Position Description

1. General Information

Name of the position	**Photovoltaic integration in urban environment**
Foreseen enrolment date	1 October 2023
Position is funded by	• COFUND, Marie Skłodowska-Curie Actions (MSCA), Horizon Europe, European Union • Université Savoie Mont Blanc (USMB) • University of New South Wales (UNSW)
Research Host	Université Savoie Mont Blanc (LabOratory proCess bulldings Energy – LOCIE UMR CNRS/USMB 5271)
PhD awarding institutions	Université Savoie Mont Blanc & University of New South Wales
Locations	Primary: Le Bourget-du-Lac, France Secondary: Sydney, Australia
Supervisors	Christophe Ménézo (USMB) Mat Santamouris (UNSW)
Group of discipline	Building Physics, Heat and Mass Transfer, Radiation, Urban Physics

2. Research topics (only one of these projects will be funded)

Project 1*: Mitigation of Solar Photovoltaic Heat Island effect and Energy performance enhancement*
Climate change can already be felt through global warming, increase in the frequency and intensity of extreme events such as heat waves. These issues have particular relevance to urban areas where valuable assets are concentrated and more than 2/3 of the world's population will resides in 2050. Moreover, the projected global-scale changes is exacerbated by city-scale phenomena, such as the formation of heat islands (UHI), which during heat wave events, results in many deaths. however, countries must also ensure their energy independence while limiting greenhouse gas emissions. It is in this sense that Europe, which is particularly exposed to these two problems, is pushing for the development of renewable energies and their massive integration in urban areas. In this context of deep modification of urban fabrics, it is absolutely essential to ensure that this does not generate new problems that could amplify the effects of urban heat island and penalize the production of urban solar power plants whose performance and ageing are strongly related to their operating temperature level. The proposed topic aims to address these two strongly. The interrelated issues. This will be studied using a multi-scale approach combining experimental and numerical studies.

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Among the investigations, the evolution of the optical and radiative properties of the solar components will be analysed. In a modelling point of view, a meso-scale analysis will be conducted while considering the impact of the solar urban surface improved properties on local climate. Tools such as Weather Research and Forecasting (WRF) which is able of capturing the high-resolution features of urban climate will be implemented. The impact of urban PVs on the urban climate and energy consumption will be assessed for the most typical configurations.

Supervisors: Christophe Ménézo (USMB), Mat Santamouris (UNSW)

Leon Gaillard (HELIOCITY), Elisabeth Defrance (ARE design), Fondation USMB

Research Fields: Urban Climate, Building Physics, Solar Energy

Project 2: *Combining Urban Climate mitigation effect and Carbon neutral cities through innovative solar PV concepts*

In the building sector, initiatives for Nearly Zero Energy Buildings (NZEBs) are gaining importance to tackle climate change, decrease of energy consumption and energy independence through integrated renewable energy production. This is particularly the case in Europe where energy planning aims at a massive integration of solar components at the scale of the urban territory. However, heat island effect that refers to a significantly warmer metropolitan area than its surrounding rural area has been documented for over a century. It is also an important issue to achieve a more sustained built environment. Higher ambient temperatures have a significant impact on the performance of photovoltaics. Facing with the scenario of energy transition aiming to massively integrate solar components, it is important to identify precisely what are the impacts of such a deployment on the urban environment. PV components collect and transform only a portion (20%) of the incident solar energy in the short wavelength range. The other part dissipates by natural or forced convection in the environment. Such modification of urban surface properties will strongly modify, the local temperature difference between air and building surfaces (BIPV), which is responsible for buoyancy to occur and may thus significantly affect the air flow regime as well as the local air temperature. The aim of the study is to investigate innovative PV for both PV cooling and Urban climate mitigation. Unlike specular reflection and diffuse reflection that occur in urban environments with conventional building materials, it is possible thanks to photonics, to design a spectral selective absorption and induce other radiation behavior for other range of wavelength. This seems to be very interesting properties in order to be able to combine both integrated solar production and urban heat island effect mitigation. This will be both investigated through experiments in controlled and real conditions and on modelling tools from local guiding the design of components to meso-scale such as Weather Research and Forecasting (WRF) which is able of capturing the high-resolution features of urban climate.

