MEDIA RELEASE
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S$8 MILLION AWARDED TO 3 RESEARCH TEAMS ON SOLAR ENERGY UNDER THE CLEAN ENERGY RESEARCH PROGRAMME

1. The Energy Innovation Programme Office (EIPO), formerly known as Clean Energy Programme Office (CEPO), announced the award of research grants totalling about S$8 million to 3 research teams under the fourth grant call of the Clean Energy Research Programme (CERP). This grant call was focused on two topics: developing thin silicon-wafer solar cells; and reducing solar system cost.

2. Considerable research efforts have focused on increasing solar cell and module efficiencies; improving manufacturing yields; and reducing material costs. As silicon material is one of the major cost contributors in solar PV manufacturing, one approach is to look at decreasing silicon wafer thickness. Another approach is to focus on decreasing balance of system costs, given that up to 50% of a PV system's total cost can be attributed to the accompanying system components. These include mounting structures, electrical cabling and power electronics. This grant call therefore seeks to support the development of innovations that could help achieve impactful cost reduction and accelerate the transition to grid parity for solar energy.

3. The 3 research proposals (Annex 1) awarded funding in this latest grant call of CERP are:

a) Development of high-efficiency crystalline/ amorphous silicon heterojunction solar cells on thin wafers *(SERIS, National University of Singapore)*

b) Novel monitoring and control unit for enhanced availability and reliability of solar PV systems – optimization of photovoltaic electricity generation in tropical power grids through radiation forecasting and system monitoring *(SERIS, National University of Singapore)*_

c) Efficient wafering and texturing of single and multi crystalline silicon solar cells *(Nanyang Technological University)*

4. Managing Director of the Singapore Economic Development Board (EDB), Dr Beh Swan Gin said, "We are excited by the quality and potential impact of the three research proposals. If successful, they can help accelerate the transition to grid parity for solar energy and increase its adoption. These projects have also generated interest from the private sector for research collaborations. Such partnerships will strengthen Singapore's ability to drive the entire value chain from research to innovation and commercialisation of clean energy technologies."

5. Dr. Ing Stefan Rinck, CEO, SINGULUS TECHNOLOGIES AG said, "SERIS is one of the leading solar research institutes in Asia, and SINGULUS TECHNOLOGIES is proud to collaborate with Dr Mueller and his team on the heterojunction solar cell project. We believe that this project will see the successful commercialisation of a technology based on our SINGULAR ICP-PECVD coating tool for anti reflection coatings for new crystalline silicon solar cells, which will reduce the cost of solar cell production and make solar PV a cost-effective alternative source of energy."

6. Said Mr Lee Fook Sun, President, Singapore Technologies Electronics Limited (ST Electronics), “ST Electronics is working towards a wide range of eco-enabling ICT solutions incorporating intelligent diagnostic and analytics systems and smart utilities solutions such as automated meter readers and intelligent energy grids to help growing cities manage resources more efficiently and to remain clean and secure. We are therefore happy to be part of the EIPO's efforts to help Singapore companies develop commercially viable eco-enabling technologies.”

7. The CERP was launched by EIPO in 2007 to accelerate research and development efforts to help drive the growth of the Clean Energy industry in Singapore. This S$50 million initiative supports both upstream and downstream commercially-relevant R&D efforts through a competitive project funding approach.

8. The fifth CERP grant call has opened on 20 June 2011. There will be two topics under this call: (i) Improving silicon wafer-based solar cell manufacturing processes and technologies; and (ii) Thin-film solar cells based on the chalcopyrite materials system. More details on the fifth call are available at the following URL: https://rita.nrf.gov.sg/ewi/CERP_05

Please see:

- Annex 1 for the write-up, lead principal investigator and research team of the 3 selected projects;
- Annex 2 for more information on CERP; and
- Annex 3 for a list of CERP’s Project Evaluation Panel members.

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About the Energy Innovation Programme Office (EIPO)

Formerly known as Clean Energy Programme Office (CEPO), EIPO is the inter-agency programme office responsible for developing and executing strategies and policies for the development of the energy sector. Led by the Economic Development Board (EDB) and the Energy Market Authority (EMA) of Singapore, EIPO reports to an executive committee co-chaired by Chairman EDB and Permanent Secretary, Trade and Industry.

