



# FLEX4H2 Flexibility For Hydrogen


Project Public Presentation



Funded by  
the European Union



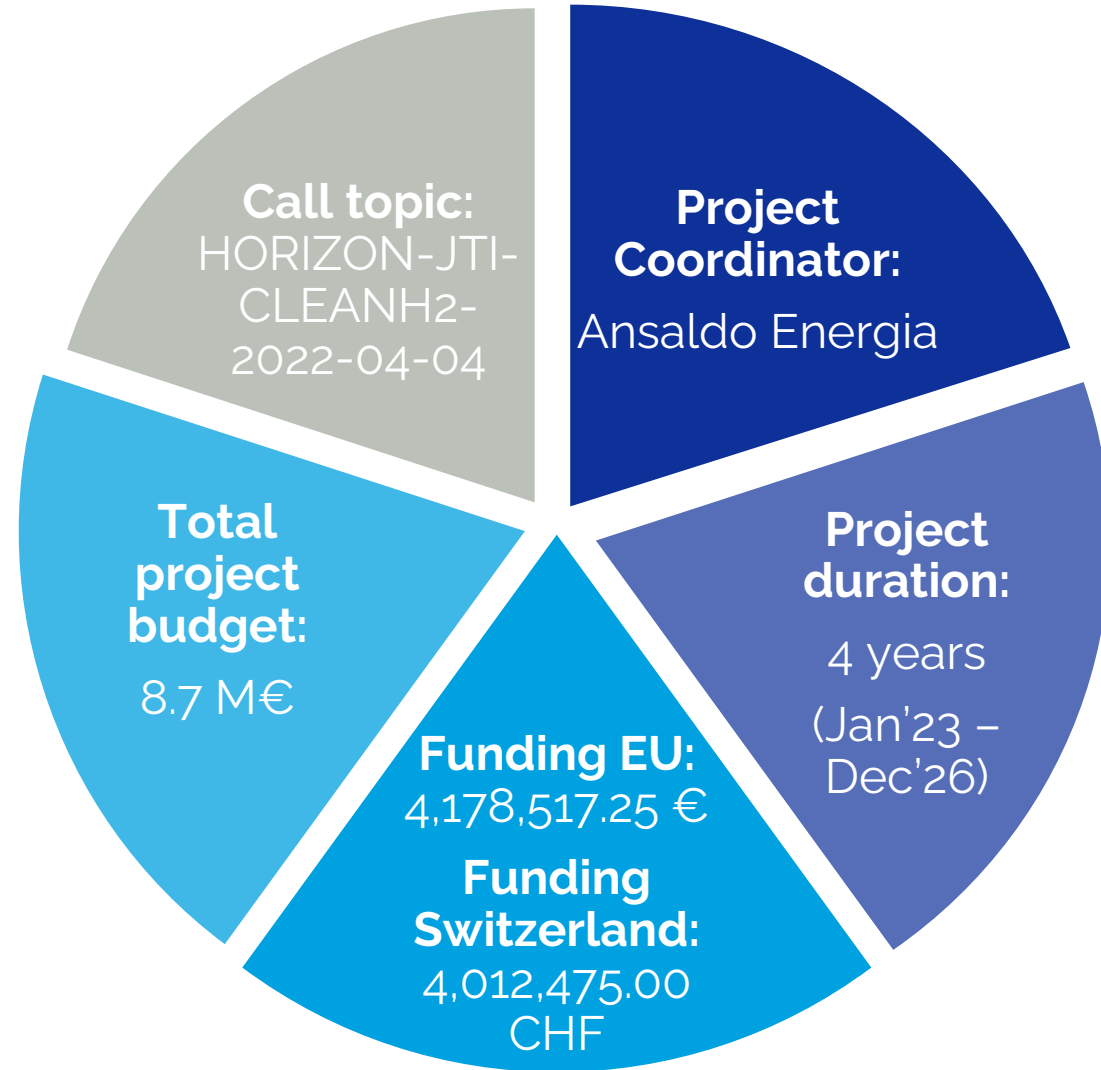
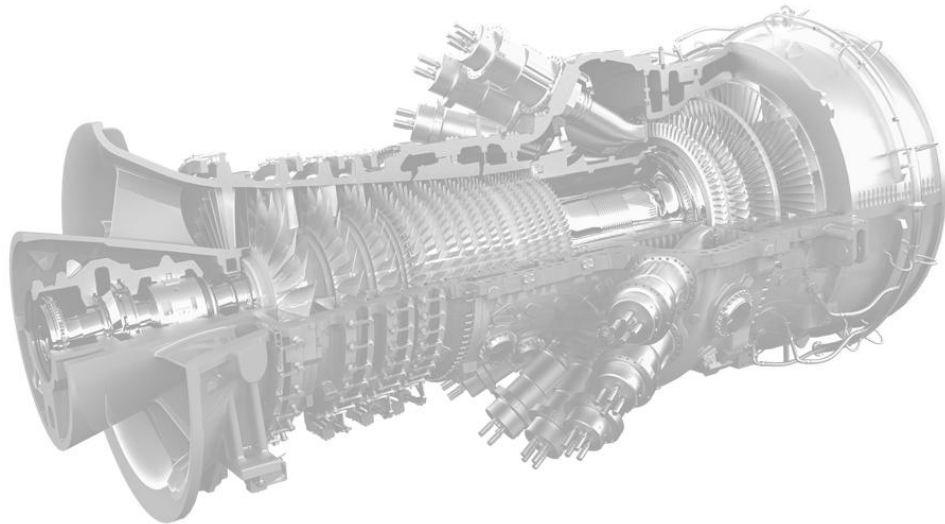
Project funded by

