EXCELENCIA MARÍA DE MAEZTU

institute IMdea energy

www.energy.imdea.org

annual report

2024

research for a sustainable energy development

David Serrano
Director of IMDEA Energy
Móstoles, December 2025

annual report
2024
www.energy.imdea.org

This report summarizes the main achievements of the IMDEA Energy Institute during 2024. The primary mission of our center is to perform R&D activities for the development of efficient, competitive, and clean energy technologies that contribute to the transition to a low-carbon energy system. A significant number of research lines are also aimed at solving environmental problems and developing materials with advanced properties for energy applications.

IMDEA Energy was created in 2007 by "Comunidad de Madrid" with a modern and flexible management system. IMDEA Energy's headquarters are located in the Móstoles Technology Park (Madrid). Scientific excellence, international visibility, and cooperation with industry are the main drivers of our Institute.

2024 was a highly successful year for IMDEA Energy. While the total number of staff remained virtually constant, both scientific productivity and external income reached record levels: 128 indexed scientific publications were produced, and external funding from competitive projects, contracts with companies, and staff grants totaled 6.73 M€. Of the 100 projects active in 2024, 39 were international, most of them awarded through highly competitive calls for proposals.

Within the context of these projects and initiatives, IMDEA Energy maintained direct collaborations with 77 research organizations and universities and 47 industrial partners throughout 2024. Furthermore, IMDEA Energy actively participated in 45 associations, technology platforms, expert groups, and other organizations during 2024, further enhancing its external visibility.

Also noteworthy is the significant impact of the various outreach activities, reflected in the continuous increase in the number of followers on the Institute's social media channels, as well as in the number of subscribers to the IMDEA Energy Newsletter.

Once again, these excellent achievements have been made possible thanks to the tremendous effort and commitment of the IMDEA Energy staff and the support received from the Regional Government of "Comunidad de Madrid".

words from the director...

annual report 2024

www.energy.imdea.org

editor
imdea energy institute

graphic design
base 12 diseño y comunicación

contents

contents

about us

The IMDEA Energy Institute is a research centre created by the Regional Government of Comunidad de Madrid in the year 2006 that operates as a non-profit foundation. The Scientific Programme of the IMDEA Energy Institute aims at contributing to the future establishment of a sustainable and decarbonised energy system, economically competitive and securing energy supply.

The IMDEA Energy Institute is committed with having a significant impact on R&D energy challenges by bringing together high quality researchers, providing them with excellent infrastructures and resources, and promoting their close collaboration with the industrial sector.

strategic framework

The strategic framework guiding the R&D priorities of IMDEA Energy is based on goals and priorities established by energy plans and research programmes at regional, national and international levels; such as the UN's Sustainable Development Goals, the Grean Deal for Europe, the Clean Energy Transition Partnership, new European Strategic Energy Technology (SET) Plan with the selected targets for 2030 and 2050; the European Research Programme Horizon Europe; the National Integrated Plan on Energy and Climate; the Spanish Strategy on Science, Technology and Innovation; technology roadmaps of recognized international institutions and associations and implementation agreements of the International Energy Agency.

laboratories

The building and laboratories of IMDEA Energy Institute are located at the Technological Park of Mostoles, Madrid, over a land of 10,000 m^2.

The excellent R&D capabilities and the first class research facilities make IMDEA Energy the ideal partner for companies, research centres and universities

Research topics

- Production of sustainable fuels
- Concentrated solar power
- Energy storage
- Smart management of electricity demand
- Energy systems with enhanced efficiency
- Valorization of CO_2 emissions
- Techno-economic evaluation of energy systems

The building has been awarded with the prestigious LEED Gold Certificate and the A Energy Efficiency Certificate.

building

IMDEA Energy
Unit of Excellence “María de Maeztu”

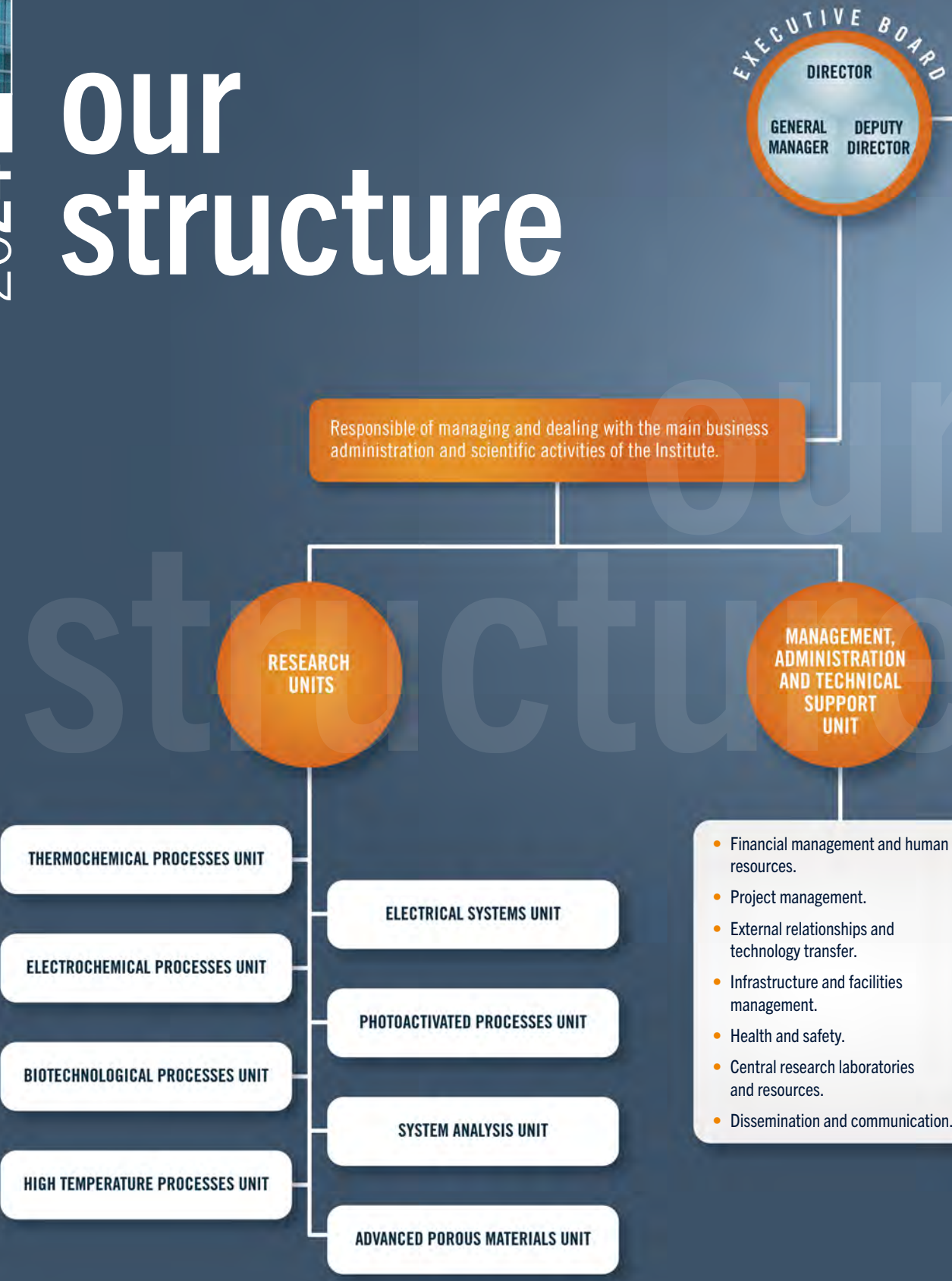
IMDEA Energy’s commitment to excellence in the recruitment of human resources, the selection of cutting-edge research lines, the provision of top-level scientific equipment and, in particular, the high quality and impact of its scientific contributions was recognized in 2020 through 2024 with the accreditation as a “María de Maeztu Unit of Excellence”, granted by the Ministry of Science and Innovation. IMDEA Energy forms part of the SOMMa network of Severo Ochoa/ María de Maeztu distinguished centers.

Unit of Excellence "María de Maeztu"

The award grant has allowed IMDEA Energy to reinforce its lines of research on decarbonization of mobility by electrification and the production of hydrogen, solar fuels and waste-derived fuels. Particularly noteworthy is the significant presence of projects related to the production of sustainable fuels for aviation, three European projects and one regional hub, as a result of this prioritization. With the support of Maria de Maeztu grant, the Institute has improved all the performance indicators in terms of scientific-technological excellence; attracting talent and training; internationalization, technology transfer and dissemination.

