HyQ

Hydrogen fuel Quality requirements for transportation and other energy applications
(256773)

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Hydrogen fuel Quality requirements for transportation and other energy applications

- 36 months
- Total budget: 3,654,709 € FCH contribution: 1,371,159 €
- The project gathers H2 economy actors from gas producers to OEMs

FC Research institutes

JRC
ZSW
CEA
VTT

Gas producer

AL
Shell
Total
Linde

National Measurement institutes

NPL
VSL

OEM

Axane

Economy + RCS

E. Energy
CCS

- HyQ aims at providing input to international RCS organisations for the standardisation of the H2 quality → automotive and stationary applications.

- H2 quality is a great importance the FC performances.

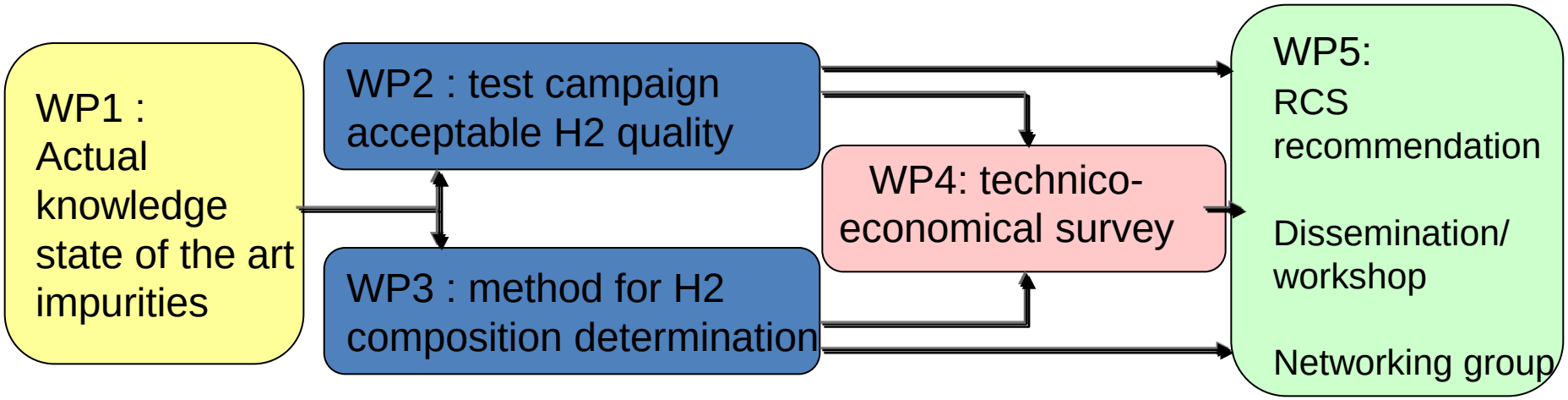
→ just few amounts of impurities in H2 (ppm and/or ppb level) dramatically impact the MEAs performances.

H2 quality	Fuel price	MEA spec.	MEA price
high	higher	Less tolerant to the impurities→ low loading	lower
low	lower	More tolerant to the impurities → high loading	high

Support to the RCS goes through:

- Studying the impact of impurities on PEMFC performance
  (single impurities, mixture of impurities, different load cycling)
- Improving the actual analytical method used to quantify the impurities in H2
- Cost-benefit analysis, ratio capex/opex

- Proposing standards (revision) in accordance with the results
- Proposing methods to test the impact of pollutant on next generation of MEAs and analytical devices

