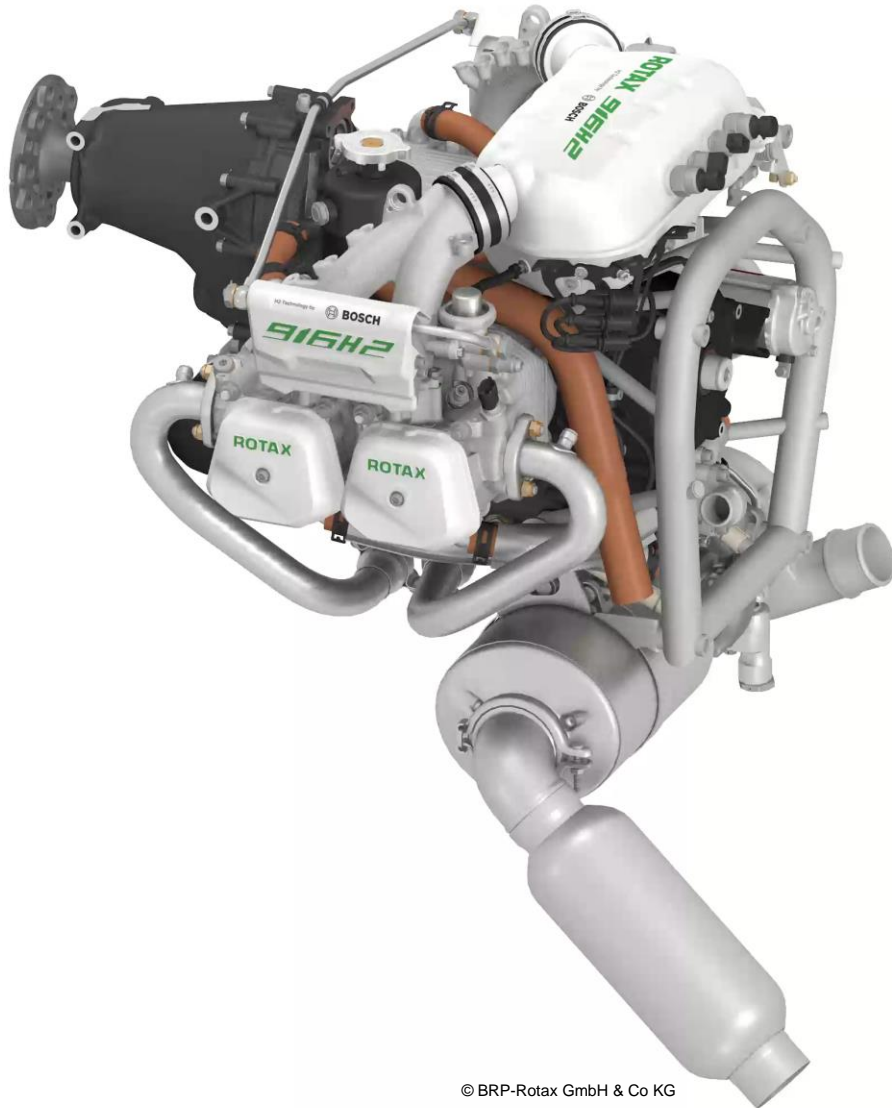


AERO Hydrogen & Battery Summit 2025

916 H2 - Engineered for Change

Hydrogen Conversion of the 916 iS Engine

Christian Grim
General Manager
Bosch General Aviation Technology GmbH



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Climate protection targets can be challenging