About the Singapore Economic Development Board (EDB)

EDB is the lead government agency for planning and executing strategies to enhance Singapore's position as a global business centre. We dream, design and deliver solutions that create value for investors and companies in Singapore. Our mission is to create for Singapore, sustainable economic growth with vibrant business and good job opportunities.

Visit www.sedb.com for more information.

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ANNEX 1

1. Development of High-Efficiency Crystalline/Amorphous Silicon Heterojunction Solar Cells on Thin Wafers

Solar photovoltaic (PV) electricity provides a widely accepted solution for sustainable energy to address the effects of greenhouse gas emissions by fossil fuels. As a result, the global installation of PV systems is increasing rapidly. To maintain the impressive growth rates, ongoing reductions of the cost ($/W) of the systems are required. This requires both improved conversion efficiency and reduced manufacturing cost for the solar cells used in these systems. The majority of today's solar cells are made from silicon wafers, whereby their thickness is about 180 microns.

Decreasing the thickness of the silicon wafers is an especially effective way to substantially reduce the material cost of manufacturing solar cells, because the wafers account for up to 50% of the cost of a PV module. Since conventional solar cell designs are not compatible with a wafer thickness of well below 150 microns, more advanced solar cell designs are required to realise the full cost benefits of thin silicon wafers. An advanced cell design that seems compatible with thin wafers is the amorphous silicon/crystalline silicon heterojunction solar cell, which has already been demonstrated to achieve very high solar cell efficiency on silicon wafers of standard thickness. The present project aims at developing a cost-effective heterojunction silicon wafer solar cell that is suitable for mass production on wafers thinner than 100 microns, with efficiencies of above 21%.

Principal Investigator:

Dr Thomas Mueller is the Head of the Silicon Wafer Solar Cell Group in the Silicon Photovoltaics Cluster at SERIS, concentrating on high-efficiency silicon wafer solar cells. He holds a combined B.Sc./M.Sc. degree in Electrical Engineering from the University of Dortmund, Germany, and a PhD degree in Electrical Engineering from the University of Hagen, Germany. Dr Mueller conducted his PhD research in the field of high-efficiency heterojunction silicon wafer solar cells. He developed a near-perfect surface passivation scheme for silicon wafer solar cells and is an internationally recognized expert in the field of heterojunction solar cells and surface passivation. His work resulted in record values for surface passivation of crystalline silicon wafer substrates and almost 20% efficient heterojunction solar cells, representing top results internationally. He obtained his PhD degree with highest commendation ('Summa Cum Laude') and his PhD thesis won the 2009 SolarWorld Junior Einstein Award.

Co-Principal Investigators:

- Dr. Matthew Boreland, SERIS, NUS

Collaborators:

- Dr. Peter Wohlfart, SINGULUS Technologies
- Dr. Rob Steeman, REC Cells
- Mr. Raul Sinocruz, First Philec Solar Corporation
- Mr. Scott Iggo, Dupont
- Mr Darren Brown, DEK Solar
- Dr. Bram Hoex, SERIS, NUS

2. Novel Monitoring and control unit for enhanced availability and reliability of solar PV systems – Optimisation of photovoltaic electricity generation in tropical power grids through radiation forecasting and system monitoring

Solar photovoltaic (PV) is set to be one of the major energy sources of the future, tapping into the virtually endless supply of energy from the sun. The actual power output of a solar system, however, can vary substantially, depending on the local irradiation conditions and the performance of the individual PV systems, making it an intermittent type of renewable energy with relatively high variability, particularly in tropical weather conditions like Singapore. This raises concerns among grid operators with regards to the influence of a growing share of solar power on the performance of their electricity grid, which seems to be further aggravated by the fact that PV systems, especially in urban areas, follows a distributed power generation architecture (mainly rooftop systems), making system monitoring and controlling a challenging task.

