ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

BIOFUELS

Biofuels are solid, liquid or gaseous fuels obtained from biomass. They serve as a renewable alternative to fossil fuels in the transport sector, helping to reduce greenhouse gas emissions and improve the security of supply. Bioethanol, biodiesel and biogas are examples of biofuels.

Research at the University of Bologna includes the development and characterization of biomass crops and agricultural residues, sustainability assessment models and the optimization of conversion technologies to produce advanced biofuels.

- New lignocellulosic and oil crops, and innovative and resilient cropping systems to be developed in marginal land
- New industrial catalytic processes, operating on a laboratory or pilot plant scale, for the production and upgrading of biofuels
- Production of H2 or syngas from biomass through reforming
- Logistics and conversion technologies of biomass
- Development of hybrid thermochemical/biological methods for the production of energy, biofuels and bio-materials from residual biomasses
- Cultivation of algae strains adapted to the production of biofuels
- Participation into large pre-commercial demonstration plants for the production of automotive, aviation and maritime biofuels from lignocellulosic or waste biomass
- Risk analysis, risk assessment and legal compliancy in biofuel production
- Environmental and social sustainability of advanced biofuels, including analysis of Indirect Land Use Change (ILUC) in the production of biomasses

HIGHLIGHTS

At the Industrial Crops Lab activties focus on herbaceous lignocellulosic and oil crops dedicated to biorafinery, bioenergy and biofuels.

At the Laboratory of Algal Biology a photobioreactor systems is used for the controlled growth of algae to be transformed in plastic materials, biofuels, biomasses for gasifiers or pyrolysers, fertilizers, or for the treatment of waste water.

At the Pyrolysis Lab agricultural byproducts and sludge are valorized thanks to the application of small scale pyrolysis to screen process conditions and catalyst for the biomass and waste conversion.

European Projects

GOLD - *Bridging the gap between phytoremediation solutions on growing energy crops on contaminated lands and clean biofuel production* H2020

FlexJET - *Sustainable Jet Fuel from Flexible Waste Biomass* H2020

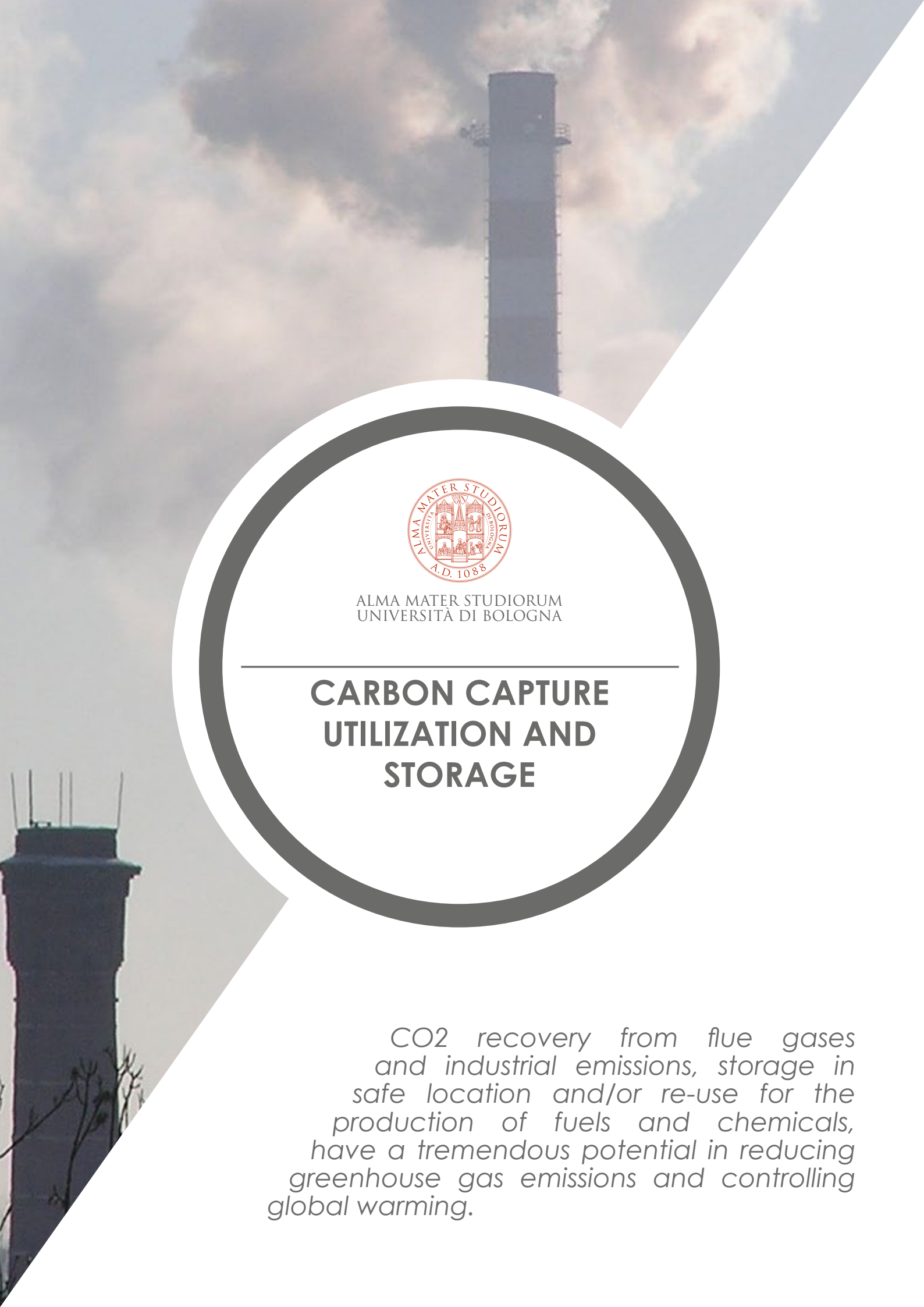
BECOOL - *Brazil-EU Cooperation for Development of Advanced Lignocellulosic Biofuels* H2020