UNIT OF EXCELLENCE MARÍA DE MAEZTU
GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA E INNOVACIÓN
AGENCIA ESTATAL DE INVESTIGACIÓN

our structure



BOARD OF TRUSTEES

The highest decision-making body responsible of the government, representation and administration, aiming to ensure the achievement of the established goals.

PRESIDENT

Prof. Dr. Martin Kaltschmitt
Institute for Environmental Engineering and Energy Economics
Hamburg University of Technology, Germany

VICE-PRESIDENT

Mr. Emilio Viciana
Regional Minister of Universities, Science and Research
Comunidad de Madrid, Spain

REGIONAL ADMINISTRATION REPRESENTATIVES

Mrs. Ana Ramírez
Deputy Regional Minister of Universities, Science and Research
Comunidad de Madrid, Spain

Mrs. Marina Villegas
General Director of Research and Technological Innovation
Comunidad de Madrid, Spain

Mr. Nicolas Casas
General Director of Universities
Comunidad de Madrid, Spain

Mrs. Bárbara Fernández-Revuelta
Deputy General Director for Research
Comunidad de Madrid, Spain

Mr. Rafael García
Deputy Regional Minister of Environment and Agriculture
Comunidad de Madrid, Spain

Mr. José de la Sota
Scientific Coordinator
Fundación para el Conocimiento madri+d
Comunidad de Madrid, Spain

INSTITUTIONAL TRUSTEES

Prof. Dr. José Antonio Calles
Rey Juan Carlos University, Spain

Dr. Yolanda Benito
Centre for Energy, Environmental and Technological Researchs, CIEMAT, Spain

Prof. Dr. José Ramón Ares
Autónoma University of Madrid, Spain

Prof. Dr. Carlos del Cañizo
Polytechnic University of Madrid, Spain

IMDEAS TRUSTEES

Prof. Dr. Arturo Romero
Complutense University of Madrid, Spain
(appointed by IMDEA Water)

Prof. Dr. Paula Sánchez
Castilla – La Mancha University, Spain
(appointed by IMDEA Materials)

SCIENTIFIC TRUSTEES

Prof. Dr. Antonio Monzón
University of Zaragoza, Spain

Dr. Francisco Girio
National Laboratory of Energy and Geology Portugal

Prof. Dr. Manuel Berenguel
University of Almería, Spain

Dr. Rufino Navarro
Institute of Catalysis and Petrochemistry, CSIC Spain

EXPERT TRUSTEES

Dr. José Jacinto Monge
Rey Juan Carlos University, Spain

Mrs. África Castro
H2B2, Spain

COMPANIES TRUSTEES

Ms. Adriana Orejas
Repsol, S.A Spain

Mrs. Pilar González
Iberdrola S.A., Spain

Mr. Vicente Alvarado
Empresarios Agrupados Internacional S.A. Spain

SECRETARY

Mr. Alejandro Blázquez
Advisoring Tercer Sector, Spain

SCIENTIFIC COUNCIL

Advisory body responsible of the elaboration of the scientific programme and of the establishment of the goals to be achieved by periods of four years as well as of the assessment of the annual performance.

Prof. Dr. Martin Kaltschmitt
Institute for Environmental Engineering and Energy Economics
Hamburg University of Technology, Germany

Prof. Dr. Antonio Monzón
Chemical Engineering and Environmental Technologies Department
University of Zaragoza, Spain

Dr. Francisco Girio
Bioenergy Unit
National Laboratory of Energy and Geology, Portugal

Prof. Dr. Michael Froeba
Department of Applied Inorganic Chemistry
University of Hamburg, Germany

Prof. Dr. Manuel Berenguel
Department of Computing Sciences
University of Almería, Spain

Dr. José A. Olivares
Los Alamos National Laboratory, USA

Dr. Rufino Navarro
Institute of Catalysis and Petrochemistry, CSIC, Spain

Prof. Dr. Gonzalo Guillén-Gosálbez
Chemical and Bioengineering Institute
ETH Zurich, Switzerland

Prof. Dr. Elena Gálvez
Institute of Nanoscience and Materials of Aragón
Zaragoza, Spain

Prof. Dr. Silvia Bodoardo
Electrochemistry Group,
Politecnico di Torino, Italy

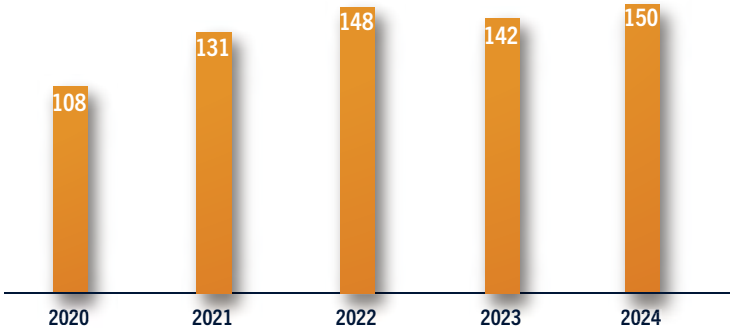
Prof. Dr. Valeria Nicolosi
School of Chemistry, CRANN, AMBER & I-Form
Trinity College Dublin, Ireland

in figures

human resources

IMDEA Energy is firmly committed to the objective of providing the Institute with a world-class staff and prestigious researchers. Accordingly, the Institute is developing from the beginning a selective process for the recruitment of scientists.

Human resources evolution



Human resources distribution by the 31st of December of 2024

- 29 Researcher Professor / Senior / Senior assistant 19%
- 27 Posdoctoral researcher 18%
- 48 Predoctoral researcher 32%
- 12 Assistant researcher 8%
- 17 Technicians 12%
- 17 Management and administration 11%

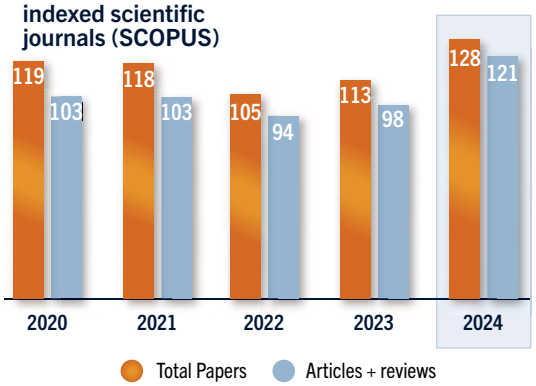
53 students in connection with the IMDEA Energy Institute in 2024

Mobility actions in 2024

10 secondments of IMDEA Energy researchers
23 visiting researchers

R&D results

Publications in indexed scientific journals (SCOPUS)



2024

118 oral presentations,
22 invited conferences
and 26 posters communications.

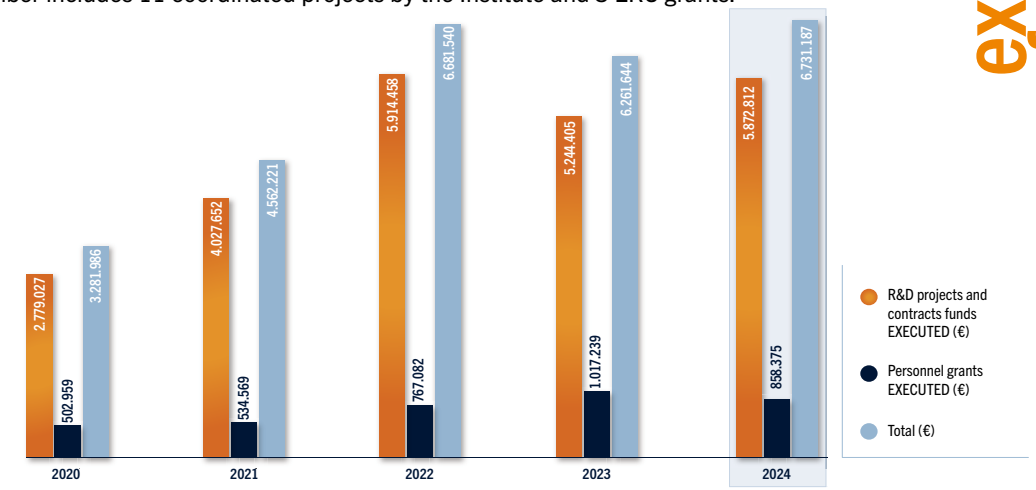
9 Ph.D. thesis defended.

