



NUS
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of Singapore



SERIS
Solar Energy Research
Institute of Singapore



Building-Integrated PV (BIPV)

Testing of BIPV Technologies in the Tropics
Technical Feasibility Studies for BIPV
Financial Assessment of BIPV Technologies
Real-Time Monitoring of BIPV Systems
BIPV Project Services

NATIONAL RESEARCH FOUNDATION
PRIME MINISTER'S OFFICE
SINGAPORE

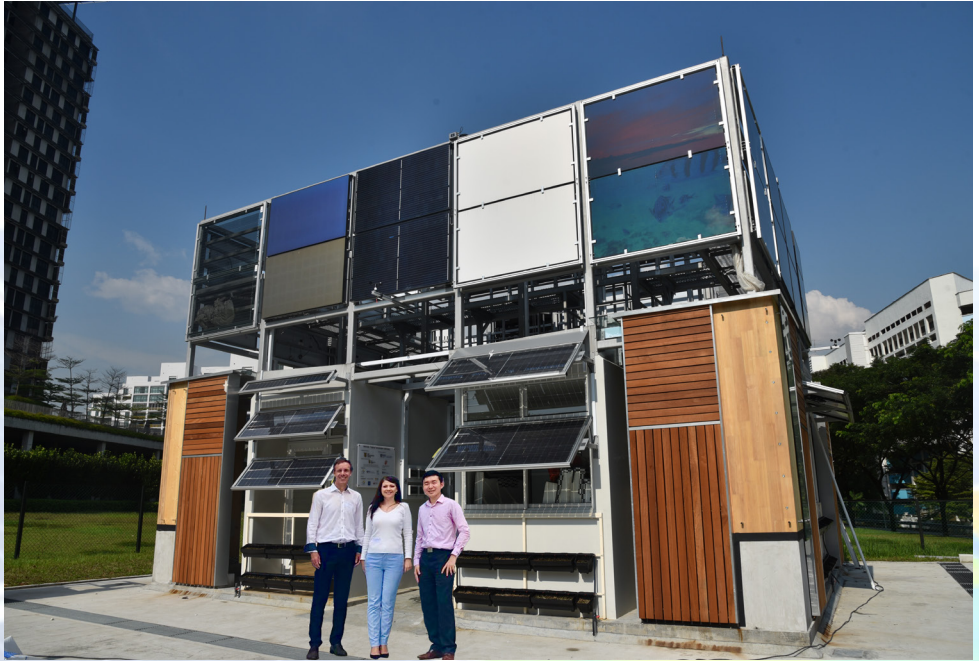


EDB:
SINGAPORE

SERIS is a research institute at the National University of Singapore (NUS). SERIS is supported by NUS, the National Research Foundation Singapore (NRF), the Energy Market Authority of Singapore (EMA) and the Singapore Economic Development Board (EDB).

BUILDING-INTEGRATED PHOTOVOLTAICS

The Centre of Competence for Building-integrated Photovoltaics (BIPV) at SERIS has specialised expertise for technical and financial assessments and conducts real-world outdoor test-bedding of BIPV technologies in the tropics.



The BIPV façade testbed at the NUS Campus comprises different types of BIPV modules including, semi-transparent, coloured, all-black, all-white, and digital printed with “underwater world” design.



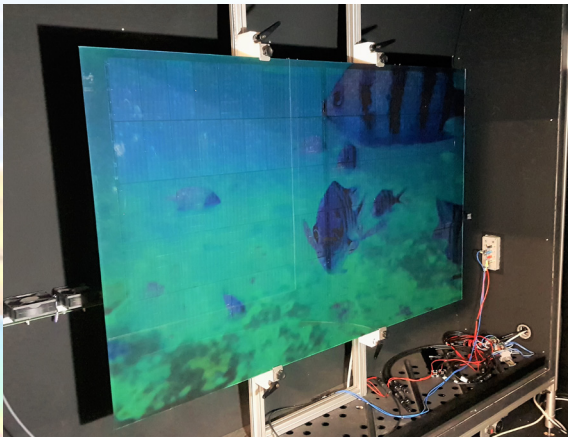
BIPV façades testing of performance and thermal properties at the School of Design and Environment at the NUS Campus

TESTING OF BIPV TECHNOLOGIES IN THE TROPICS

SERIS can assist project owners and developers in the design of their BIPV systems for performance optimisation and to meet the highest quality standards, in particular for installations in the tropics. SERIS' project services start from initial design recommendations, yield estimations until the systems are fully operational and perform as originally planned.

