E-fuel WP1 SOEC process development

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VTT fuel cells and hydrogen

Solid oxide technology

- High operation temperature: 600-850 ^{o}C
- **SOE technology offer the potential for highest electrical efficiency in electrolysis mode (80-90%) compared to other electrolyser technologies**
- **SOEC technology is reversible**: the same system can work both as a fuel cell and an electrolyser depending on power generation and grid stabilisation needs
- **SOEC has capability also for co-electrolysis of steam and CO_2, which enables more efficient power-to-X, if integrating them as part of industrial processes**
- The most commercial electrolysers are nowadays alkaline, but process has low efficiency due to needed high operation voltage. PEM based technology is more expensive than alkaline and it has also its own limiting factors like availability of iridium catalyst

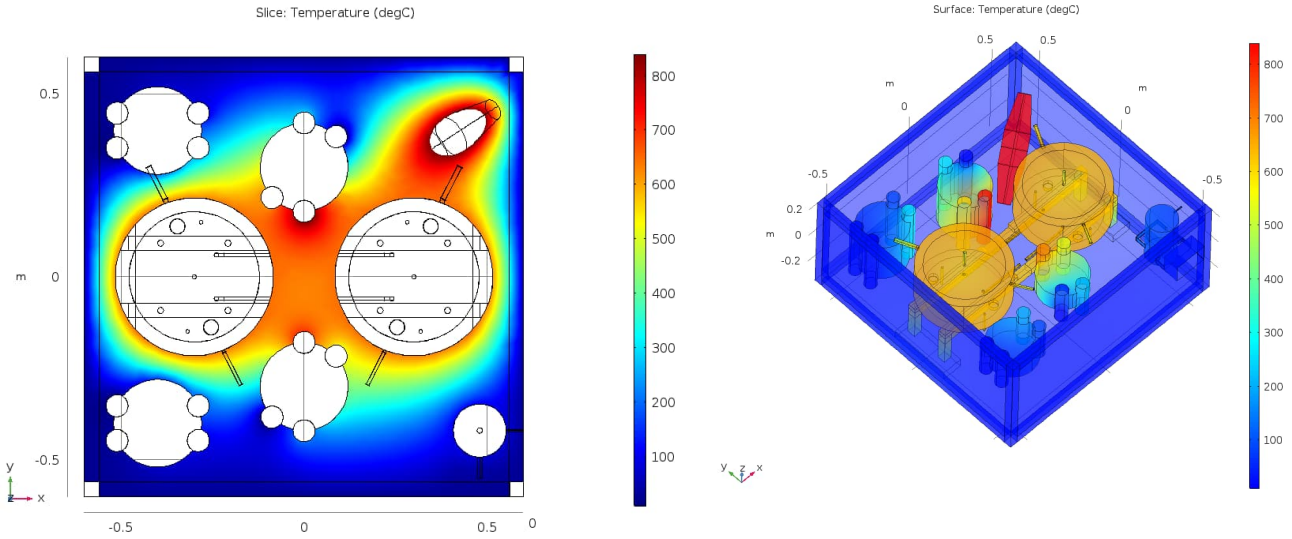
WP1 Novel high temperature electrolysis

- **Main Objectives:**
  - Development and validation of the operation 10 kW size SOEC system
  - Development of interface between hydrogen production and compression system

- **WP1 is divided in 4 separate tasks with corresponding deliverables:**
  - T1.1 SOEC system proof of concept and operation validation
  - T1.2 SOEC downstream process development
  - T1.3 SOEC system modelling and heat integration
  - T1.4 SOEC stack characterization and degradation test

Reversible SOC System Unit “RESSU”

