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HONG KONG INSTITUTE FOR CLEAN ENERGY

Power the World with Clean Energy
Build A Sustainable Future

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Hong Kong Institute for Clean Energy

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Powering a Clean Energy Future

The Hong Kong Institute for Clean Energy (HKICE) was established in 2021 to integrate interdisciplinary efforts across the university departments to tackle the grand challenges of global warming through clean energy development and carbon capture. Although severe climate change is more than imminent, only 12% of our energy supplies come from clean energy, which accounts for 30% of the electricity generated, and the burning of fossil fuels has significantly contributed to global warming. According to the UN report, the global temperature rise is approaching the breaking point of 1.5 °C, or the point of no return, with glacial collapse to release previously trapped methane gas to further accelerate global warming. It is very critical to move to a carbon-neutral future. Lighting and IT industries are the two most intensive electricity users, which account for 15% of total energy consumption each. It is difficult to imagine life without all applications provided by these sectors. Energy-efficient LED lighting and high-speed, low-power consumption internets are just two good examples of energy-saving innovations, but more needs to be done. Clean energy refers to renewable energy that we all know. The biggest challenge is to develop smart ways to efficiently harvest, store/convert, and distribute them to the needed destinations and applications. This is what we are focused on doing as an Institute to develop innovative, affordable, and mass-produceable solutions using advanced technologies. Here you can find printable solar cells, ultrasafe rechargeable batteries, wearable electronics, ultrafast information processing technologies, and smart windows that can regulate the room temperature, among a host of other innovations.

Clean Energy Demonstrations at the HKICE Office

HKICE aims to develop innovative clean energy-based technologies that can be expanded easily at scale through close collaborations with the government and private sectors to accelerate the deployment, market adoption, and equitable transition to a decarbonized energy system. The current demonstration at the HKICE office area involves the installation of semi-transparent solar cells and solar tiles for energy-generating road pavements. These items are integrated with a series of c-Si solar panels and a commercial energy storage and distribution system to provide real-time monitoring of energy generation and usage in the office. The idea is to demonstrate that building-integrated PV (BIPV) and solar walkway pavement systems can be used in a densely populated urban environment like Hong Kong to expand the utilization of clean energy. Innovative solar technologies can help turn everywhere as a power source, ranging from solar windows, solar walkway tiles, bendable solar roofs, and solar curtains, to glimmering glass façades of buildings, converting sunlight to energy.

Expanding Energy Footprints in China

A mega project, "A New-Generation of Efficient and Safe Energy Conversion and Storage System" funded by the Futian/Shenzhen government for RMB 50 million, will kick off in July, 2023 at the CityU Futian Research Institute. In this project, the HKICE researchers will demonstrate the feasibility of integrating energy generation and energy storage devices into one system for applications that can be deployed in a smart city like Shenzhen or Hong Kong to alleviate the need to transport electricity generated in remote solar or wind farms to cities thousands of miles away. This project will demonstrate how printable perovskite and organic solar cells can be installed on the façade of buildings to harvest solar energy by day and store the unused energy in ultra-safe rechargeable aqueous batteries for use at night. The research aims at translating scientific knowledge into real-life applications. Yet innovations do not come in days, but years. Prototypes are ready but more time is needed to scale up for industrialization and commercialization. HKICE will use this project as a pilot demonstration for commercializing clean energy-based technologies developed within the Institute, and fill a critical innovation gap on the path to achieving the goal of net zero emissions.

Professor Alex JEN
Director, Hong Kong Institute for Clean Energy
Lee Shau Kee Chair Professor of Materials Science

Strong Backing from Global Scholars for HKICE's Commitment to Clean Energy Development

"I appreciate HKICE's work to develop programs and projects that respond to the evolving energy needs and fortify the energy infrastructure. This work is important to ensuring our clean energy economy can also be safe, protected and reliable well into the future."

Professor Chihaya ADACHI
Kyushu University

"It is important to see clean energy technology be deployed in the world in a meaningful way. It is envisaged that HKICE to be set up to provide the necessary platform and infrastructure to bring these technologies to the community locally and internationally, which will also solidify HKICE as the provider of the clean energy solutions."

Professor Yang YANG
University of California, Los Angeles

"I believe, at this point in time, we, meaning the scientific community, are really looking for institutions that want to participate and help forge the sustainable future, a very important mission. HKICE offers the potential now for everyone to come together under one roof, and really work on these most challenging problems together."

Professor Tobin J. MARKS
Northwestern University

"It is my strong belief that, with its comprehensive intellectual focus, HKICE is ideally positioned, not only to develop and lead research opportunities of the highest quality, but also to train the next generation of professionals and research talents who would apply their skills in the clean energy area."

Professor Jean-Luc BREDAS
The University of Arizona

"I am excited with the establishment of HKICE that it will seek and engage collaborations across different research fields in the energy disciplines. I am sure it will incorporate existing research strengths and serve as the base for cooperation with international and regional organizations and associations for hosting high-profile conferences and seminars for clean energy breakthroughs."

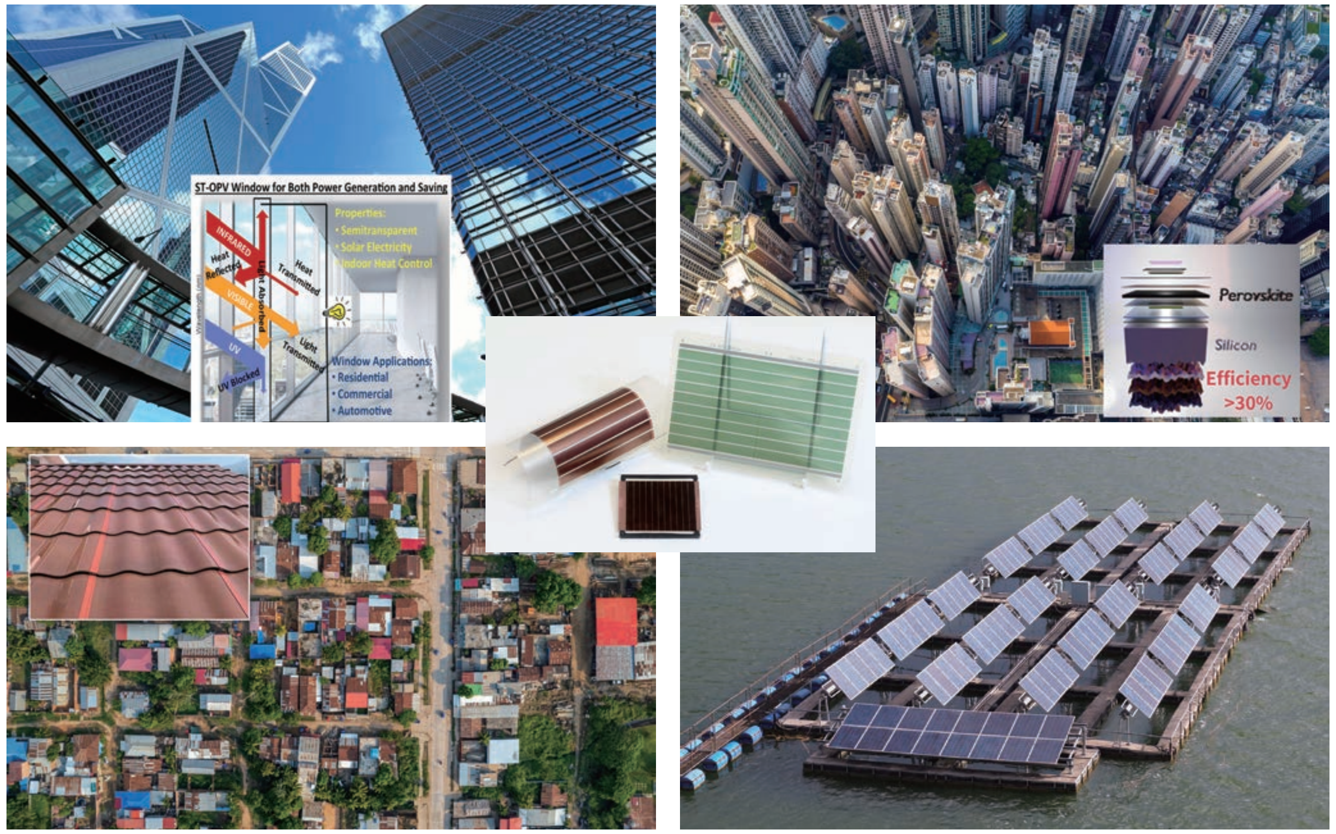
Professor Iain McCulloch
University of Oxford

"Around the world, a new energy transition is happening and these environmentally friendly alternative energy sources hold the key to combating the climate change. So I really support HKICE on its mission in promoting cutting-edge research, education, and technological development of clean energy."