SERIS BIPV testing facilities offer measurements of:

- Electrical performance (e.g. maximum power, temperature coefficient, light-soaking, hot-spots)
- Reliability, durability (e.g. potential-induced degradation, PID)
- Mechanical resistance and stability (e.g. structural design requirements)
- Safety in use (e.g. failing of module (parts), electrical safety)
- Energy economy and heat retention (e.g. solar and luminous properties, U/G value)

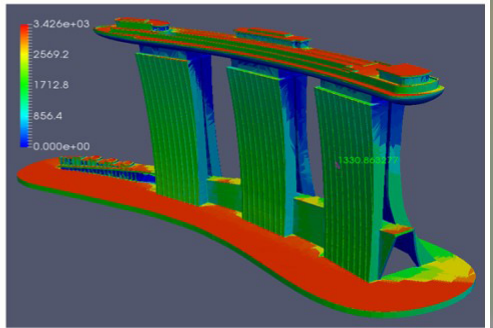
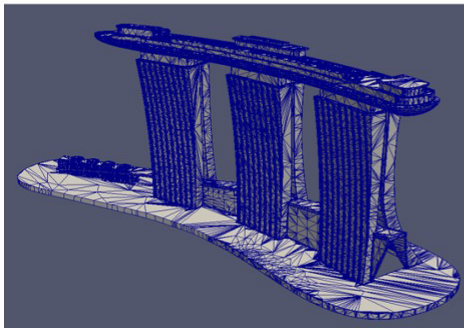
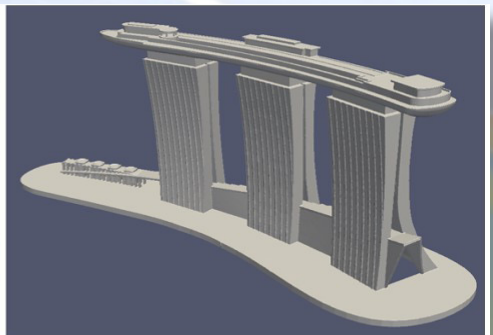


SERIS' indoor BIPV module testing facility
(example: digital printed and gold BIPV)

TECHNICAL FEASIBILITY STUDIES FOR BIPV

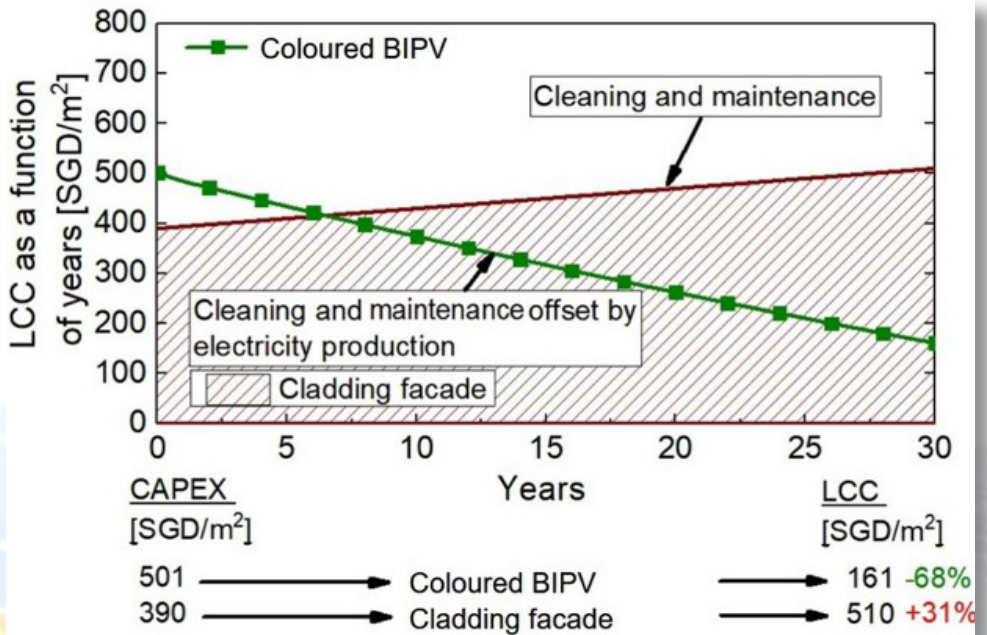
We offer technical feasibility studies for optimal placement of BIPV technologies in various building applications.

