JENBACHER

INNIO

Disclaimer

The presentation is for general information only and is not intended to serve as legal advice. If you have specific questions, please seek legal or other expert advice.

JENBACHER
INNIO

H2 FACTORY

H2 based CO2-free factory

INNIO Jenbacher GmbH & Co OG
Jenbach, Austria
www.innio.com/de

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13th of October, 2022

Pushing beyond the impossible and looking boldly toward tomorrow

INNIO is...

- A leading provider of renewable gas and hydrogen-rich solutions and services for power generation and compression at or near the point of use.
- With our Jenbacher and Waukesha products, INNIO helps to provide communities, industry and the public access to sustainable, reliable and economical power ranging from 250 kW to 10.4 MW.
- Headquartered in Jenbach, Austria, the business also has primary operations in Welland, Ontario, Canada, and Waukesha, Wisconsin, U.S.

Generating reliable and efficient power at or near the point of use

Jenbacher fleet at a glance

~33 GW
delivered globally

57 Million
Households**

1.5 x Germany**

~24,000
delivered engines

~60%
Engines digitally connected
(myPlant*)

Engines

0.2 MW ➡ **10 MW**

High efficiency & fuel flexibility

- **Pipeline gas**
- **Special gas applications**
- **PG**
- **CHP, CCHP**

Advantages

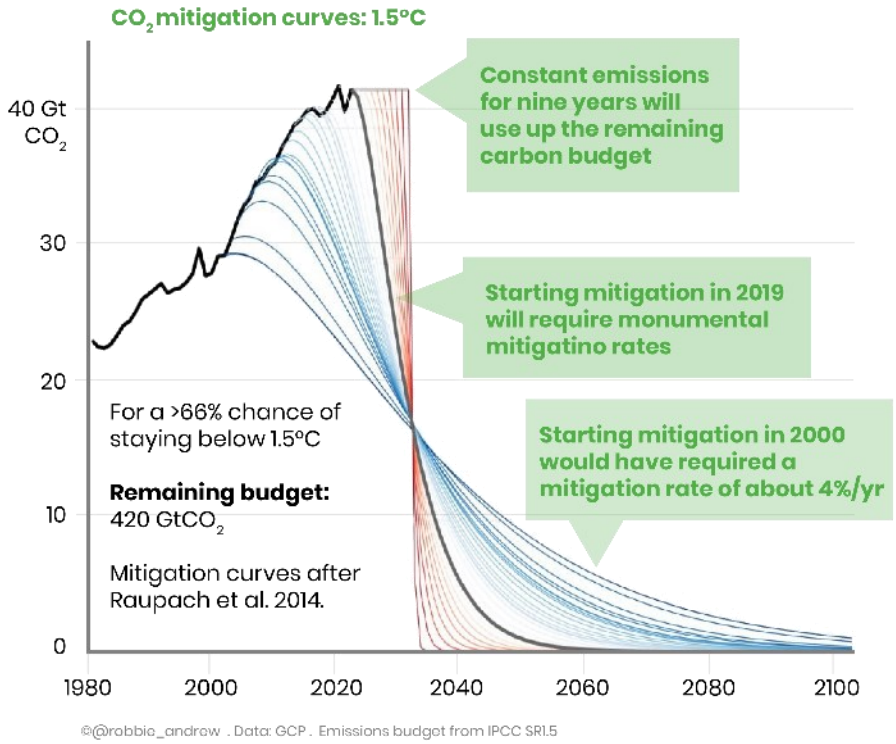
- **Overall efficiency of up to 95%**
- **Durability**
- **65 years experience**
- **Fast-start capability**
- **Fuel flexibility**
- **Lifecycle services**

