Lingnan University 2025/2026 SDG Report
SDG 7 – AFFORDABLE AND CLEAN ENERGY



318
Solar Panels

190,000 kWh of renewable energy generated annually

26
Undergraduate Courses

563
Research Outputs

Lingnan University advances **SDG 7: Affordable and Clean Energy** through interdisciplinary research, education and collaborative partnerships. Bringing together expertise in battery technology, renewable energy, energy efficiency and circular economy practices with policy and social perspectives, the University supports the clean energy transition. These efforts equip students and researchers to contribute to a more sustainable, accessible and resilient energy future.

Affordable Seawater-Based Flow Batteries for Sustainable Energy Storage

Research by Professor Chen Ze, Assistant Professor (Presidential Early Career Scholar) at Lingnan University's Wu Jieh Yee School of Interdisciplinary Studies, explores how seawater-based flow batteries can support SDG 7: Affordable and Clean Energy through cost-effective energy storage and renewable energy integration.

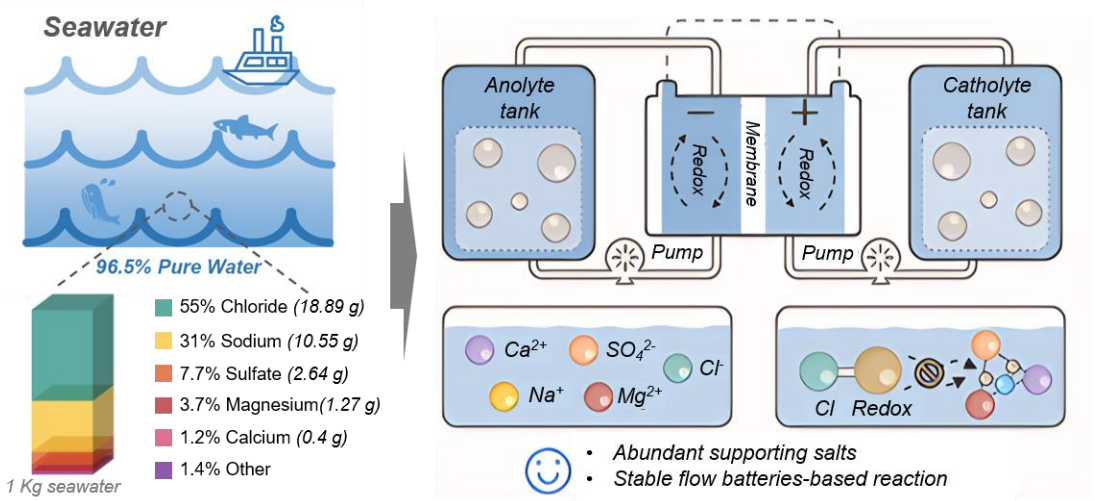
The global transition to renewable energy requires safe, affordable, and reliable ways to store electricity. Flow batteries are a promising solution. Unlike conventional batteries, they store energy in liquids that can be pumped through a battery system to store and release electricity. This makes them particularly suitable for large-scale energy storage, helping to provide a steady electricity supply even when the sun is not shining or the wind is not blowing. They therefore offer opportunities to enhance electricity supply reliability and the integration of solar and wind power. However, existing flow batteries often rely on expensive chemicals and purified water, increasing their cost.

To address these challenges, our research team developed an innovative flow battery using natural seawater as the main ingredient of its electrolyte. Instead of relying entirely on specially prepared chemical solutions, our approach takes advantage of the

naturally occurring salts and minerals in seawater. These components help maintain stable chemical reactions, allowing the battery to store and release electricity more efficiently and reliably. We also improved the battery's internal membrane to reduce unwanted chemical mixing and extend its lifetime, supporting durable and resource-efficient energy storage.

Using seawater collected from the Hong Kong coast, our battery successfully completed more than 3,500 charging and discharging cycles without significant capacity loss, achieving over 99% charge efficiency. Under higher-capacity conditions, the battery achieved 103.58 Ah per litre and maintained stable performance over 150 cycles. Further testing with seawater collected from California, England, and eastern China demonstrated consistent performance. Our preliminary economic analysis also estimated an electrolyte material cost of approximately US$42.46 per kWh of storage capacity, highlighting its potential cost advantages and contribution to energy storage affordability.

Supporting the United Nations Sustainable Development Goal 7, this research demonstrates how abundant natural resources can contribute to cleaner and more affordable energy technologies. By reducing reliance on purified water and potentially lowering energy storage costs, seawater-based flow batteries could support the wider adoption of renewable energy, strengthen sustainable energy infrastructure, and contribute to a more sustainable energy future.



