UC3M R&D FOR INNOVATION

in energy area

IDENTIFICATION OF RESEARCH ACTIVITY, TECHNOLOGIES, PATENTS, INFRASTRUCTURES, AND OTHER CAPABILITIES OF UC3M IN ENERGY AREA

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Vicerrectorado de Política Científica

Servicio de Apoyo al Emprendimiento y la Innovación

The Entrepreneurship and Innovation Support Service (SEI) of the Universidad Carlos III de Madrid wants to present the potential of the university in this "knowledge map" through the research areas developed in the frame of R&D projects, both national and international, patents and other results of UC3M investigators, in the Energy Area.

The global knowledge obtained, the experience of collaborating with the industry, the existence of infrastructures and proper laboratories and, above all, the multidisciplinary nature of UC3M are characteristics that provide an added value so that our support towards the innovation of institutions, big companies and SMEs has an integral quality.

We invite you to deepen the knowledge of the UC3M and to collaborate in new R&D and innovation projects.

Entrepreneurship and Innovation Support Service
Universidad Carlos III de Madrid

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R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
MATERIALS SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING			
Numerical Modelling, Simulation and Industrial Mathematics (GMSMI) **PI: Luis López Bonilla**	• Hydrogen combustion and gas synthesis in advanced gas turbines • Detonation combustion problems • Non-linear phenomena in microelectronic semiconductors • Non-linear load transport in nanostructures: · Non-linear transport in carbon and graphene nanotubes	**R&D National Plan Projects** • Non-linear transport phenomena in nanostructures **R&D Regional Plan Projects (Madrid Region)** • Clean Combustion: Analysis, Modelling, and Simulation • Development of Predictive Tools for Hydrogen Combustion in Gas Turbines **Other competitive projects** • Quantum Transport in Terahertz Detectors	**Experience and Capabilities** • Modelling of graphite-based nanotubes, fullerenes, etc. including defects • Programme for the characterisation of oilfields (reservoirs) to recover permeability distribution through production data • Numerical modelling and simulation of equilibrium equations in partial derivatives or in differences for charge transport in nanodevices subjected to high electric and magnetic fields • Modelling of superconductor materials with a high critical temperature and obtaining their phase diagram • Atomistic models of the dynamics of dislocations, cracks and other defects in cubic system crystalline materials, both for simple metals and for semiconductors **Equipment** The GMSMI has considerable hardware and software capability to tackle numerical simulation projects. It also has the capability to conduct supercomputing projects through the collaboration that it has with the CIEMAT (forming a Mixed Unit) and allows it to access SGI Origin 3800 computer for parallel computation.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
MATERIALS SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING			
Material Synthesis and Processing (SIPMAT) **PI: Alejandro Várez, Belén Levenfeld**	• Power storage systems: Lithium batteries, phase change materials • Power generation systems: fuel cells • Magnetic ceramics The main line of research of the group focuses on the development and characterisation of materials for power, focusing its efforts in the production of solid state electrolytes.	**European Projects** • CONEX:ACABA: Advanced CAlcium BAtteries • HINMICO: High throughput integrated technologies for multimaterial functional Micro components • NANOLICOM: Nanoestructured Lithium Conducting Materials **R&D National Plan Projects** • Materials for lithium batteries, post-lithium batteries, and fuel cells: from laboratory to prototype • Electrodes and electrolytes for efficient power storage and production: batteries and fuel cells • Synthesis, characterisation, and processing of materials for batteries and fuel cells • New materials for fuel cells and lithium batteries • New materials for electrochemical devices: Electrodes and electrolytes for rechargeable lithium batteries and fuel cells **R&D Regional Plan Projects (Madrid Region)** • Materials for power and related materials • MATERYENER3-CM. Materials for power: electrical materials, magnetic materials, and superconductors +	**Experience and Capabilities** Preparation of new materials for electrochemical devices and particularly, polymer membrane-based (PEM) and solid oxide-based (SOFC) fuel cells and lithium batteries. The SIPMAT group has the technical capability and installations to prepare both ceramic materials (ceramic method, sol gel, liquid dissolution, mechanical milling, etc...), and polymeric materials. **Technological Offer** Electrodes for rechargeable lithium batteries. Spanish patent: ES16411180. International application: PCT WO2017158223 **Equipment** The group also has the necessary equipment for structural, micro-structural, electrical, thermal, and mechanical evaluation and characterisation of the developed materials.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
MATERIALS SCIENCE AND ENGINEERING AND CHEMICAL ENGINEERING			
Material Synthesis and Processing (SIPMAT) PI: Alejandro Várez. Belén Levenfeld		**Internal Projects (UC3M Funding)** • Strategic action in the research and development of materials for post-lithium batteries • Strategic action for the research of materials for power	

