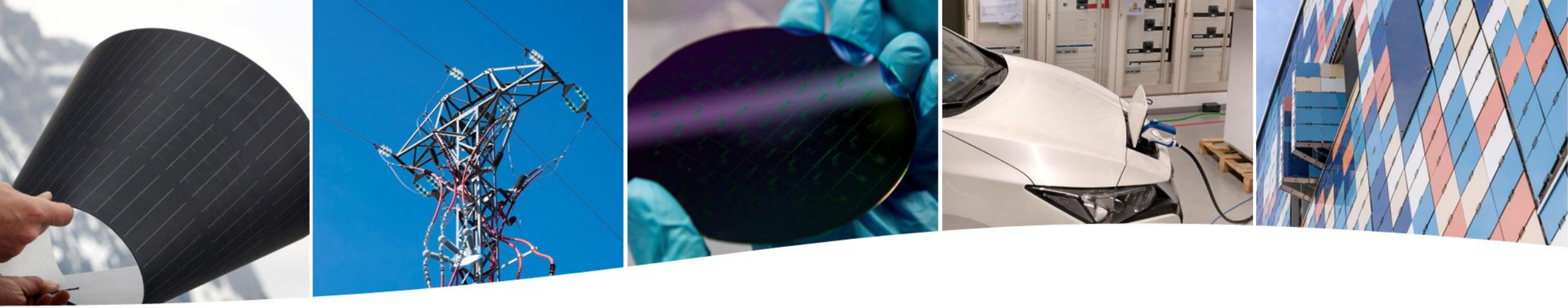

IREC

Shaping Energy for a Sustainable Future

Institut de Recerca en Energia de Catalunya (IREC)

CERCA Centres de Recerca de Catalunya

ACCIÓ Generalitat de Catalunya tecnio catalonia

INTRODUCTION

IREC
Shaping Energy for a Sustainable Future

Mission

Contribute to the **sustainable development** of society and enhance corporate **competitiveness** via:

- Innovation and the development of new technological products
- Mid- and long-term research
- Dissemination of scientific knowledge to citizens

Vision

Become a **centre of excellence** and an **international benchmark** organization in the energy field through **research**, **development** and **innovation**, working in coordination with the **administration**, the **industry** and the **academia**.

ORIENTATION

CERCA Research Centre, with a TECNIO accrediation.
IREC has a dual approach:

Market orientation

Market Orientation focusing on **technology development**, **new products** and new **technical solutions** for energy sector companies active in the same fields as IREC's established lines of action.

Long-term research

Long-term research into different aspects of the established lines of action. It will not be initially aimed at the market, but at **generating knowledge** amongst groups in the Institute itself, with a **long-term commercial projection** in mind.

LOCATION

The **IREC** has three locations: Sant Adrià de Besòs, Barcelona and Tarragona.

Sant Adrià
IREC headquarters

Barcelona

Tarragona

BOARD OF TRUSTEES

IREC
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GOVERNMENT OF CATALONIA
Departament de Territori, Habitatge i Transició Ecològica
Direcció General d'Energia
Direcció General de Recerca

GOVERNMENT OF SPAIN
Secretaría de Estado de Energía
Secretaría General de Investigación
CIEMAT (Ministerio de Ciencia, Innovación y Universidades)
IDAE (Instituto para la Diversificación y Ahorro de la Energía - Ministerio de Transición Ecológica)

UNIVERSITIES
Politècnica de Catalunya (UPC)
Barcelona (UB)
Rovira i Virgili (URV)

COMPANIES
Enagás
Endesa
Naturgy

FIGURES

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2024

220 people

166 publications

10 PhD thesis

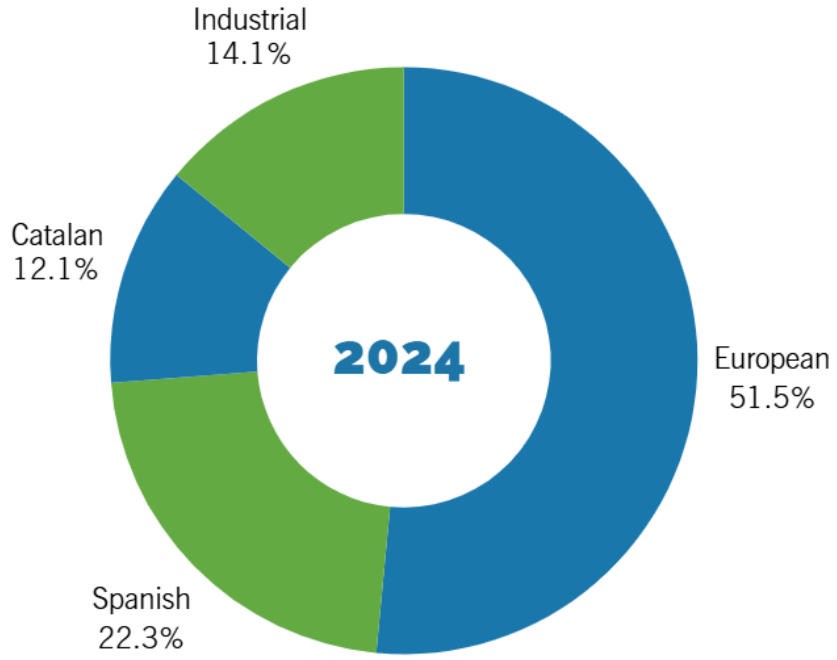
3 patent applications

total **3** spin-offs

LEDMOTIVE
Turn on the future

eolos
FLOATING LIDAR SOLUTIONS

bamboo energy



AREAS OF EXPERTISE

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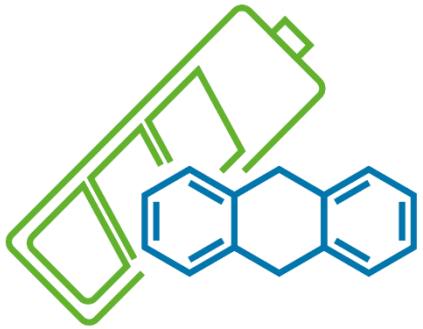
Energy & Environment

- Renewable energy sources and integration to the grid
- Sustainable mobility
- Fusion energy
- Environmental impact



Energy Storage

- Batteries
- Chemical storage
- Energy conversion
- Harvesting and other autonomous systems

Smart Energy Management

- Smart cities & districts
- Smart grids
- Distributed energy management and aggregators
- Energy efficiency in buildings

RESEARCH AT IREC

RESEARCH DEPARTMENTS

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Solar Energy Materials and Systems

Nanoionics and Fuel Cells

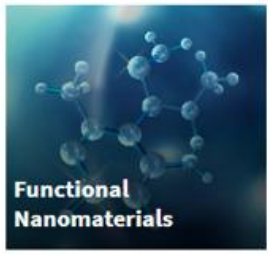
Functional Nanomaterials

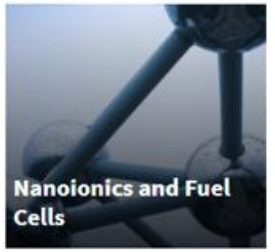
Energy Storage, Harvesting and Catalysis

Power Systems

Energy Systems Analytics

Climate Neutral and Resilient Buildings and Communities





SOLAR ENERGY MATERIALS AND SYSTEMS

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The Dept. develops innovative cost-efficient, robust and stable technologies for **next generation advanced PV products**, compatible with **industrial deployment** and suitable for **customisation**. Looking to the **ubiquitous penetration of PV** in all the scenarios of human life.