 Schweizerische Eidgenossenschaft  
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This project is supported by the Clean Hydrogen Partnership and its members Hydrogen Europe and Hydrogen Europe Research (GA 101101427), and the Swiss Federal Department of Economic Affairs, Education and Research, State Secretariat for Education, Research and Innovation (SERI).

# Project Overview



# Project Objectives



## H<sub>2</sub> combustion system design and **development**

- FLEX4H2 will develop and validate a **safe, efficient and highly fuel-flexible combustion system** capable of operating with any hydrogen concentration up to **100% H<sub>2</sub>**, at **H-Class** operating temperatures, while still meeting **emission targets** without any use of diluents.



## Validation and **demonstration**

- The combustion system will be **validated with up to 100% H<sub>2</sub> at full gas turbine operating conditions**. The full-size combustor prototype will undergo dedicated atmospheric and high-pressure testing up to Technology Readiness Level (TRL) 6.



## **Pathways** presentation

- The FLEX4H2 project will provide credible pathways for comprehensive **exploitation of the project's results** and thereby providing the basis for a firm contribution to the EU Green Deal towards decarbonisation of the electric power sector by 2030 and beyond.

# Main Impacts



## Contribution to **Net Zero** pathway

- FLEX4H2 project offers a significant contribution towards the decarbonisation of the electric power sector



## Accelerating the **transition** phase

- Solutions will be offered for full-scale GT combustors retrofittable to other non-OEM can-type combustors



## New **combustor technology**

- Handling of blends of natural gas with up to 100% of H<sub>2</sub>, without use of diluents and power derating



## Efficient **grid balancing**

- Hydrogen-fueled gas turbines carry significant potential to fill in the gaps caused by renewable energy systems (RES) intermittency and unpredictability

