



GAMMA Project

Green Ammonia and bioMethanol for
Maritima vessels



Co-funded by
the European Union

Paulo Ribeirinha

We develop and convert a bulk carrier to sail on climate-neutral fuels and green power.



Transport and trade must be made greener.

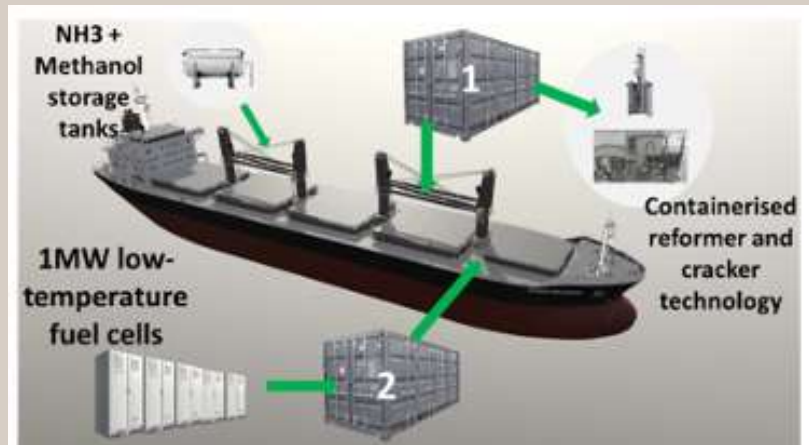
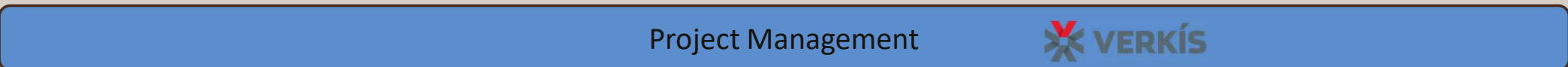
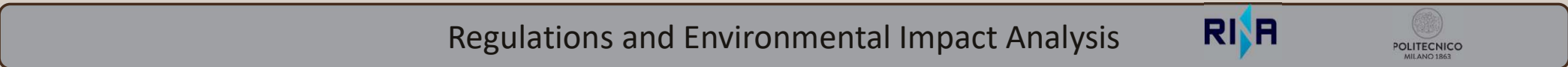
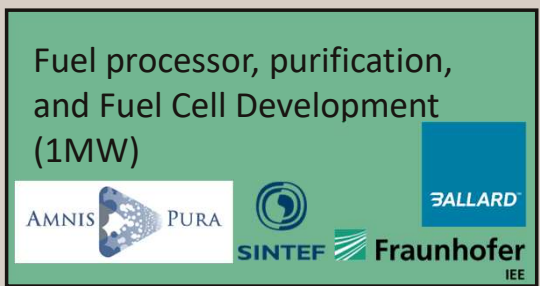
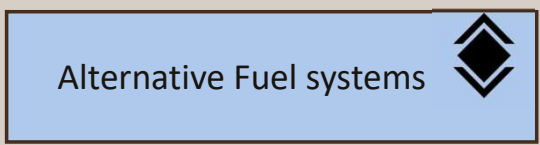
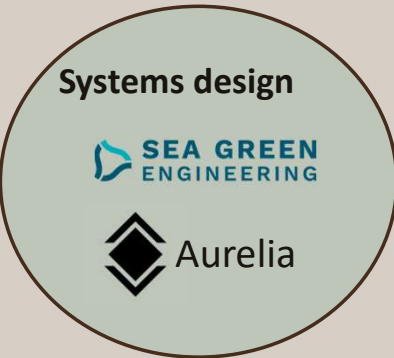
- Long-distance maritime transport supports 80-90 per cent of all global trade.
- It is responsible for about 2,5% of all global greenhouse gas emissions
- The International Maritime Organization's (IMO) goal is to reduce the industry's greenhouse gas emissions to around net-zero by 2050.
- Bulk vessel run on fossil fuel and have a very long lifetime, upgrading them to able to use climate neutral fuels, is the **GAMMA project objective**