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
THERMAL AND FLUIDS ENGINEERING			
Energy Systems Engineering (ISE) **PI: Domingo Santana**	• Fluidization • Concentrating solar energy • Thermochemical processes • Absorption machines • Water-energy nexus • Power polygeneration and hybridization	**R&D National Plan Projects** • Optimisation of solar thermal power plants, transient analysis, and the design of eccentric bayonet receivers • Development of absorption cooling machines using microexchangers, membranes, and nanoparticles for energy efficiency in buildings • Stress and strain analysis in central solar receivers • High-performance miniaturised absorption cooling machines using membrane technology • Study and design of new solar receivers • Segregation and heat transfer in vibrated beds • ENERGOS: Technologies for automated and intelligent management of power distribution networks of the future • Biomass gasification by means of a new rotating spiral distributor fluidized bed design (SSD) **R&D Regional Plan Projects (Madrid Region)** • Cardoon biomass exploitation and by-product assessment **Other competitive projects** • Solar thermal energy storage in a fluidized bed with phase change materials +	**Experience and Capabilities** • Tests for solar receiver tubes consisting of salts and other components • Heliostat field dimensioning • Thermomechanical design of solar receivers and heat exchangers • Evaluation of the production of tower-type solar power plants • Evaluation of energy potentials of biomass and waste • Absorption machine tests and dimensioning • Evaluation of energy processes (multi-criteria optimisation and exergy-based analysis) • Simulation by means of FEM and CFD **Technological Offer** • Solar power tower receiver. Spanish patent: ES2648737. • Linear solar beam-down optical system. Spanish patent: ES2648148. International application: PCT/ES2018/070169 • Adiabatic absorber for an absorption machine. Spanish patent: ES 2647967. International application: PCT/ES2017/070356 +

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
THERMAL AND FLUIDS ENGINEERING			
Energy Systems Engineering (ISE) PI: Domingo Santana		**Private Funding** • Shouhang Research Chair (Concentrating Solar Power-transient behavior of the receiver and plant optimisation for Molten Salt Power Tower) • Design and performance tool for a solar power plant of 10 MW	**Equipment** • Biolab Laboratory for characterization of solids biofuels • Thermochemical reactors Biomass Gasification in Pilot-plant scale Fluidized Bed Reactor (BBFBG) Biomass pyrolyzers • Cluster ("Helios"), with 80 cores for high-performance parallel computing • Solar concentration laboratory Molten salt loops for experimentation on molten salt solar power plant components and tubes • Absorption Absorption machine component test bench

THERMAL AND FLUIDS ENGINEERING

R&D GROUP

Thermal Engineering, Energy and Atmosphere (ITEA)

PI: Antonio Lecuona, Pedro A. Rodríguez Aumente

RESEARCH LINES

- PIV (Particle Image Velocimetry)
- Absorption machines
- Rotation-stabilized burners
- Solar thermal energy
- Solar cookers
- Shadowgraphy
- Jet dynamics
- Efficient energy and thermal systems of low environmental impact
- Reduction of thermal machinery and engine emission into the atmosphere
- Technology for energy assessment, for sustainable energy and the use of renewable energy
- Transport of heat and mass. Combustion
- Thermal fluid dynamic laser instrumentation
- Computer simulation of flows of industrial and environmental interest
- Environmental impact on the atmosphere of forms of matter and energy
- Technical acoustics
- Thermal micro-machines
- Micro heat exchangers
- Shadowgraphy
- Solar cookers

RESEARCH PROJECTS

European Projects

- HOT (CleanSky): Humidity Optimisation Tool
- COUNTERFOG: Device for Large Scale Fog
- Decontamination

R&D National Plan Projects

- Solar thermal energy technologies and technologies for harnessing residual heat at low and medium temperature integrated in the electric network
- Solar thermal energy technologies and technologies for harnessing residual heat at low and medium temperature integrated in the electric network
- Solar thermal energy technologies and technologies for harnessing residual heat at low and medium temperature integrated in the electric network (VARIOSOL)
- Integrated solar cold advanced absorption with electricity

R&D Regional Plan Projects (Madrid Region)

- Direct production of air at a high temperature and turbocharged pressure in concentrating solar collectors

Private Funding

- Physical absorption of ammonia vapour in the air of large enclosures using water droplets
- Modelling of a thermal storage cell
- Modelling and new designs of stratified water storage tanks

+

TECHNOLOGICAL OFFER / OTHERS

Experience and Capabilities

- Human and technical resources with the capabilities to provide real and practical solutions to the problems of interests in different sectors of the industry
- Capacity to act as a group, like an environmental and technological advisory, consultation and R&D office, in the atmospheric field
- Prototype development
- Design engineering projects
- Customized specialized training

