First Project Workshop

In Pilsen and Online

Building a new battery system (like a jigsaw!)

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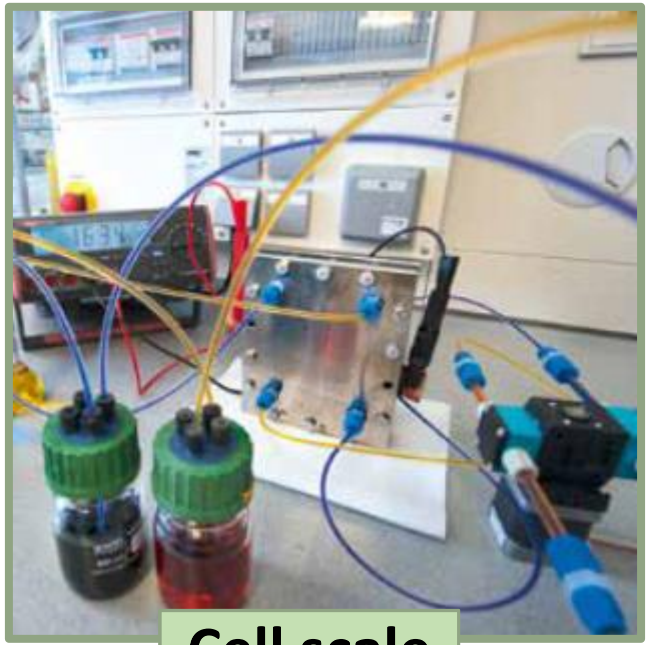
The research leading to these results has received funding from the European Union under Grant Agreement no. 875613

Introduction

Upscaling a flow battery: 2 simple steps



Cell scale

1.

Stack scale

2.

System scale

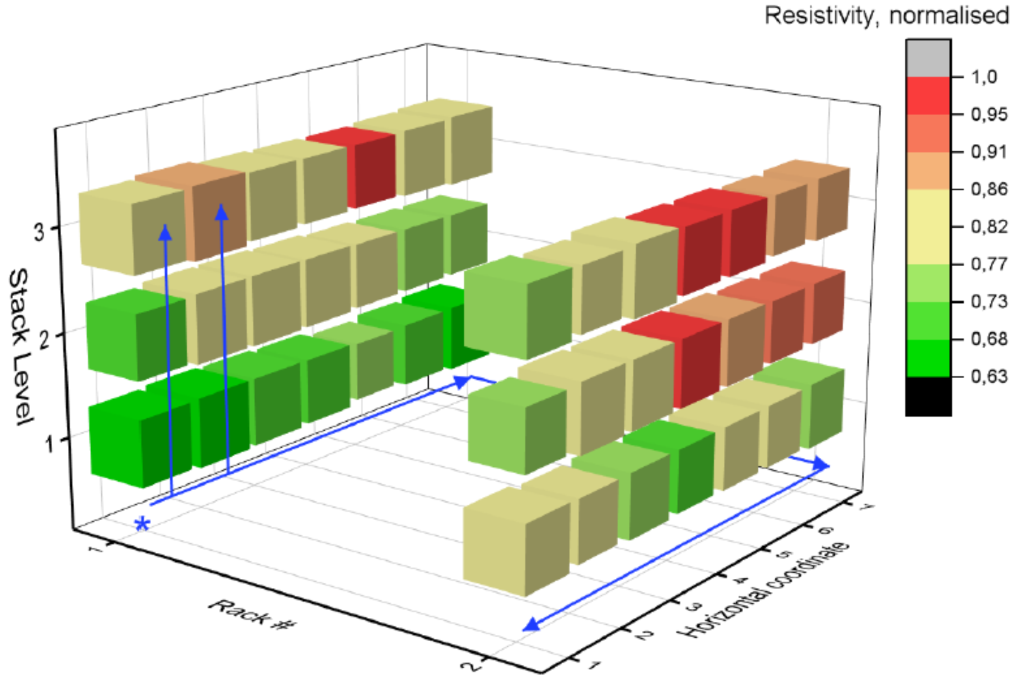
Introduction

"It thus can be appreciated that designing a flow battery to maximize system energy efficiency is a somewhat complex process (...)"

Final Report of the NASA Redox Storage System Development Project, 1984

What are the challenges?

- Homogeneous distribution of electrolyte → different flow behaviour in cell vs. stack
- Choosing the right materials, components
- Finding suitable power electronics
- ...