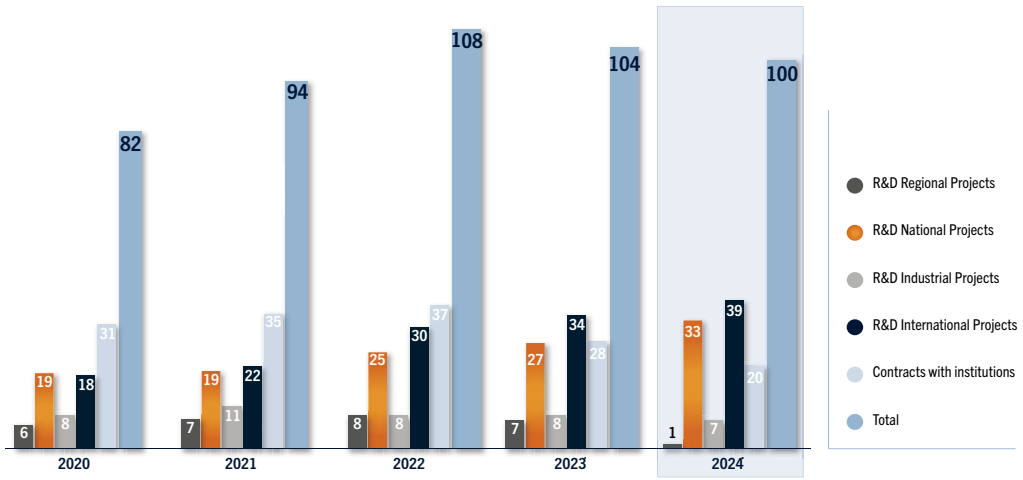
1 new patent application and 1 patent granted.

external funding

The portfolio of the Institute research projects is characterized by its diversity in terms of funding source, being remarkable the high degree of collaboration with industries and research institutions of the energy sector.

IMDEA Energy has increased its involvement and leadership in projects funded in international competitive calls during 2024, being active a total of 39 international projects. This number includes 11 coordinated projects by the Institute and 3 ERC grants.



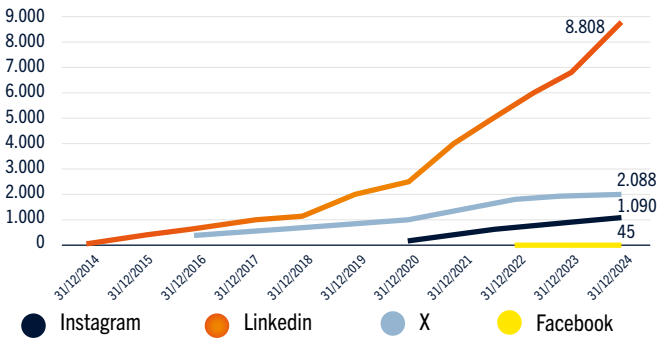


social impact

Evolution of the followers in social networks

12.031
followers at the end of 2024

23%
of increase respect to 2023



cooperation & networking

Cooperation and networking with industry, research centers and academia in R&D and innovation is one of the key objectives of the IMDEA Energy Institute. In 2024 IMDEA Energy maintained direct collaborations with 77 research organizations and universities and 47 industrial partners, mainly within the framework of ongoing R&D projects.

During 2024 IMDEA Energy had an active participation in 45 associations, technology platforms, expert groups and associations in the energy sector, 8 of them were international, as an essential point to increase its external visibility, establish new links with companies and research organizations and obtain updated information on the initiatives in the different fields of energy.

research lines

Energy storage coupled to renewable energy and transport

Technologies and systems for the storage of energy enabling the increased penetration of renewable energies and the distributed generation of electricity.

Electrochemical energy storage

- Nanostructured materials for electrochemical capacitors and advanced batteries.
- Electrochemical capacitors with high energy density.
- Low-cost redox flow batteries.
- Development of testing protocols for batteries and supercapacitors.

Thermal and thermochemical energy storage

- Phase change materials (PCM) with macro-encapsulated structures and storage systems for solar thermal power plants and industrial waste heat recovery.
- Thermal energy storage with gas/solid systems in thermoclines and moving bed exchangers.
- Thermochemical storage systems making use of high temperature redox reactions.

Production of sustainable fuels

Biofuels, alternative fuels and bioproducts aiming at the decarbonisation of the transport sector.

- Biofuels and bio-products from microalgae carbohydrates.
- Biofuels via fast pyrolysis or catalytic pyrolysis of lignocellulose biomass and residues.
- Upgrading of bio-oils by catalytic hydrodeoxygenation processes.
- Development of CO_2-free fuels by solar driven thermochemical cycles.
- Solar fuels production by artificial photosynthesis.
- Valorization and dehalogenation of plastic wastes.

Concentrated solar power

Efficient and dispatchable solar concentrating technologies for power generation, industrial process heat and production of solar fuels and chemicals.

- Optical design of modular schemes for solar thermal power plants.
- Solar receivers and reactors for new heat transfer fluids.
- Solar technologies for fuels and chemicals production with CSP.
- Increasing solar-to-electricity conversion efficiency and dispatchability.

Smart management of electricity demand

Management, reliability and stability aspects of future electricity networks and new algorithms for demand management and renewable integration.

- Demand forecasting and network management algorithms.
- Reliability of power systems with high penetration of renewables.
- Building and residential demand modelling.
- Distribution network applications and services.
- Power electronics and power interfaces.

Energy systems with enhanced efficiency

Technologies and strategies for efficient end-use of energy in buildings, industrial processes and environmental applications.

- Control systems and algorithms for energy efficiency in industrial applications.
- Capacitive deionization for energy efficient water treatment.
- Solar heat for medium and high temperature industrial processes.
- Integration of renewable energy technologies in buildings.

Valorization of CO_2 emissions

CO_2 valorization routes by its transformation into high-demand valuable products.

- CO_2 photoreduction for energy storage and fuels production.
- Multifunctional materials and solar reactors for photoactivated processes.
- Thermo-catalytic routes for CO_2 transformation in industrial processes.

Techno-economic evaluation of energy systems

Sustainability assessment, optimisation of processes and modelling for energy planning.

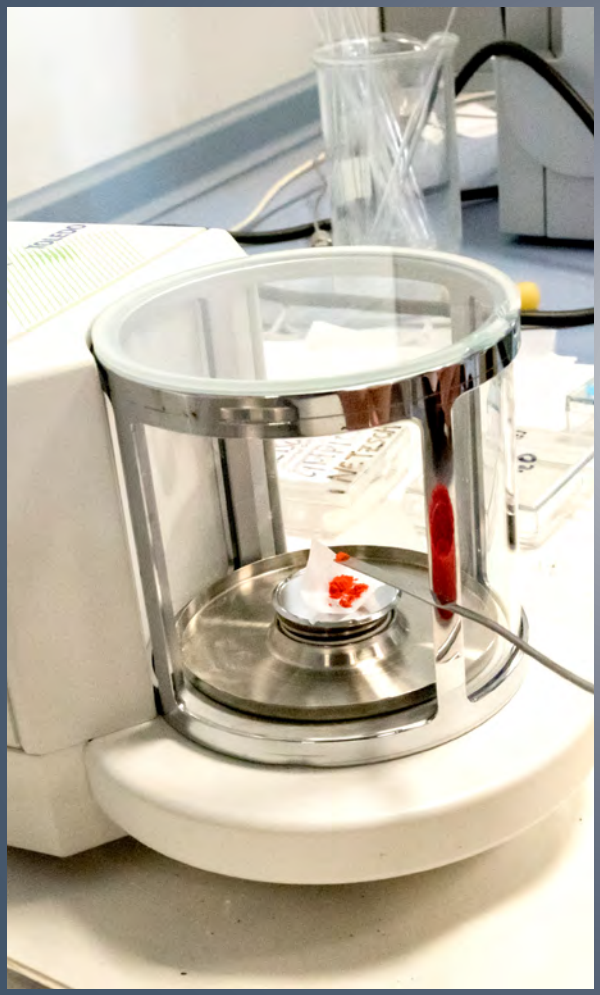
- Process simulation and optimization.
- Life cycle management, sustainability and social aspects.
- System modelling and technology roadmapping.