Technological Offer

- Solar dryer. Patent ES2626253
- Expansion, absorption, and compression device for absorption machines. Spanish patent: ES2556225
- Energy storage method and system for storing energy. Spanish patent: ES2554133. Co-ownership with the UPM
- Solar energy steam separator-generator. Spanish patent: ES2543975
- Solar oven. Spanish patent: ES2540160
- VARIOSSOL: System for the production of heat, cold, and optionally electricity, based on mid-temperature thermal collectors and an innovative absorption machine located in the solar field, thus not taking up machine room space and not having the risk of freezing and overheating

+

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
THERMAL AND FLUIDS ENGINEERING			
Thermal Engineering, Energy and Atmosphere (ITEA) PI: Antonio Lecuona, Pedro A. Rodríguez Aumente		**Others** • Electricity accumulation by means of combined absorption with wave energy converting device for power optimisation (WEGSES-Wave Electric Generator With Sorption Energy Storage)	**Equipment** • Testing of engines of up to 200 kW with the capacity to evaluate the indicated cycle and energy balance • Combustion chamber up to 200 kW • Heat and cold storage systems • Absorption machine with a 17 kW ROBUR boiler • Split heat pumps and 4 m^3 cryogenic chamber • Stereoscopic particle image velocimetry system with a high spatial resolution (LFCPIV) and temporal (Dynamic PIV) resolution • Laser Doppler interferometer with phase information (PDA) • Test bench for the characterisation of aerosols (MALVERN) and two-phase psychrometric flows • High-speed image analysis in digital video • Reverberating chamber for the measurement of sound power, insulation, absorption coefficient and reverberation time. Sonometry and spectral analysis • Equipment for measuring polluting combustion gases • Numerical simulation with commercial and in-house developed codes • Weather station oriented to solar energy • Argon-ion, Neodymium-Yag and Helium neon lasers • Temperature and pressure calibrator. Stagnation probes • Temperature and humidity-controlled climatic chamber

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
THERMAL AND FLUIDS ENGINEERING			
Fluid Mechanics (GMF) **PI: Antonio Luis Sánchez**	• Combustion • Multiphase Flows • Microfluidics • Fuel Cells • Mass transfer in flows with bubbles. • Acoustics of flows with bubbles. • Computational fluid mechanics. • Detonations and supersonic flows • Low density jet hydrodynamic stability. • Steady Streaming in turbulent flows • Dynamics and stability of liquid jets subjected to the influence of gravity	**European Projects** • ITN MyPlanet **R&D National Plan Projects** • Fundamental ultra-compact rotary engine combustion analysis • Sustainable Combustion Research • Multiphase modelling of relevant thermal-fluid problems in energy generation and exchange systems with industrial application • Droplet and bubble generation: analysis of the collective dynamics in natural and engineering processes with industrial and environmental applications **R&D Regional Plan Projects (Madrid Region)** • Development of predictive tools for hydrogen combustion in gas turbines • Clean combustion: analysis, modelling and simulation • Relevant fluid-reagent phenomenon study in the development of clean combustion technologies **Private Funding** • Experimental characterisation of fuel jet atomization • Development of a non-invasive technique to measure the pressure in a porous medium with bubbles	**Experience and Capabilities** The GMF's expertise lies in using analytical, numerical, and experimental techniques to solve thermal fluid dynamic problems of industrial interest. **Technological Offer** • Numerical calculation of fluid-mechanic processes of industrial interest • Experimental characterisation of fluid-mechanic processes of industrial interest • High capability to perform numerical calculation of fluid-mechanic processes of industrial interest • Theoretical analysis of fluid-mechanic processes of industrial interest **Equipment** The GMF has an experimental and numerical laboratory equipped with the latest equipment capable of tackling a wide range of fluid dynamics-related problems. Furthermore, it has the following in-house laboratories: • Numerical calculation laboratory • Aerodynamics and hydrodynamics measurement laboratory • Stability laboratory • Fuel cell laboratory • Acoustics laboratory • Hydrodynamic channel and wave channel

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
THERMAL AND FLUIDS ENGINEERING			
Appropriate Technologies for Sustainable Development (LTA) **PI: Ulpiano Ruiz-Rivas Hernando**	• Thermal solar systems • Photovoltaic-eolic electrification • Systems for harnessing human energy • Water pumping and treatment • Biodigestion	**International Projects** • Renewable Energies Education Network (RENet) • Participatory Integrated Assessment of Energy Systems to promote Energy Access and Efficiency (PARTICIPIA) **R&D National Plan Projects** • Development of absorption cooling machines using microexchangers, membranes, and nanoparticles for energy efficiency in buildings • Molten salt solar reactor for solar-biomass hybridization • High-performance miniaturised absorption cooling machines using membrane technology **AECID Projects** • Teaching and research collaboration for an engineering degree in renewable energies in UNAN-Managua • Renewable energy research support workshop for sustainable rural development in universities of Nicaragua	**Experience and Capabilities** • Thermal solar systems · Solar kitchens (solar oven, parabolic and semi-parabolic kitchens) · Solar driers (pilot plant and laboratory drier with an alternative source) • Biodigestion systems for biogas production from organic waste · Discontinuous anaerobic biodigesters · Measurement and control systems • Electricity production · Microhydraulic installation · Manual production. Bicycle dynamo system · Battery charging with photovoltaic solar panels • Water pumping and distribution · Manual pumping (Afridev, Malda, Mecate...) · Water hammer pumping (rampump) · Photovoltaic pumping • Water treatment · Slow columns · Solar methods. SODIS **Equipment** **Appropriate Technologies Laboratory:** Centre for the development of teaching activities, research, technical assistance and support for in-house projects

