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EUROPEAN UNION
STRUCTURAL FUNDS

La Suma de Todos
Comunidad de Madrid
www.madrid.org

Presentation

www.energy.imdea.org

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IMDEA Institutes

- IMDEA is a network of research centers.
- Regional level.
- Seven autonomous institutes.
- Operational since 2007.
- About 400 researchers.

imdea energy

imdea water

imdea nanoscience

imdea materials

imdea food

madrid institute for advanced studies imdea software

imdea networks

IMDEA Energy Institute

- Not-for-profit R&D Foundation.
- Legally founded in 2006 by Madrid's Government.
- Activity began in 2007.
- Mission: promote and carry out R&D activities for the development of a sustainable energy system with special emphasis on renewable and clean energy technologies.
- Organized into six research units.

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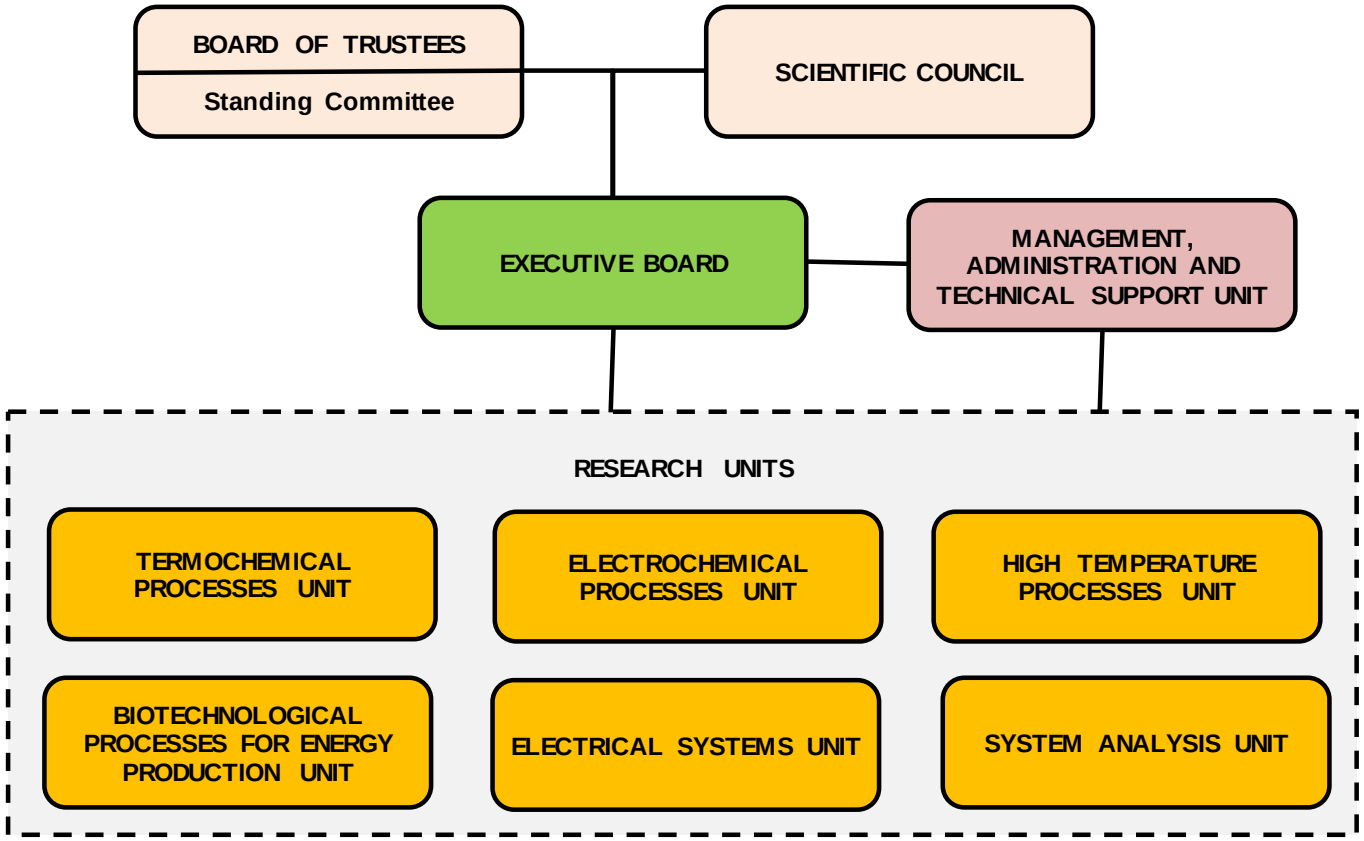
Organisation Structure