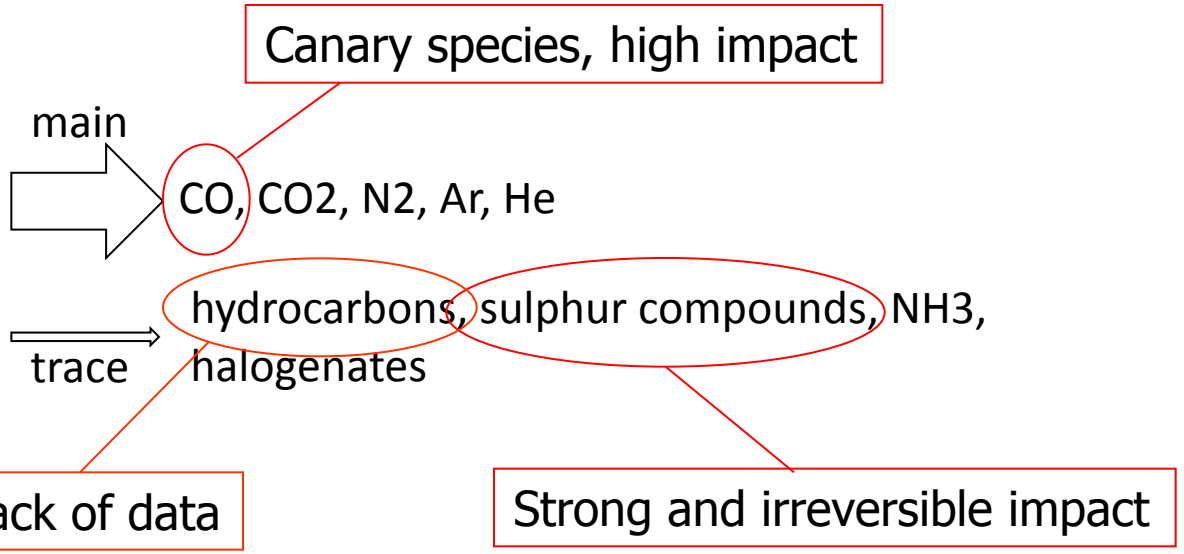


H2 production process

Mapping the different impurities from the different H2 production/purification process.

Hydrocarbons Reforming/ Pressure Swing Adsorption

38 Mt/year



Water electrolysis ⟹ (trace) halogenates

H2 Analytical Methods

SoA analytical methods

Impurities	technics	Detection
CO (200 ppb)	FTIR, GC, CRDS	10-100 ppb
HCHO (10 ppb)	CRDS, GC-PHID	10-100 ppb
Total S compounds (4ppb)	GC-SCD GC-PDHID IC	Without concentration: 1 ppm With concentration: 4 ppb With concentration: 10 ppb 1 ppb
NH3 (100 ppb)	IR, TDLAS	1-100 ppb
Halogenates (50 ppb)	IC, GC	5-50 ppb

→ Hard to quantify, need inert material

→ « total halogenates species »: need to be precisely identified

Improvments from HyQ:

CO → on-line analysis (PDHID) <200 ppb: OK

HCHO → Use of CRDS and H2 matrix

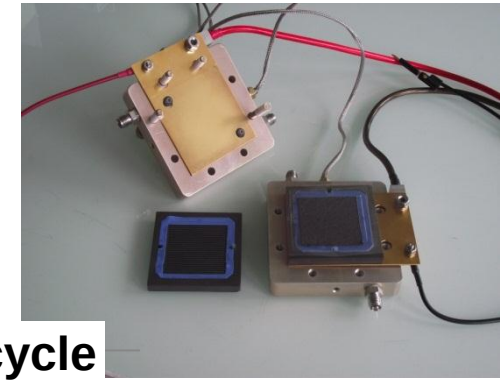
H2S → Method without pre-contration GC PDHID: ~ 10 ppb