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
ELECTRICAL ENGINEERING			
Power Control (GCP) **PI: Santiago Arnaltes**	• Wind generator control Variable speed electric generator control for wind turbines: doubly-fed asynchronous generators and full converter synchronous generators. • Control of photovoltaic inverters and PCS for BEES Network-connected and isolated inverter power control. Power plant controllers (PPCs) and energy management systems (EMSs). • Integration in renewable energy network Wind farm, photovoltaic power plant, and energy storage system control under network integration requirements. High-voltage DC (HVDC) transmission system control.	**R&D National Plan Projects** • Total Photovoltaic Platform. This is a project to provide photovoltaic power plants with a platform that allows optimum manageability of said plants • Integration of offshore wind energy in the electrical system in Spain by means of multi-terminal DC links **R&D Regional Plan Projects (Madrid Region)** • PRICAM-CM. Intelligent electrical network programme in the Madrid region **Private Funding** • Inertia emulation analysis and definition by means of electronic power converters • HVDC interconnection offshore wind farms based on Diode Rectifier Units (DRU). Study of DC networks for the collection of energy from wind farms and its interconnection to high voltage power networks • FACTS and HVDC generator damping system analysis • Network-connected energy storage system to facilitate the integration of non-manageable renewable energy sources in the electrical network • Wind integration study in Uruguay • Simulation platform for the dynamic models of generation, loads, FACTS, and HVDC +	**Experience and Capabilities** The Power Control group (GCP) is a group whose expertise lies in the development of novel solutions for solving industrial problems relating to equipment and electrical power system control in the field of renewable energies, fundamentally, wind energy, photovoltaic energy, and storage systems. **Technological Offer** • Method for the distributed control of frequency in an offshore wind farm. Spanish patent application: P201731257 • Method and system for controlling a set of wind farms connected in series to a high-voltage DC link. Spanish patent: ES2620972. International application: PCT/ES2018/070106 • Method and system for controlling the voltage and frequency in an isolated network. Spanish patent: ES2584535. International application: PCT WO2016156636. European Patent: EP3276771 **Equipment** • Electric power control system research laboratory The Power System Control group has a complete laboratory equipped with benches with different types of generators, inverters, real-time controllers, instruments, and simulation tools.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
		ELECTRICAL ENGINEERING	
Power Control (GCP) PI: Santiago Arnaltes		• Hybrid energy storage (electrochemical) systems. Applications for electric vehicles and complementary network services • Evaluation of electric vehicle battery performance in terms of application thereof as a system for the distributed storage of energy in a smart-grid	

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
ELECTRICAL ENGINEERING			
Diagnosis of Electrical Machines and Insulating Materials (DIAMAT) **PI: Juan Carlos Burgos**	• Detection of partial discharges with high-frequency sensors • Monitoring and diagnosis of electrical machines and transformers for "Smart Grids" • Characterisation of electrical insulation systems • Algorithms for the localization of partial discharges • Instrumentation and measurement of voltages, intensities, and magnetic fields by means of non-invasive methods	**R&D National Plan Projects** • Optimisation of the drying processes of power transformers on site • Advanced electrical and opto-magnetic instrumentation development for measuring partial discharges in transformers • ENERGOS: Technologies for automated and intelligent management of power distribution networks of the future • Multichannel measurement equipment in partial discharges based on high-frequency inductive sensors • Intelligent sensor for the localization and identification of partial discharges in electrical asset maintenance • Moisture dynamics in transformers insulated with vegetable oil • Improvement of transformer insulation systems by means of dielectric nanofluids	**Experience and Capabilities** • Design and development of new techniques for the maintenance of power transformers • Study of the aging processes of insulating materials and development of techniques for monitoring their status • Characterisation of insulating materials and evaluation of the insulation status by means of dielectric tests • Predictive and improved maintenance of insulated cables and electrical machines by means of the differentiation of partial discharges and electrical noise • Designing HF and VHF inductive sensors for measuring partial discharges • Measurement and localization of electromagnetic pulses with UHF sensors **Technological Offer** • Calculating the loss in service life of transformers • Calculating short-circuit stress in transformers • Inductive sensor with galvanic insulation for the detection and measurement of high-frequency current pulses. Patent: ES2340750 • Method and device for the differentiation of partial discharges and electrical noise. Spanish patent: ES2014/0701199 • Algorithms for the classification, separation and identification of impulse signals in environments with low signal-noise ratio +

