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CALL-FOR-PROJECTS MANUAL

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Preamble

A chair is a multidisciplinary academic project, developed thanks to sponsoring. The support is provided without counterpart, which distinguishes the chair from other service agreements. The chair's academic activities, including research, training, dissemination, and entrepreneurship are co-defined by the chair initiators and the funding partners. The academic freedom of the researchers is guaranteed, and no financial profit can be generated from this initiative.

Thanks to its agile structure, the chair can easily attract national and international researchers and, thus, position itself as a research and development hub in the projected field. The chair also offers a fertile ground for university students who can feed from the different activities of training and dissemination.

Positioning of the UM6P's Chair in Sustainable Energy:

The chair in Sustainable Energy at UM6P is an OCP/UM6P initiative. It promotes a.o. research and development in the fields of generation, storage, distribution and use of energy, which is needed to maintain social welfare and development. The chair places special emphasis on the related economic, environmental, educational, and social aspects.

Vision and objectives of the Chair

The Chair pursues activities that ensure energy sustainability with actions aiming to have:

- A scientific impact through, publications, seminars, and conferences.
- An economic impact through IP generation and licensing, technology transfer to industry and startups, with the aim of adding value to Moroccan resources in general and OCP's in particular.
- An educational impact by providing tools and modules for an innovative learning pedagogy, and setting up an international network for students' traineeships and academic collaboration.
- A social impact by proclaiming sustainability as a strategic objective and placing it at the core of all activities.
- An environmental impact by placing renewable energy, water-energy nexus, recycling and waste valorization in focus.

Research Activities of the chair

1. To develop research programs in energy sustainability matters.
2. To encourage scientific exchange and collaborations through seminars, a visiting professors & students' program and collaborations with top-class universities and research centers around the world.
3. To promote generation of Intellectual property in the area funded by the chair and set up path to potential commercialization.

4. To promote the publication of research studies in peer-reviewed journals in the areas covered by the Chair.
5. To organize international scientific congresses in research areas covered by the Chair. In general, the chair aims to address impactful activity subjects along the energy value chain that includes energy generation, energy storage, energy distribution and energy utilization, as well as cross-value topics such as energy efficiency and water-energy nexus.

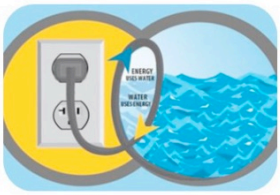
Energy Generation

Energy Storage

Energy Distribution

Energy Utilization

Energy Efficiency



Water energy nexus

The chair's activities are organized in 6 separate trusts, defined in the next paragraphs.

1

Trust 1: Li and Na ion batteries, redox-flow batteries: Materials and Technologies

The goal of the program

The aim of this program is to identify and support research and development needs in the area of electrochemical-based energy storage. In particular, the program will include research and developments in the field of batteries and supercapacitors and will cover both low and high TRL technologies and developments **(TRL 2 to TRL 8).**

As electricity storage devices, batteries and supercapacitors are among the key enablers to achieve a low-carbon economy. Therefore, the market for these devices is growing very rapidly and is becoming very strategic.

The program will focus on either developing and demonstrating **innovative** next-generation battery and supercapacitor or enhancing **existing** technologies for **stationary applications**. Next generation batteries will include developments aiming high energy devices such as Li-metal based batteries (including Li-S), solid state batteries, and Li-ion redox flow batteries. Research aiming at alternative technologies such as low-cost Na-ion batteries and technology to improve safety are also eligible in this program. Research that can ensure material sustainability trough recycling are encouraged to submit as well. Research and developments that can include the integration of sensors and/or advanced characterization (operando techniques, evaluation methods of SOH) and modeling methods are also eligible. Research and developments aiming the enhancement of existing Li-ion batteries, either by improving performance (e.g. life-cycle, safety), or by reducing the cost and enhancing the sustainability (local and abundant biomass, low utilization of critical mineral or/and utilization of abundant minerals in Morocco, production process, recycling) are also encouraged to apply to this program.

Finally, all proposals must also address the potential for **upscaling of the materials and devices** to achieve high level of sustainability and effectiveness.

