Decarbonization of Mobility
by Hydrogen Powered
Special Vehicle Fleets

HyFleet – Fuel Cell Electric Off-Road Vehicle

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Austria's Research Center for Hydrogen Technologies

HyCentA Research – Leading Hydrogen Innovation

- **120+ researchers** mechanical engineering, physics, chemistry, process engineering, electrical engineering
- **600+ projects** successfully completed
- **20+ years of R&D expertise**
- **State-of-the-art research**, testing and refueling infrastructure
- **International Cooperations**

Extra-university research organization at Graz University of Technology (TUG)

Project Contents

TRL

HySnow

Demonstration of Functionality

- FCE Snowmobile Demo
- H_2 Infrastructure Demo

HyFleet

Maturation of Technology

- Core Competences
- Modular Powertrain
- Supply Chain
- High-Level FC Research
- Modular & Scalable H_2 Infra
- Supplier Structure
- Sales / Configurator Tool

Small Series

Series Development

- Industrialization
- Vehicle Production & Assembly
- Industrialization of H_2 Infrastructure
- International Expansion

Project Consortium

Fuel Cell Electric Side-by-Side Vehicle (SSV)

- Fuel cell electric powertrain
- Road approval
- Inclinations up to 60% possible
- Up to 135 kW electrical power
- Driving range of up to 400 km

- 5.2 kg H_2 at 700 bar
- Modular 90 kW fuel cell system
- Refueling time less than 5 minutes
- Min. freeze-start temperature of -20 °C

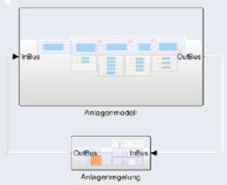
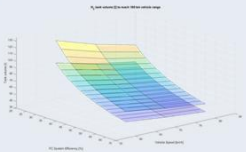
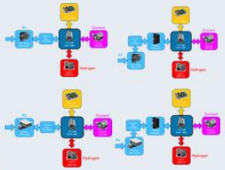
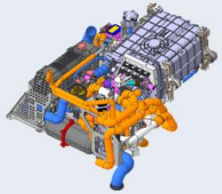
ZERO EMISSIONS AT THE TAILPIPE

CLEAN HYDROGEN TECHNOLOGY

BUILT FOR TOUGH CONDITIONS

RELIABLE. EFFICIENT. READY TO WORK.

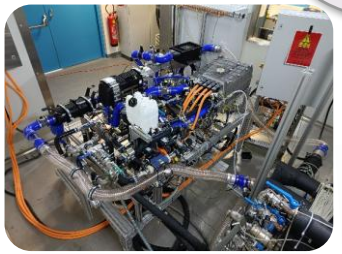
Development Process

System Requirements		Concept Definition		Development & Realization	
Customer Requirements	**Drive Cycle**	**Simulation**	**Powertrain Concept**	**Design & Development**	**Testing & Validation**
§ Legal Conditions Speed Power Agility Efficiency € Costs ... Other Attributes	Speed / Time • Torque • Resistances • Vehicle Mass • Slope	 	 • Efficiency • Costs • Mass • Volume • Consumption	 • Eco Design Criteria • Modular Systems • Near-Serial Production	 • Safety • Reliability • Durability • Driveability
Optimization Loops					
Tools					
• Requirement & Specification List • Market Analysis • Standards & Regulations	• Real Driving • Cruise M • Coast Down Test • Empiric Coefficients • Physical formulas	• Measurement Data • Characteristic Maps • Backward Simulation • Dynamic Programming Algorithm	• Matlab Simulink	• CAD Tools • Finite Element Method • Mockup • Matlab Simulink	• Design Verification Plan • Test Bed Operation • Chassis Dynamometer • Real Driving Operation