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
ELECTRICAL ENGINEERING			
Diagnosis of Electrical Machines and Insulating Materials (DIAMAT) PI: Juan Carlos Burgos			**Equipment** • High-voltage Testing and Research Laboratory (LINEALT) belonging to the network of laboratories of the Madrid region

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
		ELECTRICAL ENGINEERING	
Electrical Energy Networks and Systems (REDES) **PI: Julio Usaola, Hortensia Amarís**	• Quality of electric supply • Integration of wind energy into the electrical system. • Electric energy market • Smart Grids	**European Projects** • Ideal Grid for All (IDE4L) • Multi-scale data assimilation, advanced wind modelling and forecasting with emphasis to extreme weather situations for a secure large-scale wind power integration (SAFEWIND) • Advanced Tools for the Management of Electricity Grids with Large-Scale Wind Generation (ANEMOS PLUS) • Prediction of Waves, Wakes and Offshore Wind (POWWOW) **R&D National Plan Projects** • Distribution network intelligent supervision optimisation (OSIRIS) • Smart grids project in Corredor de Henares (PRICE-GENE) • Integration of renewable energies into smart grids (RESmart) • Consorcio Solar de I+D (CONSOLIDA): Integration of thermoelectric solar energy in the electrical system on the Spanish mainland • Domestic system for recharging electric vehicle batteries (DOMOCELL) • Strategies for the efficient integration of renewable energies • Distribution Power Networks with Dispersed Energy Generation +	**Experience and Capabilities** • Evaluating the technical and economic impact of the integration of wind systems into the national energy network • Studying electrical energy markets • Analysing electrical networks **Technological Offer** • Electrical system research: Electric supply and market quality • Reliability of electrical systems with high renewable energy participation • Strategies for participation in renewable and aggregating energy markets • Integration of renewable energies into electrical energy markets and networks • Monitoring and estimating the demand in smart grids with a high deployment of smart counters • Strategies for reducing losses and detecting electricity theft in smart grids • Models for the dynamic analysis of wind generators suitable for studying the interaction with the electrical network • Active filter for improving energy efficiency in electric installations • Status estimation and demand management in smart grids +

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
ELECTRICAL ENGINEERING			
Electrical Energy Networks and Systems (REDES) PI: Julio Usaola, Hortensia Amarís		**Private Funding** • Formulas for the procurement of electrical energy to meet the demand of large industrial consumers in Europe	**Equipment** • THALES measuring equipment especially developed for evaluating the quality of the energy produced by the wind generators according to international standard IEC 61400-21 • Network analysing instruments • Electrical network analysis and simulation tools and programmes: PSCAD/EMTDC, ATP, MATLAB, PSS/E (educational license), GAMS • Power-In-The-Loop OPAL-RT real time simulation equipment

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
TELEMATIC ENGINEERING			
Communication Networks and Services (RSyC) PI: Arturo Azcorra, David Larrabeiti, María Calderón, Francisco Valera	• Energy efficiency in telecommunication systems and networks	**European Projects** • Connectivity management for energy optimized wireless dense networks (CROWD) **R&D National Plan Projects** • Energy efficiency in content distribution. Ministry of Science and Innovation	**Technological Offer** • Energy-saving method based on micro-shutdowns for a wireless device in a telecommunication network *(Método de ahorro de energía basado en microapagados para un dispositivo inalámbrico en una red de telecomunicación).* Spanish patent: ES2598169. International application: PCT/ES2017/070520. Co-ownership with UNIBS • Method for optimizing energy consumption of a network. Co-ownership with NEC. International patent application: WO2012/100785 A1

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
TELEMATIC ENGINEERING			
Telematic Applications and Services (GAST) PI: Carlos Delgado Kloos	• Efficient energy saving strategies in sensor networks • Efficient energy management in Big Data systems • Energy efficiency in vehicles • Energy consumption in ubiquitous computing environments	**R&D National Plan Projects** • Architecture for energy efficiency and sustainability in ambient intelligence (ARTEMISA) • Healthy and Efficient Routes in Massive Open-Data Based Smart Cities: Smart Driving and Semantic Data Handling (HERMES-SMARTDRIVER) **Private Funding** • The Nokia Chair	**Equipment** • **Ubiquitous Computing Laboratory:** · Measurement and optimisation of energy consumption in mobile phones application · Measurements and recommendations on energy consumption and execution of cryptographic algorithm, security protocols (eg. SSL), and digital certificate management

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
COMPUTER SCIENCE			
Applied Artificial Intelligence Group (GIAA) PI: José Manuel Molina, Jesús García Herrero	• Automatic learning techniques and data mining • Evolutionary computation and multi-objective optimisation • Agents and multi-agent systems: web, information retrieval, recommendation, e-commerce, sensor management	**Private Funding** • ENERGOS: Technologies for automated and intelligent management of future power distribution network systems. Development of technologies allowing progress in the creation and implementation of smart grids	**Experience and Capabilities** • The Applied Artificial Intelligence group, GIAA, is renowned in Spain for its capability to solve engineering problems through the incorporation of state-of-the-art artificial intelligence techniques: automatic learning, evolutionary computation, data analysis, multi-objective optimisation, fuzzy systems, and intelligent agents.