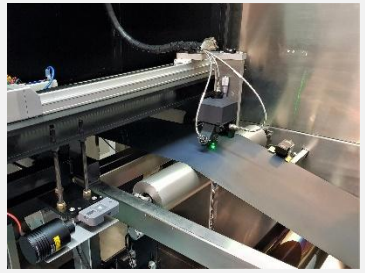
PV MATERIALS AND DEVICES

- New PV concepts and materials beyond silicon
- Research in IoT-PV and Agri-PV
- Technology testing platform
- Demonstration of industrial transferability

CHARACTERIZATION

- Materials and devices characterization
- Statistical and AI assisted data analysis

INDUSTRIAL PROCESSES



- Real-time Industrial process monitoring
- Validation of new methodologies for fast inspection
- Provide solutions for efficient processes

3 TRL 8

SOLAR ENERGY MATERIALS AND SYSTEMS

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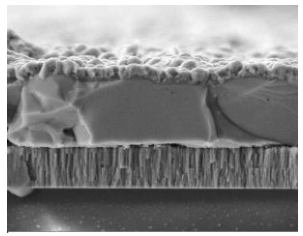
HIGHLIGHTS

HI-BITS

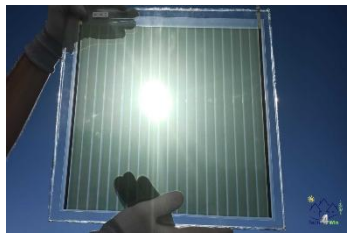
MATERIALS



Materials without critical raw elements.
Thin film fabrication for PV applications

BIPV

BIPV



Flexible and (semi) transparent solar cells for easy integration in buildings

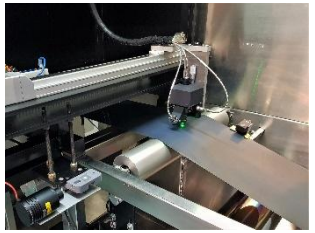
CUSTOM-ART

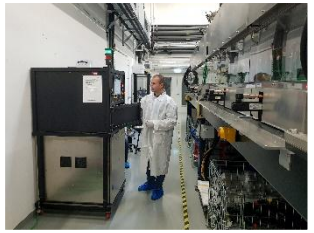
DEMONSTRATION

PV-integrated BIPV and PIPV prototypes under real-world operational conditions

PLATFORM-ZERO

ADVANCED CHARACTERIZATION





Easy process monitoring design for integration in both research and industrial lines

NANOIONICS AND FUEL CELLS

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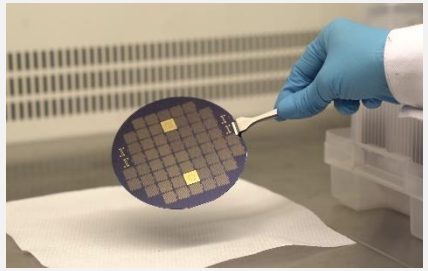
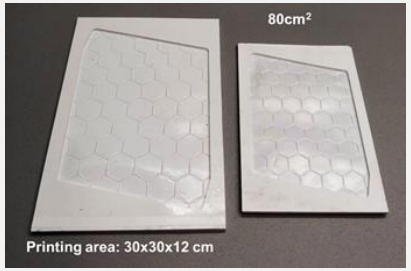
The Department aims at mastering mass transport phenomena in inorganic materials to deliver a new generation of solid-state energy devices enabled by advanced manufacturing and AI technologies.

NANOIONICS & IONTRONICS



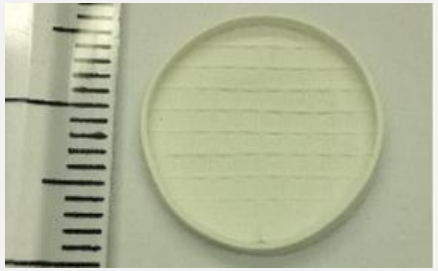
- New concepts
- Ionic or mixed ionic electronic conduction
- Interface-dominated materials
- IoT devices
- Thermoelectrics

ADVANCED MATERIALS AND PROCESSING



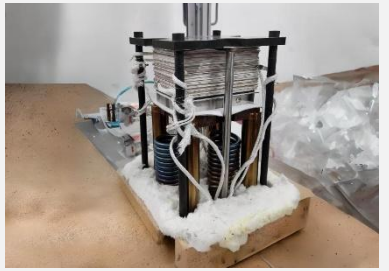
- Thin films and microfabrication
- 3D printing (ceramics)
- Complex geometries
- Materials discovery by AI

ALL-SOLID-STATE-BATTERIES



- New generation of Li-ion batteries
- 3D printing and thin-film coating
- New families of highly performant materials

FUEL CELLS AND ELECTROLYSERS



- Hydrogen tecnologies
- 3D printing
- Syngas generation
- Power-to-gas technologies
- SOFC and SOECs
- Synthetic fuels
- AI and machine learning

1 TRL 7

NANOIONICS AND FUEL CELLS

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HIGHLIGHTS

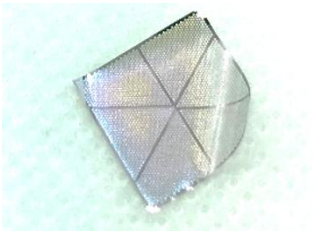
H_2 TECHNOLOGIES

DEMONSTRATOR


kW range co-electrolyser for hydrogen production or CO_2 methanation

EPISTORE

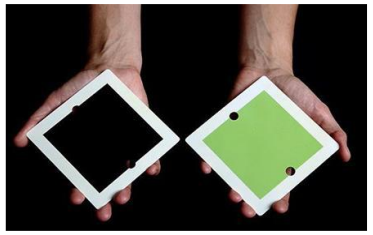
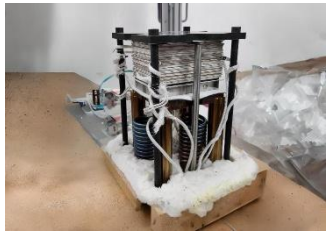
MICRO-DEVICES