Professor Henry J. SNAITH
FRS, University of Oxford

HKICE: Mapping a Sustainable Pathway Towards Net-zero

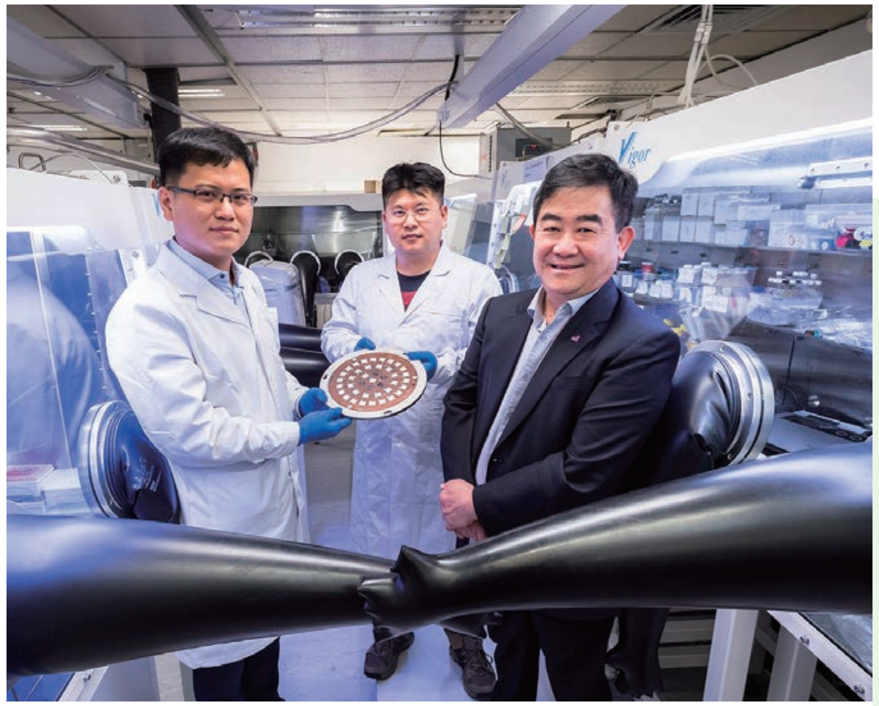
Energy Generation



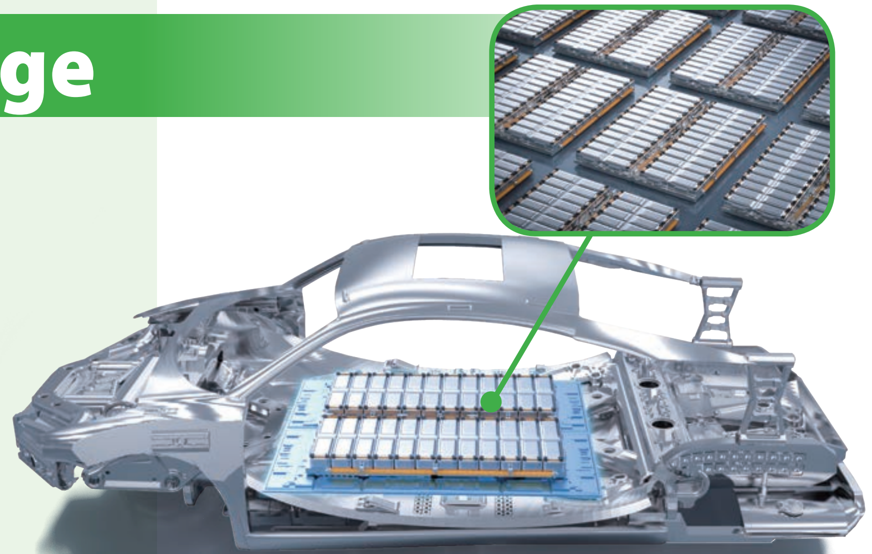
Urban solar farm with various types of PV panels used as building integrated photovoltaics (BiPVs)

Research for solar energy generation is one of the main focuses of HKICE, which is rapidly booming and is expected to lead the growth in global renewable capacity. Competing/complementing with Si and CdTe-based solar cells, the printable organic and perovskite solar cells are promising in providing high power conversion efficiencies and low energy costs than current PV technologies. Our research spans across fundamental and applied material and device investigations, including theory/simulation, new material explorations, smart device configurations, device upscaling, stability/environmental testing, etc. With different precursor/material formulations, solar cells could be printed in desired forms with colours and semi-transparency, allowing them to be widely used in Building-integrated PVs (BIPVs) for urban solar farm applications.

"Among different renewable energy options, 'solar energy' is the most abundant which plays a critical role in helping achieve the carbon neutrality target," said Prof. Alex JEN, Director and (Acting) Thrust Leader of Energy generation.



Energy Storage



Energy storage system (left) combined with renewable energy systems and battery pack for electric vehicle (right).

I. Advanced Batteries Technologies

Energy storage technologies are widely used, and different application scenarios have different requirements. The development of electric vehicles in recent years has remarkably promoted the development of high-energy lithium-ion batteries, large-capacity battery packs, and battery management systems. On the other hand, renewable energy (like solar and wind) is intermittent and need large-scale energy storage technologies to address the seasonal mismatch between variable renewable energy generation and consumption. For these systems, safety and low cost are primary concerns, which calls for new technologies, including aqueous batteries, solid-state batteries, etc. to meet these requirements precisely.

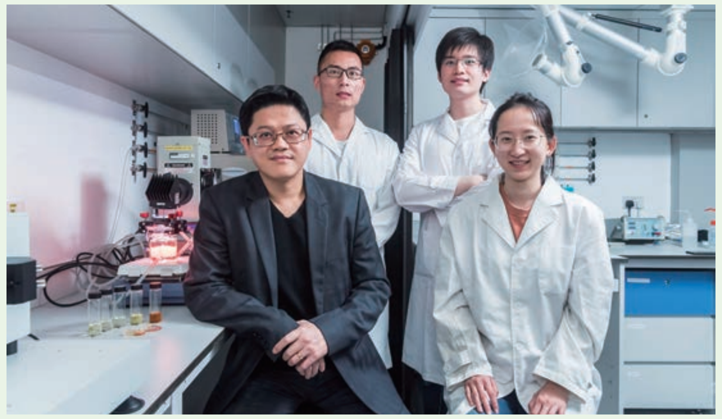
"... Previously, the most commonly used is pumped hydro energy storage, which has been bounded by many geographical restrictions. The industry has started to develop viable pathways toward large-scale energy storage; among them, electrochemical energy storage is one of the most convenient and reliable ways", said Prof. Chunyi ZHI, Thrust Leader of Energy Storage.

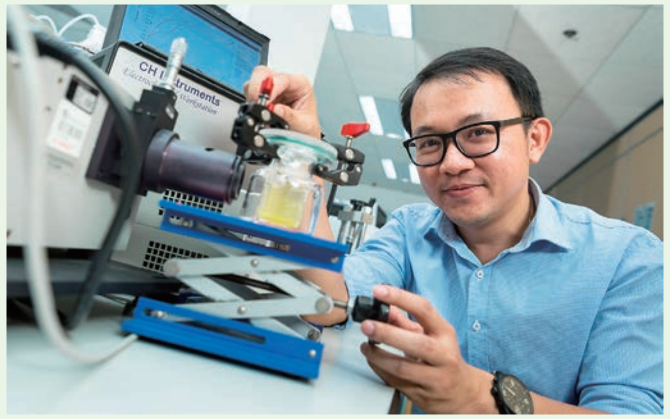
II. Hydrogen Generation and Energy Fuels

We also lead research on clean hydrogen production via photocatalytic and photoelectrochemical reactions with various photoactive semiconductors under visible light. Hydrogen generation from the photocatalytic splitting of water as well as the photocatalytic conversion of CO_2 into chemical fuels (e.g. methane and methanol) are two major examples of solar fuel production assisted by solar energy. These reactions have demonstrated the potential to simultaneously address the energy shortage and environmental issues by minimizing the usage of fossil fuels. Clean hydrogen fuel cells are promising technologies favoring long-life, high-use applications, and infrastructure development for fast and safe fueling of heavy-duty fuel cell trucks, rail, and marine vessels.

"...energy research community is examining various means on the energy supply-side to explore the feasibility of converting renewable energy into various forms of chemical energy carriers so that they can be used as fuel or industrial feedstock," said Prof. Yun Hau NG, Thrust Leader of Hydrogen Generation and Energy Fuels.

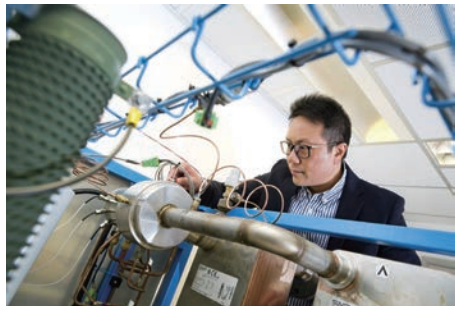
(Left) Prof. Sam HSU lead a team to unravel the interfacial interactions of the lead-free perovskite for efficient hydrogen production. (Right) Prof. Yun-hau NG and his team uses sunlight to split water into clean hydrogen to generate renewable energy and applies photo-electro-catalysis to enhance the conversion efficiency of solar energy.

