

Bi-EN 2024

**Congreso Nacional
de Energía Inteligente**

Tecnologías para producción y transporte de hidrógeno verde
Technologies for the production and transport of green hydrogen

Christian Bidart



Today's agenda

1. Fraunhofer Society and Fraunhofer IMM
2. Reforming
3. Fuel Processor in a Fuel-Cell System
4. IMM Hydrogen Technology
5. Why IMM Compact Reformer Technology
6. Models of Collaboration

1. Fraunhofer Society

- 75 institutes and research institutions
- More than 29,000 employees
- Annual research budget totaling 2.8 billion €



1. Fraunhofer Society

Joseph von Fraunhofer (1787 – 1826)

Researcher

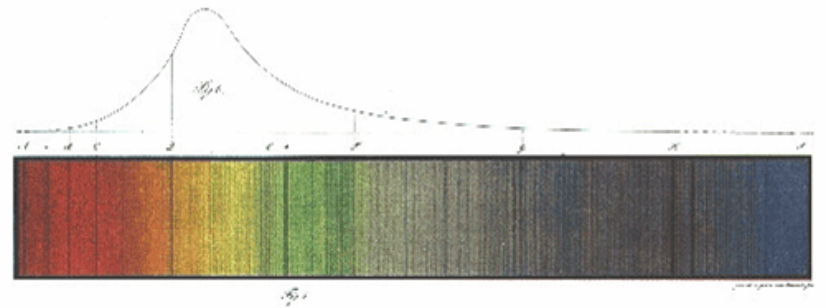
- Discovery of the »Fraunhofer lines« in the solar spectrum

