



XARXA d'R+D+I
ENERGY FOR SOCIETY

**PRODUCTS
SOLUTIONS
SERVICES**



CATALOGUE



Current energy challenges require innovative solutions.

The Energy for Society Research, Development and innovation Network (XRE4S) is an ecosystem that groups the expertise of researchers in Catalonia working in the energy field. It gathers 35 groups from 14 universities and research and technological centers, involving more than 500 researchers. It aims to transform research knowledge into solutions to improve the quality of life of the society.

The technological solutions, products and services by the XRE4S are summarized in this catalogue. It offers licensing and commercialization opportunities for companies, creates a basis for common projects to boost valorisation and tech transfer and welcomes investors who can support technology development and proof of concepts, or investments in spin offs.

MEMBERS OF THE NETWORK





XARXA d'R+D+I
ENERGY FOR SOCIETY

TECHNOLOGIES

- Selective deposition of thin films on microdevices (CNM-IMB-CSIC)
- Polymers made from carbon dioxide and biomass (ICIQ)
- Electroanodes for hydrogen production (ICIQ)
- Organic semiconductor type n by UV-VIS irradiation (ICMAB-CSIC)
- CASE- the demand aggregator (IREC)
- Micro-oxygen sensor (IREC)
- Versatile and resilient power converter (IREC)
- Manufacture of catalysts for synthetic gas production (IREC)
- Flexible heating and cooling solutions (IREC)
- Building reduced energy models (IREC)
- Nanostructured flexible fabrics for thermoelectrics (IREC)
- Smart Energy Management Solution - SEMS (IREC)
- Data driven methods to provide enhanced energy services (UdG)
- Membrane housing device for sustainable water treatments (UdG)
- Electro-bioremediation (UdG)
- A dynamic thermal system for minimizing energy demands in buildings (UdL)
- Production or commercialization of bio-based PCMs (UdL)

TECHNOLOGY BY:

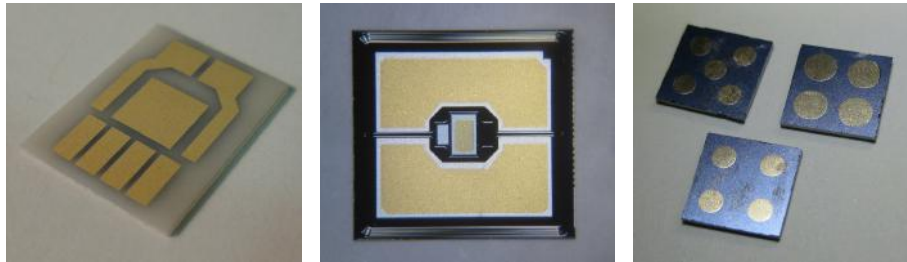


CHALLENGE

Selective deposition of materials on microelectronic devices

APPLICATIONS

Microelectronics
Deposition of metals
Thin films



DESCRIPTION

A new **shadow-masking method** based on a set of **self-aligned metallic masks** allows the **selective metallization of microelectronic substrates and devices** for the implementation of tracks and pads. It is based on a set of masks that doesn't need photolithographic process or complex alignments. These are self-aligned by rods matching with corresponding orifices, defining the deposition patterns. A frame on the top allows fixing the masks and the substrates.

This technique can be used, for example, to: remetalize the Al pads of power devices allowing their topside brazing or chip-embedding techniques, define pads and tracks in ceramic substrates or define contacts in piezo substrates.

NOVELTY

- Avoids photolithographic or chemical processes
- Cheap and fast method
- Easy to implement
- Provides a good resolution (tens of microns)

FURTHER DEVELOPMENT

This technological process is completely developed and can be used with standard deposition equipment.

DESIRED PARTNERS

Industrial partners mainly working on deposition of metals, and thin layers in general, for the implementation and exploitation of this technology.

CURRENT TRL

>7

TIME-TO-MARKET

This technological process is currently available.