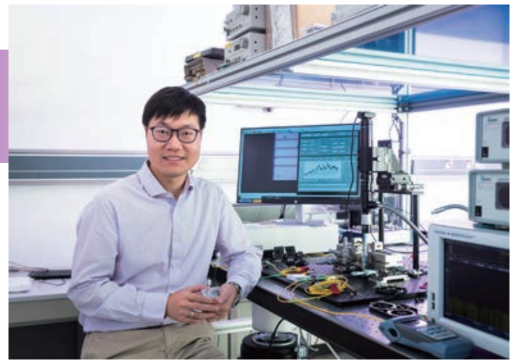


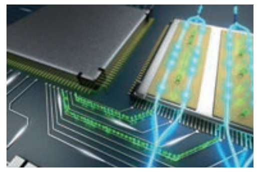


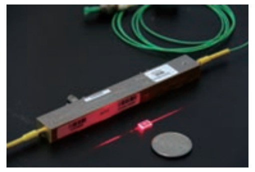
Energy Saving

The commitment to low-carbon emissions among countries and cities means they have set high-level goals not just in renewable power production, but more importantly, in daily electrical facilities with both high energy- and cost-efficiencies.









(Left) Prof. Michael LEUNG leads a team to turn waste heat from air-conditioner into electricity. (Right) Prof. Cheng WANG develops a high-performance photonic chips and energy efficient modulator for optical communications

Alongside the development of various renewable energy pathways for the power sector, large-scale master strategies of building sectors are indisputably important, as they account for 90% of electricity consumption in Hong Kong. As we step up efforts on green buildings with various energy-supporting and managing subsystems such as smart appliances, windows, sensor controls, integrated renewables, and local storage, thermal energy is one of the key global objectives in energy saving measures.

Lighting, IT Communications and PC severs are major electricity consumers that account for a total of 30% of the total energy consumption. HKICE strives for creating energy-efficient systems for both lighting and communications, mapping the renewable energy transition. There is no one-size-fits-all solution for energy saving. By adopting these technologies, we can make significant progress toward achieving sustainable development and a more energy-efficient future.

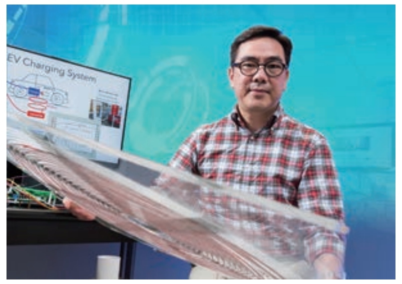
Energy Distribution

Renewable energy nowadays shares an important sector of >10% of global electric power systems, and is expected to grow continuously in the future. The high penetration of renewables directly affects the generation mix and the daily generation meeting demand, since this renewable energy supply continuously varies depending on weather conditions and causes a dynamic mismatch between supply and demand. Other conventional power must respond accordingly to maintain a stable and reliable power supply. Active loads which are power-electronics based also affect the stability of the power distribution system as these active loads reduce the system's damping significantly, leading to oscillations in a wide range of frequencies.

Grid flexibility is challenging as most existing grids were not built to accommodate intermittent renewables. New technologies integrating renewable and distributed energy sources, including solar and power storage systems, into the power distribution system require advanced technologies like grid-forming power converters and smart inverters for stable and resilient grid operations.

".... complex smart grids to be described in terms of cyber-multitudinal-physical systems (CMPS) which can effectively incorporate the effects of coupling of various types of (sub) systems, and hence offer a realistic model and platform for stability analysis, performance assessment and system design for ensuring an adequate level of resilience and robustness of our future power grids," said Prof. Michael TSE, Thrust Leader of Energy Distribution and Smart Grids

In view of the pressing need for maintaining the needed resilience, functionality, and efficiency of power grids, our globally leading, interdisciplinary HKICE team has initiated the study of the various problems of power electronics penetration into power grids and their implications on the stability and robustness of power networks. We specifically aim at bringing together two distinct perspectives, namely, bottom-up (local) and top-down (global) perspectives, and examine the current progress and future direction of research in power systems amidst the extensive deployment of power electronics.



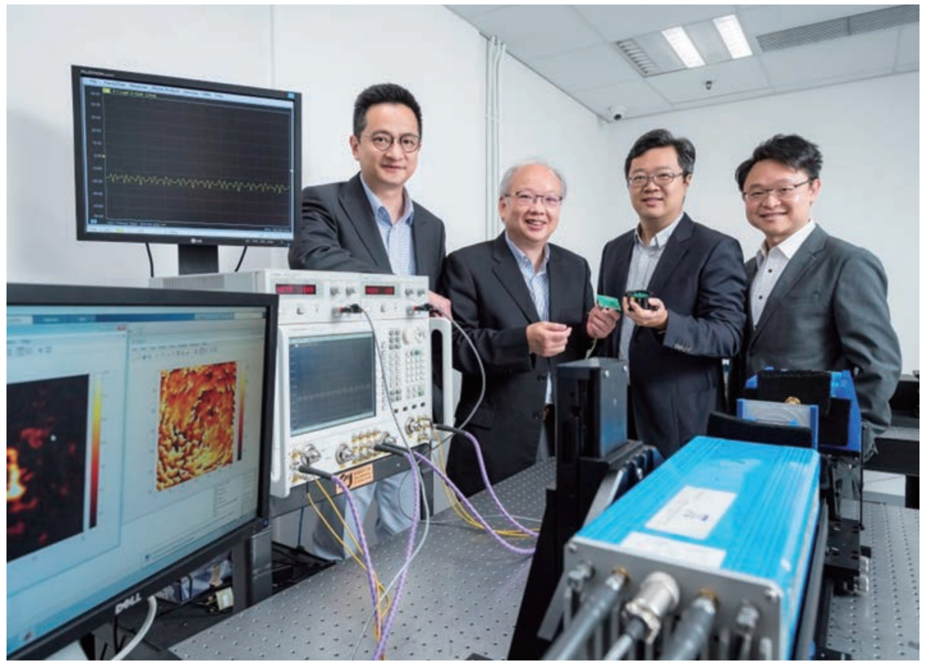
(Left) Professor Michael TSE leads a team to develop research on complex behaviour of power electronics and energy systems. (Right) Prof Henry CHUNG develops a new technology that could save at least 4.5% of energy in mobile networks

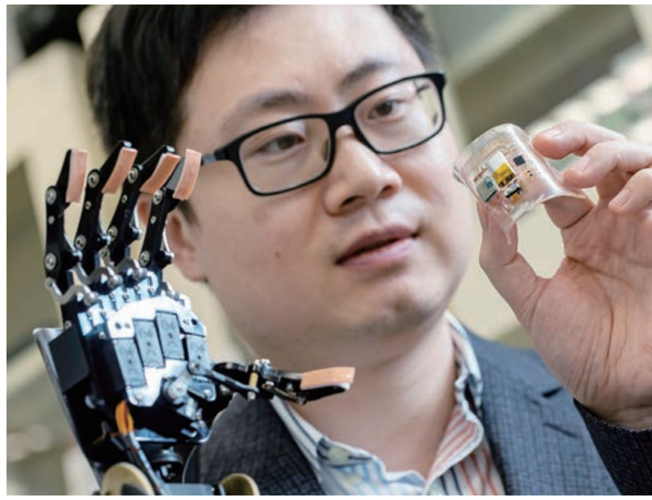
Smart City

Smart cities are the way of the future, and the HKICE is leading the way in developing innovative solutions for sustainable energy in smart city development. HKICE is driving progress in several critical areas, including the building sector, where it is leading the charge in developing cutting-edge technologies like building-integrated PV systems, smart lighting systems, and thermal energy storage and conversion.

HKICE is also exploring data-centric technologies, high-speed communications, healthcare systems, energy analysis, and smart water and waste management, all of which are vital in driving the evolution of the smart city.

With its multidisciplinary team of experts, HKICE's innovative research initiatives can transform smart cities' daily operations and living styles. Through its game-changing technologies, HKICE is paving the way for a more sustainable and efficient future for smart cities, making it an essential player in the development of smart cities worldwide.





(Left) Prof. Johnny HO and his team join hands to advance the development of terahertz (THz) technology for telecom applications. (Right) The flexible, multi-layered electronic skin developed by Prof. Xinge YU and his team is the cornerstone of the new Robotic VR system. The sensors on the robotic hands provide haptic feedback to the user.

Energy Analysis and Policy

Embracing the latest science and research, green power is currently the fastest-growing global energy source. With an ambitious goal of the net-zero target, the speed and the scale of its deployment will keep growing, driving the transformation of the energy markets. Along with this goal, it is essential not only to track the trend in the green power market, but also to evaluate the energy portfolio, and timely response to the ongoing load and demand in the overall energy landscape.

On the pathway to large-scale renewable energy deployment, there are many techno-economic challenges ahead – from grid flexibility, transmission, and the storage system at the national scale, to energy equity concerns and the global energy market design. More complex issues like resource access, environmental, market, and human behaviour, policy regulations, and incentives are multidisciplinary challengesthat would be the key research agenda for further studies. Meanwhile, an economic balance between technologies and cost-benefits for unexpected outages and seasonal mismatch is a decisive step on the pathway to the large-scale renewables transition.

All these challenges will vary as a function of increasing shares of the renewables in the power mix, and cannot be solved by any entity. There are no simple solutions on the pathway toward zero-emission goals. Cross-disciplinary interactions and continuous re-evaluation will help guide the electricity industry and increase our odds on decarbonization goals.

Directorates

Alex JEN, Director of HKICE, Acting Thrust Leader of Energy Generation, and Chair Professor at MSE, CHEM, SEE and MNE, has research scopes on Organic/Hybrid Functional Materials and Interface Engineering in Functional Devices for Photonics, Energy, Sensors, and Nanomedicine and Controlled Self-Assembly for Nanostructures

Hin-Lap Angus YIP, Associate Director of HKICE and Professor at MSE and SEE, has research scopes on the development of next-generation printable, flexible, and efficient solar cells, and LEDs for energy generation and conservation.