This project aims to reduce the cost of nation-wide PV electricity by addressing exactly those two areas of concern: reducing the influence of intermittency by forecasting the irradiance and ultimately the power output of solar systems in Singapore, and optimizing the systems' operation through smart monitoring of the highly dispersed PV electricity generation units, eventually increase both, availability and reliability of solar power generation. It aims to combine time- and spatially-resolved irradiance forecasting with a real-time data transmission network across the whole island. This allows Singapore to develop a PV-penetrated power grid that has high-end system monitoring functionality (fault detection, performance analysis and power output control) and PV forecasting capabilities at the same time, laying the foundation of making Singapore a highly predictable PV power grid with best availability and reliability benchmark levels.

Principal Investigator:

Dr Thomas Reindl is Director of the Solar Energy Systems cluster at Solar Energy Research Institute of Singapore (SERIS). He started with photovoltaics in 1992 at the solar division of SIEMENS' Coporate R&D before moving on to P.R. China to work as a foreign expert with China's largest solar cell and module manufacturer at that time. He later held various management functions in SIEMENS and SIEMENS Solar. Before joining SERIS, he was Chief Operating Officer in charge of procurement and systems engineering at ILIOTEC, one of the leading German PV systems integration and installation companies with a strong focus on remote monitoring and quality control, eventually surveilling more than a 1,000 PV systems. Dr Reindl holds a Master in Chemistry, a PhD in Natural Sciences and an MBA from INSEAD, all awarded with highest honours. He is a Member of the German Solar Energy Industry Association, Member of the Advisory board of CORE (Council and Renewable Energies in the Mekong Region) and Member of the INSEAD Alumni Association Germany. He has numerous publications and conference presentations as invited speaker on both, the scientific and the economic aspect of solar photovoltaics. He is an expert in the area of solar energy systems and has extensive industrial experience in solar photovoltaic, which allows him to drive the leading-edge scientific research of this project, but also the applicability of the results for industry and grid operators.

Co-Principal Investigator:

- Prof. Joachim Luther, SERIS, NUS

Collaborator:

- Mr. Toh Wan Yin, ST Electronics (Info-Comm Systems) Pte Ltd

3. Efficient Wafering and Texturing of single and multi crystalline silicon for solar cells

One way to lower PV cell manufacturing costs is to improve manufacturing productivity, particularly in the process of creating wafers (150 – 180 µm thick) efficiently (known as wafering) from the cast silicon ingot and in the subsequent texturing process. Current manufacturing processes for wafering and texturing used in silicon PV cell production have largely evolved from those used in the semiconductor industry. Thus, there is a need to develop innovative processes and innovative process enhancements to achieve increased number of wafers per unit time while having minimal impact on subsequent processes such as texturing.

With the desire to efficiently produce wafers, this project aims to investigate a newly developed process called fixed-abrasive (diamond) wire sawing (FAWS) which has the potential to improve productivity by as much as 50% and understand the effects of texturing surfaces from the FAWS technique and develop alternative methods for texturing. This proposal, by addressing the two related areas of wafering and texturing, will have a significant impact on the growth and wider adoption of silicon based PV technology by improving productivity and lowering costs.

Principal Investigator:

Prof. Sathyan Subbiah's (Mech & Aerospace Eng, NTU) expertise is in mechanical material removal process development, particularly on fundamentals of material removal and fracture. For the past two years he has built considerable expertise at NTU in material removal using abrasive processing via several industry projects mainly funded by Rolls Royce (total funded money > S$1 million from 2008-present). He has also undertaken some preliminary experimental and modelling work in fast-fracture of brittle materials using a high-pressure chamber arrangement built in-house at NTU. He also has experience working with ultrasonic vibration assisted machining and has run experiments with a setup built in-house; a paper has been published based on these experiments. He has many other experiences which include managing a S$250,000 project funded by NTU/MOE AcRF Tier-1 grant. He currently supervises 6 Research Associates and 3 Ph.D. students at NTU.

