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CONSULTING

Micro Gas Turbine Retrofit for 100% Hydrogen Operation

Energy & Turbomachinery Network
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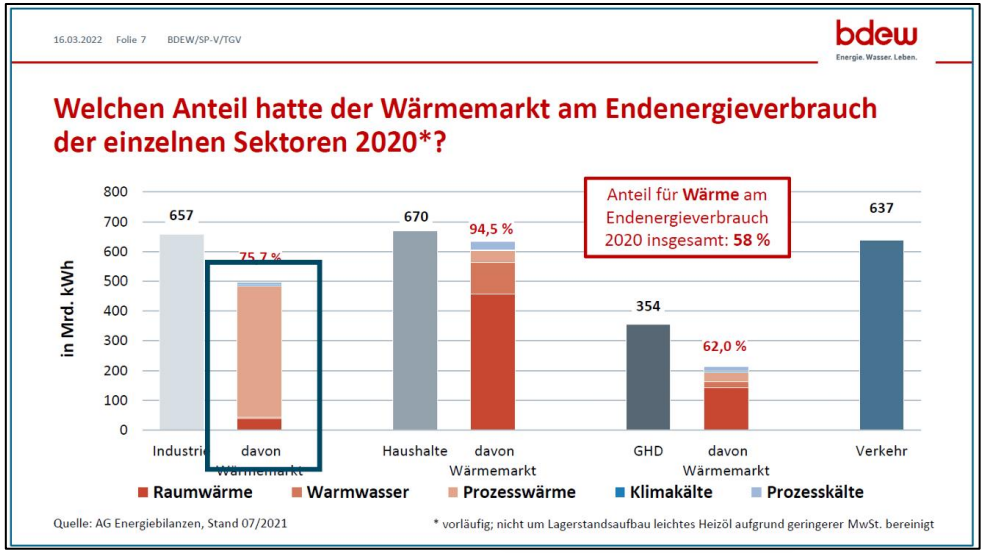
Micro Gas Turbine Retrofit for 100% Hydrogen Operation
Agenda

- Background, Market and Partners
- Combustion System F400
- Retrofit Works and Scope
- Fuel Mixing Skid
- Demonstration and Achievements
- Summary and Outlook

Background, Market and Partners (I)

- **CHP Systems are the backbone for the generation of process heat for small and medium-sized industrial businesses.**
- As a reference, almost 20% of Germany's total energy consumption is used for generating industrial heat
- **PSC is committed to provide climate-neutral renewable fuels solutions to this customer base to support their transition to climate-neutrality**
- Even for micro gas turbines, the consumption of renewable fuels, e.g. hydrogen, is considerable.
- That is why we believe **micro gas turbines in the range of 100 kW_{el} are the best frame size to enter the market with a 100% hydrogen solution:** Generation of the required fuel amount from locally generated wind and PV energy is feasible and the technology required is available.



CHP Units operated on NG (Germany)	50 – 100 kW	101 – 500 kW	501 kW – 1 MW	Sum
Gas Motor	1286	3587	827	6062
Gas Turbine	130	196	36	
More than 6'000 CHP units between 50 kW and 1 MW are in operation on NG, which are to be modified or replaced over time.				

Markstammdatenregister Germany, 01-10-2024, Units with KWK Register-Nr. and NG as primary fuel

Background, Market and Partners (II)

Our micro gas turbine technology is based on a close cooperation with our partners

The German Aerospace Center, Institute of Combustion Technology (“DLR”)

The combustion chamber system used for the H_2 Retrofit has been developed by our partner DLR and is manufactured by PSC under license

Ansaldo Greentech S.p.a.

