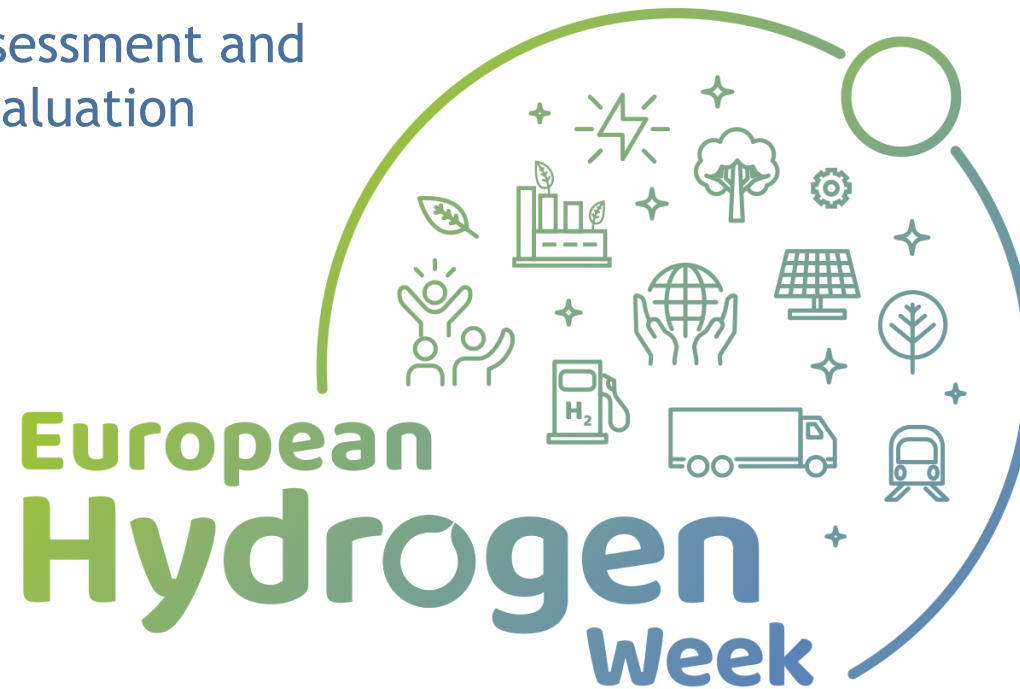


HYDRAITE

## Hydrogen Delivery Risk Assessment and Impurity Tolerance Evaluation



Jaana Viitakangas

VTT

<https://hydraite.eu/>

[jaana.viitakangas@vtt.fi](mailto:jaana.viitakangas@vtt.fi)



EUROPEAN PARTNERSHIP



Co-funded by  
the European Union

#EUResearchDays  
#PRD2022  
#CleanHydrogen

# Project Overview

- Call year: 2017
- Call topic: FCH-04-1-2017 Limiting the impact of contaminants originating from the hydrogen supply chain
- Project dates: 1.1.2018 - 30.9.2021
- % stage of implementation 01/11/2019: 100 %
- Total project budget: 3499867.50 €
- Clean Hydrogen Partnership max. contribution: 3499867.50 €
- Other financial contribution: -
- Partners: VTT, CEA, Powercell, NPL, ZSW, ZBT, SINTEF AS



# Project Summary

## HYDRAITE - Hydrogen Delivery Risk Assessment and Impurity Tolerance Evaluation

The objective of the project was to solve the issue of H<sub>2</sub> quality for transportation applications:

### *Lack of representative data for ISO 14687 H<sub>2</sub> fuel standard impurity limits*

- Effects of contaminants, originating from the H<sub>2</sub> supply chain, have been studied
  - Methodology for determining the effect of contaminants in automotive PEMFC system

### *Lack of European laboratory capable to perform full H<sub>2</sub> analysis according to ISO 14687 and EN 17124:2018*

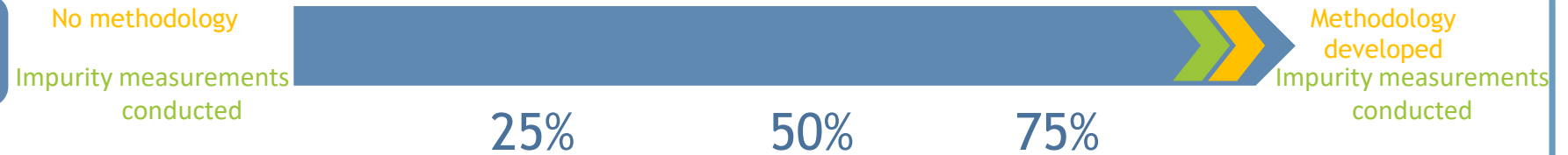
- Three European H<sub>2</sub> laboratories established to offer services to the FCH community
  - A network of expert laboratories able to provide qualitative analysis for new compounds with potential negative effect to the FCEV