TO-SYN-FUEL - *The Demonstration of Waste Biomass to Synthetic Fuels and Green Hydrogen* H2020

SWEETFUEL - *Sweet Sorghum: An alternative energy crop* FP7

S2Bio - *Delivery of sustainable supply on non – food biomass to support a "resource-efficient" Bioeconomy in Europe* FP7

OPTIMA - *Optimization of Perennial Grasses for Biomass Production* FP7



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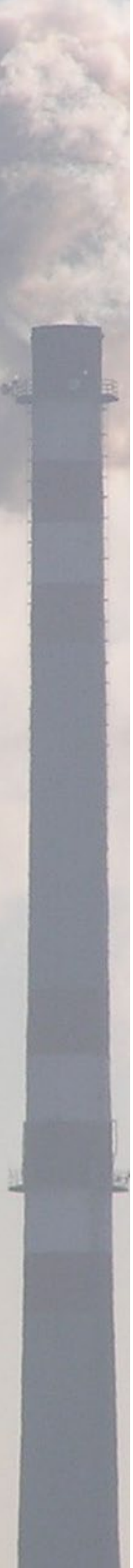
CARBON CAPTURE UTILIZATION AND STORAGE

CO_2 recovery from flue gases and industrial emissions, storage in safe location and/or re-use for the production of fuels and chemicals, have a tremendous potential in reducing greenhouse gas emissions and controlling global warming.



CCUS covers a vast area of research and application which involves extremely different expertises and topics. Thanks to its multidisciplinarity, the University of Bologna covers most of them.

- **Membrane** based technologies for Pre and post combustion CO2 capture and purification
- **Development of catalysts and catalytic processes** the production of fuels and chemicals from captured CO2
- Incorporation of CO2 into added value organic compounds by means of **metal metal-free and photo-catalytic protocols**
- **Biotechnological processes** for CO2 microbial reduction to biomethane and/ or fixation into biomolecules
- **Thermo, electro and photoelectro-activation** and reduction of CO2 to chemicals and fuels
- **Switchable solvents** and surfactants for CO2 capture and utilization
- **Safety and Risk Analysis of CO2 transportation and storage** in CCUS applications
- Flue CO2 fixation by using **algal cultures** for biomass production
- **Conversion of CO2 to CH4 through Sabatier reaction** by using hydrogen from renewables sources

HIGHLIGHTS

The **Catalytic Processes Development Laboratory** holds experience in using CO2 as an alternative carbon source for the production of fuels and chemicals. Advanced sustainable processes are developed by using organic carbonates for the gas-phase reduction of CO2, as well as catalytic and photo-electrochemical processes for CO2 valorisation to provide low carbon fuels and chemicals.

Membrane laboratory (MEMLAB) has strong experience in CO2 Capture thanks to several collaborations with companies dealing with biogas upgrading, natural gas sweetening and hydrogen purification. Membrane properties and performances can be tested in a wide range of operative conditions thus addressing both pre and post combustion carbon capture, as well CO2 removal from different industrial streams.

The **Laboratory of Algal Biology** has a specific experience in algal cultivation for industrial purposes. Residual CO2 from methane upgrade is used to grow algae in pilot photobioreactors.

European Projects

NANOMEMC2 - *NanoMaterials Enhanced Membranes for Carbon Capture Development of innovative CO2 selective membranes with high flux and selectivity suitable for application to both Pre and Post-combustion Capture processes* H2020.

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ENERGY EFFICIENT BUILDING

A way to fight against climate change effects and to improve cities resilience and people comfort.

The University of Bologna is deeply involved in studying and implementing the role of energy efficient building in framing the future of climate change mitigation and adaptation. The focus is on urban, peri-urban and rural areas and on existing, ancient and new buildings.

Main research fields

- Innovative procedures and systems for renewable energies exploitation in building
- Innovative technologies for achieving energy efficient, resilient and smart buildings
- New paradigm of intervention of cultural/artistic buildings retrofitting
- Methods and understanding of buildings thermal effects on urban microclimate
- Building envelopes' add-ons and prefabricated plug and play systems.BIM (Building Information Modeling) application on buildings and research on scenario/simulation based on decision making processes
- Integration of energy efficient buildings paradigm in existing built environment
- Smart Home paradigm and integration on the district perspective
- Indoor monitoring for energy comfort in different typologies of buildings (schools, offices, residential, etc.)
- Energy occupant behaviour in urban planning, energy efficiency awareness and the role of policy instruments to tackle the user-related impact

HIGHLIGHTS

The **OFF_line Laboratory of Innovation and Energy Efficiency** deals with: study of materials, components, traditional and innovative building technologies; sustainability and renovation of existing buildings; smart, circular and green districts; retrofitting methods with focus on energy efficiency of building over-cladding; definition of packages of pre-assembled high energy and environmental performance solutions; LCA approach.

The **Interdepartmental Centre for Applied Research on Buildings and Construction (CIRI-EC)** promotes research co-operation and innovation with industries and small/medium enterprises by means of applied research on buildings and construction technologies, technological support, knowledge transfer and business development.