Inventor

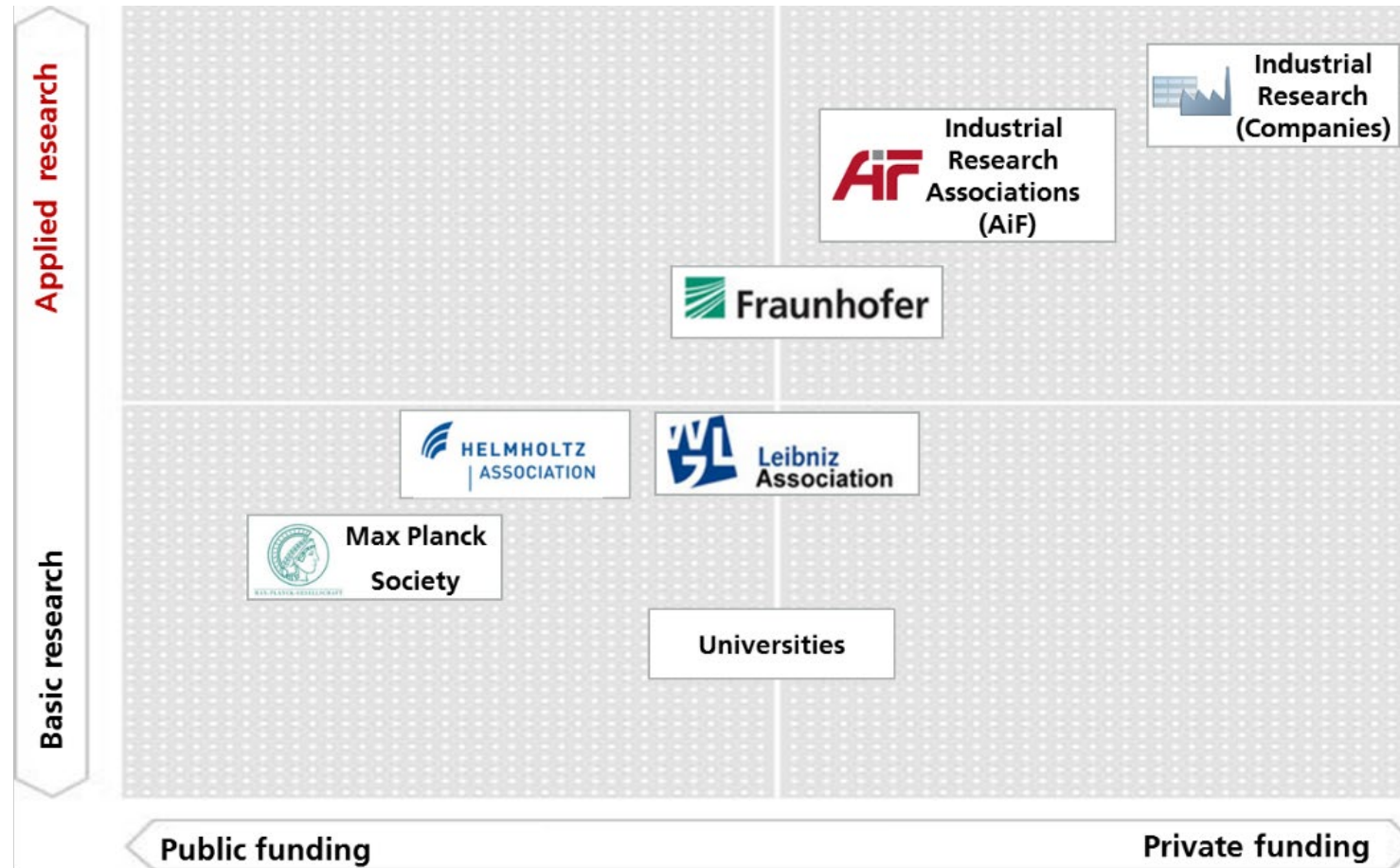
- New methods for processing lenses

Entrepreneur

- Director and partner in a glassworks



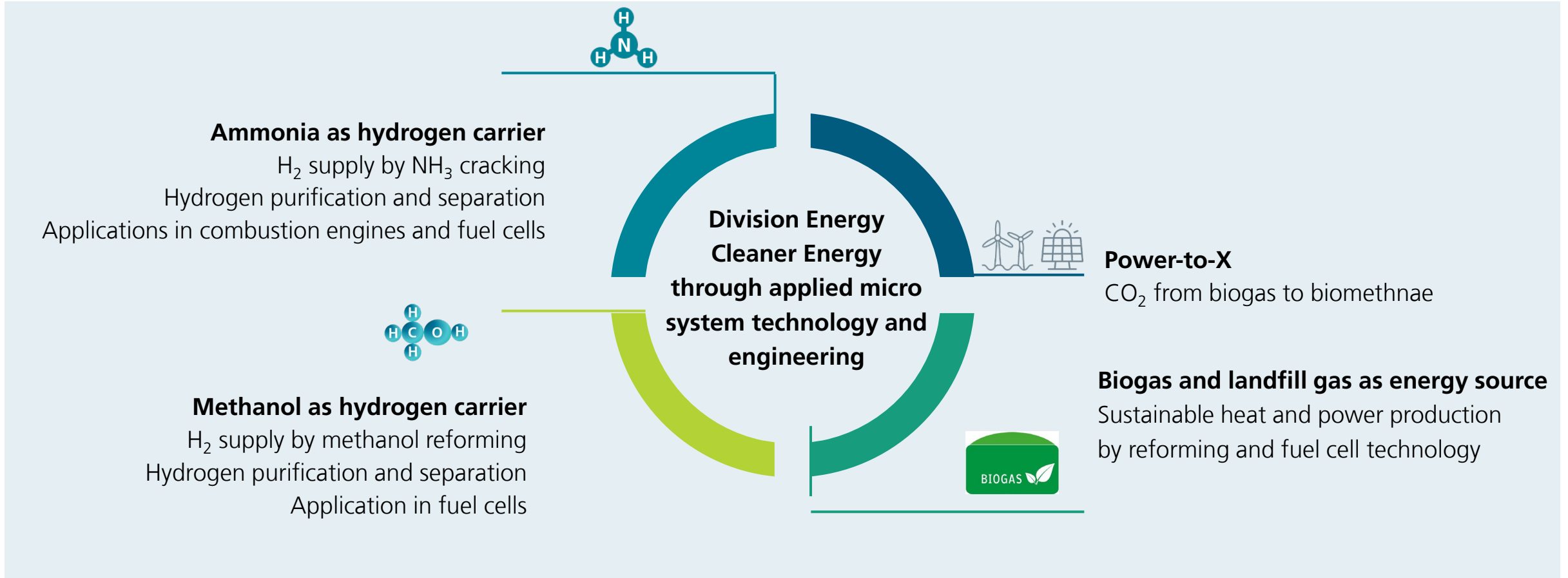
1. Fraunhofer Society



Source: BMBF Germany (simplified)

1. Fraunhofer IMM

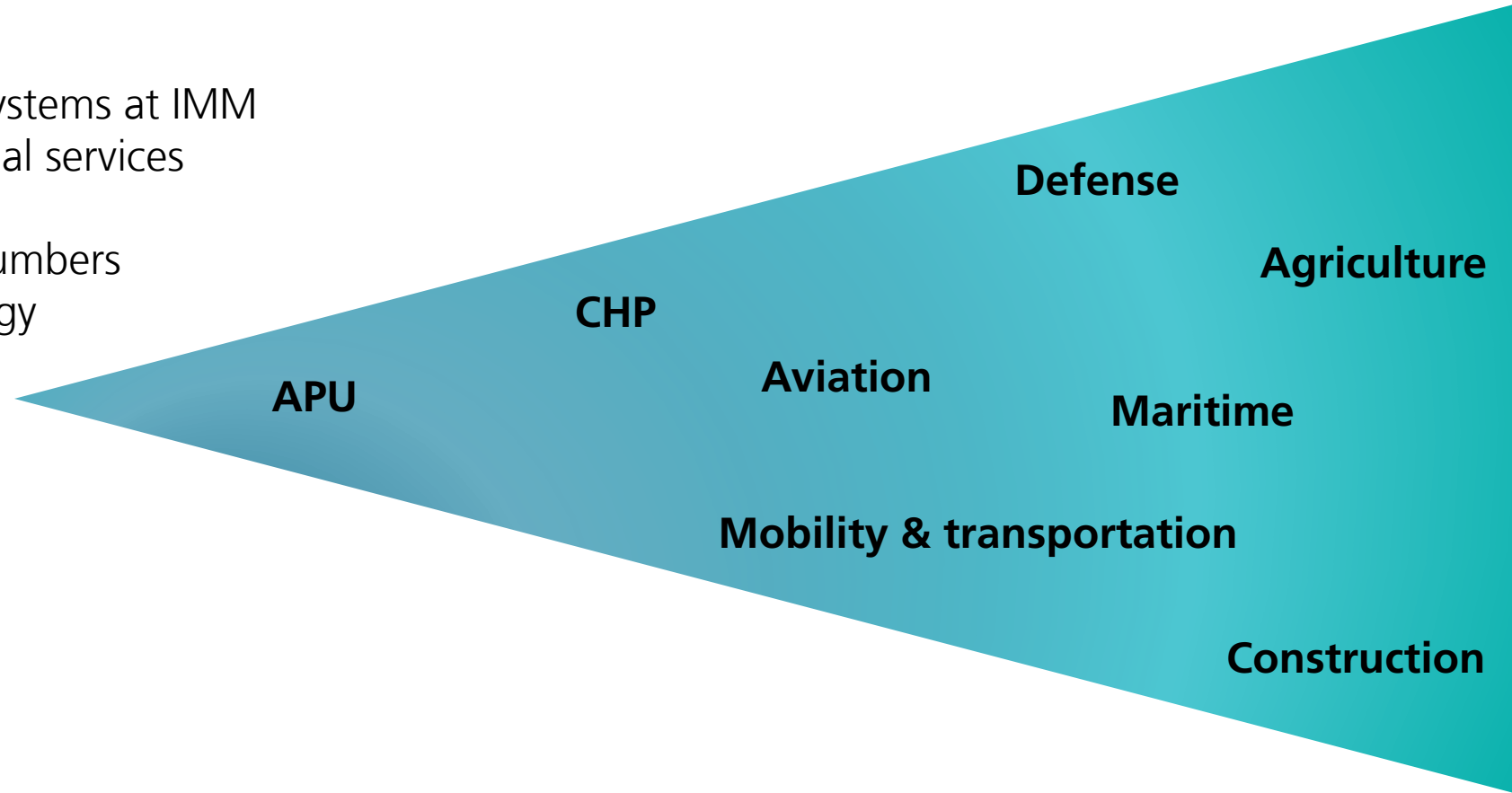
IMM hydrogen Technology



1. Fraunhofer IMM

IMM hydrogen Technology

- Proven scalability of technology
- Fabrication of reactors and full systems at IMM
Contractors available for special services
- Production of systems in large numbers
Licensing for reactor technology
- Prospects for future markets