### *Lack of public data on fuel composition from HRS (supply-chain derived), both from sampling nozzle and from inline monitoring*

- Technical data on fuel composition from HRS from sampling campaigns
- Inline monitoring of H<sub>2</sub> fuel quality

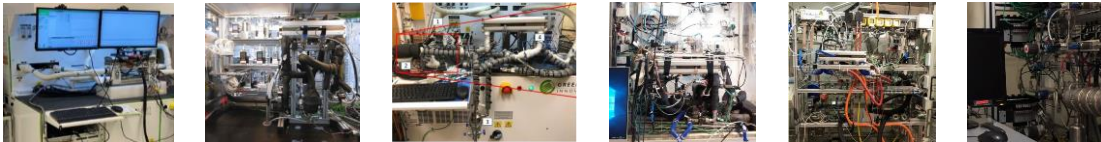
# Project Progress/Actions - Impact of contaminants

## Achievement to-date



Validating the methodology for studying the effect of impurities on FC stacks

- Six laboratories (VTT, CEA, NPL, ZSW, ZBT and SINTEF) conducted impurity measurements for data for ISO 14687 development
- FC measurements completed with CO, CO<sub>2</sub>, sulphur, ionic liquids, freon and toluene



- Recommendations for FC stack contaminant measurements in automotive-type operation
- Test protocol for determining the effect of contaminants for automotive PEMFC
- All partners: test systems with anode gas recirculation, and online gas analysis
- The use of <sup>13</sup>CO for contamination studies (oxidation rate monitoring with <sup>13</sup>CO<sub>2</sub>)
- First-of-a-kind sulphur poisoning measurements with short stack and anode gas recirculation

# Project Progress/Actions - European H2 laboratories

## Achievement to-date

No laboratories  
deployed  
No inter-comparisons

25%

50%

75%

3 laboratories  
deployed  
3 inter-comparisons  
between laboratories

Set up of three European hydrogen quality laboratories, capable for full analysis according to EN 17124: NPL, ZSW and ZBT.

- Analysis according to EN 17124 / ISO 14687, with (partial) compliance to ISO 21087:2019

## Laboratory intercomparisons

- Analysis of 30 HRS samples
- Project intercomparison (project partners & external laboratory)
- HYDRAITE intercomparison (involving sampling and analysis)

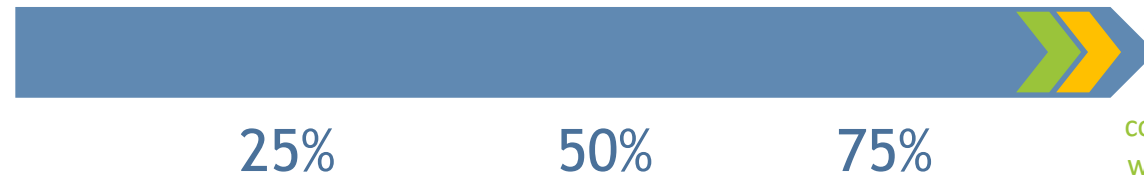


# Project Progress/Actions - H2 fuel composition on HRS

## Achievement to-date

0 HRS samples

No online monitoring  
at HRS



30 samples collected

Data on fuel  
composition (variation)  
with online monitoring

### Technical data on fuel composition from HRS

- 3 sampling campaigns completed with public data of total of 30 samples
  - 1<sup>st</sup> SC: 10 H<sub>2</sub> samples from NO, SE and DE analysed by 3 project laboratories + one external
  - 2<sup>nd</sup> and 3<sup>rd</sup> SC: 20 samples collected from DE

### Inline monitoring of hydrogen fuel quality

- The concept for PEM-based sensor and HRS online quality monitoring established
  - PEM sensor in fuel cell and H<sub>2</sub> pumping mode
  - HRS online monitoring in Ulm for 30 d



# Risks, Challenges and Lessons Learned

The implementation of the overall systems have been more demanding task than anticipated

Some delay in setting up the H<sub>2</sub> laboratories, due to delays in equipment delivery and commissioning, but also the additional requirements of ISO 21087:2019 (methods for the instrument calibrations, unexpected to be normative)

Inline monitoring of H<sub>2</sub> fuel quality at HRS was delayed first due to unlucky events at Norway, then by covid19 travel restrictions





# Exploitation Plan/Expected Impact

## Exploitation

*EU Horizon Results Booster, PDES-C service*

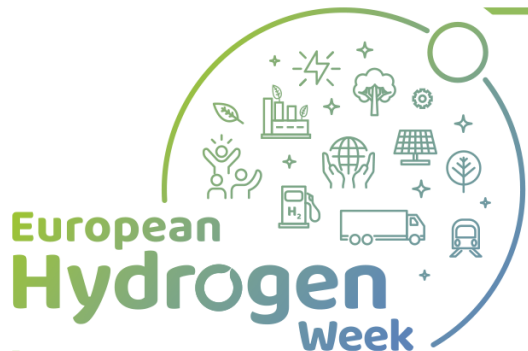
- KER #1 Online hydrogen quality sensor
- KER #2 Establishment of hydrogen quality laboratories & sampling



