

SATELLITE IMAGERY FOR SOLAR MAPS



Research Engineer Yehia Eissa was a part of the team that created UAE's solar maps, and he shares with *SatellitePro ME*, an overview of the two-year exercise that started with studying satellite images at Masdar's receiving station to creating a model more suited to the unique environmental conditions over the region



Joining the Abu Dhabi-based Masdar Institute of Science and Technology in 2010 as a Master's student in the Water and Environment Engineering programme, Egyptian-born Yehia Eissa considers himself privileged to be part of the team that created a satellite-based solar mapping tool developed and validated at Masdar and utilised for producing 15-minute solar irradiance maps, along with monthly and yearly solar irradiation maps for the UAE's Solar Atlas.

Commenting on its uses, Eissa, now a Research Engineer, says, "Solar maps have many uses and helping in locating appropriate sites for solar power plants, is one of them. More significantly, solar maps are critical in knowing which solar technology should be used depending on factors such as direct radiation, diffused radiation and so on."

Dr. Hosni Ghedira, Director, Research Centre for Renewable Energy Mapping and Assessment, Masdar Institute, explained the need for a regional model thus: "While

in theory the UAE receives the same if not far more solar energy than Europe or North America, in reality the dusty atmosphere cuts out as much as 90% of the sun's energy during a heavy dust storm. Even on cloud-free days, there is often far less solar energy than might be expected for such a hot and sunny country."

To ensure future projects are more realistic, there was a need to create a locally relevant model.

Satellite images from the geostationary Meteosat Second Generation satellite were used to create accurate solar maps. Ground stations used for collecting data, according to experts cannot compare with satellite images in terms of the comprehensive information, offered by geostationary satellites for the region under study. Still, data collected at ground stations are necessary to calibrate and validate satellite-based models.

Initial application of existing models

The project began in 2010 and the team

The largest photovoltaic (PV) plant in the MENA region located in Masdar City



“[The project] spans computer sciences, civil and environmental engineering, atmospheric science and remote sensing through satellite data processing. Our satellite receiving station captures a terabyte of image data – a full hard disk’s worth – every week, all of which must be processed in near real-time”

- Dr. Hosni Ghedira, Director, Research Centre for Renewable Energy Mapping and Assessment, Masdar Institute

began by using existing models devised by researchers in Europe and North America.

Commenting on the results of using existing models, Eissa states: “We found that there was a general overestimation in terms of direct radiation and an underestimation of the dust component. Moreover, the models devised elsewhere typically focus on cloud cover. Overall, we have less than 20% cloud coverage in the UAE, where dust and humidity are more significant. We therefore decided to devise our own model that takes into account the local environmental conditions.”

To create the solar atlas, the team needed to take into account the impact of airborne dust and water vapour on solar energy. While the project towards developing solar maps began in 2010, the final working model came to shape in March 2012 after rigorous process of tests to prove its accuracy in local conditions.

As per a press statement issued by Masdar in June 2012: “Following a launch at the Rio+20 Earth Summit 2012 held

in June 2012 in Rio de Janeiro, Brazil, the monthly and annual solar maps have been made available online to the public. In addition, we provide live updates every 15 minutes and this is available to our stakeholders that include – The UAE Ministry of Foreign Affairs, Dubai Supreme Council of Energy, the Environment Agency- Abu Dhabi (EAD), UAE National Centre of Meteorology and Seismology (NCMS), Masdar Power, the International Renewable Energy Agency (IRENA) and the World Energy Council (WEC), among others.”

Interest in electricity from solar powered plants is reportedly increasing in the GCC countries. The targets set by individual governments for electricity production from renewable energy sources are: Abu Dhabi: 7% by 2020; Dubai: 5% by 2030; Saudi Arabia: 16-GW PV and 25-GW CSP by 2032; Kuwait: 5% by 2030; Oman: 5% by 2020 and Bahrain: 10% by 2030.

Testing the accuracy of the model

Eissa explains, “Among the preliminary steps undertaken when the project started in 2010 was to collect data from the Masdar Institute’s satellite receiving station. We receive images from Meteosat Second Generation, a geostationary satellite every 15 minutes. With our model calibrated according to the regional environmental conditions, each set of data is used to calculate the intensity of solar radiation.”