... but we have the experience for every type of mobility

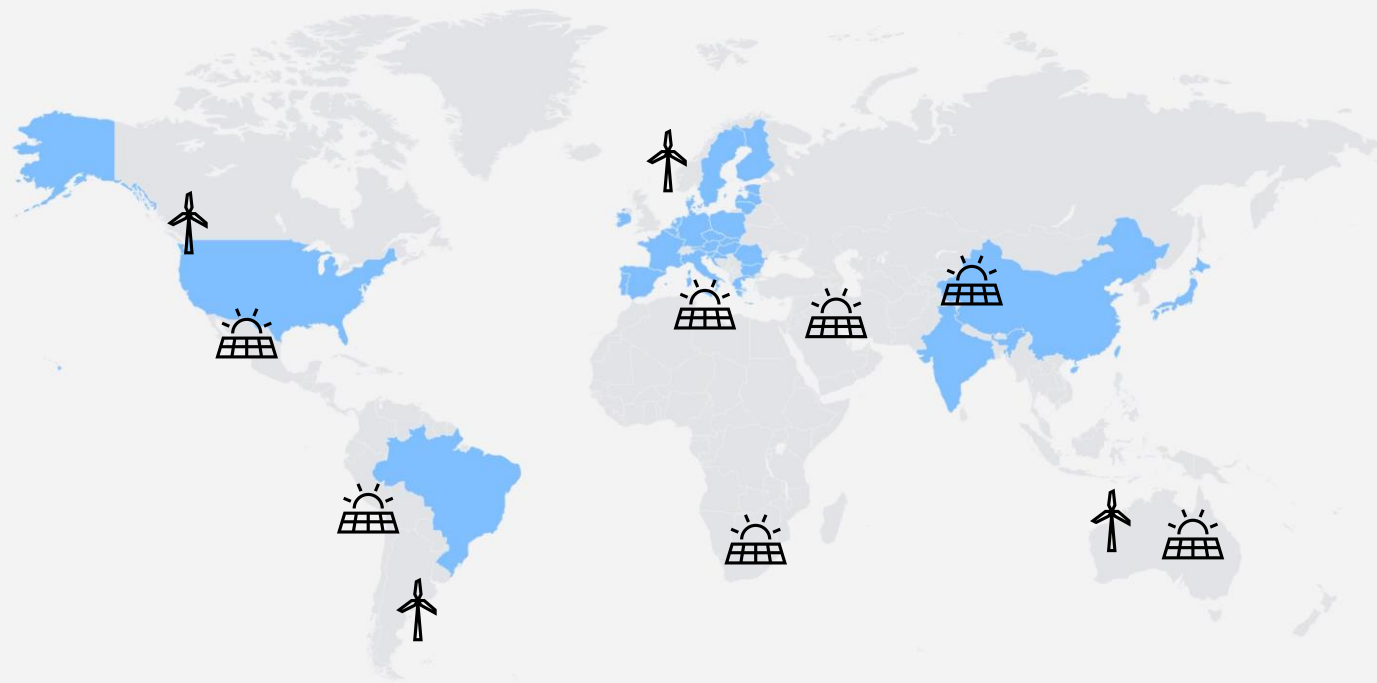


The mobility of the future should be **sustainable and affordable**, and **perfectly fit** each customer's requirements.