HIGREEW INNOVATIONS & EXPECTED TARGETS

HIGREEW Prototype: Specifications

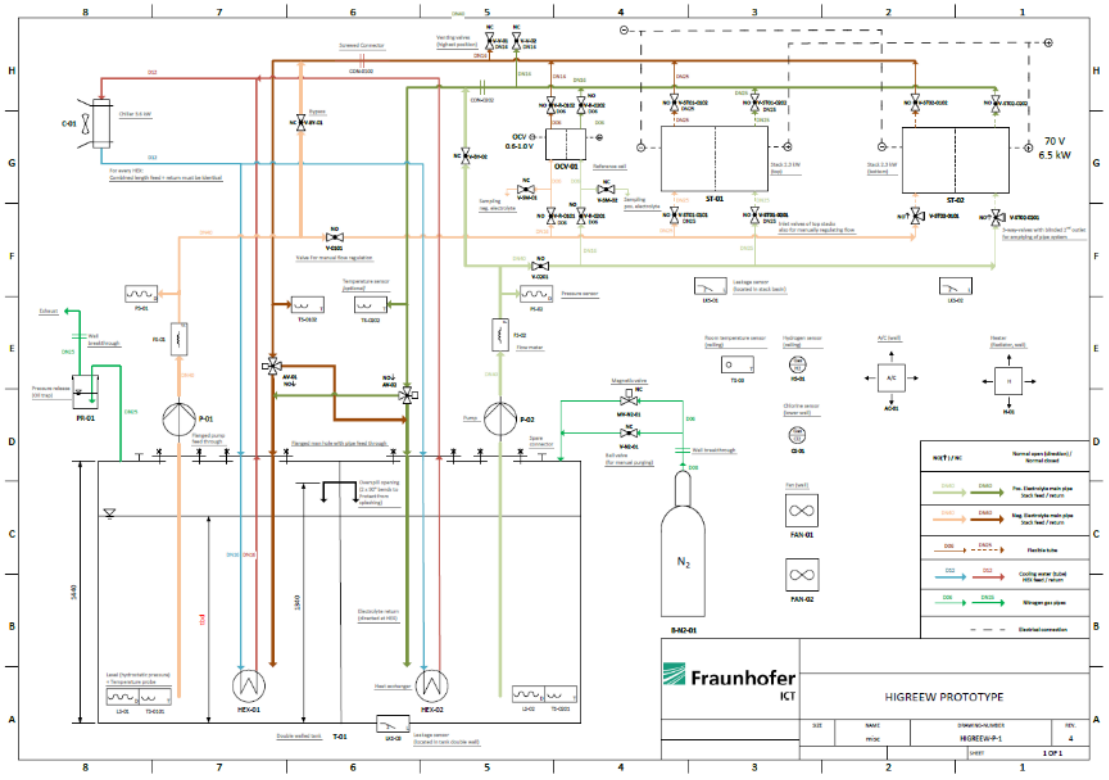
On-site requirement:	10-ft-container
Rated power:	**5 kW**
Rated energy:	**20 kWh (4h)**
Efficiency:	**80 %**

CURRENT RESULTS

Balance of Plant (BoP)

Prototype design

- Stack configuration ✔
- Piping design ✔
- Component selection ✔
- Prototype design freeze ✔
- Prototype construction

