIFETIME PROVEN OVER 55 YEARS** ihT

Picture dated 1971 .....→ Situation in 2017... the plant (128MVA) has been shut down end 2015... after operating for 45 years

**TECHNOLOGY : EXAMPLE LARGE SCALE PLANTS** ihT

ZIMBABWE (1975-2015)

28 ELECTROLYSERS TYPE S-556  
**21,000 Nm<sup>3</sup>/h H<sub>2</sub>**  
28 x 4MVA – **112MVA / 100MW**  
(OVERHAULING WORKS MADE BY IHT)

PERU (1965-2000)  
STILL IN OPERATION

7 ELECTROLYSERS TYPE S-540  
**5'200 Nm<sup>3</sup>/h H<sub>2</sub>**  
7 x 4MVA – **28MVA / 25MW**  
(OVERHAULING WORKS MADE BY IHT)









# TECHNOLOGY : EXAMPLE LARGE SCALE PLANTS

ZIMBABWE (1975-2015)

28 ELECTROLYSERS TYPE S-556

**21,000 Nm<sup>3</sup>/h H<sub>2</sub>**

28 x 4MVA – **112MVA / 100MW**  
(OVERHAULING WORKS MADE BY IHT)



PERÙ (1965-20XX)

STILL IN OPERATION

7 ELECTROLYSERS TYPE S-540

**5'200 Nm<sup>3</sup>/h H<sub>2</sub>**

7 x 4MVA – **28MVA / 25MW**  
(OVERHAULING WORKS MADE BY IHT)





# TECHNOLOGY : LIFETIME PROVEN OVER 55 YEARS



Picture dated 1971 .....



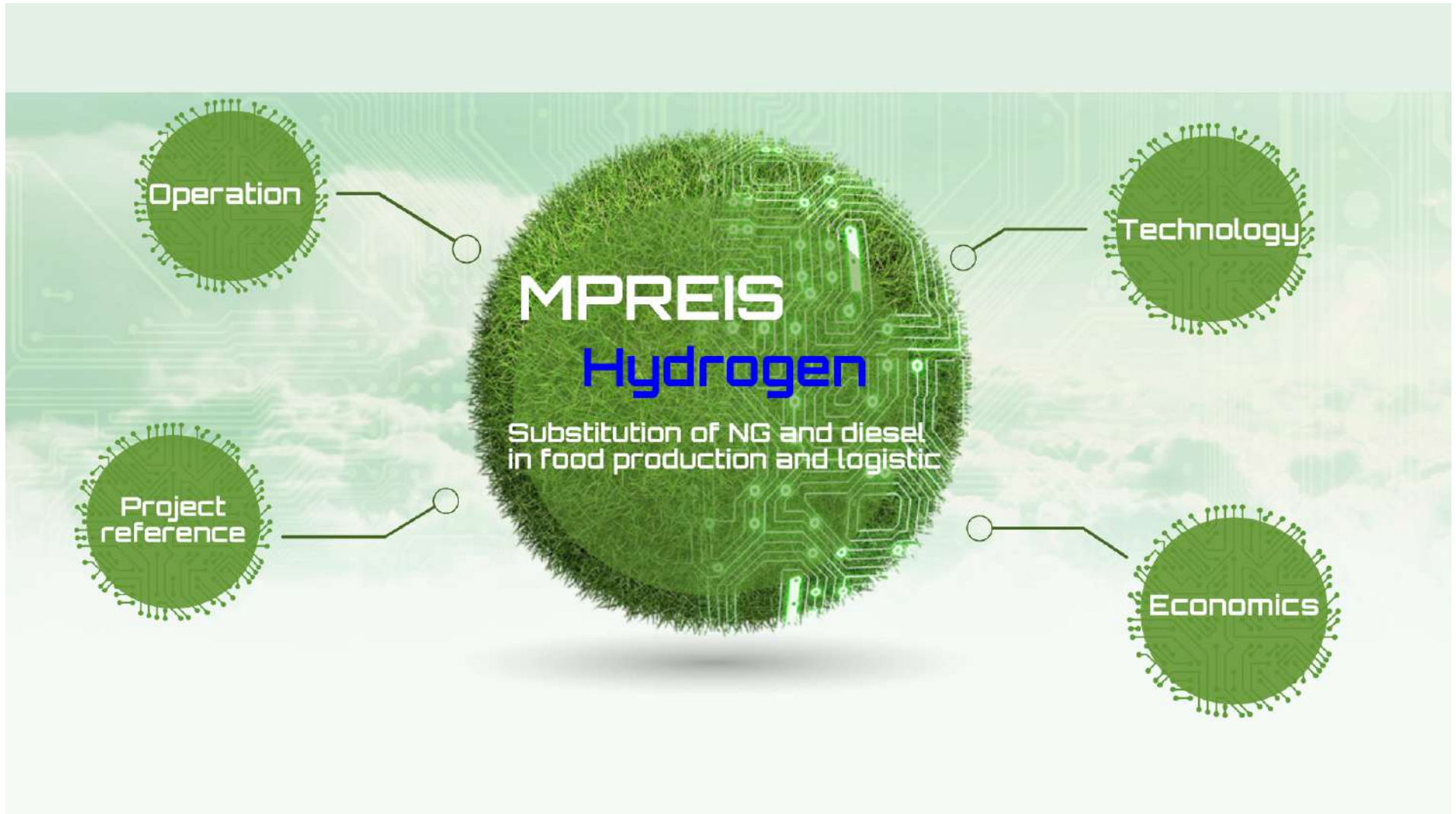
Situation in 2017... the plant (128MVA) has been shut down end 2015... after operating for 45 years