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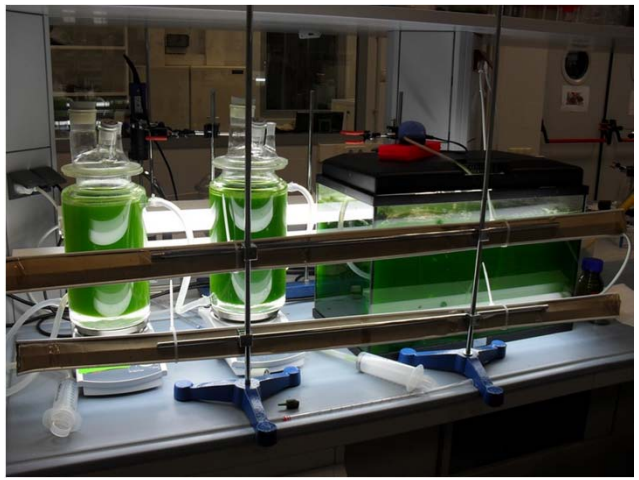
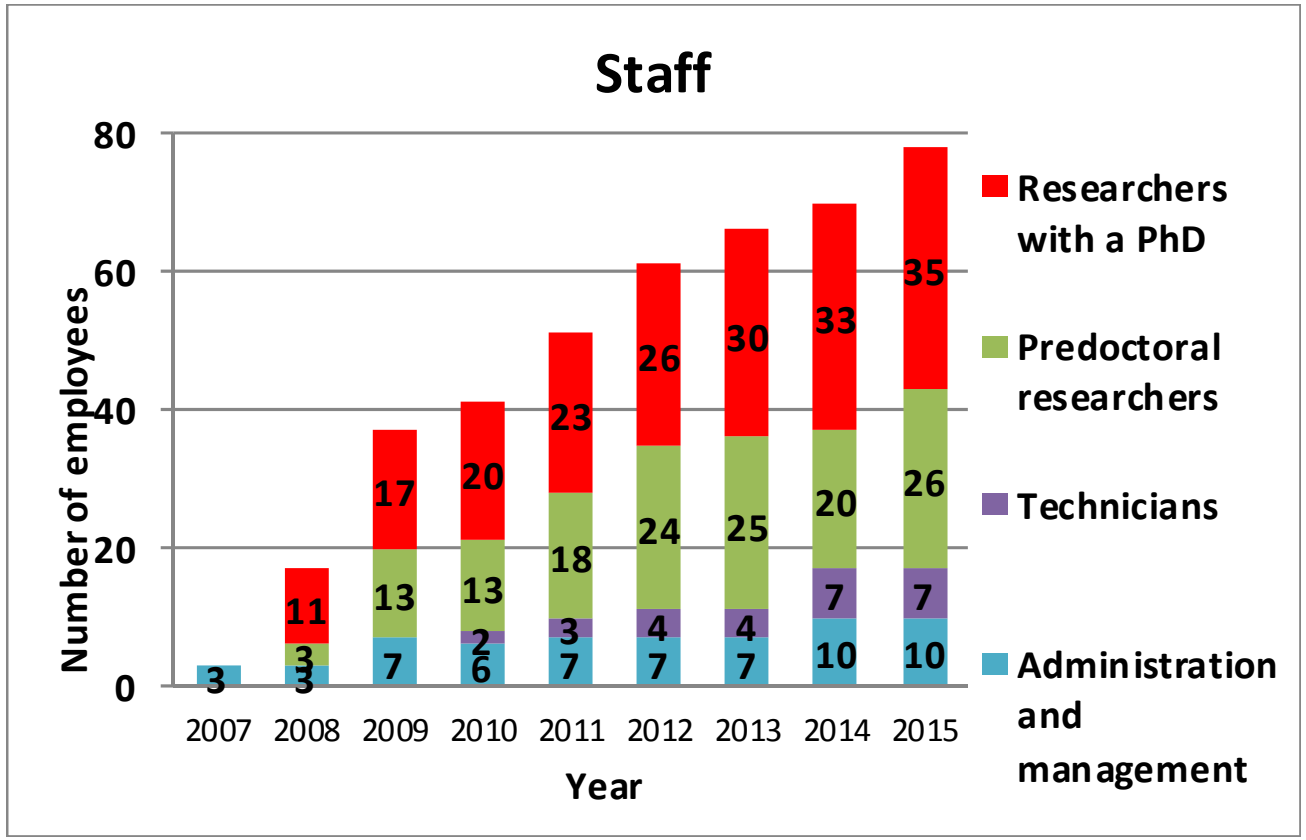
Research lines

- **Production of sustainable fuels**: hydrogen and biofuels.
- **Solar power**.
- **Energy storage**: electrochemical, thermal and thermochemical systems.
- **Energy systems with enhanced efficiency**: capacitive deionisation.
- **Smart management of electricity**.
- **Confinement and valorization of CO_2**.



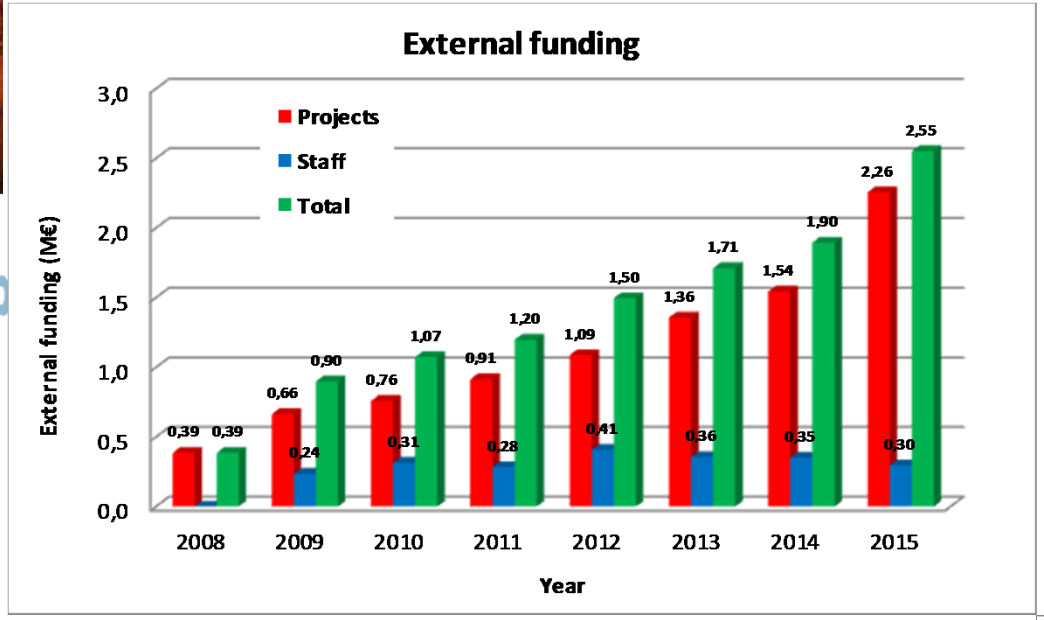
Staff



Roughly 1/3 foreigners, including about 15 nationalities

Type of activity	Number of students 2014
B.Sc and M.Sc final projects	19
Internships	25
Total	44