Ultra-compact micro-SOC devices

3D printing

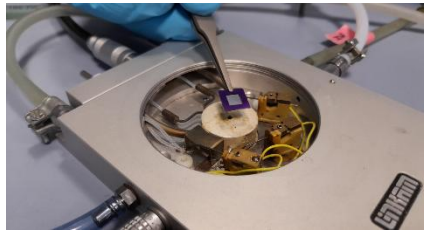
ADVANCED MANUFACTURING

Multimaterial ceramic 3D printing of enhanced energy devices

HARVESTORE

ADVANCED CHARACTERIZATION



Novel energy and harvesting concepts in the nanoscale

FUNCTIONAL NANOMATERIALS

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Shaping Energy for a Sustainable Future

The Department designs and engineers **nanomaterials** with optimized **functionalities** and applies them in **energy conversion**, **energy storage** and **environmental remediation** products.

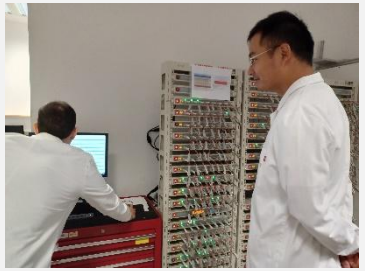
NANOMATERIALS DESIGN

- DFT design
- Solution-based synthesis
- Surface chemistry
- Nano-to-macro processing
- Scale-up and recycling

BIOMASS-DERIVED PRODUCTS

- Added value chemicals
- Coupled redox reactions
- New electrocatalysts
- Strategies for product separation/purification
- Viability and cost analysis

BATTERIES AND SUPERCAPACITORS



- Catalysts optimization
- Metal-air, metal-S batteries
- Solid-state electrolytes
- Li,Na,Zn,Al,Mg-based batteries
- Battery pack demonstrators

1 TRL 4

FUNCTIONAL NANOMATERIALS

HIGHLIGHTS

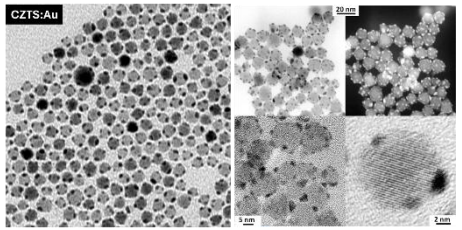
UNION

PROTOTYPE

New thermoelectric materials

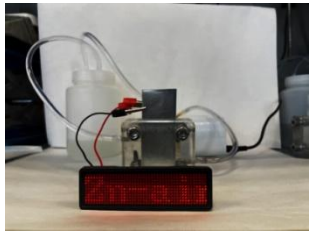
SYDECAT

MATERIALS



Photocatalysts

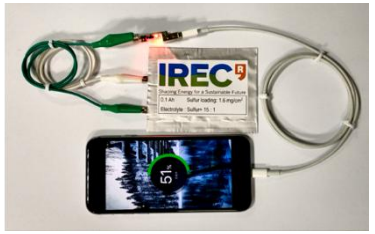
PROTOTYPE



High entropy alloys as oxygen catalysts in Zn-Air batteries

2BOSS

PROTOTYPE



Metal-sulfur batteries

ENERGY STORAGE, HARVESTING AND CATALYSIS

Shaping Energy for a Sustainable Future

Divided into 2 groups: The **Battery Materials group** develops new electrode materials, components, and electrochemical storage systems. The **Sustainable Fuels group** focuses on catalytic technology development, from the synthesis of specific catalysts, the reactor design and protopyting until on-site validation.

BATTERY MATERIALS

- Electrode and battery cell fabrication
- Lithium battery chemistries
- Post-lithium batteries
- Supercapacitors
- In-situ studies
- Ageing and postmortem analysis

SUSTAINABLE FUELS

- Development of catalysts
- Design and prototyping of reactors
- Validation of technology on-site

3 TRL 7

ENERGY STORAGE, HARVESTING AND CATALYSIS

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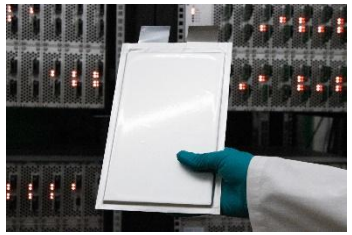
HIGHLIGHTS

COBRA

PROTOTYPE



Co-free Li-ion battery for next generation electric vehicles

FISCHER-TROPSCH

PROTOTYPE

Fischer-Tropsch reactor for CO_2 conversion to synthetic liquid fuel

BIOMETHANE

PILOT

Validation of biogas to synthetic natural gas reactor in a rural environment

SOLAR HYDROGEN

DEMONSTRATOR

Photoelectrocatalytic demo site for the generation of solar hydrogen

POWER SYSTEMS

POWER SYSTEMS

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The Department aims to provide technical solutions (software and hardware) for the challenges of future electric grid, bringing innovation in aspects for a secure, resilient and RES-based electric system.

CYBER-PHYSICAL SYSTEMS

- LORA-technologies
- CyberSecurity
- PMU Systems
- Energy Cloud-based platforms
- Hardware development

OFFSHORE RENEWABLE ENERGY

- LCOE and LCA estimation
- Modelling of floating Systems
- Digital twin for O&M
- Advanced control (local and coordinated)

POWER ELECTRONICS

- Modelling and optimal design
- Multilevel converters
- Prototyping and test
- Multiport configurations and fault-tolerant

ELECTRICAL NETWORK

- State estimation & fault-location
- Resilience (risk assessment and mitigation)
- Grid operation & microgrids
- Advanced control (local and islanded)

ENERGY STORAGE

- Modelling and characterization
- Advanced BMS
- Advanced models
- Novel Integration schemes
- New battery configurations