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
COMPUTER SCIENCE			
Evolutionary Computation and Neural Networks (EVANNAI) **PI: Pedro Isasi**	• Bioinspired computation: Genetic algorithms, evolution strategies, genetic programming, particle swarms • Multi-objective optimisation. • Automatic learning / data mining. • Artificial neural networks	**R&D National Plan Projects** • Evolutionary learning and optimisation for solar radiation prediction and integration • MOVES: Efficient and sustainable mobility management • PROSOL: Integrated model for solar energy forecasting	**Technological Offer** • System for the efficient control of power and chemical plants • Artificial Intelligence software for data optimisation, prediction, and analysis

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
COMPUTER SCIENCE			
Interactive Systems Laboratory (DEI) PI: Paloma Díaz Pérez	• Smart grid control and monitoring	**Private Funding** • ENERGOS (Technologies for automated and intelligent management of power distribution networks of the future). Operator -operating environment interaction study	• **Energos-Visual:** Multilayer smart grid visualisation in electrical network control centres adaptable to operator situation (normal or emergency situation) and activity

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
		ELECTRONIC TECHNOLOGY	
Displays and Photonic Applications (GDAF) PI: José Manuel Sánchez Pena, Carmen Vázquez García	• Electro-optic devices and applications • Advanced instrumentation and sensors • Photonic devices for optical networks	**European Projects** • Bluespace. Development of a system for feeding remote antennas with light transmitted with optical fibre in future 5G mobile networks (5g-ppp.eu/bluespace) **R&D National Plan Projects** • New photonic techniques for transmission, monitoring, and sensing in low consumption broadband networks • Sustainable technologies for optical fibre-based sensing and communications in the transportation and biomedical sector **Regional R&D Consortiums** • SINFOTON: Instrumentation and Sensors in photonic technologies (sinfoton-cm.es)	**Experience and Capabilities** • Development of an optical fibre pyrometer for contactless measurement of high temperatures whose possible applications include, among others, measurement of the temperature in the cores of solar thermal power plants and in machining processes • Optical network data consumption analysis and monitoring techniques to reduce consumption • Transmission of energy to remote equipment with optical fibre • Development of prototypes for level measurement in flammable liquid tanks • Development of optical fibre-based sensors for detecting and measuring bubbles in fluidized beds. One of the applications is to help in the characterisation of combustion processes in biomass plants • Designing of integrated optical fibre components to reduce the consumption of computers with optical connections and of plastic fibre data networks +

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
ELECTRONIC TECHNOLOGY			
Displays and Photonic Applications (GDAF) PI: José Manuel Sánchez Pena, Carmen Vázquez García			**Technological Offer** • Two-colour fibre optic pyrometer. Spanish patent: ES2587435. International application: WO2016170213 • Method and system for monitoring optical fibre networks. Spanish patent: ES2576748 • System for Measuring Fuel Level in Ultralight Aircrafts. Spanish patent: ES2333931 • Self-referenced fibre optic sensor for detecting liquid and/or for measuring liquid. Spanish patent: ES2343607 • Novel, speckle-based technique for detecting vibrations in structures

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
ELECTRONIC TECHNOLOGY			
Electronic Power Systems (GSEP) **PI: Emilio Olías, Andrés Barrado**	• Electronic power system analysis, design and optimisation • Magnetic component analysis, design and optimisation • Photovoltaic and hybrid energy system design and optimisation • Electromagnetic interference measurement and correction in equipment and systems. Electromagnetic compatibility.	**National R&D Plans** • Integrated intelligent power electronics for power control and management in IIoT • Modeling and control strategies for stabilising the interconnection of power electronic converters • Power supply systems for on-board and portable applications based on emergent energy storage devices and sources • Modular converters applying advanced control strategies implemented in digital platforms • Energy storage and management system for hybrid electric car based on fuel cell, battery, and ultracapacitors **Regional R&D Plans (Community of Madrid)** • New generation of photovoltaic strategies, materials, and devices for improved utilisation of solar energy I • High-frequency inverter with MPPT for photovoltaic systems with network connection **In-house Projects (UC3M)** • Strategic action in electronic power systems applied to transport **Other competitive projects** • Power distribution system for a new electric power generator based on wave movement +	**Experience and Capabilities** The Electronic Power Systems (GSEP) group provides comprehensive services in the consultation, analysis, custom design, and optimisation of electronic power systems and magnetic components, as well as photovoltaic and hybrid energy systems, and electromagnetic compatibility. • **Energy conversion systems** · Converter design, modeling, and optimisation · Design of prototypes · Modeling of DC supply systems, including a behavioural model of converters and stability analysis · CAD tools for electronic power system and equipment design • **Magnetic components** · Design of magnetic components · Optimisation of magnetic component volume, losses, and temperature · Finite element-based analytical models of high-frequency magnetic components · Contactless power supply systems • **Photovoltaic and hybrid energy systems** · Optimisation of power electronics in photovoltaic systems · Design of energy control, regulation, and conditioning systems for autonomous and networking systems · Hybrid systems +

