ENERGY MARKET AUTHORITY
Our Clean Energy Future

MEDIA RELEASE

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Future-proofing EMA's Energy Management System for a Sustainable Future

The Energy Market Authority (EMA) has commissioned an enhanced Energy Management System (EMS II) with advanced tools and capabilities to better monitor and control Singapore's electricity transmission network and generating plants, as well as monitor the natural gas transmission network.

2 EMS II has incorporated additional capabilities such as a solar photovoltaic (PV) forecasting model, optimised situational awareness, and enhanced automatic power generation control capabilities, to further improve power grid resiliency and reliability. EMS II will play a crucial role as Singapore harnesses more low-carbon energy sources to achieve net-zero carbon emissions by 2050.

Nerve Centre of Singapore's Power System

3 The energy management system is a real-time mission-critical operational technology system that detects any abnormal condition or malfunction of equipment in the power and gas systems. It transmits the information to the Power System Control Centre, the nerve centre of Singapore's power system. Power system operators are responsible for real-time, round-the-clock monitoring and control of the power system. Operators analyse system data and take action when necessary, to ensure 24/7 safe and reliable supply of electricity and gas. Key features of the EMS II can be found in Annex A.

Incorporating New Energy Sources into the Grid

4 Electricity demand is expected to grow over the medium to long term as industries seek to reduce carbon emissions, while electricity-intensive sectors such as advanced manufacturing and the digital economy expand. With system peak demand forecasted to increase at a compound annual growth rate of up to ~5% over the next five years, Singapore will need to tap on new energy sources such as solar and electricity imports from the region to meet our future electricity demand. EMS II will

allow EMA to manage new energy sources connected to the electricity power grid more effectively.

5 One such enhancement is the integration of a Solar Photovoltaic (PV) Forecasting Model that utilises data from real-time, island-wide solar irradiance sensors and satellite images as well as a machine learning algorithm. This allows EMA to better forecast solar PV output and take pre-emptive actions to manage solar intermittency, which could result in imbalances between electricity demand and supply in the power system. Solar PV output forecasts are also provided to the Energy Market Company, Singapore's wholesale electricity market operator, to generate dispatch schedules for each half-hourly dispatch period, including procuring additional reserves or energy.

6 In addition, EMS II has Automatic Generation Control capabilities that can send signals to charge and discharge Energy Storage Systems (ESS) – which are large batteries that can store solar energy – in response to power fluctuations in the electricity grid. Prior to the enhancements, the previous EMS could only control and monitor conventional generators. The new capabilities allow EMA to promptly manage changes in demand and supply, a crucial enhancement in ensuring a reliable and stable electricity supply as Singapore scales up solar PV deployment.

7 Mr Ngiam Shih Chun, Chief Executive of EMA, said: "As Singapore transforms our energy sector, more renewable energy sources such as solar and electricity imports will be connected to our electricity grid. It is thus critical to enhance our control systems to better manage and ensure the electricity grid's continued stability. EMS II is designed to bolster EMA's operations and future-proof our grid infrastructure. This helps pave the way to meeting Singapore's net-zero goals and securing a clean energy future."

Future-proofing Power System's Control Infrastructure

8 EMS II is also equipped with Intelligent Alarm Processing (IAP), which bolsters the power system operators' situational awareness in the event of any power disruption. This new function synthesises alarms received from the power plants and transmission substations in times of emergencies. The IAP would thus help EMA respond to these alarms more effectively by reducing the risk of information overload on the operators in the control room, enabling quicker decision-making and response to issues, minimising downtime, and enhancing overall system reliability.

9 EMS II also incorporates advanced cybersecurity features that protect the system against malicious cyber threats. For example, the EMS now includes an

endpoint detection and response tool which monitors and collects data from computers and other devices within the network to mitigate malicious cyber threats.

10 These improvements significantly enhance EMA's capabilities in safeguarding Singapore's energy system and ensuring its reliability.

ANNEX A: Key Features of EMA's Energy Management System

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About the Energy Market Authority

The Energy Market Authority (EMA) is a statutory board under the Singapore Ministry of Trade and Industry. Through our work, we seek to build a clean energy future that is resilient, sustainable, and competitive. We aim to ensure a reliable and secure energy supply, promote effective competition in the energy market and develop a dynamic energy sector in Singapore. Visit www.ema.gov.sg for more information.

