ELECTRA

High temperature electrolyser with novel proton ceramic tubular modules of superior efficiency, robustness, and lifetime economy

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Project website:
http://www.mn.uio.no/smn/english/research/projects/chemistry/electra/

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Programme Review Days 2017
Brussels, 23-24 November

PROJECT OVERVIEW

- Call year: 2013
- Call topic: SP1-JTI-FCH.2013.2.4: New generation of high temperature electrolyser
- Project dates: 2014-03-03 – 2017-06-02
- % stage of implementation 01/11/2017: 100%
- Total project budget: 3,788,980 €
- FCH JU max. contribution: 2,240,552 €
- Other financial contribution: 1,548,428 €
- Partners: UiO(NO), ITQ CSIC(ES), SINTEF(NO), MARION(FR), CoorsTek Membrane Sciences(NO), Abengoa Hidrogeno(ES), Carbon Recycling Int.(IS)

PROJECT SUMMARY

ELECTRA Objectives:

Develop and demonstrate scalable fabrication of tubular HTE cells with proton conducting electrolytes for a 1 kW multi-tube module.

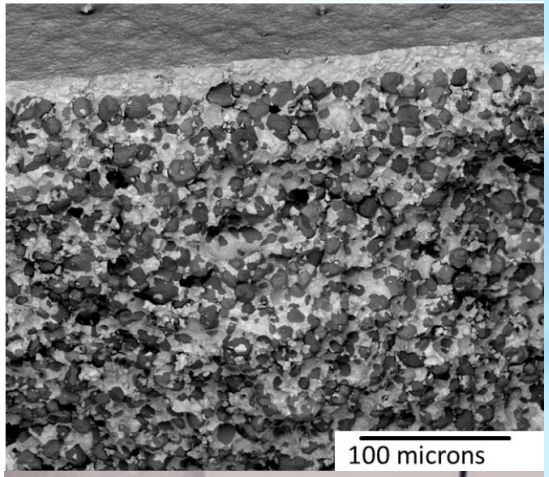
Demonstrate proof-of-concept HT CO_2 and steam co-electrolysis.

ELECTRA Global positioning vs int. SotA:

Produce directly dry pressurised H_2 more efficiently and safely than competing electrolyser technologies due to proton ceramic electrolyte and tubular geometry.

ELECTRA Application and market area:

Integration of HTE technology with geothermal and solar-thermal power.

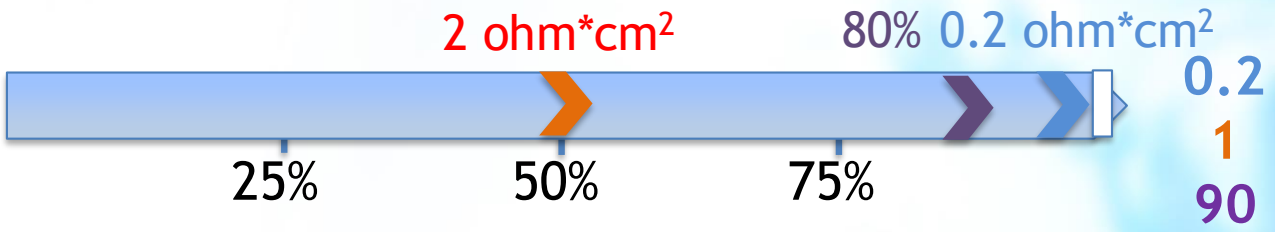


PROJECT PROGRESS/ACTIONS – Performance

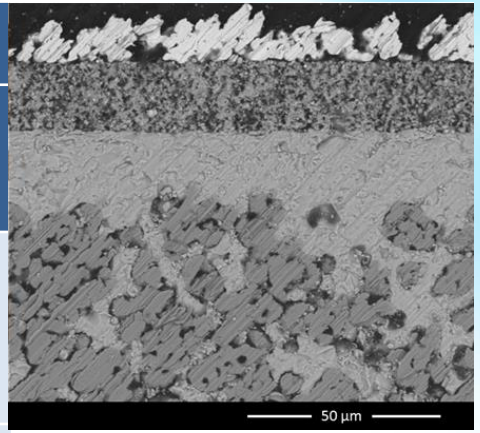
Status at month 39 of a 39 month project (100% implementation) at 02/06/2017