mutiple components → Development of the device

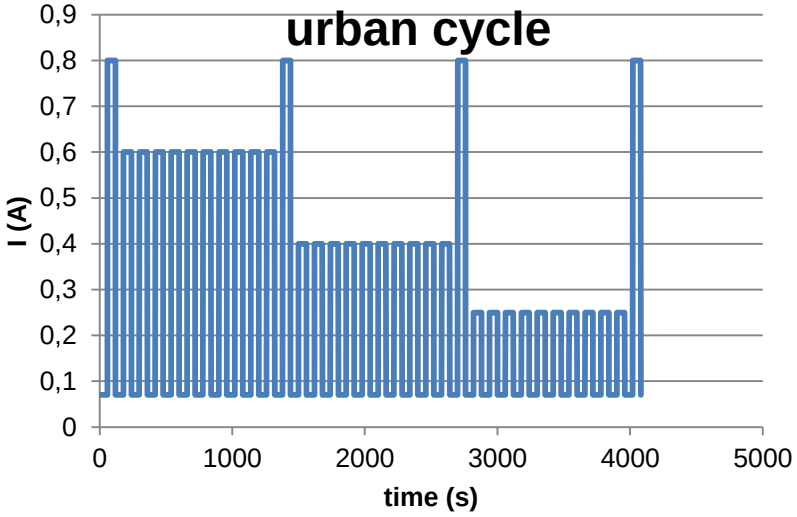
Impact of impurities on PEMFCs

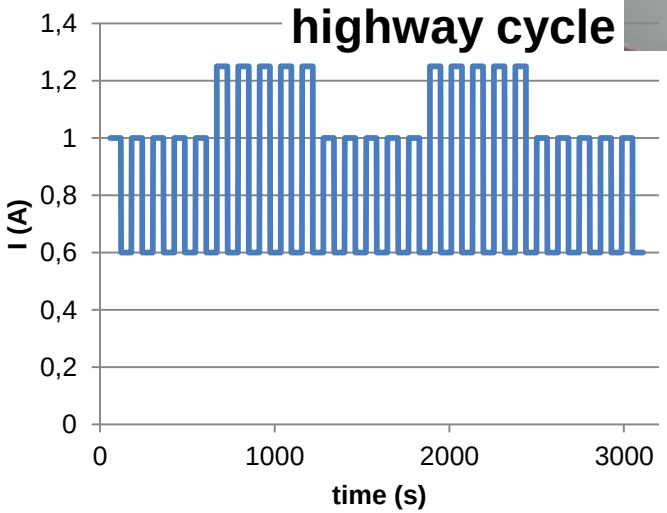
Definition of common material:

- FCT end plates
- graphite polar plates, single channel design to avoid drop water accumulation
- low anode Pt loading MEA : enhance the impact of pollutant
- tune the conditions for selected MEA



Definition of different load cycle : steady sate and dynamic





Impact of impurities on PEMFCs

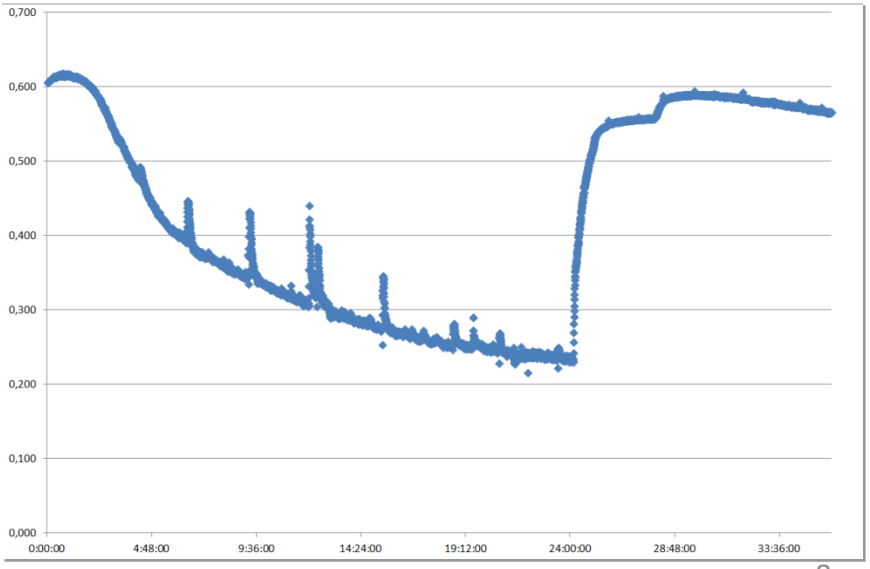
How to quantify the impact of pollutant:

- Comparing the U Vs time curve for pure H2 and under pollutant
  → impact on performances

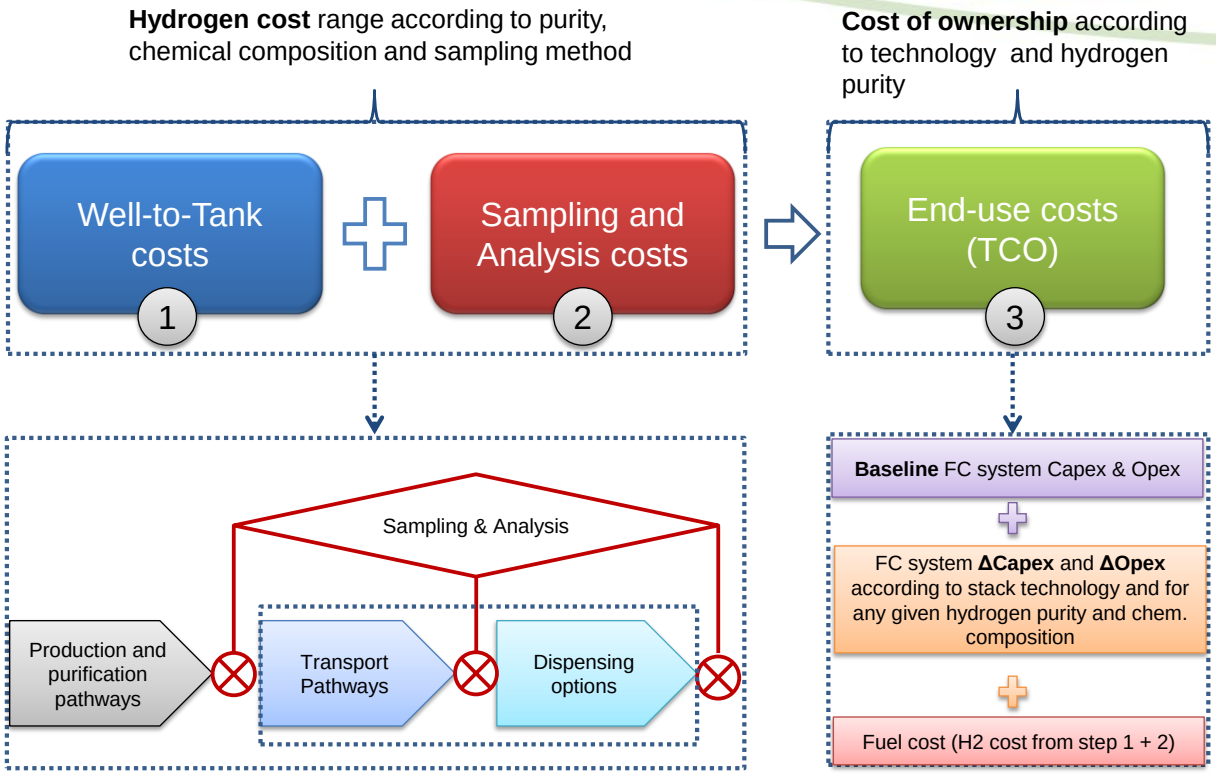
- Perform IV curve (FCTes^{QA} procedure) EIS, CV before and after the pollution phase both under pure H2
  → impact on degradation

