

11. BRANCHENTAG WASSERSTOFF WIEN

H2 DEMONSTRATION MIT  
BHKW's IM MW BEREICH

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EVN Forum, 8. April, 2025

**JENBACHER**



# AGENDA

Introduction

H2 Blending until 2020

Demonstrating 100% H2 Applications

Ammonia

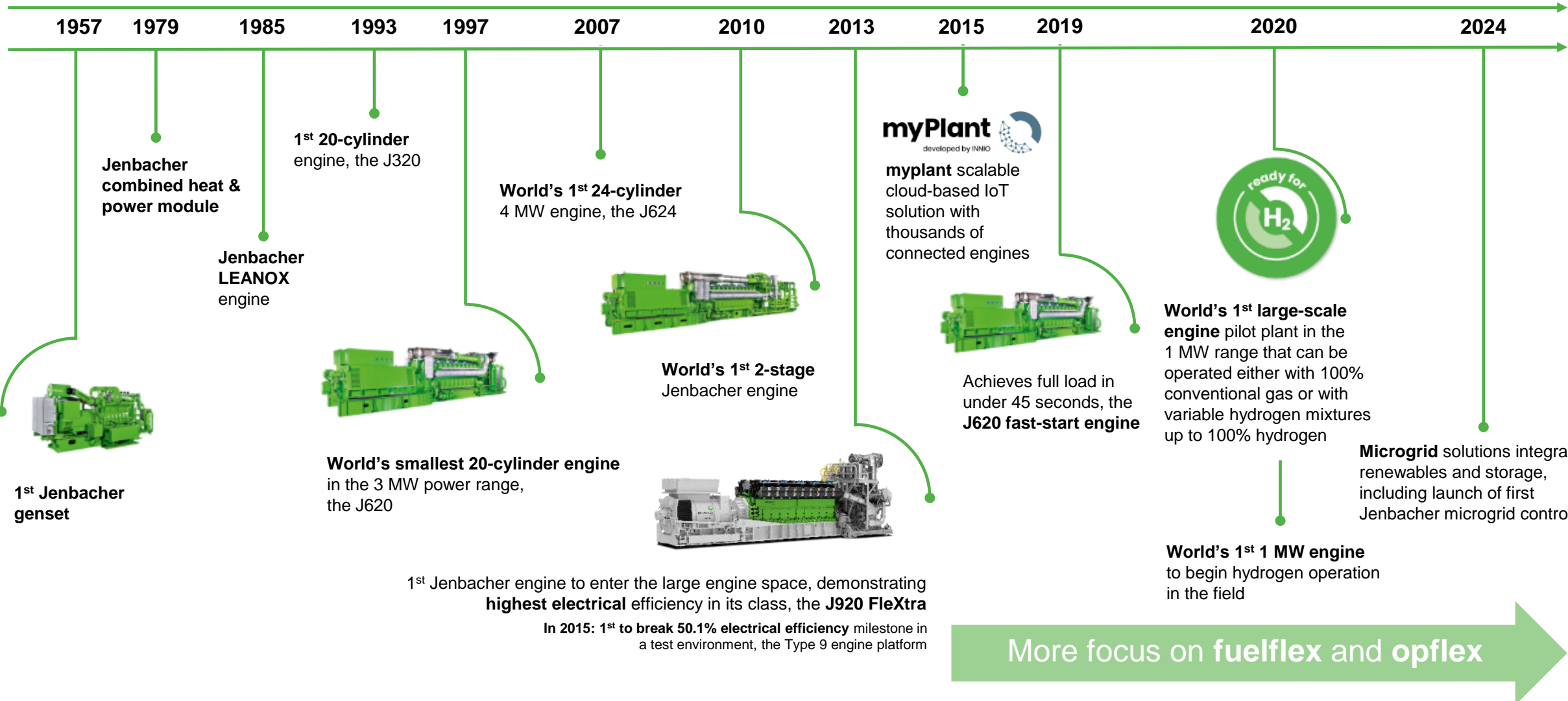
Case Studies



INNIO Group is a leading energy solution and service provider headquartered in Jenbach (Austria), with other primary operations in Waukesha (Wisconsin, U.S.) and Welland (Ontario, Canada)