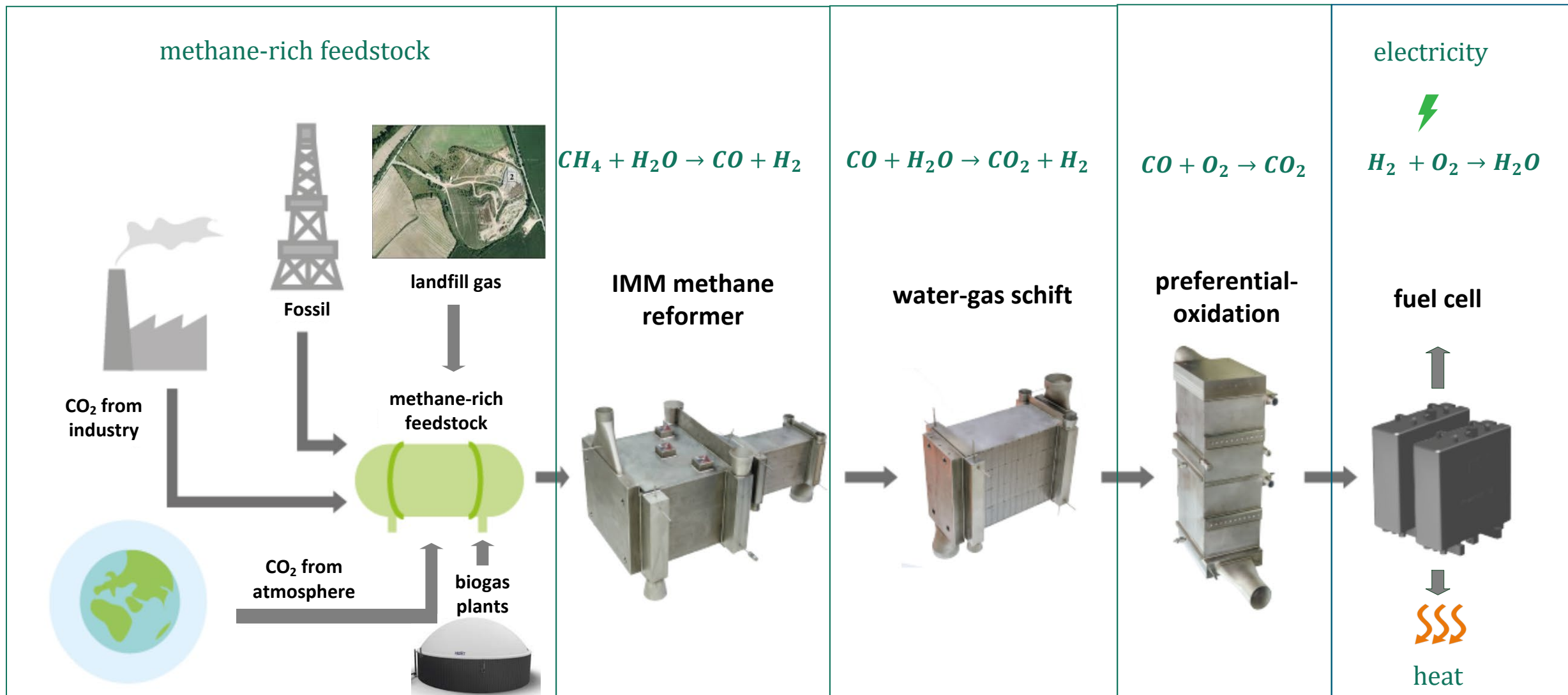
1. Fraunhofer IMM

IMM hydrogen technology - Development of integrated and automated systems



IMM technology & know-how enables costumers to generate hydrogen on site by developing turnkey-systems

2. Reforming for Methane-Rich Gases

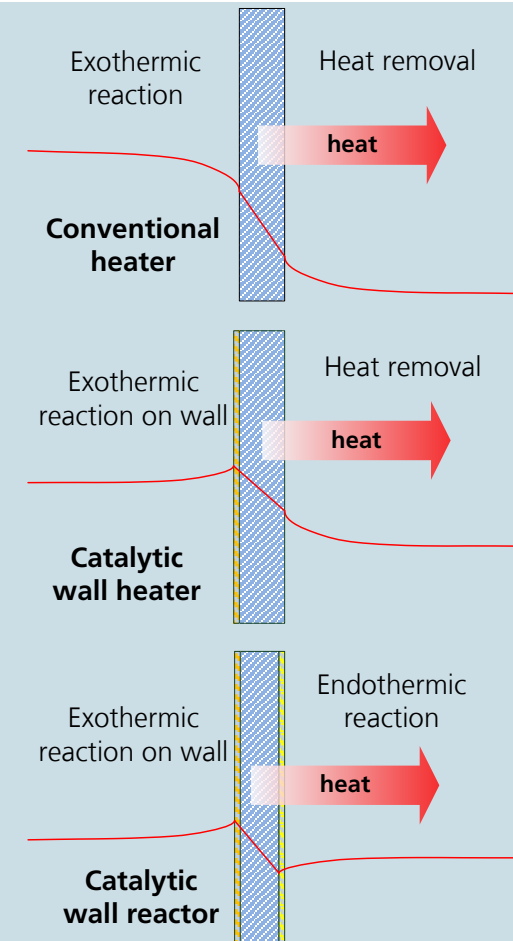
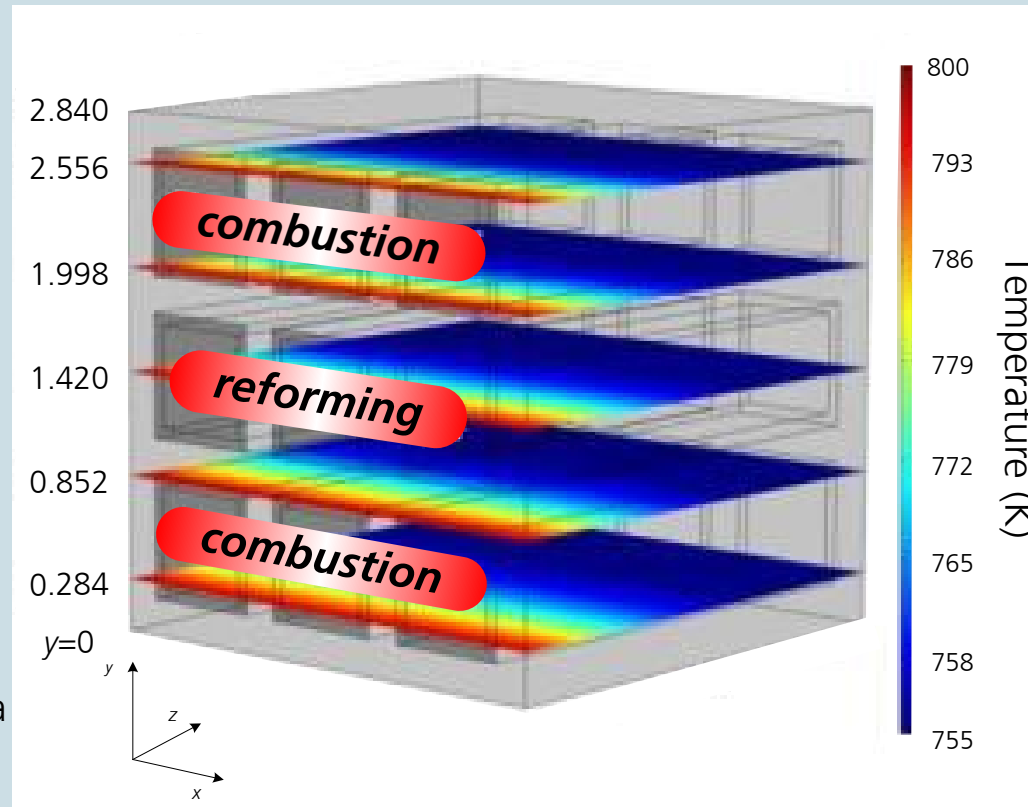


