



2023

# KOREA EUREKA Day

Meet with SPAIN

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SOEC Technology, KERIONICS



## CONTENTS

**1** KERIONICS

**2** Products & technologies

**3** Challenges

**4** Ideas for a Korea – Spain  
collaboration

**KERIONICS is dedicated to the development of solutions and products aligned with the **industrial challenges** posed by the zero-energy impact economy (Green Hydrogen, Decarbonization, Energy Storage, Renewable generation, Electrification)**

**Our mission is the development, manufacturing and commercialization of the **core components for high temperature electrolyzers****

## 1. KERIONICS

**KERIONICS** was born for the commercial exploitation of the patented R&D solutions developed by the **Institute of Chemical Technology (ITQ)** a joint research centre of the Spanish National Research Council (CSIC) and the Polytechnic University of Valencia (UPV).

The ITQ is a highly regarded institute (among the top 3 in Europe) with a staff of 360 employees engaged in multiple R&D projects. The institute is a leading reference worldwide in new materials (ceramic technology) and industrial catalysis.



INSTITUTO DE  
TECNOLOGÍA  
QUÍMICA



UNIVERSITAT  
POLITÀCNICA  
DE VALÈNCIA



**CSIC**

CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS



## 2. PRODUCTS & TECHNOLOGIES - SOEC ADVANTAGES OVER ALKALINE AND PEM

**High-temperature electrolysis (SOEL) is a technology that enables achieving the highest efficiency values (80-90%)**

**It generates the largest amount of H<sub>2</sub> for each kWh of electricity consumed.**

**The incorporation of SOEL technology in the industry enables the utilization of waste heat to generate H<sub>2</sub> with efficiencies almost reaching 90%, thereby diminishing the ultimate cost of H<sub>2</sub> (\$/kg H<sub>2</sub>) through decreased electricity consumption (Opex) and plant expenses (Capex)**

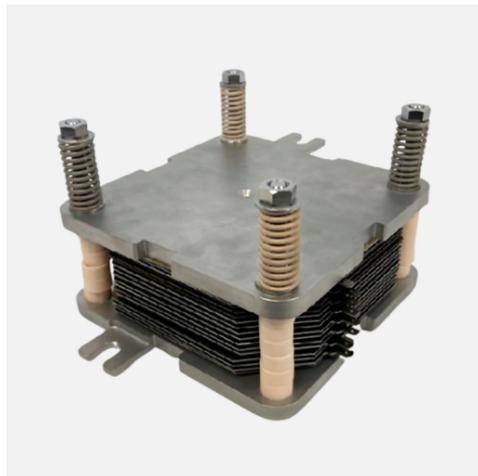
## 2. PRODUCTS & TECHNOLOGIES - PRODUCT LINES

### MEA



Membrane electrode assembly:  
Advanced ceramic component  
to be integrated in the stacks for  
O<sub>2</sub> and/or H<sub>2</sub> generation.

### STACK



Stack: Main component for the  
High Temperature Electrolyser  
(SOEL)  
Product lines: 5 cells, 20 cells and  
40 cells

### ELECTROLYSER

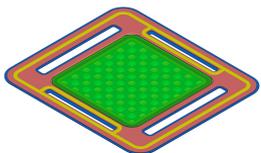


High temperature

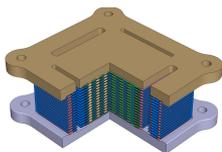
Product lines: electrolyzer Testing  
and demo edition

## 2. PRODUCTS & TECHNOLOGIES - IP COMPETITIVE EDGE

### SRU SOEL



### STACK SOEL



1. **Air electrode - Improved efficiency at intermediate temperatures**
  - Best performance for energy production
  - Best performance for heat production
2. **Catalyst systems - Improved oxygen permeability and best performance in adverse conditions**
  - Oxycombustion
  - Acid environments
  - CO<sub>2</sub>
3. **Industrial facility process - Revalue industrial waste for the generation of two gases**
  - Improve the performance (permeate flow) of incomplete combustion and revalue waste streams from a plant and transform them into products with greater added value.
4. **MEA's breakthrough manufacturing process - New manufacturing process**
  - High accuracy
  - Thickness reduction
  - Reduction of the scrap parts
  - Applicable to any support shape
5. **System Capex reduction - Improved configuration of the interconnectors**
  - Reduction of the manufacturing costs of the stacks
  - Reduction of the CAPEX investment
  - Reduction of the scrap parts