Expected Impact

- To develop a strong knowledge/know-how in a wide range of electrochemical storage materials and devices that will possibly enable the emergence of a locally owned battery-exporting industry.

- To achieve the goals of the Moroccan challenges in term of putting innovative, sustainable, and low-cost materials and approaches in elaborating materials and developing electrochemical energy storage. Speeding up the deployment of batteries for energy storage applications

- The utilization of abundant and sustainable materials to reduce the pressure on limited natural resources and to achieve batteries and supercapacitors with the best performance.

2

Trust 2: Solar and grid technologies

The goal of the program

The direct conversion of sunlight into electricity using solar cells is a key technology for the sustainable energy supply of the future. Solar cells made from silicon are currently the most efficient solar cells available for residential use. Generally, silicon based solar cells are more efficient and longer lasting than non-silicon-based cells. The second generation of solar cell technologies, usually called thin-film solar cells, are made from few micrometers thick layers of semiconductor materials like amorphous thin film silicon, cadmium telluride (CdTe), Copper, Indium, Gallium, Selenide (CIGS) or others…The combination of using less material and lower cost manufacturing processes allow the manufacturers of solar panels made from this type of technology to produce and sell panels at a much lower cost. The third generation of solar cell technologies are made from a variety of new materials including organic dyes or polymers and hybrid perovskite materials. The main advantages of thin-film solar cells and modules compared to today's silicon wafer photovoltaic technology are flexibility and lower production cost. Regardless of the technology used for the conversion of light rays by the photovoltaic effect, efforts are always focused on improving the performance and stability of these devices, as well as on transferring the results at the laboratory scale to the market. These challenges include the development of new materials, device architecture, encapsulation materials or the substitution of expensive materials and manufacturing processes that are used today.

This research program aims to push forward the performance of different solar cell technologies to achieve ultimate yields through the use of alternative materials and manufacturing methods, or by the combination of different technologies in so-called tandem cells. The objective is to develop efficient and economically viable materials, preparation methods (e.g. active thin films growth), advanced modeling tools, and devices for solar energy conversion. Research activities will cover: Photovoltaics (inorganics, organic and hybrid), concentrated solar power and their integration in smart grids and buildings, green hydrogen production etc. The program will cover both low and high TRL technologies **(TRL 2 to TRL 8).**

Expected Impact

- To develop a strong knowledge/know-how in a wide range of solar energy materials and devices that will possibly enable the emergence of a locally owned solar energy-exporting industry.

- To develop innovative and optimized technologies (e.g. Silicone, thin films, organic and perovskite etc.).

- To develop processes for the fabrication of solar cell technologies at larger scale using green coating and printing techniques.

- To carry new research that aims at developing tandem solar cells and modules. This technology offers very good perspectives for taking solar cell efficiency much further.

- To develop new functional materials for CSP applications, with enhanced lifetime and resistant against different stresses such as soiling, erosion by sand particles or UV degradation.

- To develop resistant coatings at high temperature for thermal energy storage.

- To create an African research cluster in the field of solar cell technologies to reach excellence and acquire knowledge and know-how by the various University partners, and Industrial research units in Morocco and abroad.

- To strengthen training and education programs in the field of renewable energies and more particularly in solar cell technologies