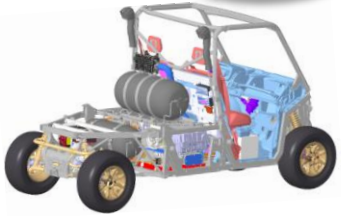
HyFleet - Highlights

Vehicle Driving Tests

Vehicle Assembly & Installation

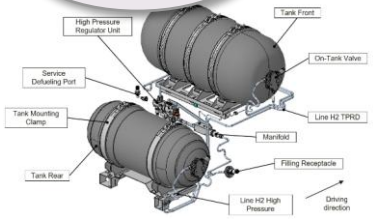


FC-System Testing

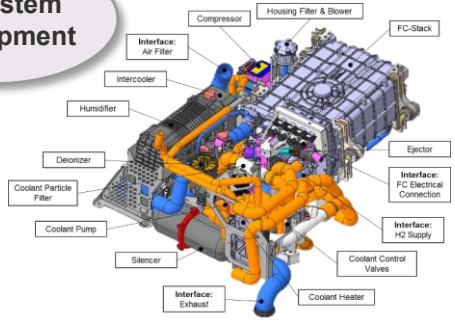


Vehicle Integration & Approval

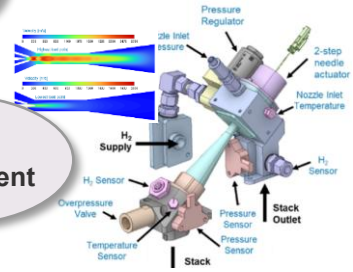
DC/DC Development



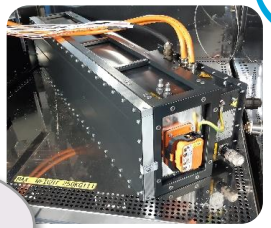
Hydrogen Storage System



FC-System Development



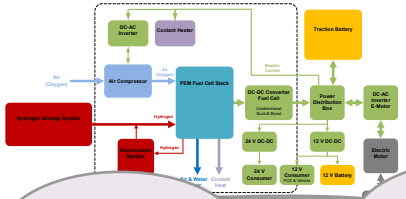
Ejector Development



Battery Development

E-Drive Development

Powertrain Layout



Fuel Cell System

Highlights

High Performance Stack
NM12 single stack from EKPO with high power density

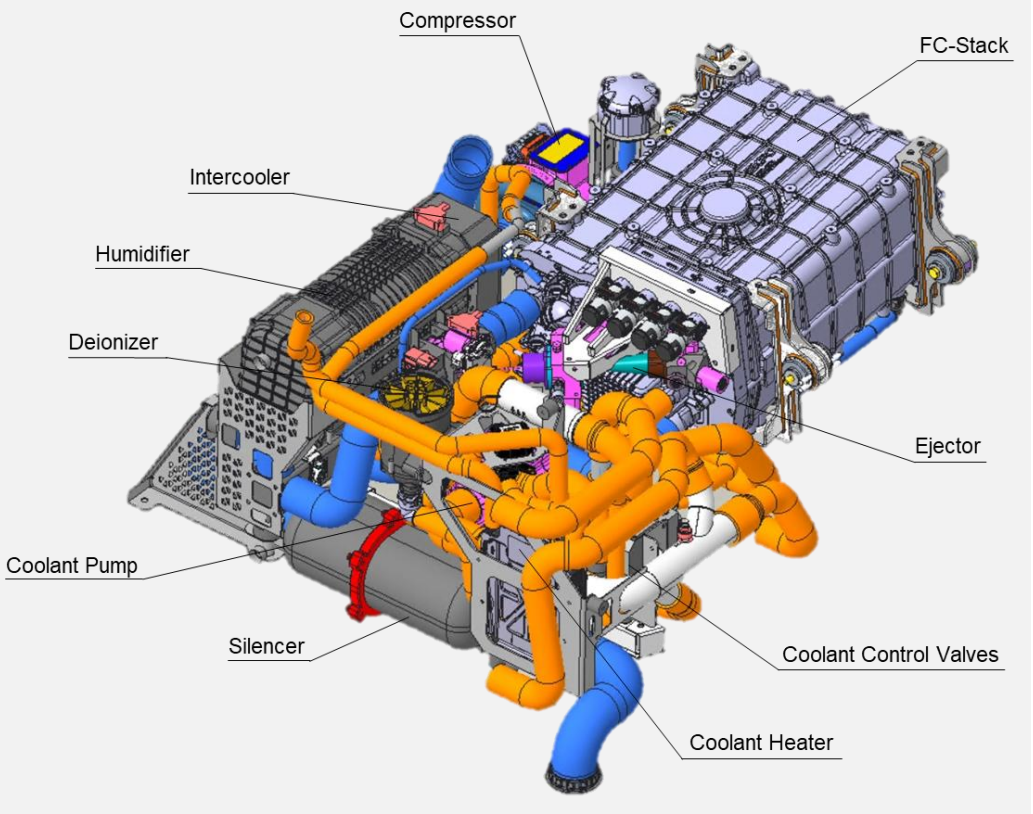
Passive recirculation
Two step needle ejector for low and high load operation

Humidification
Maximum system performance and durability through a wide range of environmental conditions.