- Impurities tested: CO, HCHO, H2S, NH3

- Multi components impact



Cost benefit analysis



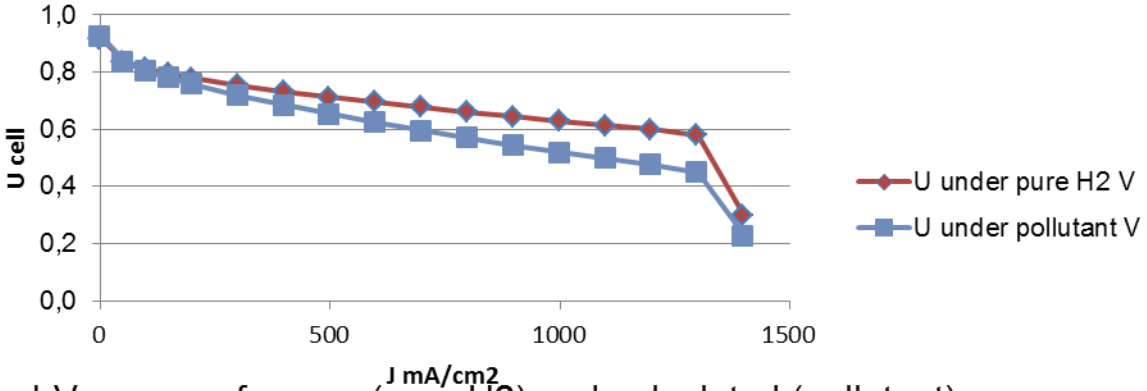
Capex/opex for gas production and PEMFC operation

Cost benefit analysis

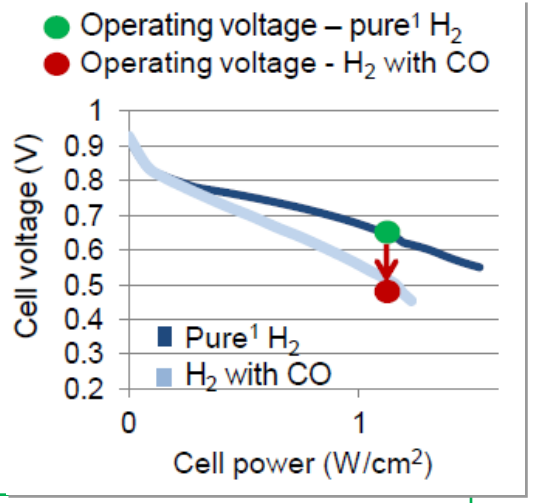
Impact of the pollutant on the PEMFC - CAPEX

IV curve is the data of interest to size a stack.
Drawing an experimental IV curve with impurities containing H2 is not the solution

The idea is to know the IV curve that can be obtained when feeding the MEAs with different quality of H2. (quality based on CO content)