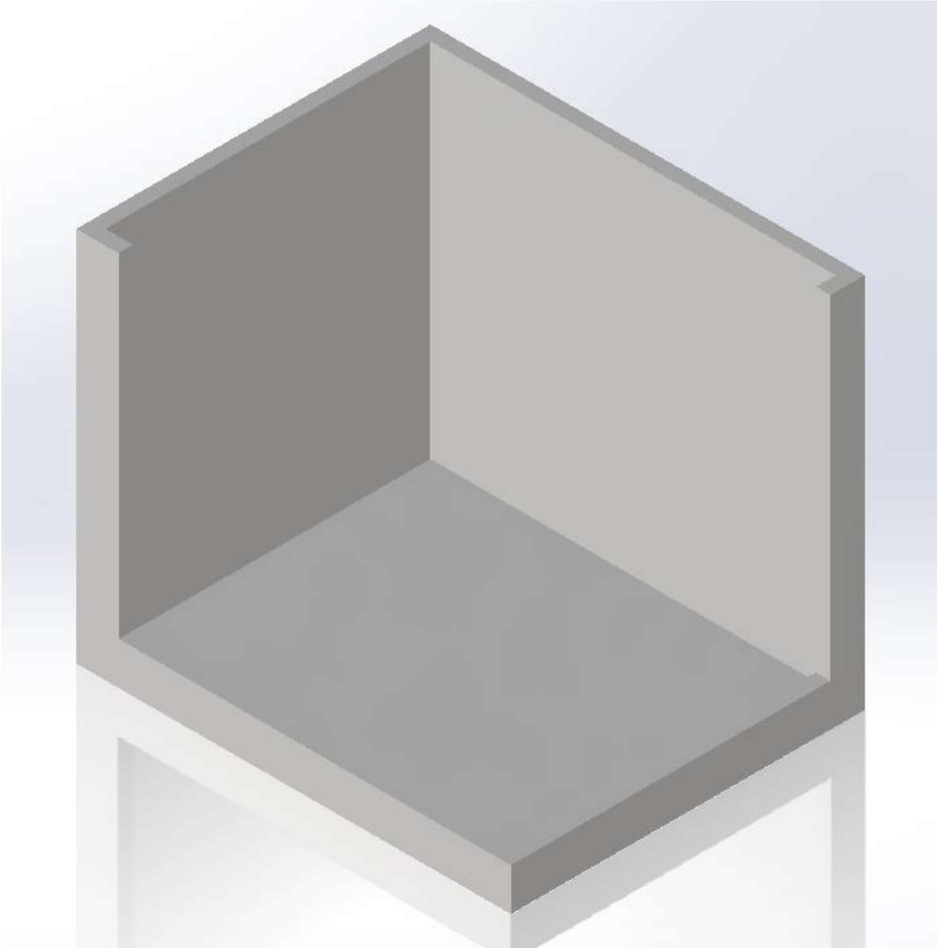


HIGREEW Prototype: Container

Container features:

- 10-ft ISO container: 2.8 x 2.4 x 2.4 m
- Thermal insulation
- Wall ventilators for air exchange
- Electrical installations
- **Sensors** for:
  - Temperature
  - Gases

https://caru-tech.com/

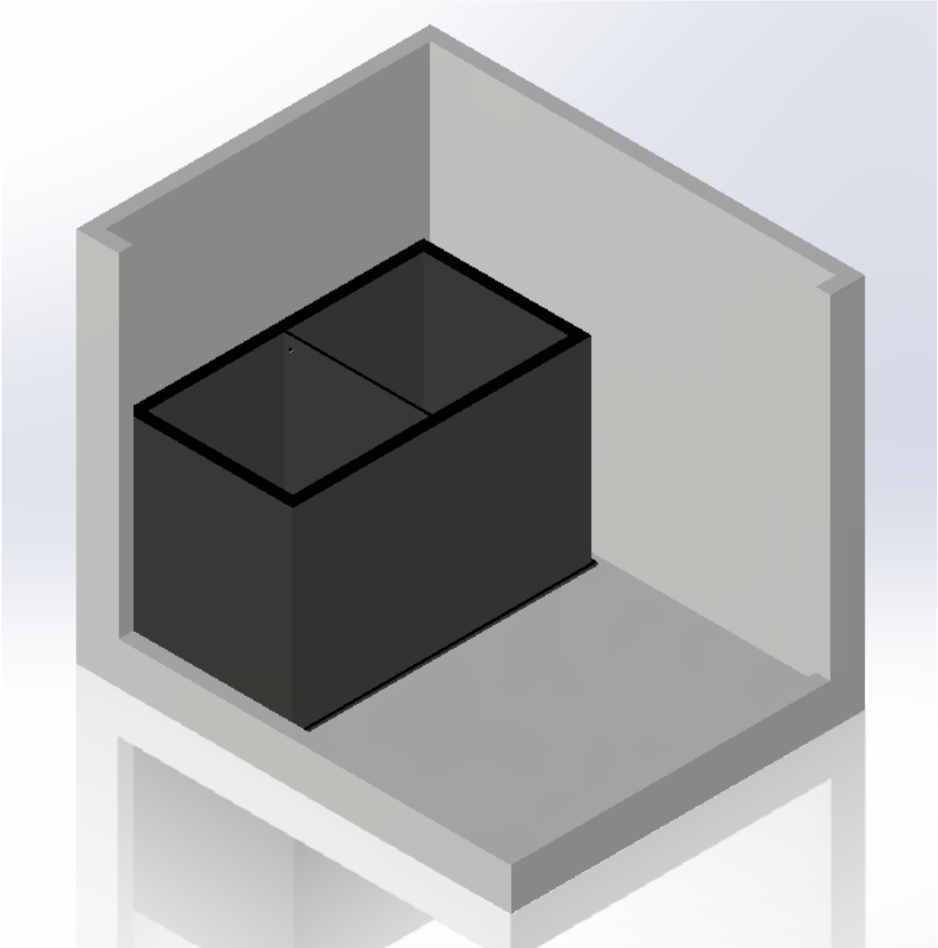


HIGREEW Prototype: Tank(s)

ENERGY

Rectangular tanks due to limited space:

- Made from PE or PP
- Double walls to comply with safety regulations
- Space for thermal management
- **Sensors** for:
  - Filling level
  - Temperature
  - Leakage detection (double wall)