research lines

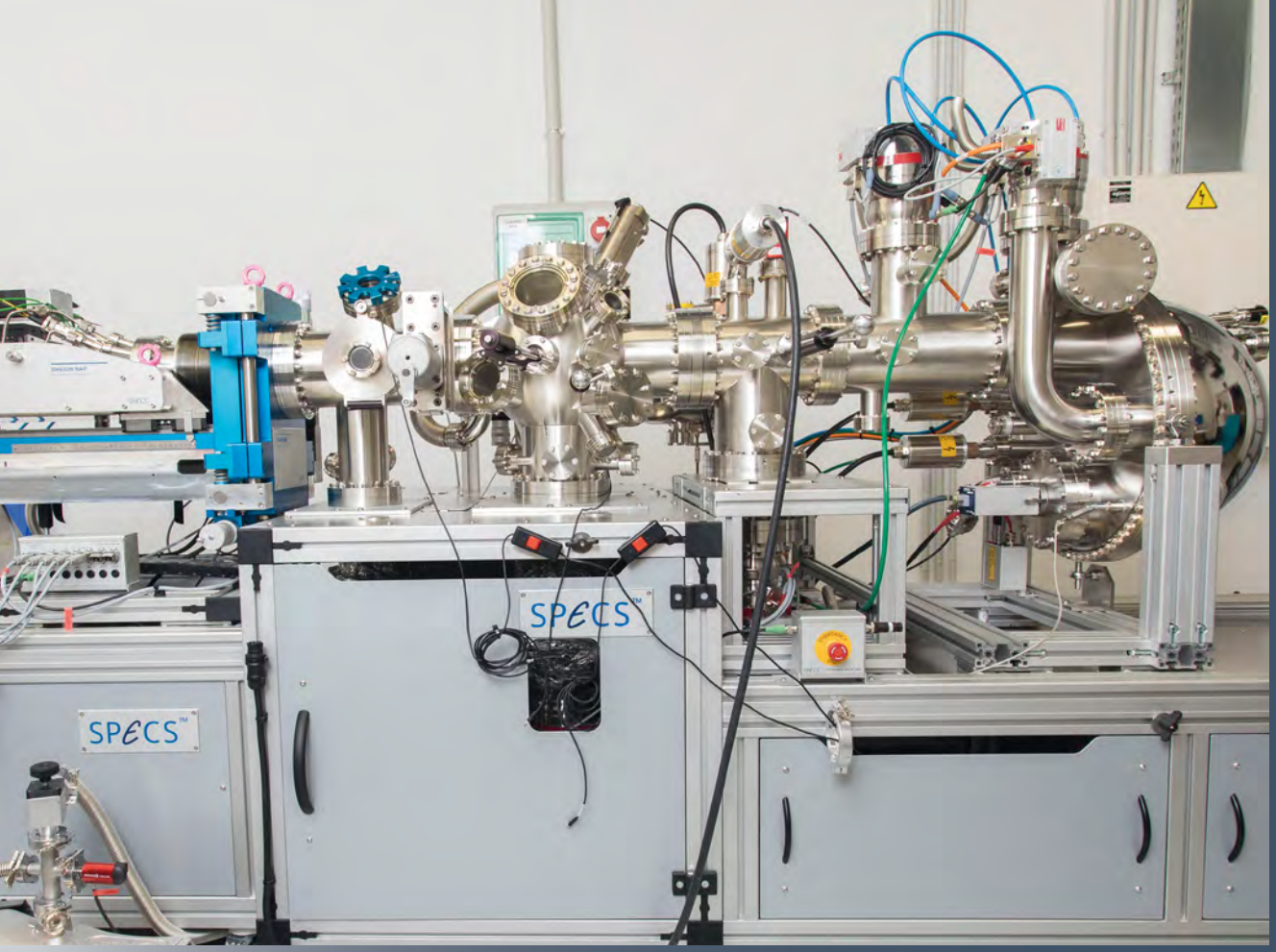
scientific facilities

Instrumental Techniques

- Chemical characterization techniques: mass spectrometry; gas/mass chromatography; NOx chemiluminescence analyzer; pyrolyzer / gas chromatography- mass spectrometry (Py/GC-MS); elemental analysis ICP – OES; AOD decomposition system (calorimetric pump) and CHONS.
- Thermogravimetric analysis (TG-DTA) in an oxidising (air), inert (Ar) or reductive (10% H_2/Ar) atmosphere.
- Properties of solids: textural and chemisorption.
- X-ray diffraction with PDF structural analysis and controlled atmosphere chamber up to 900 °C and 10 bar.
- Spectroscopy: IR (DRIFT, ATR and VEEMAX), UV-vis-NIR, Raman and fluorescence.
- Thermal diffusivity determination.
- Microscopy: atomic force, SEM, FEG-SEM.
- Biotechnological characterisation techniques: GC, HPLC equipped with different columns and detectors (IR, MS, UV-VIS, HPAEC-PAD). Electrophoresis instrumentation for recombinant DNA technology, protein purification and analysis.
- Near-ambient pressure (NAP) XPS which allows the in-situ characterisation of photocatalytic processes under illumination at different gas atmospheres and pressures up to 25 mbar.



scientific facilities



Pilot Plants Facilities

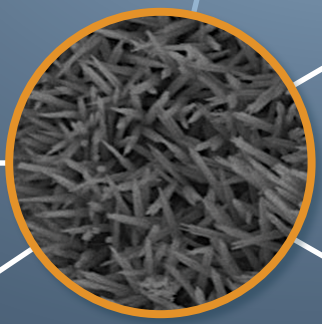
- High Flux Solar Simulator Kiran-42 with an electrical power of 42 kW that with the use of seven 6- kWe short-arc Xenon lamps is able to reach irradiances at the focal point near 4,000 kW/m^2 and a total power of 12 kW.
- Test bench of batteries for the programming of different test procedures and charge and discharge cycles. It allows analyzing the electrochemical devices performance, cyclability, aging and failure modes.
- Smart Grids Laboratory for the simulation of electrical systems operation, including the integration of renewable energies, storage systems and electric vehicle in order to get an efficient management of the energy resources.
- Pilot plant for the production of advanced biofuels via thermochemical transformations of biomass: catalytic pyrolysis and hydrodeoxygenation.
- Photobioreactors pilot plant which has been designed in order to compare and optimise the most common algae cultivation systems.
- Solar fuels photoreactor formed by a compound parabolic concentrator (CPC) coupled to a gas chromatograph.

Solar Field

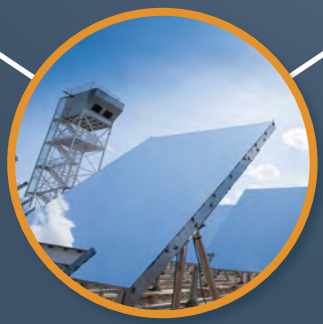
- Consisting of 169 heliostats, 3 m^2 each, with an experimental platform located on top of an18 m height tower. This facility allows testing receivers, reactors and materials up to 250 kW thermal power under irradiances above 2000 kW/m^2.

research units

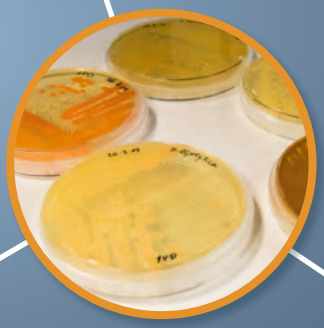
Thermochemical Processes Unit



Electrochemical Processes Unit

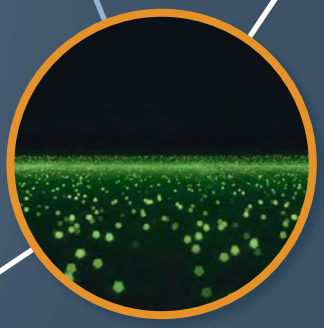


High Temperature Processes Unit



Biotechnological Processes Unit

System Analysis Unit



Photoactivated Processes Unit

Electrical Systems Unit

Advanced Porous Materials Unit

Thermochemical Processes Unit

Prof. Dr. David P. Serrano
Research Professor
Head of the Unit

Dr. Patricia Pizarro
Senior Researcher
(Associated)

Dr. Javier Fermoso
Senior Assistant
Researcher

Dr. Inés Moreno
Senior Assistant
Researcher
(Associated)