External funding

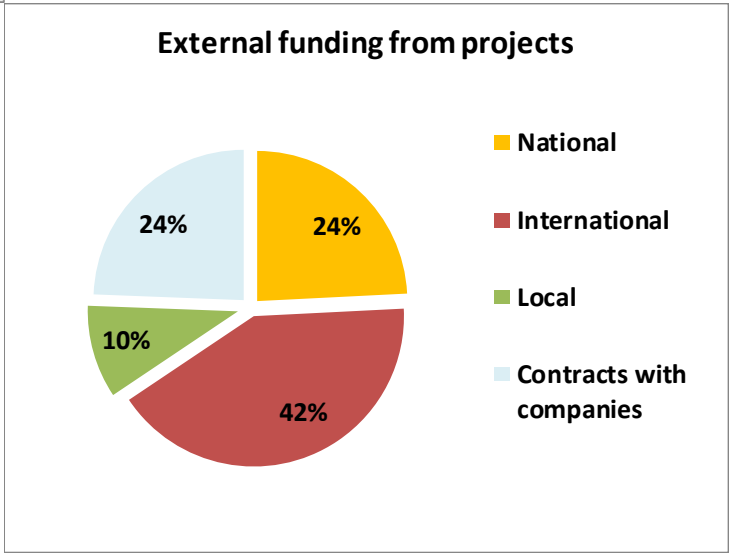


PROJECTS	Alive	Requested
Internationals	7	10
Spanish	16	13
Company contracts	8	2

Coordination of an international project with 17 partners and budget > 9 M €.

Staff funding:

- **Programme AMAROUT Marie Curie.**
- **Programme Ramón y Cajal.**
- **Programme Juan de la Cierva.**
- **Predoctoral grants FPI.**
- **Iberdrola Foundation Fellowships.**



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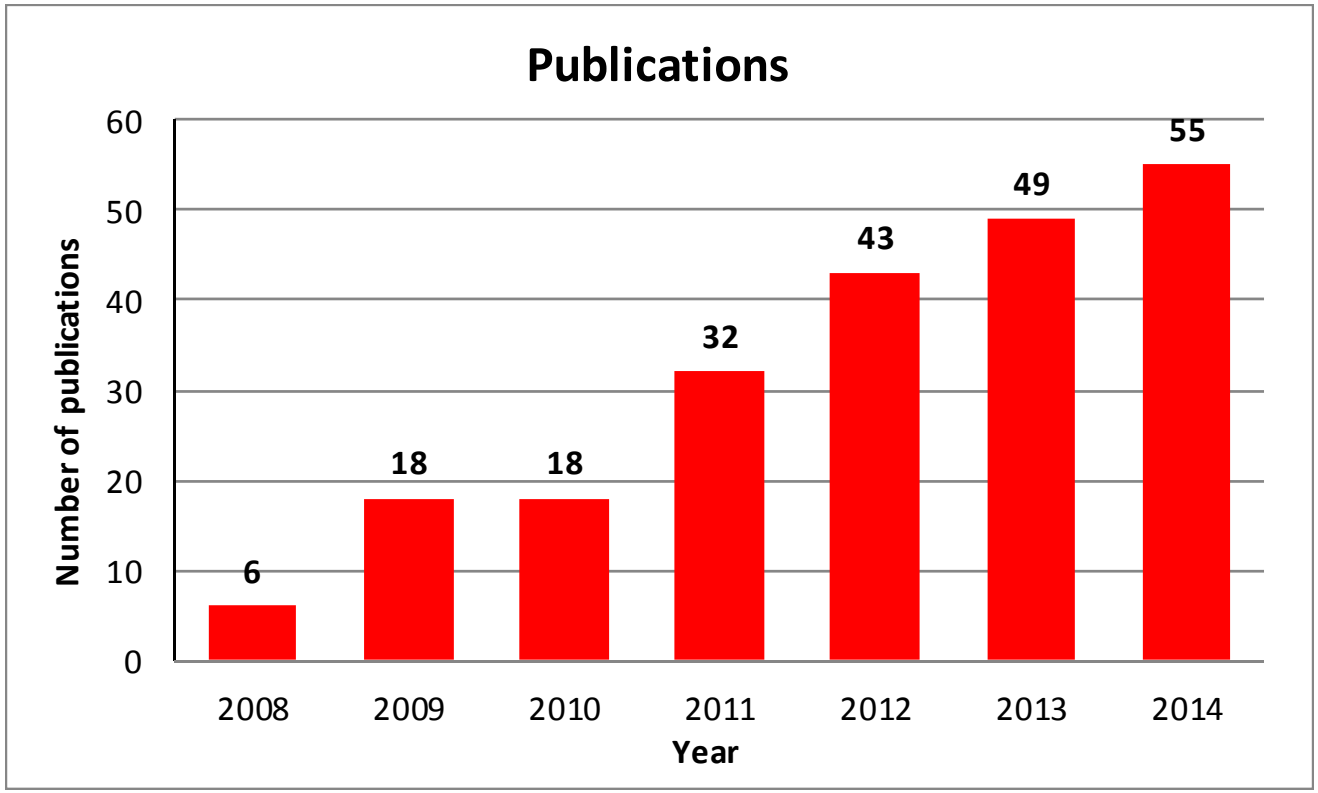
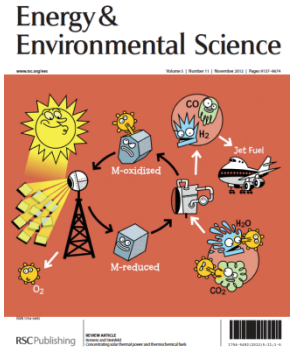
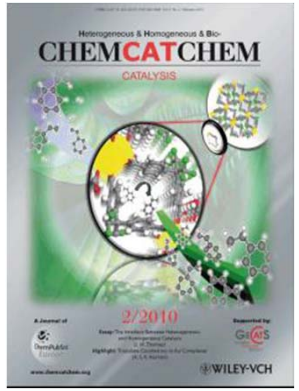
Scientific publications in indexed journals (Scopus)







COMMUNICATIONS TO CONGRESSES IN 2014: 57 (18 invited)

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Technological Services

Capabilities (I)

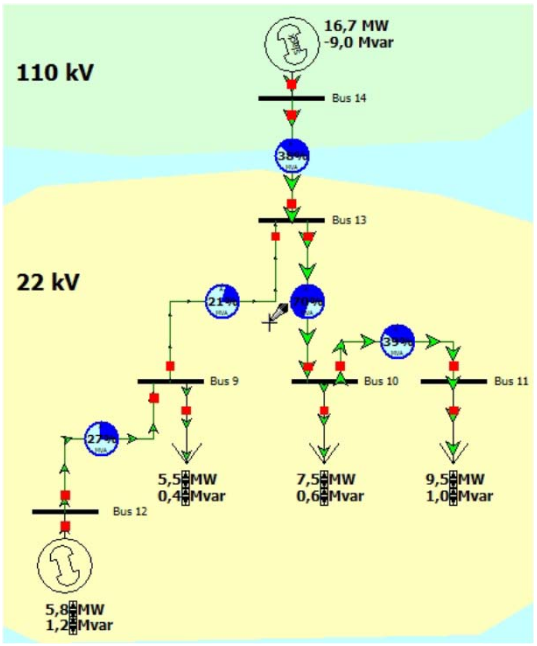
- **Management and life cycle analysis**: LCA, LCA+DEA, LCC, “emergy” analysis, carbon footprinting and analysis in support of environmental declarations applied to products, processes and services.