THE AIM IS CO2 NEUTRAL MOBILITY

CO2 neutral mobility has

... the challenge to fuel all powertrains with renewables



Schematic representation

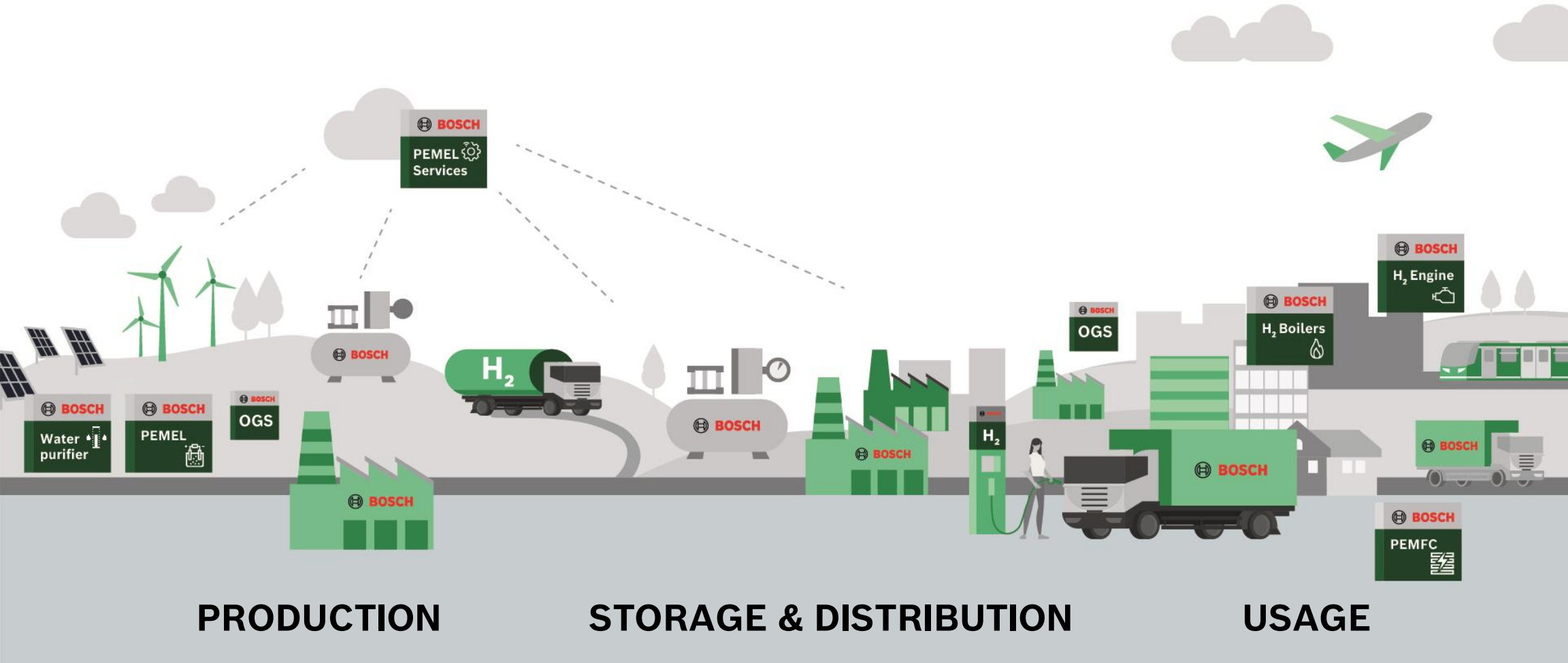


Area with high solar power potential



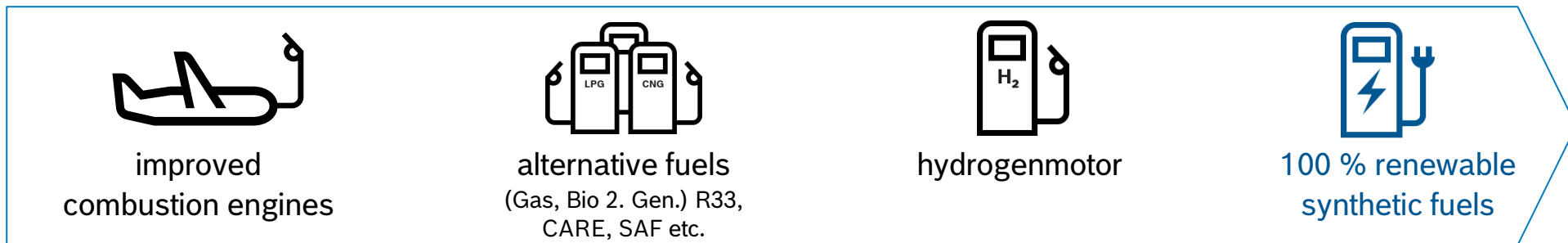
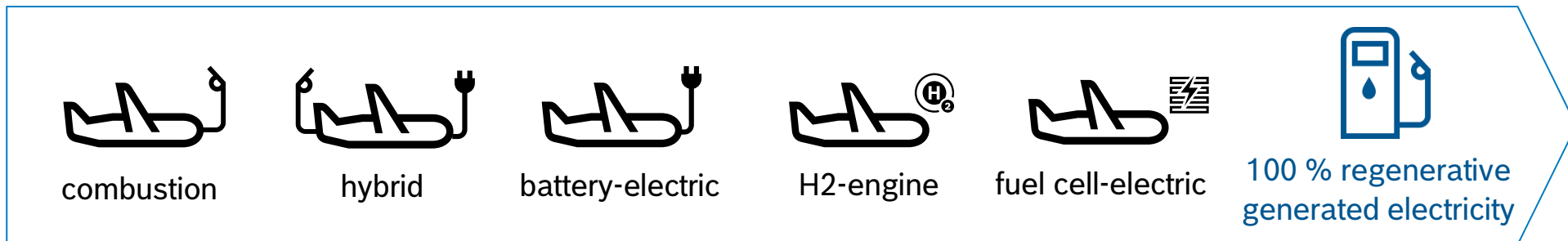
Area with high wind power potential

Fueling powertrains with renewables needs a holistic approach
... and we offer the whole hydrogen lifecycle (example)