ANNEX A: KEY FEATURES OF EMA'S ENERGY MANAGEMENT SYSTEM

S/N	Feature	Description
1.	Managing the Integration of Solar Photovoltaic (PV) into the Grid	In the past, the EMS could only estimate how much solar energy was generated using solar irradiance data from across Singapore. As solar PV output fluctuates based on weather conditions, it was challenging to forecast solar power output, which can lead to imbalances between electricity demand and supply output from solar PV systems. [NEW] With the integration of the Solar PV Forecasting Model, EMS II is able to utilise data from real-time, island-wide solar irradiance sensors to anticipate solar PV power output. This allows EMA to take pre-emptive actions to manage solar intermittency and balance the electricity supply and demand in the power system. The Model is able to forecast island-wide solar irradiance[1] up to one hour ahead, with an average error rate[2] less than 10%; one of the best accuracy rates for solar forecasting in the tropics. Forecasts from the Model will also be provided to the Energy Market Company (EMC), Singapore's wholesale electricity market operator, to be factored into the market clearing process. This allows the electricity market to procure additional reserves or energy by dispatching the power generating plants and energy storage systems to increase/decrease their electricity supply to meet demand. The Model was developed by the Solar Energy Research Institute of Singapore (SERIS) at the National University of Singapore and supported by EMA and the Meteorological Service Singapore (MSS) of the National Environment Agency (NEA). [1] The Solar PV Forecasting Model utilises data from real-time irradiance sensors installed on rooftops of buildings and electrical substations across Singapore. It also incorporates numerous dynamic solar PV forecasting techniques such as satellite imagery and machine learning algorithms to generate round-the-clock solar irradiance forecasts at regular intervals from 5 minutes to 24 hours ahead. [2] The Solar PV Forecasting Model has a nRMSE (normalised root mean square error) of less than 10% up to 1 hour ahead, on average.
2.	Monitoring and Adjustment of Electricity Generation	Prior to the enhancements, the Automatic Generation Control (AGC) monitored the electricity demand and automatically adjusted the output of conventional generators every few seconds to match the dynamic changes in electricity demand. This automated process ensures a continuous balance between electricity supply and demand. It also allows the system operators to fine-tune the output of individual generators when unexpected changes occur in the power system. [NEW] The AGC has since been enhanced to model Energy Storage Systems (ESS) and is able to send control signals to charge and discharge ESS in response to the fluctuations in the electricity grid

		because of intermittent solar PV generation. This is a crucial enhancement as Singapore scales up solar PV deployment, part of efforts to achieve net zero greenhouse gas emissions by 2050.
3.	Monitoring of Power System	In emergencies, system operators could be overwhelmed by the large number of alerts and alarms. [NEW] The EMS is now integrated with intelligent alarm processing and network analysis features to enhance the power system operators' awareness of power system conditions. • **Intelligent alarm processor** synthesises alarms in the event of emergencies, if any, and identifies the root causes of events. This enables power system operators to make quicker decisions in responding to abnormal events so as to secure the power system. • **Network analysis** uses robust algorithm techniques to analyse the electricity transmission network and model all types of power system equipment, such as power plants, transmission cables, transformers, series reactive devices, high-voltage direct current (HVDC) links, shunt reactors, etc. in the power system.
4.	Combating cyber threats	The EMS is equipped with cybersecurity controls such as anti-malware software and a host intrusion detection system, among other capabilities. [NEW] Advanced cybersecurity controls and tools have been introduced in EMS II to strengthen the system's cyber resiliency. For example: • **End-Point Detection & Response Tool,** which monitors and collects data from computers and other devices within the network to detect and respond to malicious cyber threats.
5.	Dispatcher Training Simulator	The Dispatcher Training Simulator (DTS) serves as a training tool for simulating a crisis scenario to train our power system operators to manage the power system emergencies. This simulator allows trainers to create and simulate scenarios for a realistic crisis environment where system operators can practice their responses to different emergency situations.