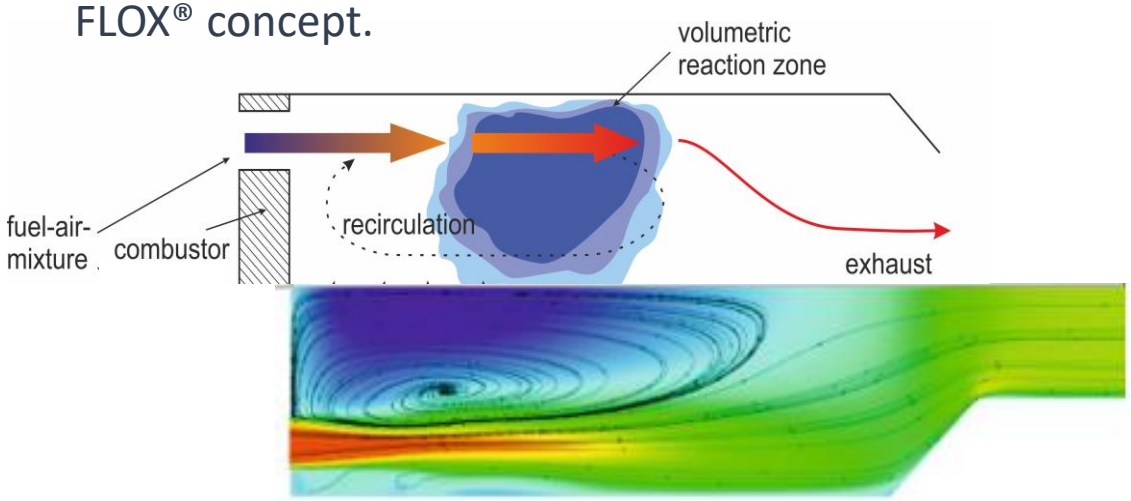
PSC is the German market distributor and service provider for Ansaldo’s AE-T100 micro gas turbine. Ansaldo is providing turbine system OEM support to PSC for the H2 retrofits.

Based this cooperation PSC is able to provide both, the retrofit of existing micro gas turbine units as well as the delivery of new units

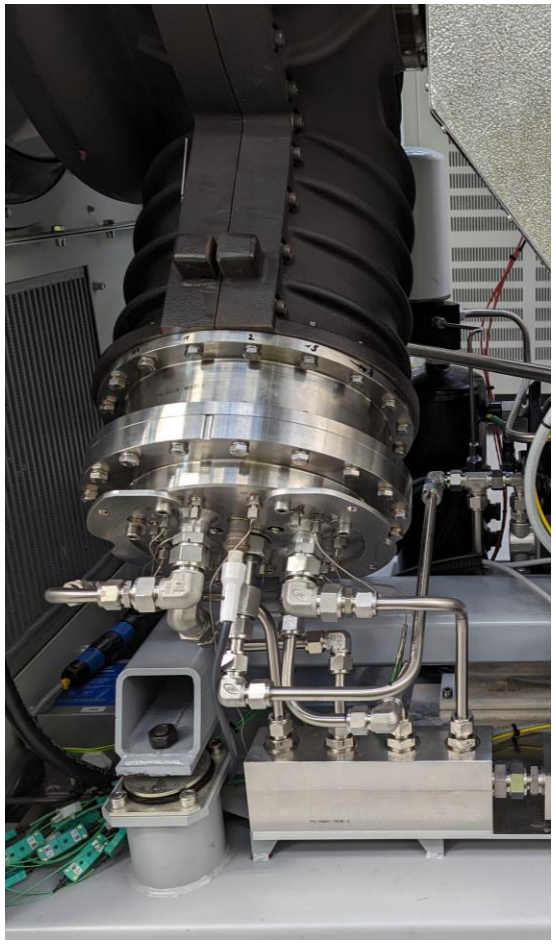
This market view, and the availability of our partners, led to the decision to offer H2 Retrofits to the AE-T100 micro gas turbine system

Combustion System F400

- The F400 used for retrofitting is a jet-stabilized combustion system based on the FLOX® concept.