2. Reforming

The catalytic wall reactor

Simplified heat management & design

- Heat transfer takes place from the fluid to the wall at the reactor inlet almost completely
- Coupling of heat release and uptake through the lateral heat conduction of the wall is advantageous
- The lateral heat transfer conductivity of the wall is high
- The unit cells shown on the right are repeated in a pile up to 200 times as shown in the diagramme



2. Reforming

Requirements for a CHP system

- The process has to be self-sustaining after start-up: no electrical heating must be required.
- It must be highly efficient
- The fuel processor must start up quickly, within the 15-20 minute range
- The electrical power demand during start-up has to be as low as possible
- Carbon monoxide concentration in the reformat has to be as low as possible

IMM has developed a fuel processor for a concrete CHP application

- High energy integration through the use of plate heat exchanger-reactors
- Optimal catalyst utilisation
- Stability, or robustness, in any operation mode

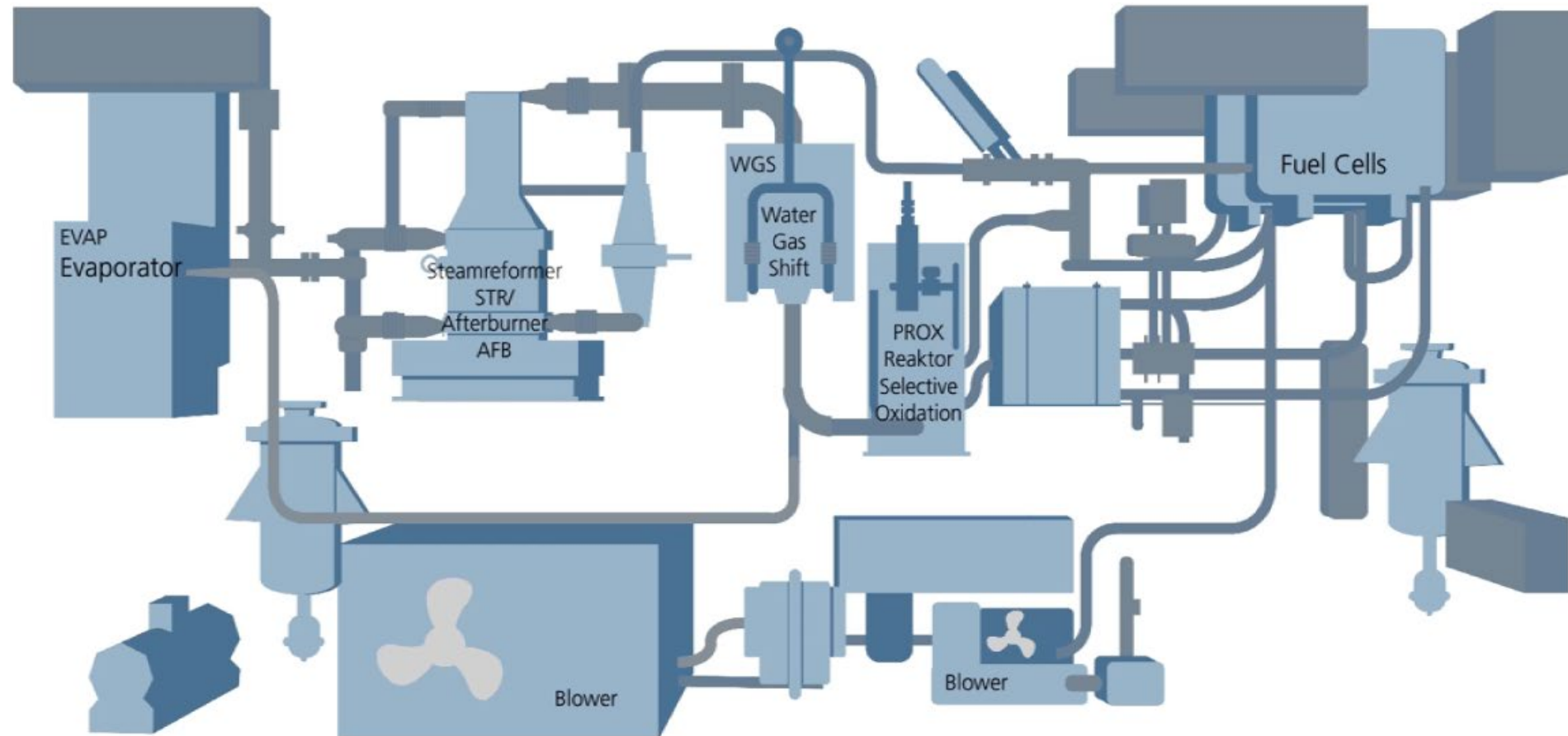
2. Reforming in a CHP System

Fuel-processor *versus* internal-combustion engine in CHP systems

- Reduction of dependency of efficiency on the load compared to combustion engines
- Highly dynamic operation thanks heat integration; optimal utilisation of mass and heat flows
- No low-frequency noise emissions as typical with conventional CHP systems
- Low maintenance requirements owing to largely avoiding moving parts
- Avoidance of emission of pollutants such as nitrogen oxide and sulphur-based compounds through catalytic cleaning and adsorption
- Compact and highly efficient by the application of micro-channel plate heat exchanger technology