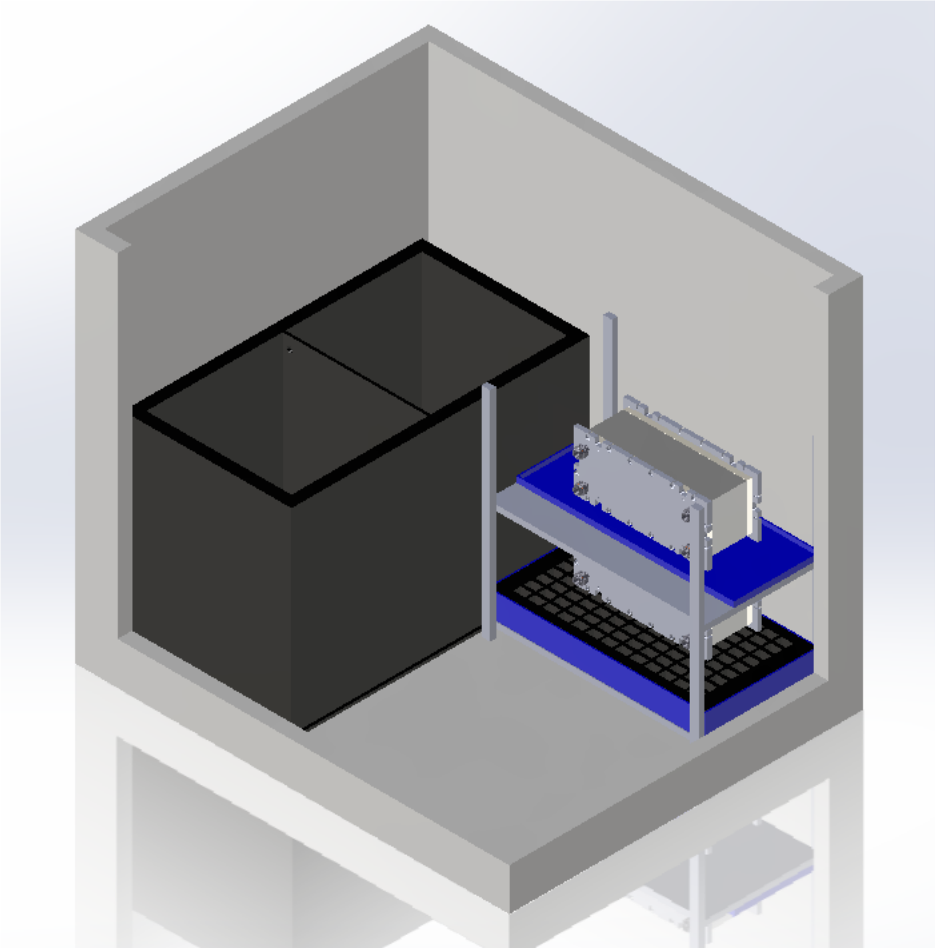


HIGREEW Prototype: Stacks

POWER

2 AORFB Stacks

- Power (each): ca. 2.5 kW
- With active materials as specified by project partners of WP2
- Located in plastic basins to protect from spillage
- **Sensors** for:
  - Leakage detection



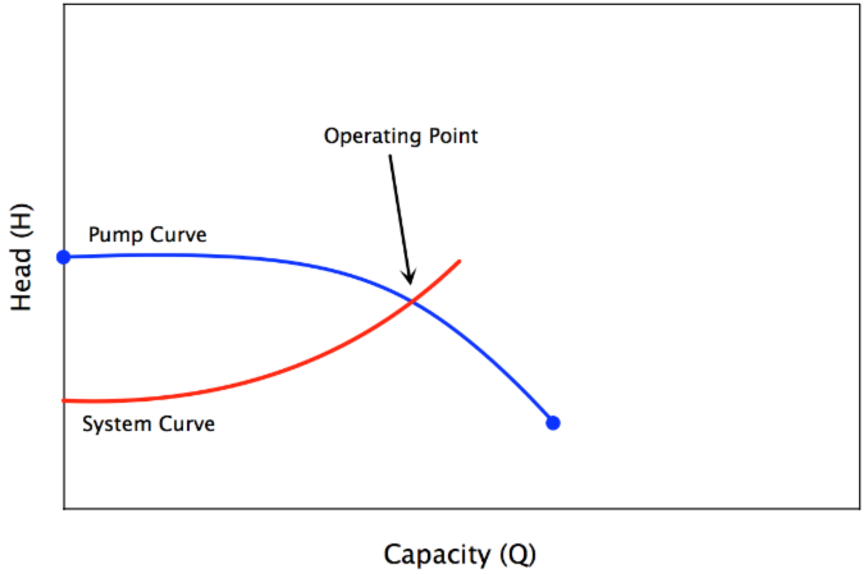
HIGREEW Prototype: Pumps

Required flow rate $\dot{V}$ (Faraday's law)

$$\dot{V} = \lambda \frac{I}{z\,F\,c\,(1 - SOC)}$$

Total pressure loss Δp in piping system

$$\Delta p = \underbrace{\frac{\rho}{2}(u_1^2 - u_0^2)}_{\textit{Dynamic loss}} + \underbrace{\rho g (h_1 - h_0)}_{\textit{Hydrostatic loss}} + \frac{\rho u_m^2}{2}\left(\underbrace{\lambda_R \frac{L}{d_i}}_{\textit{Pipe friction}} + \underbrace{\sum_j \zeta_j}_{\textit{Fittings, valves, etc.}}\right)$$