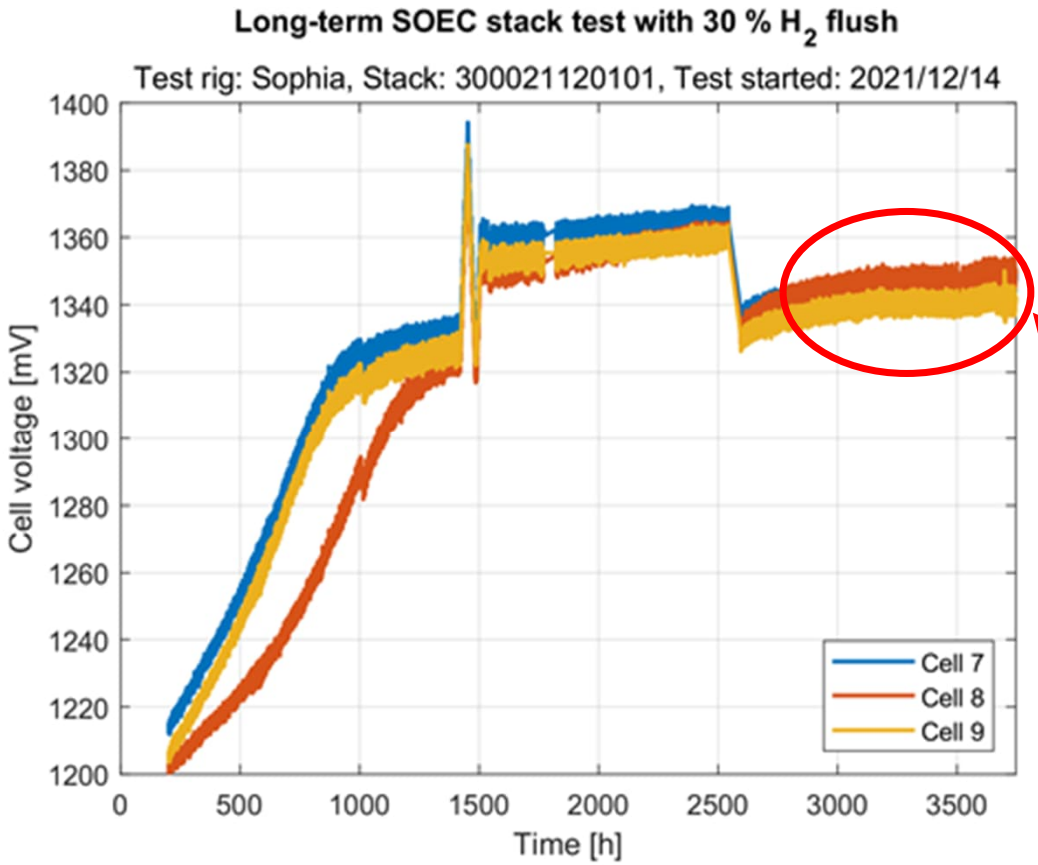
- Highly instrumented **Re**versible **S**OC **S**ystem **U**nit “**RESSU”** designed and build by VTT
- High efficiency and suitable for integration with various energy sources and P2X, adaptability to local energy needs (supports grid stabilisation with high penetration of renewable electricity)
- Good technology base for green, flexible and efficient energy systems



WP1 Novel high temperature electrolysis

T1.4 SOE Stack testing at VTT

- 2 long-term 3500h+ performance tests with Elcogen 15 cell stack has been been done and the latest test run still continues
- 15 cell stack tests together with later E3000 stack (119 cells) tests are givíng valuable information of stack performance to be utilized with VTT's SOE system «Ressu» and Convion's demonstration unit (10 x E3000 stack)