According our experience

... we shall use all paths to achieve CO2-neutral mobility





Sustainable Aviation

Bosch Aviation Technology



Bosch Aviation Technology

... is supporting CO2 free powertrain alternatives

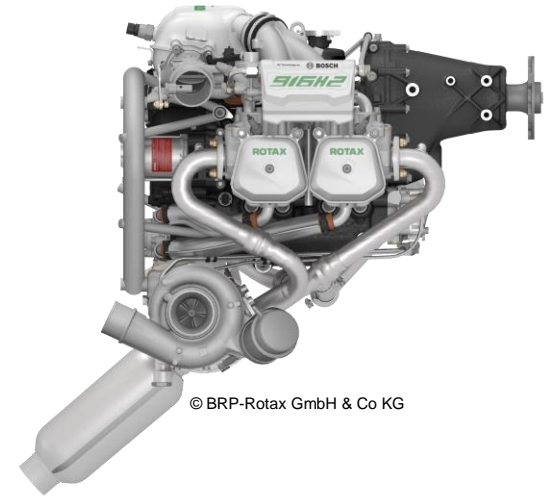


Bosch Aviation Technology

... is supporting CO2 free powertrain alternatives



916 H2 innovation project



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916 H2 innovation project

... is based on proven system and hydrogen expertise from BOSCH

BOSCH focus applications

PC / LCV & HD / Off-Road



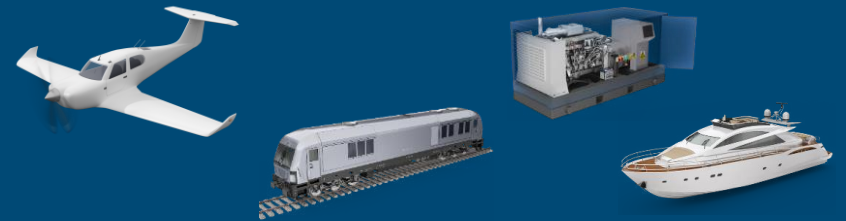
BOSCH platform extension