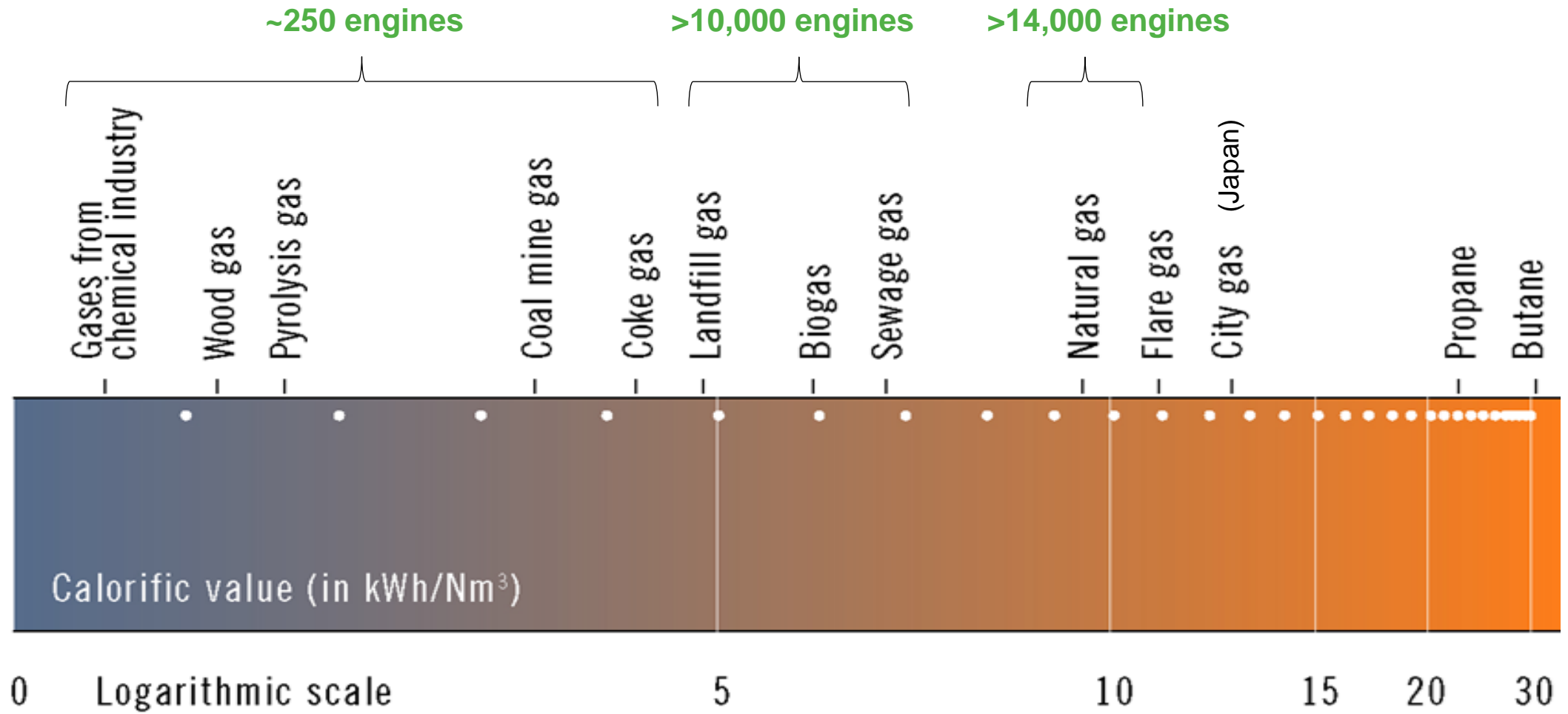
# CONTINUOUS EVOLUTION IN INNOVATION MAKES SUSTAINABLE ENERGY WORK TODAY

## Timeline



# GAS ENGINE FUEL RANGE

Jenbacher engines



# PROVEN EXPERIENCE WITH HYDROGEN & HYDROGEN MIXTURES

30 yrs experience



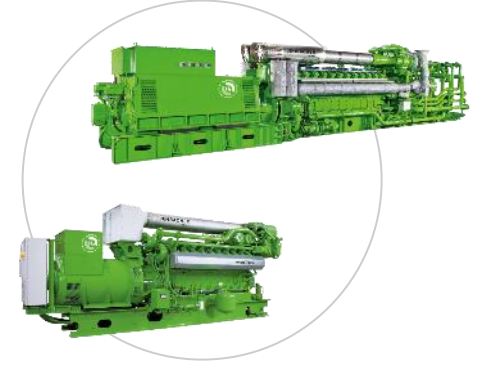
4 x 200,000 oph



CO<sub>2</sub> neutral



Traditional gas / hydrogen mixture



**Process gas**  
Tailgas (Krems)  
COD 1996

**Waste to Energy**  
Syngas (Mutsu)  
COD 2003

**Dual Gas**  
H<sub>2</sub> blending (Hychico)  
COD 2008

**Pure Hydrogen**  
2021+

>95% H<sub>2</sub> as fuel

H<sub>2</sub> ~15-17 vol%  
CH<sub>4</sub> ~1.5 vol%  
N<sub>2</sub> ~80-87 vol%  
LHV ~0.5 kWh/m<sup>3</sup>

H<sub>2</sub> ~30-40 vol%  
CO ~25-30 vol%  
N<sub>2</sub>&CO<sub>2</sub> ~35 vol%  
LHV ~2.5 kWh/m<sup>3</sup>

H<sub>2</sub> ~0-42 vol%  
CH<sub>4</sub> ~100-58 vol%  
LHV ~10-7 kWh/m<sup>3</sup>

H<sub>2</sub> 100 vol%  
LHV ~3 kWh/m<sup>3</sup>

Commercial operation

Future

More than 250 MW installed with syngas / process gases, 90 projects, 28 countries

# H2 BLENDING UNTIL 2020

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# H<sub>2</sub> ADMIXING DEMO PROJECTS

## 30%v H<sub>2</sub>

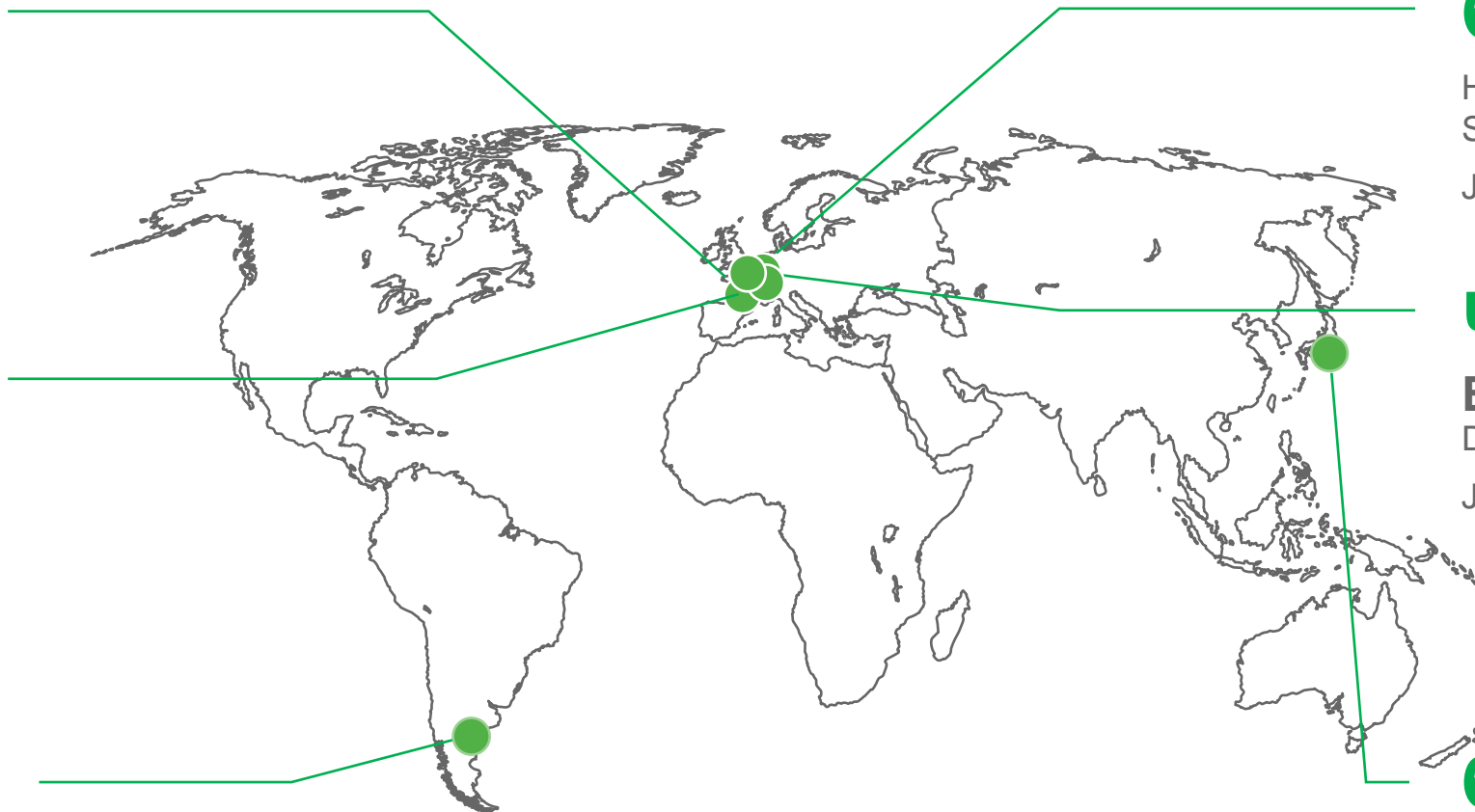
Bozen - Italy  
Horizon 2020 Demo  
J612, main fuel NG

