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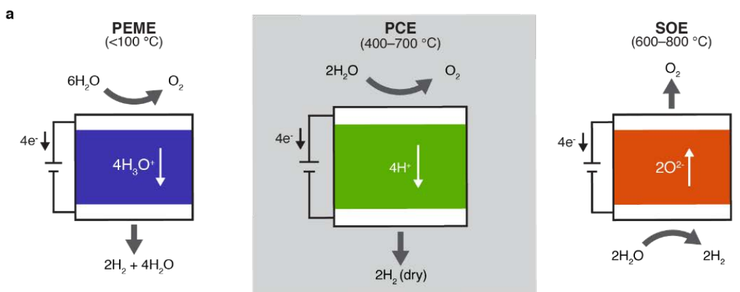
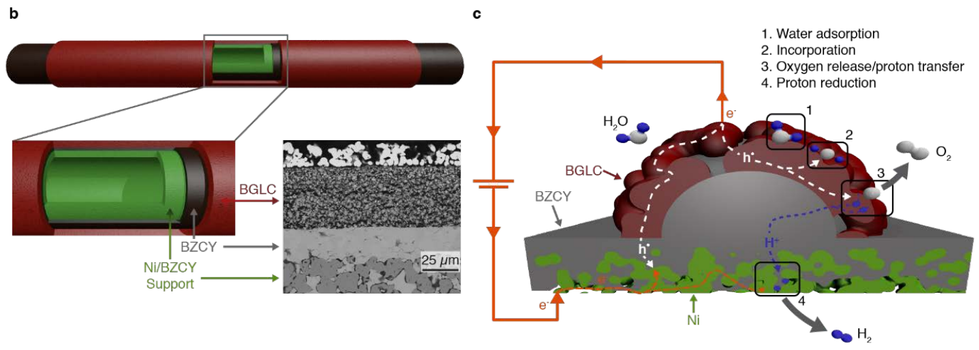
Scaling up of Tubular Proton Ceramic Electrolysers (PCEs)

Incentives for developing high temperature electrolysers (HTEs) using proton conducting electrolytes stem from the fact that a proton ceramic electrolysis cell (PCE) pumps out and pressurises dry H_2 directly. Existing HTEs design utilises the high packing density of planar stacks, but the hot seal and vulnerability to single cell breakdown give high stack rejection rate and questionable durability. We investigate instead tubular cells, mounted in a novel module with cold seals that allows monitoring and replacement of individual tubes. All cells consist of a porous Ni-BZCY cathode for the H_2 side (self-standing or supported on a porous BZCY tube), a dense BZCY-based electrolyte, a porous anode for the H_2O+O_2 side, and a current collector system.

Tubular PCE concept and design

PCEs can produce dry hydrogen directly without dilution by unreacted steam (SOE) or water drag (PEME), and the tubular geometry allows higher pressure tolerance.

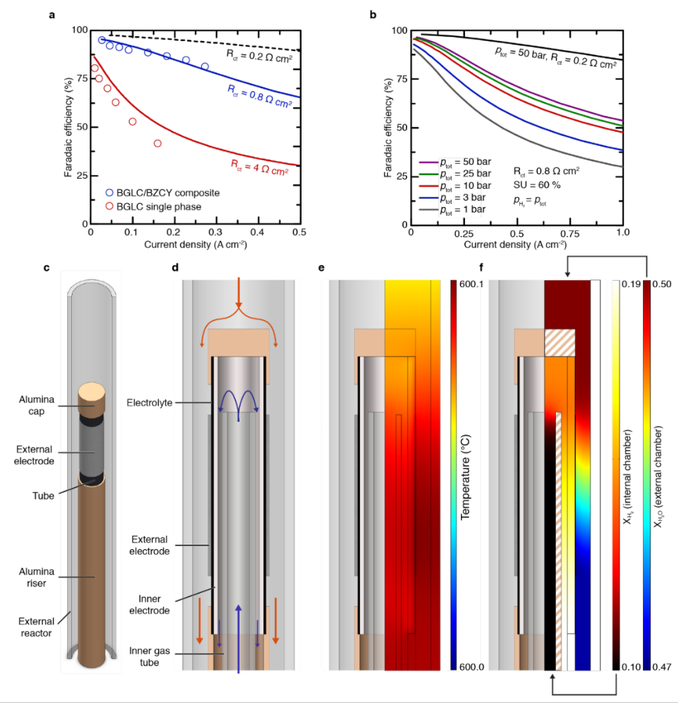




BGLC is selected as steam anode to promote mixed protonic electronic conduction and facilitate water splitting reaction