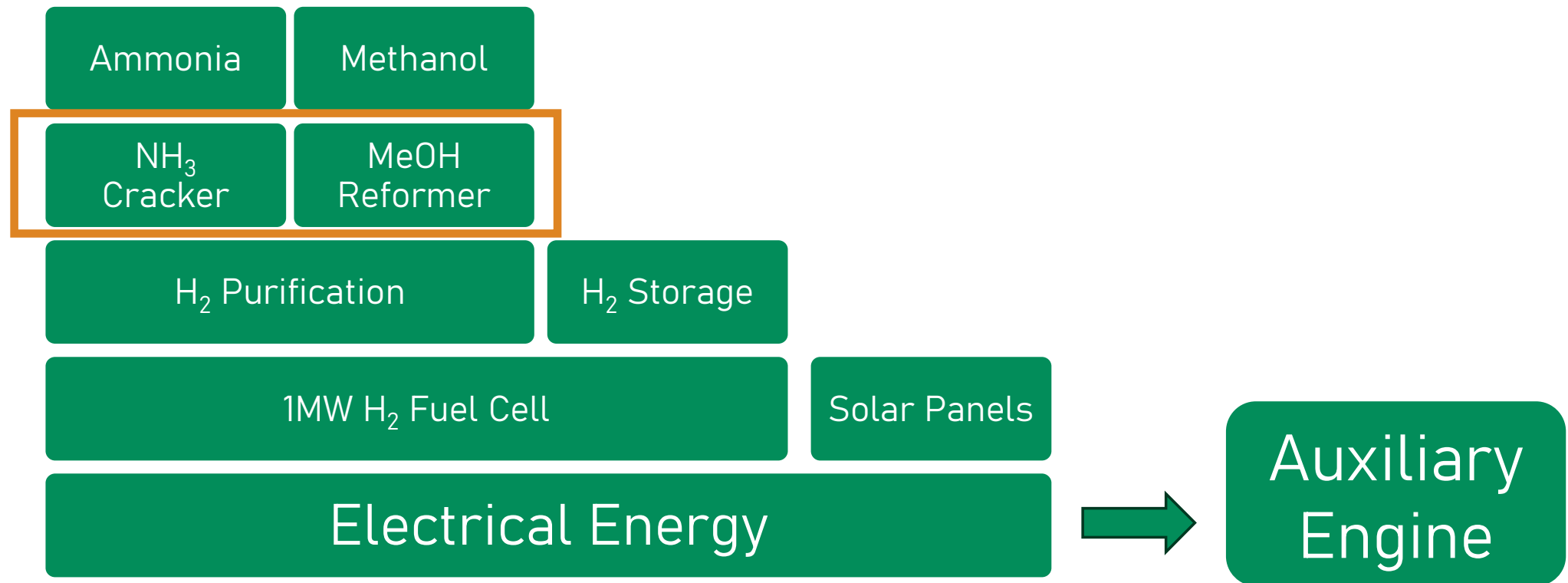
THE GAMMA Project

- Energy transition of commercial vessels
- Safe integration of e-fuels and fuel systems
- Fuel efficient, hybrid-electric operation and
- Emissions saving