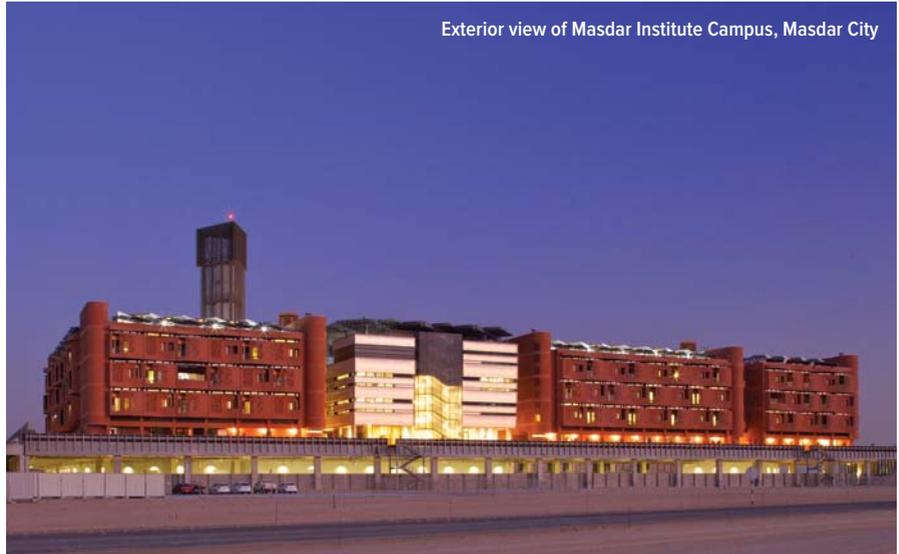
To develop and validate the model, ground measurements were taken into account.

Eissa recalls: “We have access to six ground stations across the UAE that have collected measurements for a period of four years. We calibrated our model using data from three stations and tested it with data from two totally independent stations taken in a different year. We based our accuracy on the independent stations that were not used to calibrate our models.”

While Eissa did visit a couple of grounds stations out of personal interest, the rigorous process of testing the validity of the model over the two-year period was conducted in-house at the sprawling

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Yehia Eissa, Research Engineer, Masdar Institute



Exterior view of Masdar Institute Campus, Masdar City

Masdar campus in Abu Dhabi.

The near real-time solar maps reportedly divide the UAE into patches of nine kilometres square, and offers measurements every 15 minutes for each patch. Monthly and annual maps are presented at the same spatial resolution (i.e. 9 km²).

Regional significance of the solar atlas

“We have images from the satellite since 2004 and with the model, we have been able to produce solar maps showing long-term variability that would enable decisions on various environmental projects including deciding on the optimal location of solar power plants,” explains Eissa underscoring the larger significance of the landmark project for the region.

While the beta version of the Solar Atlas was released in April 2012 with an official announcement on the sidelines of the earth summit in Rio de Janeiro, the monthly and annual solar maps have been freely available online since early 2013 and can be accessed by governmental organisations, researchers or private enterprises for assessing the technical feasibility of any proposed renewable energy project.

The significance of the project is best described in the words of Dr Taha

Ouarda, Deputy Director of the Research Centre for Renewable Energy Mapping and Assessment at Masdar Institute: “Innovation in the field of renewable energy lies in developing state-of-the-art techniques that are adapted to the local climate and environment. Of-the-shelf tools are not necessarily adapted to produce adequate results in the UAE and the GCC countries. Such developed tools can then be used and adapted in other countries with similar conditions, like the Gulf region as well as the Sahel region in Africa. The centre in Abu Dhabi will share its knowledge and empower others to draw from its ideas and actions for a sustainable future.”

Speaking to *SatellitePro ME*, Yehia Eissa made it seem like it was all in a day’s work, although, the atlas project for a region would be a complex and challenging process.

Giving us a glimpse into the range of expertise the project called for, Dr. Ghedira is reported to have said: “It spans computer sciences, civil and environmental engineering, atmospheric science and remote sensing through satellite data processing. Our satellite receiving station captures a terabyte of image data – a full hard disk’s worth – every week, all of which must be processed in near real-time.” **PRO**