IP PROTECTION

European granted patent (2019-11-06)

TECHNOLOGY BY:

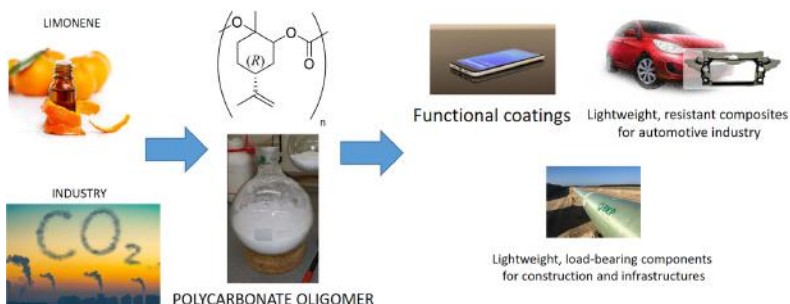


CHALLENGE

CO₂ capture and valorization
Renewable materials

APPLICATIONS

Advanced materials
Functional coatings
Adhesives and packaging



DESCRIPTION

The technology relates to a method for the production of a new class of **polycarbonate materials** (PLC) which can serve as a platform in the development of **functional coatings**, **packaging ingredients** and other **advanced materials**. The polycarbonates are made by co-polymerization of limonene oxide with carbon dioxide, both cheap, accessible and renewable ingredients.

NOVELTY

- Renewable feedstock (non-edible biomass and CO₂)
- Possibility to use the material as a platform to reach a plethora of applications
- Potential alternative to BPA-based PC
- Functionality on-demand: Due to the pendant double bond various functionalities can thus be introduced

FURTHER DEVELOPMENT

- Scale-up the process
- Develop niche high performance applications of product (with industrial partners)

DESIRED PARTNERS

Companies developing new polymer materials who could incorporate these products in their final product formulations, eventually after further functionalization.
Biorefineries for PLC production

CURRENT TRL

4-5
(PLC limonene product)

TIME-TO-MARKET

3 years

IP PROTECTION

In-house know-how
US patent application filed

TECHNOLOGY BY:

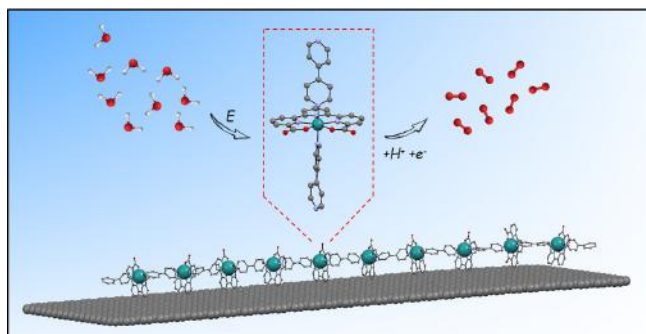


CHALLENGE

Cheap and sustainable production of hydrogen.
Water hydrolysis

APPLICATIONS

Hydrogen synthesis, solar fuels, artificial photosynthesis, electrodes, electrolyzers



DESCRIPTION

The technology relates to a highly performant **water oxidation electroanode** useful in **water hydrolysis** for the oxidation of water and **production of hydrogen**. The electroanode comprises a coordination oligomer of a molecular catalyst strongly attached to an electrode surface via supramolecular interactions with **no need for a binder** to fix the catalyst to the electrode. Such an electrode can be used in water hydrolyzers for hydrogen generation. The production of hydrogen is **high-yielding** even when water hydrolysis takes place at neutral pH.

NOVELTY

- High current density even at neutral pH and low potential
- No binder required to fix the catalyst to the electrode
- Large surface coverage
- Prepared anode is robust

FURTHER DEVELOPMENT

- Long term testing and pre-pilot validation
- Pilot testings (incorporation of anode in electrolyzers)

DESIRED PARTNERS

Companies or technology centers operating in the electrodes/electrolyzers fields, partner for demonstration and/or commercialization.