3. Fuel Processor in a Fuel-Cell System

Fuel processor in a fuel-cell system



3. Fuel Processor in a Fuel-Cell System

Catalysts for methane steam reforming

Robust catalyst

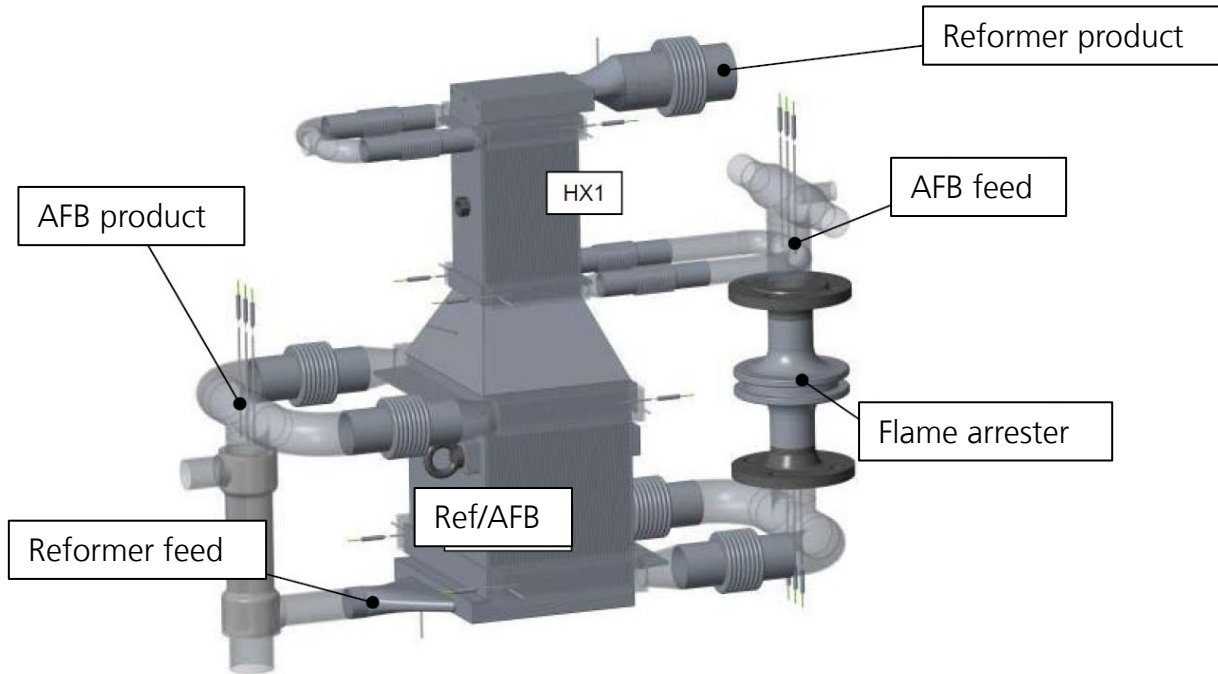
- No pre-treatment necessary
- No performance drop after longer shut-down

Catalyst technology suited for

- Natural gas
- Biogas
- Synthetic natural gas from power-to-gas

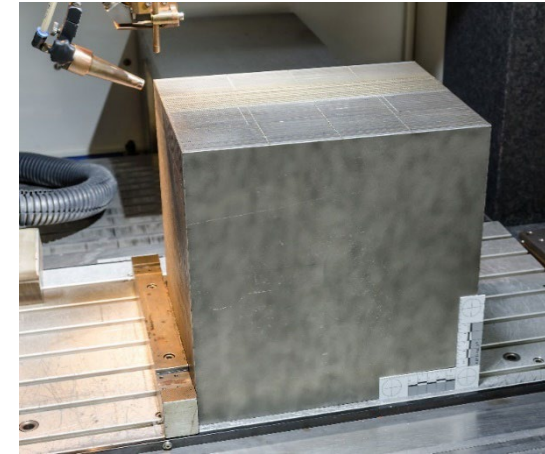
3. Fuel Processor in a Fuel-Cell System

Integrated afterburner (REF/AFB) and heat-exchanger



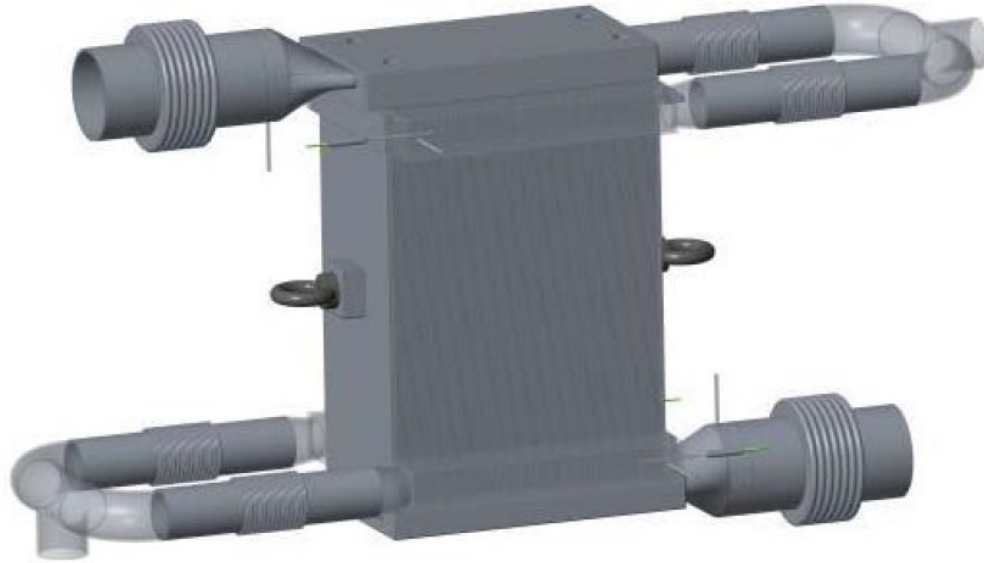
12,500 catalyst coated channels on each side
1.5 mm channel
1x1 mm plate thickness
36 kW-heat exchange between REF and AFB

84 kg stack
280 x 280 x 210 mm dimension
775°C operating temperature
co-current operation