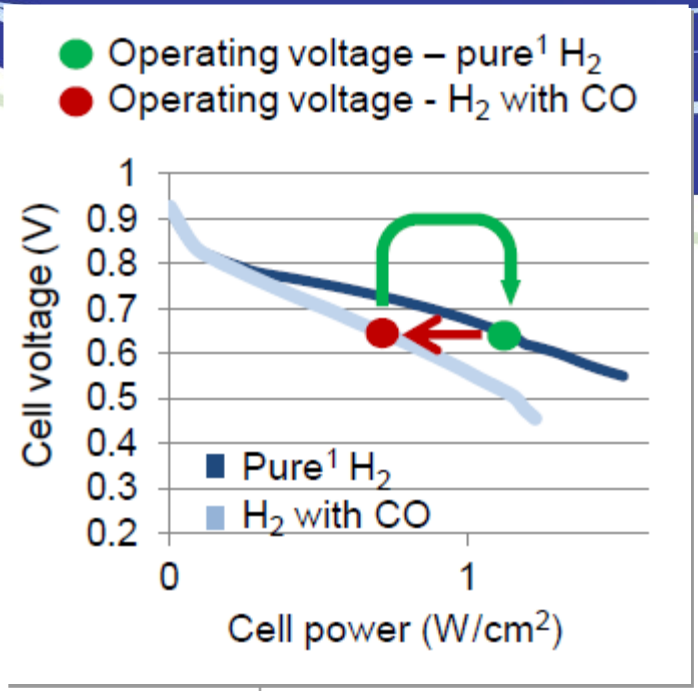


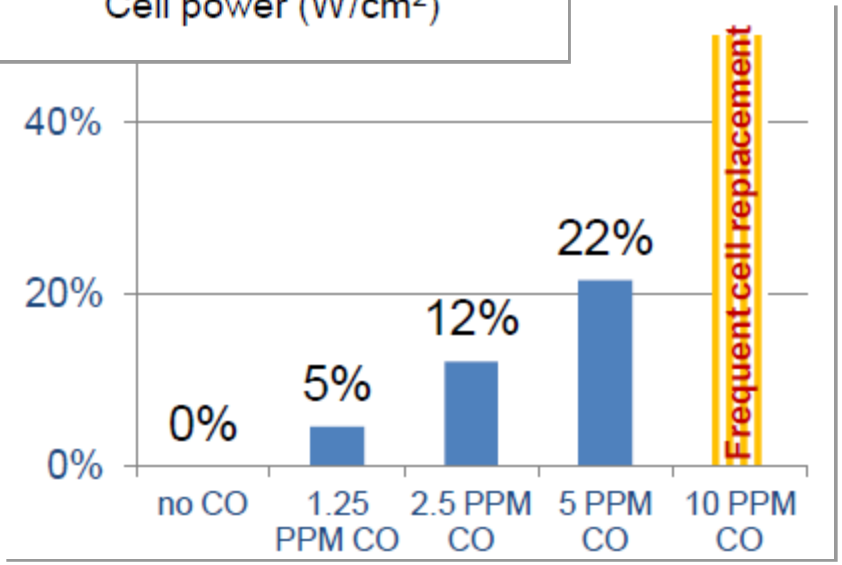
I-V curve, reference (pure H2) and calculated (pollutant)



Pt loading mg/cm2: 0,05	CO concentration ppm: 1	St H2: 1,2	cell area cm2: 25

H_2 Production	Requiring ISO-compliant[1] CO levels only marginally affects the wholesale H_2 price
FC systems	CO concentration in the H_2 fuel over 2 – 5 PPM increases stack Capex costs by a third or more
H_2 quality analysis	Analysis of CO levels can have major impact on fuel cost. However infrequent analysis strategies at high volume reduce this cost to negligible amounts (<1 Eurocent per kg-H_2)





Topic SP1-JTI-FCH1: Refueling and transportation infrastructure
Pre-normative research on fuel quality

→ Facilitate H2 commercialization thanks to standard

To discuss the standards:
impact of pollutant on FC,
H2 analytical methods,
impact on the price,
Interlaboratory check of the results,
reproducibility of the experiments.

→ One of the most important challenge is the decrease of the price of the catalyst part of the FC: which impact on H2 purity recommendation

Which anode Pt loading to have 0,1 mg_{Pt}/cm^2 MEA and which impact of actual standard H2 quality

- Conclusion from **Autostack** has been used for the cost-benefit analysis

- The Analytical method are validated by an interlaboratory comparaison via **EURAMET**

- HyQ is supported by National Measurement system (UK),

ZSW wuould like to continue research on H2 quality thanks to a national project,
CEA and VTT works also on reformate gas via Premium Act (JTI) and Demo (national)

- HyQ contributes to RCS avtivities on H2 quality:

→ lots of partners are members of ISO TC 197 WG 12-14
→ at the end of the project a workshop on impact of H2 purity on PEMFC will be organised

Training and education: 1 PhD (VTT), postdoc (JRC), student (Linde, NPL)

- Technology Transfer / Collaborations
  - the project is closely link to the ISO, numbers of the partners are members of the TC 197 WGs 12-14
- Project Future Perspectives
  - The study of the impact of CO should be closely related to the advance of the future MEA development.
  - The study of the impact of CO should be closely related to the advance in the H2 production processes.
  - The H2 quality will be used to define the new specification of MEAs / system.