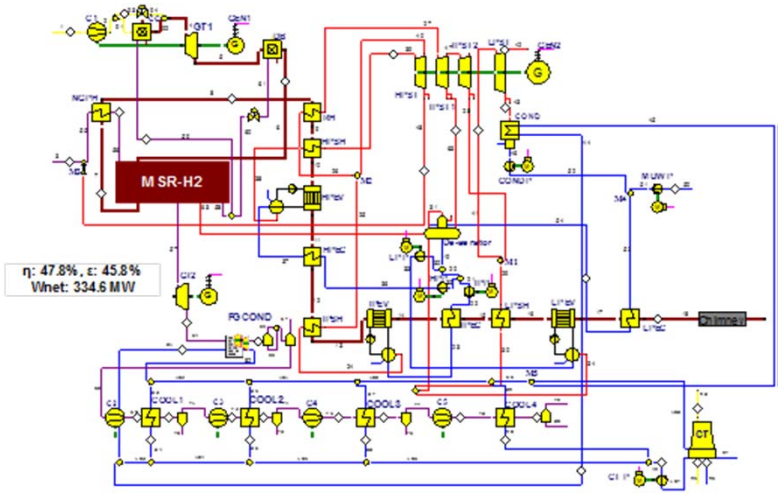
- **Process simulation and feasibility studies**, thermodynamic analysis, energy and exergy balance, socio-economic, techno-economic and sustainability studies and scenarios.

- **Synthesis and characterisation** of catalysts, materials for high temperature and energy storage, nanoparticles sol-gel, coating of electrodes and electrochemical cells.

- **Proactive management of power networks and conversion of electrical energy.** Static and dynamic modelling of power networks and microgrids. Real-time control. Design and control of power electronics interfaces.

- **Optical-mechanical engineering** and optical-energetic characterisation systems. Characterisation and simulation of high flows of solar radiation and high temperatures: thermal imaging systems, CCD and CMOS cameras, pyrometry and calorimetry.





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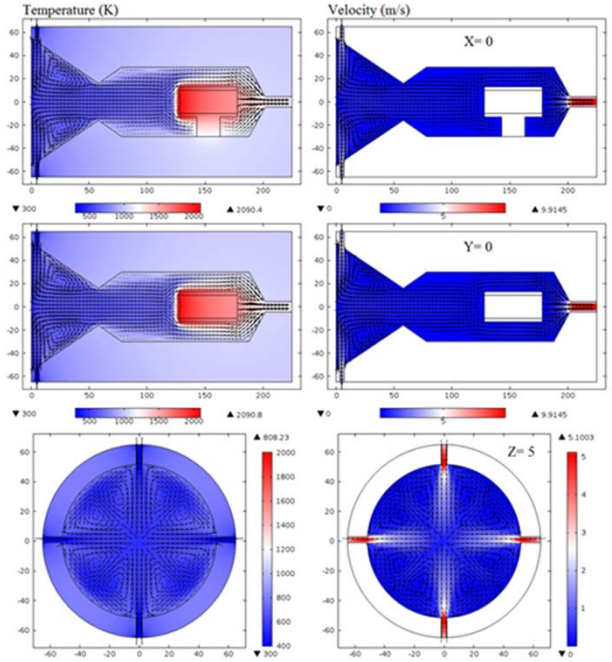
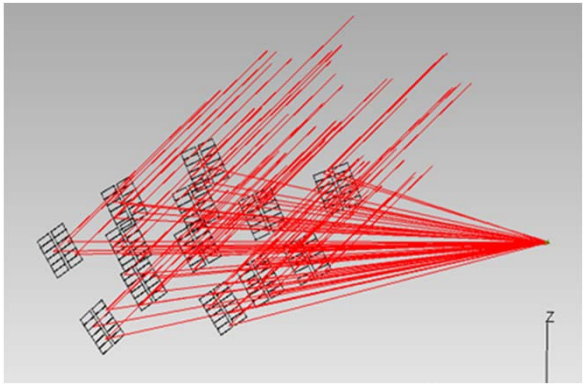
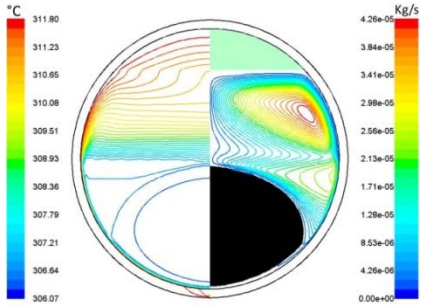
Capabilities (II)

- **Simulation and modeling:**
  - **Thermal fluid dynamics**, CFD (COMSOL Multiphysics).
  - **Process simulation** and data processing (Matlab-Simulink).
  - **Electric** (IPSA, PowerWorld).
  - **Ray tracing** (TracePro).
  - **Annual performance** (STEC/TRNSYS).
  - **3D computer-aided design** (SolidWorks).
  - **Data acquisition and process control**(LabVIEW).
  - **Calorimetric loops**.

- **Technology watch and foresight** on renewable energy and energy technologies.







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Pilot plant facilities

- **High-flux solar simulators of 7 and 42 kW**. Surface treatment and synthesis of materials. Advanced solar concentration optics. Solar receivers and reactors. Thermal fluids for high temperature applications.