Advisory Services for Hong Kong Power Sector's Participation in the Southern China Carbon Capture, Utilisation and Storage (CCUS) System

Undertaken by Professor LI Jia, Associate Professor at Lingnan University's Wu Jieh Yee School of Interdisciplinary Studies, this advisory project examines how Hong Kong's power sector could participate in regional carbon capture, utilisation and storage (CCUS) infrastructure in Southern China. Scheduled from August 2025 to February 2026, the project focuses on assessing potential CO_2 storage sites in Guangdong, comparing pipeline and shipping options, and developing commercial and cost models.

It aims to provide a strategic participation roadmap aligned with CLP's decarbonisation strategy and regional CCUS development timelines.

SDG 7 – Affordable and Clean Energy

The project supports power sector decarbonisation by exploring how Hong Kong's electricity generation sector could access regional CO_2 transport and storage infrastructure. Its assessment of technical feasibility and costs aims to inform commercially viable approaches to reducing power-sector emissions, contributing to the transition towards lower-carbon electricity generation.

SDG 9 – Industry, Innovation and Infrastructure

The project supports the planning of cross-border low-carbon infrastructure, including CO_2 pipelines, shipping routes and geological storage facilities. By evaluating infrastructure requirements, storage capacity and commercial arrangements, it aims to inform the development of regional CCUS networks and strengthen the evidence base for sustainable industrial infrastructure investment.

SDG 13 – Climate Action

The project explores potential pathways for large-scale carbon emissions reduction through Hong Kong's participation in regional CCUS hubs. Its technical, regulatory and economic assessments will inform a strategic roadmap for participation between 2025 and 2040, supporting evidence-based climate mitigation planning and alignment with regional decarbonisation efforts.

SDG 17 – Partnerships for the Goals

The project supports cross-border collaboration among CLP Power Hong Kong Limited, Guangdong CCUS stakeholders, China Southern Power Grid, academic and geological experts, and relevant government and regulatory agencies. By examining shared infrastructure, business arrangements and regulatory requirements, it aims to facilitate coordination between Hong Kong and Guangdong in pursuit of shared climate objectives and regional low-carbon development.

Monitoring Greenhouse Gas Emission Point Sources From China Space Station

With Professor LI Jia, Associate Professor at Lingnan University's Wu Jieh Yee School of Interdisciplinary Studies, participating in the research collaboration, this project aims to develop a greenhouse gas monitoring system using observations from the China Space Station and related satellite platforms. Running from August 2025 to August 2028, it will combine space-based observations, data analytics, ground-truth verification and blockchain technology to identify and quantify emission point sources and provide secure, transparent and traceable emissions data.

SDG 7 – Affordable and Clean Energy

The project aims to provide reliable greenhouse gas emissions data that can inform clean energy transition strategies. By identifying emission sources and analysing trends, it could help policymakers and industry stakeholders assess emissions associated with energy use and prioritise opportunities for lower-carbon energy systems.

SDG 9 – Industry, Innovation and Infrastructure

The project advances space-based environmental monitoring and secure digital infrastructure by integrating satellite observations, data analytics and blockchain technology. Its planned data-processing framework and geospatial visualisation platform will support the development of innovative tools for emissions monitoring, while blockchain integration aims to strengthen data integrity, transparency and traceability.

SDG 13 – Climate Action

The project aims to strengthen the capacity to identify, quantify and track greenhouse gas emissions, supporting evidence-based climate mitigation and carbon reduction strategies. By combining space-based observations with ground-truth verification, it seeks to provide validated emissions data for regulatory monitoring and compliance assessment, with potential future applications in carbon credit verification.

SDG 17 – Partnerships for the Goals

The project brings together expertise from Lingnan University, the Hong Kong University of Science and Technology, Hong Kong Baptist University, and the Technology and Engineering Center for Space Utilization of the Chinese Academy of Sciences, with support through the Innovation and Technology Commission's Innovation and Technology Support Programme. This cross-institutional collaboration combines capabilities in space technology, environmental monitoring and digital systems to advance climate technology development and support shared sustainable development goals.

Bio-Inspired, Scalable, and Tri-Mode Stimuli-Chromic Composite for Smart Window Multifunctionality

Professor KE Yujie, Assistant Professor, Wu Jieh Yee School of Interdisciplinary Studies contributed to this collaborative research on multifunctional smart windows, supporting SDG 7: Affordable and Clean Energy, particularly through building energy efficiency and energy-saving materials.

Smart windows offer a promising approach to saving building energy and reducing carbon emissions by regulating light transmission. As the technology develops, demand is increasing for multifunctional windows that provide not only energy savings but also privacy control and aesthetic flexibility. However, designing and fabricating materials that combine these functions remains challenging.