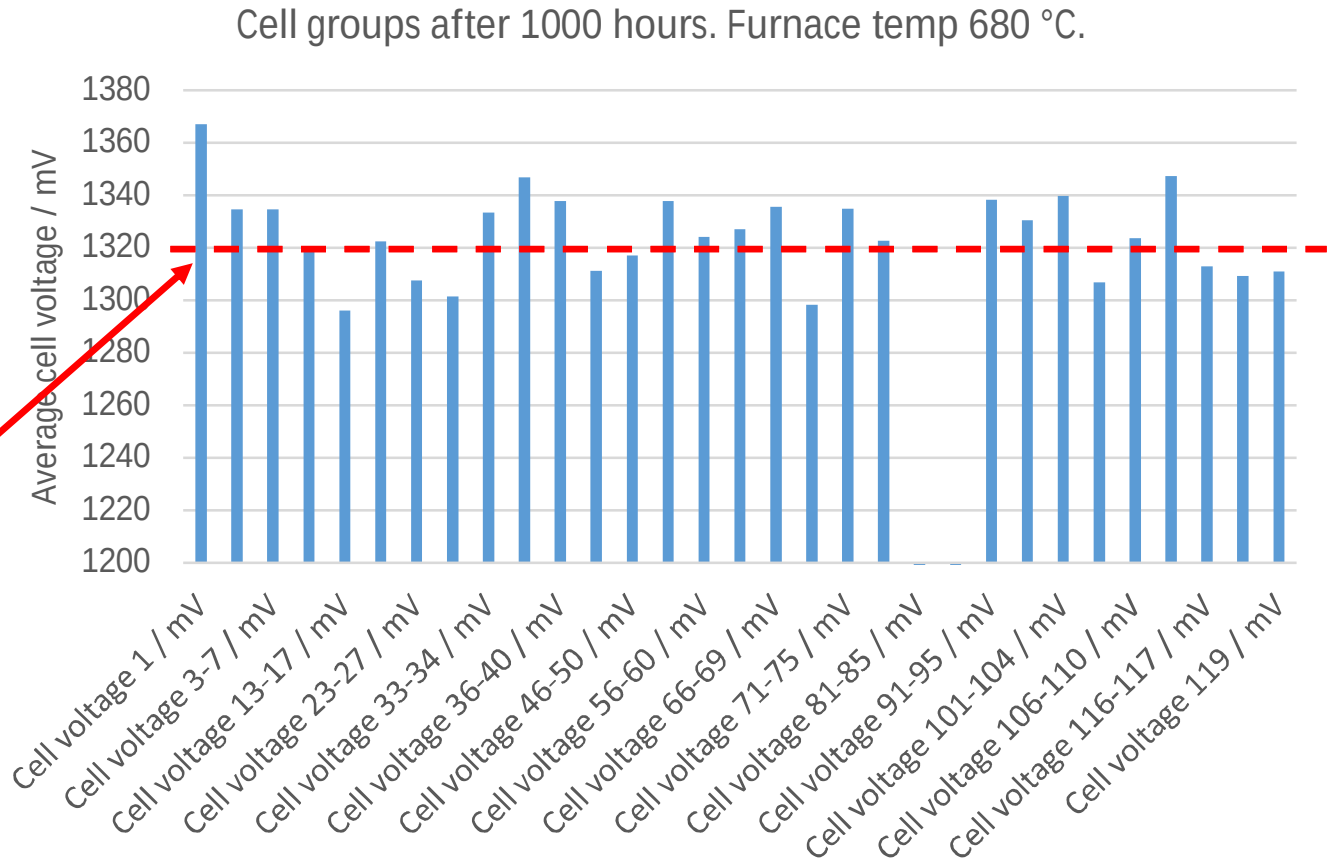
Degradation
~0.5% / 1000h

WP1 Novel high temperature electrolysis

T1.4 SOE Stack testing at VTT

- Test station for Elcogen E3000 stack (119 cells) has been built and 2000h long-term-test has been started in Q2/2022
- @1000h: relative even cell voltage and temperature distribution, ΔT_{max} ~20 ^{O}C

