7 AFFORDABLE AND CLEAN ENERGY

Research & Innovation

Integrated Self-Sustained Solar Energy Management System

Against the backdrop of real-world development and application of solar energy management systems in Hong Kong, scholars from the Department of Electrical and Electronic Engineering collaborated with the Electrical and Mechanical Services Department of the Hong Kong Government to conduct a study including several trials to collect data from photovoltaic (PV) systems and environmental conditions, for the purpose of commissioning and enhancing software, developing a benchmarking tool for nearby PV systems, and creating an open-data platform.

This study **won a Gold Medal at the 48th International Exhibition of Inventions of Geneva**. Pilot tests have been performed to maintain the secure operation of PV systems, including a graphical user interface that explains software functions that identify, for example, local weather conditions, PV system output over time, data logging and reporting, fault reporting, and predictive maintenance scheduling.

The implementation of clean and sustainable solar energy management systems is supported by Hong Kong Government policies and targets related to renewable energy adoption, with the aim of achieving long-term environmental and energy goals. The study provides techniques essential to ensuring secure operation of PV systems, thus contributing to the reduction of global carbon emissions and mitigation of climate change and its adverse effects. The integrated solar energy performance management toolkit introduced in 2022 and the integrated self-sustained renewable energy explorer developed in 2023 will benefit not only Hong Kong society but also help attain the goal of global carbon neutrality.

Advanced Electrode Materials for Sustainable Calcium Rechargeable Batteries

With a view to progressing towards a “zero carbon” society, members of the Research Institute for Smart Energy have been exploring the use of various advanced materials to make calcium rechargeable batteries greener. For a feasible anode material, the research team used an electrolyte, calcium borohydride in dimethylacetamide, and inserted calcium ions into commercial graphite through a co-intercalation mechanism to achieve significant energy storage capacity and an unprecedentedly fast (dis)charge capability. For the cathode, the team developed a sodium vanadium fluorophosphates open-framework that can be used as ultra-stable and fast-kinetic calcium-ion intercalation hosts, which have a capacity degradation rate of only 0.02% over 2,000 cycles. It is noteworthy that other naturally abundant materials, including perylene tetra-carboxylic diimide, have also been examined as viable electrode materials. The team showcased how new technologies can be developed for manufacturing next-generation calcium batteries that have high energy and a long life at a low cost.

Teaching & Learning

Low-Cost Energy Infrastructures for East Africa

The Department of Electrical and Electronic Engineering offers the service-learning subject "Low-cost Energy Infrastructures for Developing Regions" for students to apply their classroom learning in real-world settings as they translate the concept of economic electricity generation systems and electric devices as infrastructure for improving quality of life in underprivileged areas. The subject aims to equip students with knowledge and skills for basic electricity usage assessments and improvements, and to raise their awareness of the reality of living in impoverished developing regions. They are also introduced to significant energy poverty issues, including the psychological and physiological impact on affected communities and individuals, with the purpose of instilling in them a sense of civic responsibility and engagement.

This academic year, partnering with the "Habitat Green in East-Africa" programme run by the Service-Learning and Leadership Office, PolyU students joined forces with visiting students and teachers from the University Social Responsibility Network and their counterparts from secondary schools in Hong Kong to deliver a two-week service project, in which they designed and developed green energy solutions for **around 400 families in remote villages in Rwanda**. Students made full use of their theoretical and practical knowledge and skills to give back to those in need, whereby they could empathise with and fulfil their civic responsibility to those facing energy poverty, and ultimately, reflect on their roles and duties as professional and morally accountable global citizens.

Subject: Renewable Energy Technologies

Focusing on topical areas related to renewable energy resources, renewable energy use and environment, and climate change, the Department of Mechanical Engineering offers this subject to introduce students to fundamental concepts relating to the three components of renewable energy systems, namely conversion, storage, and utilisation. Students get to learn about energy conversion in solar, wind, geothermal, and nuclear energy; biomass conversion; hydrogen and fuel cells; and artificial photosynthesis that involves photo/electrochemical carbon dioxide and nitrogen reduction. They also study energy storage that is portable in lithium-ion batteries, large-scale in flow batteries, site-dependent in compressed air and pumped hydro systems, and in chemicals. Apart from this, they also investigate efficient energy use in industry and buildings, together with topics relating to energy saving and pinch analysis. Ultimately, they are encouraged and guided to apply theoretical knowledge of renewable energy systems to the innovative design and practical evaluation of major renewable energy systems.

Outreach & Engagement

Cooling Pokfulam Village with Reduced Energy Consumption

In order to facilitate the application of sub-ambient cooling materials to rooftops of squatter and old residential buildings, Umi Coating New Material Technology Company Limited, an academic-led start-up from PolyU, has collaborated with the Home Affairs Department of the Hong Kong Government to initiate a pilot home-cooling scheme, offering a pro-bono coating service to more than ten squatter buildings in Pokfulam Village.

In this project, the team used their own patented sub-ambient radiative cooling technology for the purpose of lowering indoor temperatures, thereby reducing electricity consumption. It was found that the coated surfaces have the ability to lower surface temperatures by more or less 25°C and reduce indoor temperatures by approximately 3°C by reflecting energy from the sun and radiating the absorbed heat back into space. It can thus be concluded that such an eco-friendly, long-lasting, self-cleaning, low-cost polymeric radiative cooling coating can help contribute to a reduction in electricity consumption.

Solar photovoltaic systems on campus

Governance & Operations

Green Library and Energy Optimisation on Campus

The PolyU Library has undergone a major extension and revitalisation that has created over 2,100m² of additional operational floor area, featuring a range of energy-efficient elements and renewable energy technologies, such as variable speed drives in chillers, demand-controlled ventilation systems, exhaust air heat recovery, a building energy management system, a photovoltaic system, and low-emissivity insulating glass, highlighting the University's long-term commitment to sustainability. The refurbishment project **won a prestigious Grand Award and three special awards from the Building Services Division of The Hong Kong Institute of Engineers, the Best of Design Awards from The Architect's Newspaper in the US**, as well as **a Special Award in interior design from The Hong Kong Institute of Architects**.

Further green initiatives have also been implemented across the PolyU community. A pilot scheme involved installing smart energy meters for future energy optimisation through big data analytics and solar photovoltaic systems at multiple spots throughout the main campus for clean energy generation. Additionally, heating, ventilation, and equipment used in air conditioning has also been replaced and optimised in order to enhance efficiency and minimise electricity consumption. Moreover, various incentive programmes and campaigns have been organised to raise sustainability awareness among University members.