4 TRL 8

POWER SYSTEMS

HIGHLIGHTS

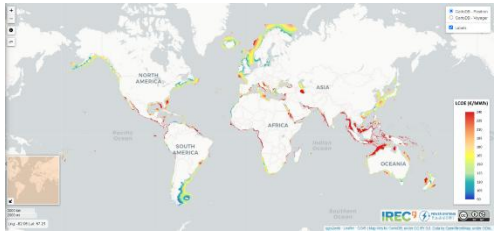
RESISTO

PREDICTIVE TOOL

Helps to protect Doñana National Park towards extreme events using AI techniques

FOWAPP

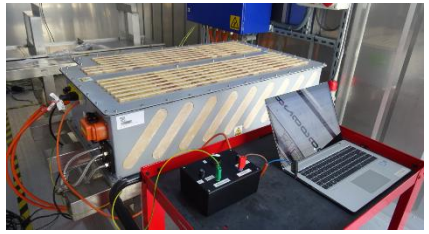
APP



Global map of costs for floating offshore wind energy

COBRA

PROTOTYPE



Lighter and safer automotive battery system for electrical mobility

CYBER-SECURITY

TESTING INFRASTRUCTURE

SDN technology to resist cyberattacks in an electrical grid system

ENERGY SYSTEMS ANALYTICS

The Department, divided into 3 groups, focuses on energy system integration, the economic/social/regulatory impact assessment and the life cycle to understand how to increase reliability, reduce costs and minimize environmental impacts in our energy systems.

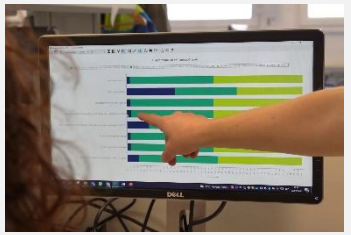
ENERGY SYSTEM INTEGRATION

- Intelligent energy management
- Integration of sustainable mobility
- Data science for management of energy
- Battery management

ENERGY ECONOMICS, SOCIAL&REGULATORY IMPACT ASSESSMENT

- Policy and regulation research
- Techno-economic analysis
- Socio-economic evaluation
- Market and consumer behaviour dynamics
- Energy poverty
- Risk assessment

ENERGY TECHNOLOGIES, LCA AND SUSTAINABILITY



- Life cycle assessment and costing (LCA-LCC)
- Social life cycle assessment (S-LCA)
- Carbon footprint
- Eco-design
- Circular economy

4 TRL 8

ENERGY SYSTEMS ANALYTICS

HIGHLIGHTS

ANALYSIS

Carbon footprint analysis of the biomethane reactor at the company Ahidra

ANALYSIS

LCA to describe the environmental performance, KIPs for recyclability and the Energy Payback Time

REFER

PILOT PLANT

Second life EV battery integration in the self-consumption system of a public library (Montgat)

GROWSMARTER

PILOT PLANT

Optimal EMS for NISSAN headquarters (BCN) with vehicle-to-grid chargers, storage systems and PV

CLIMATE NEUTRAL AND RESILIENT BUILDINGS AND COMMUNITIES

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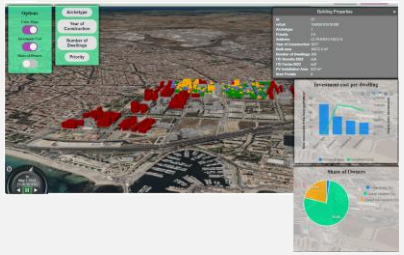
The REACT Department aims To develop technological solutions, methodologies and provide simulation tools that will allow buildings and urban areas to contribute to the energy transition in our society, with a special focus on the requirements of Mediterranean climate.

URBAN SIMULATION



- Positive Energy Districts
- Simulation tools (2D or 3D)
- Tools for decision-makers and citizen engagement
- Assessment methodologies for cities
- Sustainability and business scenarios

BUSINESS MODELS

- Policies and business models
- Local/regional decarbonization pathways
- Large-scale granularity
- Mitigation and adaptation to climate change

INDOOR AND ENVIRONMENTAL QUALITY

- Evaluation of impacts in buildings and urban areas
- Quantification of social and economic benefits
- Support policymakers
- Empowerment of population
- Well-being of citizens

ENERGY FLEXIBILITY

- Advanced control strategies for complex systems
- Multiple energy sources, vectors and factors
- Improve efficiency and lifetime of HVAC systems

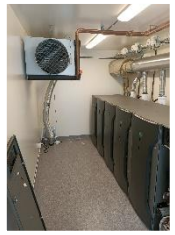
4	TRL	8

CLIMATE NEUTRAL AND RESILIENT BUILDINGS AND COMMUNITIES

HIGHLIGHTS

WEDISTRICT

DEMONSTRATOR




Waste heat recovery of fuel cell powered data centre

ARV

DEMONSTRATOR



Sustainable Plus Energy Neighbourhoods (SPEN)

SOM COMUNITAT

APP

Web-service platform able to unveil the potential energy communities

CCE

TESTING


Monitoring indoor environmental comfort in sports facilities to help reducing energy use

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LABORATORIES

MATERIALS LABORATORIES

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Nanoionics and Fuel Cells lab:

· Nanostructures and thin film oxides-fabrication and characterization
· Advanced oxide materials and devices-fabrication and characterization, including large area PLD, CVD and a ceramic 3D printer
· Electrochemical characterization, from microdevices to kW-stacks

Functional Nanomaterials lab

· Nanomaterials engineering: colloids, thin films, nanocomposites, gels, aerogels
· Electrocatalytic, photocatalytic and catalytic materials and tests
· Charge and thermal transport characterization
· Nanomaterial-based energy storage and conversion devices

Energy Storage, Harvesting and Catalysis lab:

· Electrode/catalyst fabrication and thin film deposition
· Battery fabrication, assembly and testing
· Electrochemical and photoelectrochemical testing
· Catalytic reactors and reactor modelling (CFD)

Solar Energy Materials and Systems lab:

· Thin film processing
· Advanced characterization
· Prototyping and integration
· Optical workshop