## 2. PRODUCTS & TECHNOLOGIES - MATURITY LEVEL (TRL)

2016

2017

2018

2019

2020

2021



IP transfer to KERIONICS 3x

Manufacturing O2 MEAs

Raw materials in TRL9

MEA O2 TRL8

IP additive process for MEA

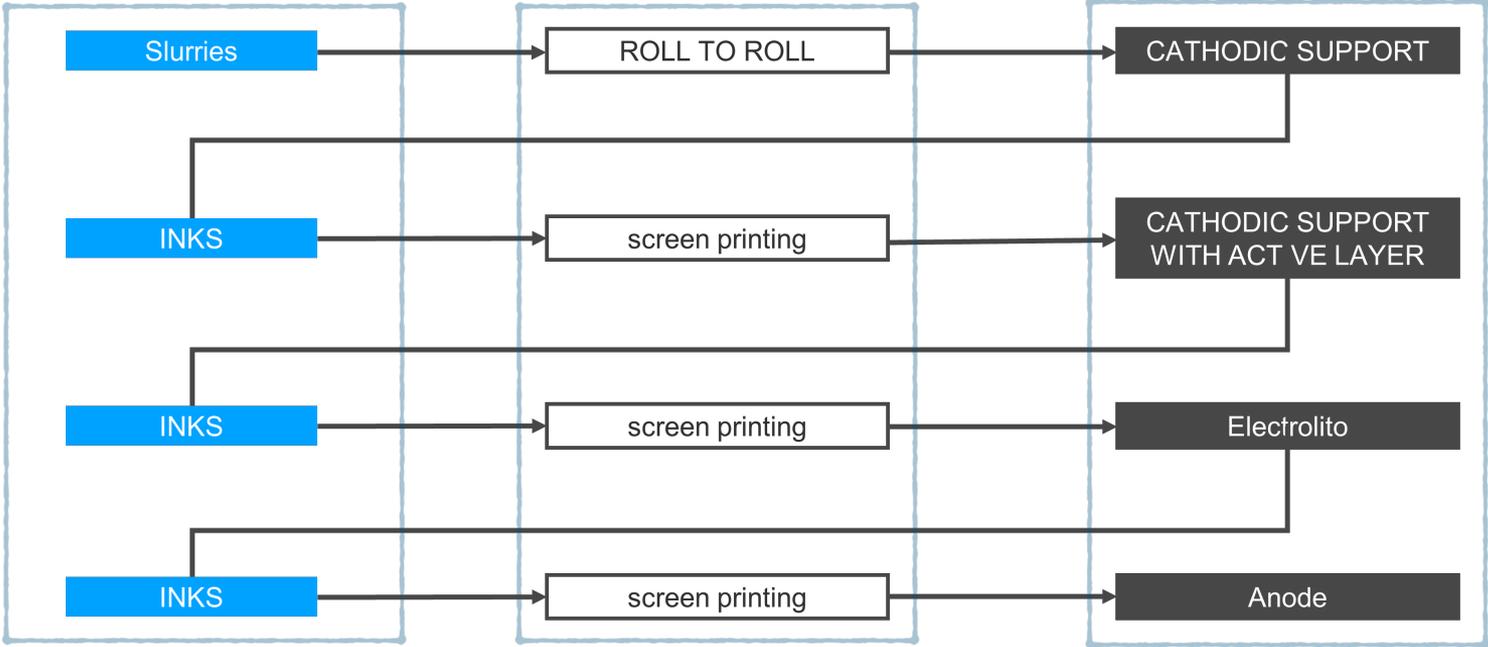
Team and strategy restructuring

Trademark registration

- ▶ In Q1 2021 change of strategic direction and focus on the H2 generation market
- ▶ 2022 Development of a functional Stack prototype
- ▶ 2023 Green hydrogen generation with proprietary tech and prototype sells
- ▶ 2024 PRE COMMERCIAL SELL