CURRENT TRL

3

TIME-TO-MARKET

5-6 years

IP PROTECTION

European Patent application filed (2020)

TECHNOLOGY BY:

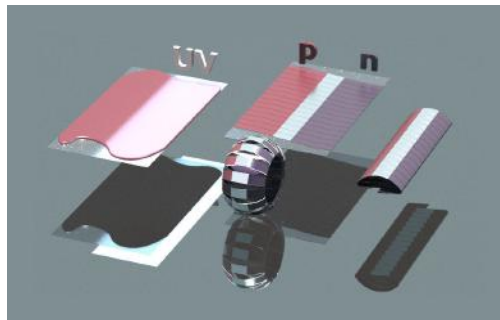
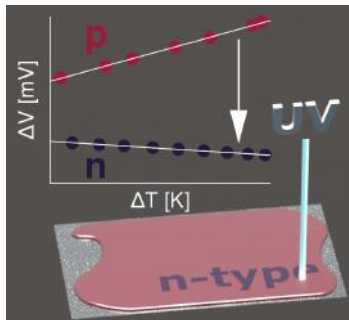


CHALLENGE

Cheap, non toxic
thermoelectric generators

APPLICATIONS

Organic thermoelectric
generators for distributed
sensor applications



DESCRIPTION

The **fabrication processes** of n- or p-type semiconducting devices usually requires the deposition of both n- and p-type materials, which have different processing requirements. In the proposed method, **only one solution** of a p-type material has to be deposited. Subsequently, it can locally be **irradiated with light** to convert the material to n-type according to the needs. Application to thermoelectricity has been **demonstrated**, using a **large-scale, roll-to-roll coating** compatible in-plane geometry that showcases the convenience of the developed method, while also using the inherent advantages of **flexible substrates** to their fullest.

NOVELTY

Focus on simple processing, leveraging the expected advantages of organic semiconductor technology (roll-to-roll processing, large area fabrication, cheap, scalable, sustainable...)

FURTHER
DEVELOPMENT

Validation of the technology for specific applications. Currently running 2 projects to extend this technology: (i) Sensoraïm (AGAUR Producte) and (ii) Orgivine (ERC Proof of Concept).

DESIRED PARTNERS

Industrial partners

CURRENT TRL

4

TIME-TO-MARKET

5 years

IP PROTECTION

European patent granted
(EP3381069B1)

TECHNOLOGY BY:



CHALLENGE

Making demand aggregation a reality

APPLICATIONS

Distributed energy resources
Energy markets
Global cloud computing



DESCRIPTION

CASE is a software platform of choice for **demand aggregators**. Demand aggregators are the **new market actors** that enable **demand side response** and **flexibility** to participate in energy markets and grid services. It provides advanced technological solutions to **monetise demand management** and **flexibility** of energy assets to allow the **integration of renewable energy sources**.

CASE aims to accelerate the **energy transition**, **democratize** the access to cleaner and cheaper energy, placing the **consumer in the center** of the energy system.

NOVELTY

- Reduces energy cost
- Improves innovation and sustainable corporate image
- Increases energy efficiency
- Scalable- it is based on the cloud

FURTHER DEVELOPMENT

Technology and market deployment, growth and market expansion. Pre-commercial proof-of-concept program in 2021.

DESIRED PARTNERS

Industrial and commercial partnerships to demonstrate CASE technical and economic feasibility: energy retailers, aggregators, ESCO's, EV fleet managers.

CURRENT TRL

6

TIME-TO-MARKET

<1 year

IP PROTECTION

The technology is licensed exclusively to Energeia SL.