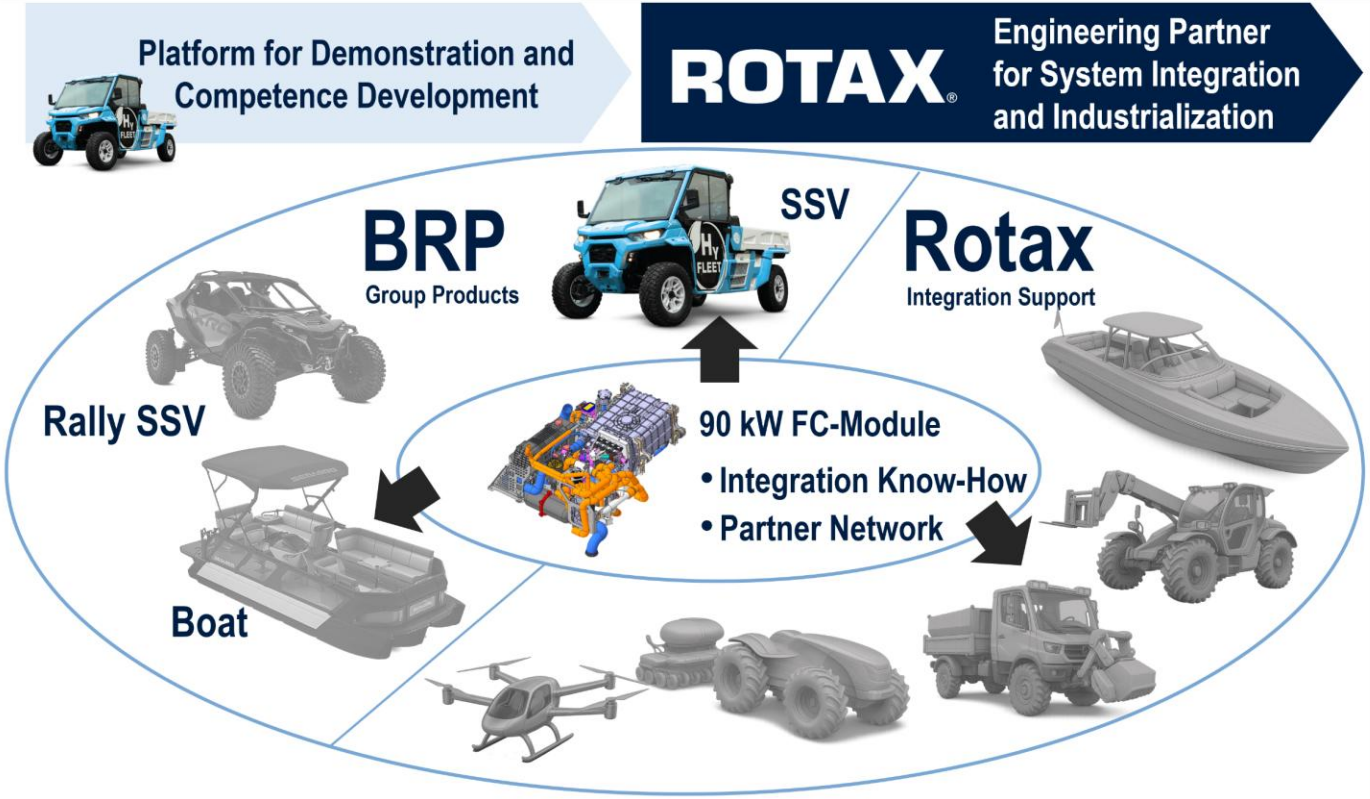
Safety Features
Fuel shut off, fuel pressure relief, high voltage interlock configuration, H2 leak detection

Specifications

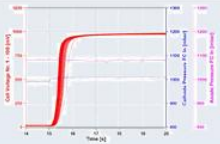
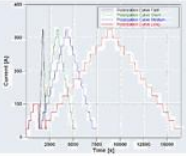
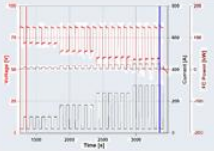
Net system power	BOL 90 kW
Max. efficiency	60 %
Dimensions	1050 x 770 x 460 mm
Weight	195 kg
Min. start-up temperature	-20 °C