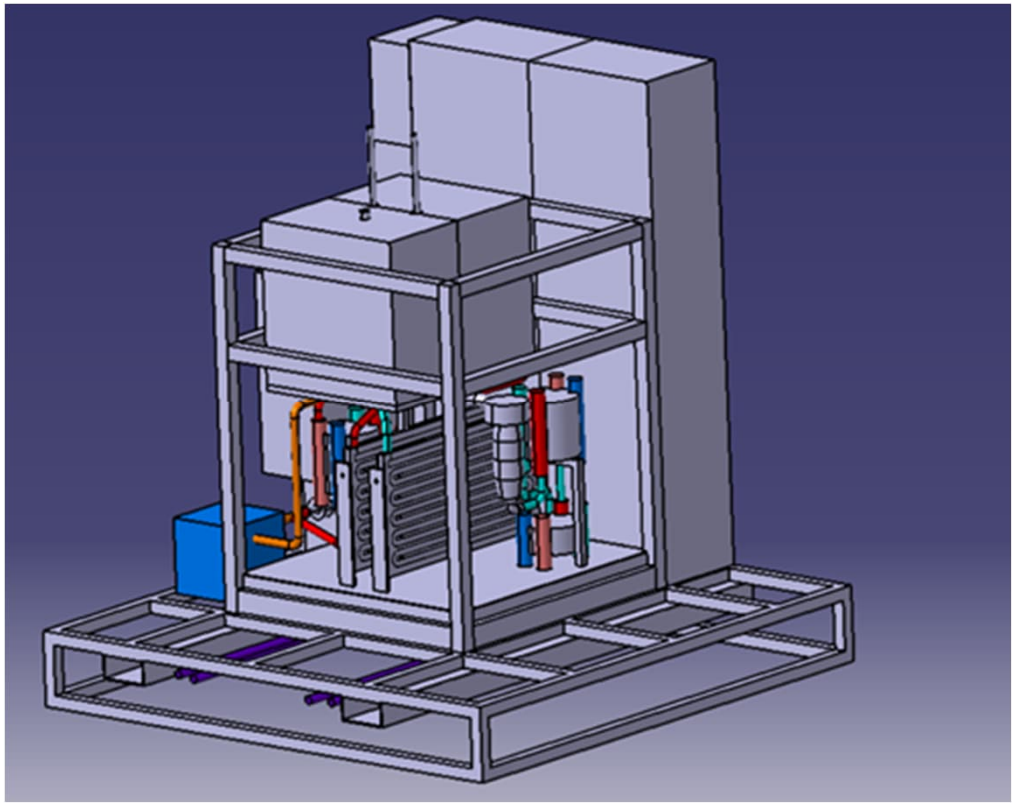
Average cell voltage ~1320mV @1000h



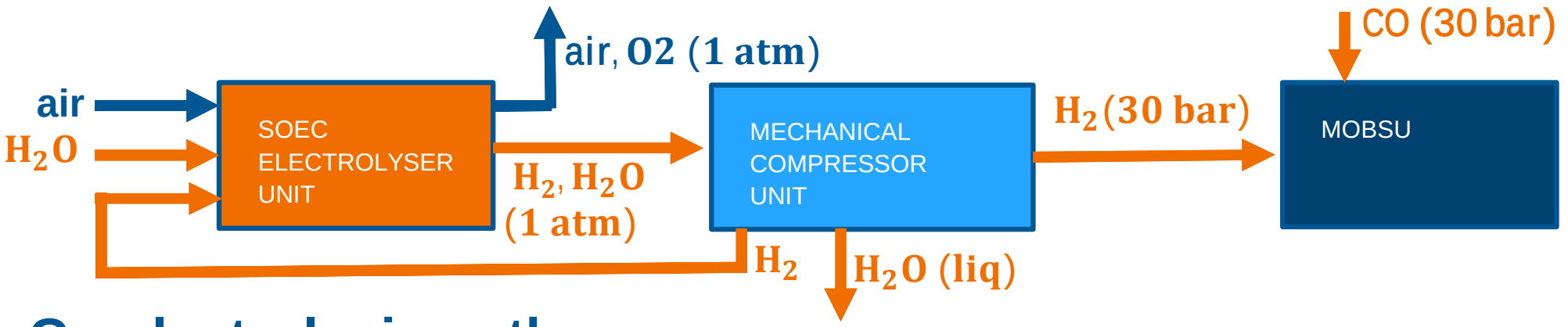
WP1 Novel high temperature electrolysis

T1.1 SOEC System proof and operation validation
T1.3 SOEC System modelling and heat integration