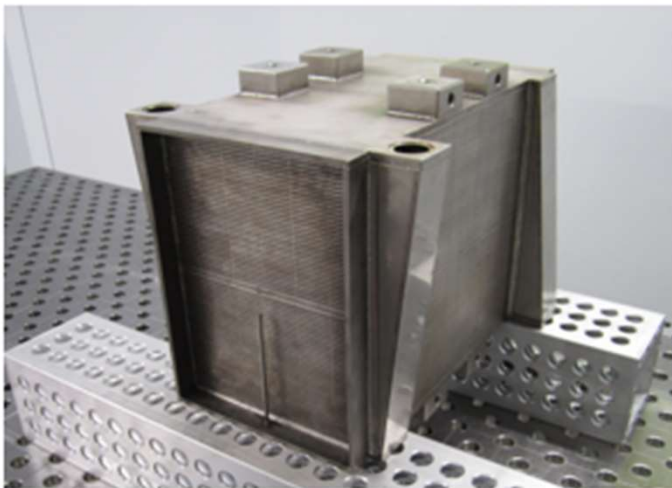




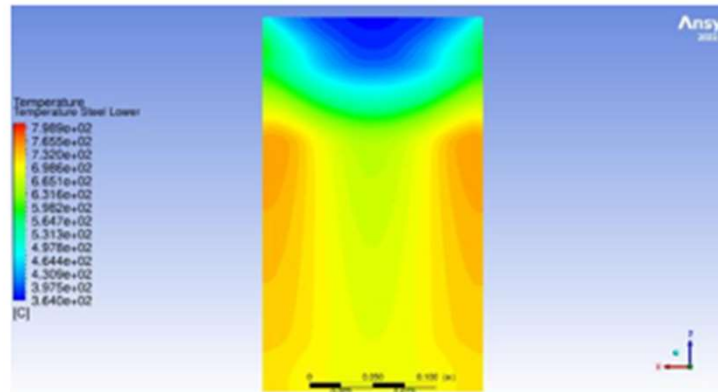
GAMMA e-fuel and solar system



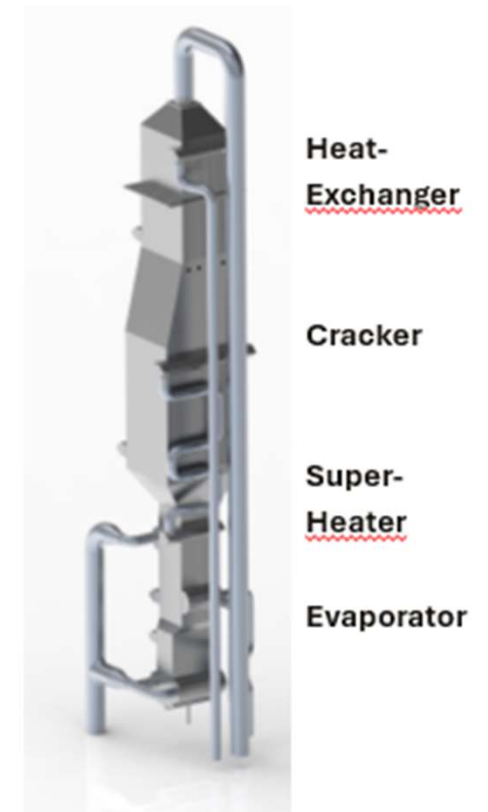
1. Ammonia - IMM Compact Ammonia Cracker Technology