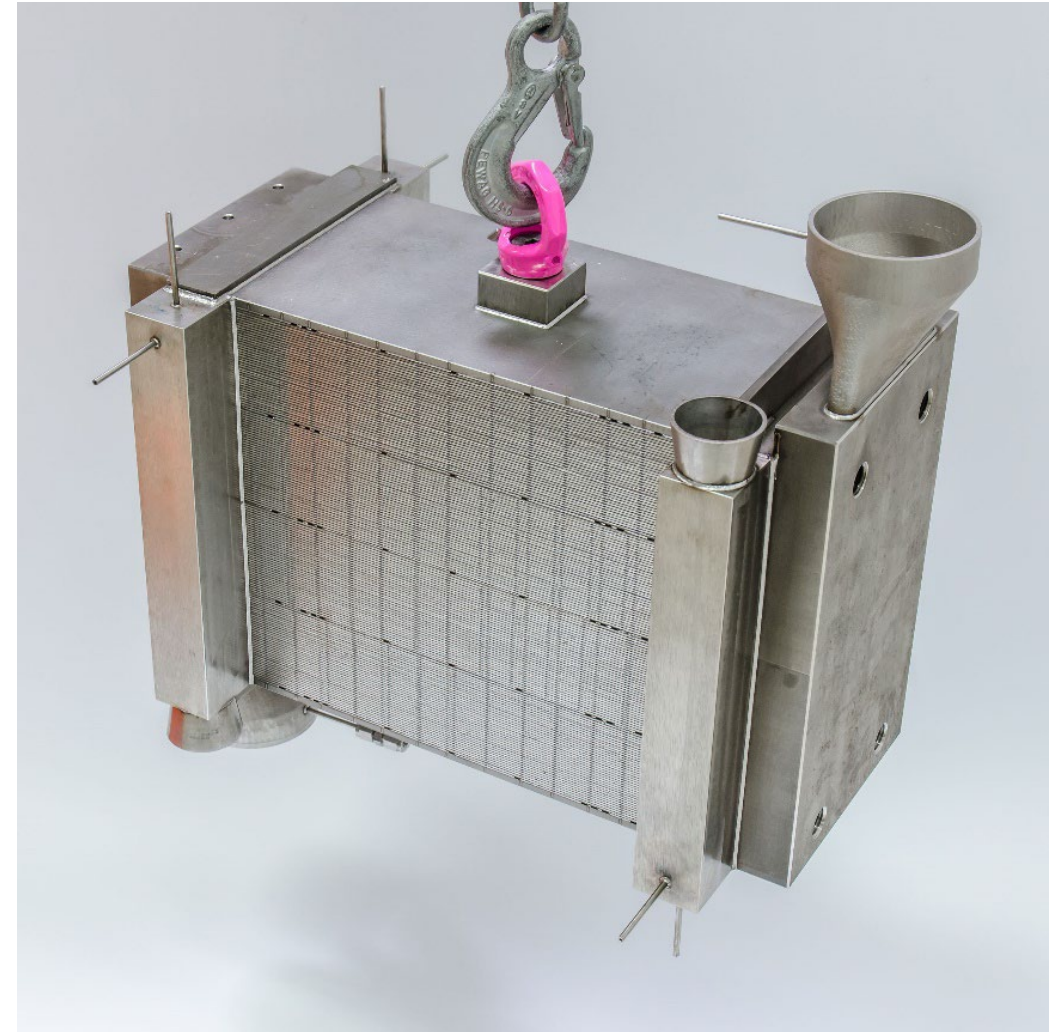


3. Fuel Processor in a Fuel-Cell System

Single stage water-gas shift reactor - counter-current air-cooling

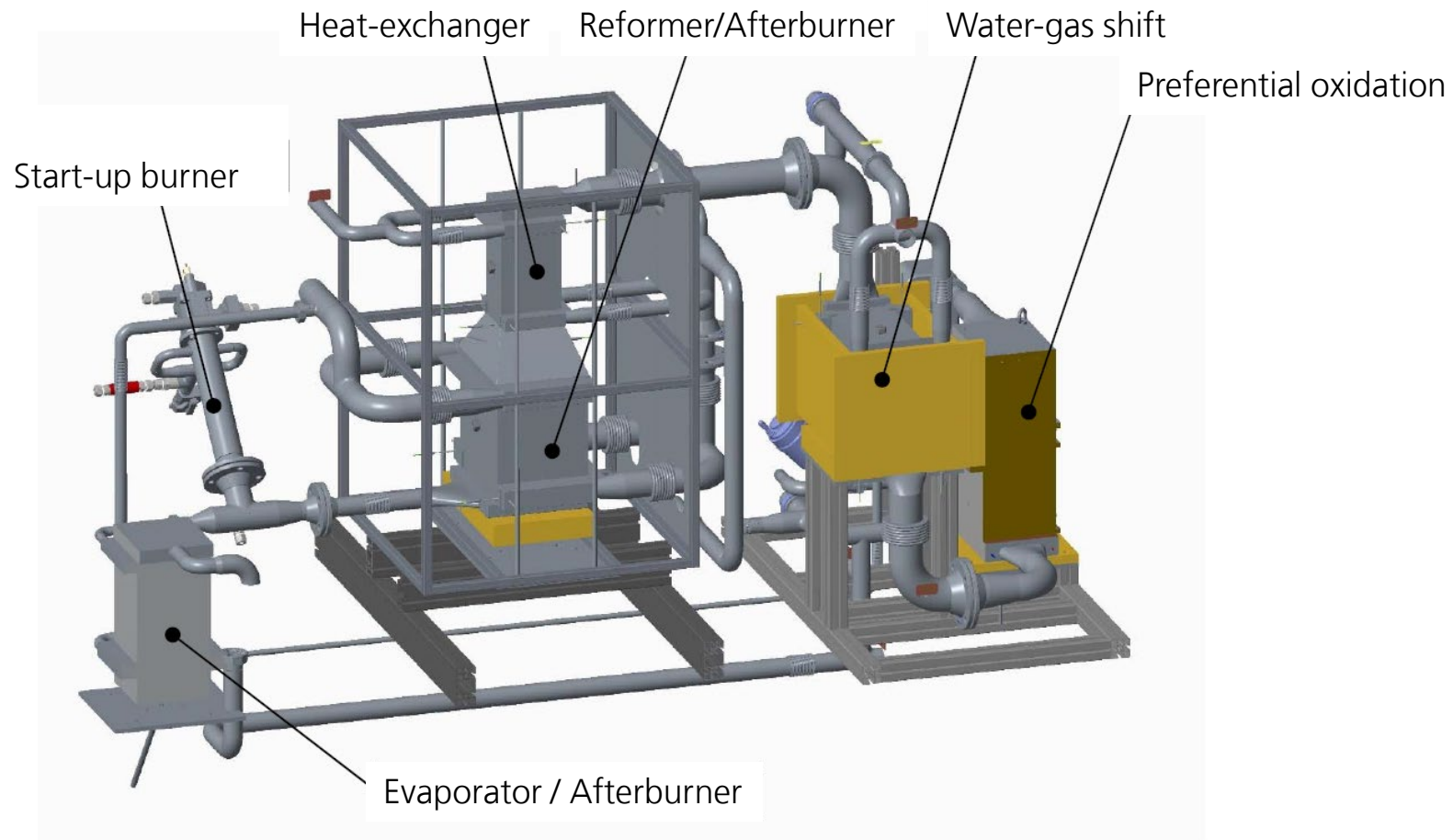


54 kg stack weight
6,800 catalyst coated channels (reformate side)
6,800 cooling channels
5 kW cooling power