Co-Principal Investigator:

- Prof. David Butler, NTU
- Prof. Chen Zhong, NTU

Collaborator:

- Prof. Steven Danyluk, Georgia Institute of Technology

ANNEX 2

Background Information on Clean Energy Research Programme (CERP)

CERP aims to kick start the R&D activities in Clean Energy in Singapore. R&D proposals will be received through calls for proposals in specific themes identified by EIPO (top down approach) or in open theme calls (bottom up approach). This programme will be instrumental in helping to develop the technological capabilities needed to accelerate the growth of the Clean Energy industry in Singapore.

The first CERP call for proposals was an Open RFP in the solar technologies domain and closed in January 2008. A total of S$10 million was awarded to 8 research teams, chosen out of 60 submissions from both the public and private sectors. The proposed studies include research on thin-film photovoltaics (PV) and high-efficiency concentrator cells.

The second CERP call for proposals was focused on novel roof-mounted solar-harvesting devices and systems for the tropical region. A total of S$15 million was awarded to 8 research proposals, spanning a vast range of innovations such as solar-driven cooling systems, hybrid PV thermal systems and optimisation of performance of solar systems under the diffuse sunlight conditions typically experienced in the tropics.

The third CERP call for proposals was focused on improving solar cell efficiency and storage systems developed for renewable energy. A total of S$13 million was awarded to 5 research proposals. The proposed studies include research high reliability, long-life and low-cost lithium-ion batteries for green energy storage applications and advanced superstrates for micromorph silicon solar cells.

Eligibility and Funding Support

CERP calls for proposal are open to Institutes of Higher Learning (IHLs), public sector agencies, not-for-profit organisations and private sector companies based in Singapore. Collaborations among the above organisations are eligible too.

IHLs, public sector agencies and not-for-profit organisations will qualify for up to 100% funding support of approved direct qualifying costs of a project. Private sector companies will qualify for up to 70% of the approved qualifying direct costs of a project. Only IHLs and not-for-profit entities would be allowed support for indirect costs. These include up to 20% of qualifying costs for overhead costs.

Evaluation Processes

Proposals will be sent to international peer reviewers who are recognized experts in Clean Energy. Top ranked proposals will then be submitted to EIPO's Project Evaluation Panel (PEP) comprising eminent international and local members. The PEP will then evaluate and recommend the proposals for EIPO's consideration for funding support.

Applications

Calls for proposal are publicised on NRF's RITA system. Interested applicants may find out more about the CERP calls and submit their applications for the next call through the system.

For more information on the next call, please visit the following URL:
https://rita.nrf.gov.sg/ewi/CERP_05

ANNEX 3

Clean Energy Research Programme - Project Evaluation Panel Members:

(Chair) Assoc Prof Ho Hiang Kwee	Director, Urban Solutions, Det Norske Veritas (DNV) Clean Technology Centre, Singapore. (Formerly Director, Experimental Power Grid Centre, Agency for Science, Technology & Research (A*STAR)
Prof. Andrew William Blakers	Director of the Australian Research Council Centre for Solar Energy Systems, Foundation Director of the Centre of Sustainable Energy Systems Australian National University (ANU), Australia
Prof. Masafumi Yamaguchi	Director of the Super High Efficiency PV Research Centre Principal Professor, Toyota Technological Institute, Japan
Dr. Arthur E. Pontau	Deputy Director, Combustion & Industrial Technology, Sandia National Laboratories, USA
Prof. Christophe Ballif	Head of the Chair, Photovoltaics and Thin Film Electronics Laboratory, Institut de Microtechnique (IMT), Université of Neuchâtel, Switzerland
Mr. Ang Kian Seng	Director, Research, Building and Construction Authority (BCA), Singapore
Ms. Teh Poh Suan	Deputy Managing Director (Building Research), Housing & Development Board (HDB), Singapore
Dr. Sanjay C Kuttan	Ex-Director, Industry Development, Energy Market Authority (EMA) Singapore
Mr. Ananda Ram Bhaskar	Head, Energy Conservation & Environmental Technology Unit, National Environment Agency (NEA), Singapore
Mr Goh Chee Kiong	Director, Cleantech, Singapore Economic Development Board (EDB)