European Projects

e-SAFE - *Energy and Seismic affordable renovation solutions H2020*

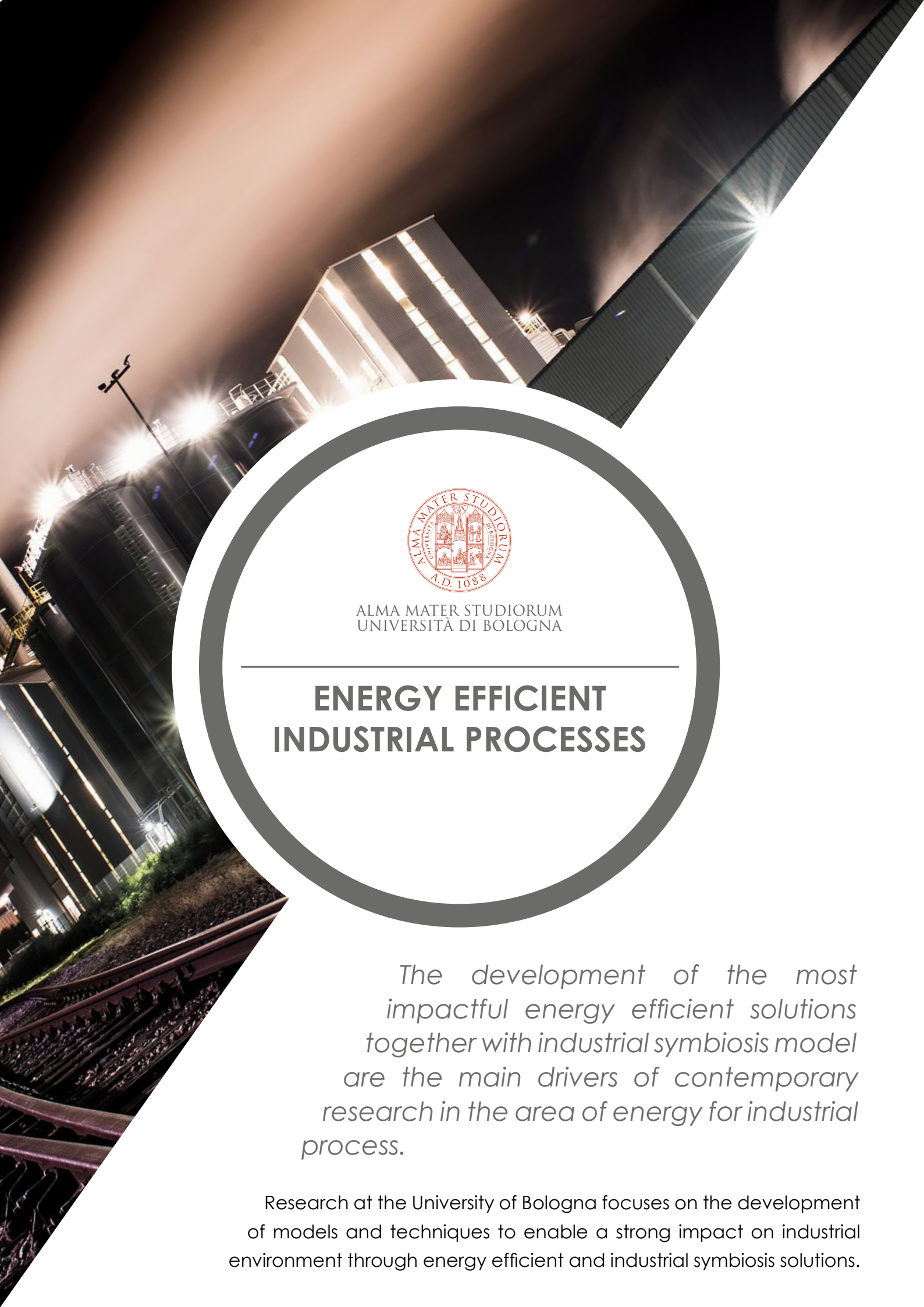
Hybrid-BioVGE - *Hybrid Variable Geometry Ejector Cooling and Heating System for Buildings Driven by Solar and Biomass Heat H2020*

DRIVE 0 - *Driving decarbonization of the EU building stock by enhancing a consumer centred and locally based circular renovation process H2020*

TripleA-reno - *Attractive, Acceptable and Affordable deep Renovation by a consumers orientated and performance evidence based approach H2020*

Pro-GET-one - *Proactive synergy of inteGrated Efficient Technologies on buildings' Envelopes H2020*

ABRACADABRA - *Assistant Buildings' addition to Retrofit, Adopt, Cure And Develop the Actual Buildings up to zeRo energy, Activating a market for deep renovation H2020*



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ENERGY EFFICIENT INDUSTRIAL PROCESSES

The development of the most impactful energy efficient solutions together with industrial symbiosis model are the main drivers of contemporary research in the area of energy for industrial process.

Research at the University of Bologna focuses on the development of models and techniques to enable a strong impact on industrial environment through energy efficient and industrial symbiosis solutions.

Energy efficient solution for industrial processes

- Development and test of solutions for the improvement of the industrial equipment aimed at maximizing energy efficiency
- Development and test of tools for the performance of energy audits and able to give support to management about energy decisions
- Design or optimization of technical solutions and integrated control systems for the smart operation for renewable heating and cooling systems in industrial application
- Design and development of technical solutions that cover the highest possible heating and/or cooling demand by means of solar thermal energy

Industrial waste energy recovery

- Design and development of solutions for an efficient and cost effective heat recovery in industrial facilities
- Development and validation of simulation tools able to perform cost-benefit assessments for the selection of the best technologic option to recover industrial wasted energy
- Design and development of cost effective solutions for district heating and/ or cooling systems

Optimization of the value chain and industrial symbiosis

- Design and development of cost effective solutions for production, transformation, transport and temporary storage of thermal and electrical energy in industrial districts
- Development and test of devices and instruments for the implementation of energy cooperation in industrial clusters
- Development and validation of business models and service concepts at service provider level for joint energy services

HIGHLIGHTS

Cooperation with Laboratories on industrial solution for energy efficiency, such as **Henergia** to assess solar technologies for the production of electricity and heat, and the production, storage and use of hydrogen for large scale application.