ENERGY SMARTLAB

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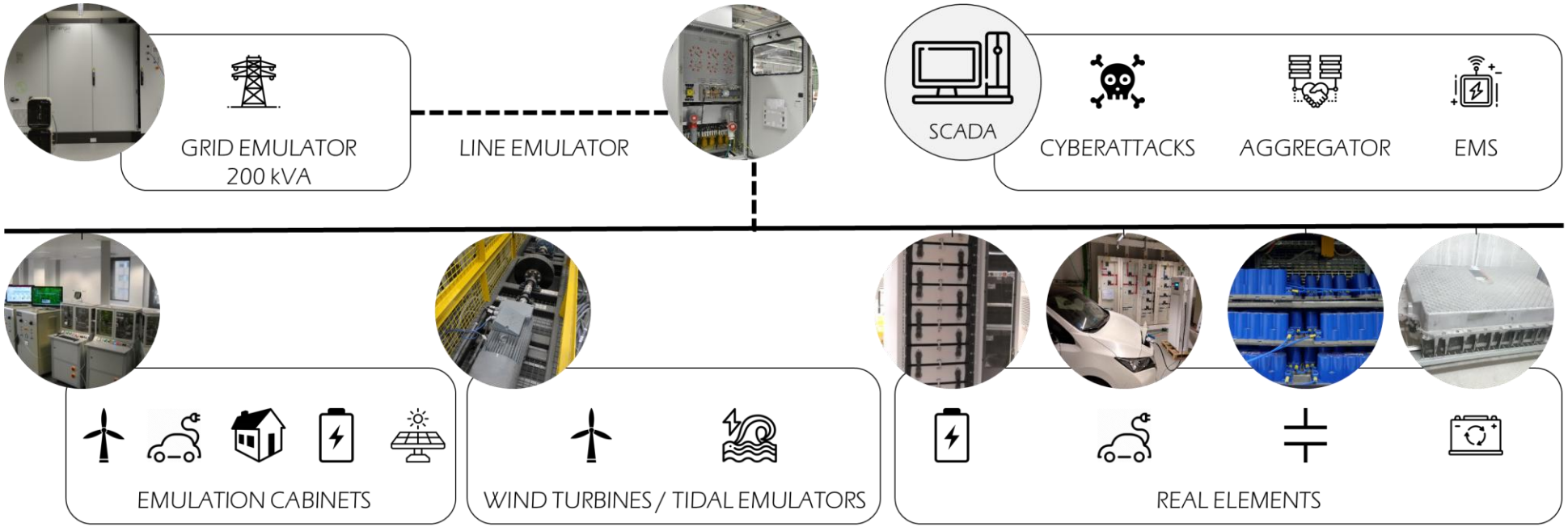
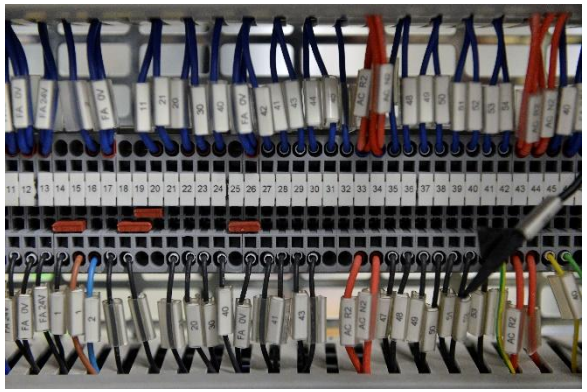
The laboratory is equipped with communication and electric infrastructures as a part of a flexible low voltage microgrid testing environment, which could work in either a centralized or distributed topology.



ENERGY SMARTLAB

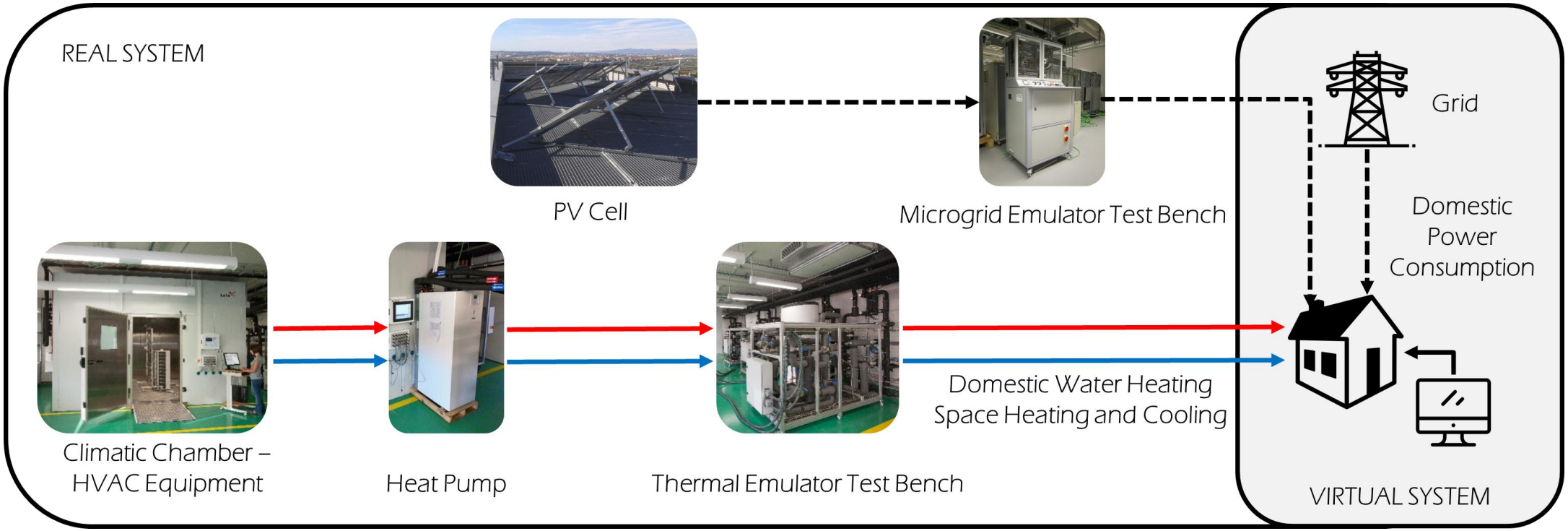
CAPABILITIES

- Control and communications architectures enable to test and validate Energy Management Systems (EMS), aggregator management strategies and emulate cyberattacks. Energy SmartLab and SEILAB are connected to test policies and management strategies at district level
- The grid emulator allows the test of faults, dynamics, islanded operation and perform power hardware-in-the-loop
- Set of emulator cabinets that can reproduce the electrical behaviour of generators, storage systems and consumers
- Rapid prototyping and validation of electric equipment
- Design, development and deployment of devices to monitor and control energy consumption, generation and storage



SEILAB

The **Semi-Virtual Energy Integration Laboratory** (SEILAB) provides advanced expertise to assess the development and integration of renewable energy solutions and innovative thermal and electrical equipment that are designed to improve energy efficiency in buildings and energy systems.