R&D OBJECTIVES

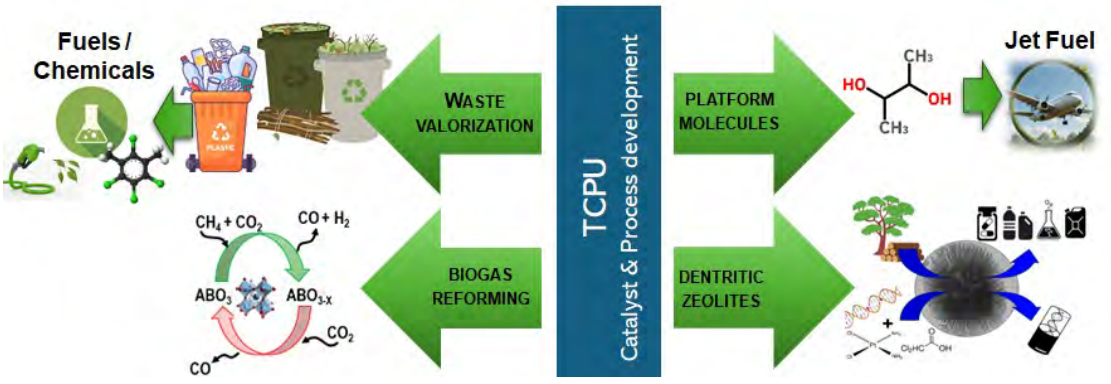
- Development of materials (catalysts and adsorbents) for the improvement or adaptation of thermochemical processes that contribute to the energy transition and the circular economy using different types of waste streams as resources.
- Development of zeolitic materials with dendritic morphologies and unique properties of great interest in different applications.

R&D LINES

- Waste valorization through thermochemical-catalytic routes.
- Catalytic conversion of waste-derived platform molecules.
- Catalysts for biogas reforming using chemical reaction cycles. Development of dendritic zeolites and their potential applications.

RELEVANT PROJECTS AND NETWORKING

- By 2024, the TCPU has participated in 11 research projects distributed across the following themes: 9 on organic waste valorization (including biogas reforming and platform molecule conversion); 1 on the development of biofilters from biochars; and 1 on the synthesis and applications of dendritic zeolites. The Community of Madrid is funding two projects: BIOCHARFILT (a grant to attract young research talent) and HUBS MAD VUELA SOSTENIBLE (Sustainable Flying Hub). The national government is funding six research projects: ADBIOCAP, UPGRES, CIRPLACAR, HYWARE, HYPY-CAT, and PCoN-M3 (CONCERT-Japan Research and Innovation Joint Call / PCI 2023). In addition, the TCPU participates in the European YAF project (HORIZON-MSCA-2022-DN-01), coordinates the HORIZON EUROPE project BIOCTANE, and Prof. David P. Serrano is the PI of the ERC Advanced Grant TODENZE. Finally, the TCPU participates in the German project EVERYCARBON as a subcontracted group.
- The TCPU maintains contact and collaborations with various universities and research centers both nationally and internationally, including ICP-CSIC, Rey Juan Carlos University, Autonomous University of Madrid, University of Calabria (Italy), Charles University (Czech Republic), Åbo Akademi University (Finland), Hamburg University of Technology (Germany), Paul Scherrer Institute (Switzerland), INRAE (France), Universidade Federal do Rio Grande do Norte (Brazil), and Universidade Federal do Rio Grande do Sul (Brazil). New contacts include the Instituto Superior Técnico (Portugal) and Eindhoven University of Technology (Netherlands). Furthermore, Prof. Dr. David Serrano is a member of the External Evaluation Committee of CIESOL (a joint center between the University of Almeria and CIEMAT/PSA) and of the Advisory Committee on Unique Infrastructures of the Ministry of Science, Innovation and Universities. In 2024, he was appointed a member of the Science and Technology Council of the Community of Madrid and of the Royal Academy of Exact, Physical, and Natural Sciences of Spain. In 2024, Patricia Pizarro served as secretary of the Governing Board of the Spanish Zeolite Group (GEZ).



High Temperature Processes Unit

Dr. José González-Aguilar
Senior Researcher
Head of the Unit

Dr. Manuel Romero
Research Professor

Dr. Ricardo Conceiçao
Senior Assistant Researcher

R&D OBJECTIVES

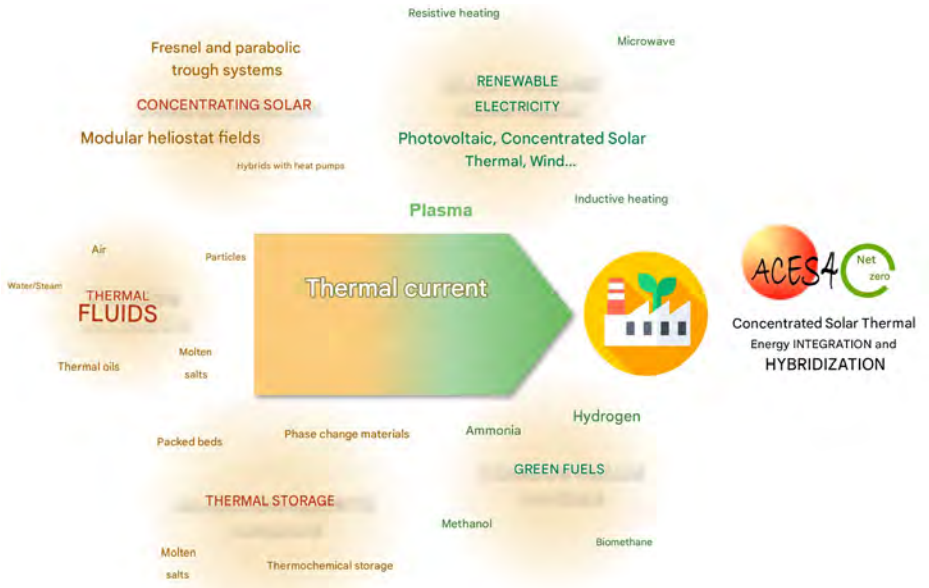
- Modular, efficient, dispatchable and cost-effective high temperature solar concentrating technologies for production of solar fuels and chemicals, industrial process heat and power generation.

R&D LINES

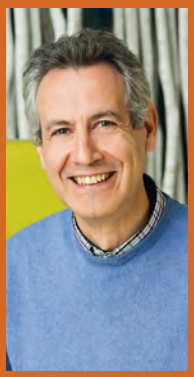
- Modular schemes of solar thermal systems for their integration into urban and industrial environments
- Advanced solar receivers and reactors (pressurized, volumetric and particles) and heat exchangers.
- High temperature thermal storage (thermochemical, sensible and phase change).
- Synthesis of solar fuels and chemicals through solar and electrolytic processes at high temperature.
- Analysis of integration of solar energy in industrial processes, heat recovery and environmental impact (advanced thermodynamic cycles, water-energy nexus, glint and glare).

RELEVANT PROJECTS AND NETWORKING

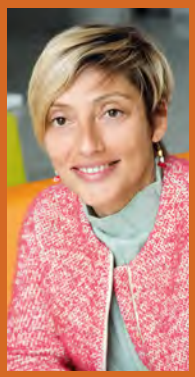
- The High Temperature Process Unit (HTPU) focuses its research on thermal technologies, with special emphasis on applications involving very high concentration of sunlight and high-temperature steam electrolysers. In 2024, HTPU research projects addressed three main topics: (i) Concentrated Solar Thermal Power, developing new numerical tools based on artifical intelligence to enhace the solar field efficiency by improvements in soliling assessment and aiming point strategy, and experimental devices for accurate flux characterisation in solar receivers, and testing new air-based solar receivers (HE ASTERIX-CAESar, HE SHARP-sCO2, National HECTOR) (ii) Solar fuels and hydrogen by means of redox thermochemical cycles and photothermal process, and high-temperature steam electrolysers. This area is alligned with the Maria Maeztu prgram in its 2nd research line and gathers the EU project HE Sun-to-Liquid-II and the national AGATA on Sun to Liquid II project on solar energy production of aviation fuels using concentrated solar energy, the FCH/JU PROMETEO project on solar heat and power for Solid Oxide Electrlysers and the regional GREENH2-CM with an important deployment of experimental outdoor facilities. (iii) Collaborative networks and infrastructures, in which the R&D unit contributes with its expertise and facilities to international collaborations as member of the ERIC EU-Solaris (for example, in the HE RISenergy or the EU-SOLARIS funded project FLARES) and actions run in the framework of the IEA TCP SolarPACES);
- In addition, HTPU participates in the Joint Program on Concentrated Solar Power (EERA JP-CSP). At the national level, HTPU also participates in the Spanish technology platform on CSP (SolarConcentra) and in the Energy Storage Working Group (GIA), an initiative of the Spanish Ministry of Economy and Competitiveness, and participates in the IEA SolarPACES Task II. Dr. José González is a member of the Board of Directors of the International Solar Energy Society (ISES).