Sports & race cars



BOSCH further applications

Genset / Rail / Aviation / Marine



PC ... Passenger Car / LCV ... Light Commercial Vehicle / HD ... Heavy Duty



916 H2 innovation project

... is based on proven system and hydrogen expertise from BOSCH

BOSCH focus applications

PC / LCV & HD / Off-Road



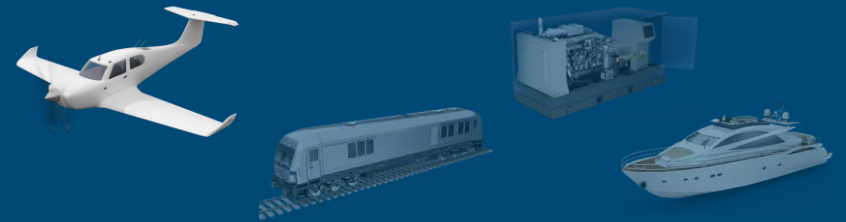
BOSCH platform extension

Sports & race cars



BOSCH further applications

Genset / Rail / Aviation / Marine



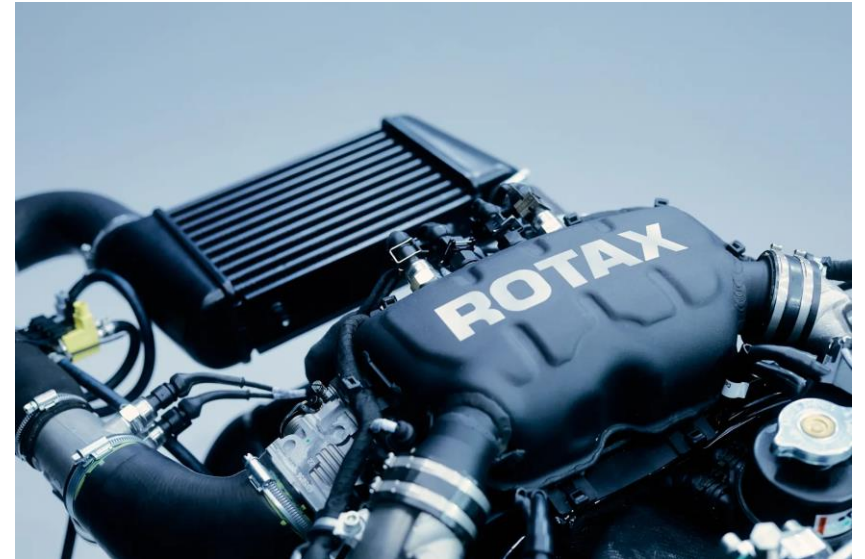
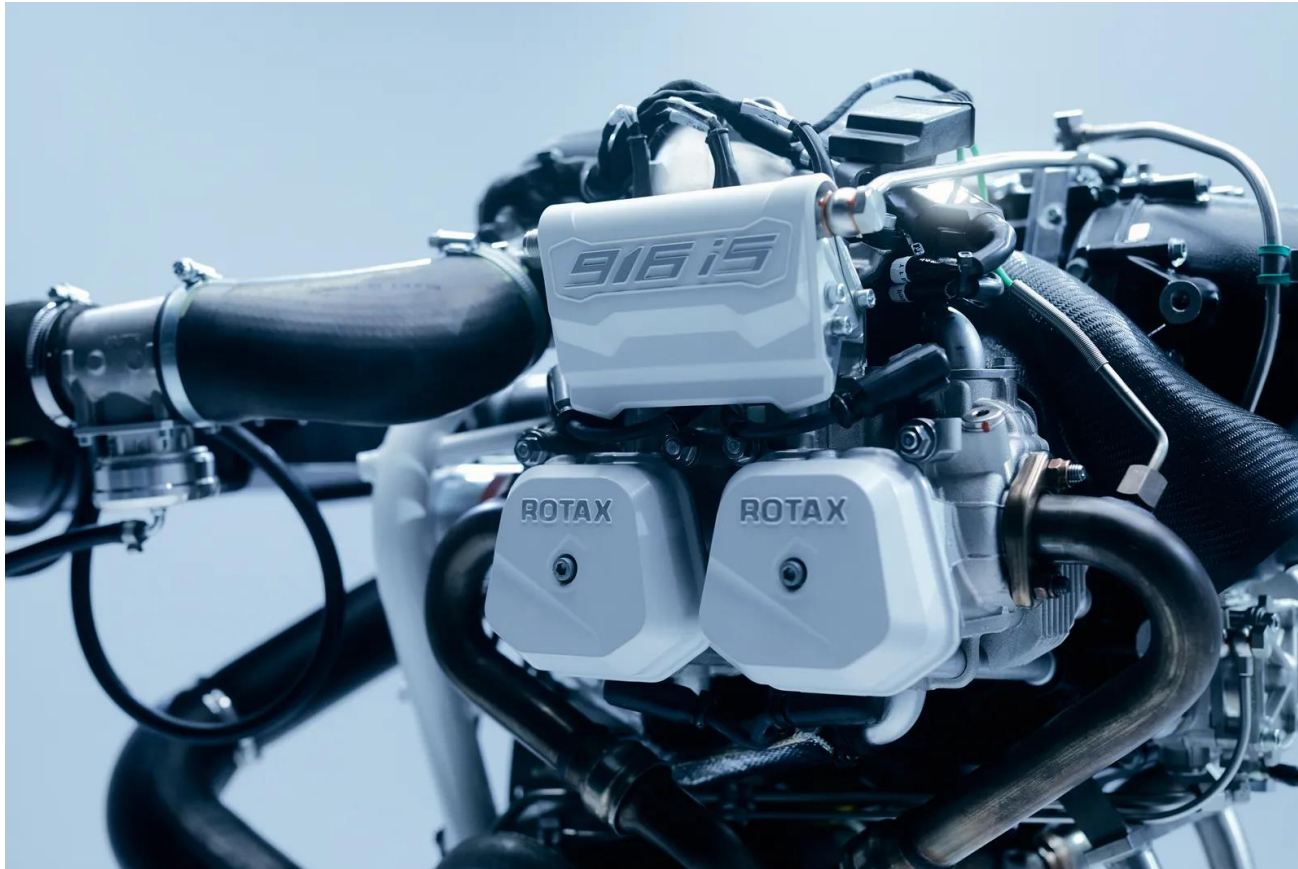
PC ... Passenger Car / LCV ... Light Commercial Vehicle / HD ... Heavy Duty