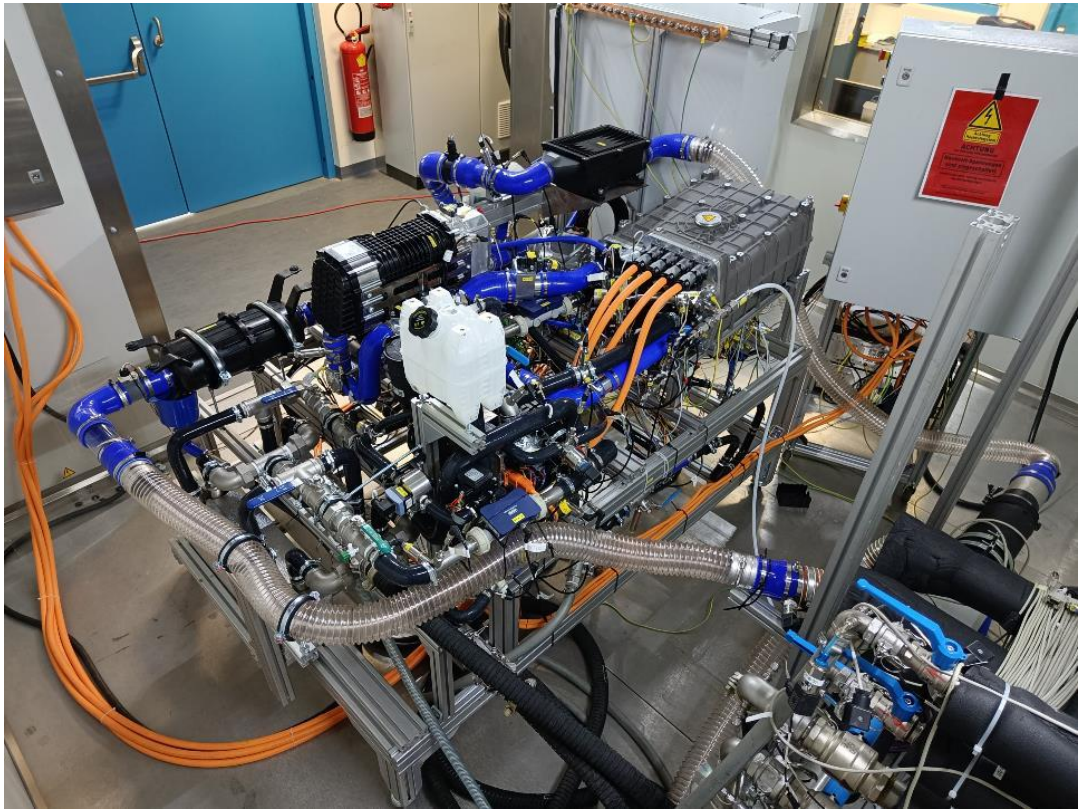
Modular Fuel Cell Electric Powertrain



Testing Process

Planning and Commissioning			Testing			
Planning	**Pretesting / Integration**	**Commissioning**	**Characterization Testing**			**Specific System Testing**
			Short-Term	**Long-Term**	**Instationary**	
• Test bed layout • FCS layout and interfaces • Risk analysis • Communication layout • State machine • Warning alert protocol • Definition of test cycles	• UUT Software Tests (SiL, MiL, HiL) • HW integration of UUT (mechanical & electrical) • HW & SW integration of additional testing equipment • Preparation of test bed • Communication Tests	• Sensor Tests • Actuator Tests • BoP Components • Safety Check • HV Check • Bleeding Tests • Leakage Tests • Measurement Devices Tests • Calibration	• Limit Testing • Start-Up • Shut-Down • Emergency Shut-Down • OCV Test	• Stationary Tests / Reference Cycle • Polarization Curves • Parameter Studies (Lambda, Purge, TCool) • FC Regeneration • AST	• Drive Cycles (WLTP, etc.) • Dynamic Load Cycle • Accelerated Stress Tests (rH, T,...)	• Non-Standard Tests (Ambient conditions) • "Extreme" Tests (Freeze Start Tests, High Temp SD ...) • HiL Tests • Inclination Test • Component Qualification
						

Impressions from the Testbed



Impressions from Field Testing

Additional Information

- For more information, please visit the following website:
  - https://www.klimafonds.gv.at/projekt/hyfleet/

Funding Authorities:

FFG Promoting Innovation.

klima+ energie fonds

Federal Ministry Innovation, Mobility and Infrastructure Republic of Austria

Publizierbarer Endbericht

Gilt für Studien aus der Programmlinie Forschung

A) Projektdaten

Allgemeines zum Projekt	
Kurztitel:	HyFleet
Langtitel:	Decarbonisation of Mobility by Hydrogen Powered Special Vehicle Fleets
Zitiervorschlag:	-
Programm inkl. Jahr:	Zero Emission Mobility 2020
Dauer:	01.04.2021 bis 31.12.2025
KoordinatorIn/ ProjekteinreicherIn:	BRP-Rotax GmbH & Co KG
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Federal Ministry Economy, Energy and Tourism Republic of Austria

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