Electrochemical Processes Unit



Dr. Jesús Palma
Senior Researcher
Head of the Unit



Dr. Rebeca Marcilla
Senior Researcher

Dr. Enrique García - Quismondo
Senior Assistant Researcher

Dr. Julio Lado
Senior Assistant Researcher

Dr. Patil Nagaraj
Senior Assistant Researcher

Dr. Sergio Pinilla
Senior Assistant Researcher

R&D OBJECTIVES

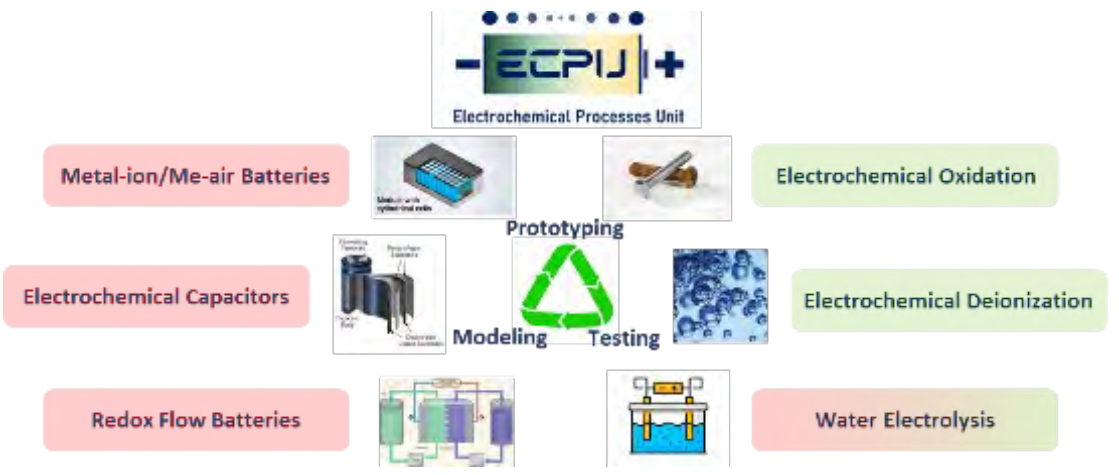
- Electrochemical energy storage devices and systems for stationary and transportation applications.
- Energy-efficient electrochemical devices and processes for environmental applications.

R&D LINES

- Design and manufacturing of flow batteries with novel chemistries free of critical materials.
- Materials and components to improve the performance, cyclability, and recycling of lithium-ion and other metal batteries.
- Design and scaling of capacitive and Faradaic deionization processes to capture valuable or potentially hazardous ionic species dissolved in natural or wastewater.
- New testing methodologies and accelerated testing of batteries and supercapacitors to determine their aging based on storage and usage conditions.
- Application of electrochemical methods for the electro-oxidation of organic pollutants.
- Production of renewable hydrogen by electrochemical methods.

RELEVANT PROJECTS AND NETWORKING

- In 2024, ECPU participated in a total of 23 research projects. Eight of them were European projects: 1 ERC Consolidator (MFreeB), 2 Horizon 2020 FET-Proactive (HySolChem and LIGHT-CAP), 1 EIC Open (MeBattery), 1 EIC Booster (MeBatFol), 2 Marie Curie ITN (POLYSTORAGE and eNargyZinc), and 1 EDF (NOMAD). Regarding national projects, 3 correspond to the knowledge development program (OMBAT, Net4Bat, and B3ES), 3 to the ecological and digital transition program (MicroBat, Solarfless, and BEST-MODA), 1 to the transformation and resilience program (Nitro-D-Cell), and 1 to the public-private collaboration program (BASSERE). Regarding regional projects, two were talent attraction projects (SELECTVALUE and ADEMOSSBat), one was an industrial doctorate (SHEAR), and one was a strategic positioning project in green H2 and fuel cells (Green H2-CM). In addition, four contracts were signed with the companies Verisure, Master Battery, Gnanomat, and Unbound Potential.
- In terms of networking, ECPU members have actively participated in the Specialized Electrochemistry Group of the Royal Spanish Society of Chemistry (Dr. Rebeca Marcilla as treasurer) and in the Spanish Technology Platform for Energy Storage (Dr. Jesús Palma as vice president).



Biotechnological Processes Unit

Dr. Cristina González
Senior Researcher
(Associated)
Head of the Unit

Dr. Elia Tomás
Senior Assistant
Researcher

Dr. Elvira Romero
Senior Assistant
Researcher

R&D OBJECTIVES

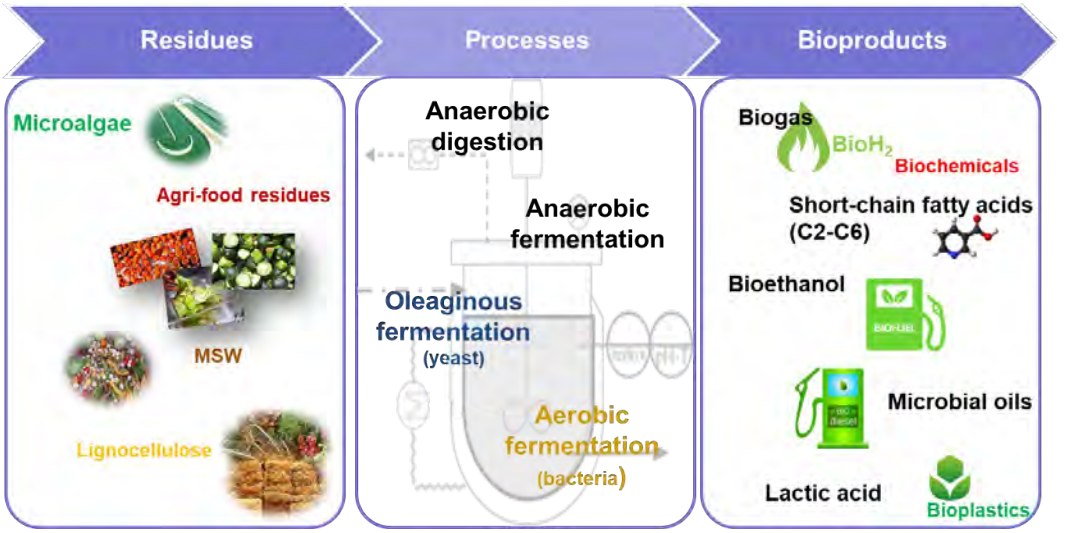
- Recovery of C (N and P) from waste/residues to produce biofuels and bioproducts.

R&D LINES

- Anaerobic digestion of waste streams for biogas production.
- Anaerobic fermentation of waste streams to produce short-chain fatty acids (SCFAs).
- Biofuels and lignocellulosic bioproducts.
- Use of the carboxylate platform: production of hydrogen and microbial oils.

RELEVANT PROJECTS AND NETWORKING

- In 2024, the Biotechnology Processes Unit (BTPU) participated in various national and international projects related to the use of waste streams for the production of alternative compounds (short-chain fatty acids (SCFAs), microbial oils, and lactic acid) and energy products (bioethanol and biogas). During this period, BTPU has participated in 8 projects, 2 of which are European (OLEOFERM- ERA CoBioTech (2021-2024) and YAF (HORIZON-MSCA-2022-DN-01 (2023-2028), 5 national (BIOMIO-2021-2024 , UPGRES_2021-2024, RAVIOLIC 2022-2024, RESOPLA 2022-2024 and CEL_BIONIC 2024-2027) and 1 regional (H UB Madrid Vuela Sostenible 2024-2027). Both BIOMIO and RESOPLA are coordinated projects led by BTPU. Similarly, OLEOFERM and YAF are international projects coordinated by BTPU. Additionally, in 2024 UBPT has been working on a contract with company with the Canal de Isabel II.
- Recognizing the importance of international visibility for establishing key collaborations, BTPU actively participated in various COST Actions (Greenering, Euromicroph, and WIRE) throughout 2024. In this regard, BTPU led the European project YEAST4BIO (2019–2024), funded by COST and H2020, which involved more than 150 researchers from 35 countries and concluded in May. As a result of its participation and leadership in the aforementioned projects, BTPU actively collaborates with leading research groups and European companies. Furthermore, BTPU is an active member of BIOPLAT and BIOCIRC.