46,000 Microchannels
Weight 75 kg
Height 0,246 m
Width 0,174 m
Length 0,295 m

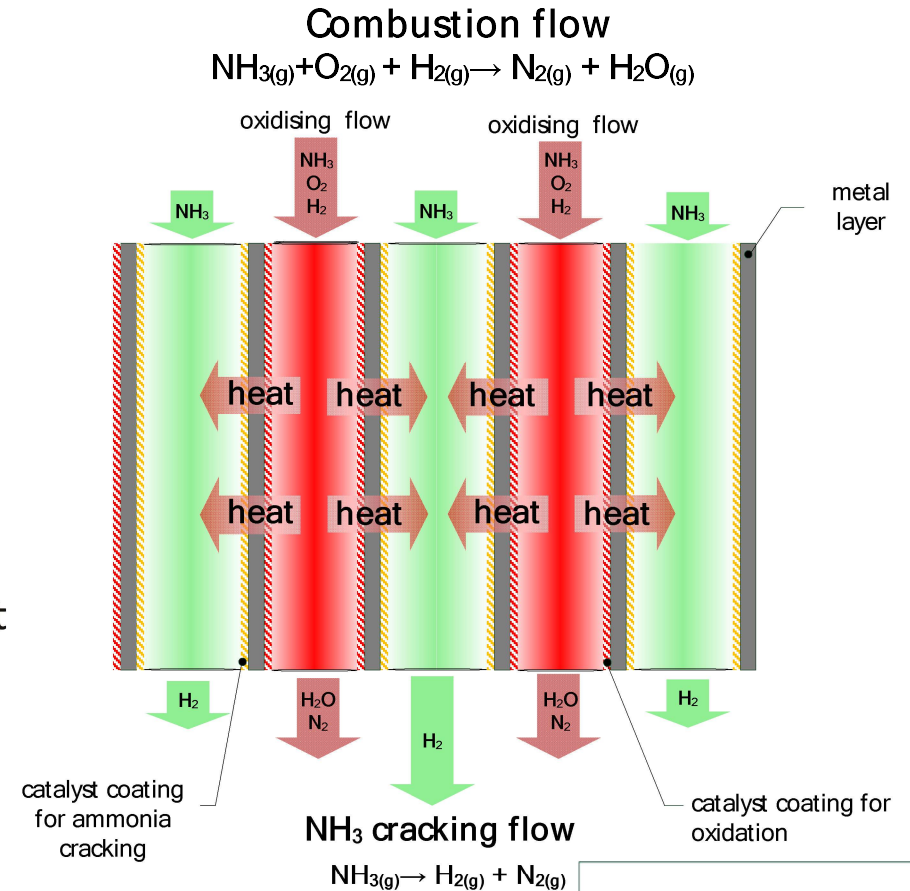


Ref: S. Blauth, J. Damay, S. Osterroth, C. Leithäuser, C. Hofmann, G. Kolb, M. Wichert, K. Steiner, M. Bortz, Chem. Ing. Techn.



IMM Compact Ammonia Cracker Technology?

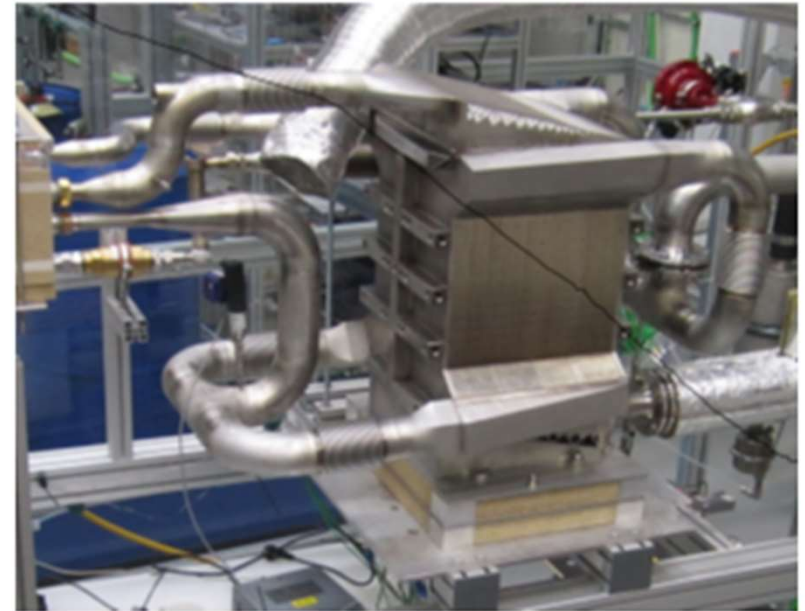
- **90% efficiency** of the process compared to 70% for conventional technology due to integrated PSA off-gas combustion
- **Lower carbon dioxide footprint** compared to electrically heated reactor concepts
- **90% size reduction** of the cracking reactor – important especially for mobile / space limited applications