**CSIC:** The Spanish National Research Council. **MEA:** Membrane electrode Assembly. These are advanced or functional ceramics that are mounted on an O2 and/or H2 generation stack/module. **TRL:** Technology Maturity Index **IP:** Intellectual Property **TRL4:** technology validated in lab **CURRENT TRL STATUS (OCT 2023):** TRL 5 – 6 technology **validated** in relevant environment (industrially relevant environment in the case of key enabling technologies - **EX-situ Bop**)

### 3. CHALLENGES - MEA



RAW MATERIALS DEVELOPMENT

PROCESSES SCALE UP

PRODUCTS

## 3. CHALLENGES - STACK

### 1. Operation modes requirements

- SOFC, SOEC, Co-Electrolysis, Oxygen ionic Membrane Reformer (OMR), Oxygen ionic Membrane Syngas (OMS)

### 2. Stack manufacturing automation for scale up:

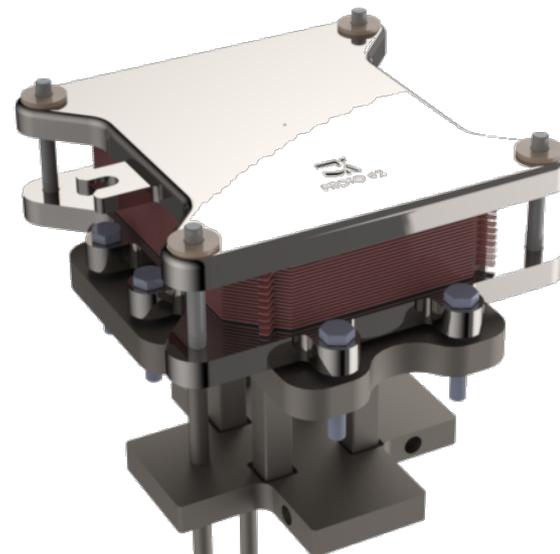
- Components assembly
- Sealing application
- Stack closing

### 3. Quality checks & Assurance:

- Stamped parts with tolerance  $\pm 0,1$
- in line leakage test
- in line welding test

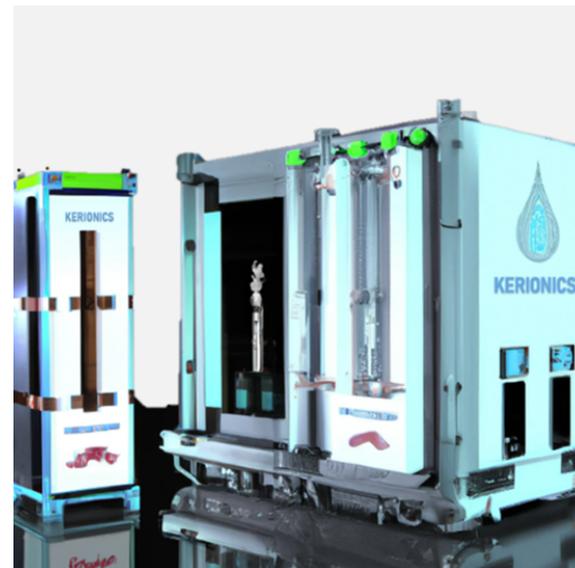
### 4. Life cycle = Degradation of materials:

- Coatings & Thin films
- High temperatura materials (steel)



### 3. CHALLENGES - Bop / Electrolyzer

1. **Power electronics design, development and supply:**
  - AC/DC inverter
  - System ctrl and monitoring
2. **Software design, development and supply:**
  - HMI layer
  - Data acquisition
  - System Ctrl
  - IA layer for preventive maintenance
3. **Environmental health and safety:**
  - Leakage gas detection
  - Thermal risks
  - Electrical
4. **Hardware supply:**
  - Piping, valves
5. **Design, development and supply of: Thermal recovering and integration solutions + Compression and Storage solutions**