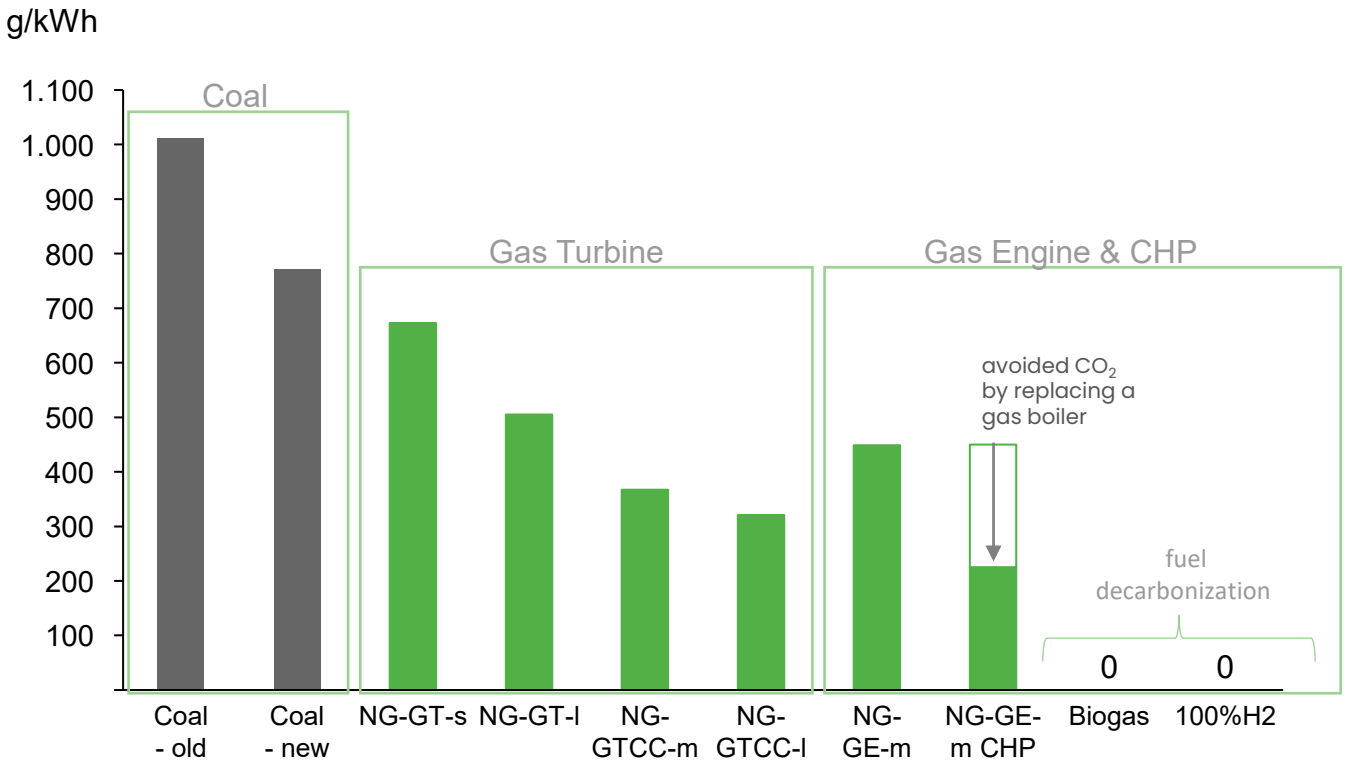
Jenbacher focused on power generation and services

*Indicates a trademark **Source: World electricity consumption per el. household, 2014, https://wec-indicators.enerdata.net/world.php ***Sources: DE electricity consumption per dwelling, 2018, https://www.odyssee-mure.eu/publications/efficiency-by-sector/households/electricity-consumption-dwelling.html ; Number of households in Germany, 2019, http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=lfst_hhnhtych&lang=en

CO_2 Budget – Replacing CO_2 intensive Technology with Available Solutions Today

Traditional Gas CHP as alternative to coal power – CHP reduces CO_2 intensity below today's electricity mix