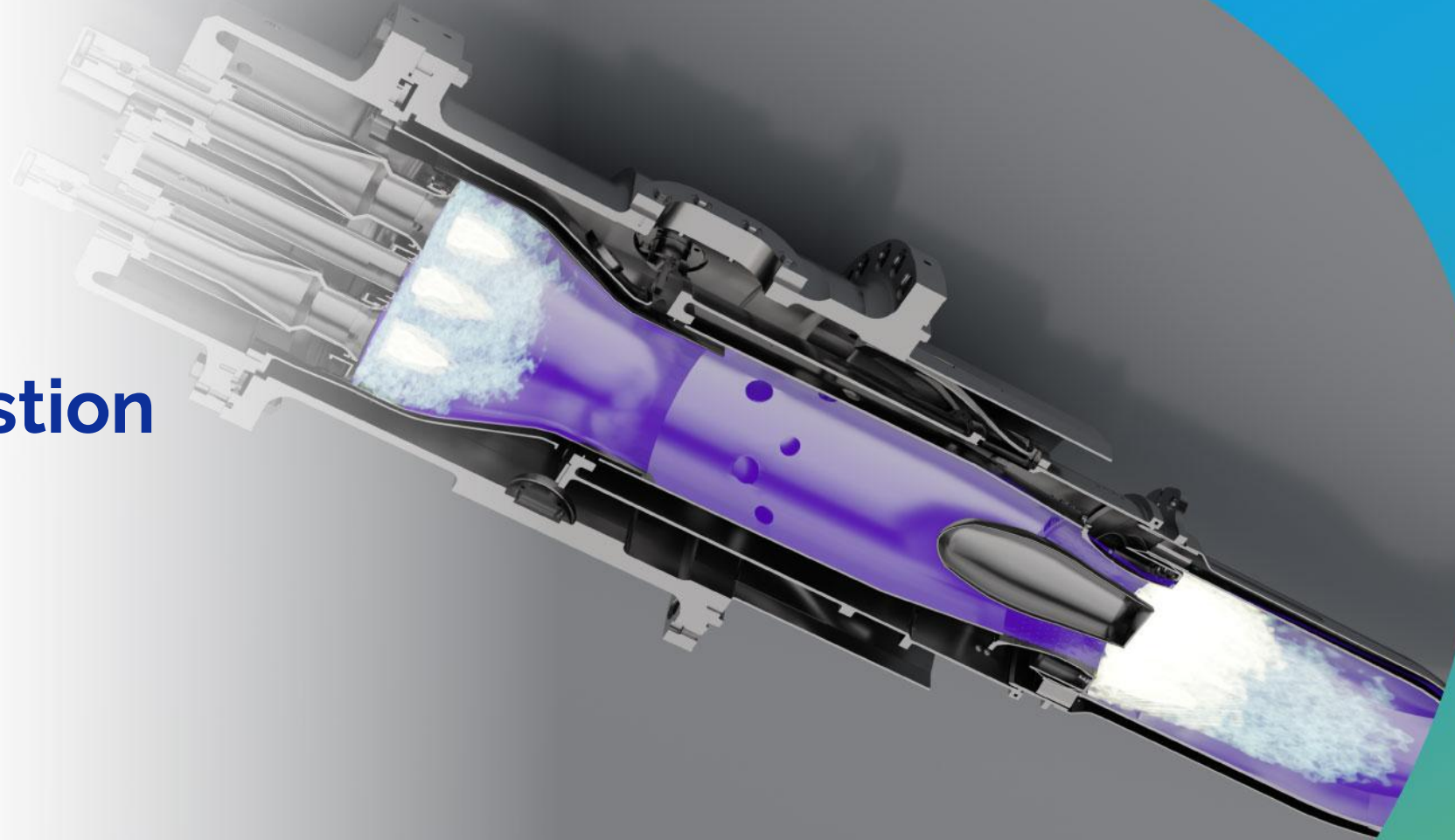


## **Re-utilisation** of existing infrastructure

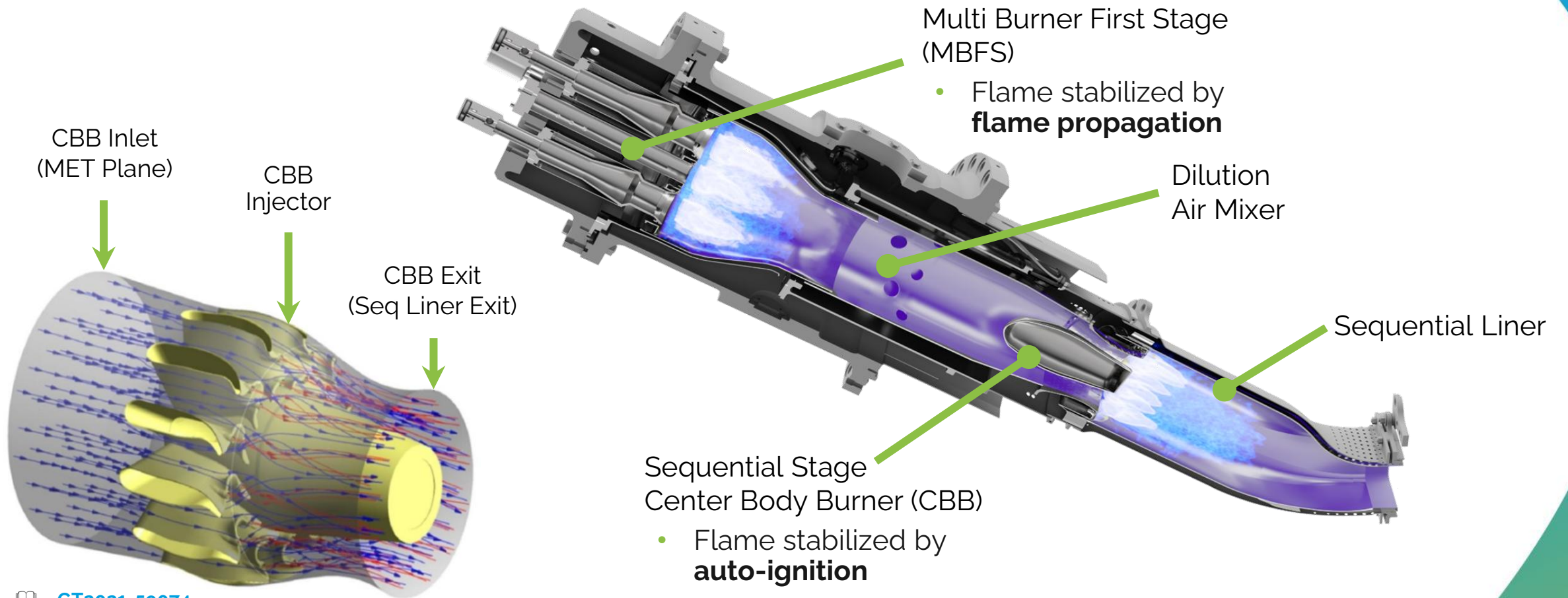
- Reuse of current infrastructure and thus