



SMARTENERGY

Integrating Hydrogen into Mining Microgrids

Christian Pho Duc, Smartenergy, Managing Director H₂ Projects

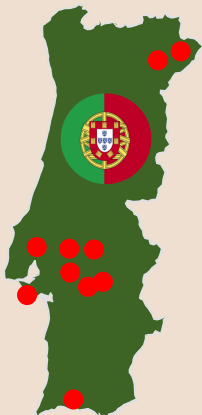
Hydrogen and Mines Virtual Summit

6-7 October 2020

Who we are

Smartenergy is a private investment firm committed to sustainable investments into renewable energy & related innovation ventures

We are expanding our project portfolio from pure RES (PV and wind) to integrated RES and green H₂ projects – much like the journey of microgrids in mining



>1GWp PV project pipeline in Portugal

4 green H₂ projects selected by government under IPCEI












Why we are here today

We see significant potential in integrating green H₂ into microgrids in mining

We would like to share a number of key learnings from our experience with green H₂ projects in Europe, which are relevant for the mining context as well

01 4 lead projects, from which 2 are off-grid Similar setting compared to off-grid remote mining sites

	Project 1	Project 2	Project 3	Project 4
 Photovoltaics	150 MWp (DC)	50 MWp	72 MWp	63.5 / 143.5 ³⁾ MWp
 Power grid connection	no (off-grid)	no (off-grid)	yes (on-grid)	yes (on-grid)
 Electrolyser	100 MW	30 MW	20 / 40 ¹⁾ MW	60 MW
 Annual H ₂ output	ca. 4260 t	ca. 1600 t	ca. 5,000 t ²⁾	ca. 3750 / 6260 t ⁴⁾
Primary use of Green Hydrogen	 Gas grid injection	 Gas grid injection	 Mobility	 Industry  Gas grid injection

1) Ability to import electricity (mainly at night) would be required; 2) Total output, incl. expansion option; 3) 80 MWp PV expansion planned, if electrolyser is built; 4) Without / with import of electricity from the grid during night hours

What we can learn from our projects

Key parameters to optimize to achieve efficient load factor

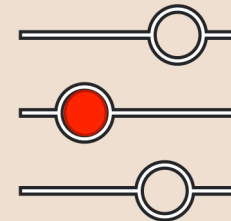
02



High utilization of electrolyzer is key to achieve somewhat economical H_2 production costs



Stable RES production over time (combination of PV and wind can achieve this)



Optimized sizing of electrolyzer (capacity) relative to RES capacity

03

What this means for H₂ in microgrids in mining: Holistic, integrated micro-grid planning and optimization needed

1. Use cases in mining sites:

- H₂ as fuel for heavy duty vehicles
- H₂ as means of energy storage for reconversion to power via stationary fuel cells



2. Optimization logic

RES profile:

Local generation profile from PV and wind?

H₂ as vehicle fuel:

H₂ quantity needed for heavy duty vehicles?

H₂ as energy storage:

H₂ quantity needed for power reconversion during low RES-production?

Optimization

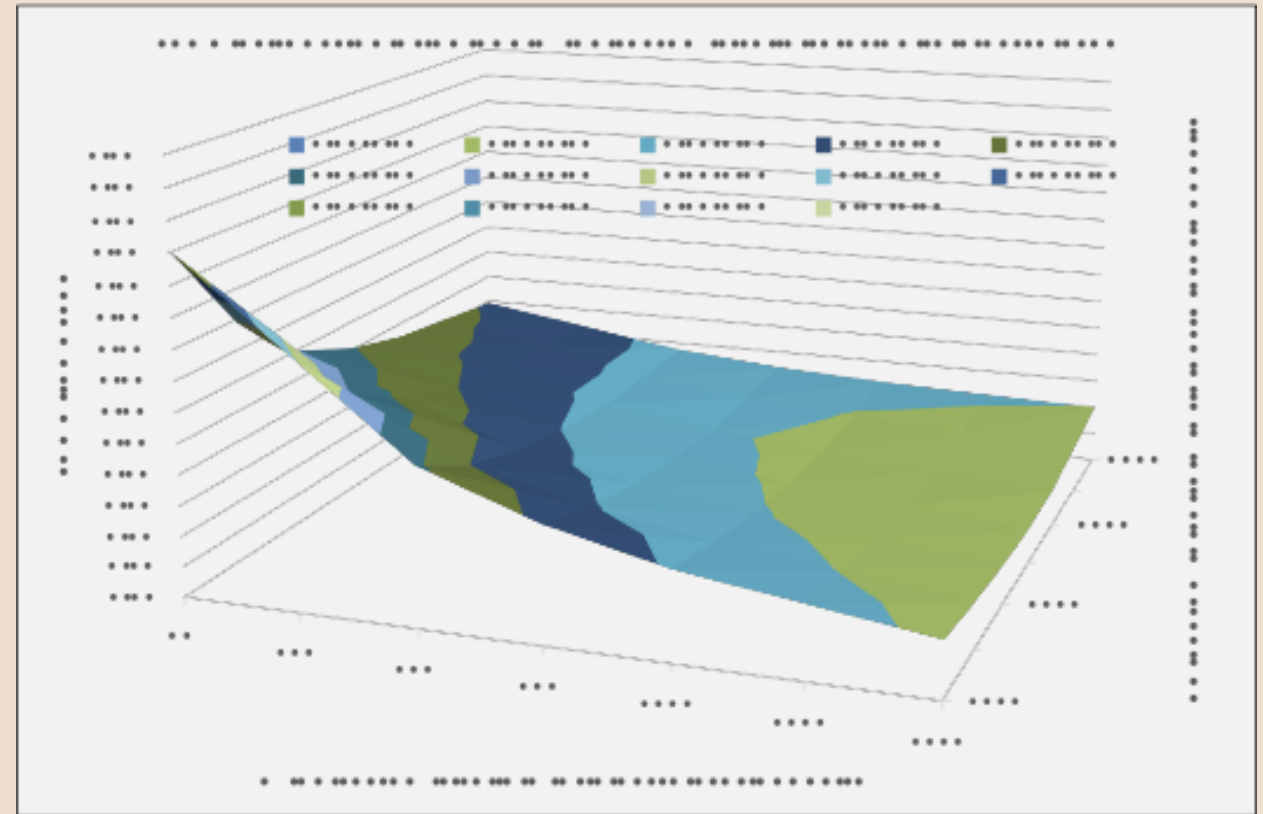
How to size RES and electrolyzer capacity to cover energy needs of the mining site most economically?

To feed a micro grid efficiently:
multi parameter optimisation to achieve lowest
LCOH in combination with loading factor is key

04

Important simulation criteria in our models:

- LCOE (with relevant parameters)
- EL Capex & Opex
- EL Loading Factor
- Sizing optimum of PV, EL
- Adding Wind (and sizing)
- Battery Storage
- Load requirements
- H2 buffer / storage / transport / logistics (depending on offtake model)



Example optimization analysis PV / Wind / EL sizing on idealized project in Southern Europe (with some mid-term assumptions of inputs parameters). **Source: Smartenergy**



Thank you!

Christian Pho Duc
Managing Director H₂ Projects

c.phoduc@smartenergy.net

Smartenergy Invest AG
Sihleggstrasse 17
8832 Wollerau SZ
Switzerland

smartenergy.net