Wenjun ZHANG, Associate Director of HKICE and Chair Professor at MSE and CHEM, has research scopes on thin film technology, energy conversion and storage materials, nanoelectronic and optoelectronic devices, and surface and interface engineering

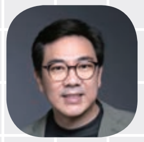
Thrust Leaders

Kwok Hi Michael LEUNG, Thrust Leader of Energy Saving and Chair Professor at SEE, has research scopes on solar photocatalysis, fuel-cell electrochemistry, hydrogen production, advanced refrigeration and air-conditioning, marine anti-fouling, and energy and carbon management.

Shu Hung Henry CHUNG, Thrust Leader of Smart City and Chair Professor at EE, has research scopes on smart grids, renewable energy conversion, machine intelligence for power electronics, energy-saving and environmentally-friendly solutions, and IoT-enabled power management systems.

Yun Hau NG, Thrust Leader of Hydrogen Generation and Energy Fuels and Professor at SEE, has research scopes on green hydrogen production, solar fuels, photocatalytic water splitting, and the photoreduction of CO_2.

Chunyi ZHI, Thrust Leader of Energy Storage and Chair Professor at MSE, has research scopes on aqueous batteries, solid-state batteries, and electrocatalysis.



Chi Kong Michael TSE, Thrust Leader of Energy Distribution and Smart Grids and Chair Professor at EE, has research scopes on power distribution, power conversion technologies, power electronics systems, and smart grids.

Members

Kyoung Jin Alicia AN, Associate Professor at SEE, has research scopes on seawater desalination using membrane technology, emerging technologies for wastewater treatment and resource recovery, membrane fabrication and characterization, and their applications for removing emerging pollutants

Yu CHAI, Assistant Professor at PHY, has research scopes on soft matter physics, polymer physics, self-assembly, soft and flexible electronics, scanning probe microscope, and In-situ characterization techniques.

Furong CHEN, Chair Professor at MSE, has research scopes on High space/ time-resolved 3D atom dynamics, aberration-corrected electron optics design and manufacture, energy-saving smart glass, and transparent display.

Guohua CHEN, Chair Professor at SEE, has research scopes on the advanced materials for Lithium-/Sodium- ion batteries, surface functionalization using chemical vapor deposition of polymers, and Lithium-Sulfur batteries for high-performance energy storage.

Yun CHI, Chair Professor at MSE and CHEM, has research scopes on the organic light-emitting diodes, true blue, near-infrared, and phosphorescent emitters.

Shuahrat Singh CHOPRA, Assistant Professor at SEE, has research scopes on life cycle assessment of emerging technologies, techno-economic analysis, carbon audit and management, and resilience of critical infrastructure networks.

Walid DAOUD, Professor at MNE and MSE, has research scopes on energy harvesting, self-powered electronics, and smart wearable technologies.

Liang DONG, Assistant Professor at SEE and PIA, has research scopes on applying socioeconomic and environmental modeling to assess sustainable technologies and policies.

Zhanxi FAN, Assistant Professor at CHEM, has research scopes on the controlled synthesis of novel low-dimensional metal-based nanomaterials and their potential applications in catalysis, clean energy, gas separation and storage, environmental remediation, etc.

Mandy Meng FANG, Assistant Professor at SLW, has research scopes on international economic law, energy law, environmental law, and Chinese renewable energy law and policy.

Shien-Ping Tony FENG, Professor at ADSE, has research scopes on low-grade heat-to-electricity conversion photovoltaic technology electrochemical nanofabrication.

Jr-Hau HE, Professor at MSE, has research scopes on memristor synapses for neuromorphic computing, solar fuels, 2D materials, energy- and light-harvesting nanomaterials for solar cells, photodetectors, LEDs, and electronics for harsh environments.

Chung Yin Johnny HO, Professor at MSE, has research scopes on nanomaterials and their hetero-nanostructures for energy-harvesting, electronic and optoelectronic devices.

Guo HONG, Associate Professor at MSE, has research scopes on the advanced materials for self-healing electrodes, multi-functional electrolytes and thermal management of aqueous batteries and flexible devices.

Hsien Yi Sam HSU, Associate Professor at SEE and MSE, has research scopes on interfacial dynamics, hybrid materials, and energy transformation applications.

Jinlian HU, Professor at BME and MSE, has research scopes on wearable materials for healthcare, nanogenerators for wearable electronics, smart polymers, fibres, and textiles for wearables, and sensors for traditional Chinese medicine.

Chaoqiang JIANG, Assistant Professor at EE, has research scopes on power electronics, electric vehicle technologies, machines and drives, and wireless power transfer.

Chun-Ho Jason LAM, Assistant Professor at SEE, has research scopes on recovering valuable resources from yard waste and e-waste using renewable energy-powered technology.

Denvid LAU, Associate Professor at ACE, has research scopes on functionalized construction materials that are necessary for the development of smart and sustainable cities.

Chun Sing LEE, Chair Professor at CHEM and MSE, has research scopes on organic electronics devices and nanomaterials for energy, environmental and biomedical applications.

Dangyuan LEI, Professor at MSE, has research scopes on radiative cooling, smart windows, energy-saving buildings, green electronics, solar photocatalysis for hydrogen production, plasmonic nanophotonics, solar cells, plasmonic biosensing, and meta-surface imaging.

Wanxin LI, Associate Professor at PIA and SEE, has research scopes on socio-technological and institutional innovations toward sustainability transitions.

Sze Ki Carol LIN, Associate Professor at SEE, has research scopes on production of bio-based chemicals, materials, polymers, and biofuels with a circular economy context.

Qi LIU, Associate Professor at PHY, has research scopes on the studies of cathodes, Li-ion/ Sodium-ion batteries, synchrotrons, scattering, phase transition, and battery safety.

Chunhua LIU, Associate Professor at SEE, has research scopes on electric motors and drives, electrified transportation (EV, aircraft, ship), electric propulsion systems, power electronics, renewable energy integration, and microgrids.

Bin LIU, Professor at MSE, has research scopes on electro-/photo-catalysis, in-situ/ operando characterization techniques, wastewater treatment, electrochemical devices, and surface chemistry.

Jingdong LUO, Associate Professor at CHEM, has research scopes on near-infrared molecular photonics and organic nonlinear optics.

Mohammad K. NAZEERUDDIN, Chair Professor at Swiss Federal Institute of Technology Lausanne (EPFL), has research scopes on the material design and development of metal complexes for dye-sensitized solar cells, charge-transporting materials for perovskites solar cells, and organic light-emitting diodes.

Ehsan NEKOUEI, Assistant Professor at EE, has research scopes on incentive design for energy markets, energy market analysis, market expansion and development, and policy design and assessment.

Chin PAN, Chair Professor at MNE, has research scopes on the ultra-high-performance counter flow diverging microchannel heat sink, the thin-liquid film evaporation heat sink, and the two-phase forced and natural circulation loop of seawater.

Yung Kang Will PENG, Assistant Professor at CHEM, has research scopes on the understanding of nanomaterial surface chemistry for the design of hetero(photo) catalysts.

Sai Kishore RAVI, Assistant Professor at SEE, has research scopes on solar fuels, artificial & semi-artificial photosynthesis, waste-to-energy, solar desalination, bio-photovoltaics, biogenic electronics, and functional nanofibers (air filters and e-textiles).

Andrey ROGACH, Chair Professor at MSE, has research scopes on nanomaterials synthesis and advanced optical spectroscopy single-atom photocatalysts for hydrogen generation, efficient perovskite LEDs, and infrared photodetectors.

Patrick SIT, Associate Professor at SEE, has research scopes on battery materials and processes, photovoltaic materials, and the catalysis for energy storage

Chaoliang TAN, Assistant Professor at CHEM, has research scopes on 2D materials, flexible energy storage devices; electronics, neuromorphic devices and nanomedicine.

Sai Wing Stephen TSANG, Associate Professor at MSE, has research scopes on advanced spectroscopy and in-situ characterization techniques for the investigation of charge transfer and crystallization processes in emerging photovoltaic materials.

Chi Yan Edwin TSO, Associate Professor at SEE, has research scopes on heat transfer & thermofluids, energy and built environment, daytime passive radiative cooling, thermochromic smart windows, nano-engineered surfaces for thermal science, and energy-efficient building technologies.

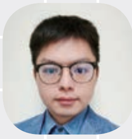
Feng WANG, Professor at MSE, has research scopes on nano-chemistry, optical materials and devices, energy conversion and transfer, luminescence imaging and spectroscopy, and flexible sensors and display.

Cheng WANG, Associate Professor at EE, has research scopes on the photonic integrated circuits, and energy-efficient optical interconnects for data centres.

Jian WANG, Assistant Professor at SEE, has research scopes on E-chem Energy, operando characterizations, water electrolysis, fuel cells, and fast-charging batteries.

Steven WANG, Associate Professor at MNE and SEE, has research scopes on atmospheric water harvesting, thermal energy recovery, low-energy building techniques, indoor air and ventilation, and interfaces and droplets.