reduction of investment costs



# Sequential Combustion Technology



# Sequential Combustion Layout

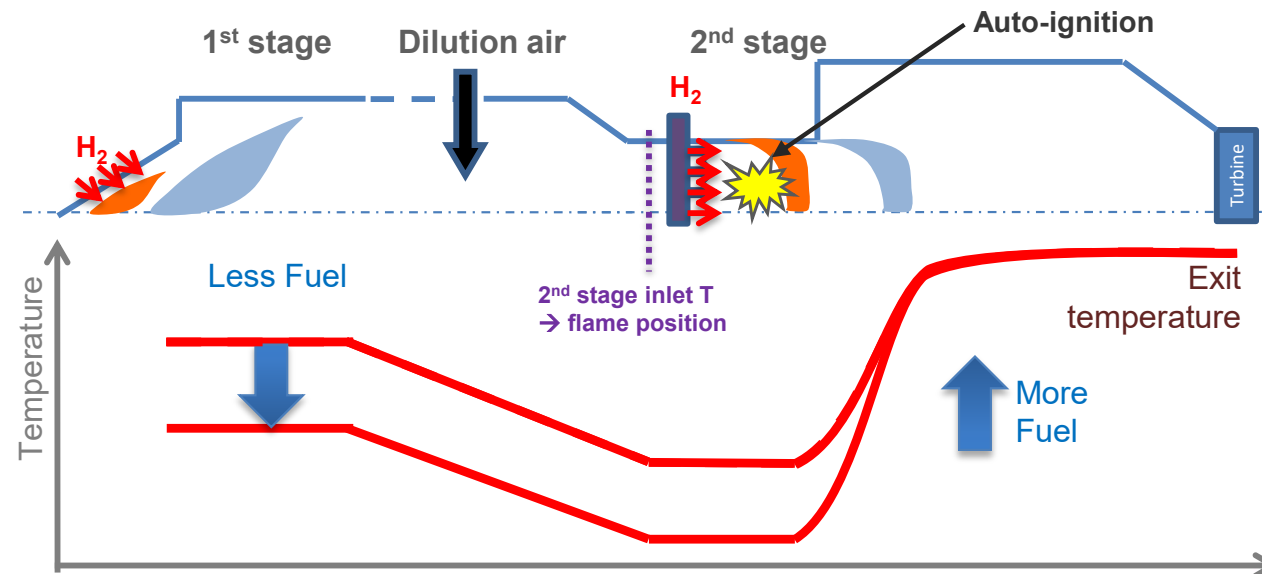
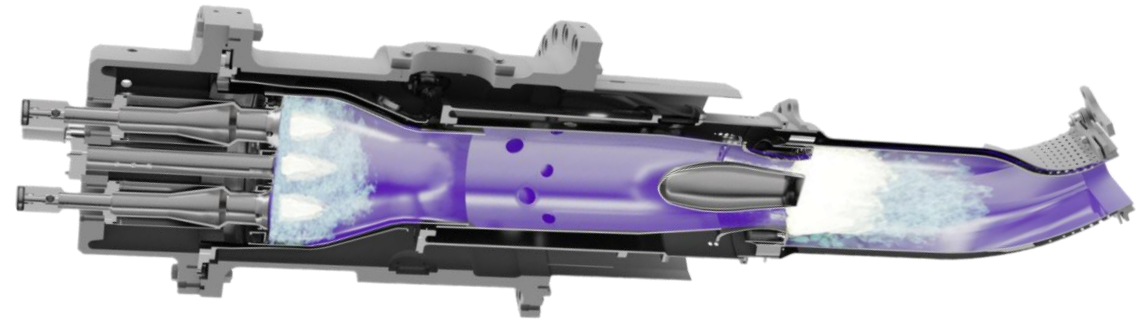