To address this challenge, the research presents a scalable method for producing a composite film with three modes of light regulation: thermochromism, mechanochromism, and hydro-/solvatochromism. These modes respond to changes in temperature, mechanical strain, and exposure to water or solvents, respectively. The film combines a bio-inspired, hierarchically structured surface with a functional elastomer base, enabling multiple optical responses within a single material system.

Through combined experiments and simulations, the researchers reveal the mechanisms underlying these responses: strain-induced deformation of surface structures, wettability-controlled refractive-index matching, and thermally responsive nanostructural resonances. These findings provide a scientific basis for designing adaptive light-regulating materials.

Alongside good energy-saving performance, the method offers several advantages. Energy-saving and privacy functions can be controlled independently, while the additional hydro-/solvatochromic mode provides another means of regulating privacy under extreme circumstances. Designable patterns and colours also allow the material to meet diverse aesthetic requirements.

By combining energy efficiency, privacy control, multifunctionality and scalable fabrication, this research demonstrates the potential of advanced materials to support more adaptable building technologies. It may inspire future developments in multifunctional smart windows and methods for controlling light across space and time, contributing to energy-efficient buildings and lower-carbon built environments.

Bio-Inspired Multifunctional Smart Windows: Surface Wrinkle-Crack for Dynamic Optical and Wettability Modulations

Professor KE Yujie, Assistant Professor at Lingnan University's Wu Jieh Yee School of Interdisciplinary Studies, contributed to this collaborative research on bio-inspired multifunctional smart windows. The study supports SDG 7: Affordable and Clean Energy through its focus on building energy efficiency, adaptive optical materials and energy-saving technologies.

Smart windows offer a promising approach to improving building energy efficiency. Bio-inspired designs aim to combine independent energy-saving and on-demand privacy functions, although further improvements in material performance are needed. This research presents an improved composite comprising tungsten-doped vanadium dioxide (W-VO_2), silica (SiO_2) nanospheres and polydimethylsiloxane (PDMS) elastomers. The composite can simultaneously deliver privacy and energy-saving modes at a relatively low temperature of approximately 45\,^\circ\mathrm{C}.

The study investigates how surface morphology influences optical regulation and wettability, providing insights into silica-based wrinkle formation. Diffraction patterns demonstrate that surface wrinkles are more effective than cracks in achieving privacy

control. Increasing surface wrinkles and cracks also changes the material from hydrophilic to hydrophobic, with the water contact angle increasing from $19°$to $115°$. This finding suggests potential for self-cleaning functionality, adding another useful feature to multifunctional smart windows.

The research further demonstrates that silica nanospheres are essential to wrinkle formation. Small gaps between neighbouring spheres promote localised strain and increase the overall Young's modulus, resulting in larger wrinkle amplitudes. These findings strengthen understanding of how material composition and surface structures can be designed to achieve desired optical and surface properties.

By combining an improved fabrication method with a deeper understanding of surface behaviour, the study provides a foundation for future developments in mechanochromic and thermochromic materials, multifunctional smart windows and bio-inspired optical design. Its integration of energy-saving performance, on-demand privacy and potential self-cleaning functionality could support more adaptable, energy-efficient buildings, contributing to a more sustainable built environment.

Highly Solar-Modulated and Robust PNIPAM/HEMC Smart Windows

Professor KE Yujie, Assistant Professor at Lingnan University's Wu Jieh Yee School of Interdisciplinary Studies, contributed to this collaborative research on energy-efficient smart windows. The study supports SDG 7: Affordable and Clean Energy by advancing building energy efficiency, thermal regulation and energy-saving materials.

Energy-efficient windows are considered one of the most promising strategies for reducing building energy consumption. An ideal thermochromic smart window should combine high stability, high luminous transmittance and outstanding mechanical properties. However, existing technologies face challenges in achieving these requirements simultaneously.

To address these limitations, the researchers synthesised composite hydrogels containing hydroxyethyl methyl cellulose (HEMC) and thermoresponsive poly(N-isopropylacrylamide) (PNIPAM) for application in smart windows. These materials respond to temperature changes, enabling adaptive control of solar transmission and supporting indoor temperature regulation.

The composite hydrogels exhibited excellent solar modulation of 74.97%, luminous transmittance of 84.98%, and strong mechanical performance, with a reversible compression ratio of up to 74%. They also offered faster response times and superior thermal stability compared with traditional hydrogels. Importantly, the materials retained excellent optical properties after 80 heating–cooling cycles, demonstrating their durability under repeated temperature changes.

The PNIPAM/HEMC smart windows demonstrated superior indoor temperature control. Compared with normal glass, calculations for a typical office building fitted

with these windows indicated annual energy reductions of 19.2, 28.2, 74.8 and $49.7\ \mathrm{kWh\ m^{-2}}$ in Beijing, Hong Kong, Bangkok and Kuala Lumpur, respectively. These findings highlight the potential for building energy savings across different climatic conditions.