2. Methanol - IMM 75 kW Methanol Reformer



Dimensions
L x W x H = 510 x 315 x 320 mm³



Consumption
32 kg/h methanol

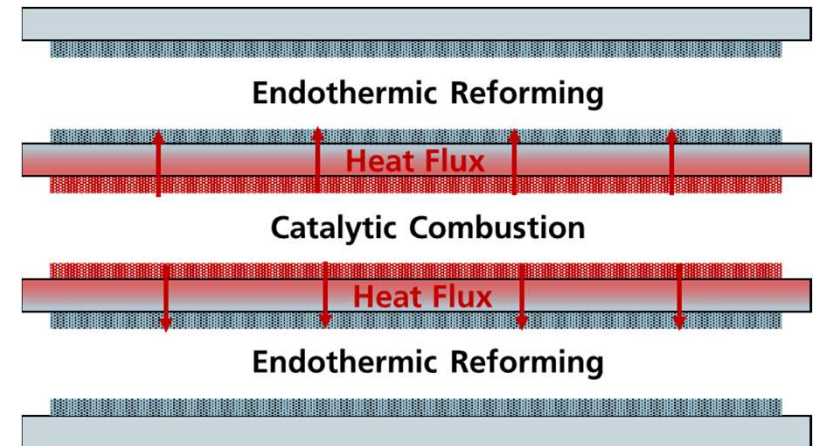


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More info: Dr. Gunther Kolb, gunther.kolb@imm.fraunhofer.de

IMM Fuel Processor Technology

- Microstructured reactors and novel catalysts



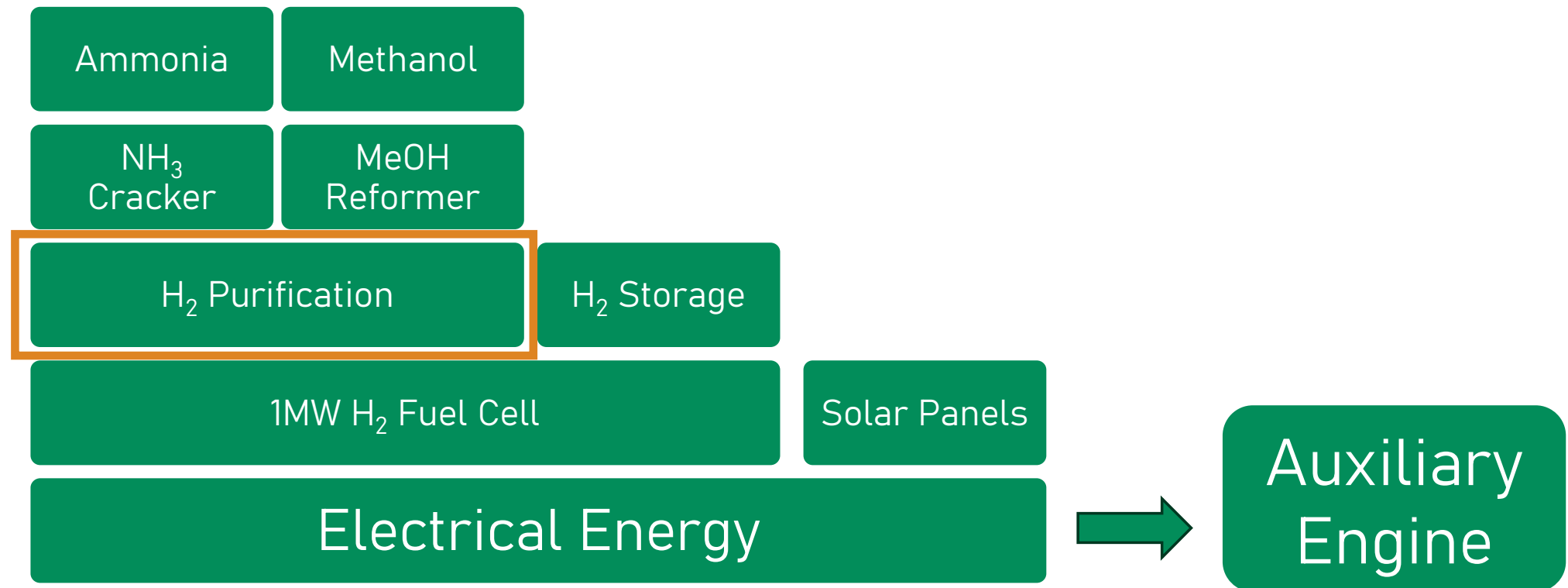
IMM catalysts

- Unique, patented catalyst technology for methanol steam reforming in microchannels
- **One order of magnitude more active than conventional technology**
- Proven long-term stability