## 30%v H<sub>2</sub>

Biogas Stream- Austria  
2008 Demo  
J312, main fuel NG

## 42%v H<sub>2</sub>

Hychico – Argentina  
Operating since 2008  
J420, main fuel NG



## 60%v H<sub>2</sub>



H2ORIZON - Stuttgart  
Shipped Q2/2020  
J312, main fuel NG

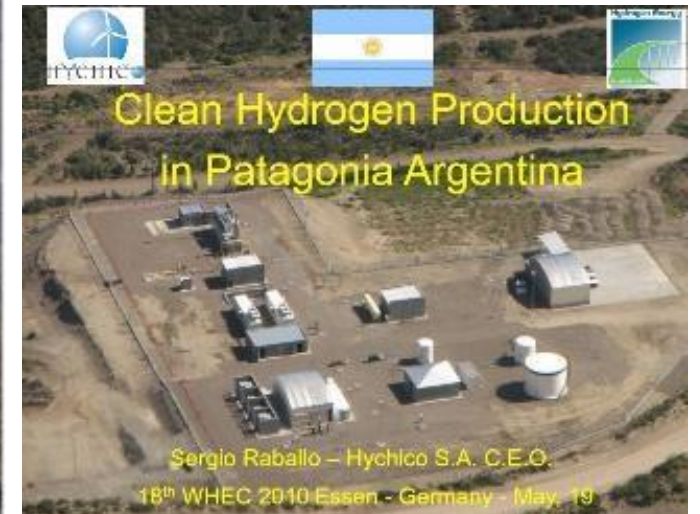
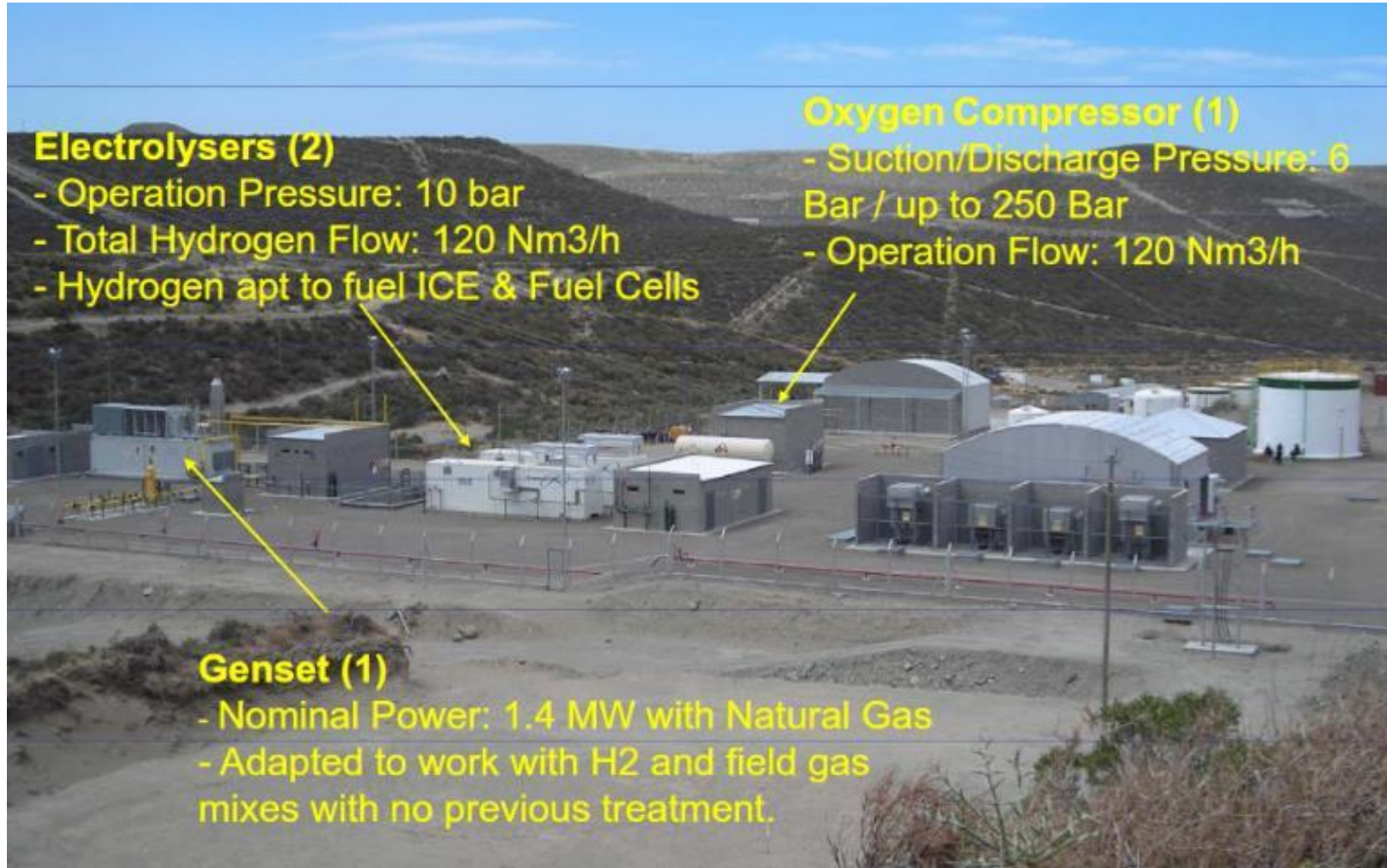
## up to 100% H<sub>2</sub>