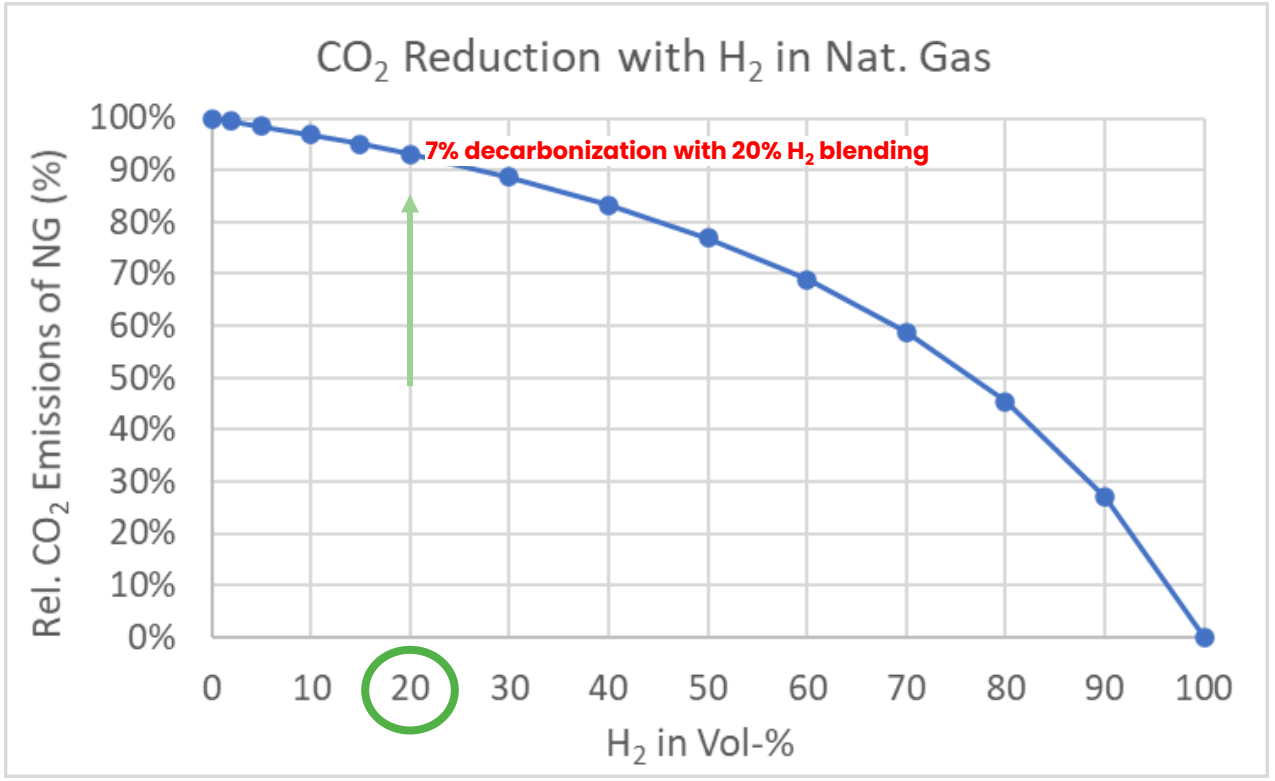


Ready for Hydrogen* – background information

Hydrogen mixing to pipeline gas changes gas properties

		NG	Hydrogen
CH4	Vol-%	97.6	0
C2H6	Vol-%	2	0
C3H8	Vol-%	0.4	0
H2	Vol-%	**0**	**100**
LHV	kJ/Nm³	**36 730**	**10 800**
WI	kJ/Nm³	48 704	41 000
MN	-	**92**	**0**
Stoichiometric air required	Nm³/Nm³	9.7	2.4
Laminar flame speed	cm/s	38	>300