3. Fuel Processor in a Fuel-Cell System

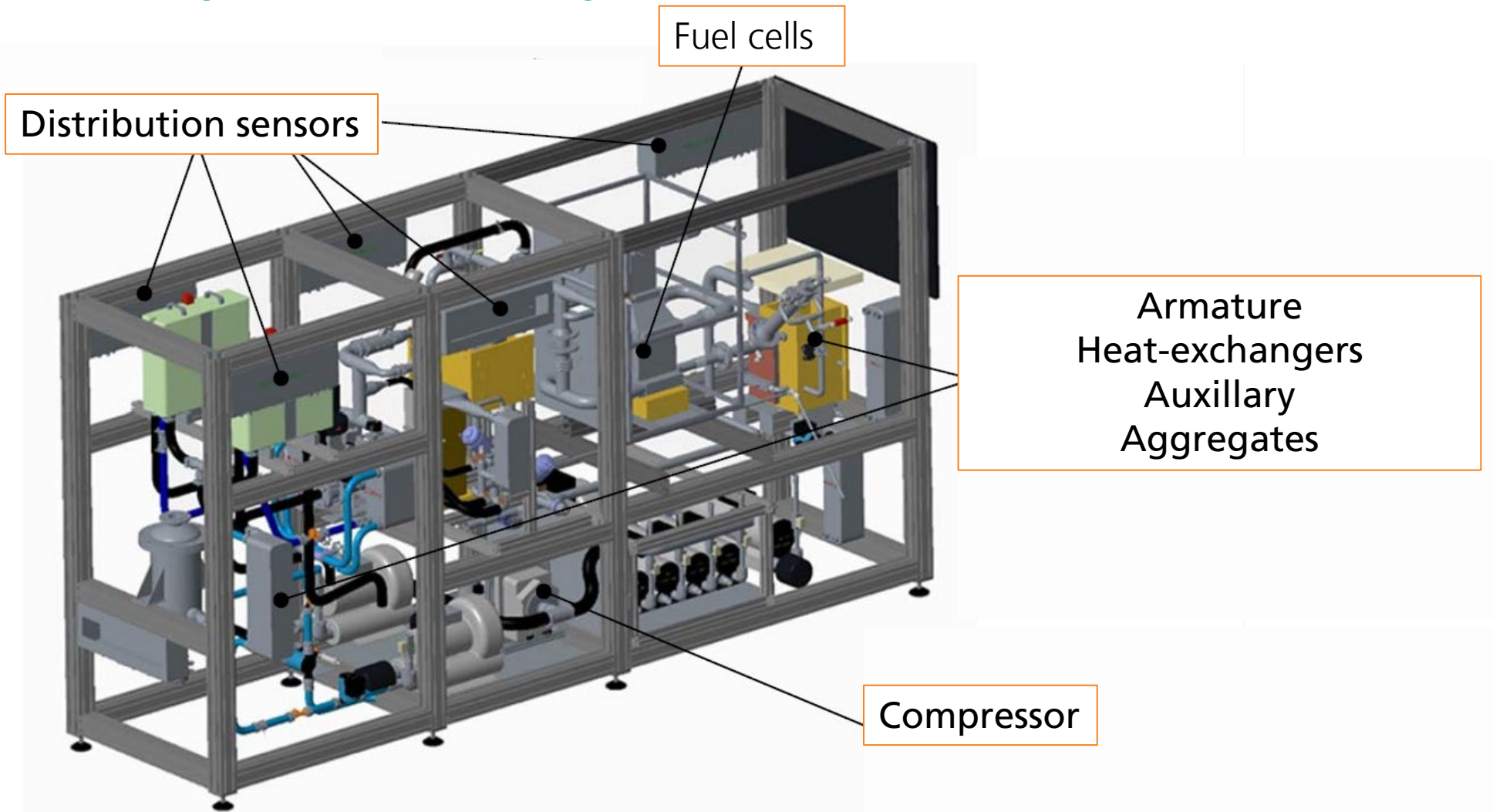
The importance of preferential oxidation