**Eon** Hanse - Hamburg  
Demo 2020/2021  
J416, main fuel NG

## 60%v H<sub>2</sub>

Ando Hasama - Japan  
Demo 01/2020  
J312, main fuel NG

# HYCHICO, ARGENTINA SITE





DEMONSTRATING  
100% H<sub>2</sub>  
APPLICATIONS

JENBACHER



# H<sub>2</sub> APPLICATIONS FOR POWER GENERATION

First H<sub>2</sub> movers



Developed H<sub>2</sub> infrastructure

**Datacenter**

**2**



back-up power

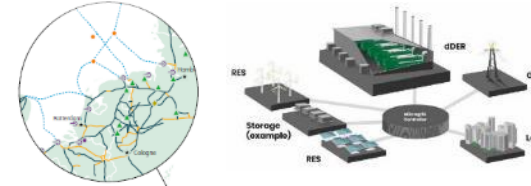
**H<sub>2</sub>-Demo projects**

**4**



typically green H<sub>2</sub>

**H<sub>2</sub>-Hub & Microgrids**



**Grid balancing**

**5**



blue or green H<sub>2</sub>

**1**

**Industrial H<sub>2</sub>**

**3**



typically gray H<sub>2</sub>

**Islands**



**Flexible CHP**



blue or green H<sub>2</sub>

# KremsChem, KREMS, AT

## H2 rich process tailgas expansion project

Existing since 1996



Extension 2024 (COD Q2, 2024)



\*

**4 x J320**  
~2,400 kW

**4 x J420**  
~3,300 kW

### Baseload operation

- 8,000+ oph / yr / engine
- 200,000 oph / engine (2023)

H<sub>2</sub>: ~15-17 vol%  
 CH<sub>4</sub>: ~1.5 vol%  
 Rest: N<sub>2</sub> and CO<sub>2</sub> } **>95% H<sub>2</sub> as fuel**

LHV: ~0.5 kWh/m<sup>3</sup>

### Baseload operation

- CHP with steam generation

H<sub>2</sub>: ~19 vol%  
 CH<sub>4</sub>: ~0 vol%  
 Rest: N<sub>2</sub> and CO<sub>2</sub> } **>98% H<sub>2</sub> as fuel**

LHV: ~0.55 kWh/m<sup>3</sup>

# NORTH C DATACENTERS, EINDHOVEN, NL

## First data center with H2-Engines for emergency backup

### NorthC Data Center

Small-scale regional DC in Netherlands, Germany, & Switzerland

15 local DCs, with 10 in NL

Carbon neutral by 2030

DC Groningen (2022): 1<sup>st</sup> with standby H<sub>2</sub> fuel cell

**DC Eindhoven (2023):** 1<sup>st</sup> with 6 x Jenbacher JGC420 H<sub>2</sub>-Engines

Going forward ... new and replacement standby power based on H<sub>2</sub>

### Data Center Eindhoven – 6 + 2 H<sub>2</sub>-Engines

6 MWe ... standby power based on 6 + 2 x 1 MWe JGC420 H<sub>2</sub>-Engines

Replacing concept with multiple 1.5 – 2.0 MWe standby diesel generators

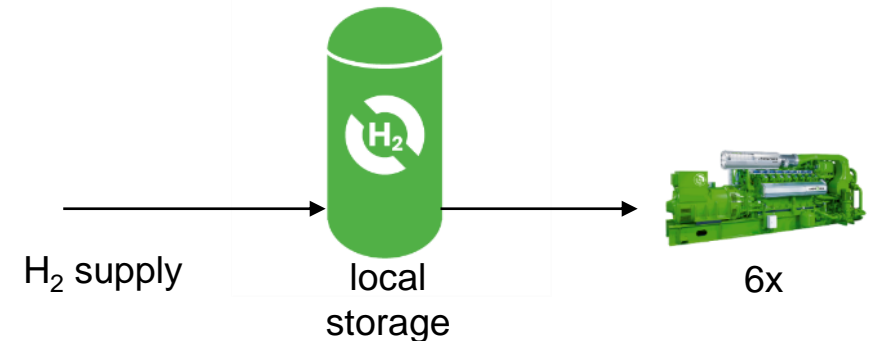
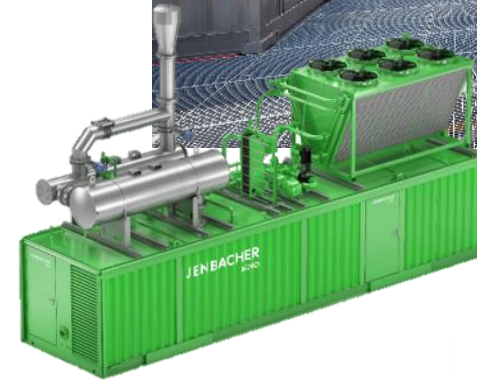
Re-designing concept for UPS & cooling/chillers

Dual fuel H<sub>2</sub>-Engines (pipeline gas as back-up fuel)

H<sub>2</sub> as main fuel from local H<sub>2</sub> storage until H<sub>2</sub> pipeline is available

Pipeline gas as backup fuel in case of longer grid failures

<https://www.northcdatacenters.com/en/about-us/sustainable-data-centers/>



# HYOSUNG H2-ENGINE, ULSAN, SOUTH KOREA

J420	Pipeline Gas	100% H <sub>2</sub>
Electrical output	1,060 kW	1,060 kW
Electrical efficiency*	38.4%	~38.4%
Total efficiency	~89%	~85%
NO <sub>x</sub> emissions	<250 mg/Nm <sup>3</sup> @ 5%O <sub>2</sub>	<100 mg/Nm <sup>3</sup> @ 5%O <sub>2</sub>
CO <sub>2</sub> emissions	226 g/kWh <sub>el</sub>	0 g/kWh <sub>el</sub>
H <sub>2</sub> consumption		~83 kg/h

## Largest 60 Hz H2-Engine IPP CHP in Asia

Hydrogen as a by-product from polypropylene production from Hyosung chemical

Hyosung Heavy Industries is demonstrating the use of hydrogen and designed it as an industrial CHP (with steam boiler)

H2-Engine delivery in 2023, successfully commissioned in mid-2024

H2-Engine installation and service provided by INNIO Group's Jenbacher authorized distributor RNP



# RAG UNDERGROUND HYDROGEN STORAGE, AUT

1<sup>st</sup> of its kind in Europe - world's 1<sup>st</sup> 100% hydrogen storage facility in a porous underground reservoir