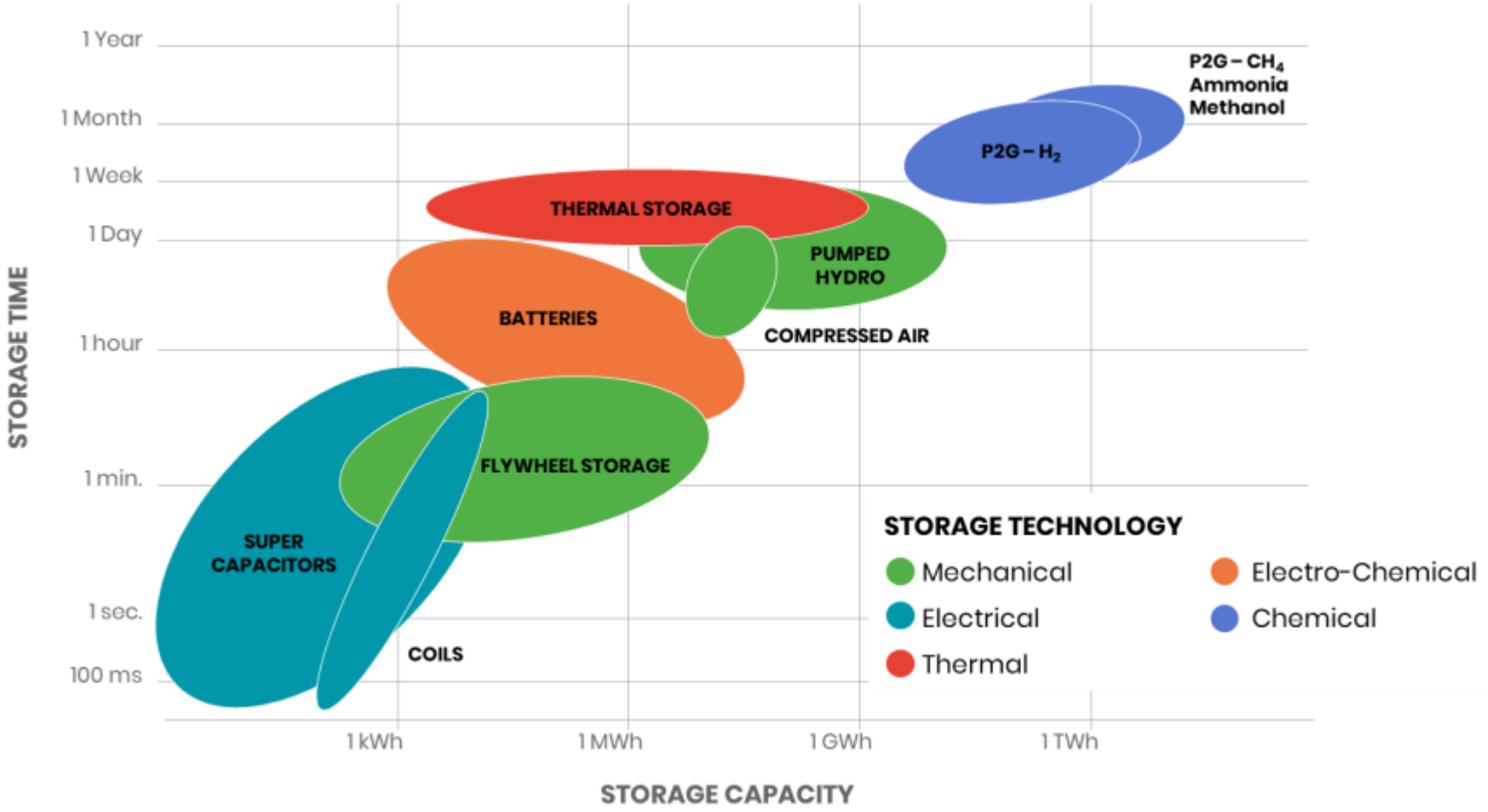
Hydrogen added to pipeline gas



* Optional scope on demand.

Increased renewable energy production & energy storage can support sustainable decarbonization

Energy storage systems



P2X fuels

- Hydrogen
- Ammonia
- Methanol
- Synthetic Natural Gas (SNG)

Energy storage for one month, in the TWh range → P2X

Combustion parameters of selected P2X fuels

IC engines operate on a wide range of fuels: from fast- to slow-burning

		Methan	H_2	Ammonia	Methanol
CH_4	Vol-%	100	0	0	0
H_2	Vol-%	0	100	0	0
NH_3	Vol-%	0	0	100	0
CH_30H	Vol-%	0	0	0	100
LHV	kJ/Nm³	35,784	10,800	13,665	
LHV	kJ/kg	50,013	120,000	18,720	19,900
Auto-ignition temperature	°C	595	585	657	439
Minimum ignition energy	mJ	0.29	0.017	8	0.14
MN I Octan number	-	100 / 130	0 / -	- / 130	- / 119
Lam. Flame speed	cm/s	38	350	7	36
Density	kg/Nm³	0.66	0.08	0.73	786