Xue WANG, Assistant Professor at SEE, has research scopes on nanomaterials, electrocatalysis; CO_2 electroreduction; e-fuels synthesis, and reaction engineering



Ruquan YE, Associate Professor at CHEM, has research scopes on CO_2 reduction, electrochemistry, and water splitting.

Xinge YU, Associate Professor at BME, has research scopes on flexible electronics, skin-integrated haptic interface, bio-integrated electronics, and biomedical studies.

Xiaocheng ZENG, Chair Professor at MSE, has research scopes on lead-free perovskites solar cells, low-dimensional materials, nanocatalysis, and machine learning.

Kaili ZHANG, Professor at MNE, has research scopes on supercapacitors, lithium-ion batteries, energetic materials and devices, and energy-related studies.

Hua ZHANG, Chair Professor at CHEM, has research scopes on Phase engineering of nanomaterials (PENs).

Qichun ZHANG, Professor at CHEM and MSE, has research scopes on carbon-rich materials and their application in organic optoelectrical electronics and energy-related fields.

Lin ZHANG, Associate Professor at PIA and SEE, has research scopes on energy and sustainability economics, energy efficiency, and green business and sustainable finance.

Zijun ZHANG, Associate Professor at SDSC, has research scopes on interdisciplinary research which is dedicated to AI for power and energy engineering.

Zhedong ZHANG, Assistant Professor at PHY, has research scopes on quantum nonlinear spectroscopy, ultrafast light-matter interaction, and quantum thermodynamics.

Xiaoyan ZHONG, Associate Professor at MSE, has research scopes on Electron Microscopy of Functional Materials, Electron Magnetic Circular Dichroism

Zonglong ZHU, Associate Professor at CHEM and MSE, has research scopes on solar cells, hydrogen energy, and interface engineering.

Energy Generation

I. Solar Cells Technologies
- Novel Solar Power with Perovskite PVs and Organic (-Inorganic Hybrid) PVs
- Multi-junction, Flexible, and Semi-transparent PVs
- Solar Device Upscaling
- Solar Modules Development and Reliability Assessments
- Comprehensive Stability Assessments
- Building Integrated PVs
- Agrivoltaic Technologies

II. Other Clean Energy Generation
- Tidal Wave Energy
- Thermoelectricity
- Green Nuclear

Energy Storage

I. Advanced Batteries Technologies
- High-energy Ion-based Batteries
- Aqueous Electrolyte Batteries for Large-scale Energy Storage
- Supercapacitors and Hybrid Capacitors
- Battery Safety and Reliability

II. Hydrogen Generation and Energy Fuels
- Hydrogen Generation and Fuel Cells
- Solutions for Fuel Cell Electric Vehicles and Grid Cells
- Biorefinery Technologies
- Smart CO_2 Utilization and Conversion

Energy Saving

I. Heat Treatment
- Thermoelectric and Thermal Management
- Energy Saving and Environmental-friendly Solutions

II. Electronics Devices for Power Management
- Power-saving Optoelectronic Devices and Sensors
- Fast and Low-powered Network Communication

Energy Distribution

Grid Technologies and Power Electronics
- Renewables Integration and Microgrid Technologies
- Multi-energy Systems and Grids
- Machine Intelligence for Power Electronics

Smart City

I. Smart Electronics and System Integration
- IoT-enabled Power Management Systems
- Wearable Electronics and/ or Bioelectronics for Healthcare

II. Green Urban Infrastructure
- Transportation Electrification
- Smart and Sustainable Green Buildings
- New Communication Technologies
- Solar Seawater Desalination

III. Waste Treatment
- Wastewater Reuse and Resource Recovery
- CO_2 Reduction
- Energy and Carbon Management

Energy Analysis and Policy

I. Energy Assessment and Analysis
- Trend Assessment on Energy Portfolio, Technology, Industry, and Policy
- Techno-Economic Analysis
- Socio-technological Assessment

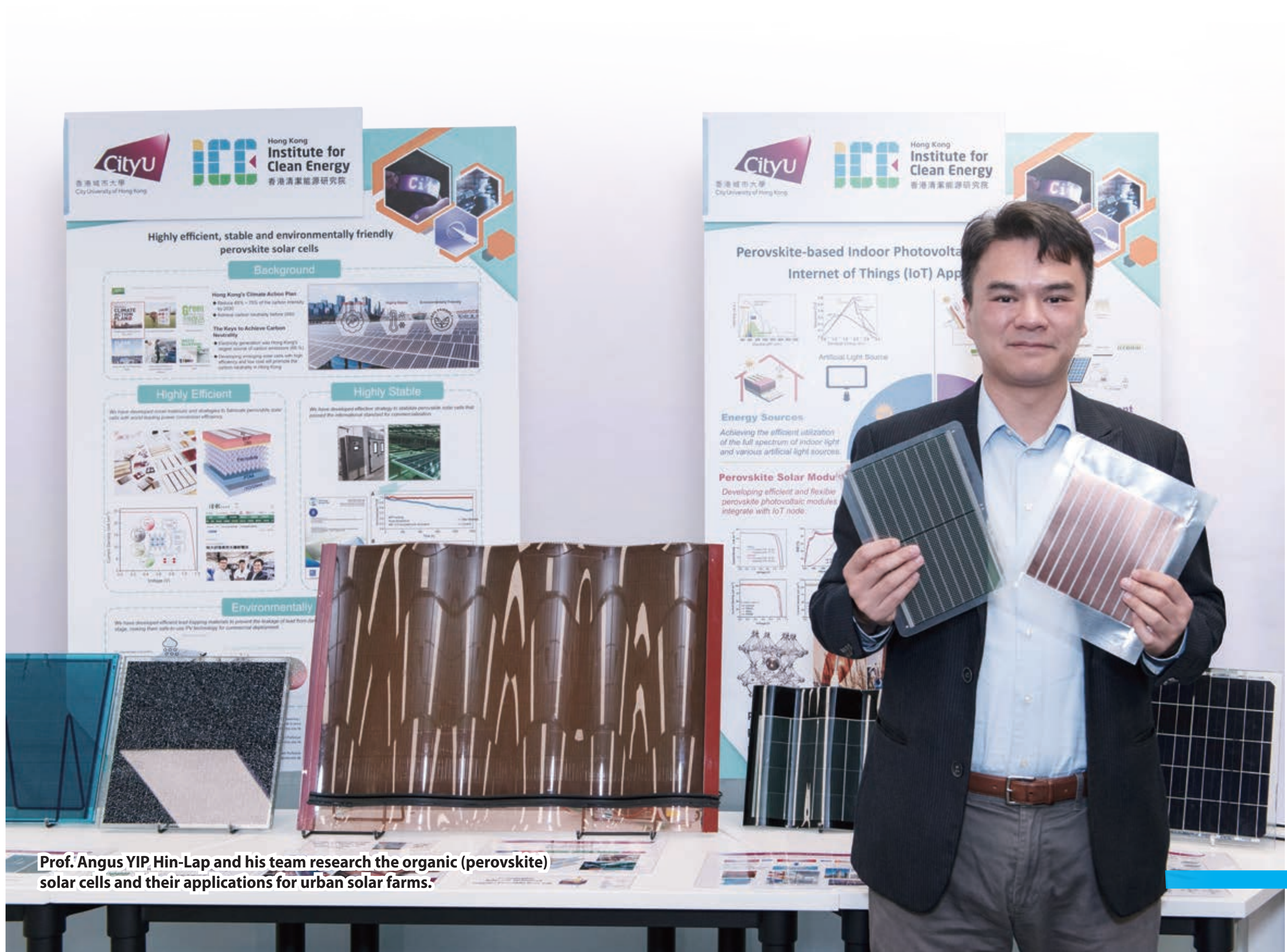
II. Policy Strategies on Clean Energy Development
- Trend Assessment on Energy Technology, Industry, and Policy
- Environmental and Social Impact Evaluation
- Sustainability Analysis in Energy
- Energy Technology Policy Strategies

Next-Generation Printable Solar Cells - A Solution for Urban Solar Farms

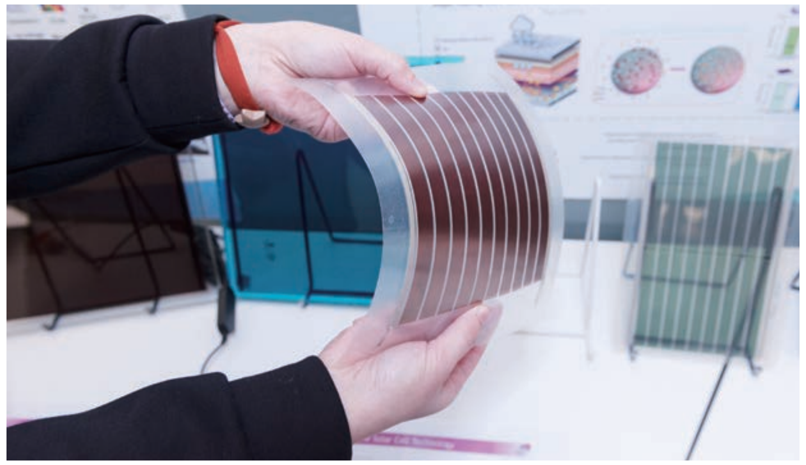
Imagine there are plants that can merge with the exterior walls of buildings, and the chlorophyll of these plants can convert sunlight into electricity for apartments or offices. They can also stick onto EVs to power vehicles or integrate with the fabrics of clothes and bags to charge your cell phones. And these plants can be easily and inexpensively reproduced by rapid printing, just like printing newspapers.