TECHNOLOGY BY:

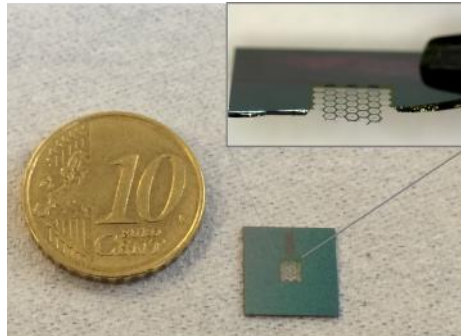


CHALLENGE

Miniaturisation of oxygen sensor and integration on silicon technology

APPLICATIONS

Industrial gas boilers
 Industrial combustion processes
 Automotive sector



DESCRIPTION

A **customizable micro-fabricated zirconia-based sensor** which provides a **fast and stable response** to different **oxygen** concentrations.

It comprises a nanometric membrane and self-heating elements, everything integrated in less than 1 cm².

Microfabrication techniques, added to the know-how of the group, allow to **adapt the design** of the sensor to any space constraint.

NOVELTY

- Improve burners efficiency: reduction of harmful emissions
- Nanomembrane on silicon: small volume
- Microfabrication: large-scale low-cost production
- Response time: in the range of milliseconds

FURTHER DEVELOPMENT

Complete integration of the system.

DESIRED PARTNERS

- System integrators
- Boiler manufacturers
- Automotive sector distributors

CURRENT TRL

4

TIME-TO-MARKET

5 years

IP PROTECTION

The sensor fabrication process and its utilization are protected by a Spanish patent (ES2537587B1)

TECHNOLOGY BY:

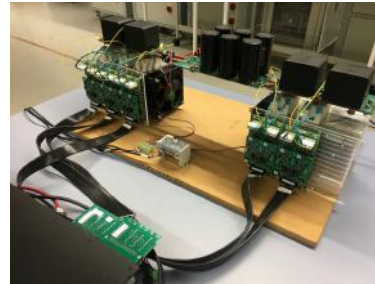
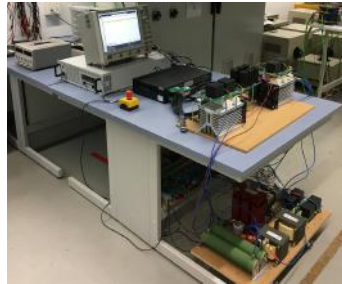


CHALLENGE

Minimize the impact of failure in the electricity service

APPLICATIONS

Fault-tolerant converters, specially relevant for remote areas or critical systems



DESCRIPTION

Power converters are essential for the energy transition towards a system based on renewable electric energy generation, the electric power storage and the electrification and integration of the new vehicles. This **power converter** is adapted to **handle renewable energy** efficiently: from generation, storage to the electrification and integration of new vehicles. It is **fault-tolerant**, avoiding internal failure of the switches, **saving money** and network **problems**. Additionally, it is internally **reconfigurable**, remaining in operation after the fault (automated), while minimizing redundant components.

NOVELTY

- 40% of capital cost reduction
- Provides reliability of the electrical network
- More than 50% extended lifespan
- Facilitates the implementation of renewables

FURTHER DEVELOPMENT

After the development and lab-testing of the technology (ongoing), it is required a scale-up for the proof-of-concept, and testing in real conditions.

DESIRED PARTNERS

Industrial partners in the field of power electronics and investors interested in the scale-up and potentially a spin-off creation.

CURRENT TRL

4

TIME-TO-MARKET

4 years

IP PROTECTION

Patent pending

TECHNOLOGY BY:

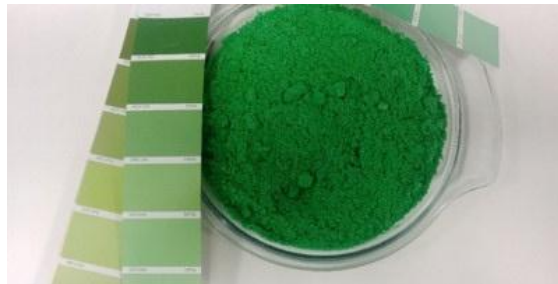


CHALLENGE

Suitable catalysts for advanced methanation reactors

APPLICATIONS

Conversion of CO₂ into renewable natural gas



DESCRIPTION

The technology consists on the manufacturing of **catalytic material** able to **convert green hydrogen** and **carbon dioxide** to **renewable fuels**. The developed material is suitable for **advanced reactors** and processes. The materials and the process has been implemented in a pilot plant at relevant environment; specifically, in a waste water treatment plant. The catalyst exhibited **higher activity**, **stability** and **tolerance to industrial impurities** compared to the commercial references. The obtained **synthetic natural gas** has similar composition than the fossil natural gas and can be used in the same applications, i.e. household heating, industry and power.

NOVELTY

- Can be implemented in advanced micro-reactors
- Increase efficiency of catalytic reactor (about 25%)
- More stable, 4x volume reduction vs commercial catalysts

FURTHER DEVELOPMENT

- Expand the portfolio of the catalytic materials
- Catalyst shaping according to customer requirements

DESIRED PARTNERS

Reactor engineering companies (for testing the catalysts), end-users (energy industry or companies that aim to convert carbon dioxide into synthetic natural gas) and investors or accelerators.

CURRENT TRL

5
 (tested in a relevant environment)

TIME-TO-MARKET

2 years

IP PROTECTION

n/a

TECHNOLOGY BY:



CHALLENGE

Improving thermal energy efficiency in buildings

APPLICATIONS

Heat pumps, flexible heating and cooling loads, control and operation of HVAC systems



DESCRIPTION

Two complementary **control algorithms** improve **operation** and **performance** of **heating and cooling** systems:

A **fault detection and diagnosis** (FDD) algorithm assesses heat pump performance, identifies anomalies to reduce energy and operational costs

A **predictive control scheme** (MPC) enables to plan and operate heat pumps or other HVAC systems in an optimal way based on external inputs. The solution takes into account the specificities of the system, short-term forecasts of weather, occupancy and prices.

NOVELTY

- 20-30% energy savings
- Better heat pump maintenance
- Improved thermal comfort
- Reduction of energy bills (up to 30%)

FURTHER DEVELOPMENT

Testing the solution in real buildings- pilot testing.

DESIRED PARTNERS

Heat pump manufacturers, facility managers, aggregators of flexibility, owners or constructors of buildings, developers of energy management systems.

CURRENT TRL

5-6

TIME-TO-MARKET

1-3 years

IP PROTECTION

n/a

TECHNOLOGY BY:

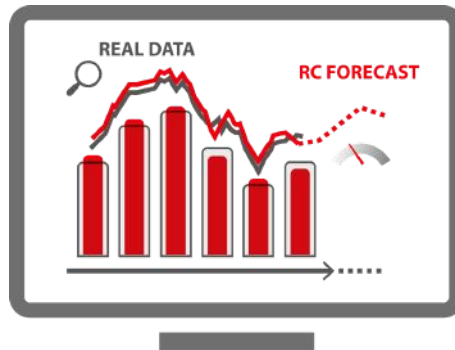


CHALLENGE

Improving energy efficiency in new or existing buildings

APPLICATIONS

Energy audits, recommendations to users, predictive control, flexibility at district level



DESCRIPTION

Building reduced models (RM) are **simplified building behavior algorithms** that predict the energy profile using few resources. The models define the **key parameters** able to **explain and forecast** the energy demands and consumption behaviour of the building. They can be adapted to various cases, ready to be implemented in existing technologies or devices. They can predict the user behaviour and user interaction with the building and serves for the assessment and predictive maintenance of technologies.

NOVELTY

- 20-30 % energy savings
- 30-50 % energy cost reduction
- Improved thermal comfort
- Optimized maintainance

FURTHER DEVELOPMENT

Train the existing reduced models with real data coming from existing buildings to harmonize the solutions and define the required optimal steps for case-to-case adaptation.