916 H2 innovation project

... is also based on reliable engine technology from BRP ROTAX

ROTAX



© BRP-Rotax GmbH & Co KG



The 916 iS engine

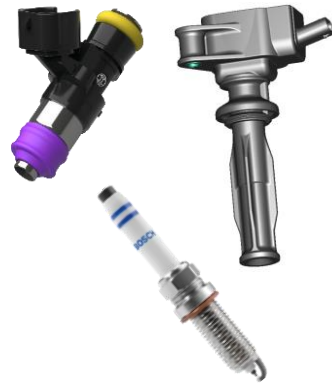
... was modified to be capable of 100% H2 operation

ROTAX



Modification of the injection system

BOSCH H2 port fuel injectors, ignition coils, spark plugs and prototype engine controls



Intake manifold adaption

Gas guide tubes to avoid backfire caused by hydrogen's low ignition energy



Optimize the synchronization

Camshaft sensors was installed at the cylinder head to enhance control possibilities



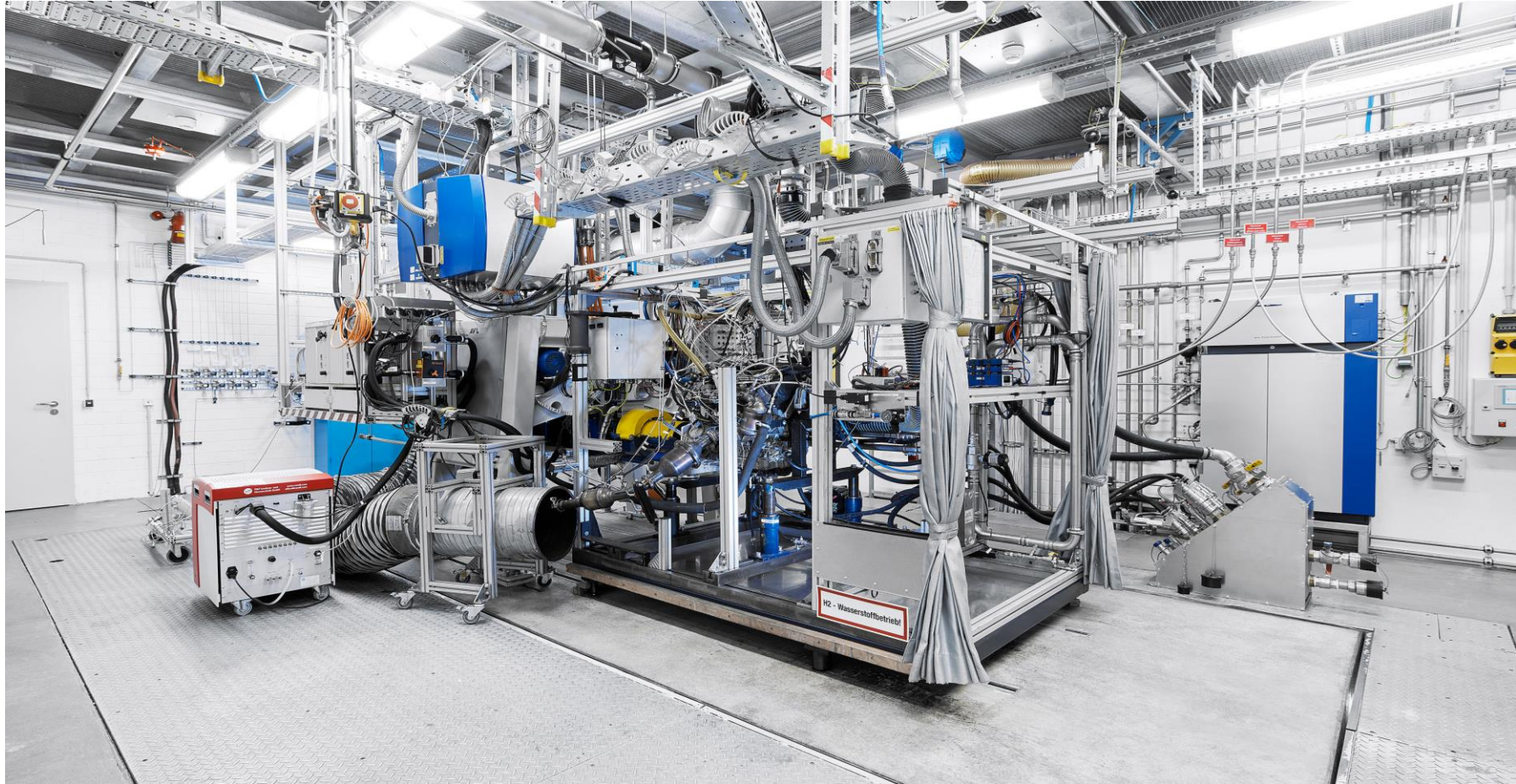
Installation of additional sensors

Needed for engine operation or in addition for collecting measuring data at test bench



The 916 H2 innovation project

... was ready for the test bench in about 3 month



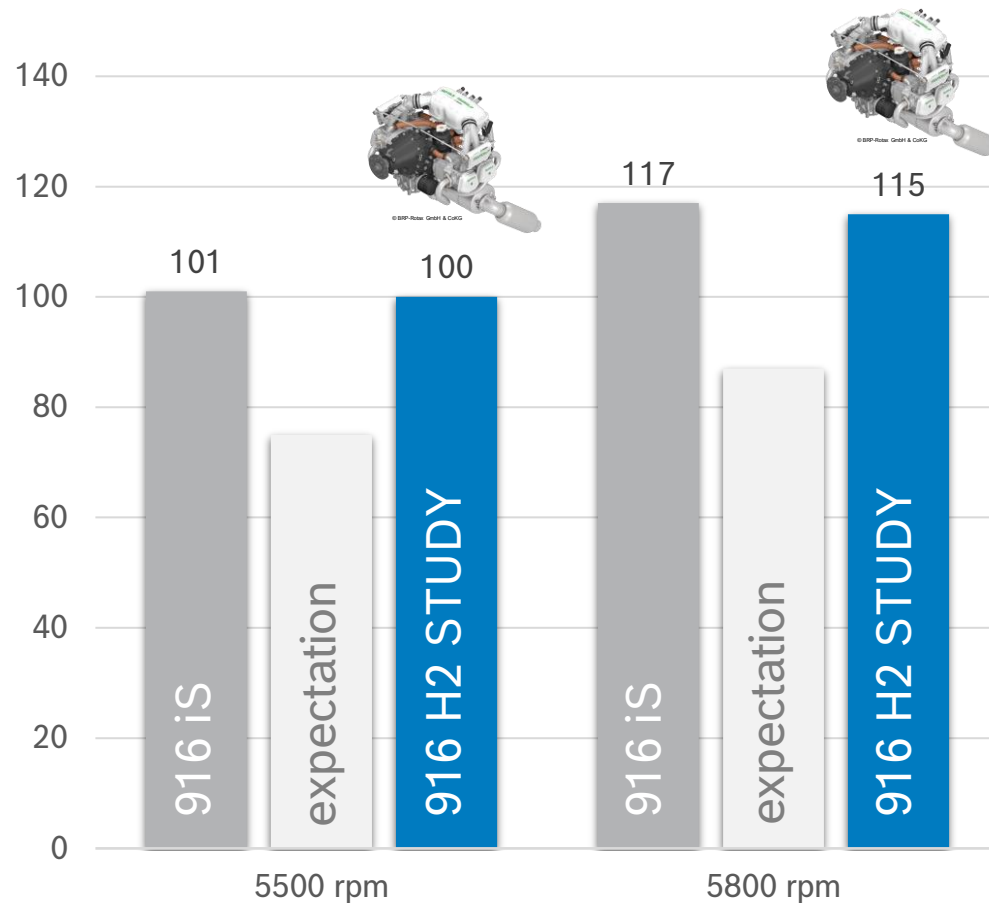
The engine performance

... **significantly exceeded our expectations**

We reached H2 performance on gasoline level!