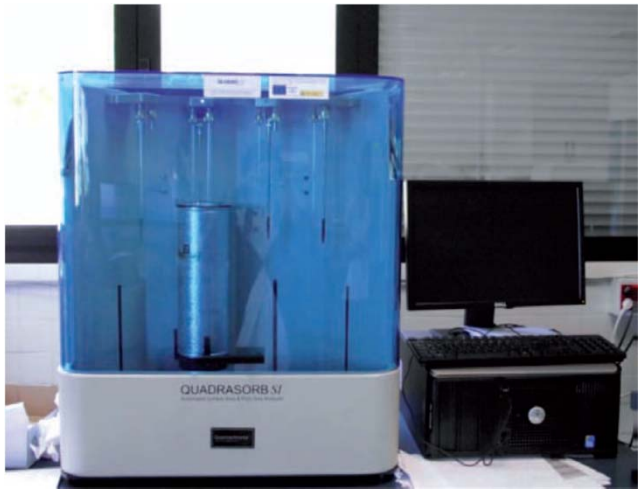
- **Smart Energy Integration Lab SEIL**. Real-time emulation of AC and DC power networks and microgrids. Development of optimal dispatch algorithms for energy resource management. Stability analysis, power quality and control strategies for microgrids and power electronics converters.

- **Test Installation for batteries and electrochemical capacitors EDTL** with various assay protocols in DC and AC. Simulation of demand cycles in powers from 0.3 to 30 kW under controlled temperature and humidity.

- **Production and conversion of biomass** in open and closed photobioreactors. Pyrolysis (thermal or catalytic) on fluidised bed reactor and hydrodeoxygenation on fixed bed reactor, coupled to systems of volumetric and chromatographic analysis.

Instrumental techniques

- **Chemical characterisation techniques:** mass spectrometry, gas/mass chromatography. Elemental analysis ICP-OES 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 structural analysis PDF and controlled atmosphere chamber up to 900 ºC and 10 bar.
- **Spectroscopy:** IR (DRIFT, ATR and VEEMAX), UV-vis-NIR, Raman and Fluorescence.
- **Thermal Diffusivity determination.**
- **Microscopy:** Atomic force with next probe, SEM scanning electron and optical.
- **Biotechnological characterisation techniques:** GC, HPLC equipped with different columns and detectors (IR, MS, UVVIS, HPAEC-PAD). Electrophoresis instrumentation for recombinant DNA technology, protein purification and analysis.



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Research topics

Solar energy and high temperature

Objectives

- Concentrating solar power systems engineering.
- High temperature components and applications.
- Production of solar fuels and chemicals.

Research lines

- ✓ Solar concentration plants for high efficiency and integration in urban environments.
- ✓ Solar concentrators, heliostats and optical engineering.
- ✓ Advanced thermal fluids.
- ✓ Solar receivers and reactors.
- ✓ Development of techniques for characterisation and simulation of high flows of solar radiation and at high temperatures.
- ✓ Integration of solar technologies for thermal, electric and hydrogen production contribution.
- ✓ Reduction of metal oxides, solar assisted combustion.

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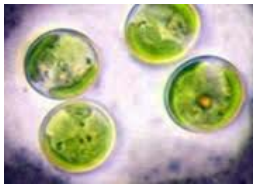
Sustainable fuels

Objectives

- Production of H_2: CH_4 decomposition, thermochemical cycles.
- Production of biofuels from biomass.



Research lines

- ✓ Catalysts for H_2 and advanced biofuels production.
- ✓ Production of high value-added materials: graphene and carbon nanotubes.
- ✓ Enzymatic treatment and pyrolysis of lignocellulosic biomass.
- ✓ Biorefineries.
- ✓ Production of microalgae to obtain biofuels.
- ✓ Genetic modification of microorganisms to increase the production of biofuels.
- ✓ Production of biofuels from municipal solid waste.

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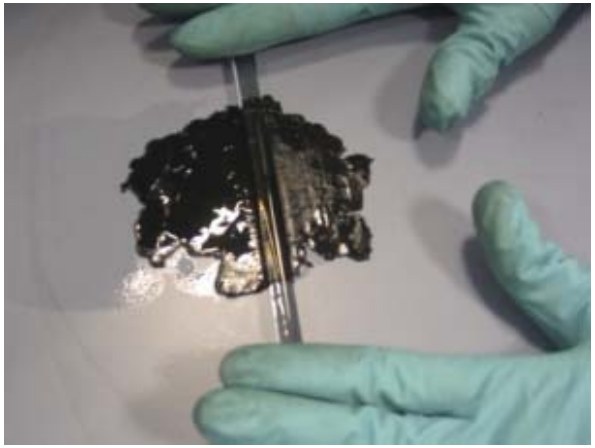
Energy storage

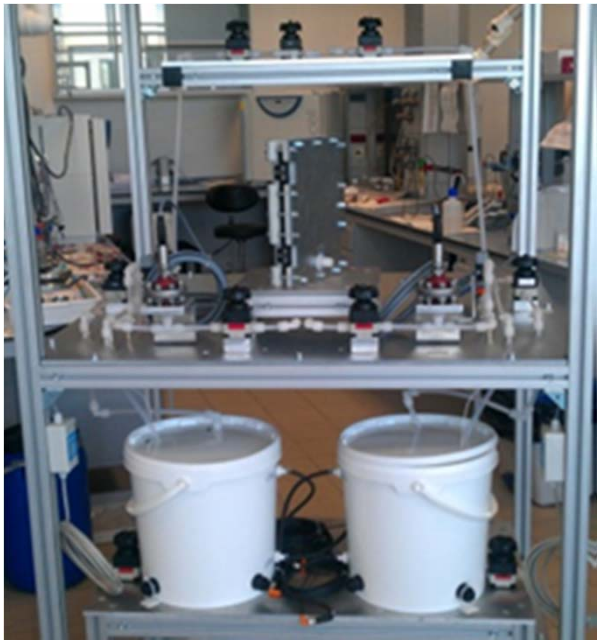
Objectives

- Storage coupled to renewable sources.
- Sustainable mobility.



Research lines

- ✓ Materials for high energy density capacitors and advanced batteries.
- ✓ Thermochemical storage using ceramic materials and redox systems.
- ✓ Design and modelling of electrochemical reactors:
  - ✓ flow batteries,
  - ✓ metal-air batteries and
  - ✓ supercapacitors.
- ✓ Characterisation and testing of electrochemical energy storage devices at laboratory and pilot plant scales.