Research on **Aquifer Thermal Energy Storage** (ATES) systems is carried out at the University of Bologna. ATES systems have still not been explored but they allow using aquifers as a source for thermal energy, providing heating and cooling for buildings and reducing up to 60% CO2 emissions.

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ENERGY STORAGE

A strategic technology asset for energy systems (e.g. smart grids) with widespread deployment of renewable energy sources and the driver of zero emission E-mobility. Hybrid systems, combining different storage technologies, represent a promising solution in several application fields.

Progress in energy storage requires the exploitation of skills at all levels of the value chain. Different aspects of science, including fundamental chemistry and physics, materials science, engineering and economics are involved. Due to its multidisciplinary nature, the University of Bologna is the ideal research partner in the field of energy storage.

- Electrochemical characterization of electrochemical energy storage devices
- High-voltage supercapacitors
- Hydrogen based storage systems
- Lab-scale next-generation lithium metal and lithium-ion batteries
- Life Cycle Assessment of storage devices
- Modeling and characterization of electrical energy storage devices
- Optimal management of storage units in smart grids
- Power to Gas and Power to Liquid
- Pumped-hydro Storage
- Residential (thermal) storage
- Storage for e-mobility
- Storage and converters for fast charging station
- Storage and converters for photovoltaic generation
- Superconducting Technologies for Energy Storage (SMES and flywheels)
- Thermal Smart Grids

HIGHLIGHTS

The **Laboratory of Electrochemistry of Materials for Energetics (LEME-CHIM)** develops activities concerning: characterization of lab-scale lithium batteries, supercapacitators, fuel cells, synthesis of electrode and electrolyte materials and separators, electrode processing, integration of electrochemical energy storage devices with solar cells and fuel cells.

The **Laboratory of Magnet Engineering and Applied Superconductivity (LIMSA - DEI)** develops power superconducting devices and high field magnets, also in collaboration with CERN and ITER. Prototypization and modelling activities are carried out.

European Projects

CONDOR - *COmbined suN-Driven Oxidation and CO2 Reduction for renewable energy storage H2020*

HyFlow - *Development of a sustainable hybrid storage system based on high power vanadium redox flow battery and supercapacitor - technology H2020*

CuBER - *Copper-Based Flow Batteries for energy storage renewables integration H2020*

OSMOSE - *Optimal System-Mix Of flexibility Solutions for European electricity* H2020

LABOHR - *Lithium-Air Batteries with split Oxygen Harvesting and Redox processes* H2020.

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FUEL CELLS & HYDROGEN

Fuel cells, as an efficient conversion technology, and hydrogen, as a clean energy carrier, have a great potential to help fight carbon dioxide emissions, to reduce dependence on hydrocarbons and to contribute to economic growth.

Fuel Cell and Hydrogen research at the University of Bologna is conducted through a multidisciplinary approach that involves general and inorganic chemistry, physics of matter, microbiology, biotechnology, chemical engineering and industrial engineering.

As regards **Fuel Cells**, the following activities are developed:

- Electrochemistry, chemical physical characterization and synthesis of **polymeric, inorganic and carbonaceous materials** for proton exchange membrane fuel cells and for microbial fuel cells for water treatment. Considered materials are: electronically conducting polymers; organic electrolytes, including room temperature ionic liquids; transition metal oxides and alloys; nanostructured and porous carbons
- Development and testing of **polymeric bioelectrodes** for the realization of biofuel cells transforming **agro-industrial wastes** in electric energy
- Characterization and modelling of **perfluorosulphonate ionomeric materials** for proton exchange membrane fuel cells
- Design, preparation and characterization of hydrogen bonded **hybrid inorganic-organometallic acid** salts for application in solid fuel cell technology
- Experimental analysis of small **low-temperature fuel cells** for **stand-alone and/ or cogenerative applications**

As regards **Hydrogen**, the University of Bologna is active in:

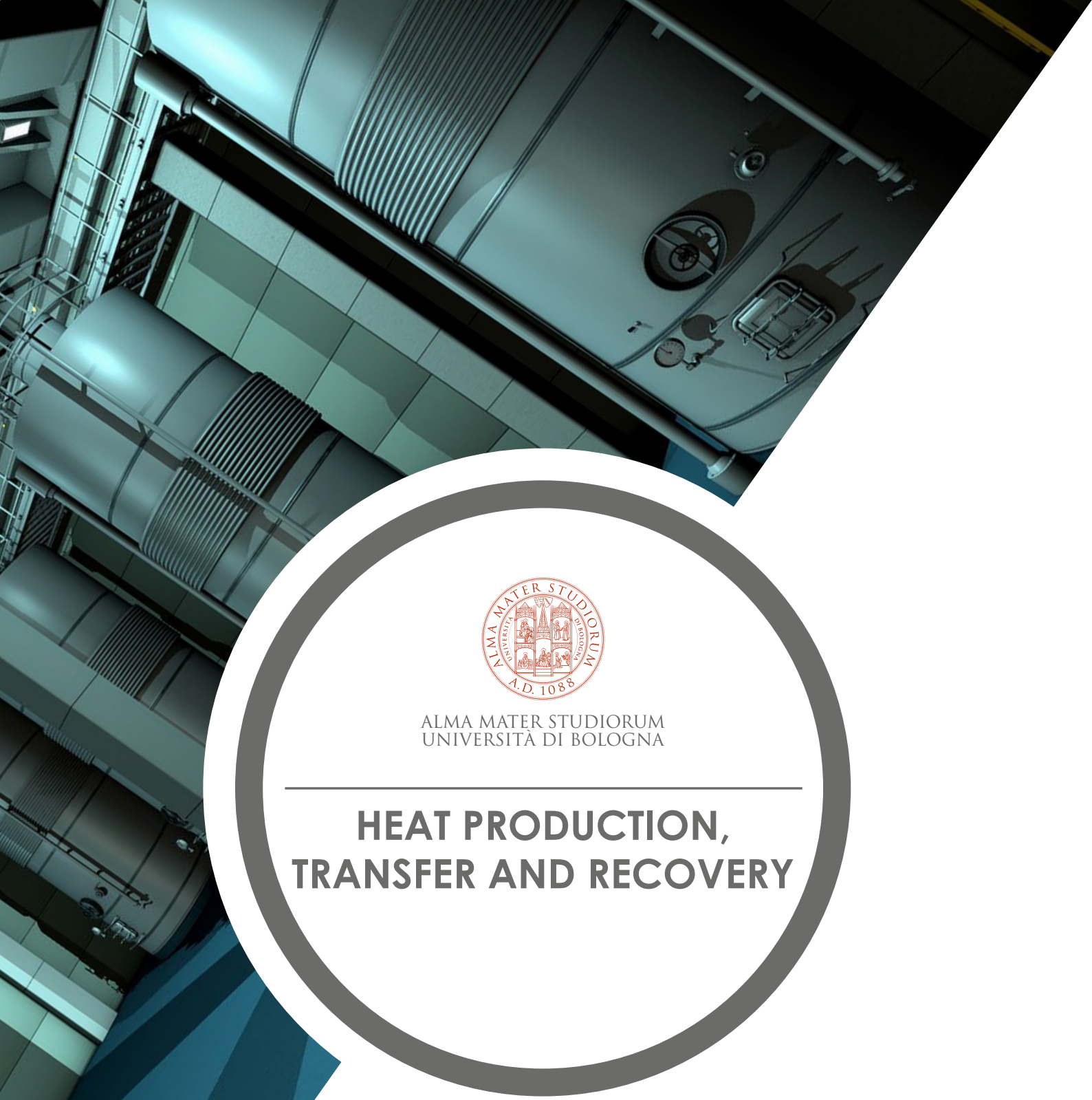
- **Metal hydrides** for solid-state hydrogen storage: synthesis, structural/chemical analysis, and characterization of hydrogen sorption properties
- Membranes and membrane separation processes for **hydrogen purification**: fabrication and testing of Pd-Ag based membranes and of polymeric membranes
- **Hydrogen and syngas production** by catalytic partial oxidation, steam-reforming and autothermal reforming of natural gas and gasification of biomass applied to plants of different size using structural catalyst and membrane integrated reactors
- Study and development of processes for the solar and **bio-production of hydrogen** and of organic compounds for the chemical industry from **agro-industrial wastes and other organic wastes** using solid catalysts either suspended-cell and attached-cell bioreactors

HIGHLIGHTS

European Projects

GREENAIR: Generation of hydrogen by Kerosene Reforming via efficient and low emission new alternative, innovative, refined technologies for aircraft application FP7.

GREENSYNGAS: Advanced cleaning devices for production of Green Syngas FP7.



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HEAT PRODUCTION, TRANSFER AND RECOVERY

Heat production, transfer and recovery are key activities to increase our planet sustainability, which are investigated to find innovative solutions in civil and industrial environment.

Research at the University of Bologna regards the development of models and techniques to allow for a strong impact within several application fields.

Waste Heat Recovery

- Design and development of solutions to recover the wasted heat produced in processes of industrial sectors with, for instance, ORC cycles, heat pumps or district heating
- Development and test of materials for the recovery of high enthalpy heat able to withstand at temperature higher than 700 °C
- Development and test of new Heat Transfer Fluids (HTF) and Phase Change Materials (PCM) to improve heat exchange and heat storage accumulation

Thermal energy production by biomass

- Development and test of innovative filtration systems for residential biomass heating systems
- Development and test of new fuels as fast pyrolysis bio-oils for residential biomass heating boilers with low environmental impact
- Development and test of micro-scale biomass combined heat and power (CHP) technology based

District Heating Implementation

- Development of new approaches for the design and for the operation of District Heating and Cooling (DHC) energy networks aiming at maximising the use of the local wasted heat and renewable energy sources
- Design and development of new approaches for district heating and cooling networks able to reduce energy transportation losses as for instance low temperature district heating
- Development and validation of tools and models as, for instance, self-learning control systems based for instance on cloud able to give indications for the operation and maintenance of district heating and cooling (DHC) networks

HIGHLIGHTS

Significant research projects to study the feasibility of sewage sludge energy recovery through relevant plant solutions have been carried out in collaboration and thanks to the support of the national multiutility HERA.

European Projects

Hybrid-BioVGE - *Hybrid Variable Geometry Ejector Cooling and Heating System for Buildings Driven by Solar and Biomass Heat H2020*

MIGRATE - *Research and training network on Miniaturized Gas flow for Applications with enhanced Thermal* H2020.

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MATERIALS FOR ENERGY

Materials are central and often critical to accelerate the evolution and future impact of new energy technologies. Whether dealing with energy conversion, harvesting or storage, the development of new materials with improved functionalities plays a pivotal role in efficiency, reliability, cost-effectiveness, and sustainability.