# Truck:

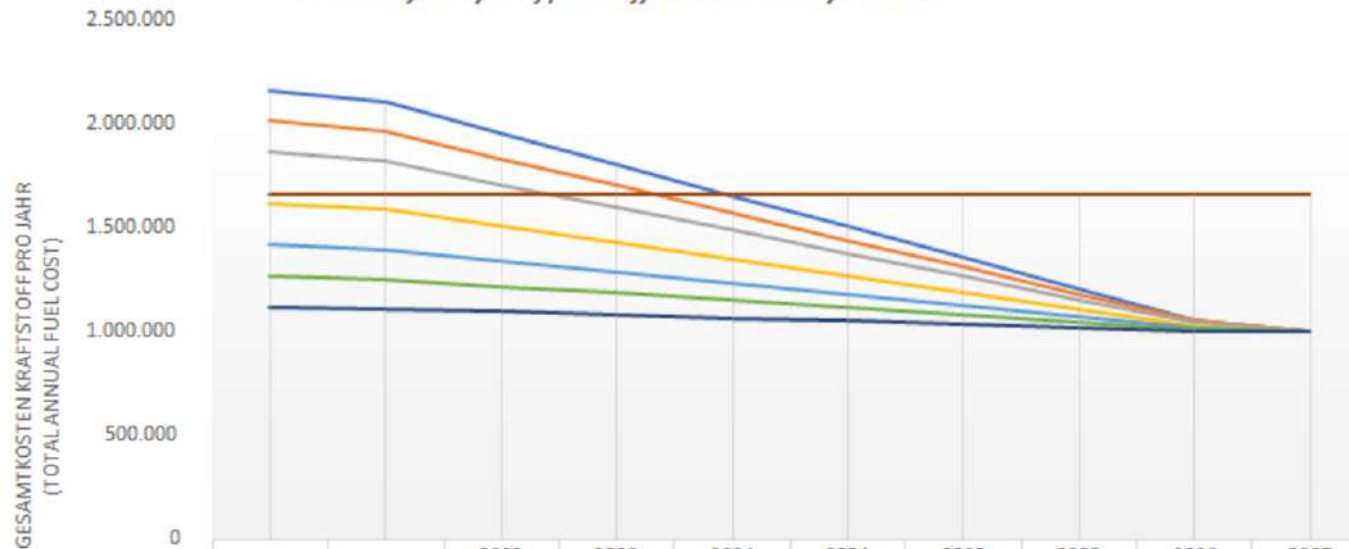


Hyundai 26ton FC-truck:  
Delivery of trial fleet (3 trucks) in 2nd quarter  
of 2020