SEILAB

CAPABILITIES

- Semi-virtual testing approach: operation of real equipment as a function of dynamic virtual models
- Testing the performance of components or complex energy systems under defined building and environmental conditions
- Development and integration of innovative, sustainable and renewable building energy supply systems: thermal solar systems, photovoltaics, micro-cogeneration, energy storage, heat pumps and other HVAC equipment
- Analysis of equipment behaviour at particular transient phases
- SEILAB and Energy SmartLab are connected allowing to test aggregator policies and management strategies for districts

STRATEGIC INITIATIVES

PLEMCAT

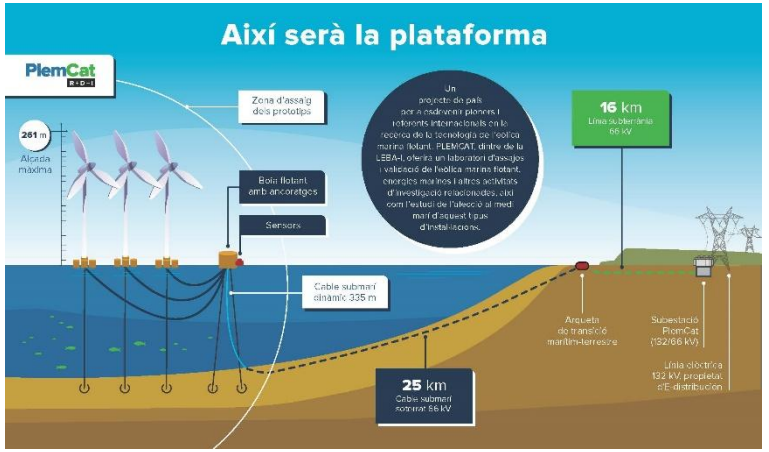
PLEMCAT will offer an area in the Mediterranean Sea, within LEBA-I, with a laboratory for testing and validation of **floating wind power**, **marine energies** and other related research activities, as well as the study of the **impact on the marine environment** of these types of installations.

It is led by IREC and with the support of the Generalitat de Catalunya.

Plemcat will:

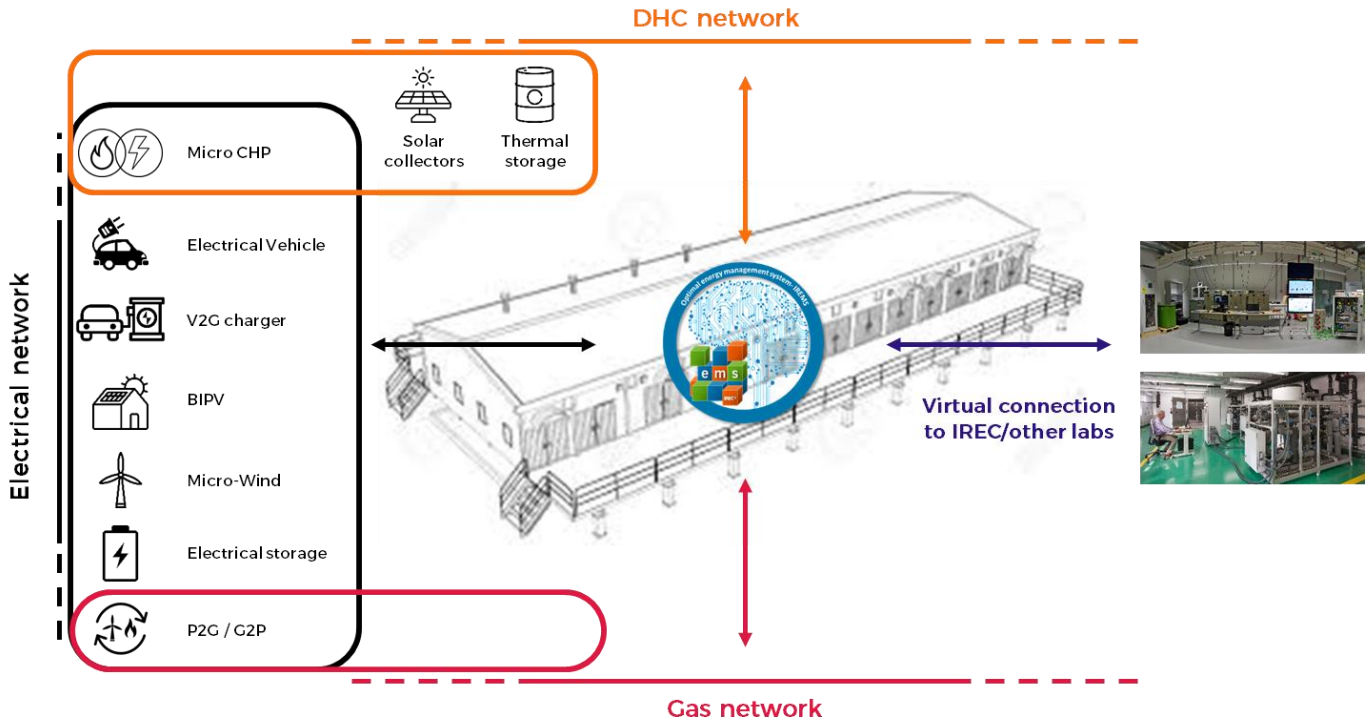
- shed light over the offshore energy projects in the Mediterranean
- attract talent, investment, knowledge and research opportunities
- position Catalonia as a reference in offshore energy

LINK



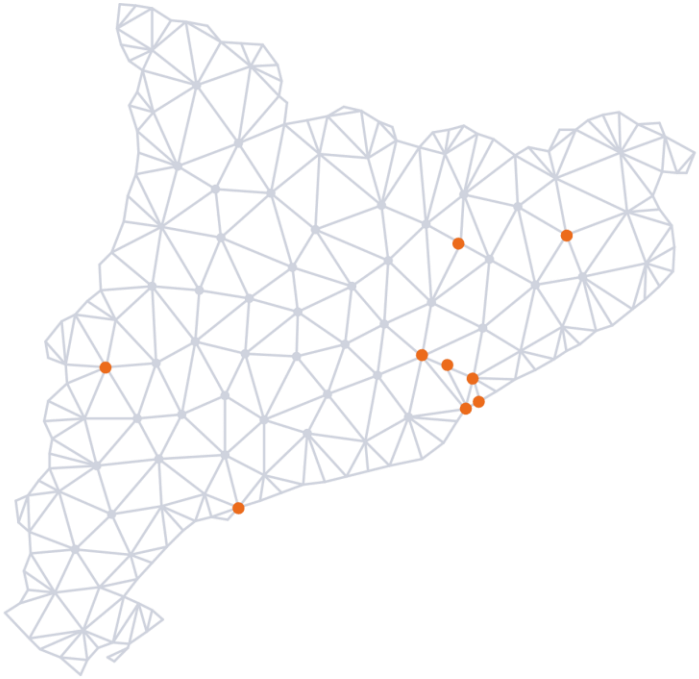
PRIMA PLATFORM

R+D+I platform for the energy transition led by IREC that aims to transform the energy sector through research, development, commercialization and deployment of low carbon, energy efficiency and renewable energy technologies .