https://commons.wikimedia.org/wiki/File:Pump_curve_and_system_curve.png

4 HIGREEW Prototype: Pumps

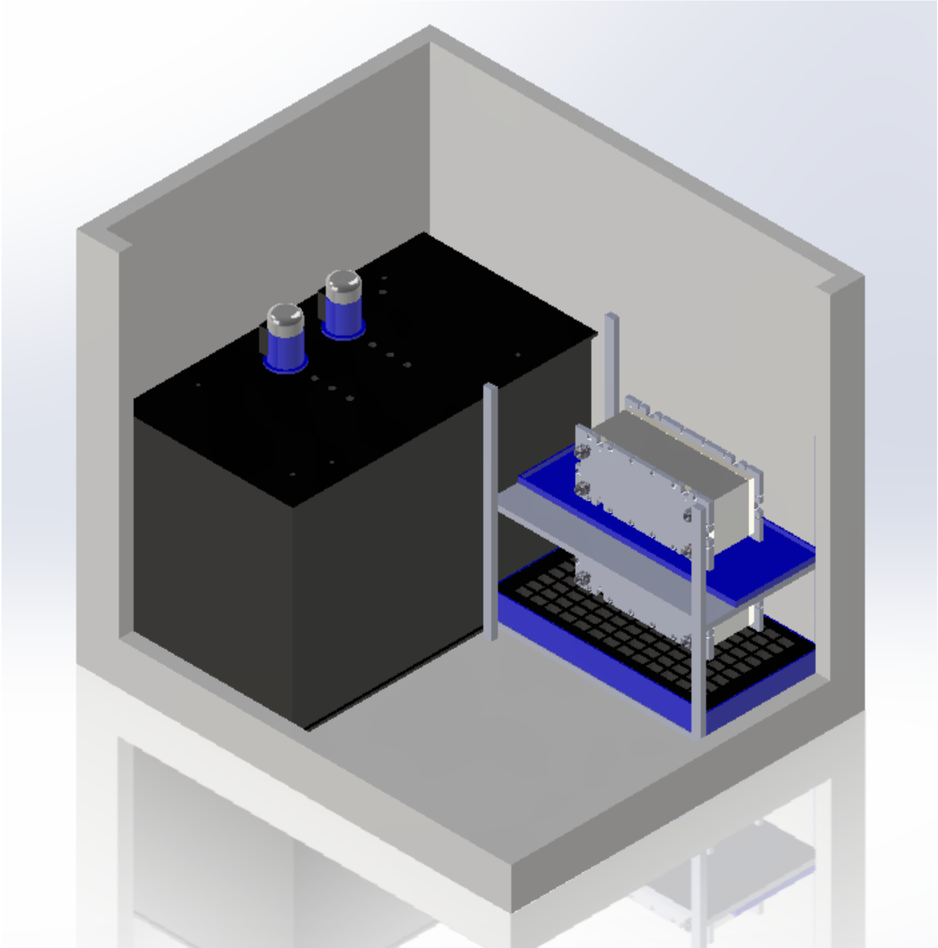
2 vertical centrifugal pumps

- Positioned on top of tanks

Desired for RFB:

