

SHORT TERM SCIENTIFIC MISSION (STSM) SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

Action number: CA16202

STSM title: Initial studies for evaluating the impacts of dust on the viability and performance of solar farms through collaboration with DLR and Plataforma Solar de Almería (PSA).

ECOST-STSM-Request-CA16202-45117

STSM start and end date: 07/09/2019 to 15/09/2019

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PURPOSE OF THE STSM:

The purpose of this visit was to take initial steps for evaluating the impacts of dust on solar farms and their maintenance and electricity output. The visit was also aimed at learning/discussing and establishing collaborations with colleagues at DLR and Plataforma Solar de Almería (PSA) as these institutes have a unique track record (and also instrument) for studying soiling of different types of solar panels.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

The work carried out during my visit could be divided into three categories: 1- learning and training, 2- planning future work and 3- specify tasks for the future collaborations and agreed studies.

For the first step, we discussed the previous and ongoing research performed at DLR, the objectives of those studies and existing gaps. Initial training on some of the software used in these studies particularly Greenius https://www.dlr.de/sf/en/desktopdefault.aspx/tabid-11688/20442_read-44865/ which has been developed by DLR (and used in their studies) was performed, including comparison with System Advisor Model (SAM), which is provided by National Renewable Energy Laboratory (NREL) in the US.

In PSA visits, which is the largest concentrated solar power (CSP) research facility in the world, I learned about different equipment used in this research environment for studying soiling. Different types of mirrors and panels (both CSP and PV), which are part of the ongoing research on the impact of soiling on solar energy output (their performances are monitored daily) were also visited and discussed to explore what novel studies can be developed based on the current research.

To plan our future work and collaborations, we discussed two current gaps/less explored subjects with respect to soiling solar panels and their impacts on solar energy output and maintenance costs.

The first subject was the impact of climate change on the soiling of solar panels. Following discussing the available research capacities at DLR we agreed to study future scenarios of climate change and their impacts on the increased frequency of dust storms and based on that forecast explore how much solar energy generation would be affected due to dust storms in future e.g. in 2040 or 2050 (for large scale solar farms)

For the 2nd research, we agreed to explore how physicochemical properties of the dust particles affect their attachments to the PV panels or CSP mirrors surfaces. Attachment of dust particles to the surface of CSP mirrors and PV panels can be attributed to the physicochemical properties of these colloidal particles particularly the organic matter contents. Such characteristics likely affect scattering properties of the atmosphere and also light from the surface of CSP mirrors and PV panels.

To specify the tasks, for the first study we rely on DLR expertise for modelling the outputs of solar farms under different scenarios and me as an environmental scientist with some knowledge about climate change, dust storm and features of dust as colloidal particles collaborate on this research. In the second study DLR would distribute CSP mirror and PV panel samples to its network of collaborator (in different locations) to expose the samples to dust in the open air and then retrieve them. The experiments required in this research include Scanning Electron Microscopy (SEM) to identify the particle shapes (and potentially their sizes), organic matter (total and dissolved) and particle size analysis. Through the University of Wolverhampton I can provide some of the equipment required for this research, including SEM and particle size distribution (Malvern Mastersizer) analysis

DESCRIPTION OF THE MAIN RESULTS OBTAINED

Apart from the training that I had on current research methods and equipment in DLR and PSA, we planned for future collaborations and we specified the tasks that each party needs to carry out. As mentioned in the previous sections the following research projects are among the results of this visit.

1-Studying future scenarios of climate change and its impacts on the increased frequency of dust storms and based on that forecast we explore how much solar energy generation would be affected due to dust storms in future e.g. in 2040 or 2050 (for large scale solar farms) to answer the following questions: (A) how frequent do we need to clean solar panels, compared to the present time (B) how much soiling and dust events add to the maintenance costs and energy price generated by solar farms and (C) how much extra energy storage capacity or production by other means are required to compensate for the times that large scale solar farms perform under their expected capacities.

2-Evaluating how physicochemical properties of the dust particles affect their attachments to the PV panels or CSP mirrors surfaces.

The outcome of this STSM resonates well with the objectives of inDust grants particularly establishing a network involving research institutions. Also one of the outcomes of the collaboration between DLR scientists and me, as an academic at the University of Wolverhampton, would be using dust monitoring observations and dust forecast products to determine how the solar energy output would be affected in the immediate future, within the next 72 hours based on the available models including Barcelona Supercomputing Centre Dust Forecast models. In addition to enhancing cooperation between the European research institutes, the agreed collaborations and studies would involve countries from the MENA region, which inherently improves current R&D activities with tangible socio-economic outputs.

FUTURE COLLABORATIONS (if applicable)

As mentioned in the previous sections two different but relevant research subjects were discussed, agreed and the relevant tasks were specified between the colleagues at DLR (and PSA) and the University of Wolverhampton. These studies would also involve the network of DLR at the MENA region for collaborating on collecting the dust samples.