Total pressure drop from REF to PrOx lower than 100 mbar

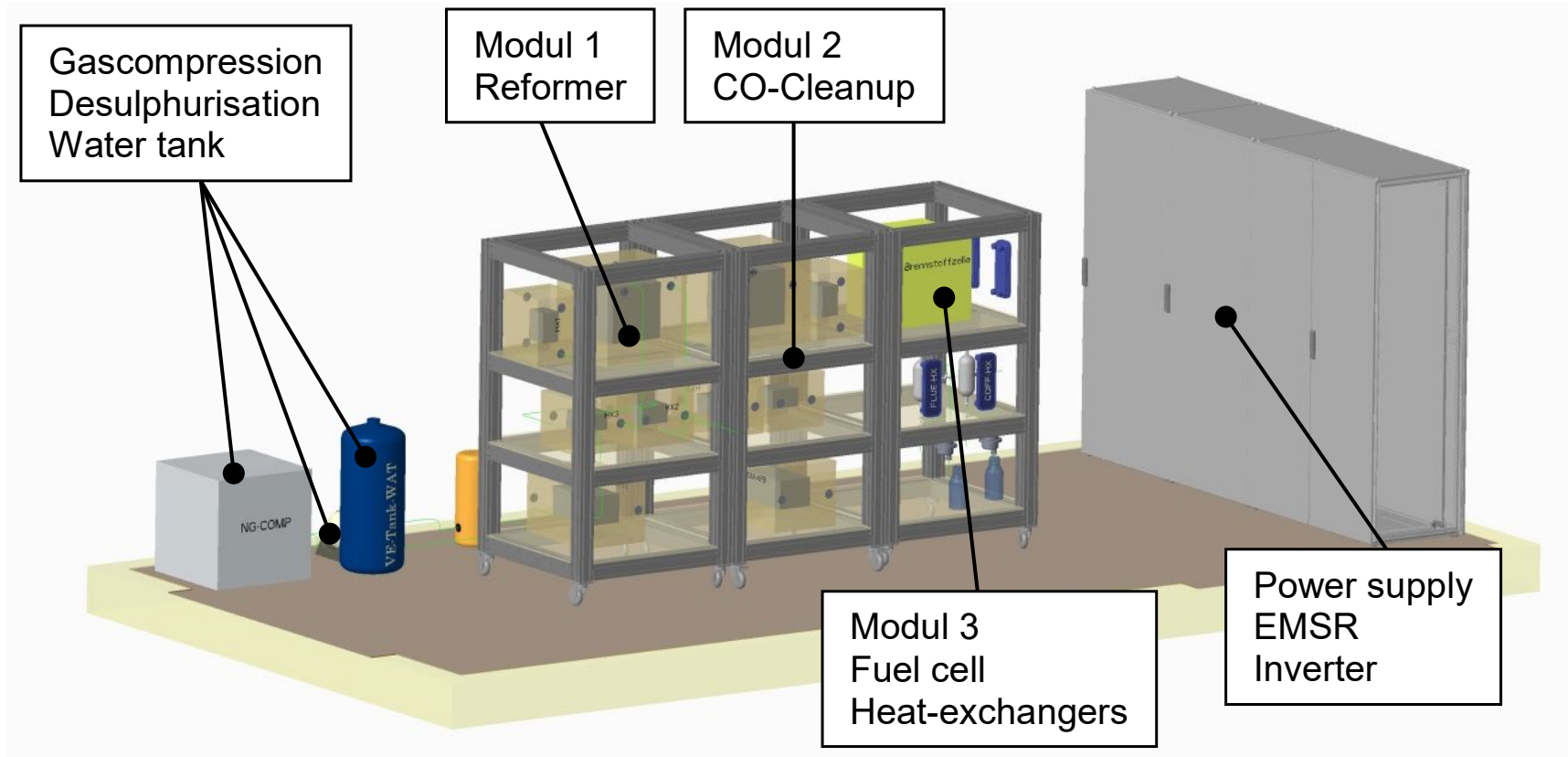
3. Fuel Processor in a Fuel-Cell System

Electricity and hot water generation for buildings



3. Fuel Processor in a Fuel-Cell System

Fuel cell system as a CHP system



3. Fuel Processor in a Fuel-Cell System

Complete system including fuel cell, BoPs and control system

Demonstration and experimental system:

- 200 temperature measurement points in fuel processor
- 628 voltage measurements in fuel cell
- Monitoring of many other parameters
- PEM fuel cell technology was chosen because of its high reliability and durability
- High overall efficiency of the combined heat and power unit higher than 95%
- Electrical efficiency 35%



3. Fuel Processor in a Fuel-Cell System

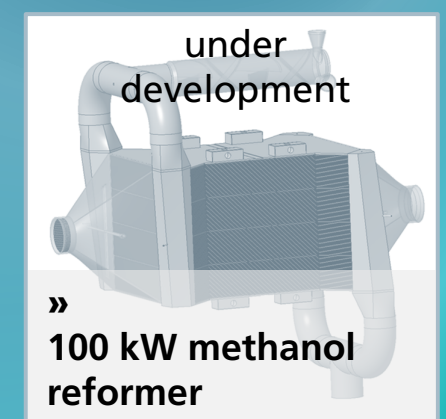
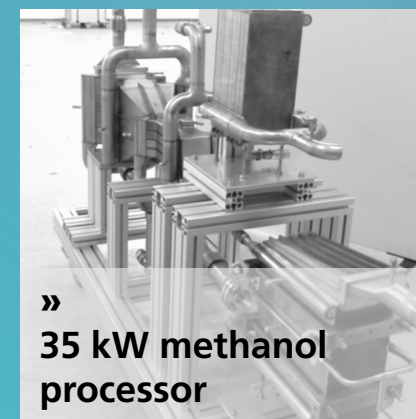
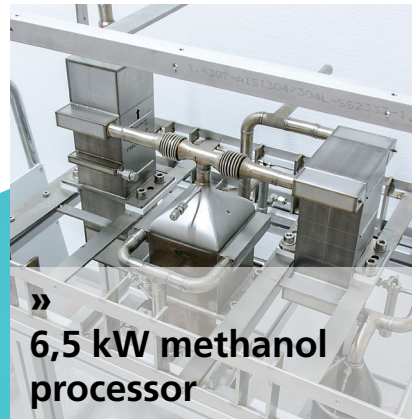
Electricity and hot water generation for IMM building



4. IMM Hydrogen Technology

Future growth

- Proven scalability of technology
- Fabrication of reactors and full systems at IMM
 - Contractors available for special services
- Production of systems in large numbers
 - Licensing for reactor technology
- Prospects for future markets



4. IMM Hydrogen Technology

Future growth

Use of Methanol is advantageous when...

- Application is off-grid
- Power demand is too large to be covered by battery
- Small tank size is favored
- Unskilled personnel operates the system
- Low noise emission is favored



Examples for applications

- Construction sites
- Agriculture
- Shipping
- Aviation
- Military
- Recreational vehicles

4. IMM Hydrogen Technology

Future growth

GAMMA project: a bulk carrier that sails on e-fuels



- EU funded-project through Horizon Europe Framework Programme
- Fraunhofer IMM is contributing its experience in the development of fuel processor technology, particularly in **methanol reforming** and ammonia cracking.
- The patented IMM catalyst technology is used for methanol steam reforming in microchannels. This is an order of magnitude more active than conventional technology and has proven long-term stability.
- The IMM microreactor technology used has better heat management and higher catalytic converter utilization

www.imm.fraunhofer.de/de/presse-publikationen/gamma.html

5. Why IMM Compact Reformer Technology

Benefit from **20 years' experience in fuel processor development** for stationary, mobile and portable applications.

IMM has experience in **developing the control system** which enables fully automated operation of fuel processor and fuel cell

The fuel processor design needs to be **optimised for your specific application**

- Fuel cell type
- Power range
- Specific market requirements; fabrication techniques need to be chosen accordingly

6. Models of Collaboration - Our Offers

- **Contract Research**

- Applied research and development for industry
 - Feasibility studies, proof of concept
 - Development and construction of demonstrator and prototype systems
 - Method development and optimisation

- **Joint Research**

- Publicly funded research projects
 - International or national funding and collaboration





Make use of our new capabilities in our brand new extension building

- Extensively equipped labs for catalyst testing
- Extensively equipped technical hall for system testing

www.imm.fraunhofer.de



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Thank you for your attention