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# Sequential Combustion Flexibility

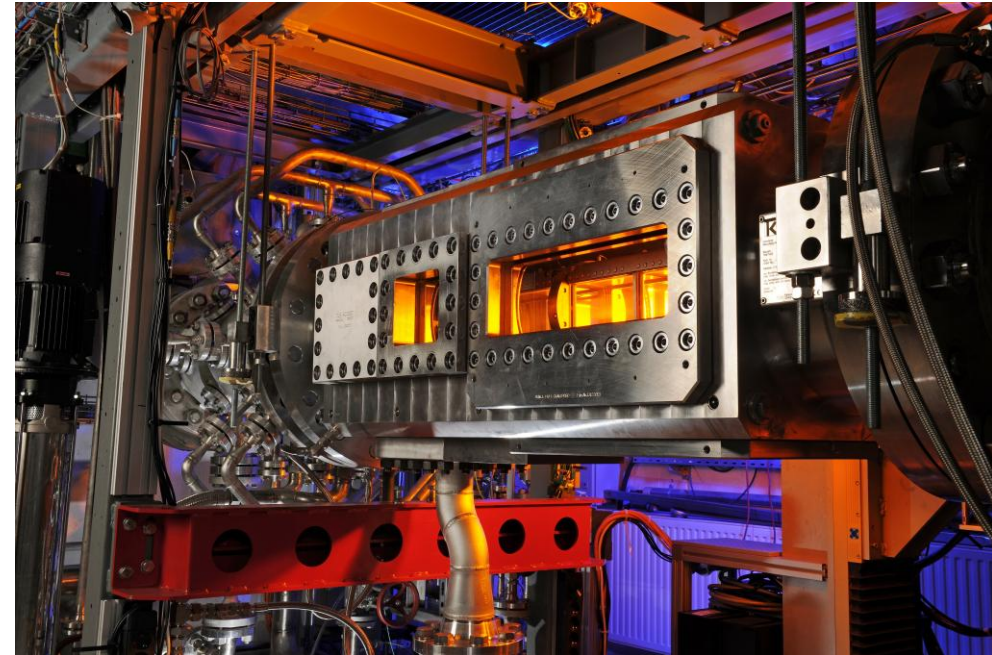
## Sequential combustion systems with H<sub>2</sub>