IMM microreactor technology

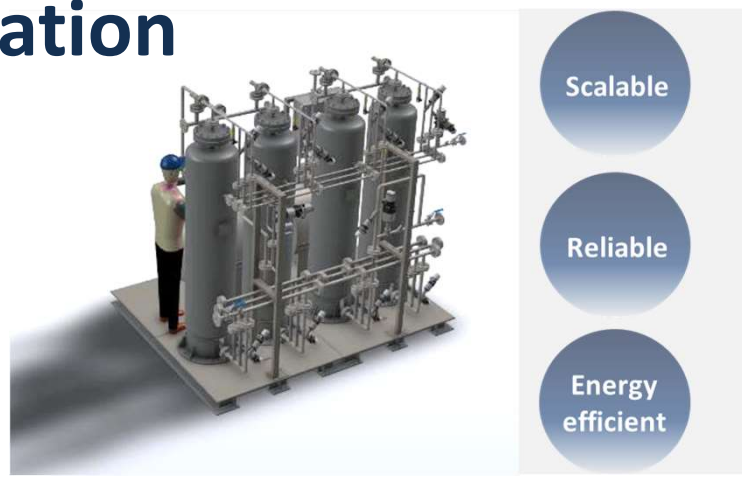
- Better heat management
- Higher catalyst utilization
- Off-gas combustion for heat recovery → higher efficiency
- **Overall: 90% reduction in reactor size via microchannel technology**

GAMMA e-fuel and solar system



Amnis Pura hydrogen purification technology

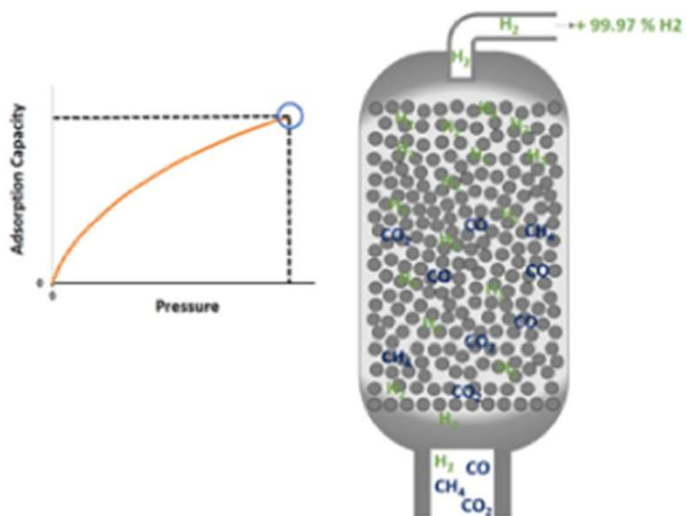
Pressure Swing Adsorption technology



Working principle:

The working principle is the selective adsorption of one or more components of a gas mixture on an adsorbent material packed in two or more beds.

PSA involves two main steps: adsorption and desorption. Because adsorption is enhanced by the pressure, the adsorption step is carried out at high pressure. The desorption step is performed afterward by depressurizing the bed.



Amnis Pura hydrogen purification technology

Own developed adsorbent material



Own developed adsorbent material

Low cost (ca. 5 € /kg);
High selectivity for CO, the
bottleneck in H₂ purification.

Customized solutions

Continues process optimization to improve hydrogen recovery, purity and energy efficiency



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2021 Projects

NL

- Natural gas refoming
- 99,999 % Purity
- 89 % Recovery
- 16 bar Op. Pressure



2022 Projects

UK

- Natural gas decomposition
- 99,999 % Purity
- 80 % Recovery
- 1,5 bar Op. Pressure



2023 Projects

UK

- Natural gas decompositon
- 99,9 % Purity
- 80 % Recovery
- 1,5 bar Op. Pressure