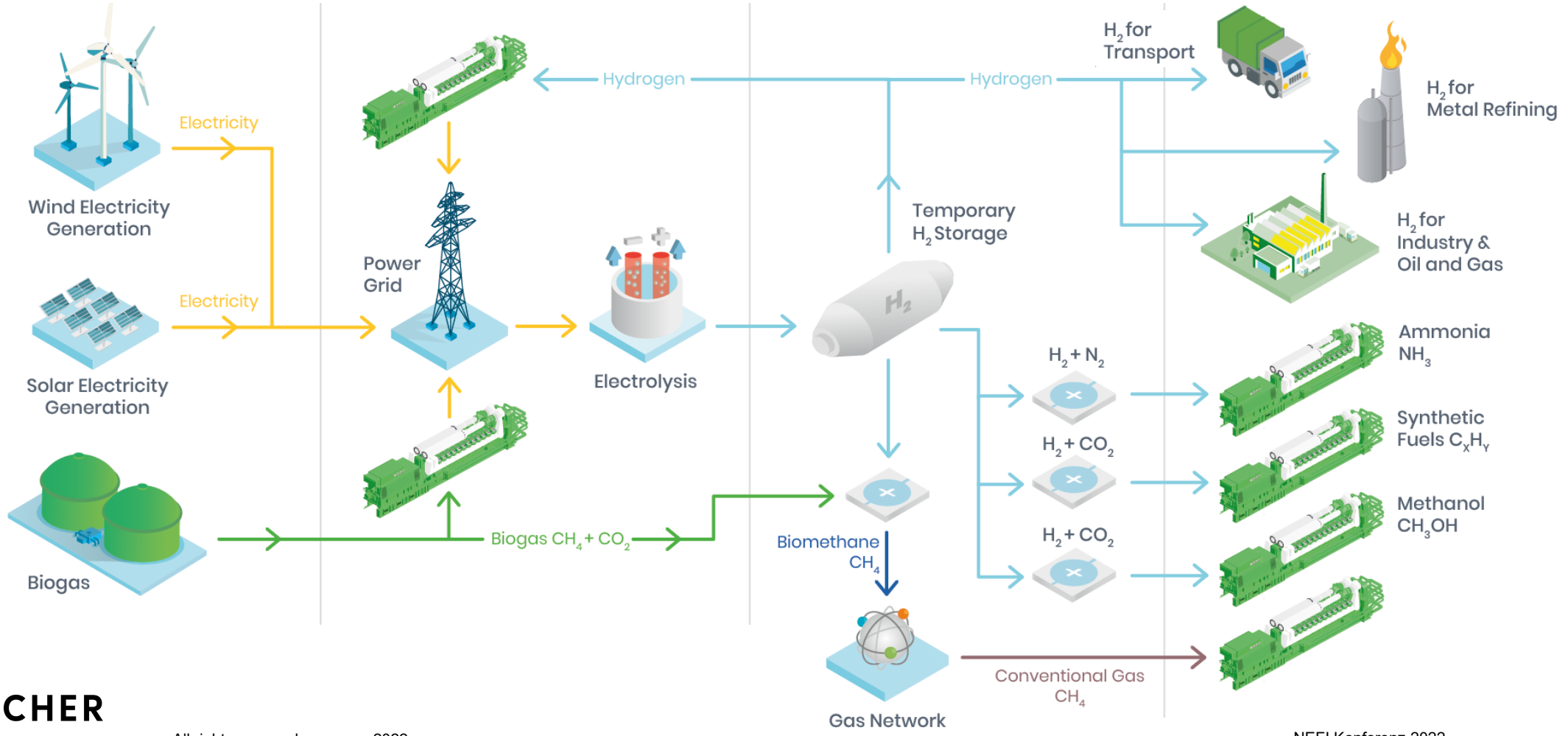
Role of Jenbacher Engines in a renewable powered world