- High efficiency
- Designed for continuous operation
  → material compatibility

https://renner-pumpen.de



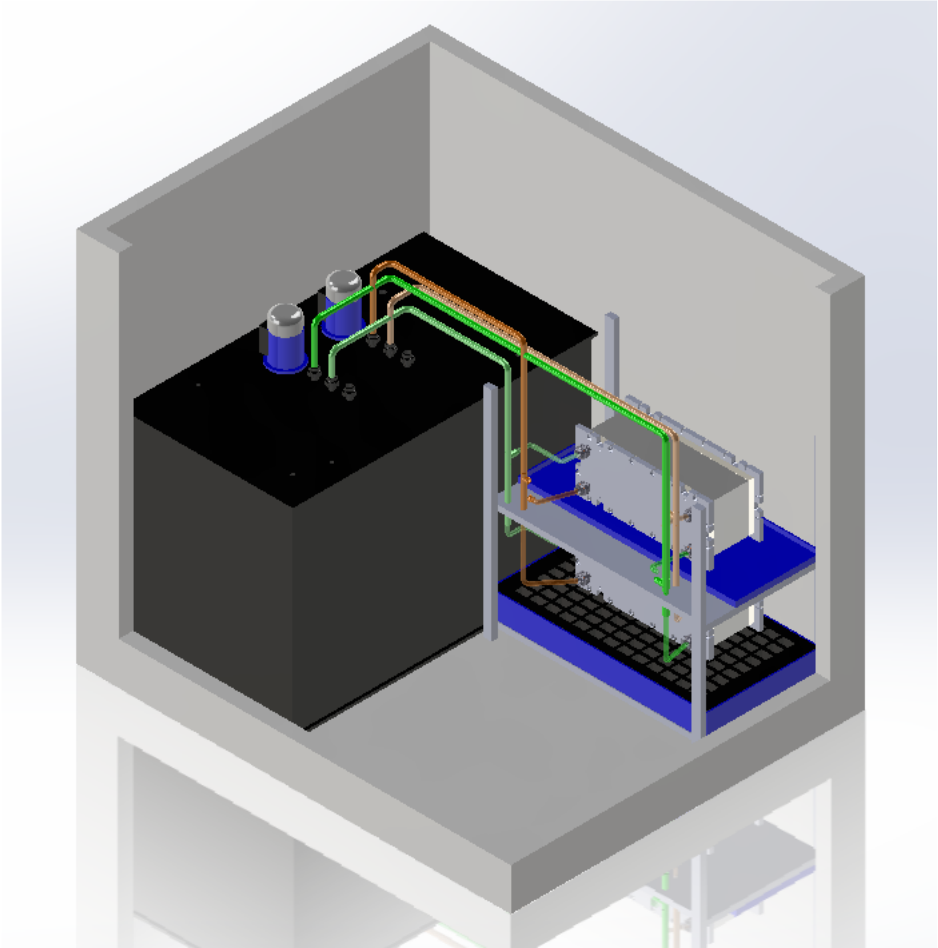
HIGREEW Prototype: Piping system

Piping system:

- Pipe material: PVC

Compatibility testing

- Stacks connected with flexible tubes
- **Sensors** for:
  - Pressure
  - Flow rate
  - Temperature



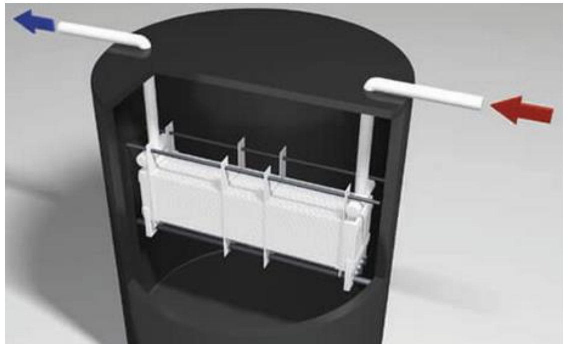
HIGREEW Prototype: Cooling system

Reaction heat flow (approximation)