3

Trust 3: Hydrogen and fuel cell technologies

The goal of the program

The potential economic benefits of renewable Hydrogen, Ammoniac and fuel cell technologies is increasingly well-recognized by governments and industry, notably by companies engaged in the fossil fuel and its derivate industries who are at the forefront of global decarbonization efforts.
At the core of renewable hydrogen technologies is electrolysis, which utilizes renewable electricity to split water into hydrogen (**green hydrogen**) and oxygen/chlorine; NOx/nitrogen into ammonia; and CO_2 into CO, syngas, and formic acid. In addition, renewable hydrogen can be used in secondary conversion processes such as methanation, hydrogenation, and Fischer–Tropsch to generate a range of hydrocarbon products as well as in the Haber–Bosch process to generate ammonia. Notably, water electrolysis is seeing increased deployment around the world. In fact, renewable hydrogen pricing is at least two times more expensive than hydrogen generated from fossil fuels, declining electrolyze capital costs resulting from economy of scale and adoption of a new generation of cost-effective catalysts (either replacing commercial Pt/Ir catalysts or decreasing their loading) alongside declining electricity pricing is leading to competitive levelized costs across various jurisdictions. While most work (research and demonstration level) with "renewable H_2" has focused on using clean water. The direct utilization of seawater presents challenges, specifically for electrode and membrane stability and the formation of Cl_2 over O_2 for the anode reaction. Considerable research and funding are being directed to develop stable systems that can directly use seawater or through a combination of reverse osmosis water purification and electrolysis. In contrast, the utilization of wastewater for electrolysis is more mature with a number of commercial systems capable of converting gray water to hydrogen. It is expected that further understanding of the chemistry of these technologies may bring solutions to address the concerns of water issues in hydrogen production.
The global ammonia fertilizer market is supplied by ammonia generated using the Haber–Bosch process that requires high pressures and temperature, as well as high-purity hydrogen and nitrogen feed. To decarbonize this hard-to-abate industry, a number of renewable power-to-ammonia routes are being actively investigated: (i) using renewable hydrogen for the Haber–Bosch process, (ii) conversion of pure nitrogen into ammonia using electrolysis, improving energy efficiency of Haber–Bosch from the current 15 kWh/kg_{NH3} to 8 kWh/kg_{NH3}.
The program will also support advanced development in fuel cell technologies. These developments will include research on new and efficient nano-catalyst, membrane, and electrolytes for different fuel cell technologies (SOFC, AFC, PEMFC, etc.). The projects proposed in this program cover a broad TRL segment with projects from TRL2 to TRL 8

Expected Impact

- To reduce the production cost of fuel cell systems, while increasing their lifetime to levels competitive with conventional technologies.

- To increase the electrical efficiency and the durability of the different fuel cells.

- To increase the energy efficiency of production of hydrogen mainly from water electrolysis and renewable sources.

- To demonstrate on a large scale the feasibility of using hydrogen to support integration of renewable energy sources into the energy systems.

- To overcome technical barriers through R&D of hydrogen and ammonia production, delivery, and storage technologies, as well as fuel cell technologies for transportation, distributed stationary power, and portable power applications.

- To address safety issues and facilitate the development of model codes and standards.

4

Trust 4: Carbon: capture, utilization, separation, and sustainable transformation

The goal of the program

Carbon capture and utilization is very important to achieve the objective of zero emissions. In this program we aim the development of a set of technologies aiming the capture of CO2 emissions at source (coming from combustion of fuel, steel and cement industries, refineries) in order to prevent it emission into the atmosphere. The program will support all research and development of different technologies based on adsorption, absorption or membrane separation and capture of CO2. In particular, eligible projects must be dedicated on highly innovative and efficient materials and/or process for decarbonization (ultra-porous materials, MOFs, solvents, etc.).
The utilization of CO_2 consists into its transformation into an economically valuable product. CO2 can either be transformed into new materials, chemicals, and fuels via chemical reactions, but it can also be used as a solvent (supercritical solvent) in some applications. Therefore, projects aiming the development of process transformation of CO_2 onto valuable products are also strongly encouraged. As examples, utilization will include CO2 transformation into methanol and biofuel. Finally, a systematic approach to costs and emission of capture and utilization process must be conducted during each proposal. The projects proposed in this program cover a broad TRL segment with projects from TRL 2 to TRL 8.

Expected Impact

- To develop a strong knowledge/know-how in a wide range of CO_2 capture technologies and materials that will possibly enable the emergence of a locally owned technology-exporting industry.
- The utilization of abundant and sustainable materials to produce efficient materials for CO2 capture.
- To reduce CO_2 emission by Moroccan industries by implementing new technologies based on advanced materials.
- To transform a waste to valuable products.

5

Trust 5: Water-energy nexus

The goal of the program

The aim of this program is to develop policies addressing water rights and water impacts of energy production are introducing additional incentives and challenges for decision making. Proposals should identify, develop, demonstrate and test innovative, multi-beneficial solutions that can deliver good water status, in terms of quantity and quality, and sustainable energy security.

