MEDIA RELEASE

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$15 million Awarded to Innovations in Energy Storage

Six projects with the aim to develop cost-effective energy storage innovations that can be effectively deployed in Singapore will receive a total of $15 million in research grants from the Energy Market Authority (EMA).

2. The projects, selected after a grant call launched in May 2015, will look at enabling the deployment of energy storage under Singapore's hot, humid and urbanised environment:

i. Natural gas storage in a Solidified Natural Gas form. This method allows natural gas to be stored using less energy, at improved stability, and up to 50 percent reduction in storage costs as compared to storing as Compressed Natural Gas (CNG). National University of Singapore is working on this project.

ii. Developing next-generation metal oxide-based batteries that will have five times the cycle life of existing graphite-based lithium-ion ones, be able to charge faster and be more cost-effective. The new batteries will also be better suited to operate under Singapore's hot and humid climate. Nanyang Technological University (NTU) aims to achieve this by coupling its patented titanium oxide-based anodes with the lithium-based cathodes from partner Durapower Technology Group (a lithium-ion battery manufacturer and subsidiary of New Resources Technology).

iii. Developing a cost effective Distributed Energy Storage System (DESS) that connects lithium-ion batteries at multiple sites (eg HDB blocks) under a centralised control system. Such a system can more effectively manage the fluctuating output of intermittent generation sources, such as solar. NTU will work with Sunseap Leasing and Panasonic Asia Pacific on this.

3. On the importance of energy storage for Singapore, EMA Chief Executive Ng Wai Choong said: "Energy storage innovations have the potential to facilitate the widespread deployment of renewables such as solar energy in Singapore. Energy Storage can also play a role in enhancing the stability and reliability of the power system by supplementing power when required."

4. Speaking as one of the project winners of the Energy Storage Grant Call, New Resources Technology Chief Executive Officer Kelvin Lim, said: "We recognise the importance of continual technology innovation, and the need to provide a strong commercialisation strategy and manufacturing facility through a local battery company. We hope this collaboration will contribute towards the start of building of a strong and successful local ecosystem for energy storage systems in Singapore." Mr Lim is concurrently President of Durapower Technology Group.

5. Details of the six projects, selected from over 30 proposals received, are in the Annex attached.

ABOUT THE ENERGY STORAGE PROJECTS

No.	Title	Description	Project Team
Innovate battery technologies suitable for deployment in Singapore's hot and humid climate and highly-urbanised environment			
1.	Ultrafast Charging, Long Life and Cost-effective Lithium-Ion Batteries for Stationary Energy Storage **Project summary:** To develop metal oxide-based batteries for increased cycle life and stability within Singapore's hot and humid climate.	Conventional graphite-based lithium-ion batteries suffer from a number of operational and deployment challenges, including high costs, limited cycle life and low operating temperature. This project will develop a class of metal oxide-based batteries by using the project team's patented titanium-oxide based anodes and lithium-based cathodes from its partnership with lithium-ion battery manufacturer Durapower Technology Group (subsidiary of New Resources Technology). This new class of batteries will improve its cycle life by five times, reduce cost for the anodes, and offer faster charging capability and higher energy density compared with existing graphite-based lithium-ion batteries. The project will factor in Singapore's hot and humid climate and dense urban population.	**Principal Investigator:** Assoc Prof Chen Xiaodong, NTU **Co-Investigator:** NTU **Collaborators:** New Resources Technology (NRT); NTU
2.	Condensed-phase Aqueous Redox-flow Battery (CARB) System: A Large-Scale Stationary Energy Storage Technology for Near-Term Deployment in Singapore **Project summary:** To test-bed a CARB system that is non-flammable and has a smaller footprint.	Redox flow batteries are used in grid-scale energy applications such as peak shaving. However, they are often of low energy intensity and require considerable space for deployment. This project will develop and test-bed a Condensed-phase Aqueous Redox-flow Battery (CARB) system that is water-based to make it non-flammable, unlike lithium-ion which uses a flammable electrolyte. This system will have a smaller and lower cost footprint, and will be suitable for local grid-scale energy applications (eg peak shaving) at wider operating temperatures of up to 80°C.	**Principal Investigator:** Assoc Prof Wang Qing, NUS **Co-Investigators:** NUS; Temasek Polytechnic **Collaborators:** Duralite Power; GenPlus; HDB; Temasek Polytechnic

3.	Development of Sodium-ion Battery Pack for Stationary Storage Systems **Project summary:** To make sodium-ion batteries competitive with existing lithium-ion batteries.	Sodium-ion batteries are gaining popularity as a promising replacement for lithium-ion batteries, as sodium is non-toxic, costs less and is widely available. However, their performance (eg rate of charge/discharge and cycle life) pales in comparison with lithium-ion batteries. This project will develop and test-bed large-scale non-flammable sodium-ion batteries suitable for grid-scale applications in local conditions. They are expected to cost half the price of lithium-ion batteries, with an enhanced cycle life and capacity over current sodium-ion batteries.	**Principal Investigator:** Assoc Prof Palani Balaya, NUS **Co-Investigator:** NUS **Collaborator:** Daily Life Renewable Energy
Develop cost-effective and reliable solutions			
4.	A Cost-Effective Solidified Natural Gas (SNG) Technology for Energy Storage to Strengthen Energy Resilience in Singapore **Project summary:** To develop SNG with increased storage stability and capacity at lower costs.	Solidified natural gas (SNG) is a promising replacement to liquefied natural gas, (LNG) as it allows natural gas to be stored using less energy in the form of hydrates. This project will develop SNG with improved storage stability and capacity over conventional options such as LNG and compressed natural gas (CNG). This will result in SNG being more easily stored and used as a backup fuel in the event of a natural gas supply disruption. SNG will achieve up to 50 percent reduction in storage costs compared with conventional CNG technology.	**Principal Investigator:** Asst Prof Praveen Linga, NUS **Co-Investigator:** NUS **Collaborator:** Lloyd's Register Global Technology Centre
5.	Grid-wide Intermittency Management by Aggregation of Distributed Energy Storage Systems **Project summary:** To build a Distributed Energy Storage System (DESS) to manage intermittent generation sources in Singapore.	Most centralised energy storage solutions suitable for Singapore are currently not cost-competitive and carry the risk of a single point of failure. This project will develop and test-bed a cost-effective Distributed Energy Storage System (DESS) that connects lithium-ion batteries at multiple sites (eg HDB blocks) under a centralised control system. Such a system can more effectively manage the fluctuating output of intermittent generation sources, such as solar. The DESS is also able to increase the power grid's ability to support up to 50 percent more intermittent generation sources. If successful, this could demonstrate a potentially viable business model for distributed energy storage systems for our National Electricity Market of Singapore.	**Principal Investigator:** Asst Prof Tang Yi, NTU **Co-Investigators:** NTU; Panasonic Asia Pacific; Sunseap Leasing **Collaborators:** Aalborg University (Denmark); HDB; NTU

Increase power conversion efficiency			
6.	Development of High Performance and Energy Efficient Matrix Converter for Interfacing Battery Energy Storage with Utility Grid **Project summary:** To improve power conversion efficiency and power quality for utility-grid based power electronic converters.	Traditional power electronic converters usually result in considerable energy conversion losses when they convert and transfer energy from the batteries to the grid. This project will develop a single stage power converter to cut down energy conversion losses. The new power converter will offer better power conversion efficiency and improved power quality compared with existing power electronic converters.	**Principal Investigator:** Assoc Prof Panda Sanjib Kumar, NUS **Co-Investigator:** NUS **Collaborator:** Rolls-Royce Singapore