Renewable Energy Production

Energy conversion P2G & G2P

Energy Storage

Hydrogen Usage



Type 4 – H_2 Version

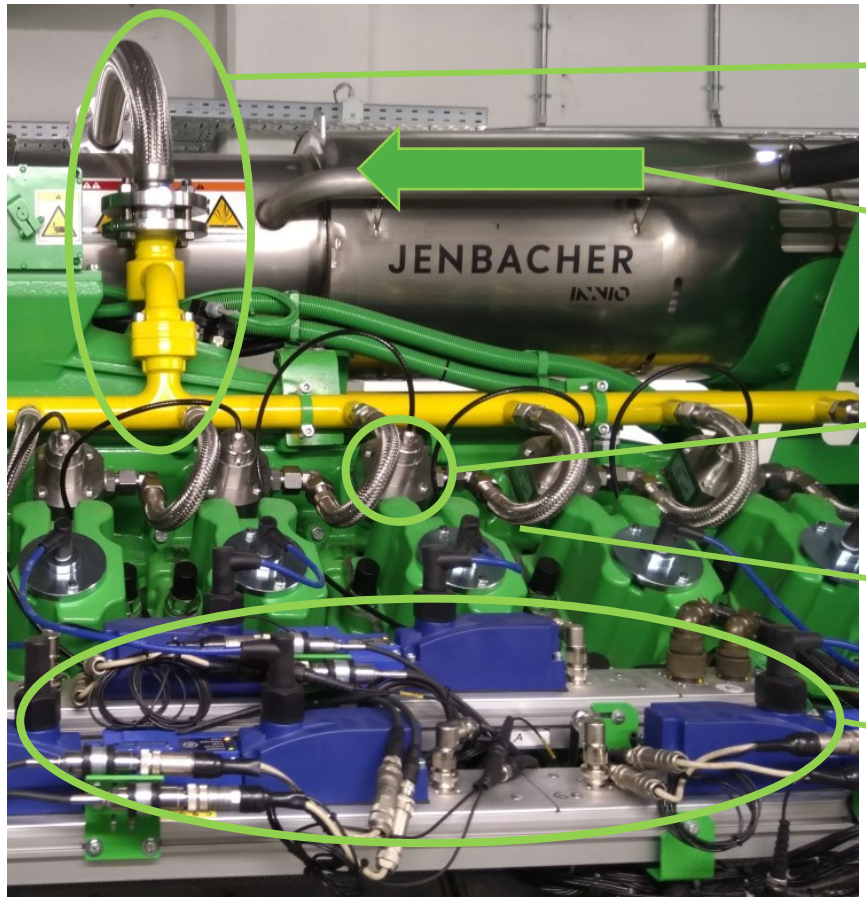
Pipeline gas vs. Hydrogen

Jenbacher Type 4 – Mixture charged

Pipeline gas operation

- Gas dosing
- Gas mixer
- Compressor
- Mixture cooler

Jenbacher Hydrogen* Engine – Port fuel injection



H_2 Supply / Gas train

Compressed air

Port Injection (PI) Valve H_2

Lube oil H_2 - optimized

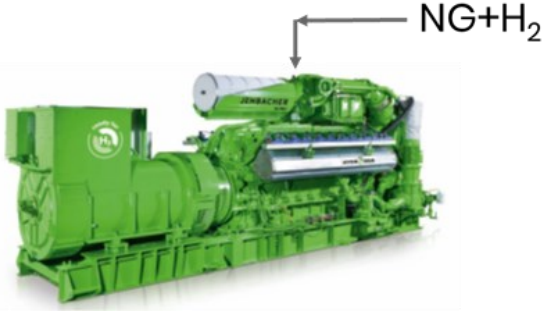
Cylinder pressure-based control

* Optional Scope on Demand.