## Summer operation

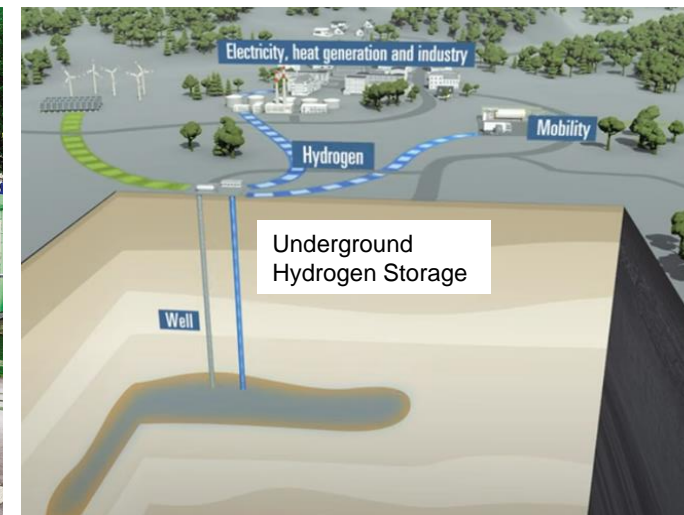
- Solar PV overcapacity
- 2 MW electrolyzer for green H<sub>2</sub> production
- H<sub>2</sub> compression

## Seasonal storage

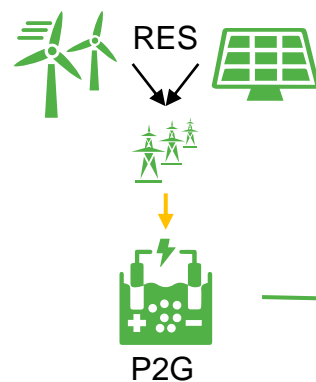
- 1.2 million Nm<sup>3</sup> H<sub>2</sub> storage in modified NG storage
- Gas chromatograph at H<sub>2</sub> discharge
- 8 km H<sub>2</sub>-pipeline from H<sub>2</sub>-storage to CHP unit
- Up to 600 Nm<sup>3</sup>/h H<sub>2</sub>-pipeline capacity

## Winter operation

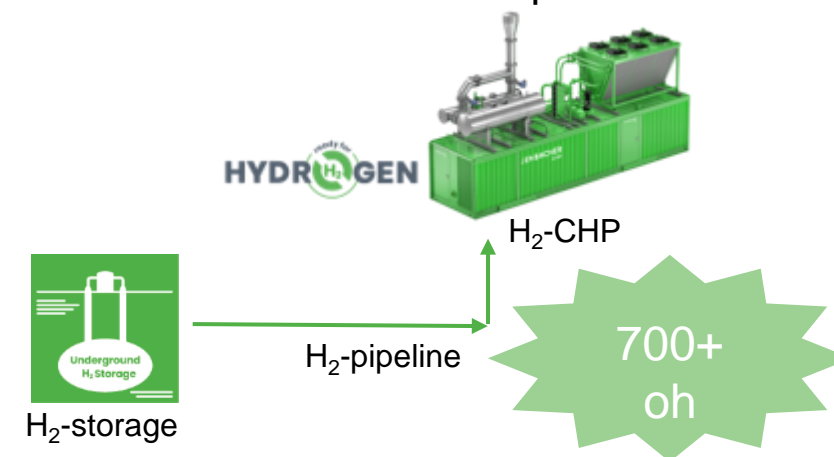
- J412 containerized CHP
- 530 kW electrical output & 550 kW heat output
- 100% H<sub>2</sub> & up to 40% NG/60% H<sub>2</sub> mixture
- Commissioning date early 2024
- ~2,000 to 4,000 oh/yr



## Summer operation



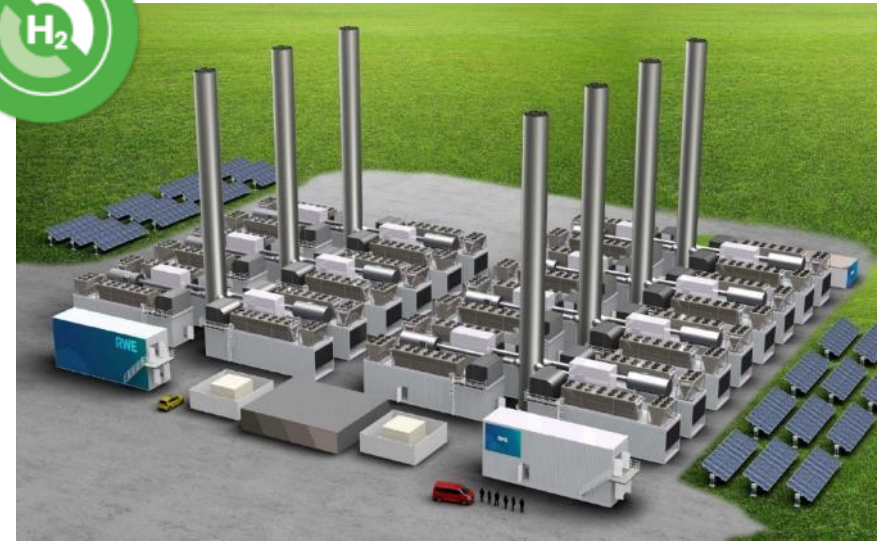
## Winter operation




# “READY FOR H2” - RWE GUNDREMMINGEN, GER

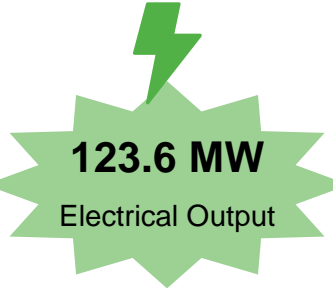
## Highly flexible gas power plant

- **Modular Gas Engine plant** with low installation costs
- Multi engine plant allows **high efficiency** over entire load range
- Identical units for **reduced maintenance** cost
- Remote monitoring with **myPlant** allows unmanned operation
- “Ready for H2”
- Connected to **110kV grid**







**26 x JGS 624**  
**2 x JGS 620**  
Pipeline gas



**123.6 MW**  
Electrical Output



**up to 46.8%**  
Electrical efficiency



**2026+**  
Year of commissioning

# READY FOR H<sub>2</sub> – WHAT DOES IT MEAN?

## INNIO Definition



All new Jenbacher engines are "Ready for H<sub>2</sub>"

In general, „Ready for H<sub>2</sub>“ Jenbacher units can be converted to operate on up to 100% hydrogen in the future. Details on the cost and timeline for a future conversion may vary and need to be clarified individually.

Furthermore, all models can be offered with the option to operate with up to **25% (vol) H<sub>2</sub>** in the pipeline gas.

**Type 4** engines are offered for **100% H<sub>2</sub>** operation today

**Type 6** engines will be developed for **100% H<sub>2</sub>** operation in 2025

Jenbacher then covers the full range of **500 kW to 4 MW** of hydrogen products.