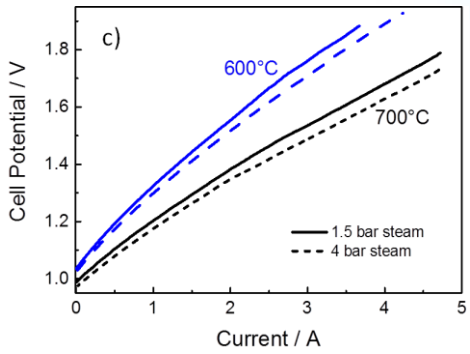
Achievement to-date

% stage of implement.



Aspect addressed	Parameter (KPI)	Unit	SoA 2017	FCH JU Targets	
				Call topic	2017
Performance	Steam anode ASR @ 700°C and 4 bar H_2O	ohm*cm²	0.2	0.2	0.2
	Cell ASR @700°C and 4 bar H_2O	ohm*cm²	1	1	1
	Electrical efficiency @ 0.2 A/cm²	%	80	90	90



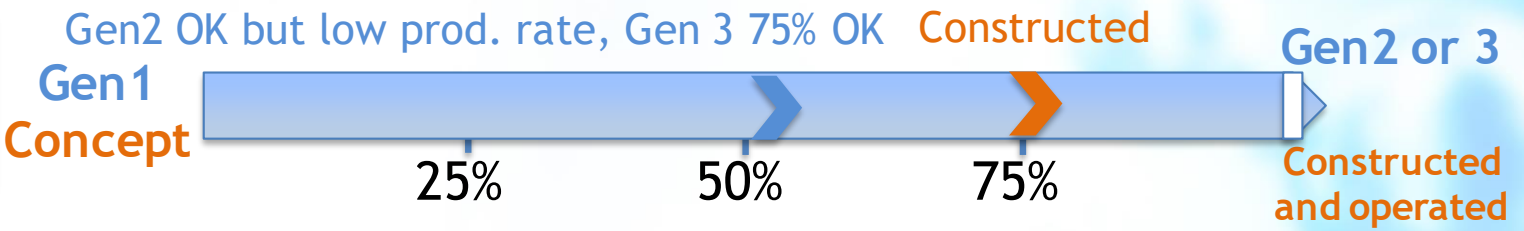


PROJECT PROGRESS/ACTIONS - Tubular module developments

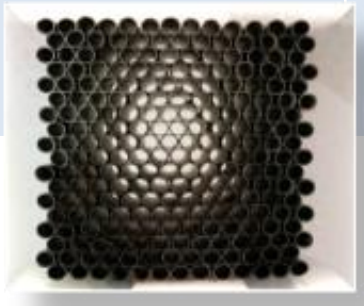
Status at month 39 of a 39 month project (100% implementation) at 02/06/2017

Achievement to-date

% stage of implement.



Aspect addressed	Part aspect	Measure of development	Status
Tubular module developments	Tube development and production	Gen1=Single tube Gen2=Stacked single segments Gen3=Segmented-in-series monolith	Gen1: Produced in large numbers. Gen2: 2-segment stacks. Produced in small numbers. Gen3: 3 of 4 layers developed. No full complete tube production.
	18-tube 1 kW multitubular module	Design, construction, commissioning, functionality test.	All aspects completed. Ready for operation. Final electrolysis test not completed due to delayed stacked tube production.



PROJECT PROGRESS/ACTIONS - Process integration and techno-economics

Status at month 39 of a 39 month project (100% implementation) at 02/06/2017

Achievement to-date

% stage of implement.