Electrical Systems Unit

Dr. Milan Prodanovic
Senior Researcher
Head of the Unit

Dr. Javier Roldán
Senior Assistant
Researcher

R&D OBJECTIVES

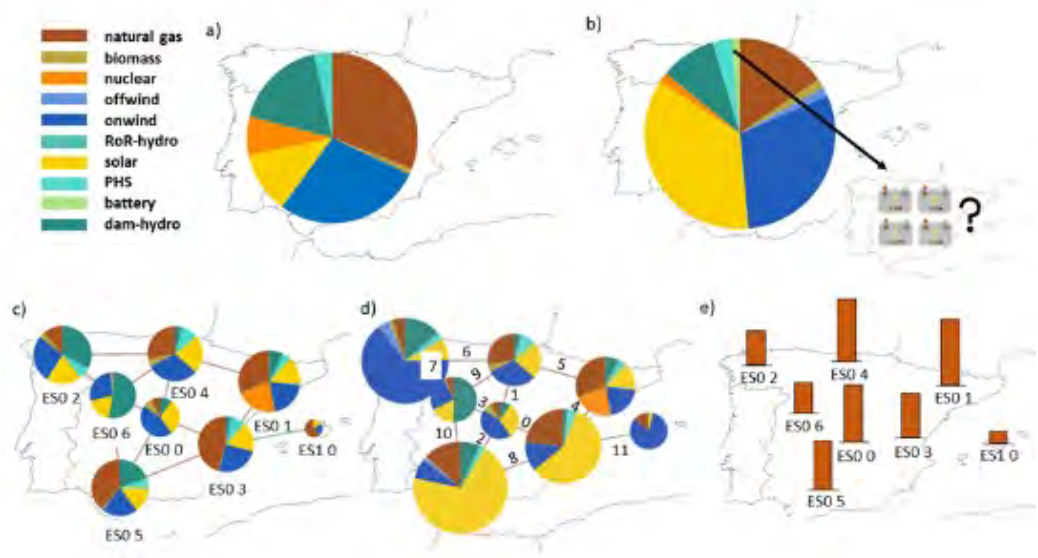
- Improving the control and stability aspects of future power grids with a high percentage of renewable and storage technologies.
- Optimization-based algorithms for demand management and renewable energy integration.
- Increasing energy efficiency in industrial applications.

R&D LINES

- Integration of renewable energy and energy storage.
- Control of power converters for applications in electrical networks.
- Stability of electrical grids with high penetration of renewable energy.
- Energy management and energy efficiency applications.

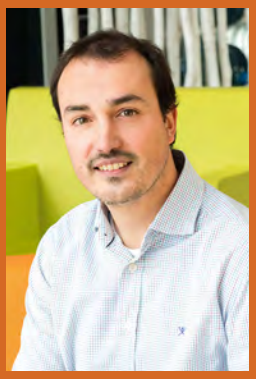
RELEVANT PROJECTS AND NETWORKING

- In 2024, the Electrical Systems Unit (ESU) participated in various research and development projects. The main research activities were carried out within the framework of the national projects REDESFUERTES (2023–2026), BEST, and SOLARFLESS (2022–2025). These projects addressed aspects related to control, stability, and flexibility in the integration of renewable sources and storage systems into electrical grids, the control of power electronic interfaces in grid applications, the holistic modeling of battery systems, and the hybridization of batteries with renewable generation plants. Regarding collaboration with the industrial sector, the main projects were DYNAMIC-COMPENSATION (2023–2026), focused on the design of a new product for power conditioning, and COPOWCO, in collaboration with IMV Corporation, aimed at the analysis of the electromagnetic compatibility of power converters in industrial applications. Towards the end of the year, two new projects were launched: the national project with industrial participation, BASSERE, and the European project HVDC4ISLANDS, within the framework of the CETP (Clean Energy Transition Partnership).
- The ESU actively participated in the activities of the Spanish Technology Platform for Electrical Networks (FUTURED), particularly in the Power Electronics working group. Furthermore, in 2024, the unit continued its work as an associate member of the Spanish Platform on ICT Applications for Energy Efficiency (EnerTIC).



System Analysis Unit

Dr. Javier Dufour
Research Professor
Head of the Unit



Dr. Diego Iribarren
Senior Researcher

R&D OBJECTIVES

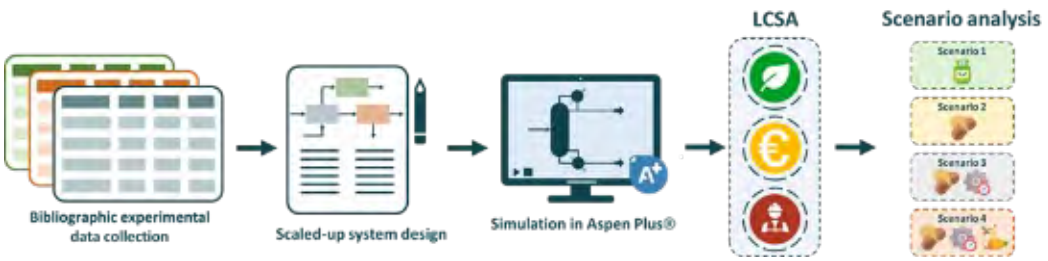
- Analysis of the sustainability of energy systems.
- Design, scaling, simulation and process optimization.
- Energy systems modeling for energy planning.

R&D LINES

- Sustainable design of hydrogen systems.
- Converting waste into energy within the framework of the circular economy and producing clean fuels.
- Development of energy models oriented towards sustainability.

RELEVANT PROJECTS AND NETWORKING

- During 2024, the Systems Analysis Unit (SAU) participated in various regional, national, and international projects, as well as research contracts, all related to sustainability analysis, process design and optimization, and energy planning. Related to hydrogen technologies, the SAU coordinated three European projects: SH2E (H2020-FCHJU, 2021-2024), eGHOST (H2020-FCHJU, 2021-2024), and HyPEF (HORIZON-JTI-CLEANH2, 2024-2026). In addition, it has participated in 4 other European projects: NOUVEAU (HORIZON-RESILIENCE, 2022-2025), NIMPHEA (HORIZON-JTI-CLEANH2, 2023-2026), JUST-GREEN AFRH2ICA (HORIZON-JTI-CLEANH2, 2023-2025) and HYPOP (HORIZON-JTI-CLEANH2, 2023-2025). At national level, it has participated in the HYWARE project and in the regional project, Green H2 Madrid, as well as in 2 contracts.
- In the field of photoactivated processes, the SAU collaborated in the development of the European projects HYSOLCHEM (FETPROACT, 2021-2025) and DESIRED (HORIZON-CL5, 2022-2026), and the national project SOLFUTURE (2021-2025). Within the field of circularity, the SAU has collaborated in two European projects LIFE Superbiodiesel (2020-2024) and OLEOFERM (ERA CoBioTech, 2021-2024) and two national projects, UPGRES (2021-2025) and CIRPLACAR (2022-2025), as well as in the European doctoral network YAF (2023-2027), the regional innovation hub Madrid Vuela Sostenible (2024-2027) and in four contracts. Additionally, it has participated in the NOMAD project (2022-2026), funded by the European Defense Fund, and in two contracts on the development of life-cycle inventories for the energy sector and on the sustainability assessment of recycled carbon fiber.
- In 2024, SAU senior researchers participated in various networking events such as GENERA, Energyear Mobility, and the Energy and Decarbonization Forum. Furthermore, Professor Javier Dufour is the leader of the Cross-Cutting Activities Technical Committee of Hydrogen Europe Research and of Task Force 1 of the European Hydrogen Sustainability and Circularity Panel. Dr. Diego Iribarren has been the Coordinator of the Spanish Life Cycle Assessment Network.