ENERGY FOR SOCIETY NETWORK

Leader: IREC — Shaping Energy for a Sustainable Future



35 Research groups

14 Academia centers

500+ Researchers

participants:

Barcelona Supercomputing Center · CIMNE · eurecat · ICIQ · UVIC Universitat de Vic Universitat Central de Catalunya · laSalle Universitat Ramon Llull · Universitat de Girona · Universitat de Lleida · CNM IMB · CSIC · ICMAB · ICN2 · UPC Universitat Politècnica de Catalunya Barcelonatech · Universitat de Barcelona

collaborators:

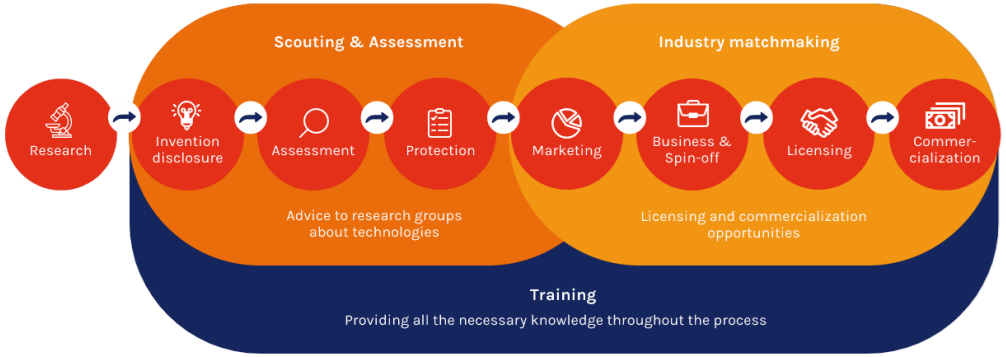
CEEC Clúster de l'Energia Eficient de Catalunya · DEMETER · INCASÒL Institut Català del Sòl

Mission

Promote the technology transfer and valorisation of energy technologies to industry and society.

The mission is to increase the impact of the technology transfer to the productive and social sector in Catalonia; and convert XRE4S in a pool of innovation in energy at international level.

Valorisation and tech transfer program

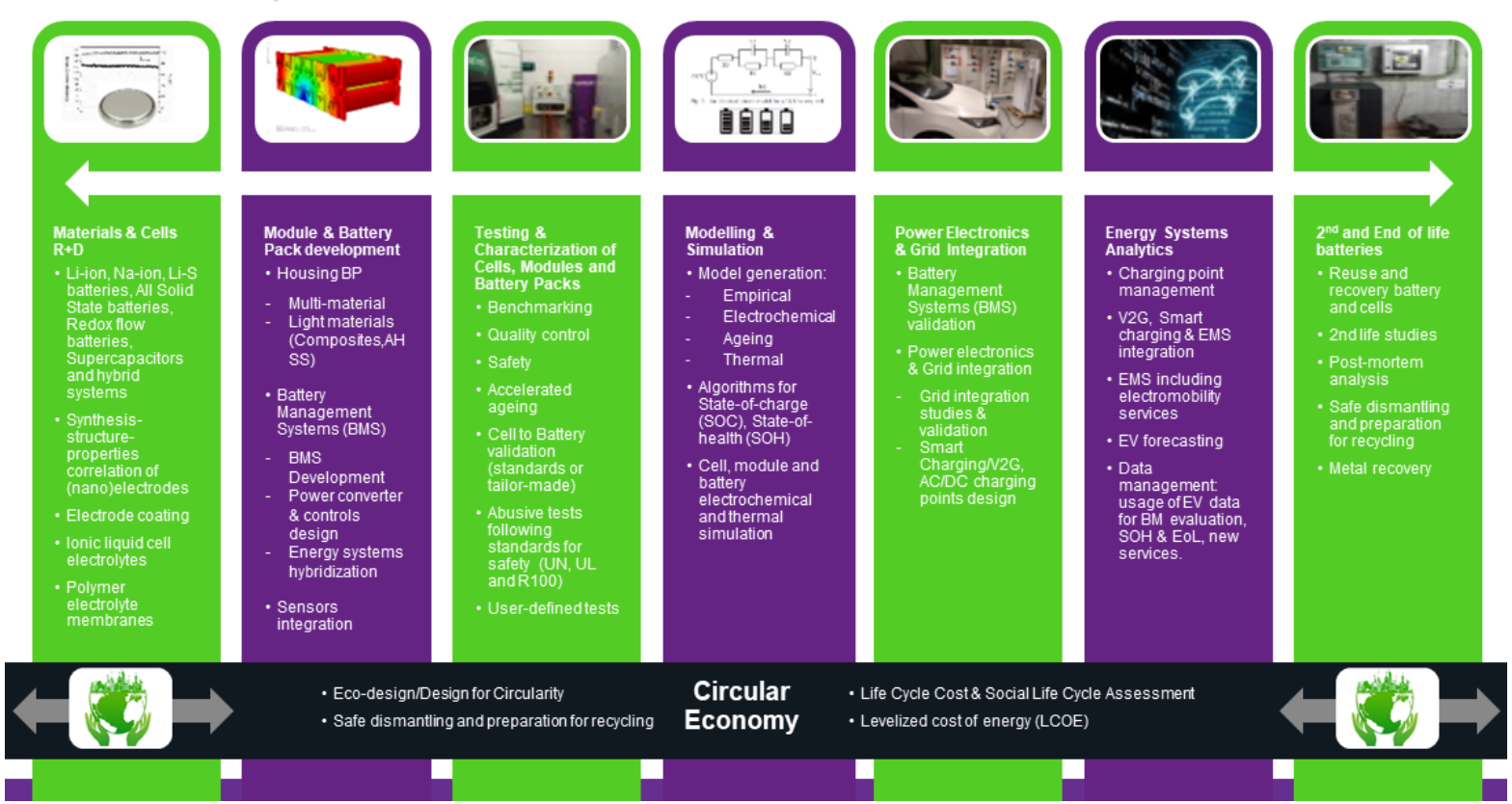


Activities

PROMOTION · SCOUTING & ASSESSMENT · MATCHMAKING · TRAINING

BATTECH

Joint Research Unit between IREC and EURECAT – a reference center to cover all the R&D&i of the **battery ecosystem in southern Europe**, which includes research, development and innovation of the entire value chain of the next generation of **electric cells and batteries** for the **markets** of **electric mobility**, **renewable energies** and **capital goods**.