## MPREIS fuel costs development in substitution scenario "Diesel- to FC-trucks 2020 to 2027"

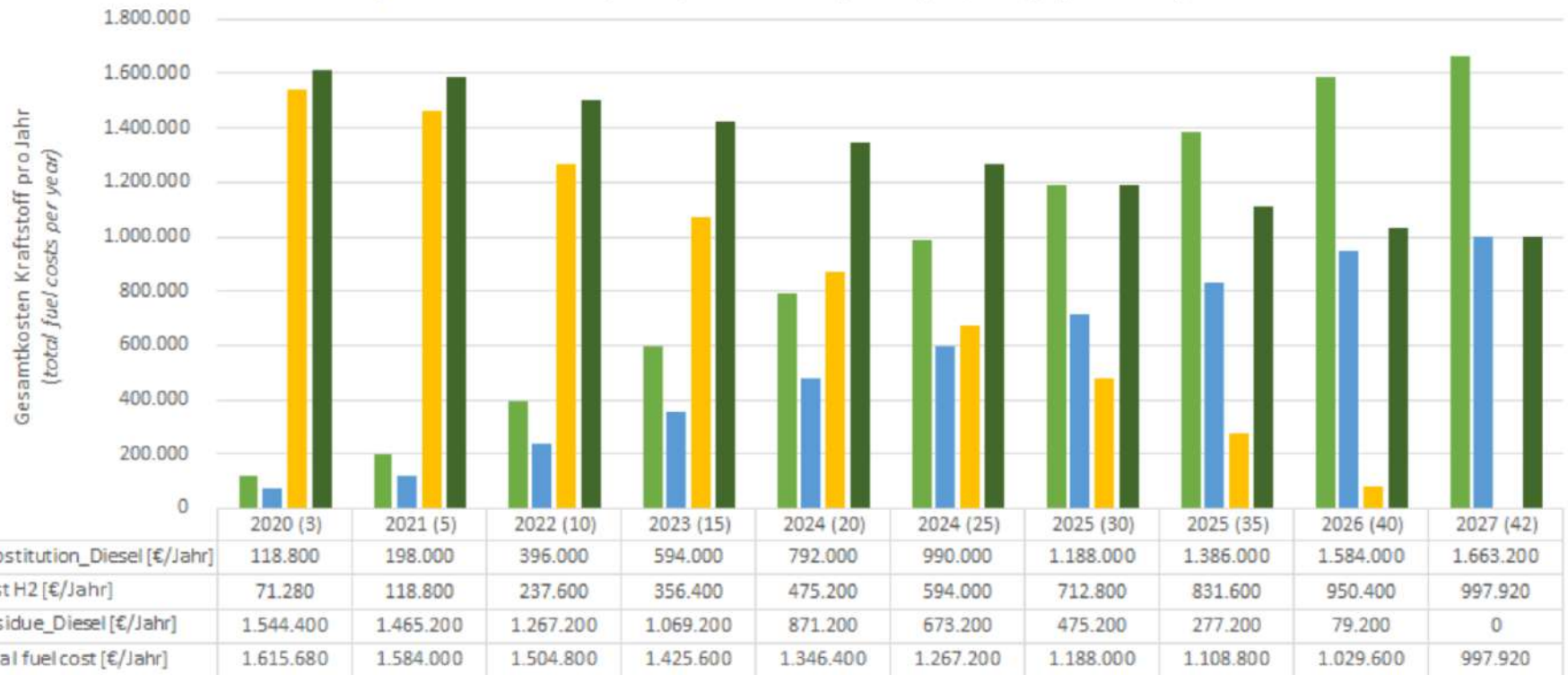
*Sensitivity analysis of price difference electricity vs. diesel*



	2020 (3)	2021 (5)	2022 (10)	2023 (15)	2024 (20)	2024 (25)	2025 (30)	2025 (35)	2026 (40)	2027 (42)
— Diesel 1,35 €/Liter	2.162.249	2.102.540	1.953.267	1.803.994	1.654.721	1.505.448	1.356.175	1.206.902	1.057.629	997.920
— Diesel 1,25 €/Liter	2.012.913	1.960.862	1.830.735	1.700.608	1.570.480	1.440.353	1.310.226	1.180.098	1.049.971	997.920
— Diesel 1,16 €/Liter	1.863.577	1.819.185	1.708.203	1.597.221	1.486.240	1.375.258	1.264.276	1.153.294	1.042.313	997.920
— Diesel 1 €/Liter	1.615.680	1.584.000	1.504.800	1.425.600	1.346.400	1.267.200	1.188.000	1.108.800	1.029.600	997.920
— Diesel 0,88 €/Liter	1.415.570	1.394.152	1.340.607	1.287.062	1.233.517	1.179.973	1.126.428	1.072.883	1.019.338	997.920
— Diesel 0,77 €/Liter	1.266.234	1.252.475	1.218.075	1.183.676	1.149.277	1.114.878	1.080.478	1.046.079	1.011.680	997.920
— Diesel 0,66 €/Liter	1.116.899	1.110.797	1.095.543	1.080.290	1.065.036	1.049.782	1.034.529	1.019.275	1.004.021	997.920
— Nur Diesel-LKW, 1€/Liter	1.663.200	1.663.200	1.663.200	1.663.200	1.663.200	1.663.200	1.663.200	1.663.200	1.663.200	1.663.200



**MPREIS fuel costs development in substitution scenario "Diesel- to FC-trucks 2020 to 2027"**  
 price-basis: H2 is 50 €/MWh, diesel is 103 €/MWh (=1€/Liter), Spread: 53 €/MWh



Years (number of FC-trucks in brackets)

■ Substitution\_Diesel [€/Jahr] ■ Cost H2 [€/Jahr] ■ Residue\_Diesel [€/Jahr] ■ Total fuel cost [€/Jahr]

Summary opportunistic revenue (cost savings) prognosis 2020 until 2027

