PhD Position

## Dynamics of particles on solar farms under turbulent environmental conditions

### Project summary

**Solar power is rising in prevalence**, and open deserts are ideal locations for solar farms worldwide, but **excessive heat and wind-propelled debris reduce efficiency in power output and induce degradation in their expected life**. Increased velocity and mixing promote capture of material from desert floors causing higher rates of deposition and fatigue-inducing impact even in mild conditions (figure 1). This results in significant power generation losses of the photovoltaic panels of up to 35% and the need to use costly cleaning methods, that involve unsustainable large amounts of water and human labor. We will investigate particle deposition over surfaces, and their transport as a function of size distribution. Such particles have a complex dynamic of their own, as the coupling between their inertia and the turbulent flow can result in complex phenomena such as preferential concentration and settling velocity modifications.

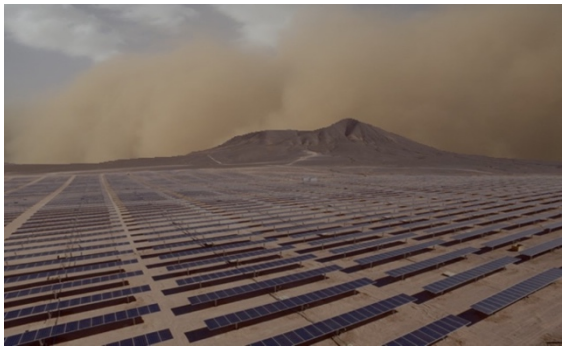

***Figure 1:*** Dust storm on a solar farm (image from https://www.opli.net/).

**This PhD project consists on an experimental study on the coupling of solar farms, turbulent flows, and particles.** This therefore focuses on the two-phase flow surrounding the photovoltaic panels. The expected output of this work is to find strategies for alleviating particle deposition.

The present project involves experimental campaigns in both LEGI (Grenoble, France) and PSU (Portland State University, USA). Experiments will be carried out at the wind tunnels available in both institutions. They are both equipped with active grids. PSU also has a 3D PIV system, while in LEGI it is possible to generate two-phase flows in the wind tunnel (and perform 2D-2C and 2D-3C PIV).

The PhD student will partition time equally between PSU and LEGI and will take advantage of expertise at both institutions on solar energy and particle dynamics. The duties of the PhD candidate can be resumed as:

- Conduct experiments at LEGI and PSU, using the available measuring techniques at both labs and construct the experimental setups.
- Do a full characterisation of the single-phase turbulent flow in PSU.
- Reproduce the experimental set-up from PSU at LEGI, but for a turbulent air flow carrying water droplets and/or dust scaled particles.
- Analyse and interpret results.

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## References


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- R. Vaillon,, O. Dupré, R. B. Cal and M. Calaf "*Pathways for mitigating thermal losses in solar photovoltaics." Sci Rep* **8,** 13163 (2018).
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- R. Monchaux, M. Bourgoin, and A. Cartellier, *"Analyzing preferential concentration and clustering of inertial particles in turbulence",* Int. J. Multiph. Flow, vol. 40, pp. 1–18 (2012).


## Location and practical aspects

3 years PhD fellowship offer, starting 2020.

The successful applicant will be hosted by the laboratory **LEGI** (located at Grenoble, http://www.legi.grenoble-inp.fr/) in the EDT team and by Portland State University located in Portland, OR USA. The student will work under the supervision of Dr Obligado and Pr Djeridi from laboratory LEGI and Pr Cal in **PSU**, USA. This project is part of an international collaboration sponsored by TEC 21 (https://www.tec21.fr), involving M Obligado and H Djeridi from LEGI in Grenoble and Prof. RB Cal from Portland State University. The project also includes funds assigned to the PhD student for conferences, consumables and small equipment.

## Qualifications of the applicant

Engineering or physics background with strong formation in fluid mechanics. Interest in experimentation measuring techniques and modelling. Experience using Matlab/Python is recommended.

## Applications

Interested candidates should send their CV and cover letter to Martin Obligado (Martin.Obligado@univ-grenoble-alpes.fr) , Henda Djeridi (Henda.Djeridi@legi.grenoble-inp.fr) and/or Raul Bayoán Cal (rcal@pdx.edu).

Deadline for the application: 10/07/2020