

ANNEX 2: SERIS - RESEARCH ACTIVITIES OVER THE NEXT 10 YEARS

The Solar Energy Research Institute of Singapore (SERIS) at NUS plans to embark on a series of research projects over the next 10 years to strengthen and deepen its solar capabilities.

Three new flagship R&D projects

- (1) *Development of a 30% efficient thin-film-on-silicon tandem solar cell in collaboration with Nanyang Technological University (NTU) and Campus for Research Excellence and Technological Enterprise (CREATE) of the National Research Foundation*

The practical efficiency of silicon solar cells is limited to about 28% under natural sunlight, whereby the world record efficiency is 26.6% at present. To boost the efficiency of silicon solar cells above the 30% threshold, they need to be combined with a second solar cell on top, to achieve a better harvest of the solar spectrum. The most promising technology path to cost-effective 30% efficient solar cells is to combine a thin-film top cell with a silicon bottom cell.

In this flagship project, NTU and CREATE will develop the thin-film top cells, while SERIS will develop optimised silicon bottom cells. Both III-V materials and perovskite materials will be investigated as top-cell materials.

- (2) *Development of low-cost, high-efficiency building-integrated PV (BIPV) modules and systems to replace parts of the building envelope with PV, including the facades*

With an existing building stock of more than 100,000 and little land for utility-scale ground-mounted PV systems, the vast majority of Singapore's PV capacity will be installed on top of, or attached to buildings. While roof-top PV systems are standard commercial practice, adding PV to the facade of existing or new buildings poses more challenges due to building regulations and lower irradiance reaching the vertical parts of a building.

SERIS will be working on high-efficiency, light-weight solar technologies that are aesthetically pleasing and yet economically viable. Such BIPV technologies open up new business opportunities as they possess immediate commercialisation and export potential.

- (3) *Development of a multi-purpose floating PV system that is suitable for off-shore applications in sheltered waters like Singapore*

SERIS is recognised as the global leader in R&D on "Floating Solar", operating the world's largest testbed at Tempeh reservoir. Given the space constraint of Singapore, there are two areas for expanding this leadership role: (i) multi-purpose floating PV structures; and (ii) off-shore floating systems, specifically for the sheltered waters in and around Singapore. Such efforts could take advantage of the well-established marine industry in Singapore, with a vision to have "energy islands" in the future which will supply energy to nearby industrial zones or living areas.

Other research projects

- **Industrial silicon wafer solar cells:** Silicon solar cells dominate the global solar market (> 90% market share), and most experts are convinced that this will not change in the next 10 to 15 years. In its first 10 years, SERIS has established itself as one of the globally

leading research institutes for industrial silicon solar cells, covering all major solar cell structures. In the coming years, SERIS will strive to maintain a leading position among the global competitors in order to increase efficiency, reduce cost, and/or enhance reliability and energy yield of silicon solar cells.

- **Industrial PV module development and testing:** In its first 10 years, SERIS has established itself as one of the globally leading research institutes for industrial PV module development and testing, with a focus on silicon PV modules. In the coming years, SERIS will strive to maintain this leadership position among the global competitors in order to increase efficiency, reduce cost, and/or enhance reliability and energy yield of silicon PV modules.
- **“Urban solar” initiatives:** These activities address the specific challenges which Singapore faces due to its high-density built environment. It includes 3D city modelling of Singapore with detailed solar potential for each individual rooftop. SERIS will also develop innovative deployment solutions for PV systems in an urban environment, such as in facades, walkways or as fences or sound barriers. One example are PV-powered sound barriers for MRT tracks. In addition, SERIS will also provide strong support and technical advisory to Singapore government agencies and industry in implementing strategic programmes such as the SolarNova programme.
- **Variability management for PV grid integration:** PV power is weather dependent and thus inherently variable. SERIS’ research in this area involves the development of a fully operational solar forecasting system, as well as impact analyses of the increasing share of variable solar power on the stability and resilience of the Singapore power system. Based on that, suitable grid integration measures, including PV inverter interactions, demand-side management and various types of storage systems shall be explored, including the concept of “virtual power plants” for PV operation. This should also lead to the development of Singapore-specific technical guidelines and standards for PV grid integration.
- **PV quality assurance:** Activities in this area aim to establish SERIS as *the* quality assurance institution for PV in Asia. As part of the “TruePower™” project, SERIS is developing an “energy rating” method for PV modules – which has the potential to fundamentally change the rating of PV modules based on “actual energy generated” in different environmental conditions, in contrast to the “rated power” method under the Standard Test Conditions (STC) that is used today. SERIS is also actively engaging in international PV system standards development and certifications, which are relevant and beneficial for the market development in Singapore (e.g. “Tropical Test Conditions”).

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