Photoactivated Processes Unit

Dr. Victor A. de la Peña
Senior Researcher
Head of the Unit

Dr. Marta Liras
Senior Researcher

Dr. Mariam Barawi
Senior Assistant Researcher

Dr. Laura Collado
Senior Assistant Researcher

Dr. Freddy Oropeza
Senior Assistant Researcher

Dr. Miguel García
Senior Assistant Researcher

R&D OBJECTIVES

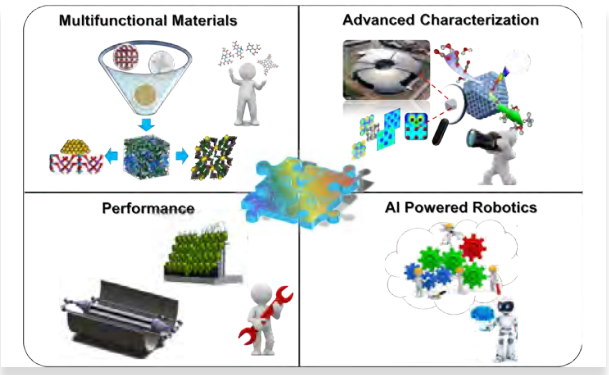
- Covering the processes and technologies that allow a smart and efficient light harvesting to drive photon-activated processes for energy and environmental applications.

R&D LINES

- Solar fuels an chemicals production including: CO2 photoreduction, H2 production, N2 fixation and added value chemical synthesis.
- Pollutants removal (i.e. NOx and VOCs photodegradation).
- Design and synthesis of multifunctional materials: inorganic, organic and hybrid systems.
- Full-spectrum light harvesting technologies for electron transfer processes.
- Combination of advanced characterisation and theoretical calculation for fundamental studies of reaction mechanisms.
- Photoreactors and devices (photocatalytic, photothermocatalytic and photoelectrocatalytic) for energy and environmental applications.
- Smart window devices based on electrochromic materials and semiconductor nanocrystals with Localised Surface Plasmon Resonance (LSPR).
- Photobatteries design.
- Photoactive materials for theragnosis applications.
- Development of robotic platforms orchestrated by AI for new-energy solutions (BRAIN Lab).

RELEVANT PROJECTS AND NETWORKING

- In 2024, the Photoactivated Processes Unit (UPFA) participated in 14 research projects and 7 funded initiatives at regional, national, and European levels.
- At the EU level, UPFA coordinated the FET Proactive action HYSOLCHEM, was a partner in the MSCA Staff Exchange BETTER XPS, and took part in the flagship CSA proposal SUNER-C.
- Nationally, UPFA has several ongoing projects, thanks in part to Next Generation funds, including: N-GREEN (2023–2026), novaCO2 (2021–2024), ARMONIA (2021–2025), FPI grants linked to Nhympha (2020–2023) and María de Maeztu (2023–2026). Additionally, UPFA coordinates SOLFUTURE and SolarChem 5.0 (both TED-funded, 2021–2025 and 2022–2025), and PEC2Change (2022–2025). Mariam Barawi and Fredy Oropeza obtained individual grants from the Consolidation of Researchers program for their projects SolarCPPBat and focoSOLAR (2023–2025).
- In addition, Fredy Oropeza and Mariam Barawi hold Ramón y Cajal fellowships (2021 and 2022 calls, respectively), and Marta Liras holds an I3 award (2022–2024), linked to her 2015 Ramón y Cajal grant. Moreover, UPFA completed the FotoArt-CM project (on multifunctional materials for artificial photosynthesis), started a CM predoctoral fellowship (Sandra Palenzuela, 2024–2027), and a PhD grant for Javier Llorente (2025–2028).
- On the industrial front, UPFA maintains contracts with Mercedes-Benz and recently launched another with REPSOL.
- On the other hand, Víctor de la Peña O'Shea represents Spain in SUNERGY and the Sunlight to X innovation community. UPFA is active in the Spanish CO_2 Technology Platform (PTECO2), where Víctor serves as Secretary General, in SUSCHEM, and the Iberian Association of Photocatalysis (AIF). Víctor is also President of the Specialized Group on Energy (GEEN) of the Royal Spanish Chemical Society (RSEQ), while Marta Liras chairs the Photochemistry Group (GRUFO).



Advanced Porous Materials Unit

Dr. Patricia Horcajada
Senior Researcher
Head of the Unit

Dr. Yolanda Pérez
Senior Researcher
(Associated)

Dr. Tania Hidalgo
Senior Assistant
Researcher

Dr. Catalina Biglione
Senior Assistant
Researcher

R&D OBJECTIVES

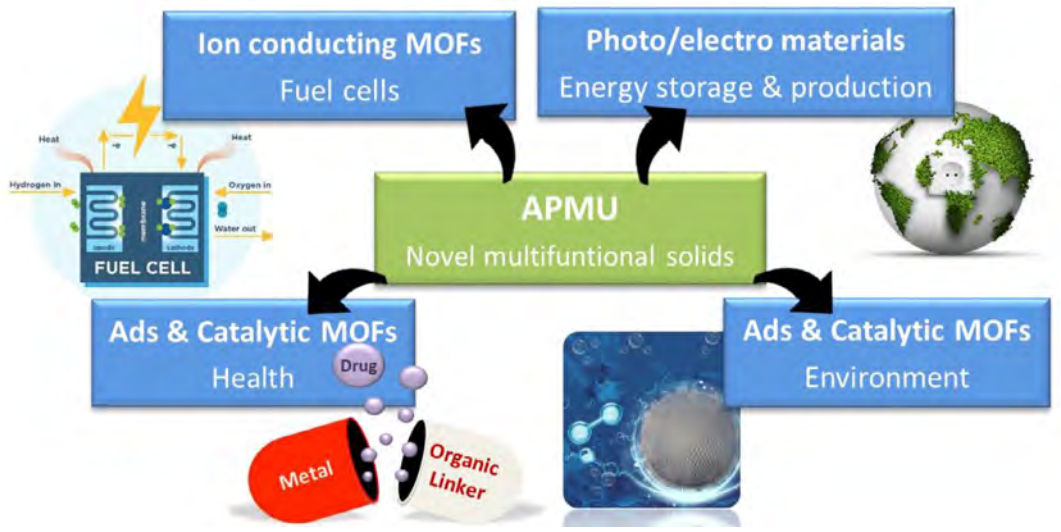
- Development of innovative multifunctional porous solids.
- Complete structural and physicochemical characterization to improve and/or adapt the properties of porous materials to specific applications.

R&D LINES

- Fuel cells: new materials with ionic conductivity.
- Energy production and storage: photo/electroactive solids.
- Health: adsorbent and catalytic biomaterials.
- Environmental: adsorbent and catalytic materials.

RELEVANT PROJECTS AND NETWORKING

- During 2024, the Advanced Porous Materials Unit (APMU) has coordinated a European project, the MSCA-ITN project HeatNMof (2020–2024), focused on heat-triggered drug release using nanosized Metal Organic Frameworks (MOF) composites. Furthermore, the APMU is actively participating in a COST action (EU4MOF), involving 10 European countries, and has hosted two researchers within the framework of prestigious MSCA-IF Individual Actions: MOF-PEM (2023–2025), focused on the application of MOFs as fuel cell components, and BioPolyMOF (2023–2025), oriented to the development of novel therapeutically active polymer-based MOFs.
- The unit is also implementing three national projects: H2MOF (2022–2024), focused on fuel cells and electrolyzers; NAPOLION (2023–2026), dedicated to CO_2 recovery; and HYLIOS (2023–2026), an industrial collaboration project focused on clean hydrogen production. At the regional level, APMU is also participating in the HUB MADRID VUELA SOSTENIBLE (2024–2026) industrial project, aimed at developing new catalysts for the production of sustainable aviation fuels.
- The APMU has a broad and high-quality network of collaborations, both national—with academic institutions such as ITQ, USC, UGR, UCM, and UAH—and international—including Stockholm University, ICGM-CNRS, TU/e, and the University of Antwerp—as well as with companies from diverse sectors, including Immaterial, Canal de Isabel II, Lantania, ISERN, Exolum, and Repsol.



annex

- R&D projects, and contracts
- personnel grants
- mobility actions
- indexed scientific publications (SCOPUS)
- intelectual property
- books and chapters of books
- other publications
- congress communications
- PhD thesis defended
- organization of scientific and industrial events
- organization of internal seminars
- participation in science dissemination activities
- training of students

annex

www.energy.imdea.org

annual report

2024

institute imdea energy

Contact
contact.enery@imdea.org
phone +34 91 737 11 20

Avenida Ramón de la Sagra, 3
Parque Tecnológico de Móstoles
E-28935 Móstoles, Madrid, Spain