Sounds like science fiction? Plants have inspired Prof. Angus YIP, Associate Director of HKICE, and his team to develop a new generation of printable solar cells that has attracted great attention in developing next-generation photovoltaics. The Hong Kong government has announced goals to achieve carbon neutrality by 2050. Fossil fuel is set to be replaced by renewable energy, of which solar energy will be a major source utilizing Hong Kong's abundant sunlight. Yet solar energy generated by conventional silicon solar panels has a few limitations: The bulky panels need much space and can be installed mainly on the rooftop. As Hong Kong's buildings have a small footprint on rooftops, they cannot generate enough electricity to meet the energy demand.

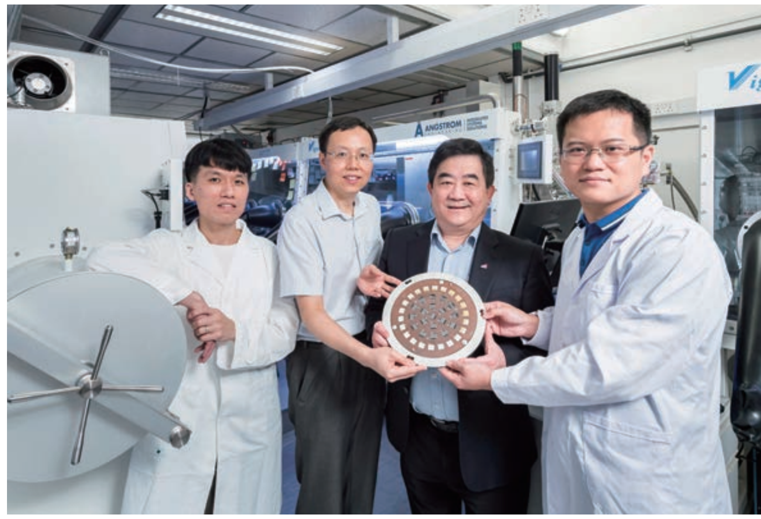
On the other hand, the city's 50,000 high-rise buildings offer a huge surface area of façade to get sunlight. Obviously, silicon solar panels are not ideal to be fitted onto the façade due to their heavy weight and brittleness, which tends to crack when the building vibrates, such as under strong winds. They are far from aesthetic, either. While silicon solar panels do not produce emissions when generating electricity, their manufacture requires significant amounts of fossil fuel energy. This is because the extraction of silicon from sand needs to go through an energy-intensive process using very high temperatures, after which they need to go through numerous processes to produce solar panels.



Prof. Angus YIP Hin-Lap and his team research the organic (perovskite) solar cells and their applications for urban solar farms.



Low-cost, printable and transparent solar cells that flexible for applications such as the solar curtains



Organic Semiconductor-based Solar Cells at the Forefront of Technology

This is where the idea of plants comes in. "Plants contain chlorophyll for photosynthesis to convert sunlight into energy," explains Prof. YIP. "We have created organic semiconductor inks, analogous to chlorophyll, that can be incorporated into solar cells to absorb sunlight to generate electricity." This third-generation photovoltaics technology is based on printable technology. Simply put, these printable solar cells can be mass-produced like printing newspapers, at a very low cost. The inks can be printed on a film which is bendable, rollable, transparent, and lightweight. It can be taped on the window or the façade of the building. Alternatively, it can be made into solar roofs, windows, curtains, tiles, greenhouses, walls, bricks, and wood decks to harvest energy from the sun to generate electricity for buildings, vehicles, and remote villages. This will open up a huge market known as Building Integrated Photovoltaics (BIPV), blending photovoltaic materials into buildings such as the roof, windows, and façade to power the building with clean solar energy.

Achieving World-record Efficiency

This ground-breaking technology lies in the development of efficient organic semiconductor inks. These materials are a class of specially designed semiconducting polymers and molecules with properties tailored to offer an array of colours and transparencies for, say, a red solar roof. The challenge is to design the right combination of materials with the best light absorption and electrical properties. "Efficiency is the key," he says. "We need to design the inks so that they can harvest both visible light and a portion of infrared light efficiently to generate more electricity." He is proud to introduce that the organic solar cells jointly developed with Prof. Alex Jen's team have been chosen to list on the US National Renewable Energy Laboratory (NREL) Champion Photovoltaic Efficiency Chart, which records the highest confirmed conversion efficiencies for champion solar cells of various photovoltaic technologies. The result has also been published in the prestigious journal, Nature Energy recently. This strongly testifies CityU's exciting development in the frontier OPV technology.

Ionic Semiconductor-based Perovskite Solar Cells to Compete with Silicon Solar Panels

"We are also developing a new class of perovskite semiconductors to maximize the light absorption and electrical properties in order to further improve the efficiency of solar cells," adds Prof. YIP. These new materials currently hold the highest potential for emerging PV development. Exciting results with very high efficiencies (>25%) and excellent stability have been produced together with Prof. Zonglong Zhu and Prof. Alex Jen, and published in several frontier journals like Science, Nature Energy, and Nature Photonics. These encouraging results have attracted global attention from the scientific community and technology investors. It also testifies to the excellent strength of the CityU group in developing high-performance, printable solar cells for commercialization. Like the organic semiconductor inks, the compositions of the perovskites can be easily tuned to maximize their overall properties. Perovskite solar cells can also be produced by simple printing or evaporation processes under low temperatures to achieve high efficiencies similar to those generated from silicon solar cells. Furthermore, they can also be integrated with Si PV to achieve unprecedentedly high efficiencies (>33%) to further lower the operation cost for scalable clean energy. By combining these vigorous developments in OPV and perovskite PV, CityU's R&D development in printable solar cells makes headway toward achieving low-cost, scalable solar energy to build a sustainable environment.

Prof. JEN's research can be found:
https://www.jengroup.info/

Prof. YIP's research can be found:
https://www.yipgroup.info/research

Prof. ZHU's research can be found:
https://zhugroupcityu.wixsite.com/zhugroup

Unveiling Innovative Solutions for the Future of Power Storage Technologies in Electric Vehicles and Large-Scale Systems

Researchers at HKICE are tackling the challenges presented by the rising demand for energy storage technologies, particularly as electric vehicles (EVs) gain popularity. This technology requires high-energy, high-power storage solutions that can withstand harsh chemical, thermal, and mechanical conditions over thousands of charge and discharge cycles. To this end, HKICE is collaborating with industry partners to develop innovative materials and processes for a range of batteries that can power the energy-efficient vehicles of the future.

Extending the Life of Lithium-ion Batteries and Creating the Next-generation Energy Storage Devices - Lithium-sulphur Batteries

Stability is of utmost importance in secondary batteries, especially those lithium-ion batteries for EVs in which batteries need to last for about ten years. Special cathode materials are needed for these batteries. Conventional cathode materials are LFP ($LiFePO_4$) and NCM/ NCA oxides (nickel, cobalt, manganese/ nickel, cobalt, aluminum).

Prof. Guohua CHEN, Chair Professor and Dean at the School of Energy and Environment, City University of Hong Kong, is doing world-leading research to modify cathode materials using chemical vapor deposition (CVD). By coating electrode particles with a 10-20 nm thin layer of conductive polymer, the battery can last 2 to 3 times longer than conventional batteries.

Such a coating can also lead to high safety because the coated particles can withstand higher temperatures without undergoing phase changes, and will not release oxygen, thereby minimizing the risk of fire, which is especially important for EVs.

CVD is a green process in which the coating is done by a vapour that generates no waste water or liquid. The unreacted vapour can be recycled and reused.

On top of that, Prof. CHEN and his research team are creating the next generation of energy storage devices using sulphur instead of cobalt and nickel in the cathode.

Low-cost sulphur can significantly bring down the cost of the battery. Lithium-sulphur batteries have also a very high energy density. The theoretical capacity of the energy density can be up to 4 times higher than NCM. Currently, the team can achieve 300 to 400 Wh/kg, which is about twice of LFP batteries, which generally deliver the 150 to 200 Wh/kg. "For the same amount of energy, we only need half of the mass, which means lighter batteries," Prof. CHEN explains.

He has a pilot plant in Shenzhen with industrial-scale facilities to produce lithium-sulphur battery pouch cells. In two years' time, the prototype will be available for industries such as robotics. "Apart from low cost, its light weight allows it to be conveniently moved around, and its high energy density means the equipment does not need to recharge frequently," he says. Research is being done with the long-term goal of applying lithium-sulphur batteries in EVs or grid energy storage.

Prof. CHEN's research can be found:
https://www.cityu.edu.hk/see/people/prof-guohua-chen

Ultra-safe Rechargeable Aqueous Zinc-based Batteries for Large-scale Energy Storage

While clean energy reduces carbon emissions, its supply is less stable than that of fossil fuel. For example, solar energy produced during the day needs to be stored for use at night. Thus, renewable energy systems need to work side by side with energy storage systems.

Energy storage is an emerging market. Traditionally, energy is stored by pumped storage hydropower, where water is pumped uphill with the electricity generated by releasing water downhill, flowing through turbines when power is needed. The constraint of this method is the need for water reservoirs. Batteries, on the other hand, are more versatile and can be placed anywhere.