Actually, water and energy systems are tightly intertwined. Water is used in all phases of energy production and electricity generation. Energy is required to extract, convey, and deliver water of appropriate quality for diverse human uses, and then again to treat waste waters prior to their return to the environment. The interactions between energy and water is considered on a regional or technology-by-technology basis. At the national and international levels, energy and water systems have been developed, managed, and regulated independently.

Recent developments have focused the attention on the connections between water and energy infrastructure. Several current trends are further increasing the urgency to address the water-energy nexus in an integrated and proactive way. Particularly, climate change has already begun to affect precipitation and temperature patterns. The population growth and regional migration trends indicate that the population in arid areas is likely to continue to increase, further complicating the management of both energy and water systems. In addition, introduction of new technologies in the energy and the water domains could shift water and energy demands.

Expected Impact

- To optimize the freshwater efficiency of energy production, electricity generation, and end use systems.
- To enhance the energy efficiency of water management, treatment, distribution, and end use systems.
- To develop the reliability and resilience of energy and water systems.
- To promote responsible energy operations with respect to water quality, ecosystem, and seismic impacts. Exploit productive synergies among water and energy systems.

6

Trust 6: Energy efficiency

The goal of the program

Energy efficiency is the ratio of service, goods or energy yield output to the energy supplied input. Energy efficiency is therefore understood to mean the rational use of energy. Optimized processes are intended to minimize the quantitative and qualitative losses that arise in detail during the conversion, transport, and storage of energy in order to achieve a specified energetic benefit with falling primary and final energy use.
The aim of this program is to develop solutions for minimizing the use of energy in general in materials production and buildings, to identify and optimize novel processes and methods that optimize energy use, to engineer structures and designs that address energy usage, and to design applications that aim to combat climate change.

In this trust, proposals should identify, develop, demonstrate and test innovative, multi-beneficial solutions that can deliver products or processes for energy saving and energy efficiency.

Expected Impact

• To optimize energy use in a range of different applications where both conventional and renewable energies are used

• To identify how the “solutions” affects the several elements that enter in its realization

• To provide as holistic approach to the “solution” taking in consideration the realities of the problem and its eco-system

Principle investigator (PI) and project team

The principle investigator of the project is a member of a Moroccan university or research institute. Other collaborators, national and/or international, from other Universities and/or from industry are welcome to participate as members of the teams.

Deliverables

- A mid-term report
- A final report

A projects-day will be scheduled **twice a year**, during which project results are presented in front of a chair's committee. Projects PIs will be informed of the Projects-day during the course of the project.

Project duration

The projects should be planned for a period of up to **12 months**. The timeline could be granted upon decision by the evaluation committee.

Funding of selected projects

Each successful project will be awarded a maximum of **400 kMAD**.

Evaluation criteria

Projects that do not belong to one of the trusts defined in the paragraph "Research" will not be considered in this call.

The projects will be evaluated by a committee of experts, determined by the chair's scientific committee, according to **the following criteria**:

Evaluation criteria	Grade
Scientific relevance of the project	10
Quality of the project proposal (planning, structure…)	40
Potential scientific impact	10
Potential economic impact of the project	10
The scientific complementarity of the members of the project	20
Multidisciplinary	10

Projects belonging to each of the trusts will be classified based on the grading determined in the evaluation criteria table. The scientific committee will decide on which projects will be awarded funding.

Submission procedures and schedule

To apply for a project, the project team must use **the dedicated platform** https://call.um6p.ma/login **create an account**, choose "**CALL FOR PROJECTS ENSUS**" in the programs list, and **submit a project file**, including all elements as per **the provided canvas**.

The file should be in a pdf file named: « ENSUS-SP2022-PI name-TRUST number ». Example : ENSUS-SP2022-Mohammed BAGHOUT-05.

Schedule

The following deadlines should be considered:

- Call for Projects: **12 July 2022.**
- Submission of project proposal: **30 September 2022.**
- Project evaluation : **10 October 2022.**
- Awards announcement: **21 October 2022.**