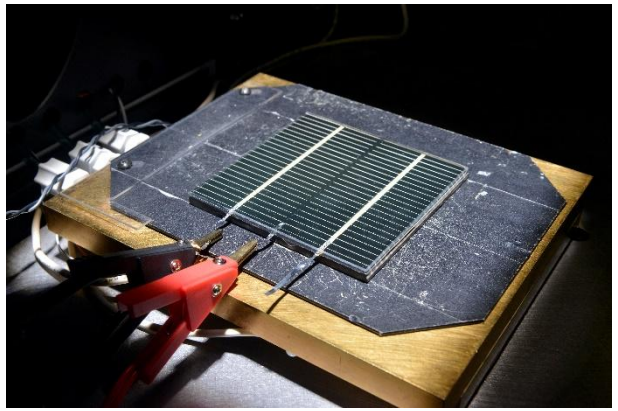
JRU IREC-UPC

Renewable technologies and solar powered systems

- Strategic research alliance between SEMS Dept. from **IREC** and MNT Group from **UPC**

- Strengthen **R+D activities** in the development of **new solar technologies** exploiting the strongly complementary in skills, know-how and infrastructure available at both groups

    - Emerging cost-efficient thin film PV sustainable technologies
    - New device architectures for advanced PV integration concepts
    - New methodologies for advanced characterization of devices and processes using machine learning and Artificial Intelligence strategies.



IREC
Shaping Energy for a Sustainable Future

TECHNOLOGY TRANSFER

POSITIONING

IREC
Shaping Energy for a Sustainable Future

ACTIVE PARTICIPATION

In national and international associations and platforms

ECOSYSTEMS LEADERSHIP

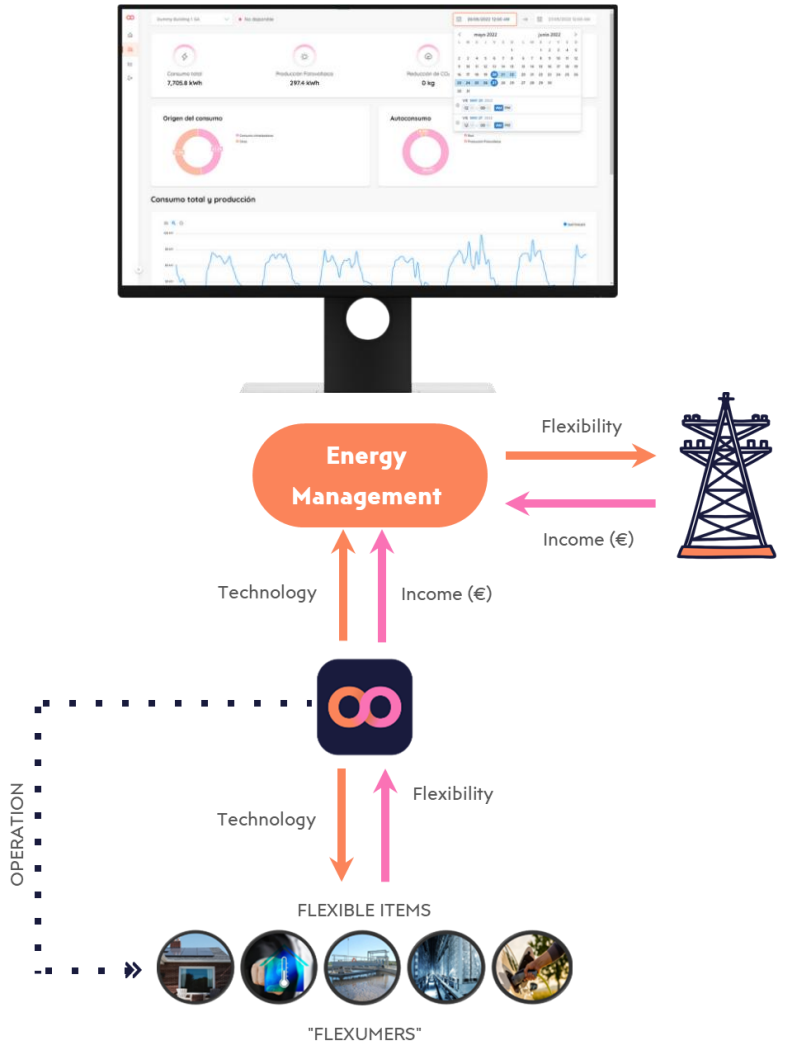
Large R+D+i, tech transfer ecosystems with more tan 100 entities involved

SPIN-OFFS

BAMBOO ENERGY

BAMBOO is a spin-off company from IREC, created in 2020. It was born to be the **software platform of choice** for demand **aggregation** offering a modular architecture and versatile platform.

It aims to accelerate the **energy transition**, democratize the access to cleaner and cheaper energy by providing ways to monetize the flexibility of energy assets and the integration of renewable energy sources.



EOLOS

IREC members created a spin-off company named **EOLOS FLOATING LIDAR SOLUTIONS S.L.**; set up in March 2014 with the objective of commercializing An energy autonomous system capable of taking accurate and reliable wind measurements at height of up to 200 meters at any offshore location, independent of water depth.

The system is fully energy autonomous, easy to transport and deploy, and designed to withstand the harshest offshore conditions.

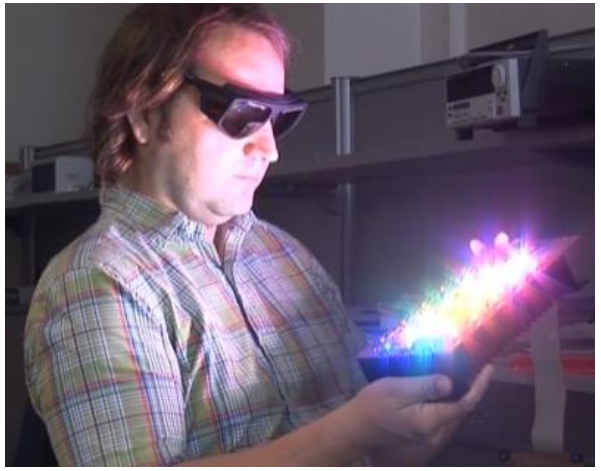
LEDMOTIVE

As a result of research carried out in the field of **lighting**, the IREC has created a technology named **Ledmotive**.

The spin-off company **Ledmotive Technologies S.L.** is established, with its activity oriented towards the technological development and commercialization of Ledmotive technology wherein IREC will participate as a stakeholder.

Ledmotive ceased its activities in 2022.

LEDMOTIVE
Turn on the future



CONTACT

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