By combining high optical performance, mechanical robustness and thermal stability, this study presents a reliable strategy for developing thermochromic smart windows. The research could support energy-efficient building design and reduced energy demand for indoor temperature control, contributing to more sustainable buildings and the broader objectives of SDG 7.

Scalable Hydrogel Smart Windows with Moisture Retention and Low Emissivity for Sustainable Buildings

Professor KE Yujie, Assistant Professor at Lingnan University's Wu Jieh Yee School of Interdisciplinary Studies, contributed to this collaborative research on scalable hydrogel smart windows for sustainable buildings. The study supports SDG 7: Affordable and Clean Energy through advances in building energy efficiency, adaptive solar regulation and reduced heating and cooling demand.

Thermochromic hydrogels show promise for smart windows but face challenges including high thermal emissivity and rapid water loss. This research presents a scalable hydrogel-based smart window that simultaneously addresses moisture retention, low long-wave infrared emissivity and large-area fabrication.

The hydrogel is synthesised by copolymerising the moisturising agent sodium pyrrolidone carboxylate (PCA–Na) with N-isopropylacrylamide (PNIPAM). This forms a stable structure that lowers the phase transition temperature to 25.7\,^\circ\mathrm{C} and improves water retention by 12% compared with pure PNIPAM hydrogels. Integrating the hydrogel with an indium tin oxide (ITO) layer further reduces long-wave infrared emissivity, supporting thermal management and energy-saving glazing.

The researchers produced a large-area demonstration window measuring $40 \times 45\ \mathrm{cm}$, achieving visible transmittance of 69.3%, solar modulation of 60.3%, and low long-wave infrared emissivity of 0.32. Demonstration testing showed an indoor temperature reduction of up to 9.0\,^\circ\mathrm{C} under daytime illumination compared with a glass-based window.

EnergyPlus simulations further indicated annual heating, ventilation and air conditioning (HVAC) energy savings of 44.9%, 46.1% and 10.1% in Bangkok, Phoenix and Changsha, respectively, outperforming conventional glazing systems. These results highlight the potential for climate-responsive building technologies to reduce energy consumption across different locations.

The integrated design maintained excellent optical performance over 100 cycles,

demonstrating durability alongside improved moisture retention. By combining scalable fabrication, solar modulation and low emissivity, the study provides a pathway towards practical energy-efficient building applications, contributing to sustainable buildings and the energy-efficiency objectives of SDG 7.

Integrated Multiband Smart Windows From UV to LWIR Based on Molecularly Engineered Thermochromic Hydrogels

Professor KE Yujie, Assistant Professor at Lingnan University's Wu Jieh Yee School of Interdisciplinary Studies, contributed to this collaborative research on integrated multiband smart windows. The study supports SDG 7: Affordable and Clean Energy through advances in building energy efficiency, adaptive solar regulation and reduced heating and cooling demand.

Smart windows offer energy-saving potential for buildings, but challenges remain in achieving multiband design across ultraviolet, visible, near-infrared and long-wave infrared wavelengths. This research presents a smart window integrating a thermochromic poly(EEEA-co-NIPAM) (PEN) hydrogel with an anti-UV layer and an indium tin oxide layer. The integrated design enables dynamic visible and near-infrared solar modulation alongside UV shielding and low long-wave infrared emissivity, supporting spectrally selective, energy-efficient glazing.

Combined experimental and theoretical analyses reveal that the 2-(2-ethoxyethoxy) ethyl acrylate (EEEA) comonomer strengthens the polymer network and forms favourable hydrogen-bonding interactions with N-isopropylacrylamide (NIPAM). These interactions promote rapid dehydration-driven chain collapse above a reduced lower critical solution temperature, accelerating the optical response during heating.

The produced window achieves solar modulation of 42.7%, nearly complete UV shielding with UV transmittance of 0.1%, and low indoor-facing long-wave infrared emissivity of 0.31. It maintains stable performance after 100 hours of UV exposure and 100 thermal cycles, demonstrating durability and reliable optical performance.

Outdoor tests demonstrate a cooling effect of 7.7\,^\circ\mathrm{C} compared with ordinary glass. EnergyPlus simulations across Singapore, San Francisco and Brisbane indicate building heating and cooling energy savings of up to 62.6%, highlighting the potential to reduce energy demand in different climatic settings.

By combining multiband light regulation with molecularly engineered thermochromic hydrogels, this research provides an effective strategy and deeper scientific understanding for developing advanced smart windows. It offers a promising pathway towards sustainable building technologies and energy-efficient building envelopes, contributing to the energy-efficiency objectives of SDG 7.