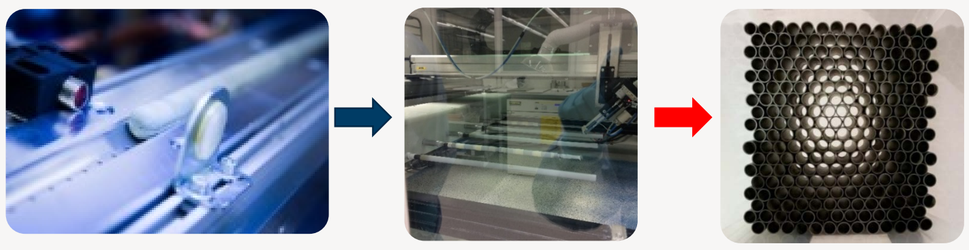
Heat and fluid flow calculations

Increased pressure and lowered electrode polarization both contributes to enhanced faradaic efficiency.



Scalable manufacturing process

- Automatic extrusion for 1m long tubes
- Spray-coating of electrolyte layer
- One co-sintering step of half-cells



Automatic 40 tons extruder with capping, cutting systems and air lifted conveyor belt

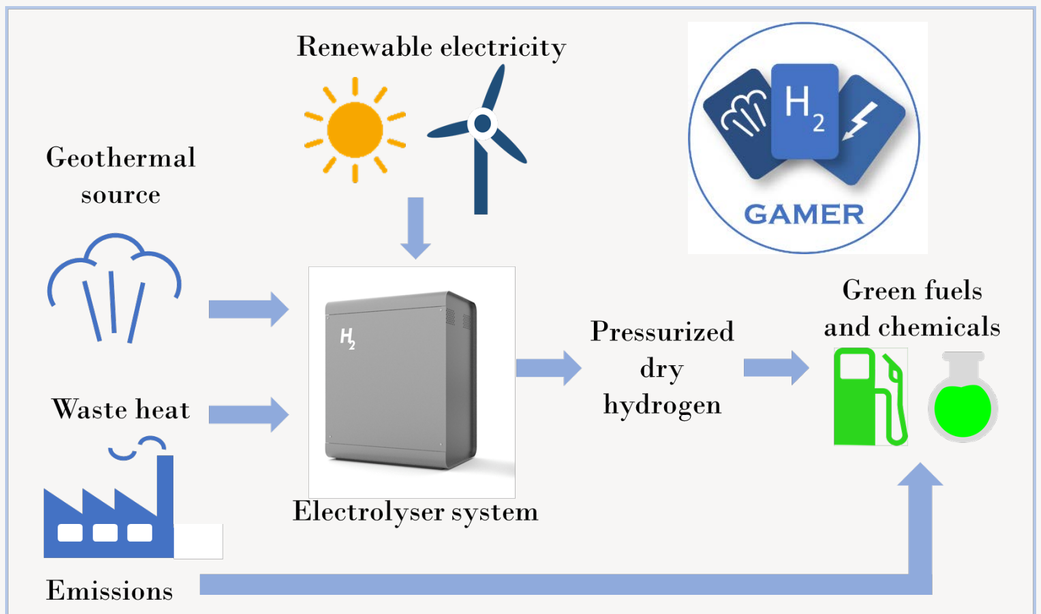
Automatic spray-coater for 40 cm long sample (batch of 6 samples)

Half-sintered cells of 25 cm length

Next Steps

In the FCH-JU project GAMER (2018-2021), we will work towards integrating novel tubular PCEs in a 10kW module for pressurized hydrogen production:

- Optimization of cell design
- Industrial pilot production of tubular cells
- Design and engineering of 10kW module
- Process design, LCA and techno-economic evaluation for green fuel production



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