None

None

Geo- and solar-thermal integration modelled

Under publication

Geo- and solar-thermal modelled

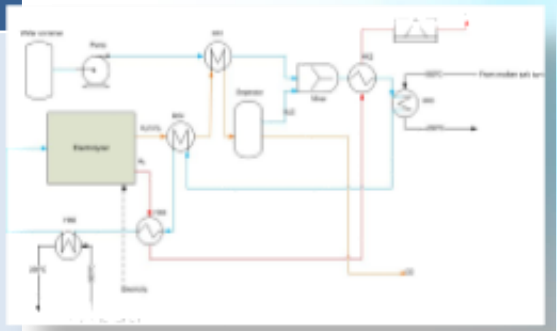
25%

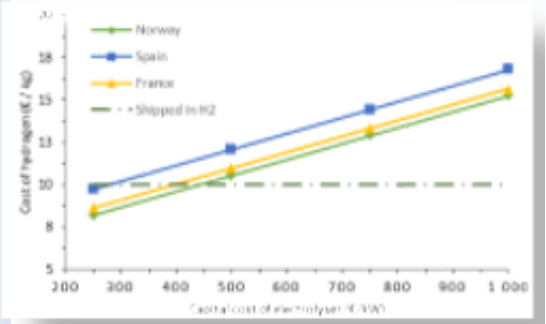
50%

75%

Techno-economics report

Aspect addressed	Part aspect	Measure of development	Status
Process integration and techno-economics	Modelling of PCE process integration with solar-thermal and geothermal	Design and construct models, parameterise, verify	Done for several cases of solar-thermal and geothermal sources, plus co-electrolysis for syngas
	Techno-economic evaluation of PCEs	Case studies designed, parameterised and evaluated with respect to break even capex and opex	Technoeconomic evaluation completed for several cases. PCE competitive if projected low mass production costs can be realised.





SYNERGIES WITH OTHER PROJECTS AND PROGRAMMES

- **Interactions with projects funded under EU programmes**
  - EFFIPRO (FP7 ENERGY): Experience and know-how on proton ceramic cells, especially air/steam electrodes (UiO, ITQ CSIC).
  - PROTON (ERA-NET): Development of double perovskite air/steam electrodes.

- **Interactions with national and international-level projects and initiatives**
  - FOXCET (RCN): Fundamentals of space charge layers in solid-state electrolyte and electrode interfaces. Mechanical properties and degradation mechanisms of proton ceramic electrolytes.
  - METALLICA (RCN): Metal-supported proton ceramic electrolyser - common efforts in solving electrolyte-related reproducibility issues.

RISKS AND MITIGATION

Time and resources for development of Gen2 and Gen3 tubes under-allocated.

- Reallocation of resources between WPs within partners.
- Step down to lower Gen# for production for multitubular module

Timing, order, and use of resources not optimal for some interrelated design and modelling tasks

- Reorganisation of time table in WPs 4 and 5

Production capacity of tubes for multitubular module under-allocated

- Reorganisation of responsibilities to free resources at critical partner
- Budget transfer between partners
- Project period extended 3 months

EXPLOITATION PLAN/EXPECTED IMPACT

Exploitation	Impact (related to ERs)
ER1&2 Fabrication (CMS, SINTEF, UiO)	Follow-up national project
ER3&4 Interconnects (UiO, SINTEF, CSIC)	Follow-up national and EU projects
ER5 Powder fabrication (MARION)	Increased sales
ER6&7 Steam electrode fundamentals (UiO)	Follow-up EU MERA-NET project
ER8 HP IT tubular PCEs (CSIC, SINTEF)	Follow-up EU FCH project (“GAMER”)
ER9&10 Integration with heat (CRI,AH)	Long term implementation in geothermal or solar-thermal plants
ER11 Design of multitubular module (CSIC, UiO)	Patent application; new industry

DISSEMINATION ACTIVITIES

Public deliverables

- D6.1 Establishment of Innovation and Exploitation Board
- D6.2 Summer School organised
- D7.4 Final report & publ. summary

Conferences/Workshops

- 2 organised by the project (Int. Summer School + IDHEA PCE)
- ≈12 in which the project has participated (but not organised)

Social media

Publications: 3

- "$Ba_{0.5}Gd_{0.8}La_{0.7}Co_2O_{6-\delta}$ Infiltrated…", R. Strandbakke *et al.*, *J Electrochem Soc*, 164 (2017) F196.
- "Development of composite steam electrodes…", N. Bausa *et al.*, *Solid State Ionics*, 306 (2017) 62.

Patents: 0

- (1 patent application under submission)

Thank You!

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