# READY FOR H<sub>2</sub> — JENBACHER PRODUCT PORTFOLIO

Available products today and tomorrow

## Power Output (kWel)

Generator Output @ 50 Hz operating on pipeline gas								A		B	C
0	1,000	2,000	3,000	4,000	5,000	[...]	10,000	H <sub>2</sub> in pipeline gas	Pipeline gas/H <sub>2</sub> engine	Pure H <sub>2</sub> engine	
								<5% (vol)	<25% (vol) <sup>1</sup> optional	0–100% (vol)	100%
Type 9							J920 FleXtra	✓	✓	25%	2025+
Type 6							J612 J616 J620 J624	✓	✓	60%	2025/26
Type 4							J412 J416 J420	✓	✓	100%	✓
Type 3							J312 J316 J320	✓	✓	60%	2025+
Type 2							J208	✓	✓	60%	2025+

In general, “Ready for H<sub>2</sub>” Jenbacher units can be converted to operate on up to 100% hydrogen in the future. Details on the cost and timeline for a future conversion may vary and need to be clarified individually.

# H2 ENGINE – TYPE 4 – 50HZ (PRE-SERIAL ENGINE)

H2 <100mg/Nm <sup>3</sup> NO <sub>x</sub> @5%O <sub>2</sub>	J412-H2	J416-H2	J420-H2
<b>Electrical Output (kW)</b>	<b>620</b>	<b>830</b>	<b>1040</b>
Thermal Output (kW)	730	970	1210
Electrical Efficiency (%)	40.3%	40.3%	40.5%
Total Efficiency (%)	88%	88%	88%
H <sub>2</sub> consumption (kg/h)	46	62	77
H <sub>2</sub> consumption (Nm <sup>3</sup> /h)	515	686	858

## Technology

- Port injection (gas pressure 8+bar)
- Cylinder selective combustion control
- Wastegate for turbo charger



Alternatively, a “Dual Fuel Product” – 100% pipeline gas / 100% H<sub>2</sub> – is available

# H2-ENGINE – BASED ON TYPE 4

## Pipeline gas vs. Hydrogen

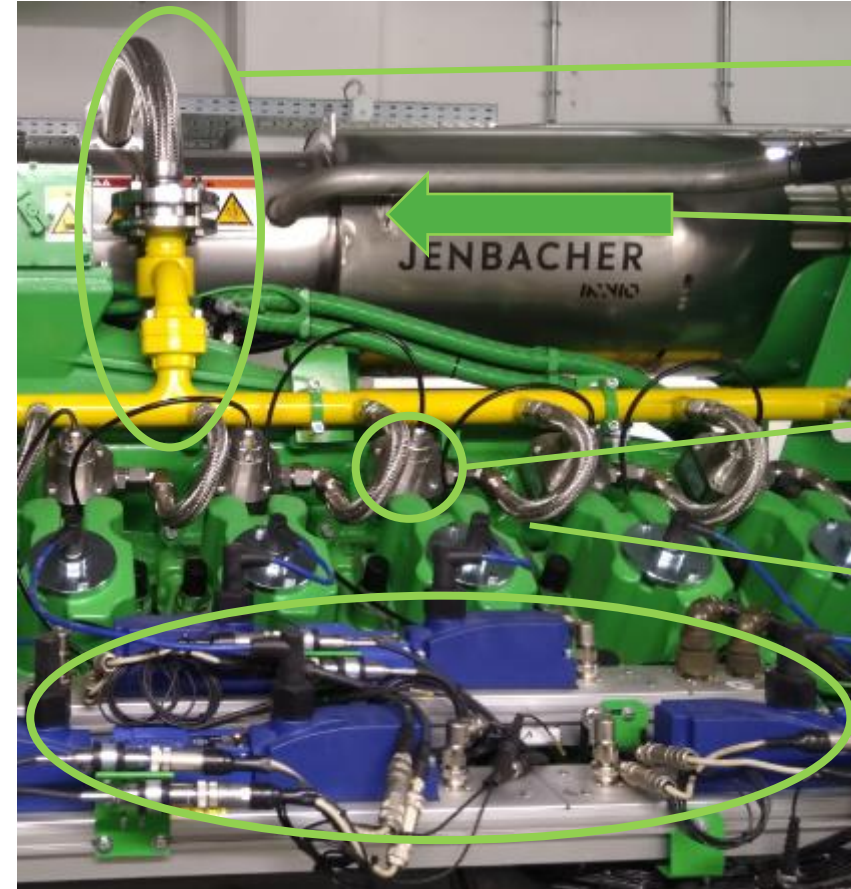
### Jenbacher Type 4 – Mixture charged

Pipeline gas operation

- Gas dosing
- Gas mixer
- Compressor
- Mixture cooler



### Jenbacher H2-Engine\* – Port fuel injection



H<sub>2</sub> Supply / Gas train

Combustion air

Port Injection (PI)  
Valve H<sub>2</sub>

Lube oil  
H<sub>2</sub> - optimized

Cylinder pressure-  
based control

\*In general, "Ready for H2" Jenbacher units can be converted to operate on up to 100% hydrogen in the future. Details on the cost and timeline for a future conversion may vary and need to be clarified individually.

# HYDROGEN GENERATION AND SUPPLY IN JENBACH

## Visualization



### H2 production

- Nom. el. power 2 x 1 MWe
- H2-production 35 kg/h total
- Annual capacity 200 – 300 t/a