H_2 admixing in pipeline gas – validation at INNIO's headquarters in Jenbach

H_2 trailer station for supply to test beds

Validation purpose

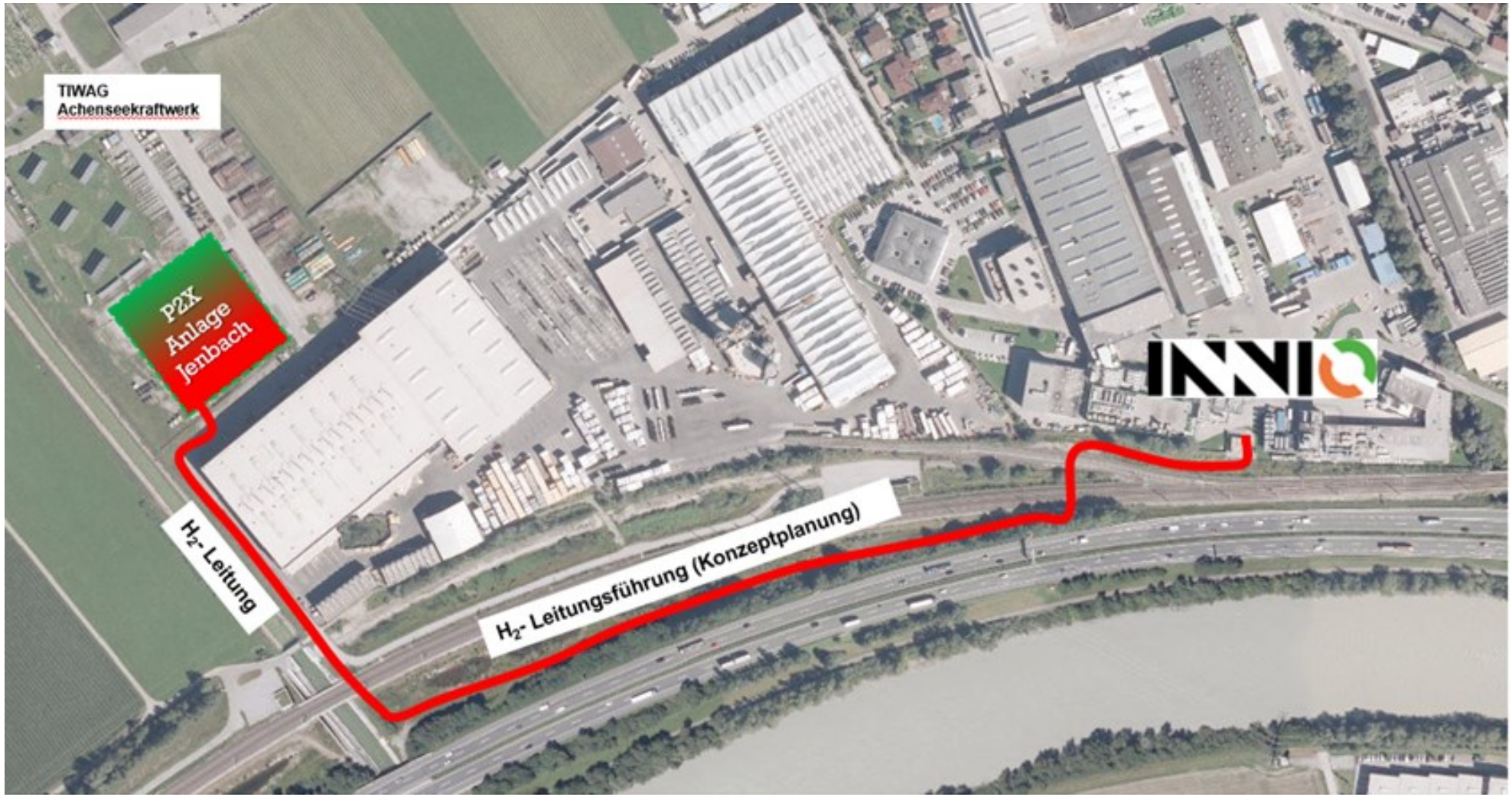


Simulation of hydrogen content in pipeline gas

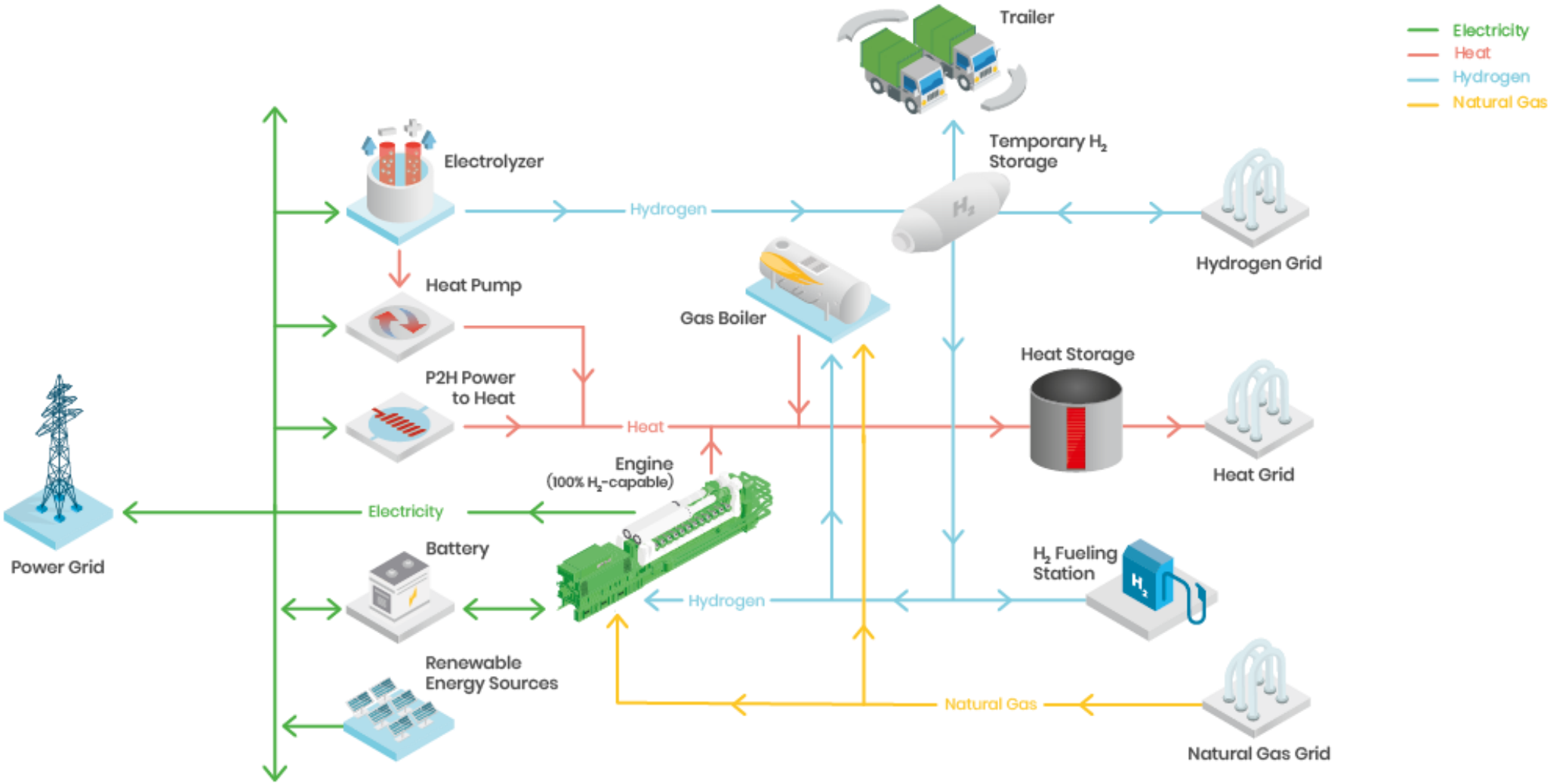
H_2 trailer station for hydrogen supply

Investments in H_2 infrastructure in Jenbach for product development

H2Factory … Hydrogen supply



H2 FACTORY INNIO's Jenbacher Options … road towards a CO_2 free plant



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