- Decrease 1<sup>st</sup> stage flame temperature
  - Compensating higher H<sub>2</sub> reactivity on the 1<sup>st</sup> stage
  - Reducing the 2<sup>nd</sup> stage inlet temperature
  - Compensating the 2<sup>nd</sup> stage H<sub>2</sub> auto-ignition
- Increase 2<sup>nd</sup> stage fuel (power)
  - compensating power loss from the 1<sup>st</sup> stage
  - Maximizing engine performance



# Testing & Validation – Scaled Combustor

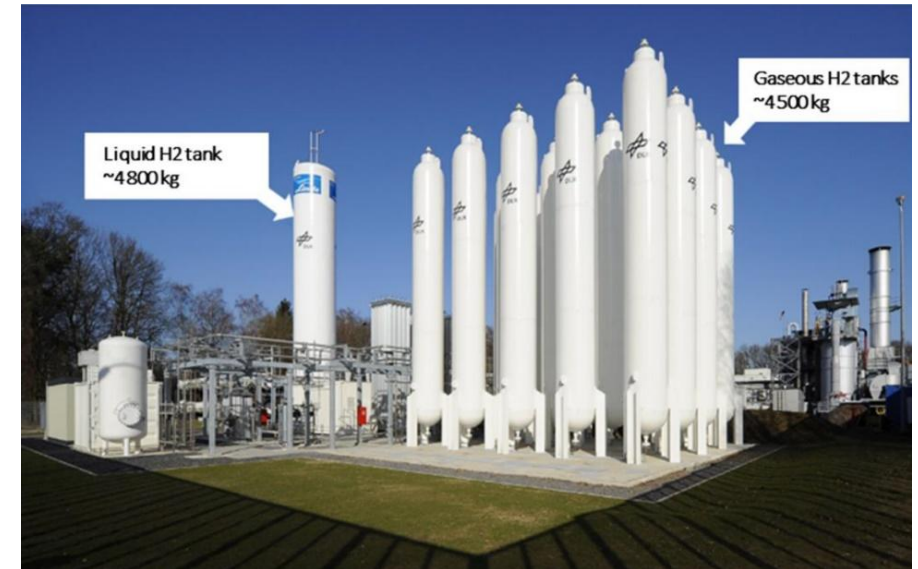
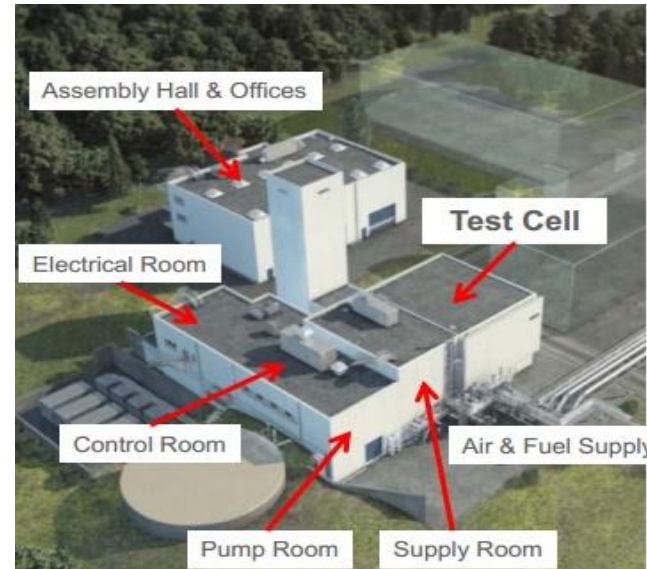
- **Pressure** up to 40 bar; flow rate of up to 1.3 kg/s
- **Operation** with various gaseous or liquid fuels
- Excellent **optical access** for optical diagnostics methods and techniques



Optically accessible high-pressure scaled sequential combustor test rig

# Testing & Validation – Full Scale Combustor

- Hydrogen capacity handled: up to 4 t/day
- Data acquisition with real-time monitoring of >1000 parameters
- Remote data monitoring (Baden, Switzerland)