### H2 storage

- H2 tank capacity 1,000 kg
- Pressure 500 bar
- Time to re-charge ~23 h

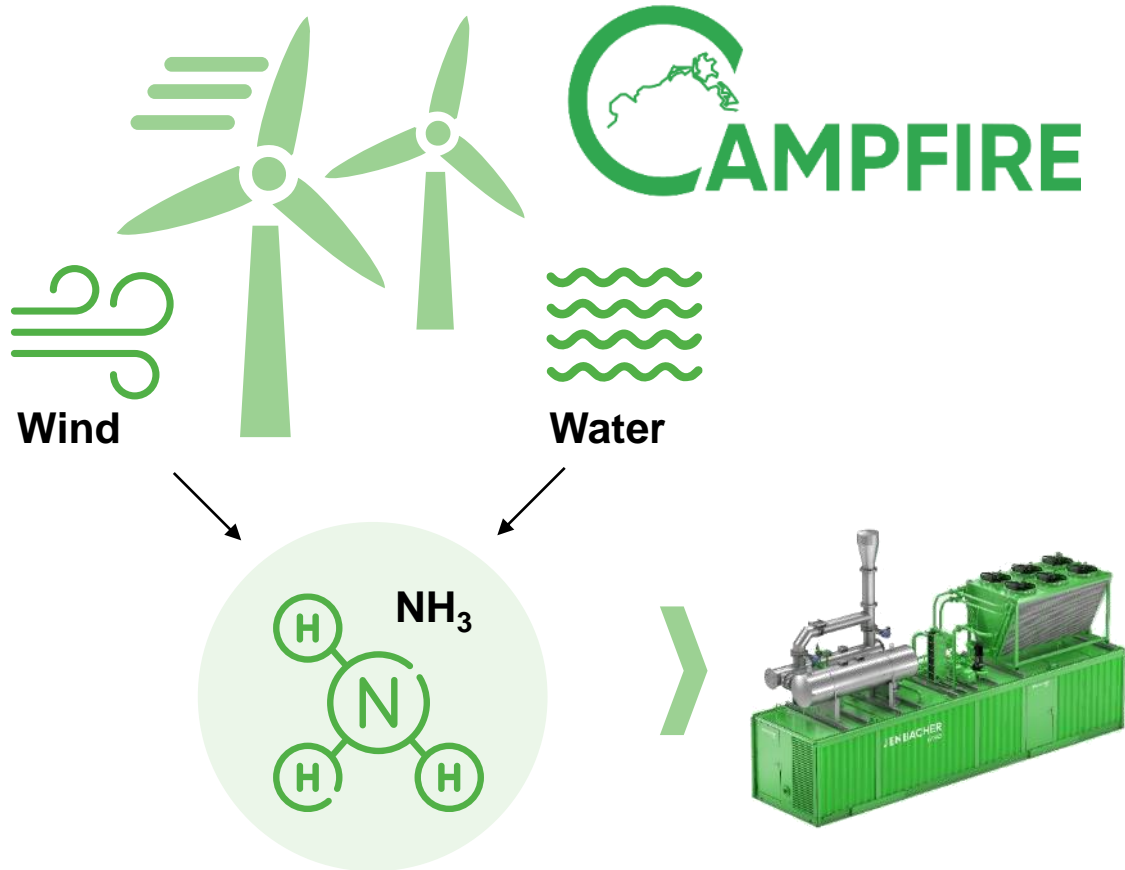
AMMONIA

JENBACHER



# PROJECT CAMPFIRE – WIND & WATER → AMMONIA

Ammonia in the context of maritime fuels and chem. energy storage systems of the future



## Aim of sub-project CF12:

- Development of a container-based NH<sub>3</sub> CHP for a stationary application
- Remote off-grid application
- Power range of 1 MW

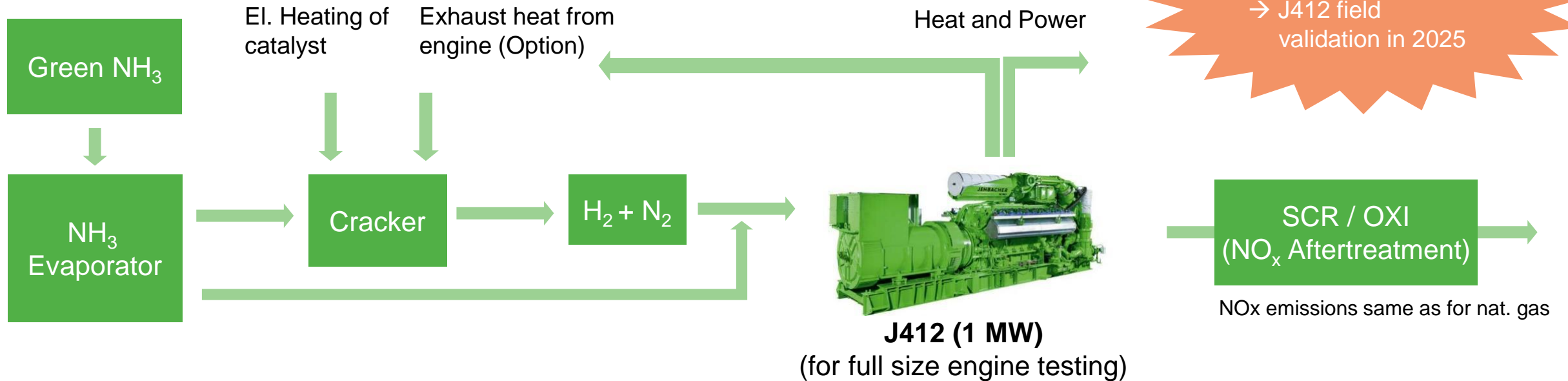
## Including

- various evaluation steps of critical components of the gas engine
- detailed design
- implementation of the container CHP plant
- integration of the NH<sub>3</sub> cracker and necessary safety equipment
- various test runs
- stationary and flexible start/stop operation
- optimizing efficiency and minimizing exhaust emissions

[Stationäre Energie - Campfire \(wir-campfire.de\)](https://wir-campfire.de/)

# GAS ENGINE OPERATING ON AMMONIA

With catalytic decomposition of Ammonia



## Catalytic decomposition of Ammonia to Hydrogen and Nitrogen to promote combustion:

Partial decomposition of Ammonia utilizing a heated catalyst (el. heating or utilization of exhaust heat)

Hydrogen and Nitrogen produced during the catalytic decomposition are blended with the main fuel (Ammonia).

The favorable physical properties of Hydrogen help promote the combustion of Ammonia in the combustion chamber of the engine.

