**Lingnan University 2024/2025 SDG Report**
**SDG 7 – AFFORDABLE AND CLEAN ENERGY**


**318**
Solar Panels

**26**
Undergraduate Courses

**377**
Research Outputs

**35**
Research Projects and Grants

Lingnan University is committed to advancing SDG 7 – Affordable and Clean Energy through innovative research, education, and partnerships that promote sustainable and efficient energy solutions. By integrating advances in battery technology, renewable energy systems, and circular economy practices with policy and social insights, Lingnan fosters practical, interdisciplinary approaches to the global clean energy transition, empowering students and researchers to build a more sustainable and resilient energy future.

**Powering Sustainable Urban Transit: Advanced Battery Management for the Mass Railway Transit System**

This impact case study showcases research from Lingnan University, supported by the MTR Research Fund, that directly contributes to SDG 7 – Affordable and Clean Energy by enhancing the efficiency and reliability of clean energy storage in public transportation. The project addresses one of the key challenges in integrating high-performance lithiumion (Liion) batteries into Hong Kong's Mass Transit Railway (MTR) system — a crucial step toward phasing out polluting nickel cadmium batteries.

The main technical challenge lies in accurately estimating the condition of Liion batteries under the MTR's demanding operational environment, characterized by extreme current loads and temperature variations. The research aims to develop low-cost, high precision algorithms for real time monitoring of a battery's StateofCharge (SoC), StateofHealth (SoH), and StateofPower (SoP). These techniques are designed to achieve over 95% accuracy for SoC and SoH, and 90% accuracy for electrochemical impedance spectroscopy, thus optimizing battery utilization and lifespan.

The outcome is a safer, more reliable, and efficient energy system for one of the world's busiest metro networks. By enabling a smooth transition to Li-ion technology, this work reduces hazardous waste, lowers the lifecycle carbon footprint of train operations, and strengthens the sustainability and resilience of Hong Kong's critical urban infrastructure. Moreover, the developed methodologies are transferable to electric vehicles and large-scale renewable energy storage, supporting wider adoption of clean energy technologies and contributing to a more sustainable future for urban mobility and energy systems worldwide.

**Preventing Premature Failure: AI-Powered Early Detection of Abnormal Batteries for a Sustainable Energy Future**

This impact case study highlights pioneering research from Lingnan University, featured as a *cover paper in Advanced Science*, offering a breakthrough solution to improve the sustainability, reliability, and affordability of clean energy storage systems. The work tackles a critical issue affecting the lifespan of large-scale battery packs used in electric vehicles and grid storage — premature failure caused by a small number of undetectable abnormal cells.

The research team developed a novel artificial intelligence technique based on few shot learning to detect lifetime abnormal cells at an early stage. By analysing only the first cycle of aging data, the model accurately identified all abnormal cells across a dataset of 215 commercial batteries, with a false alarm rate of just 3.8%. The study further revealed that conventional capacity and resistance checks — the industry's standard methods — are insufficient for dependable battery screening.

This technology represents a major shift in battery quality control and management. It enables the production of more reliable, homogeneous, and long-lasting battery packs without additional manufacturing costs or complex sensors. By preventing early pack failure, it extends battery service life, reduces electronic waste, enhances the cost effectiveness of clean energy technologies, and conserves critical raw materials.

The broader implication of this research extends beyond technical innovation. It strengthens the long-term viability of electric vehicles and renewable energy storage, both central to a low carbon economy. By making energy storage systems safer, more efficient, and more sustainable, Lingnan's work makes a direct and measurable contribution to SDG 7 – Affordable and Clean Energy, and supports the transition toward a cleaner, circular, and resilient global energy future.

**Popularizing Battery Diagnostics: A Low-cost, AI Enabled Path to Safer and Longer Lasting Energy Storage**

This impact case study presents research from Lingnan University, published in *Cell*

*Reports Physical Science*, that breaks a key technical barrier to the widespread and safe use of lithiumion batteries. The study addresses the challenge of applying Electrochemical Impedance Spectroscopy (EIS)—a powerful diagnostic tool—within real world and mobile contexts such as electric vehicles (EVs) and renewable energy storage systems. Traditionally, EIS depends on costly, laboratory based instruments, making it unsuitable for onboard deployment.

To overcome this limitation, Lingnan researchers developed a pioneering AI method capable of generating accurate EIS data in real time without additional hardware or sensors. Using virtual simulation and transfer learning, the team's deep neural network replicates high-fidelity EIS measurements with as few as 24 data groups, dramatically outperforming conventional, data intensive algorithms.

The research's primary impact lies in popularizing advanced battery health monitoring. This innovation effectively lowers the threshold for implementing comprehensive, real time diagnostics, transforming EIS from a laboratory technique into a practical and cost efficient field tool. The system enables proactive fault detection and precise state of health monitoring for batteries across various chemistries and operating conditions.

By facilitating health aware battery management, this AI driven approach will enhance operational safety, extend battery lifespan, and improve the economic and environmental sustainability of energy storage systems. Beyond immediate technical benefits, the work accelerates the integration of clean energy technologies in transport and grid applications, reducing waste and resource demand.

This development represents a crucial advance toward affordable, reliable, and sustainable energy solutions, directly supporting the objectives of SDG 7 – Affordable and Clean Energy and contributing to the global transition toward a safer and more energy efficient future.