DESIRED PARTNERS

Monitoring devices producer, BIM developers, BEMS developers, district tools producers, DSO and utilities.

CURRENT TRL

6

TIME-TO-MARKET

1-3 years

IP PROTECTION

n/a

TECHNOLOGY BY:

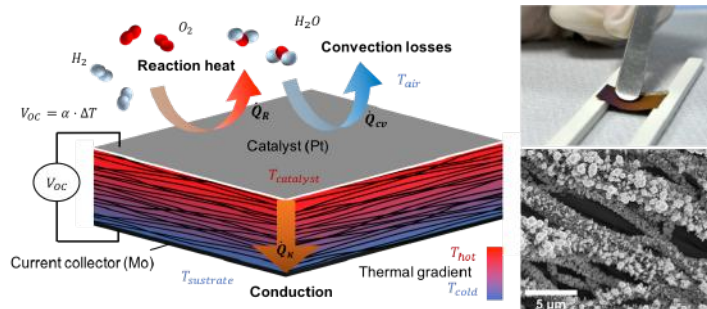


CHALLENGE

Reducing the cost and toxicity, while adding flexibility, in thermoelectric devices,

APPLICATIONS

Energy harvesting for industrial IoT and industry 4.0



DESCRIPTION

This technology is a revolutionary new **high-performing cost-effective** and **environmentally friendly thermoelectric material**. The approach centers around **nano-enabled** easy-to-handle **flexible fabrics** made of thin-walled **microtubes**. The fabric-like thermoelectrics **adapt to any hot surfaces** (such as round chimneys, unlike conventional flat batteries or TEGs), leading to a **high performance** and **mechanical properties**. In addition, the capacity of mass-production of TEG fabrics at low-cost provides access to **new markets**.

NOVELTY

- Self-powered devices: no need of maintenance
- Low-cost, large area production: automated and cheap
- Flexible material: adaptable to the substrate
- Environmentally friendly: reduction of hazardous waste
- Adaptable to any surface

FURTHER DEVELOPMENT

Development the industrial prototype, testing and scaling-up oriented to the target market.

DESIRED PARTNERS

Industrial partners and IoT manufacturers

CURRENT TRL

5

TIME-TO-MARKET

5 years

IP PROTECTION

Fiber fabrication patented (WO2016198712A1)

TECHNOLOGY BY:



CHALLENGE

Smart management of energy using different types of consumption, generation and storage

APPLICATIONS

Smart energy management for microgrids, buildings, e-parkings or local energy communities



DESCRIPTION

SEMS is a product for the **optimal management** and rational use of **energy**. It is a **hardware and software solution** for the smart and dynamic energy management of **self-consumption solutions** that is able to include multiple types of **consumption and generation units, energy storage** systems, as well as **electric vehicle** charging infrastructure or **vehicle-to-grid** systems.

SEMS offers the **intelligence** necessary to find the **optimal operation of the system**, to minimize energy costs, energy consumption peaks and emissions, all autonomously and automatically.

NOVELTY

- Monetize the flexibility of energy assets
- 10-15% reduction of energy bills and peak shaving
- 20% increase in energy storage usage
- 10% increase in self-consumption of renewables

FURTHER DEVELOPMENT

Commercialization of the product

DESIRED PARTNERS

Any company or entity requiring smart energy management

CURRENT TRL

7-8

TIME-TO-MARKET

2 years

LICENSING

The technology is licensed exclusively to Energeia SL.