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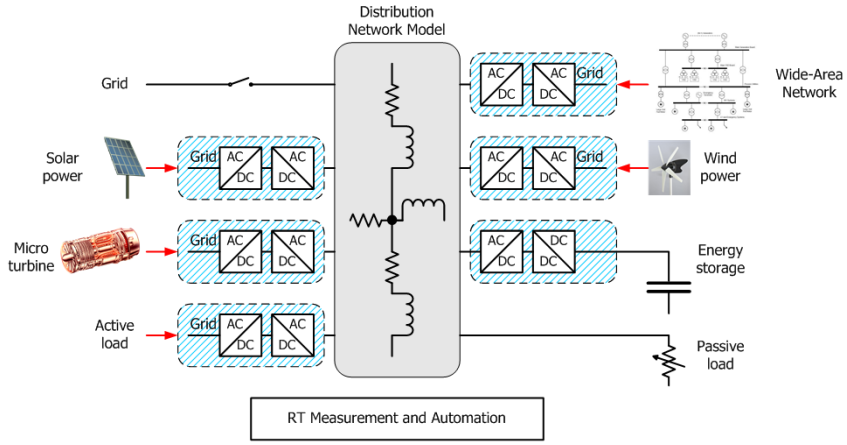
Management of electrical energy resources

Objectives

- Proactive energy resource management for distribution networks and microgrids.
- Integration of renewable and energy storage devices.



Research lines

- ✓ Management algorithms for distribution networks.
- ✓ Power networks and microgrid modelling and stability analysis.
- ✓ Design and control of power electronics converters.
- ✓ Reliability analysis of power networks with high share of renewables: solar, wind…
- ✓ Techno-economic and feasibility studies for electrical systems.

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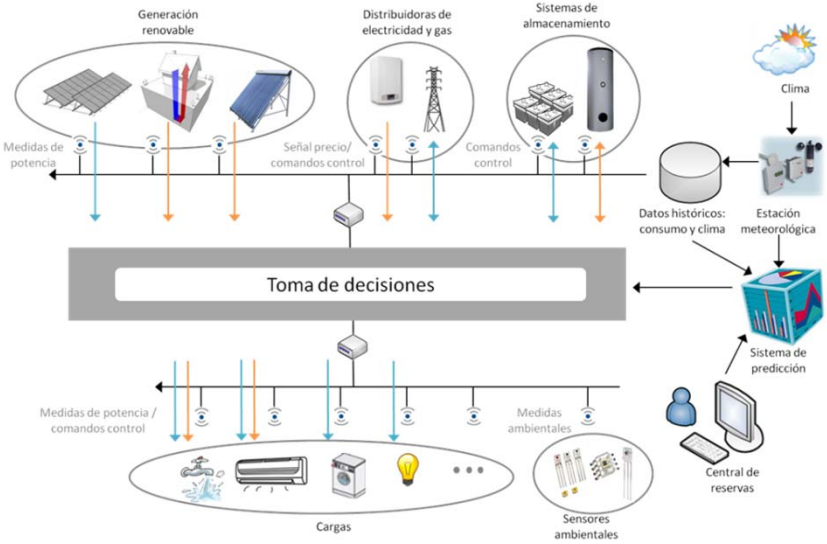
Energy systems with enhanced efficiency

Objectives

- Energy saving and efficiency.
- Optimised use of energy resources.

Research lines

- ✓ Demand management and energy efficiency in buildings, residential and commercial sector.
- ✓ Optimisation of energy supply mix.
- ✓ Management of energy resources in industrial applications.
- ✓ Energy efficiency application in vibration test systems.
- ✓ Capacitive deionisation for energy efficient water treatment.



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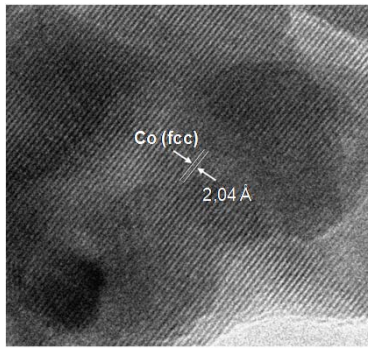
CO_2 capture and valorisation

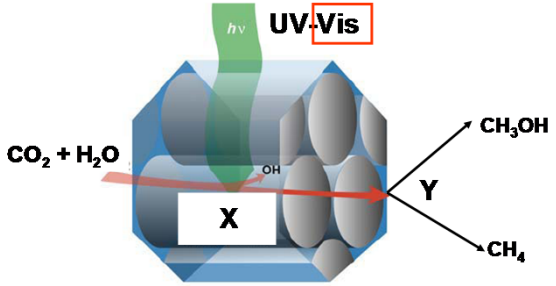
Objectives

- Photochemical valorisation of CO_2.
- Study of techniques for CO_2 capture and storage.



Research lines

- ✓ Catalysts for photocatalytic reduction of CO_2.
- ✓ Analysis of techniques for CO_2 capture and storage:
  - Life cycle
  - Environmental and
  - Techno-economic studies.



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High Temperature Processes Unit

High Temperature Processes Unit

Objectives

- Concentrating solar power systems engineering.
- High temperature components and applications.
- Production of solar fuels and chemicals.

Research lines

- ✓ Solar concentration plants for high efficiency and integration in urban environments.
- ✓ Solar concentrators, heliostats and optical engineering.
- ✓ Advanced thermal fluids.
- ✓ Thermal storage: materials and modellisation.
- ✓ Solar receivers and reactors.
- ✓ Development of techniques for characterisation and simulation of high flows of solar radiation and at high temperatures.
- ✓ Integration of solar technologies for thermal, electric and hydrogen production contribution.
- ✓ Reduction of metal oxides, solar assisted combustion.
- ✓ Simulation: solar simulator, thermodynamic cycles, calorimetric loops.