### 3. CHALLENGES - Collaborative projects supported by CDTI

Project name	Technological area	Challenges
<b>Almagreen</b>	Operation modes requirements	<ul style="list-style-type: none"> <li>Characterization of the SOC stack in different operating modes (reformer mode, partial oxidation and oxyfuel combustion)</li> </ul>
<b>Neosolar</b>	Life cycle, Degradation of materials	<ul style="list-style-type: none"> <li>Optimization of operating conditions in electrolyzer and fuel cell (reversible mode)</li> </ul>
<b>Photohy</b>	Design, development and integration solutions	<ul style="list-style-type: none"> <li>Conceptual integration with photoreactor to maximize energy efficiency</li> </ul>
<b>Hy2dec</b>	Raw material development	<ul style="list-style-type: none"> <li>Protonic Ceramic Electrolyser Cell (PCEC) material development</li> <li>R&amp;D of novel Current Collectors</li> <li>Design of proton cells optimized at temperatures of 600°C</li> </ul>

### 3. CHALLENGES - PRE COMMERCIAL SELLS

# Building complete value chains around investment

## 4. IDEAS FOR A KOREA - NOVEL AND INVENTIVE IDEAS

Within the **system** and/or **component level** scope for the Mea, Stack and Bop:

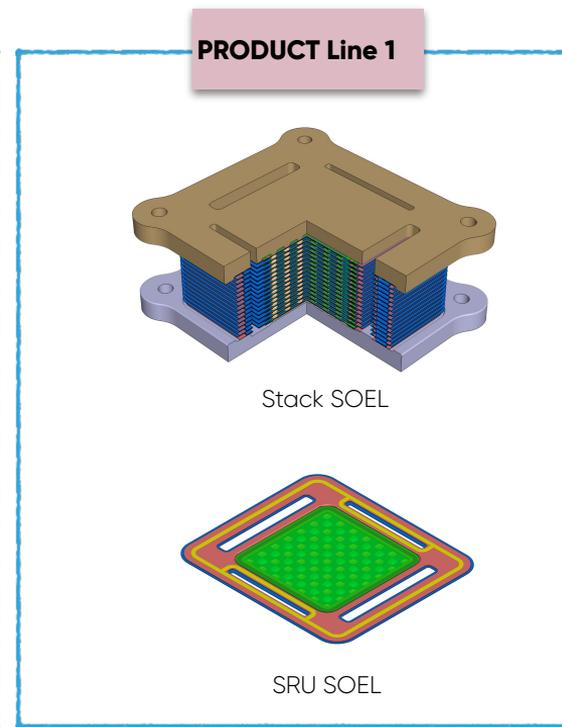
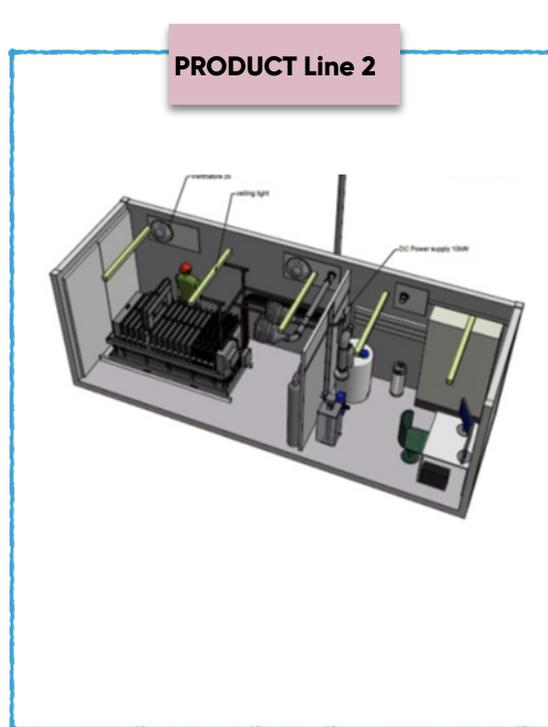
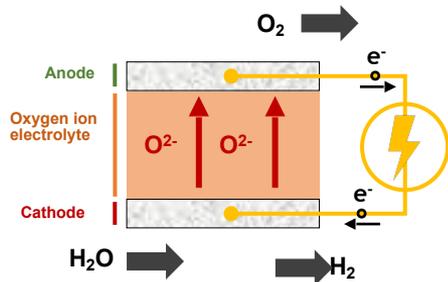
- Partner to **Co-develop**
- Partner to **outsource development**
- Partner to **outsource validation processes** of a given internal program (Standard test procedures)
- Partner to deliver **prototypes** and **demonstrators**
- Partner to **scale-up concepts** and **deliver pre-series**