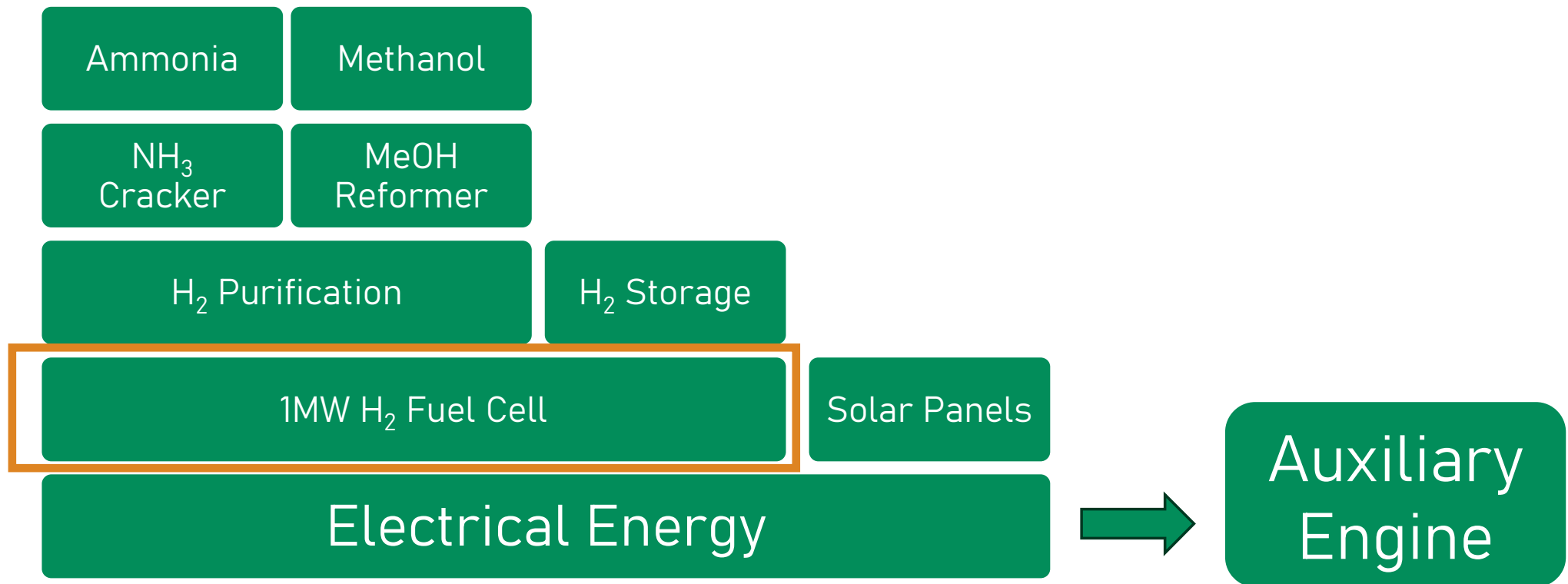
2024 Projects

Norway

- Ammonia cracking
- >99,99 % Purity
- >86 % Recovery
- 26 bar Op. Pressure



GAMMA e-fuel and solar system



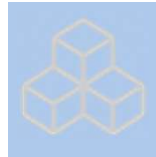
3. Marine Hydrogen Fuel Cells

FCwave200™

Rated power	200kW
Operating Voltage	350-720 VDC
Rated Current	2 x 300 – 1 x 575 Ampere
System Cooling Outlet temperature	65°C
H2 inlet pressure (max)	6.5 Barg
Environmental protection (Class req. for engine room installation)	IP44
Weight	1000 kg
Dimensions (L W H)	1209 x 741 x 2195 mm
Safety Barrier principle (Class approved)	Redundant surveillance of totally encapsulated H2 compartment



Hydrogen Fuel Cells for Shipping



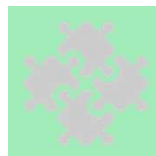
- Scalable from 200kW
- Power sizes from 200kW to several MWs to suit a range of marine applications



- High fuel efficiency means Low OPEX
- Powered by Ballard's FCgen[®] - LCS fuel cell stack which offers significantly lower life cycle cost



- Meets stringent safety standards
- Designed hand-in-hand with the marine industry to withstand the rigors of the marine environment



- Ease of Integration
- Flexible configuration that adapt to vessel power requirements and space constraints.



- Reliable and safe operation
- Uses proven components from Ballard's heavy duty module portfolio to deliver reliable performance

Demonstration

Successful retrofit of a 60,000 tonnes dead weight bulk carrier.

Show safe ship operation

Validate 3 different e-fuel systems for large freight carriers.



