

Hydrogen in Bachimaña











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Basic info of the hut







- Hot water, bar service, nursing, heating, lockers, radio, telephone, webcams, heliport and weather data collection.
- ✓ Goods and fuel supplied by helicopter.

- ✓ Opened in 2012, 80 accommodations
- ✓ 2200 m of altitude
- ✓ Off-grid





SustainHuts

Existing elements & profile





Final Workshop – 05/10/2021



Configuration proposed







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Restrictions / boundaries

- > Budget (90,000€)
- Main elements should be prototypes (specifically for project, not available as serial product, ...)
- High altitude (2,200 m)
- ► No roads (helicopter)
- Many months to produce H2

Solution

- ▷ No compressor (for simplicity)
- Small production (0.25 Nm3/h = 0.5 kg/d) @ high pressure (50 bar)
- PEM technology (off-grid, easy maintenance)
- ▷ High efficient FC at any altitude
- The maximum storage allowed by budget



Electrolyser







Supplier: Hidrógena (Spain)

Specifications:

- PEM Technology
- Production 250Nl/h, purity 99.995%
- Pressure regulation from 0 to 50 bar.
- Local console for process control and monitoring of status
- Ethernet connection for data acquisition and remote operation
- Pressure and temperature sensors
- Water tank
- Automatic warning and alarm system



Storage alternatives





Limitations: weight carried by helicopter (800 kg), low footprint (public mountain), tough climate conditions



Carbon fiber rack of bottles

18 x 50 L @200 bar

Supplier: Calvera (Carbotainer), ES

Steel tank 1800 L @40 bar Supplier: Lapesa, ES



Type IV tank 2 x 850 L @60 bar Supplier: MAHYTEC, FR

Selected:

- cheap, low weight, customizable (horizontal), no modifications required if compressor is eventually installed
- 4 kg of H2 will be stored, enough for demo purposes









Supplier: Spectronik (Singapur) Type: PEM, closed cathode, air-cooled

Datasheet	
Rated Voltage	48V
Rated Power	1200W
Fuel cell Gross Power Capacity	1600W
Rated cell voltage @ 1200W	0.67V/cell
Start-up Time	<60s
Operating Ambient Temperature	-10 ~ 40 °C
Operating Altitude	3000m AGL
System Controls	Autonomous
Communication	V-Linx via Ethernet cable
System Dimension	730 X 320 mm (on Wall)
	640 X 320 X 360 mm (Protrusion from wall)
Clearance requirement from bottom	80cm
System Weight	25kg
Hydrogen purity	Dry, 99.999%
Required H2 flow-rate & pressure @ 1200W	20 SLPM @ 0.7Bar
Delivery Pressure Max.	0.81Bar (11.75psig)
Hydrogen inlet connection	1/4" NPT male
Hydrogen outlet connection	1/4" NPT male





DC-DC converter type	Non-isolated, half-brick, buck-boost
Input voltage	9-90V
Output voltage	0-90V user configurable, 26A max
Dimension	75 x 61 x 13mm
Weight	165g
Modularity	Can be paralleled in multiple modules with Current sharing











Fuel Cell Performance Graph (at sea level). Source: Spectronik

Stack voltaje and efficiency is affected by oxygen partial pressure

At high altitude (2200 m) the effect is not critical but **some gain in efficiency** can be achieved by increasing air mass flow

Prototype includes an <u>altitude dependent</u> <u>oxidant blower control</u>: to combat less oxygen partial pressure in higher altitude, a sensor is installed in the fuel cell to adjust the oxidant blower accordingly to push more air into the fuel cell.



Challenges





- ☑ COVID-19 affected severely the planned deadlines (components installed in Nov'20 instead in May'20)
- ☑ Hut inaccessible in winter due to snow and bad weather
- Amount of helicopter is scarce, its **availability** is very dependent on weather and other factors
- ☑ Disturbances in the electrical micro-grid are stronger than observed at the beginning
- Remote connection extremely difficult





Installation





- Electrolyser and Fuel Cell in the basement (forced ventilation), storage outside the building
- ☑ H2 was produced in November '20 and is stored until June '21
- ☑ Malfunction of the stack of electrolyser -> repairment, but opportunity to install improvements (timer, less insulation, better ventilation)
- Fuel Cell did not work properly during initial operations: revision & adjustment in FHa installations.
- ☑ Currently all the system is installed and being tested:
 - \blacksquare Electrolyser is robust and safe.
 - ☑ Control system monitors any leakage of H2 & stops
 - ☑ Fuel Cell works but does not offer yet the performance expected.





Installation







Safe venting

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Installation







Fuel Cell & Control System

Voltage protection device

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Summary & Conclusions









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