"Ten years ago, there was almost no battery-based large-scale energy storage," says Prof. Chunyi ZHI, Chair Professor and Associate Dean (Research), at the College of Engineering, City University of Hong Kong. "As battery technology matured, it currently accounts for 10% of the large-scale energy storage system market." While current lithium-ion batteries are dominating this market, their safety problems are gradually exposed, in particular when large-scale systems are developed.

Aqueous batteries have great potential in this market with their superior safety performances. The first generation of aqueous electrolyte-based batteries is lead acid batteries using sulfuric acid as an electrolyte. It has low energy density, low energy efficiency, poor stability, and limited applications.

To overcome these shortcomings, a new generation of aqueous electrolyte-based battery using a zinc-based anode has been developed by Prof. ZHI and his team.

"The challenge is that the zinc metal anode is unstable, but we have developed new electrolytes to eliminate the side reactions and stabilize it," he explains. "We made zinc batteries rechargeable, thus we can now call it a stable zinc-based rechargeable aqueous battery."

The water solution is used as the electrolyte in which the anode and cathode are submerged. It is low-cost, has high energy density, and most important of all, is extremely safe. "The Zn anode is not as reactive as lithium and it is immersed in water, which can guarantee ultimate safety with no worry about fire or explosion," he stresses.

Small batteries have been produced in the lab and although more research is needed to produce the same stability and high performance in large-scale batteries, the potential is great. With its ultra-safeness and high rate capability, it can be used for uninterrupted power supply (UPS) for data centers and household or community energy storage systems, where safety is a priority.

Prof. ZHI's research can be found:
http://www.comfortablenergy.net/

Greening the Future of Energy Storage: Cobalt-Free Cathode Breakthrough for Electric Vehicles

As the demand for energy storage technologies continues to rise, the challenges extend beyond developing solutions with improved energy density and longevity. With society's increasing awareness of sustainable development and the booming demand for electric mobility, a new energy transition is underway. Considering the alternative, non-critical raw materials to sustain this industry is crucial, given the limited availability of many of the Earth's resources.

To enhance sustainability and reduce reliance on critical materials, Prof. Qi LIU, Associate Professor at the Department of Physics, City University of Hong Kong, has achieved an exciting breakthrough by creating a lithium-ion battery cathode that does not require cobalt, a material critical to the cathode's composition.

Cobalt (Co) is essential in lithium-ion batteries in electronic devices such as cell phones and electric vehicles. Yet cobalt is the most expensive material in lithium-ion batteries. Using cobalt-free cathodes can drastically reduce the cost of batteries, thus lowering the price of electric vehicles, driving up sales, and encouraging the use of green cars.

However, in the course of developing cobalt-free cathode materials, scientists face a huge problem: voltage decay. Over the past decade, thousands of scientists all over the world have been trying to solve this problem, spending millions of dollars using different methods.

"We are pleased to solve this long-standing problem in our newly developed Co-free cathode, which is also lithium-rich and Manganese-rich," says Prof. LIU.

This lithium-rich Co-free manganese-rich cathode is one of the most promising cathode materials featuring advantages such as high energy density, very low cost, and high safety.

Prof. LIU reveals that the cathode has been patented, and the scientific paper is expected to be published soon. He hopes it can be used in EV batteries and looks forward to new products coming out in three to five years.

Prof. LIU's research can be found:
https://www.qiliugroup.com/

Green Hydrogen: The Key to a Sustainable Energy Future?

Did you know that Hong Kong and Singapore are the only cities in the world that use hydrogen in their gas distribution utilities? In Hong Kong, hydrogen accounts for a significant portion (>40%) of the utility gas supply. While hydrogen is a clean-burning fuel that only produces water and energy, its production is currently dependent on fossil fuels - which is far from green.

Researchers from HKICE are working on new methods to produce "green" hydrogen, which is generated using water instead of fossil fuels. This would eliminate the carbon emissions associated with traditional hydrogen production methods. With the development of these sustainable technologies, it's possible that green hydrogen could become a major player in the transition to a low-carbon future.

Photocatalytic Hydrogen Production

Prof. Yun-Hau NG, Professor at the School of Energy and Environment, City University of Hong Kong, is producing green hydrogen using photocatalytic technology.

Photocatalytic technology makes use of photocatalyst materials immersed in water. Light brings about photoexcitation on these materials, forming photocharges which are electrons and holes. Electrons go to the water to generate hydrogen while the holes go to the water to produce oxygen.

Hong Kong is no stranger to this technology with indoor purifiers especially during the pandemic. "These holes can oxidize many organic substances including bacteria," explains Prof. Ng. "With the UV light in the air purifier, the holes can oxide the skin cells of bacteria, bursting and killing them."

Pioneer in Photocatalyst Materials

The key to generating hydrogen by photocatalytic technology lies in the design of the photocatalyst material, of which Prof. NG is a pioneer. His team is working on a number of materials and a promising one is bismuth vanadate.

According to Prof. NG, the photocatalyst material must be able to absorb as much light as possible. It also has to absorb sunlight which contains UV light and a broad spectrum, instead of only UV light in traditional devices. That is why bismuth vanadate is greenish in colour, meaning that it absorbs visible light, as opposed to the white photocatalysts that only absorb UV light and reflect all the visible light.

In addition, the photocatalyst has to be very capable of using the holes to generate more hydrogen. "We want electrons to generate hydrogen and the holes to generate oxygen. If the electrons and holes recombine, no reaction will take place," he explains. "Using the holes is the bottleneck of the reaction and bismuth vanadate is efficient at it."

Prof. NG is building larger-scale production units for demonstration and is working with private companies and various government agencies including the Electrical and Mechanical Services Department and Environmental Protection Department.

Prof. NG's research can be found:
https://www.carenergy-lab.com/

Hydrogen Production via Electrolysis in a Carbon-neutral Energy System

A carbon-neutral energy system that produces green hydrogen by electrolysis is presented by Prof. Bin LIU, Professor at the Department of Materials Science and Engineering, City University of Hong Kong.

Fully sustainable, the system uses rainwater which goes into a water electrolyzer powered by solar panels and wind turbines. The hydrogen produced will be stored in pressurized gas tanks and converted into electricity by fuel cells.

"As solar and wind energy are not stable, a storage system is needed," explains Prof. LIU. "For example, during the daytime, the hydrogen produced using solar energy can be stored and used at night to ensure stable electricity output for 24 hours."

He believes that this energy system is particularly suitable for Singapore, where solar panels are installed on rooftops but are not connected to the national grid system due to energy generation peaking at noon but dropping to zero at night which will cause big fluctuations to the national grid system.

To stabilize the electricity supply, he proposes connecting the national grid system to the carbon-neutral energy system in which some of the solar energy generated during peak hours can be used to produce hydrogen and stored for night use.

The system can also be used for electric vehicles (EVs), transforming petrol stations into hydrogen gas stations that conveniently produce hydrogen on-site.

Developing a Catalyst with Stability as Priority

The key to the system is the catalyst, which contains noble metals such as platinum and iridium. Prof. LIU and his team are trying to reduce the use of these expensive catalysts and replace them with cheaper materials such as transition metals. By lowering production costs, hydrogen can compete with and ultimately replace fossil fuel.

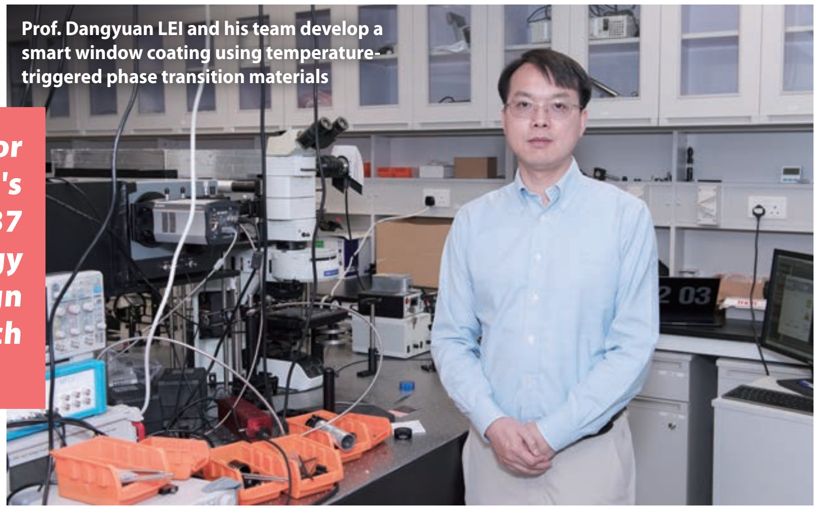
As yet no promising catalyst can completely replace noble metals and the team is developing new catalysts to which stability is crucial. Prof. LIU describes it as an activity-stability issue: "An active but unstable catalyst is useless; we are looking for an active and at the same time stable catalyst."

For Prof. LIU, developments are good so far. The team has set up a company in China and is supplying water electrolysers using their own catalysts. They are improving the technology to make it more mature in terms of performance, activity, and stability. He adds that the fruits of his research are expected to be available in the market in a few years' time.

