PRESS RELEASE

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EMA Awards $6.2 Million Research Grant to Develop Solar Forecasting Capabilities

Singapore's capability to accurately forecast solar energy output is set to grow with a $6.2 million research grant from the Energy Market Authority (EMA). At today's Singapore International Energy Week 2017 Senior Minister of State for Trade & Industry Sim Ann announced the award of the research grant to a consortium led by the National University of Singapore (NUS).

2. The consortium will look into improving the accuracy of solar photovoltaic (PV) output forecasts and grid management using techniques in weather prediction, remote sensing, machine learning and grid modelling. The system will make use of the growing pool of solar irradiance data generated as more sensors are installed on the rooftops of buildings, and weather data from the dense network of sensors installed by Meteorological Service Singapore (MSS) island wide. (See Annex for the project's full details.)

3. Currently, forecasting solar power output in Singapore, especially over long time horizons, is challenging due to the complexities of our local weather systems. Solar PV power output fluctuates depending on environmental and weather conditions such as cloud cover, and humidity. For example, extensive cloud cover on rainy days can cause significant drops in solar power output. If not properly accounted for, this may lead to imbalances between electricity demand and supply, especially when solar energy becomes a larger part of the fuel mix.

4. To mitigate the effects of solar intermittency and keep the power supply stable, EMA's power system operator will need to know the solar PV power output ahead of time in order to take appropriate actions to balance the grid. "Solar energy is the most viable renewable energy source for Singapore when it comes to electricity generation. The ability to forecast solar photovoltaic power output accurately will help our power system operator better manage the impact of solar intermittency as we integrate more solar energy into the grid." said EMA's Chief Executive, Ng Wai Choong.

5. Mr Ronnie Tay, Chief Executive Officer of National Environment Agency, said: “MSS’ expertise in local weather prediction and climatology, which is pertinent to solar forecasting, will contribute to solutions which mitigate the effects of solar intermittency. We hope that the initiative will help to eventually strengthen our national solar infrastructure and promote solar energy as a source of clean renewable energy.”

6. MSS, in partnership with EMA, will work with the consortium on the four-year project. The consortium comprises five partners: NUS; the Solar Energy Research Institute of Singapore (SERIS) at NUS; the Centre for Remote Imaging, Sensing and Processing (CRISP) at NUS; A*STAR’s Experimental Power Grid Centre (EPGC); and the Singapore-MIT Alliance for Research and Technology’s Centre for Environmental Sensing and Modelling (CENSAM).

7. Seven proposals were received in response to the Solar Forecasting Grant Call launched on 8 March 2017 by EMA together with MSS. This collaboration will ensure that the research consortium develops a solar forecasting solution that is highly reliable and, more importantly, customised to Singapore’s tropical weather.

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ANNEX

Title	Description	Project Team
Advanced Solar Power Forecasting for Safe and Reliable Photovoltaic Grid Integration in Singapore	Solar photovoltaic (PV) power output is variable. As more solar energy is integrated into the electricity grid, there is a need to ensure quality and reliability of the electricity supply. From a power system operations' perspective, there are two main challenges: (i) Forecasting solar irradiance over various times of the day; and (ii) accurately converting solar irradiance into solar PV power output. Both come with uncertainties that need to be understood for power system operation and market participation. Singapore's location in the tropics requires a suite of techniques that must be applied in order to seamlessly forecast solar output in advance. These techniques range from statistical methods for the short-term horizon (up to 30 minutes) to cloud cover predictions and complex numerical weather predictions (NWP) for hours-ahead forecasts. Singapore's highly urbanised environment adds another layer of uncertainty. Factors such as solar PV module temperatures, inverter behaviour, system degradation, and shading need to be considered. These challenges need to be addressed and quantified before the power system operator can balance the electricity generation with load demand for	**Principal Investigator:** • Associate Professor Ashwin M. Khambadkone, Department of Electrical and Computer Engineering, National University of Singapore (NUS) Faculty of Engineering **Co-Investigators:** • Dr Thomas Reindl, Solar Energy Research Institute of Singapore (SERIS) at NUS • Professor Dipti Srinivasan, Department of Electrical and Computer Engineering, NUS Faculty of Engineering • Dr Santo V. Salinas, Centre for Remote Imaging, Sensing and Processing (CRISP) at NUS • Dr Wilfred Walsh, SERIS

	dispatch, and to publish required conventional power generation capacities in the electricity market for trading. This project addresses the above issues to pave the way for rapid deployment of solar PV in the Singapore electricity grid.	• Assistant Professor Michel-Alexandre Cardin, Department of Industrial Systems Engineering and Management, NUS Faculty of Engineering • Assistant Professor William Haskell, Department of Industrial Systems Engineering and Management, NUS Faculty of Engineering • Dr Quan Hao, Experimental Power Grid Centre • Mr Eugene Chong, Meteorological Service Singapore **Collaborators:** • Dr Robert Huva, SERIS • Dr Li Xianxiang, Center for Environmental Sensing and Modeling