- Solar potential analysis of buildings / estates
- Shading analysis, estimation of the BIPV capacity installed and energy yield projections
- Review of possible technical solutions and product / system providers (in close collaboration with façade consultant)
- Develop detailed technical specifications for proposed BIPV system, to be integrated into the overall façade tender (or where suitable), including evaluation matrix
- Provide façade material recommendations to achieve necessary building certification, e.g. G-Value or solar heat gain coefficient (SHGC), U-Value



Example of a Solar Potential Analysis & 3D modelling for Urban Areas

FINANCIAL ASSESSMENT OF BIPV TECHNOLOGIES



An example of life-cycle cost (LCC) of two different façade materials as a function of the building lifetime: “Coloured BIPV” (green line) and conventional “Cladding façade” (red line)

Our financial team offers:

- Analysis of the economic viability of the proposed BIPV technologies
- Life-cycle cost / benefit, based on initial investment, operating and maintenance cost, inverter warranties, electricity production, energy efficiency savings, feed-in tariffs (if applicable), and prevailing local electricity prices
- Environmental benefits, i.e. green electricity production, avoided CO₂ emissions and carbon tax savings

REAL-TIME MONITORING OF BIPV SYSTEMS

Using our state-of-the-art proprietary monitoring system, which includes smart sensors and big data analytics coupled with an intuitive graphic user interface (GUI) enables continuous measurement of actual BIPV system parameters down to the individual string level. We provide:

- Independent power output measurements, inverter readings, weather sensor readings
- Specialised sensor readings (e.g. motion sensors for Floating PV)
- Real-time irradiance measurements
- Ambient and module temperature measurements
- Performance ratio (PR) calculations
- Live streaming of Fast Data (1-second) and Regular Data (1-minute) of weather and PV Systems parameters from various types of energy meters, inverters, including string level monitoring
- Submission of live power and irradiance data compliant with requirements from power systems operators (PSO), e.g. Singapore's Energy Market Authority (EMA)
- Tight time synchronisation of +/- 150ms
- Early fault detection by continuous benchmarking of:
 - String performance against each other
 - System performance against simulated behaviour under optimal conditions
 - Plant performance against peer installations



Example of the graphic user interface (GUI) of SERIS' real-time monitoring solution

BIPV PROJECT SERVICES

- Evaluation of different BIPV options for the building envelope during the pre-design phase and as retrofits
- Provide technical solutions, i.e. initial engineering design, façade material consultancy, specifications, tender evaluation matrix
- Assist evaluation of tender bids and technical / commercial negotiations with winning tender
- Detailed planning, construction and commissioning phases, including on-site testing services



Example of BIPV glass canopy (42 kWp) at Clean Tech One, Singapore: SERIS was technical consultant for BIPV design, tender, component selection and implementation

ABOUT SERIS

The Solar Energy Research Institute of Singapore (SERIS) is Singapore's national institute for applied solar energy research. SERIS is supported by NUS, the National Research Foundation Singapore (NRF), the Energy Market Authority of Singapore (EMA) and the Singapore Economic Development Board (EDB).

SERIS conducts research, development, testing and consulting on solar energy technologies and their integration into power systems and buildings. The institute's R&D spectrum covers materials, components, processes, systems and services, with an emphasis on solar photovoltaic cells, modules and systems. SERIS is globally active but focuses on technologies and services for tropical regions, in particular for Singapore and South-East Asia. SERIS collaborates closely with universities, research organisations, government agencies and industry, both locally and globally.

ABOUT THE BIPV CENTRE OF COMPETENCE AT SERIS

The Centre of Competence (COC) for BIPV was established at SERIS in 2017 to develop innovations around BIPV and remove industrially relevant barriers towards the accelerated adoption of BIPV in Singapore and beyond, while providing a collaborative platform with relevant stakeholders from the private and public sectors.

A key element of sustainable buildings is the passive design of their envelope, especially the facades. The thermal properties of the facade determines the solar heat gain and thus the energy consumption of the entire building. The possibility of integrating photovoltaics into facades offers great opportunities for increasing the share of renewables and improving the energy balance of a building.

SERIS has broad expertise in the areas of building integrated photovoltaic (BIPV) system design and evaluation, yield projections, technical verification, project risk assessment, real-time analytical monitoring of PV/BIPV installations, project management, owner's engineer and quality assurance.

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