**Technology areas** of Solid Oxide Cells (**SOC**) and protonic ceramic electrochemical cell (**PCEC**)

## 4. IDEAS FOR A KOREA - END USER AND SCALE UP PARTNER

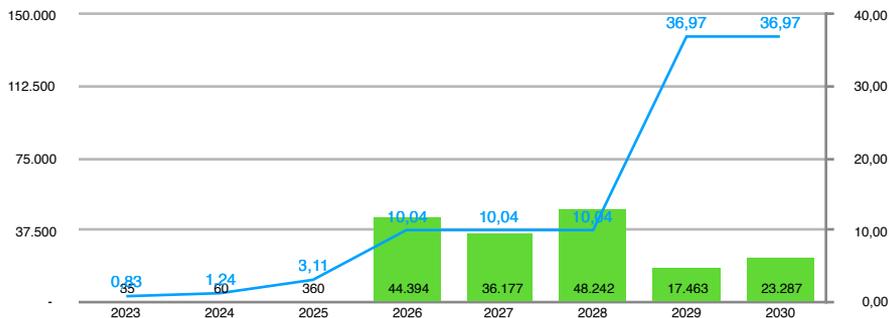
TIME LINE	2022	2023	2024	2025	2026	2027
PRODUCT PHASES	PH AD	PH INNOVATION		PH SERIES DEV	P-RELEASE	
PROCESS PHASES		PH ED Factory	PH Build Factory	PH SOP Factory		
PRODUCTION PHASES				PRE	HALF	FULL

### Electrolysis (EL)

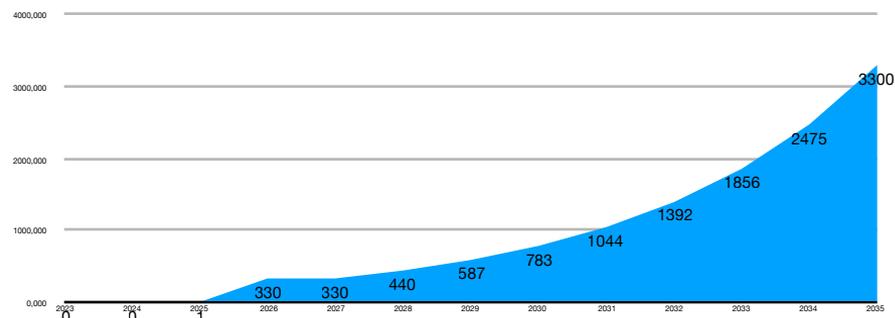


## 4. IDEAS FOR A KOREA - END USER AND SCALE UP PARTNER

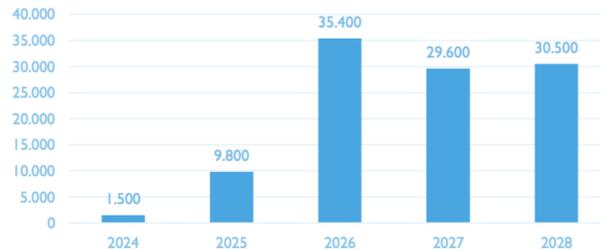
Stack power evolution (KW)



Total electrolysis power (MW/año) BP v7



Annual investment (2023-2030) (thousand €)



## 4. IDEAS FOR A KOREA - END USER AND SCALE UP PARTNER

**KERIONICS** has identified a potential global market for hydrogen production that it intends to exploit by selling equipment (stacks and SOEL electrolyzers) that can be integrated into industries with difficult decarbonization processes.

The demand for hydrogen is progressively rising in novel applications. The aim stated in the company's Business Plan involves:

A. **Identification and structuring of alliances in product and process development** (Membranes, Stack & Electrolyser) (SOEC: Solid Oxide Electrolytic Cells & PCEC: Protonic Ceramic Electrolytic Cells) to serve the markets, thus guaranteeing:

- Timelines (Accelerate the development and delivery of strategic equipment),
- Operations (Reliability),
- Taking advantage of market timing,
- CULTURE and VALUES alignment

B. **Co-exploitation:** The exploration of these collaborations in the development of products and processes involves not only the aforementioned joint development but also the possibility of commercial co-exploitation of the outcomes.

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## Thank you!