Schematic representation of the jet-stabilized burner concept (top sketch, bottom numerical simulation of the flow field)

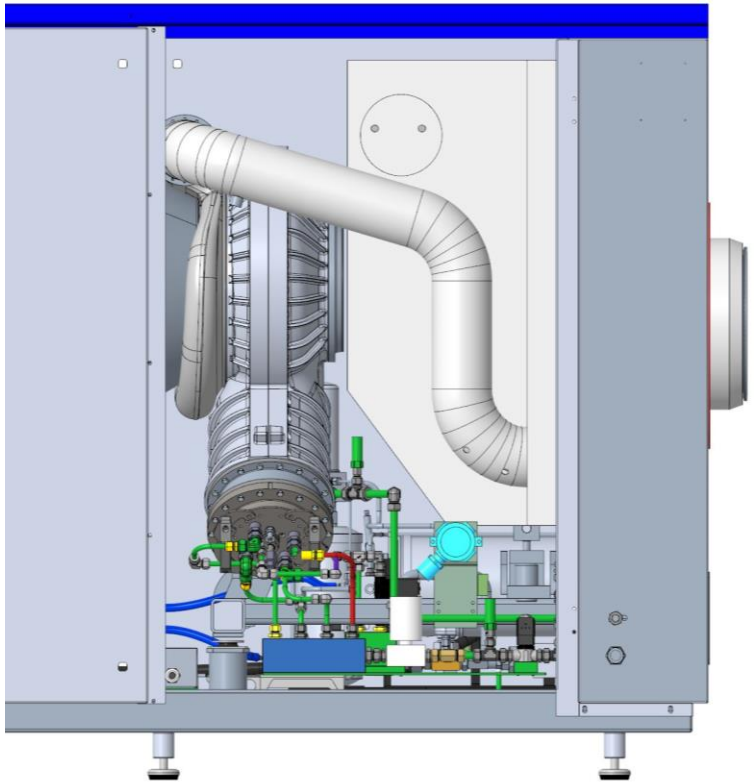


- It is characterized by a wide, stable operating range while achieving lowest CO and NO_x emissions.
- The system provides highest fuel flexibility. Biogases, natural gas or synthesis gases, or mixes thereof, can be used as fuel by adapting its configuration.
- Further advantages are high flame flashback resistance and insensitivity to thermo acoustic effects.

Retrofit Works and Scope

- Installation of F400 Combustor in the given MGT geometry. Adjustment of dilution air hole diameters and nozzle specifications based on fuel/fuel combination
- Replacement of Gas Valves and Gas Piping
- Installation of H_2 Sensor and its integration in the Safety-SPS-System
- Adjustment of turbine control parameters (e.g. for LHV values, valve openings, and start sequence). Performed in coordination with the MGT OEM.
- Compliance Analysis to ISO 19372 Microturbine Safety and Machinery Directive 2006/42/EG
- Risk analysis following EN ISO 12100 Safety of Machinery

PSC issues a manufacturer's certificate for the retrofit.



According to 2006/42/EC, the modifications made to the gas turbine installation do not constitute a substantial modification. The EC declaration of the MGT OEM remains in force.

Fuel Mixing Skid
H2 Blend Pro

A variable fuel application requires a fuel-mixing skid

- The skid H2 BlendPro 350 was developed to mix natural gas with hydrogen in any ratio, i.e. from 100% natural gas to 100% hydrogen.
- The skid is delivered with a separate SPS and its own HMI complementing the AE-T100. The desired fuel mixing ratio can be set via a local control panel or a higher-level control system via Modbus.