# CASE STUDIES

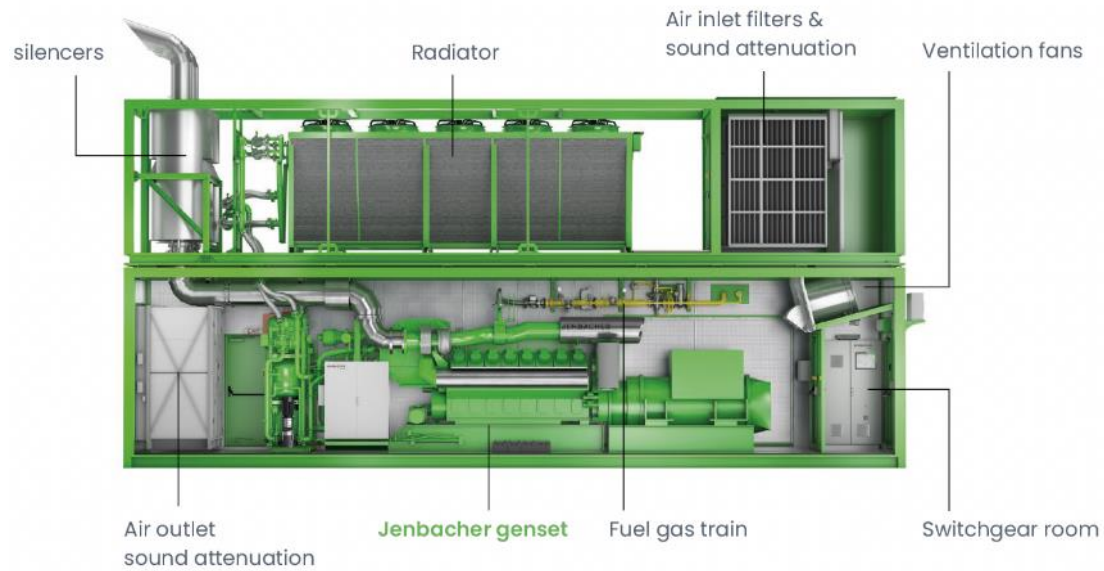
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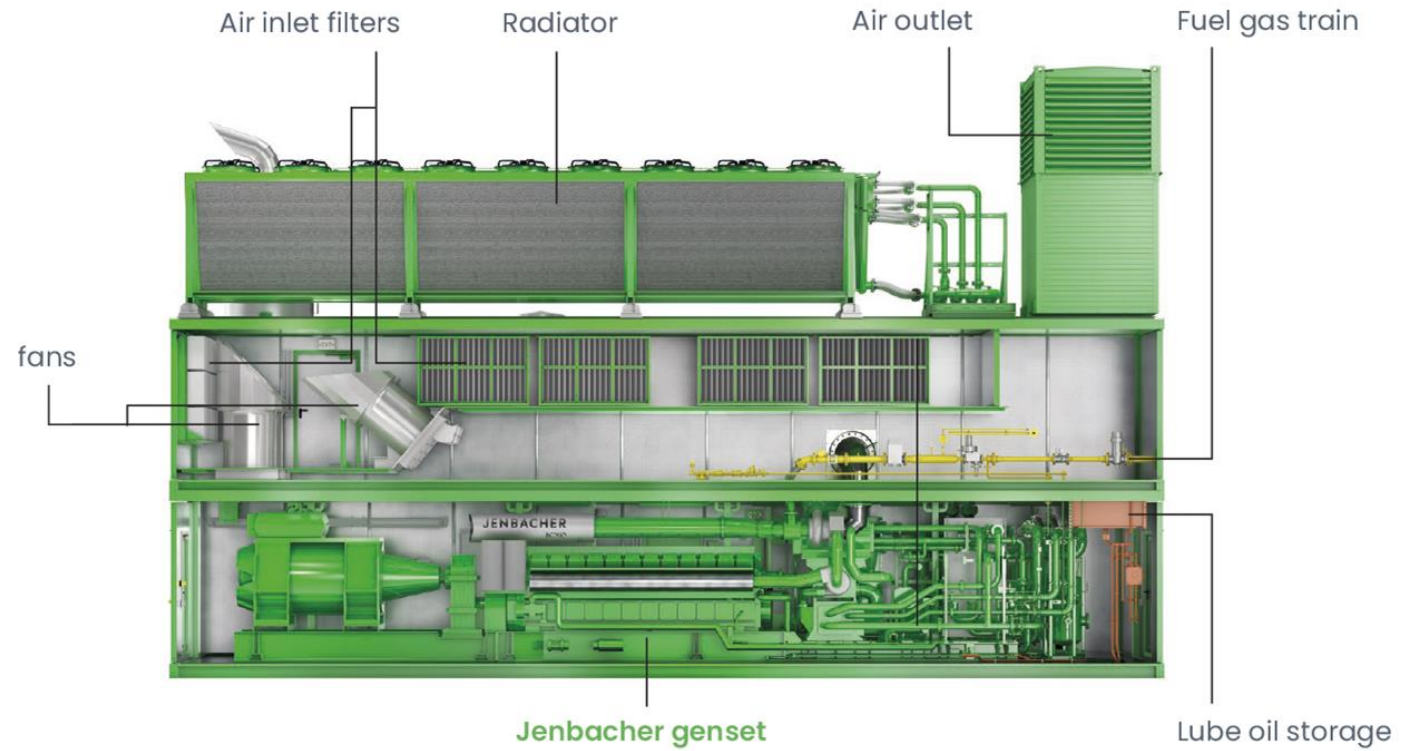


# JENBACHER – J6 SERIES ENGINES

## J620 - 3.3 MW



## J624 – 4.5 MW



# 60 MW JENBACHER GAS ENGINES, IRLAND

## For large-scale data center



**60 MW backup power for data center**

**22 x Type 6** containerized gas engines take over the peak and backup power supply

Ready to be converted to H<sub>2</sub> operation in the future

Europe's largest engine-powered data center that runs on natural gas instead of diesel

»Winthrop's Gen Team selected INNIO Group's Jenbacher team to build this power plant because these engines offer diesel-like performance combined with high efficiency and the ability to run continuously. Due to its consistent progress in implementing its ESG strategy, including hydrogen capability, the company has been awarded the Platinum Medal by EcoVadis. This makes INNIO Group's Jenbacher technology an obvious choice for us.«

Noel Molloy,  
Operation Director at Winthrop Technologies



in 45 sec. to  
100% load



for illustration only

INNIO Group is a leading energy solution and service provider that empowers industries and communities to make sustainable energy work today. With its Jenbacher and Waukesha product brands and its AI-powered myPlant digital platform, INNIO Group offers innovative solutions for the power generation and compression segments that help industries and communities generate and manage energy sustainably while navigating the fast-changing landscape of traditional and green energy sources. INNIO Group is individual in scope, but global in scale. With its flexible, scalable, and resilient energy solutions and services, INNIO Group enables its customers to manage the energy transition along the energy value chain wherever they are in their transition journey.

INNIO Group is headquartered in Jenbach (Austria), with other primary operations in Waukesha (Wisconsin, U.S.) and Welland (Ontario, Canada). Through a service network in more than 100 countries, a team of more than 4,000 experts provides life-cycle support to the more than 57,000 engines that INNIO Group has delivered globally.

INNIO Group's ESG strategy has been recognized and awarded by esteemed rating agencies such as Sustainalytics and EcoVadis. Additionally, the company's near-term climate targets until 2030 have been validated by the Science Based Targets initiative (SBTi).

For more information, visit INNIO's website at [www.innio.com](http://www.innio.com). Follow INNIO Group and its brands on [X](#) (formerly known as Twitter) and [LinkedIn](#).

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**ENERGY SOLUTIONS.**  
EVERYWHERE, EVERY TIME.