TECHNOLOGY BY:

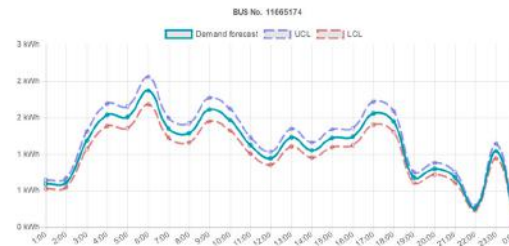


CHALLENGE

Optimal management of energy hubs

APPLICATIONS

Decision support Toolkit:
Forecasting, statistical monitoring and scheduling services



DESCRIPTION

The solution is conceived as a **commercial off-the-shelf (COTS) solution, ready to be integrated** within DMS (Distribution Management Systems), BMS/BEMS (Building Energy Management Systems), IoT middlewares and other facility operation software. A suite of web services that provides **enhanced energy monitoring and scheduling capabilities**. Monitoring methods are built on data mining methods and follow fault detection and isolation principles. Scheduling consists on optimal solutions provided by artificial intelligence methods. Data models allow to automatically build reference models for enhanced monitoring, forecasting and assets optimisation in a low voltage grid context or energy multi-vector scenarios.

NOVELTY

- Easy integration
- Multivariate modelling
- Time-granularity
- Direct connectivity with weather forecasting agencies

FURTHER DEVELOPMENT

- Prototype final integration and validation
- Valorisation and product requirements (market approach)
- Business and marketing plans

DESIRED PARTNERS

DSOs, ESCOs, monitoring system providers, aggregators, energy communities and cooperatives, facility managers, building owners, middleware providers

CURRENT TRL

6

TIME-TO-MARKET

2 years

IP PROTECTION

n/a

TECHNOLOGY BY:



CHALLENGE

Boosting reverse osmosis membrane technology towards the circular economy

APPLICATIONS

Water treatment sector



End-of-life reverse osmosis membrane

End-of-life reverse osmosis membrane hosted in the membrane housing device

DESCRIPTION

The technology gives sustainable and environmentally friendly solutions to the **reverse osmosis (RO) membrane** waste generated in the **water treatment** sector (e.g. seawater desalination) by **regenerating the membranes** for a second life and selling them back to the market. End-of-life RO membranes have to be preserved properly before the regeneration process. Preservation and the gravity-driven regeneration process are completed by the **membrane housing device** (patented). The invention will be also useful for applying recycling processes to convert the RO performance into nanofiltration and ultrafiltration performance and for manufacturing compact gravity-driven **filtration systems** using recycled ultrafiltration membranes

NOVELTY

- Cheaper to manufacture
- Easy to transport
- Easy to assemble
- Flexibility of use

FURTHER DEVELOPMENT

Scaling-up of the alternative membrane housing and membrane recycling plant, optimizing the end-of-life RO membrane sorting at the desalination facilities, establishing the business model, creation of the spin-off.

DESIRED PARTNERS

Desalination plants, membrane manufacturers and any actors in the waste treatment sector. Wastewater treatment plants that deal with complex water (landfil, leachate, swine, mining, etc).

CURRENT TRL

7

TIME-TO-MARKET

2 years

IP PROTECTION

Patent EP20382065.9

TECHNOLOGY BY:

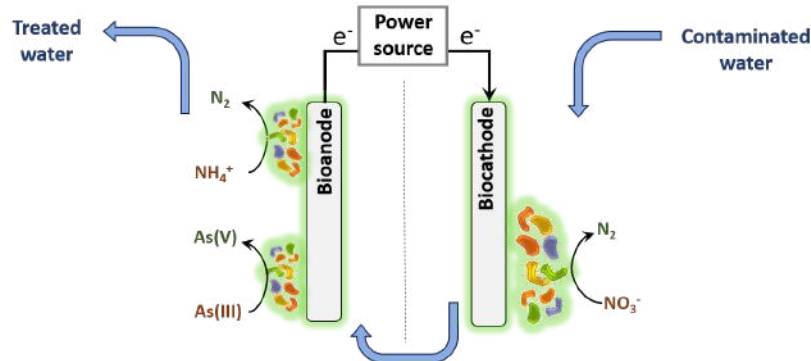


CHALLENGE

Waters contaminated with ammonium, nitrate or arsenic

APPLICATIONS

Treatment of groundwater and wastewater



DESCRIPTION

Microbial electrochemical technologies are used for the **bioremediation of contaminated waters**. Electroactive bacteria capable to use an electrode as electron donor or electron acceptor allow the **removal of ammonium, arsenic and nitrate**. Bioelectrochemical reactors are engineered and operated for the selective bioremediation of the target pollutant at **low energy costs** and **without** the need of **chemicals** addition (common method for dealing with these contaminants).