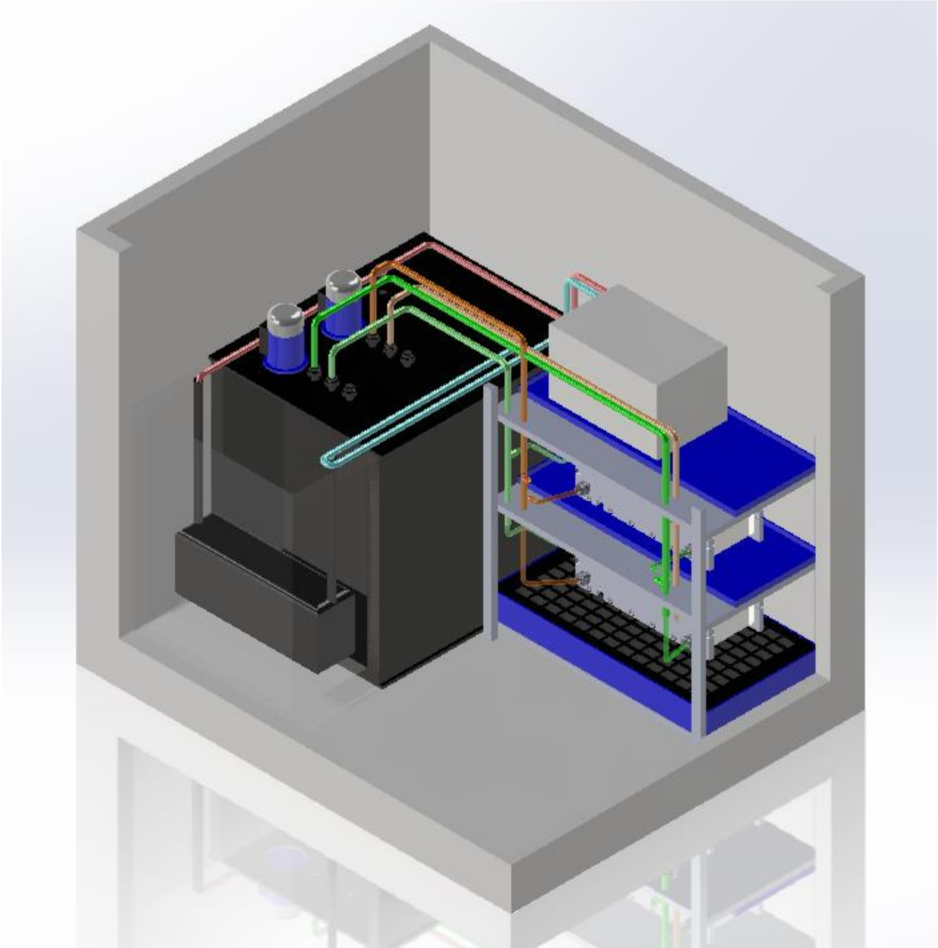
$$\dot{Q} = \frac{P}{U}(OCV - U)$$

Cooling system

- Recirculating chiller: water as cooling medium
- Submersible plastic heat exchangers



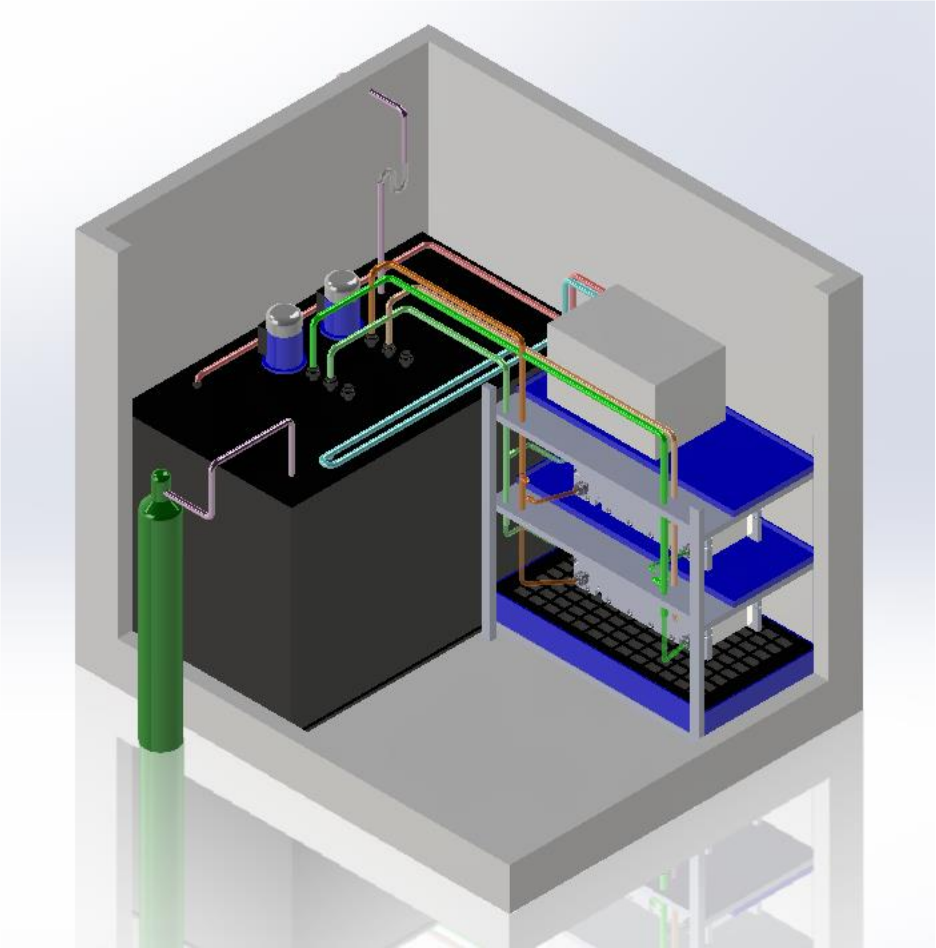
https://www.calorplast-waermetechnik.de



HIGREEW Prototype: Tank blanketing

Inert gas blanketing

- for protection of electrolyte solutions from air
- Nitrogen (or other inert gas) bottle outside of container
- Tank blanketing system