GAMMA expected results

Fuel flexibility

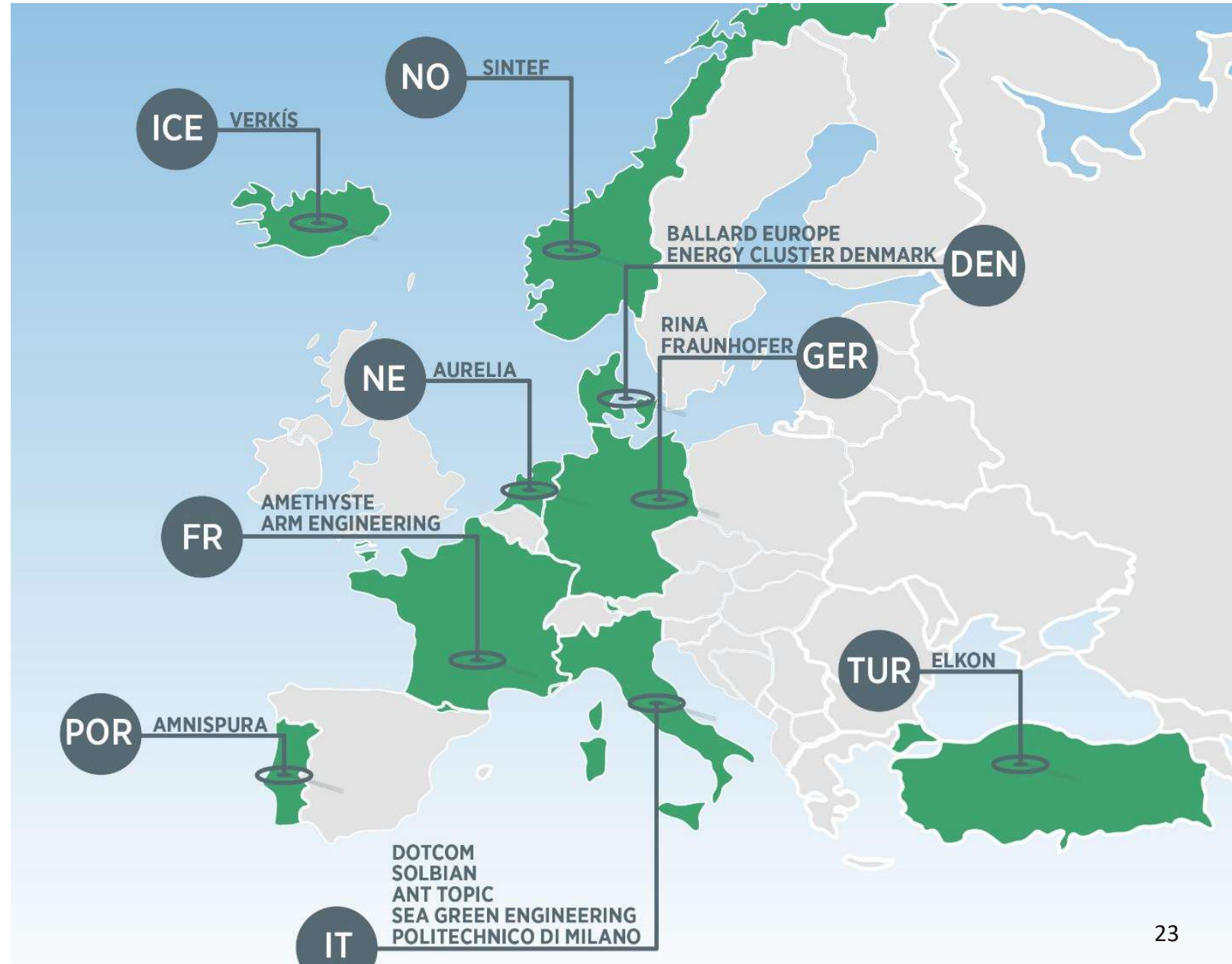
Replicable guidelines

Contribute to the Sector's decarbonization strategy



KEY FIGURES

- 16 partners
- 9 countries
- 5-year project
- 13 MEUR grant
- 17 MEUR budget



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