**Unlocking the Value of Retired Batteries: An AI Driven Solution for a Circular Economy**

This impact case study highlights award winning research from Lingnan University that advances SDG 7 – Affordable and Clean Energy by enabling a viable and efficient circular economy for energy storage. The study tackles a critical challenge in the sustainable reuse of retired electric vehicle (EV) batteries — their inherent inconsistency, which limits performance and economic value in second life applications such as renewable energy storage.

To address this issue, Lingnan researchers developed a novel metal earning and AI based method that accurately clusters retired batteries according to their remaining lifespan, using only the first three cycles of data. The approach constructs a similarity based adjacency matrix, enabling the efficient grouping of batteries with comparable degradation profiles. Compared to conventional sorting methods, the new technique reduces loss of life span in second life battery packs by at least 20%, significantly improving system efficiency and reliability.

The impact of this technology is transformative for the clean energy sector. By improving the consistency, longevity, and performance of second life battery systems, it enhances their economic value while reducing operational risks. This innovation establishes a scalable pathway for giving EV batteries a “second life” — extending their usefulness, minimizing environmental impact, and reducing resource demand associated with producing new batteries.

Overall, this research provides a practical and data driven solution to one of the most pressing issues in sustainable energy: how to make energy storage both circular and economically feasible. By promoting resource efficiency and waste reduction, it represents a pivotal step toward a sustainable, low carbon, and circular energy ecosystem, directly contributing to the advancement of SDG 7.

**Green Energy and Sustainability**

This impact case study highlights a pioneering taught postgraduate course at Lingnan University that is shaping the next generation of leaders for the global clean energy transition. The course offers a comprehensive framework for understanding renewable energy within the context of a smart and sustainable society, combining in-depth technical and interdisciplinary perspectives.

Students explore critical technologies such as solar power generation and lithium battery management for energy storage, while also examining the economic, sociological, and environmental dimensions of implementing these solutions. Through this integrated approach, the course not only strengthens technical competence but also fosters systems thinking and policy awareness essential for advancing sustainable energy practices.

Demonstrating its excellence in teaching and impact, the course achieved an outstanding CTLE rating of 5.85 out of 6.00, reflecting its effectiveness in equipping students with the knowledge and leadership skills to contribute meaningfully to SDG 7 – Affordable and Clean Energy.

**Preventing Premature Failure: AI Powered Early Detection of Abnormal Batteries for a Sustainable Energy Future**

In collaboration with leading scholars, researchers at Lingnan University have developed an AI based few shot learning method to detect abnormal battery cells using only first cycle aging data. Featured as a cover story in *Advanced Science*, this pioneering approach successfully identified all lifetime abnormal cells in a dataset of 215 commercial batteries, with a false alarm rate of just 3.8%, significantly outperforming conventional screening techniques.

This breakthrough enables the production of more reliable and longer lasting battery packs without additional manufacturing costs or sensors, effectively preventing premature failure and reducing electronic waste. By extending battery lifespan and improving consistency, the technology enhances both the economic and environmental sustainability of energy storage systems.

The innovation contributes directly to SDG 7 – Affordable and Clean Energy by advancing sustainable, affordable, and circular energy solutions, strengthening the global transition toward cleaner and more resource efficient energy infrastructure.

**On-going Projects:**
1) "Accurate prediction of vehicle remaining charging time" funded by Faculty Research Grant
2) "Low-cost detection of battery internal-short-circuit in pack applications" funded by Faculty Research Grant
3) "Key techniques for retired battery screening towards second-life applications" funded by Direct Grant

**Academic Courses:**

**SCI509 Green Energy and Sustainability in a new TPG programme**

SCI509 is a required course of a newly launched TPG programme in 2024-25, MSc in Sustainability and Environmental Analytics. The course provides a comprehensive framework for understanding renewable energy within the context of a smart and sustainable society, with a specialized deep-dive into the critical technologies of solar power generation and lithium battery management for energy storage, while simultaneously examining the economic, sociological, and environmental aspects of their deployment.

**UG courses**

Among the courses recently offered in Lingnan, 26 undergraduate-level courses address SDG7 Affordable and Clean Energy, with 5 out of the 26 highly focus on green energy and international environmental politics. The five courses are:

- Policy and Technology for Urban and Rural Development
- Environmental Economics and Policy
- Global Environmental Politics
- International Politics
- Earth Science

**Energy reduction and sustainable energy**
Lingnan University is demonstrating a comprehensive and multi-faceted commitment to energy conservation and the broader goal of achieving carbon neutrality before 2050. On campus, this involves a concerted push to reduce electricity consumption

through a suite of strategic measures, including the adoption of energy-efficient LED lighting, the installation of lighting sensors for outdoor areas, and the optimization of air-conditioning services by setting temperatures to an efficient 24°C. These behavioral and technical upgrades are complemented by community engagement initiatives, such as encouraging stair use and participation in energy-saving campaigns. A significant stride in renewable energy generation has been made with the recent installation of 318 solar panels on key buildings, including the Chan Tak Tai Auditorium, which now generates approximately 160,000 kWh of clean electricity annually. With a firm commitment to continuous improvement, the university is actively exploring additional campus locations to further expand its production of renewable energy and solidify its leadership in the fight against climate change.