Research at the University of Bologna covers a wide range of issues:

- Design and characterization (electrochemical, physico-chemical) of new (nano)materials (porous and nanostructured materials, transition metal oxides, electronic conductive polymers, organic electrolytes and ionic liquids) for efficient energy transport, storage and conversion electrochemical systems (Li-ions and Li/O2 batteries, fuel cells, etc.)
- New materials for next-generation lithium metal and lithium-ion batteries
- Design of new blends for efficient charge separation and charge transport in photovoltaics
- Materials for new electrodes in efficient energy systems: photocathods/ photoanodes in photovoltaics, etc.
- Design of nanomaterials and catalysts for CO2 photoreduction, capture, hydrogen generation and storage
- Materials for (solar, (thermo)mechanical, thermal) energy harvesting
- Innovative materials (bio inspired, nano, super-molecular, polymeric, hybrid perovskites thin films) and devices for high efficiency, low cost and sustainable energy (solar, light, wave, etc.) conversion
- Materials (Nanofibers, adapted Thermo Chemical Materials, Metal Foams and Functional Surface Technologies) for Thermal Energy Storage
- Design and development of (nano)materials and (nano)composites for energy saving, low consumption, insulation and low carbon buildings
- Materials for low and high energy superconductivity
- Design of materials for thermonuclear fusion power stations
- Materials for sustainable, energy efficient chemical separation processes
- Materials for high-voltage supercapacitors
- Novel thermoplastic polymer composite materials to enhance performance of essential components of smart grid infrastructure
- Catalysts for the transformation of biomasses into chemicals and fuels, both in the liquid and in the gas phase

HIGHLIGHTS

European Projects

HyFlow - *Development of a sustainable hybrid storage system based on high power vanadium redoxflow battery and supercapacitor – technology,* H2020-LC-BAT-2020

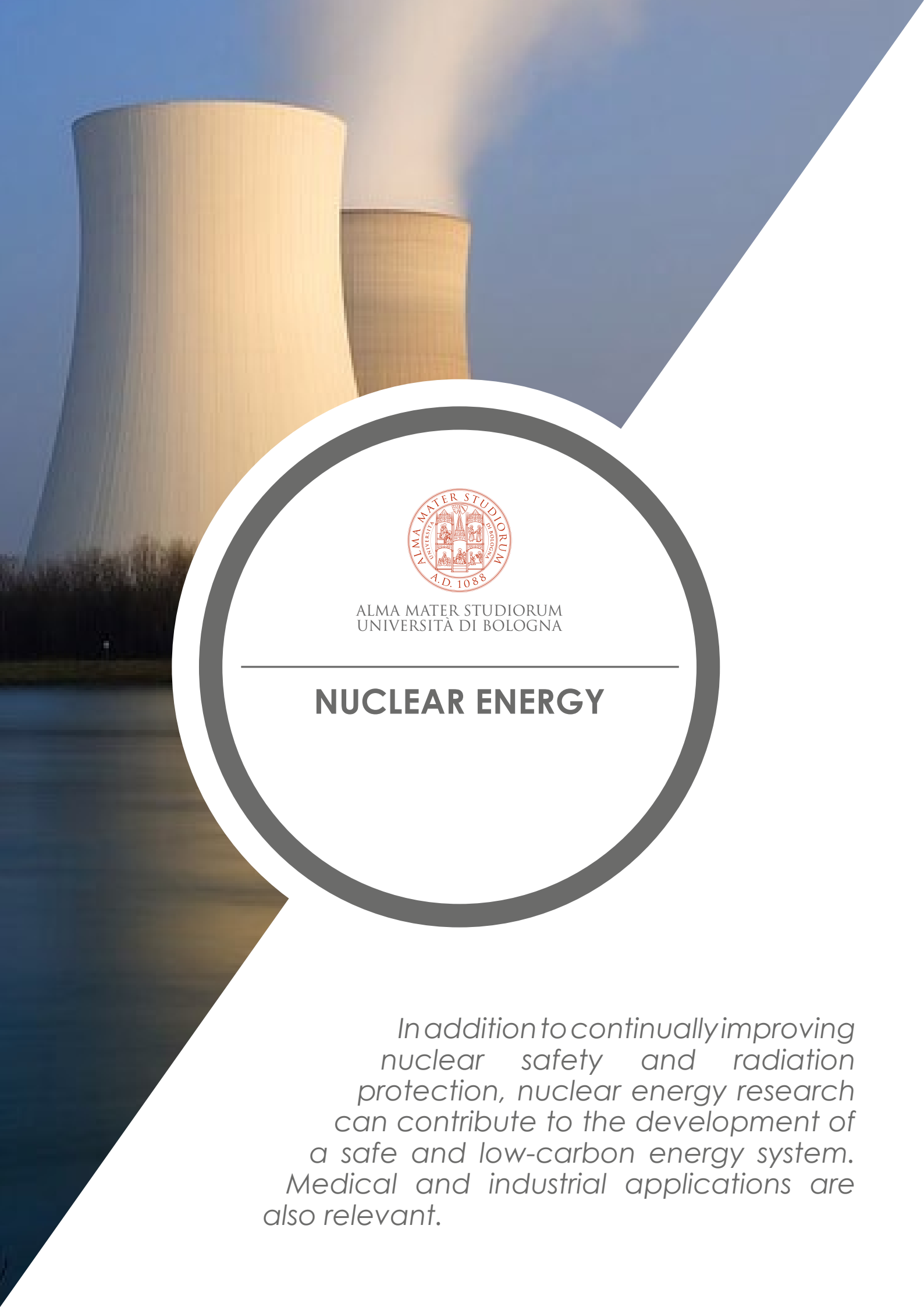
NANOMEMC2 - *NanoMaterials Enhanced Membranes for Carbon Capture*. H2020 - SC3

LEAPS - *Light effected autonomous molecular pumps: Towards active transporters and actuating materials*, H2020-ERC Adv.

GRIDABLE - *Plastic nanocomposite insulation material enabling reliable integration of renewables and DC storage technologies in the AC energy grid*, H2020 LEIT NMP.

PhotoSi - *Silicon nanocrystals coated by photoactive molecules: a new class of organic-inorganic hybrid materials for solar energy conversion*, FP7-ERC starting grant.