Since hydrogen displaces part of the intake air, the calorific value of the mixture is in general lower than in comparable gasoline operation.

The results in a power output would therefore be significantly lower under identical conditions and with a stoichiometric mixture, compared to gasoline operation.



The engine performance
... in more detail



	Engine Data during CRUISE FLIGHT condition	Engine Data during FULL LOAD condition
Engine Speed	5500 [rpm]	5800 [rpm]
Air–fuel equivalence ratio	1,4 [λ]	1,4 [λ]
Rail Pressure	12,8 [bar]	13 [bar]
Turbo Charger Speed	125.000 [rpm]	133.000 [rpm]
Boost Pressure	2,2 [bar]	2,39 [bar]
Exhaust Gas Temperature	760 [°C]	770 [°C]
Average max. Cylinder Pressure	78 [bar]*	90 [bar]**
Fuel consumption (not optimized)	89,9 [g/kWh] or 9,017 [kg/h]	84,5 [g/kWh] or 9,762 [kg/h]
ENGINE PERFORMANCE	100 [kW] and 174 [Nm]	115 [kW] and 190 [Nm]

*max. allowed pressure 78bar

**max. allowed pressure 95bar

Several engine test runs on the test bench

... **helped to understand and learn about H2 engine applications and beyond**

FURTHER ENGINE OPTIMIZATION NEEDED but overall results very promising

- NOx to be considered as residual emission
- Engine adoptions for performance, reliability and efficient operation



AUTOMOTIVE BASED TECHNOLOGY will speed up the development

- Technology, products and services are a good basis for sustainable propulsion systems and earlier market introduction possibilities. **Usable for all powertrains!**



H2 STORAGE & AIRCRAFT INTEGRATION concepts and partners needed

- Concepts will be crucial to investigate further with partners
- Out of scope during the 916 H2 innovation project



EXISTING AVIATION ENGINES AS BASIS are reliable, available and cert. basis known

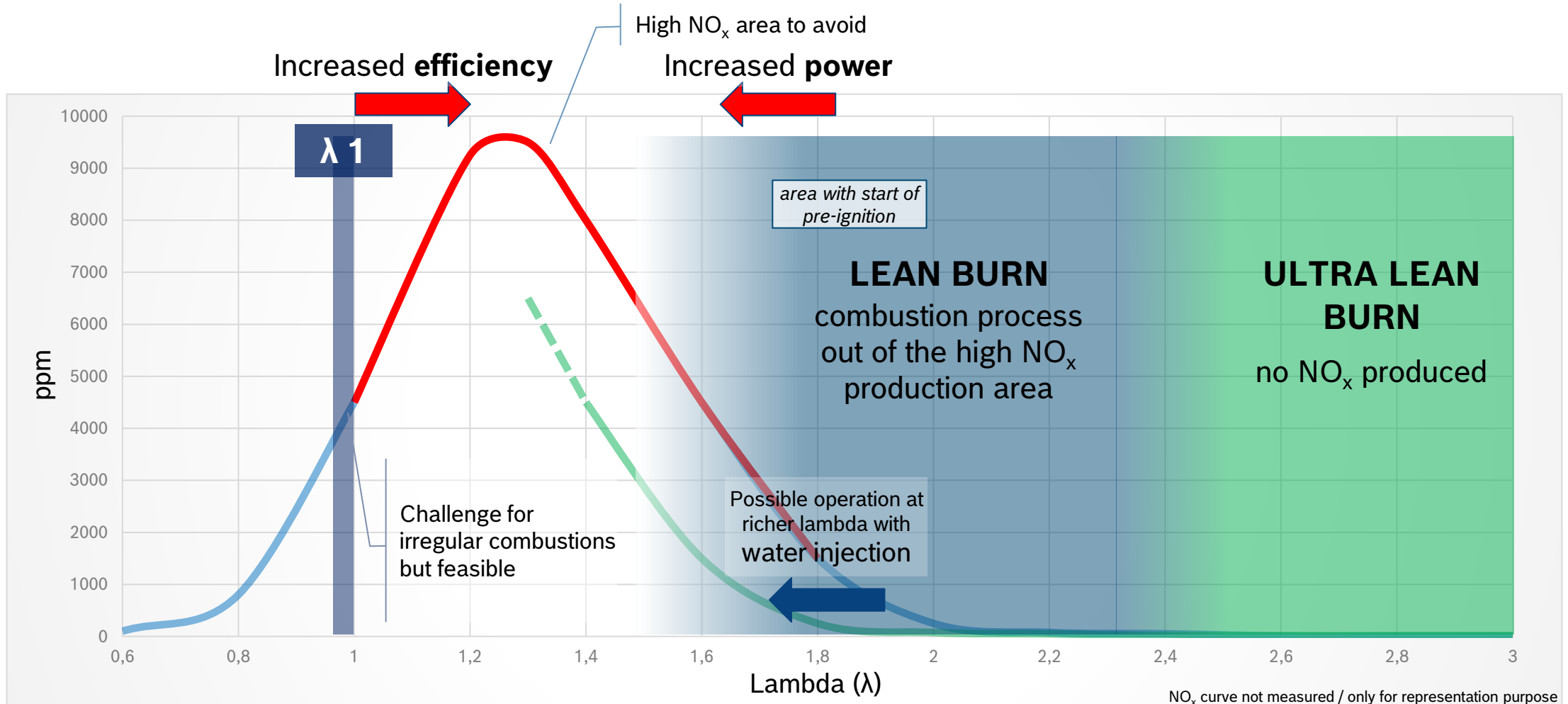
- Using existing technology might reduce upcoming certification related hurdles and aircraft installation efforts. All powertrains have a part to play!