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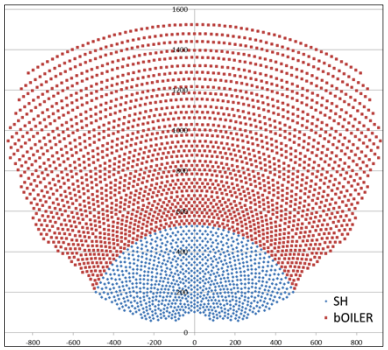
HIGH TEMPERATURE PROCESSES INTEGRATION & PERFORMANCE

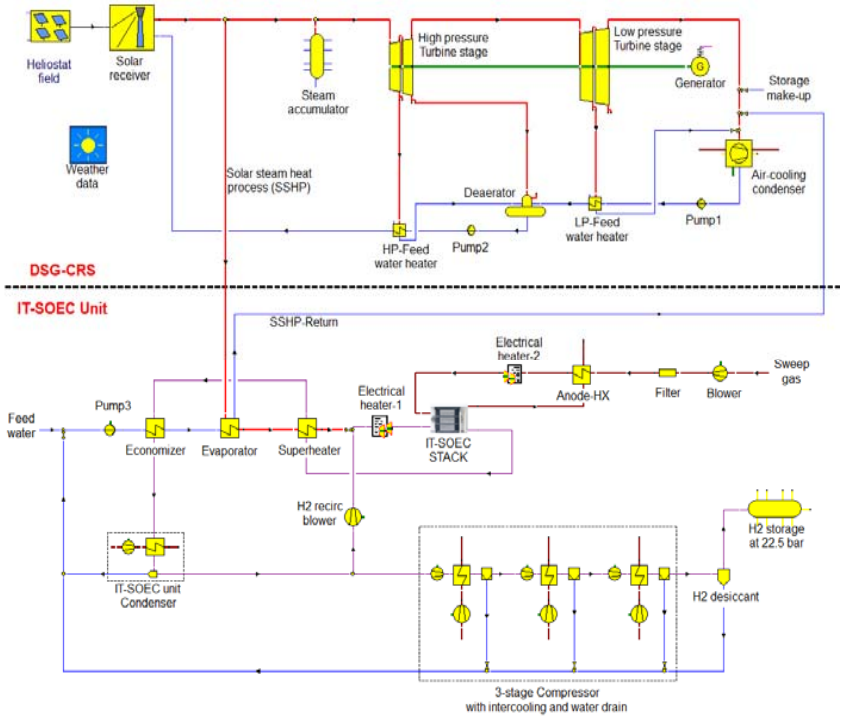
- Efficient integration schemes in power conversion systems

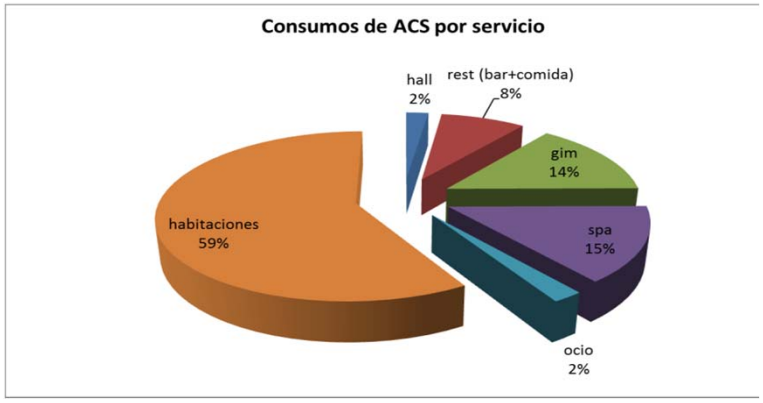
Projects: Alccones, SolarO2, SolH2, ADEL, TCSPower, CSP2, eON

Outcomes:

- Modules and components for energy analyses of CSP plants (dual receivers, integration of HT electrolysers)
- Software for energy analyses of renewable energy integration in buildings







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High Temperature Processes Unit

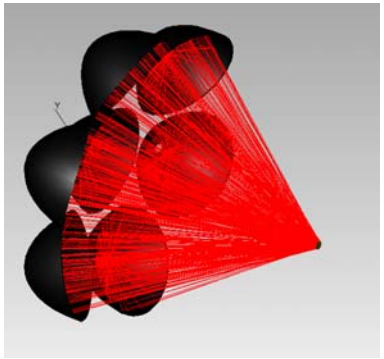
SOLAR CONCENTRATION

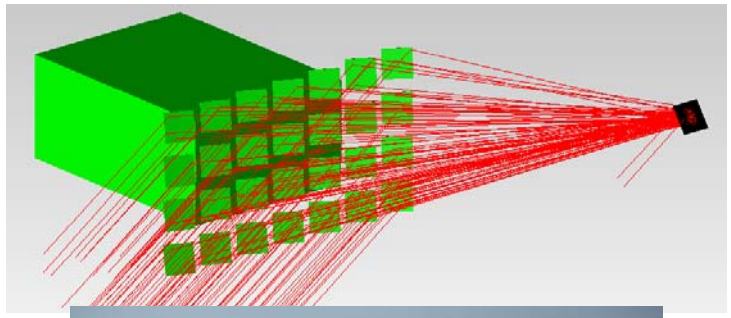
- Modular concepts with minimum environmental impact
- Solar concentration optics

Projects: Alccones, CrispTower, SolH2, SolarO2

Outcomes:

- Development of an original modular concept.
- Characterization of a new carrousel-type heliostat for CSP
- Optical design of high-flux solar simulator 42 kW_e
- Software for solar fields dimensioning





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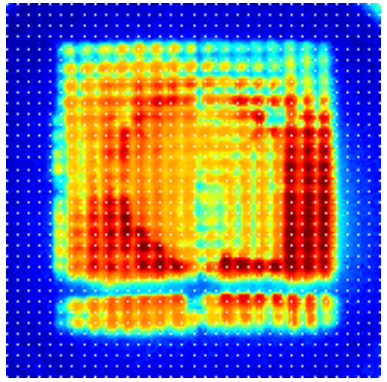
SOLAR RECEIVERS & NEW HEAT TRANSFER FLUIDS