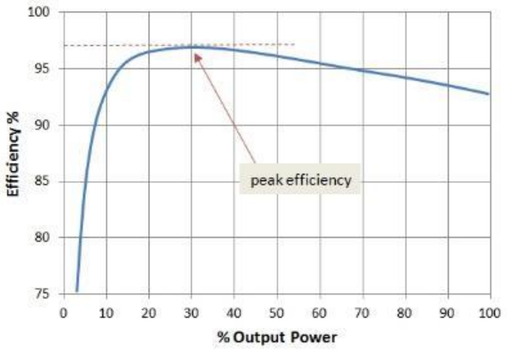
HIGREEW Prototype: (Power) Electronics

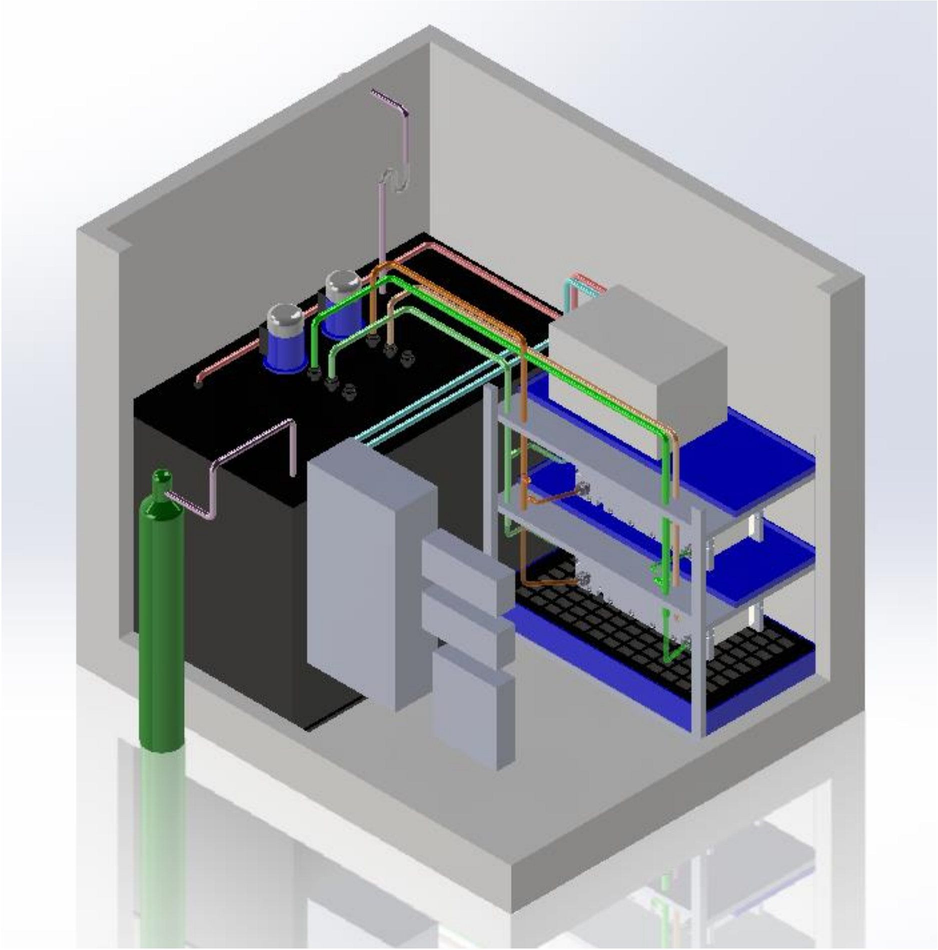
Electrical installations

- Electrical cabinet
  - Power supply for electrical components
  - Control system (BMS)
- Electrical appliances (Lighting, etc.)

PCS: AC/DC converter

- Challenges when selecting PCS for RFB:
  - Wide voltage range
  - Typically low voltage, high current





https://www.e-education.psu.edu/eme812/node/738

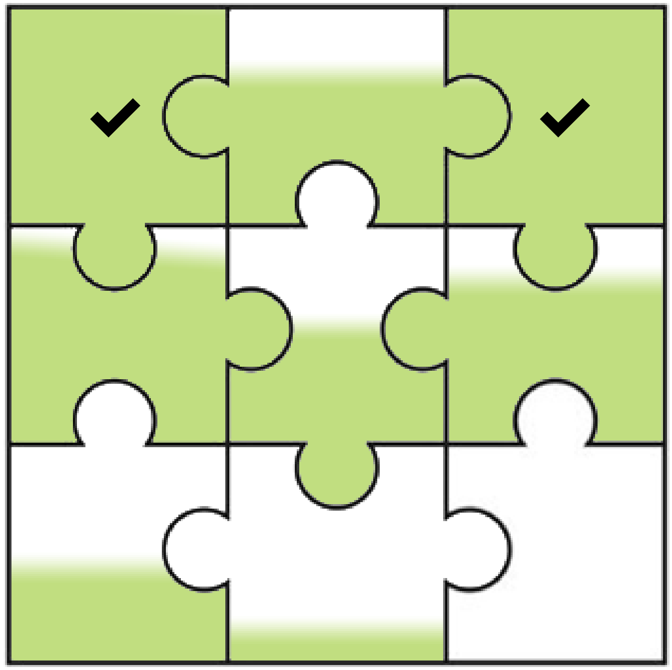
NEXT STEPS

HIGREEW Prototype: The next 6 months

1. Procurement of components:
- Container
- Stacks
- Tanks and piping system
- Sensors and other instrumentation

2. Construction of Prototype

3. Commissioning and testing
- Early system tests
- Performance testing and characterization



Thank you!

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