

Hydrogen Fuel Flexibility for Distributed Power Generation with Gas Engines



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https://www.innio.com/en/

- / INNIO is a leading technology provider of gas engines, power equipment, a digital platform and related services for power generation and gas compression at or near the point of use. With our renowned Jenbacher* and Waukesha* product brands.
- / INNIO pushes beyond the impossible and looks boldly toward tomorrow. Our diverse portfolio of reliable, economical and sustainable industrial gas engines generates 200 kW to 10 MW of power for numerous industries globally. We provide life-cycle support for more than 48,000 gas engines worldwide. And, backed by our service network in more than 100 countries, INNIO connects with you locally for rapid response to your service needs.
- / Headquartered in Jenbach, Austria, the business also has primary operations in Welland, Ontario, Canada, and Waukesha, Wisconsin, US.



Products

	Jenbacher* gas engines	Waukesha* gas engines
Technology	Gas engines (0.3-10.38 MW)	Gas engines (0.2-3.6 MW)
Target segments	Power generation	Oil & Gas Power generation
Benefits	 Electrical efficiency High total efficiency Application diversity Fuel flexibility Advanced monitoring and diagnostics 	 Hot/high BTU fuels capability High altitude and ambient capability Fast load acceptance Durability/reliability

The broadest gas-fired portfolio ... 220 kW to 10.38 MW



INNIQ

dispatchable Renewables (dRES)

Decentralized power generation and cogeneration (natural gas)



- / Reliable energy supply for remote areas
- / Supporting local power needs
- / Avoiding transport and distribution losses
- / Enhanced total efficiency
- / Jenbacher Types 2, 3, 4, 6, 9

Oilfield power (associated petroleum gas)



- Reliability for rugged, remote applications
- Reducing global warming effects from CH4 emissions and flaring
- Emission regulations driving increased use of natural gas versus diesel-powered generator sets
- / Jenbacher Types 2, 3, 4, 6
- / Waukesha* Types VGF*, VHP*, 275GL*+

Renewables and waste-to-energy utilization



- / Waste usage
- / Alternatives to fossil fuels
- Biogas, landfill gas, sewage gas, coal mine gas, special gases (steel gas, wood gas, process gases)
- / Jenbacher* Types 2, 3, 4, 6

Natural Gas / CNG / LNG

Natural Gas

Renewable Gas



This is INNIO

48,000 Jenbacher and Waukesha units 64 GW delivered globally 20,000+ Jenbacher engines 26 GW globally ~22 GW in operation globally ~65% Nat. Gas

~35% Biogas, landfill gas, sewage gas, coal mine gas, special gases (dRES)











CHP for C&I Buildings

Gas, Storage and role of gas engines



Secured backup power to RES in GER



https://twitter.com/ewi_ERS/status/1032563035448205314?s=02



Energy Storage



* ohne Industrie und GHD; Strombedarf pro Person: 1,45 MWh/a Die Datenwolken geben Bereiche an, in denen sich einzelne heute bereits realisierte Anlagen in Deutschland bewegen.

Quelle: Sterner und Stadler, Energiespeicher – Bedarf, Technologien, Integration, Springer 2014

Seasonal energy storage is one of EU's top 10 themes

Stichwort "Dunkelflaute"

With todays view P2G is needed to achieve the required time and size of energy storage with energy based on renewable energy sources.

P2G for all sectors incl. transport and heat

P2G is not a German or European topic only



Hydrogen and applications



Reciprocating engine fuels:

- Hydrogen
- Synthetic Nat. Gas
- Synthetic liquid fuels
 - Methanol
 - Ammonia

*Illustrative example, not comprehensive Source: NREL



Non natural gas utilization



Jenbacher gas engine experience with high H₂





Future scenarios (R&D example)

HyMethShip



ON THE WAY TO ZERO EMISSION SHIPPING

GREEN REVOLUTION ON THE HIGH SEA

Source: Dr. Igor Sauperl, project coordinator, LEC Graz https://www.hymethship.com/



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 768945



INNIQ

"Emission-free" Ship Propulsion (concept with Methanol CH₃OH)





- 97% reduction in GHG emissions
- Elimination of SOx and PM emissions
- Minimization of NOx emissions
- ~45% increase in system efficiency compared to the technology with conventional CO2 capture / separation
- Full-size (1 MW) system demonstrator (land based)

"Emission-free" Ship Propulsion (off-shore)





On-board setup:

- <u>CO₂ capture system (pre-combustion</u> capture incl. Water, Methanol and CO₂ tanks)
- <u>Dual fuel engine (</u>ICE)
 H₂ ... main fuel
 Methanol ... back-up fuel
 Diesel ... optional fuel
- <u>Waste heat integration</u> with absorption chillers



Installed base of Jenbacher engines



A global delivered installed base ...



In Europe ~70% of all gas engines are in CHP application





CHP benefits

Heat and Power



2.2 kWh NG ... 450 g/kWhel

to produce 1 kWh of electricity 2.2 kWh of NG are required and 450 g of CO2 are emitted.



to produce 1 kWh of electricity and 1 kWh of heat 2.2 kWh of NG are required and 450 g of CO2 are emitted. Only 50% of the NG is allocated to electricity production and boiler NG fuel is replaced.

CHP reduced fuel consumption by ~33% CHP reduced CO2 emissions by ~33%

Jenbacher gas engines operating in Denmark



Source: IB data Jenbacher, http://brancheforeningenkraftvarme.dk/wp-content/uploads/2018/04/Decentral-kraftvarme-statistik-april-2018.pdf, Den. Energistatistik Assumptions: avg. NG efficiency 44% and 460 g/MWh CO₂, avg. NG-CHP total efficiency 90% and 224 g/MWh CO₂



Reducing carbon emissions with gas engines (GE)





Three main areas of use in power generation

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- Avoiding transport and distribution losses
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- / Jenbacher Types 2, 3, 4, 6, 9

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dispatchable Renewables (dRES)

Carbon free

Renewables and waste-to-energy utilization



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- / Jenbacher* Types 2, 3, 4, 6



/ Carbon free power generation

power and cogeneration

- / Dispatchable renewable energy source (dRES)
- Using renewable fuels such as hydrogen, methanol, synthetic nat. gas, ammonia, etc.
- Using conventional proven and affordable gas engine technology
- / Any conventional application
- / Jenbacher Types 2, 3, 4, 6, 9

Natural Gas, CNG/LNG

Natural Gas

Renewable Gas

 H_2 / SNG / Methanol ...







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