To reduce the overall emissions to a minimum

... we need to have a focus on NO_x Emission Control

All other engine-out emissions (HC, CO and particles from lubricant oil burning) at very low level



NO_x curve not measured / only for representation purpose

The 916 H2 innovation project

... showed further development potential and lessons learned

Target power on the same level as with gasoline 117 kW @ 5,800 rpm



Injection

- Optimize the mass flow (increase)
- Reduced window of ignition
- Position optimization
- New Fuel Rail



Combustion

- Process optimization
- Increase tumble (homogenization)



Turbocharger

- Slightly bigger T/C for increased air volume, higher pressure to achieve wider (ultra) lean burn operation

POTENTIAL NEXT STEP: Prototypical aircraft installation including H2 tanks

for evaluation of installation criteria and tank system evaluation

Bosch Aviation Technology

... is the key partner to tackle the major industry challenges

**Prototype
Components for Proof
of Concept**



**Managing Innovation and
latest Technology
Standards**



**Highest Product
Quality in Series
(for COTS* products and
manufacturing services)**



*... Commercial off the shelf

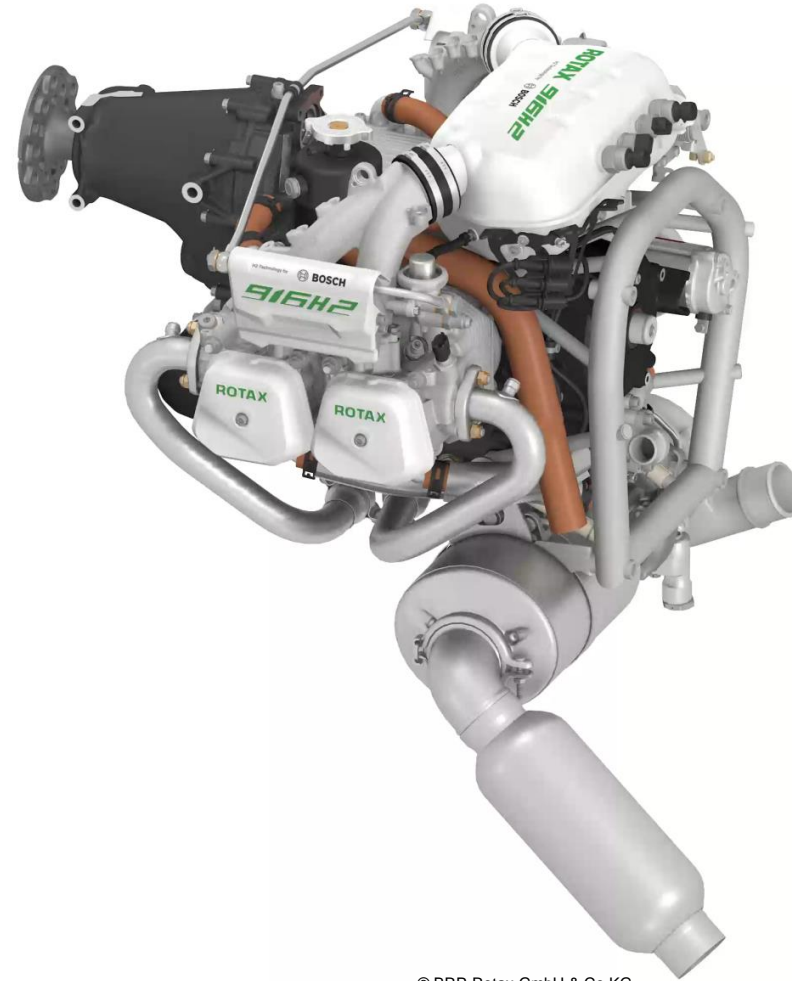
**Providing
Engineering
Method Expertise**



916 H2 - Engineered for Change

Conclusion

- **Bosch Aviation Technology has demonstrated**
 - Concept viable, even with reduced engine modifications
 - Powertrain installation is similar to gasoline combustion engines
 - Performance (power and torque) nearly at gasoline level
- Knowledge and data gained for future customer projects
- **Bosch Aviation Technology is ready for the next step!**



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