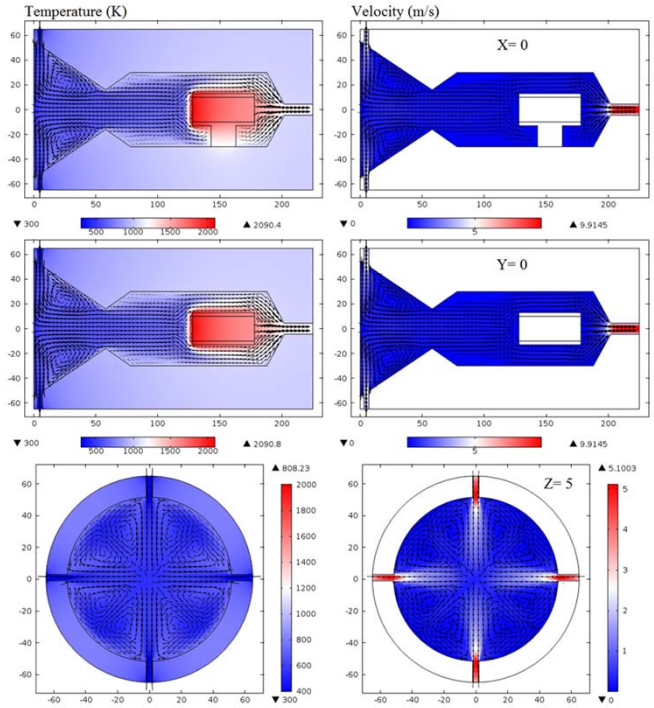
- Solar receivers and reactors
- Advanced thermal fluids for high temperature applications
- High flux/high temperature characterization techniques and simulation tools



Projects: Alccones, CrispTower, SolarO2, CSP2

Outcomes:

- Calorimetric loop for the characterization of materials for metallic and ceramic volumetric absorbers
- CFD models for receivers simulation



High Temperature Processes Unit

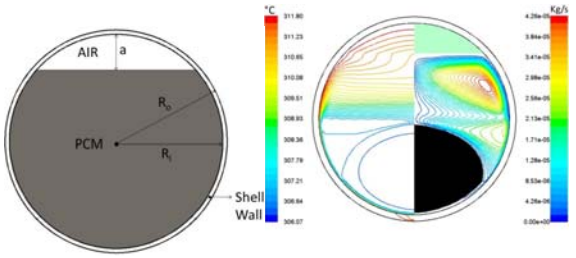
ENERGY STORAGE & SOLAR THERMOCHEMISTRY

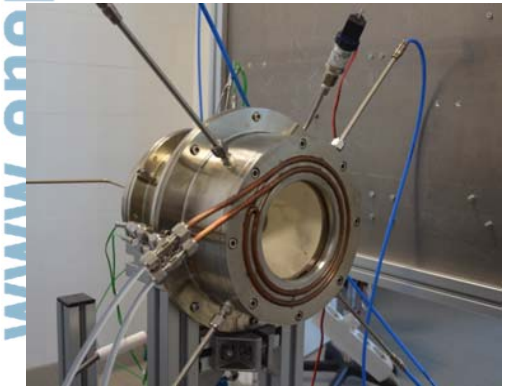
- Thermal heat storage (phase change and thermochemical) for CSP plants
- Solar-driven high temperature production of H2 /Chemicals

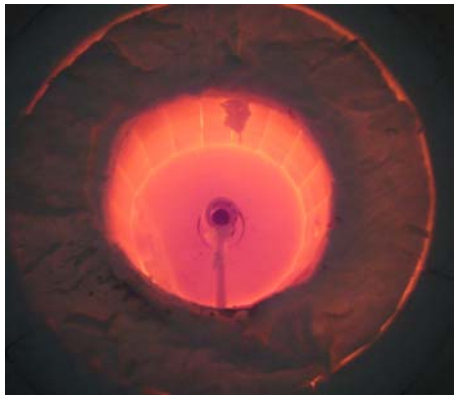
Projects: Alccones, SolarO2, SolH2, TCSPower, eON

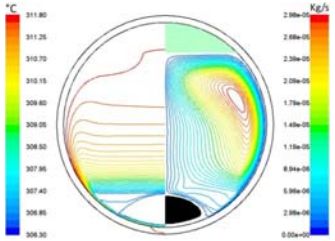
Outcomes:

- Test bed characterization of thermochemical energy storage systems based on redox reactions with metallic oxides.
- High-flux thermochemical reactor and CFD models.
- CFD models for packed bed and PCM pellets









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Collaboration with companies

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KitoZyme

GreenPower tech

IBERDROLA

PROINGESA
PROYECTOS, INGENIERIA Y GESTION, S.A.

SyV
Sacyr Vallehermoso

P&G

ELYTT ENERGY

REPSOL

acciona

ZIGOR
corporación, s.a.

ISOLUX CORSÁN

ABENGOA

Torresol Energy
reinventing solar power

skeletontech

B/E AEROSPACE

EINSA
equipos industriales de manutención s.a

Solintel

e·on

triphase
Smart inverters for R&D

NANOQUIMIA

SIEMENS

HYNERGREEN

Solvionic

IPRESARIOS AGRUPADOS

ERACHEM COMILOG

SOFCPOWER
SOLID OXIDE FUEL CELLS

comessa®

TOPSOE FUEL CELL
RETHINKING ENERGY

BÜHLER

accelopment
takes you further

HTceramix

HYGEAR

IMV
SECURE THE FUTURE
IMV CORPORATION

BEFESA

imesAPI
Servicios · Movilidad

ence
ENERGÍA & CELULOSA

eni

SILKEM

Groupe ERAMET

Networking

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Spanish

ALINNE
alianza por la investigación y la innovación energéticas

Madrid Network
CLUSTER
ENERGÍAS RENOVABLES

CAMPUS Energía Inteligente
Bioenergy & Smart Cities

esLCA
RED ESPAÑOLA de ACV

CLUB ESPAÑOL DE LA ENERGÍA
INSTITUTO ESPAÑOL DE LA ENERGÍA

AEC
ASOCIACIÓN ESPAÑOLA PARA LA CALIDAD

Spanish Technology Platforms

FutuRed

BioPlat
PLATAFORMA TECNOLÓGICA ESPAÑOLA DE LA BIOMASA

PTE HPC

Plataforma tecnológica española de eficiencia energética

M2F

pteCO2

Solar Concentra

Internationals

EERA
European Energy Research Alliance

iea
International Energy Agency

N.ERGHY
research on fuel cells & hydrogen

ESTELA

ISES
International Solar Energy Society

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