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ELECTRONIC TECHNOLOGY			
Electronic Power Systems (GSEP) PI: Emilio Olías, Andrés Barrado		**Private Funding** • Providing advice in fuel cell-based hybrid electric vehicle power supply system design and reliability testing • Development of new technologies for the manufacture of solid electrolyte fuel cells (DEIMOS). • ECOTRANS: Ecological technologies for urban transport • Characterisation of commercial electricity meters in the presence of harmonics • Auxiliary electric propulsion system for general lightweight and sport aviation • Application of identification techniques for the characterisation of commutated DC-DC converters • Development and innovation in polymeric membrane and solid oxide fuel cells • Resonant heat DC-DC converter for portable X-ray equipment • 30kW and 40kV-130kV resonant DC-DC converter for portable X-ray equipment • ISC-based high-performance AC-DC converter for TV and RADIO transmitters	• **Equipment electromagnetic compatibility** · Pre-certification testing of equipment electromagnetic compatibility · Development of EMI filters · Evaluation of environmental radiation level • **Training courses** **Patents** • *Método y dispositivo de transformación de corriente continua en corriente alterna* (Method and device for transforming direct current into alternating current). Patent: P201130897 • *Convertidor de Corriente Alterna-Continua de una Etapa con Corrección del Factor de Potencia* (Single-step AC-DC converter with voltage factor correction). Patent: ES2192992 • *Método y sistema de alimentación de una carga constituida por una pluralidad de cargas elementales, en particular de LED* (Method and system for supplying a load consisting of a plurality LED fundamental loads). Patent: ES2391218 • *Conector de cables apantallados para la medida de impedancia de transferencia superficial* (Connector of shielded cables for surface transfer impedance measurement). Patent: P201031840 • *Dispositivo para conexión de extremos de cables apantallados adecuado para ensayos de medida de impedancia de transferencia superficial* (Device for connecting ends of shielded cables suitable for surface transfer impedance measurement testing). Patent: ES2384829 +

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ELECTRONIC TECHNOLOGY			
Electronic Power Systems (GSEP) PI: Emilio Olías, Andrés Barrado			• *Convertidor CC-CC reductor-elevador sin aislamiento galvánico y respuesta dinámica rápida* (Step-up/step-down DC-DC converter without galvanic insulation and rapid dynamic response). Patent: ES2681127

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
TEORIA OF THE SEÑAL AND COMMUNICATIONS			
Multimedia Processing (GPM) **PI: Fernando Díaz de María**	• Artificial vision · Deep learning (CNNs, LSTMS, etc.) · Object detection, tracking, and recognition · Systems to aid diagnosis based on medical imaging · Video surveillance systems · Visual attention models · Image segmentation • Speech Technologies · Neural networks · Speech and speaker recognition and in adverse environments • Audio processing · Classification and segmentation · Acoustic event detection	**R&D National Plan Projects** • NowCasting: weather prediction for solar plant management. Objective: development of a short-term and very short-term weather prediction system to optimize the performance and integration of the energy generated in the electric markets by thermoelectric solar plants	**Experience and Capabilities** In the last 10 years, the Multimedia Processing group has taken on the following projects and entered into agreements in the following areas of the industry: • Object tracking in video • Automatic system for the detection of traffic accidents by means of artificial vision • Recognition of vehicle model and brand in video • System for early detection of melanomas • Renal ultrasound interpretation system • Automatic annotation of image and video content • Automatic speech recognition under conditions of cognitive stress • Weather prediction based on sky images for optimising thermoelectric solar plant performance