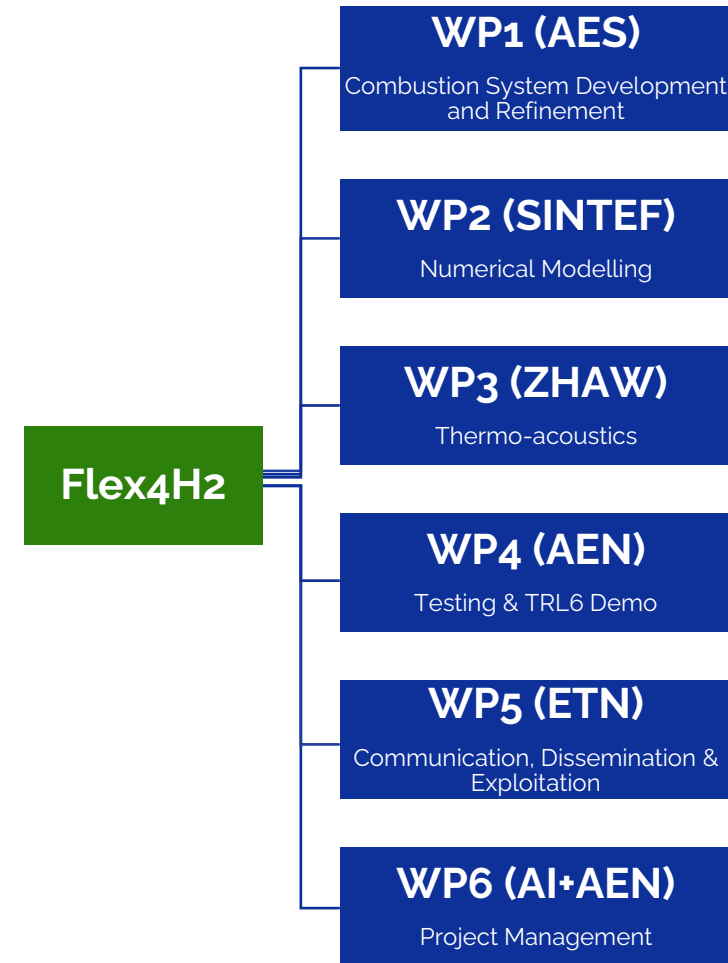
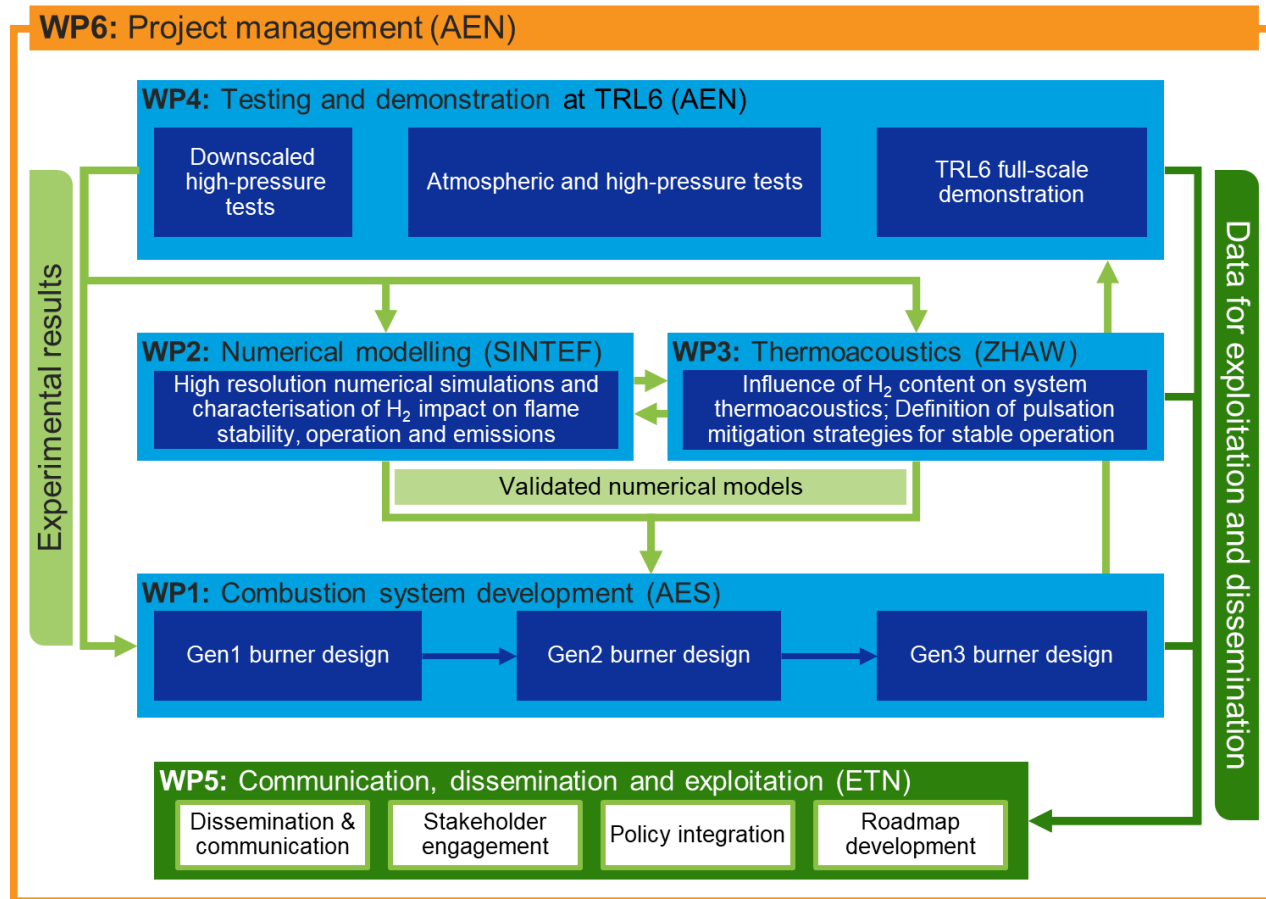