PolyWEC - *New mechanisms and concepts for exploiting electroactive Polymers for Wave Energy Conversion*, FP7-Energy.



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NUCLEAR ENERGY

In addition to continually improving nuclear safety and radiation protection, nuclear energy research can contribute to the development of a safe and low-carbon energy system. Medical and industrial applications are also relevant.

Research at the University of Bologna is conducted through a multidisciplinary approach that involves experimental physics, nuclear reactor physics, nuclear measurements as well as instrumentation, and nuclear power plants engineering.

- Development of methods and codes for the **analysis of the environmental impact of accidental releases of radioactive contaminants** with application to nuclear power and fuel cycle plant decommissioning activities
- Development of **deterministic and Monte Carlo models for the core design of nuclear reactors**
- Modeling of **neutron transport** in nuclear reactors, nuclear reactor dynamics, particle transport
- Development of **thermal-fluid dynamics codes** with application to liquid metal cooling for nuclear reactors
- Model development and safety assessments for **Generation IV reactors**
- **Radiation protection**: investigation tools in natural radiation assessment and methods for the prediction of activation in plants with neutron production
- **Cross sections measurements** of neutron-induced nuclear reactions
- **Nuclear reaction time measurements** in the interactions between heavy ions by means of the crystal blocking technique
- Research and study of "molecular-type" **nuclear resonances** in the interactions between **heavy ions**
- Experimental study of the **multi-fragmentation process** in the collisions between **heavy ions at intermediate energies**
- Experimental study of the reactions between **heavy ions at low incident energies** to obtain information on the thermodynamic characteristics of finite nuclear systems at the threshold of the **liquid-gas phase transition**
- **Ageing** diagnostics and prognostics of **nuclear power plant cables**

HIGHLIGHTS

TeaM Cables - *European Tools and Methodologies for an efficient ageing management of nuclear power plants Cables* H2020 EURATOM-FISSION

THINS - *Thermal-Hydraulics of Innovative Nuclear Systems crosscutting thermal-hydraulic issues encountered in various innovative nuclear systems* FP7 EURATOM-FISSION

LEADER - *Lead-cooled European Advanced DEmonstration Reactor*: development to a conceptual level of a Lead Fast Reactor (LFR) industrial size plant and of a scaled demonstrator of the LFR technology FP7 EURATOM-FISSION

ADVANCE - *Ageing Diagnostics and Prognostics of low-voltage I&C Cables* FP7 EURATOM-FISSION.

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RENEWABLE ENERGY

The development of the most impactful technologies enabling the accomplishment of a low-carbon energy society is one of the main drivers of contemporary research in the area of energy.

Research at the University of Bologna on Renewable Energy regards the development of models and techniques to foster the inclusion of RES into energy systems (electric, thermal, etc.).

Renewable Energy integration into Energy Systems: Advanced monitoring and control solutions of stability in electric networks with large penetration of RES; Development of advanced electrochemical storage systems for energy systems with large penetration of RES; Development of technologies and components that support enhanced integration of renewables and storage combined with intelligent control of the power flow; Design and optimization of cogeneration and trigeneration systems based on RES; Exploitation of advanced communication networks for fostering RES penetration into the electric grid; Integration of ground source heat pump and of aquifer thermal energy storage with groundwater and soil remediation.

Onshore & Off-shore Wind: Models for environmental and economic evaluation of **wind turbines**; Modelling and simulation of **airborne wind energy converters**; Design and techno-economic analysis of **multi-purpose offshore platforms** for marine renewable energy harvesting.

Ocean energy: Design of wave energy converters for **combined energy production and coastal protection** purposes; Design, manufacturing and testing of **all-polymer wave energy converters** with high performance and low cost.

Geothermal energy: Characterization of **geothermal reservoirs** for the climatization by **heat pumps**; Numerical simulation of **reservoirs, aquifers and geothermal fields**; Design and simulation of ground heat exchangers (shallow geothermics); Geochemical survey on **thermal waters and gas discharges** in geothermal sites; Dynamic simulation and optimization of **vertical ground heat exchangers and of heat pump** systems; Design and technoeconomic analysis of geothermal heat pumps.

Next generation of solar photovoltaics (PVs): Manufacturing of flexible **organic photovoltaic cells**; Manufacturing and characterization of **polythiophene based photovoltaic** devices; Manufacturing and characterization of **germanium thin film photovoltaic** devices; Defect characterization of **silicon** (crystalline, multi and nano-crystalline, amorphous) for PV applications; Technoeconomic analysis of **thermophotovoltaic systems**.

HIGHLIGHTS

European Projects:

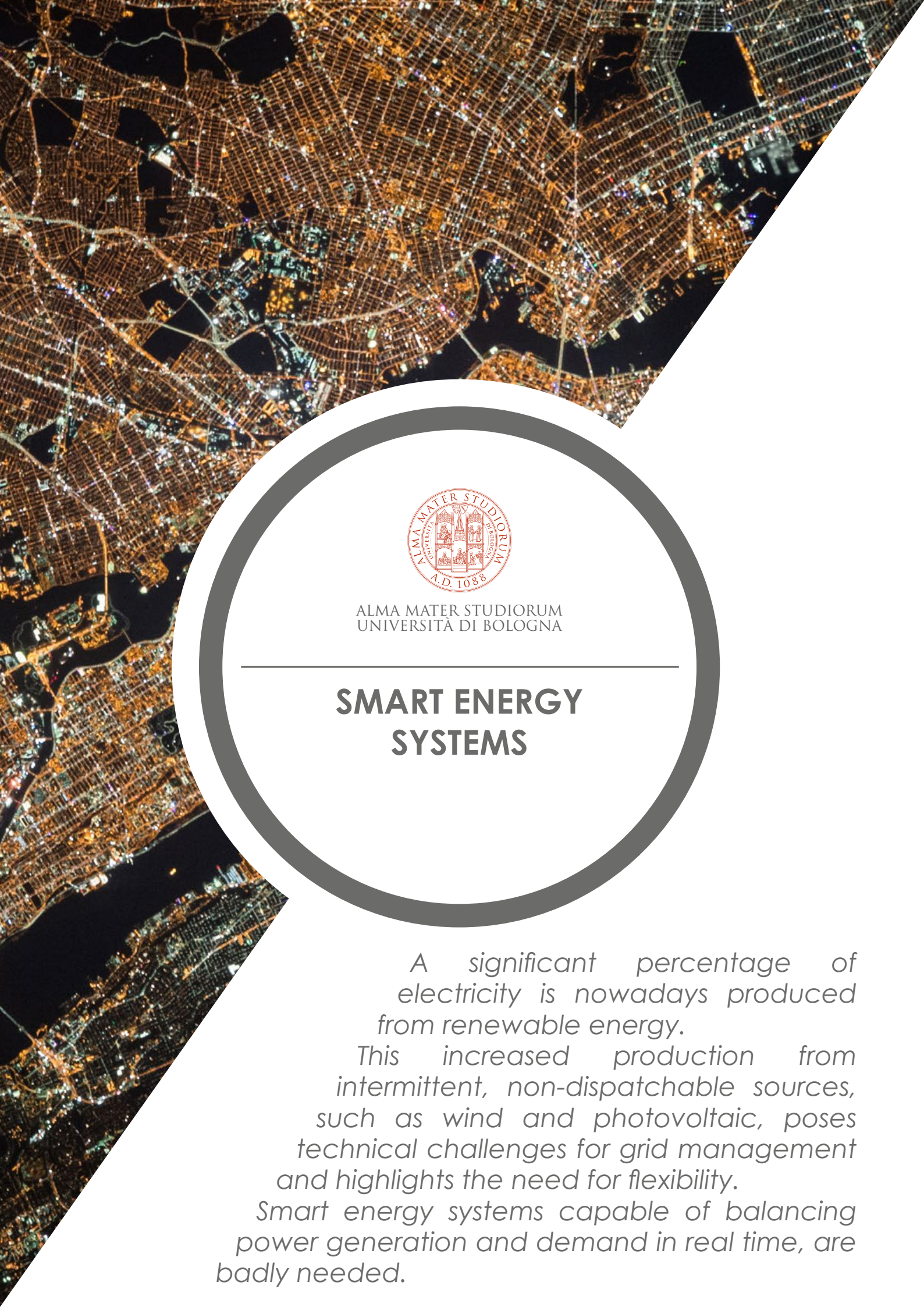
LEAP-RE - *Long-Term Joint EU-AU Research and Innovation Partnership on Renewable Energy H2020*

Hybrid-BioVGE - *Hybrid Variable Geometry Ejector Cooling and Heating System for Buildings Driven by Solar and Biomass Heat H2020*

GEOT€CH - *Geothermal Technology for €conomic Cooling and Heating* H2020

MERMAID - *Innovative Multi-purpose Offshore Platforms: planning* H2020

CORES - *Components for Ocean Renewable Energy Systems* FP7



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SMART ENERGY SYSTEMS

A significant percentage of electricity is nowadays produced from renewable energy.

This increased production from intermittent, non-dispatchable sources, such as wind and photovoltaic, poses technical challenges for grid management and highlights the need for flexibility.

Smart energy systems capable of balancing power generation and demand in real time, are badly needed.

Some research groups at the University of Bologna have been pioneers in the research on smart energy systems. Innovative solutions for distribution networks operation in presence of small scale generating plants, fully automatic scheduling systems of experimental microgrids, which include generators and storage systems and relevant components, have been developed and tested.
Main research themes:

- Analysis and Control of **distribution systems** with embedded generation from **renewable sources**
- **Power quality** improvements in distribution networks
- Automatic **fault location** in medium voltage distribution networks
- Distribution networks operation in presence of **small scale generating plants** and **micro-grids**
- Design of **mechanism and policies** to assemble, monitor and control **smart grids**
- **Decision support tools** for power producers in a competitive **electricity market**

HIGHLIGHTS

LISEP – Power Systems Engineering Laboratory

Research in the areas of production, transmission, distribution and utilization of electricity with particular reference to smart grids.
The scientific activity is carried out in connection with the Institute of Electrical and Electronics Engineers Power and Energy Society - IEEE PES.

LIT - Laboratory of Innovation Technology

Research activities regard materials and components for Electrical Engineering and smart grids. In particular:

- Electro-thermic characterization of semi-conductor and insulating materials, also nanostructured, cellular piezoelectric materials and magnetic materials
- Diagnostic of solid, liquid and gas insulating systems
- Development of diagnostic techniques for smart-grid and super-grid

European Projects

EdgeFLEX - *Providing flexibility to the grid by enabling VPPs to offer both fast and slow dynamics control services H2020*

PlaMES - *Integrated Planning of Multi-Energy Systems H2020*

SOGNO - *Service Oriented Grid for the Network of the Future H2020*

FLEXMETER - *Flexible smart metering for multiple energy vectors with active prosumers H2020*

ADMS - *SmartGrid Active Distribution Management System to accommodate Renewable Energy Sources and Low Carbon Emissions H2020*

INCITE - *Innovative controls for renewable sources Integration into smart energy systems H2020*

CONNECT - *Innovative Smart components, modules and appliances for a truly connected, efficient and secure smart grid H2020*

R3-PowerUP - *300mm Pilot Line for Smart Power and Power Discretes H2020*