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
POLITICAL SCIENCE AND SOCIOLOGY			
Sociology of Climate Change and Sustainable Development PI: Mercedes Pardo	• Social management and savings policies (energy, waste, water, noise) • Natural protected areas: Socioeconomic indicators. Governance • Sustainable development: emerging social and political trends • Social participation processes in environmental issues	**R&D Regional Plan Projects (Madrid Region)** • Social barriers and opportunities for savings and energy consumption efficiency development in the domestic area in the Madrid region **Private Funding** • Study of the factors mobilising change in the recycling habits and civic cooperation of adolescents and young adults from 10 to 22 years of age living in urban areas in Spain • Study of the factors influencing citizens' behaviour leading to a larger or smaller degree of participation in selective collection, in general, and light packagings, in particular • New forms of governance of protected natural areas as criteria for promoting sustainable rural development and contributing to the mitigation of the effects of global change • Indicator system for evaluating and tracking global change in national parks • Implementation of Sustainable Development Goals	**Experience and Capabilities** • Data and document collection, systematisation and categorization • Data analysis • Situation diagnosis elaboration • Development proposal for strategic lines, programmes, projects and activities, management of their applications, evaluation and monitoring • Design and application of evaluation indicator systems

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
		ECONOMICS	
Energy Economics **PI: Natalia Fabra Portela**	• Regulation and competition in the energy Sector: market organization, investment in capacity, vertical integration, future markets. • Investment incentive and electrical auction design • Competition and contracts in oligopolistic markets • Markets, investments, and supply security	**European Projects** • Current Tools and Policy Challenges in Electricity Markets (ELECTRIC CHALLENGES) **R&D National Plan Projects** • Cutting-edge methodology for dealing with regulatory challenges in electricity market • Competition observability of posted offer and asset auction in future markets • Technology for efficient consumption: digital counters, hourly prices, and electricity consumption in Spain (SMART) **Other competitive projects** • ENERGEIA: A tool for simulating prices in electricity wholesale markets. • Renewable energies and incentives **Private Funding** • Updating, improving, and assigning the use the ENERGEIA SIMULA computer tool: a tool for simulating prices in electricity wholesale markets	**Experience and Capabilities** • Environmental policy analysis: mechanisms for controlling the emission of greenhouse gases (emission rights markets, pollution tax, etc.) and policies supporting renewable energies • Analysis of strategic behaviour by electricity firms in energy markets with emphasis on their implications for competition policy • .Analysis of the regulation and incentives which are generated in the different stages of the energy supply chain • Experimental economics as a methodology for the analysis of auction design and operation, future markets, the impact of structural changes such as mergers or divestitures, etc. **Technological Offer** • *Energeia Software.* Strategic behaviour simulator of electricity firms in electricity markets +

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
ECONOMICS			
Energy Economics PI: Natalia Fabra Portela			**Means and Equipment** • **Experimental Economics Laboratory,** with pre-installed programmes for simulating different market designs • Electronic access to academic publications in the energy sector • Access to the publications of different companies and institutions of the sector • Computer programmes for data treatment and simulations

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
		COMPANY ECONOMICS	
Financial Economics **PI: Josep Antonio Tribó**	• Valuation of companies • Governance of the firm and corporate social responsibility • Microstructure of financial markets	**Research Projects** (PI: Juan Ignacio Peña Sánchez de Rivera) **R&D National Plan Projects** • Contact and derivative energy markets: prices, efficiency, and investment portfolios • Energy financial markets: Products, microstructure, and regulation **Private Funding** • Electricity prices in Europe: determining factors and implications for Horizonte 2020 • Energy markets • Analysis of methodologies for the valuation and design of forward contracts in underlying energy assets • Valuation of energy products • Providing technical consultancy services in the area of risk management in energy sector	**Technical Scientific Services** • Consultation • Training • Database access

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
		STATISTICS	
Statistical Modelling and Data Analysis **PI: Daniel Peña Sánchez de Rivera, Rosa Elvira Lillo Rodríguez**	• Models applied to wind energy	**R&D National Plan Projects** • Advanced statistical methods for complex data **Internal Projects (UC3M Funding)** • Strategic action in prediction and dynamic factor models	**Technical Scientific Services** • Analytical and computational decision aid tools for agents in electric energy markets • Tools for predicting electric energy prices and demand based on time series methodologies **Means and Equipment** • Computer programs for data processing and simulations • Decision-making analytical and computational tools • Computer equipment for intensive numerical calculation

R&D GROUP	RESEARCH LINES	RESEARCH PROJECTS	TECHNOLOGICAL OFFER / OTHERS
PUBLIC STATE LAW			
Urban Planning and Zoning. Environmental Issues - Public Health and Risk Management PI: Luciano Parejo Alfonso	• Sustainability and the environment • Law and the energy market • Planning, environmental management and climate • Community environment • Security, sustainability and precaution	**R&D National Plan Projects** • Law in view of innovation and risks derived from climate change **Internal Projects (UC3M Funding)** • Cities facing the most significant challenges posed by the effects of climate change **Private Funding** • Consumer protection in the energy market	**Experience and Capabilities** Analysis of the different legislations, policies, and systems regulating public administrations and hiring systems, spatial and town planning, telecommunications sector, etc.