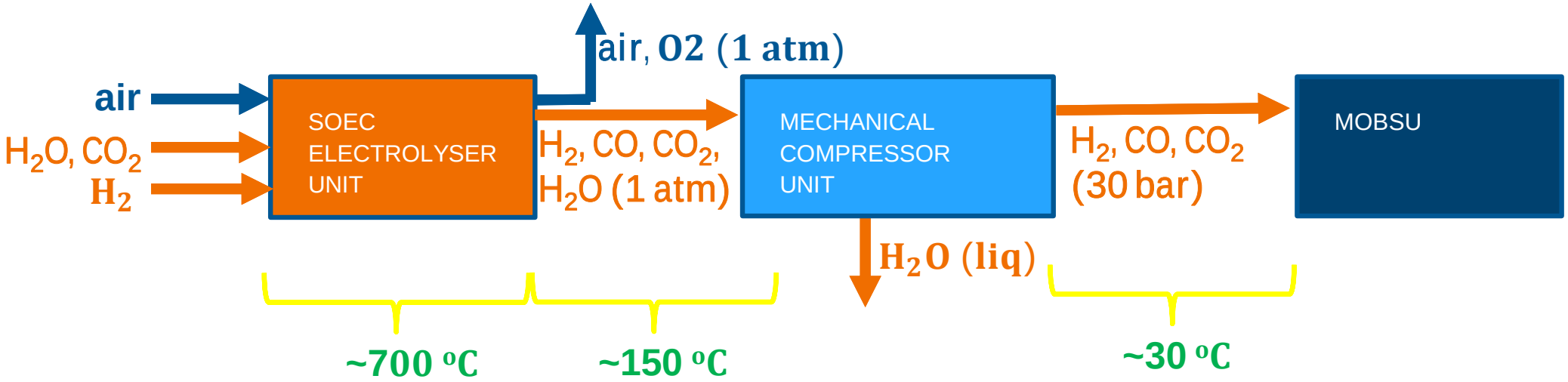
- VTT's electrolyser system design process continues and key components like steam generators and bi-directional load units have been arrived for installation
- Components for inlet gas superheaters has been ordered and their testing phase will start in Q3/2022
- Control system, automation and HMI development have also been started and actual «Ressu» system building will begin in Q3/2022



Electrolysis pathway:

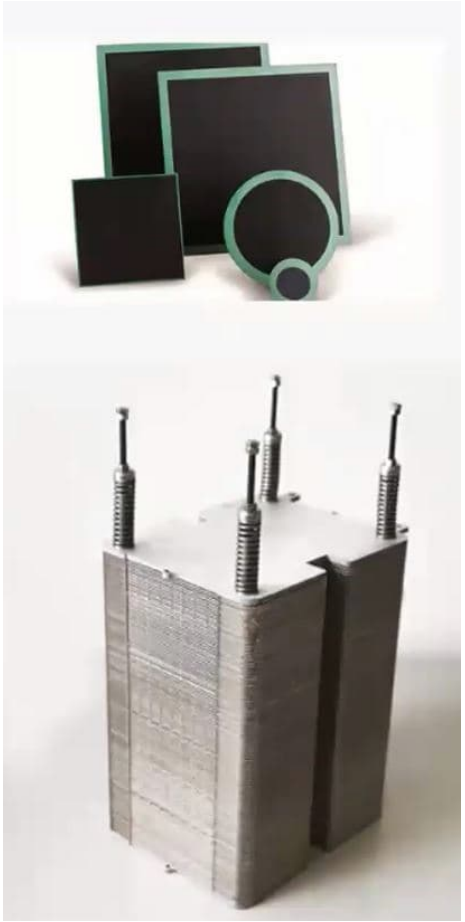


Co-electrolysis pathway:



WP1 summary and mid-term status

- VTT’s electrolyser and hydrogen/syngas compression unit development is well on track
- 15 cell stack tests (2 x 3500h+) will be completed in Q2/2022
- Long term 2000+h test for E3000 SOEC stack (119 cells) started Q2/2022 and still continues
- Elcogen's compressor unit testing started Q2/2022 and still continues
- VTT’s System design process will be completed during Q2/2022 and actual building will start in Q3/2022 and system test runs will be performed in Q1-Q4/2023



https://elcogen.com/products/solid-oxide-cell-stacks/

Thank you for your attention. Any questions?

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