Technical Data

Power consumption:
1,1 kW

Voltage:
3~ 230 V / 400 V / 50 Hz

Dimensions:
2047 mm, L 2021 mm,
B 1000 mm

Weight:
700 kg

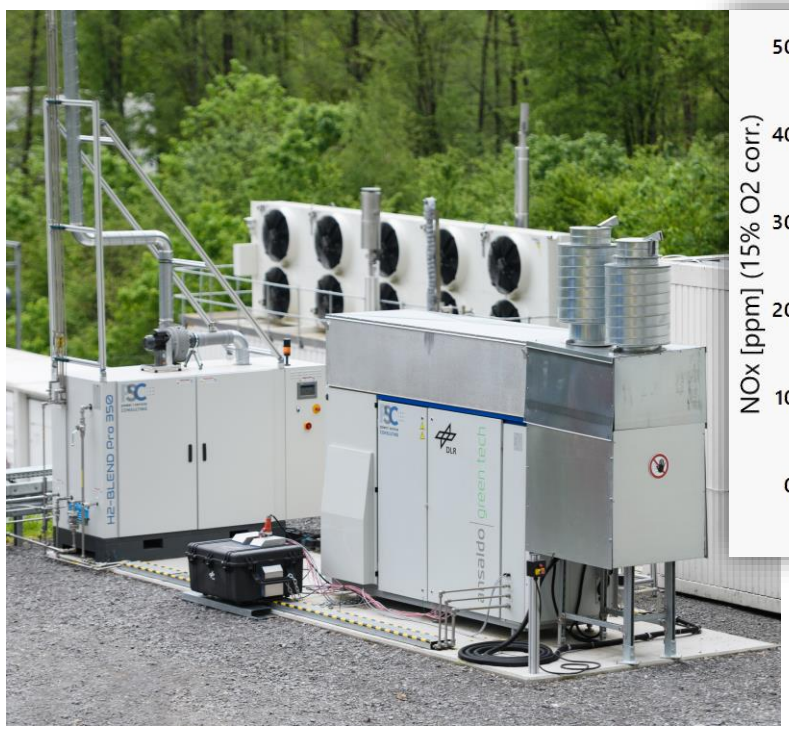
Demonstration and Achievements
Retrofit-H2 project

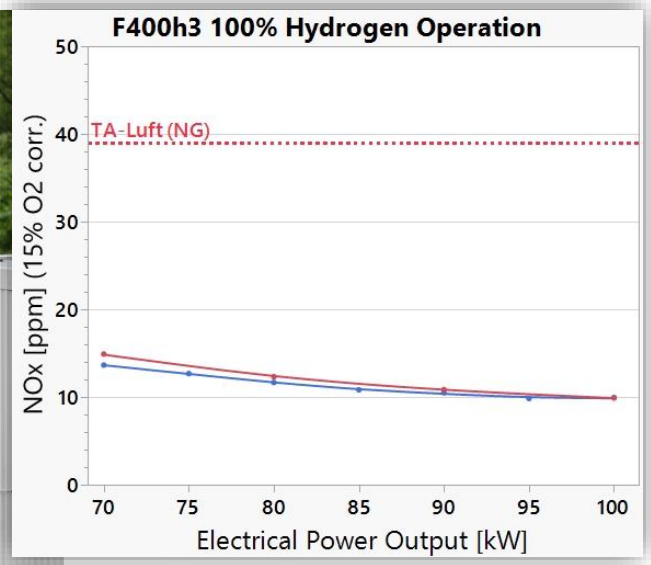
Project goals

- Develop, commission, and test of a fuel flexible combustion system for up to 100% hydrogen and fuel control and distribution system

Achievements

- Operation with 100% H2 from start to nominal load verified
- NO_x < 15 ppm (15% O_2) for hydrogen (70-100% load)
- Dual fuel capability of the F400 System confirmed
- Fuel mixing skid operation proven





BETREUT VOM

Demonstration and Achievements
First commercial contract for 100% H_2

Project goals

- Investigation of the interplay between gas turbine, battery storage, and green hydrogen, production/storage in decentralized applications
- The integration of the gas turbine

Achievements

- 100% H2 AE-T100 commissioned as part of the TH Ulm Science City Energy Park.

Energy storage and conversion system with battery storage, electrolyser, hydrogen storage and gas turbine in the Energy Park of TH Ulm

Demonstration and Achievements
Operation Experience with F400 combustor

Project goals

- Long term operation of the F400 combustor system in a customer plant to gain operation experience

Achievements

- F400 design and structural integrity confirmed
- > 5’500 OpHrs and > 500 starts (on NG)

Summary and Outlook

- The **H_2 retrofit** for the AE-T100 **micro gas turbine is market-ready** and available to customers
- **Emission levels of NO_x <15 ppm (15% O_2), significantly below the BImSchV/TA Luft limits,** have been proven during H_2 operation. Without exhaust gas treatment
- The retrofit scope can be extended to include a **mixed fuel capability**, e.g. NG and H_2, while the fuel mix can be adjusted during operation without limitation
- The **retrofit is scalable** up to Industrial Turbines with a can combustor type

Challenges:

H_2 availability at the customer's locations and at affordable pricing

For decentralized applications, a systemic integration with local fuel generation and storage capacities is required

The market dominance of gas-engine-based CHP systems with project developers

Thank you for your attention!