NOVELTY

- Usage of renewable and low-cost catalysts (microorganisms)
- Lower energy consumption

FURTHER DEVELOPMENT

- Improve current removal rates and reactor's scalability
- Implement methods for hardness removal
- System prototype demonstration in operational environment - Increase to TRL 7

DESIRED PARTNERS

Investors and industrial partners

CURRENT TRL

6
(technology demonstrated in relevant environments)

TIME-TO-MARKET

<10 years

IP PROTECTION

Patent on nitrate bioremediation:
EP 1238471.6 –
PCT/EP2013/074711).

A DYNAMIC THERMAL SYSTEM FOR MINIMIZING ENERGY DEMANDS IN BUILDINGS

TECHNOLOGY BY:



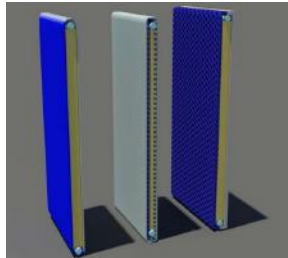
Universitat de Lleida

CHALLENGE

Minimize buildings energy consumption

APPLICATIONS

Building industry
 Application in walls, floors, roofs, fenestrations and doors



DESCRIPTION

The technology consists in a novel **dynamic thermal system** to be used in buildings to **minimize** their **energy consumption** for space **heating and cooling**. It is composed of several layers of materials, being one of them mobile and containing a material with capacity to absorb and release high amount of heat - such as **phase-change materials (PCM)**. In winter during the day, the PCM layer is exposed outdoors to capture and store solar radiation whilst by night it is placed indoors to release the absorbed energy to provide comfort to occupants. In summer, the PCM is moved to face outdoors to be solidified, and during the day is moved back indoors to discharge the cooling to the indoor environment. This system **works cyclically** and allows the building to **optimize** its **bioclimatic behavior**.

NOVELTY

- Significant energy savings
- Envelope as space heating and cooling supplier
- Unique aesthetic and commercial options

FURTHER DEVELOPMENT

To design and create a prototype to experimentally test and demonstrate its high performance under a relevant environment. Investment needs 150.000 – 500.000€.

DESIRED PARTNERS

- Industrial partners to develop a viable product
- Future clients for technology transfer under a license agreement

CURRENT TRL

3

TIME-TO-MARKET

3-5 years

IP PROTECTION

Patents filed (Spanish and PCT)

TECHNOLOGY BY:



Universitat de Lleida

CHALLENGE

Thermal energy storage materials from agro-foods

APPLICATIONS

Energy thermal storage in buildings and industry



DESCRIPTION

Bio-based phase change materials (PCMs) are prepared from oils and fats of low commercial value, such as those found in the **by-products of animal origin** not intended for human consumption.

Bio-based PCMs show a substantial **improvement of energy density performance** compared to products with similar characteristics currently on the market. The application of this product focuses on the energy aspect, as a material to be used in **thermal energy storage technologies**.

NOVELTY

- Materials based on by-products from industrial processes (fatty acids, vegetable oils or esters)
- Not based on paraffins or salt hydrates (state-of-the-art)
- Lower carbon footprint than commercial petroleum-derived PCMs and other existing bio-PCMs

FURTHER DEVELOPMENT

- To optimize the production and scale up at pilot plant level
- To design, build and commission a prototype of a heat exchanger (prototype start-up)

DESIRED PARTNERS

- Companies that produce and market storage materials
- Investors for a future spin-off

CURRENT TRL

3

TIME-TO-MARKET

4 years

IP PROTECTION

Patent granted
(WO/2017/081343)