Testing infrastructure capable to reproduce full engine operating conditions

# Project & Work Breakdown Structure



# Project Structure



# Work Breakdown Structure [1/3]

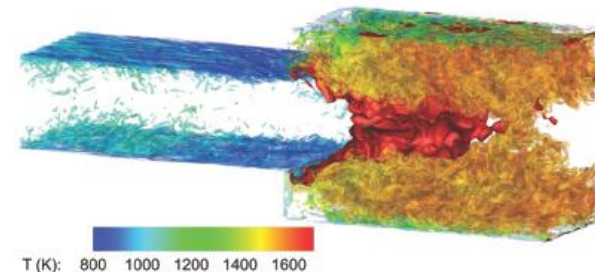
## WP1 (M1 – M48)

- Step-wise (Gen1 – Gen3) development of burner design for operation with up 100% H<sub>2</sub>.
- The development will ultimately exploit in full the numerical and experimental knowledge gained through activities in WP2, WP3 and WP4.



## WP2 (M1 – M42)

- Refinement of the design basis by pre-assessing the response of the CPSC system with high-resolution numerical simulations.
- Enhancement of flame stability whilst characterising the impact of varying H<sub>2</sub> contents on operating parameters and NO<sub>x</sub> formation.



# Work Breakdown Structure [2/3]

## WP3 (M1 – M42)

- Determination of H<sub>2</sub>-content influence on system thermoacoustics
- Enhancement of the thermoacoustically stable combustor operation at relevant loads and H<sub>2</sub>-contents

## WP4 (M1 – M44)

- Small-scale, high-pressure tests on a simplified geometry applying optical diagnostics
- Manufacturing of full-scale burner prototypes with improved design
- Characterization of combustion performance through atmospheric combustion tests of full-scale prototypes
- High pressure combustion tests of full-scale prototypes and demonstration at TRL6

# Work Breakdown Structure [3/3]

## WP5 (M1 – M48)

- Definition of effective strategies for communication and dissemination of the project activities and outcomes to the potential user community and business partners, scientific peers and policy makers as well as non-scientific audience
- Definition of effective communication means, channels and platforms

## WP6 (M1 – M48)

- Overall management and scientific coordination of the project
- Support of partners in achieving the project objectives and milestones, according to the timelines and deliverables committed to in the work plan and within the planned budget

# Thank You



[www.flex4h2.eu](http://www.flex4h2.eu)




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 Schweizerische Eidgenossenschaft  
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State Secretariat for Education,  
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