## Impact

- 3 European H<sub>2</sub> laboratories
- Public technical data on H<sub>2</sub> fuel from HRS (sampling and inline)
- Methodology for determining the effect of contaminants in automotive PEMFC system operation
- Standardization
  - ISO 14687 / EN 17124:2018
  - ISO 21087:2019
  - ISO 19880-1 annex K → a separate standard (work under ISO TC 197 WG33)





# Dissemination Activities

3 HYDRAITE SAB workshops

Invited presentations on other WS

5 Publications

Conference presentations

Active participation to standardization work;

ISO TC 197 WG 24 and WG 27, strong contribution to establishing WG 33

International networking (JARI, DOE)

Most HYDRAITE deliverables are public

<https://hydraite.eu/>

Workshop on Hydrogen Quality and Flow Metering for Hydrogen Fuel Cell vehicles



1st HYDRAITE Workshop



HYDRAITE Final Event – A platform to discuss Hydrogen Quality for PEMFCs

23<sup>rd</sup> of Sept 2021  
**Final Public Event**

A platform to discuss  
HYDROGEN QUALITY for PEMFCs



HYDRAITE contribution to the webinar on H2 quality sampling & analysis organized by TME and HE<sup>2</sup> 19th of November 2020



Metrology for sustainable hydrogen energy applications Workshop, november 7 & 8, 2018



**PRiME 2020**  
October 4-9, 2020



International Journal of Hydrogen Energy  
Volume 45, Issue 8, 14 February 2020, Pages 5565-5576

Hydrogen quality sampling at the hydrogen refuelling station – lessons learnt on sampling at the production and at the nozzle

Thomas Baqu  
Fabien Auger  
Elsevier

Determination of fuel utilisation and recirculated gas composition in dead-ended PEMFC systems

Pauli Kosti, R. R. Jaana Vittalangen, Jari Ikonen  
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https://doi.org/10.1016/j.ijhydene.2020.04.252  
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International Journal of Hydrogen Energy  
Volume 46, Issue 17, 18 August 2021, Pages 29501-29511

Assessment of hydrogen quality dispensed for hydrogen refuelling stations in Europe

Thar Anders Arhaug, A. A. A.  
Elsevier

Operando characterisation of the impact of carbon monoxide on PEMFC performance using isotopic labelling and gas analysis

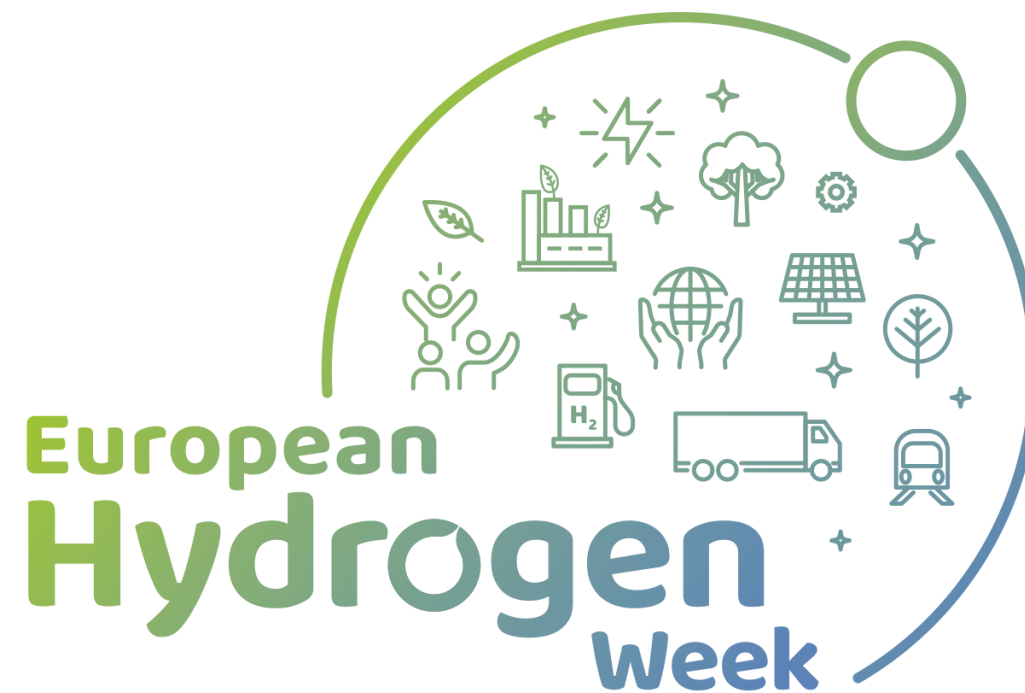
Hans Becker, A. A. R.  
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