Supervisors: Christophe Ménézo (USMB), Mat Santamouris (UNSW)

Leon Gaillard (HELIOCITY), Elisabeth Defrance (ARE design), Fondation USMB

Research Fields: Applied science, Solar Energy, Building and Urban physics, Heat and mass transfer, Photonics

Project 3: Numerical and experimental investigation on urban climate mitigation and solar power generation

With the increasing deployment of solar systems in buildings in urban environments, some future scenarios of large scale integration of photovoltaic are planed especially in Europe. It has been shown that building materials play an important role in the absorption, transport and storage of heat and moisture in the built environment. Therefore high penetration of solar PV systems in city will deeply change the properties of the urban surfaces and by the same the global energy budget influencing the urban micro-climate. In addition Urban heat island (UHI), which describes the increase in temperature of the urbanized areas compared to the rural one, is observed to intensify due to on-going urbanization and climate change. Solar components are also sensitive to their operating temperature which, when high, degrades their performance and accelerates their ageing.

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It is therefore absolutely essential to analyze the impact of a massive deployment of solar PV in urban areas and to implement solutions that can benefit both climate mitigation and the performance of PV components. the present subject aims at carrying out an experimental and numerical study allowing on the one hand to bring precise knowledge on the interrelation that there is between urban micro-climate and integration of solar components in built environment. In a second step, the work will allow to identify ways of designing and integrating solar components adapted to the urban environment in symbiosis with currently developed passive cooling techniques (cool and super cool roof, green roof). The study will be based both on experiments in controlled and real conditions and on modelling tools from local guiding the design of components to meso-scale such as Weather Research and Forecasting (WRF) which is capable of capturing the high-resolution features of urban climate.
Supervisors: Christophe Ménézo (USMB), Mat Santamouris (UNSW) Leon Gaillard (HELIOCITY), Elisabeth Defrance (ARE design), Fondation USMB
Research Fields: Building and Urban physics, Heat and mass transfer, Photonics, Applied science, Solar Energy

3. Employment Benefits and Conditions

Université Savoie Mont Blanc offers a 36-months full-time work contract (with the option to extend up to a maximum of 42 months). There is a 6-months probation period and the total working hours per week is 37h30.

The remuneration, in line with the European Commission rules for Marie Skłodowska-Curie grant holders, will consist of a gross annual salary of 28,817.28€ EUR. Of this amount, the estimated net salary to be perceived by the Researcher is 1,930 EUR per month. However, the definite amount to be received by the Researcher is subject to national tax legislation.

Benefits include

- Access to all the necessary facilities and laboratories at USMB and UNSW, as well as Solar Graduate School research facilities and laboratories.
- Tuition fee waiver at both PhD awarding institutions.
- Yearly travel allowance to cover flights and accommodation for participating in AUFRANDE events.
- 10,000 EUR allowance to cover flights and living expenses for 12 months in Australia.
- 25 days paid holiday leave.
- Sick leave.
- Parental leave.

4. PhD enrolment

Successful candidates for this position will be enrolled by the following institutions and must comply with their specific entry requirements, in addition to AUFRANDE's conditions.

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USMB

In order to register for a doctorate, the applicant must have a French research Master's degree or an equivalent diploma.

In accordance with French law, Applicants from foreign countries may have to be evaluated by the secret defence services. USMB may refuse to sign or interrupt a work contract in the event of an unfavourable assessment of the Applicant.

More information: https://www.univ-smb.fr/college-doctoral/en/doctorat/sinscrire/

UNSW

The minimum entry requirement for admission to a PhD includes:

- an appropriate UNSW bachelor degree with upper second-class honours; or
- a completed Masters by Research from UNSW with a substantial research component and demonstrated capacity for timely completion of a high-quality research thesis; or
- an equivalent qualification from a tertiary institution as determined by the Faculty Higher Degree Committee (HDC).

If English is not your first language, you will be required to provide evidence your English language proficiency. Note that your English test needs to be completed no more than two years before your enrolment at UNSW. The English language test scores requirements can be found here: https://www.unsw.edu.au/study/how-to-apply/english-language-requirements

More information: https://research.unsw.edu.au/higher-degree-research-programs

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