Prof. LIU's research can be found:
https://scholar.google.com.sg/citations?user=F4EkvTUAAAAJ&hl=zh-CN

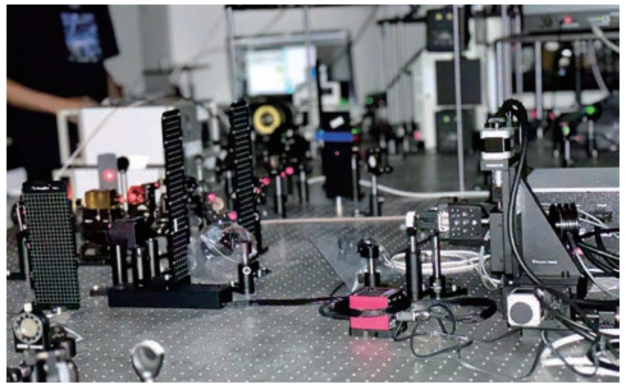
Towards a Greener Future: Transforming Hong Kong Buildings with Smart Windows and Electricity-free Cooling Paint

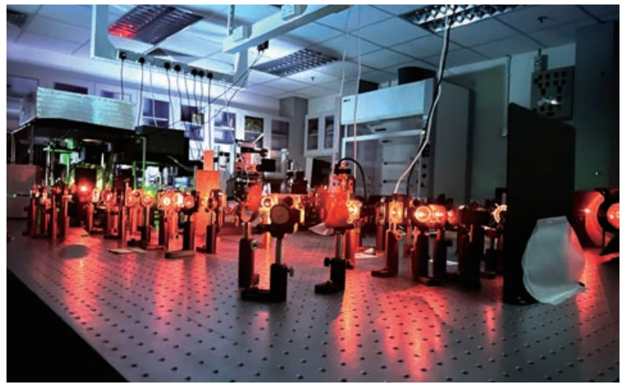
Smart windows are a game-changing solution for regulating indoor temperatures in Hong Kong's commercial buildings. Applied in Boeing 787 Dreamliner aircraft, this cutting-edge technology can revolutionize the future of building design through a simple and low-cost green approach cutting energy consumption and costs.


Prof. Dangyuan LEI and his team develop a smart window coating using temperature-triggered phase transition materials

Hong Kong's commercial buildings, of over 50,000, are known for their high window-to-wall ratio, with some buildings like the IFC boasting a nearly 100% ratio. In summer, these traditional windows allow excessive sunlight to enter the buildings, causing indoor temperatures to rise and resulting in air conditioning for > 20% of energy consumption. Conversely, in winter, approximately 50% of the heat is lost from the building, causing energy bills to soar.

Smart windows offer a cutting-edge solution to tackle the problem in commercial buildings! These windows can manage indoor temperatures and lower the building's carbon footprint by regulating the heat and light passing through the building. In summer, it





can block the near-infrared light and maximize mid-infrared radiation to cool the room while providing ample natural light. When winter rolls around, the same smart window technology can be used to warm up your space with ease. The smart windows will be a simple and efficient way out of oppressive summer heat and skyrocketing energy bills.

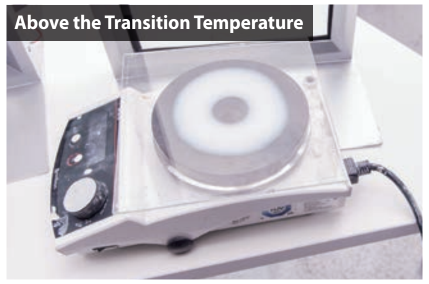
Smart Coatings using Temperature-triggered Phase Transition Materials

Prof. Dangyuan LEI, Professor at the Department of Materials Science and Engineering, City University of Hong Kong, is working with his research team in optical physics and photonic engineering to present a smart radiative cooling coating for windows for building applications. This award-winning coating uses temperature-triggered phase transition materials that have distinctively different optical properties at high temperatures and low temperatures.

His team is one of the pioneers to combine these advanced materials with passive radiative cooling technology. Passive radiative cooling is a sustainable technology that dissipates heat into outer space without using power or ozone-depleting refrigerants. As outer space is -270 °C while the earth is 20 °C, objects can passively achieve a cooling effect by emitting their bodily heat via the earth's transparent atmosphere within the mid-infrared spectral region. An example is the appearance of frost in Tai Mo Shan even when the air temperature is above 0 °C.

Fluorescent materials in soft pastel colours are added for aesthetics. With their high fluorescent efficiency, fluorescent materials emit visible light under sunlight so that we can see colours.

The result is UmiCool, an eco-friendly, long-lasting, self-cleaning, low-cost polymeric radiative cooling coating. It can reduce the indoor temperature of buildings by 6 °C



The materials' transition temperature can be customized in the range of 15 – 50 DegC

Prof. Edwin TSO and his team develop a reversible smart window with Near-Infrared-Activated Thermochromic Perovskite.

compared with the ambient temperature under direct sunlight yet without electricity consumption. UmiCool can scatter sunlight, convert absorbed UV light to fluorescence emissions and emit infrared radiation to the cold universe.

In Hong Kong, UmiCool has covered an area of 5162 m^2 including the Electrical and Mechanical Services Department's Tung Chung airport area, the Civil Engineering and Development Department's Mui Wo site, Lee Kee Group's Tai Po site, and Kaisa Group's Sai Ying Pun site.

"We selected low-cost and robust materials that can withstand extreme weather conditions for affordability and durability," says Prof. LEI. He reveals that a new material is underway that can change colour through passive radiative cooling. In winter the colour will darken to absorb more light and brightens in summer to reflect more light.

Further information on UmiCool can be found at https://umicool.hk

Passive Radiative Cooling Paint and Thermochromic Perovskite Smart Windows

Prof. Edwin TSO, Associate Professor at the School of Energy and Environment, City University of Hong Kong, is working on passive radiative cooling paint, named iPaint, a high-performance eco-friendly paint that features an edge in solar reflection and thermal emissions, resulting in a significant sub-ambient cooling effect. With a reflectivity of over 95%, this award-winning film coating can reflect most of the solar heat, and with an emissivity of over 95%, it can efficiently emit thermal energy as mid-infrared to the universe.

Offering white or a fixed colour, iPaint does not use temperature-triggered phase transition materials, but instead utilizes materials that can achieve very high solar reflectivity and emissivity for passive radiative purposes.

iPaint has an array of coating applications including EV windows, buildings, textiles and clothing, chemical storage, power equipment and smart temperature control. With distributors in Hong Kong, China, Canada, USA, the Philippines and Thailand, it generates a monthly revenue of HKD1 million at the current stage.

As for cars, collaborations with EV manufacturers are underway and are expected to launch in the market next year. Test results show that the iPaint coating and thermochromic perovskite smart window can reduce electricity consumption for air conditioning which in turn increases the mileage by 15 to 20%.

Besides the iPaint, Prof. TSO also researches thermochromic perovskite smart windows. The perovskite smart windows can transfer from a highly transparent phase (luminance transmittance = 85%) at room temperature to a light absorption phase (luminance transmittance = 30%) at high temperature, demonstrating a remarkable solar modulation ability (24%).

"For coating windows, VO_2 (vanadium dioxide) can trigger the near-infrared range but its colour is an unattractive yellowish-brown with a transmittance regulation of less than 10%. Later we worked on hydrogel which has a high transmission regulation of around 25% but as a gel, it increases the weight of the window," explains Prof. TSO.

He and his team are the first to apply thermochromic perovskites in smart windows applications. These materials have the same high transmittance regulation performance of 20-30% with a temperature that is ideal for windows at 30-40°C. They can be made into a thin, flexible film coating that can easily paste or attached to existing windows to turn them into smart windows.

But perovskites have a major drawback – it is unstable. "Our team is the first in the world to solve this issue by developing a multi-layer coating technology to protect the perovskite materials from water vapour to prevent getting damaged by chemical reaction with water," he says. This is especially important in Hong Kong where the weather is very humid.

Further information on iPaint can be found at https://i2cool.com/

Wearable Electronics to Bring an Entirely New Idea of Healthcare

Innovations require a vision. For Prof. Xinge YU, Associate Professor at HKICE and the Department of Biomedical Engineering at City University of Hong Kong, his vision is to build a brand new healthcare system that is preventative, always a step ahead of us instead of us going to the hospital when we feel unwell.

This new healthcare system can eliminate the over-reliance on the hospital system, thereby eliminating long queues and long waits in the hospital. It can also reduce the number of invasive test procedures and over-dependence on doctors, thus saving time and money.

His solution is in "soft electronics" – electronic devices that are wearable, flexible, soft and comfortable. These next-generation wearable devices, known as "skin electronics", adhere seamlessly to the skin which will make smart watches look big and bulky. "It will not bring additional burden and it is so comfortable that you do not feel that you are wearing them," says Prof. YU.

These devices can conveniently perform a myriad of functions such as real time health monitoring including blood pressure, blood oxygen level, body temperature, pulse rate, ECG signals, ultraviolet exposure, biomarkers from sweat such as sweat pH, glucose, sodium content, and other clinical and physiological signals.

As these devices are so close to the skin, they can give very accurate measurements. Furthermore, combined with machine learning and new algorithms, these wearable devices can even predict the possibility of developing certain diseases. In addition, with skin habitat interface, it can give a warning signal before a possible heart attack in the form of a vibration or the feeling of someone touching you.

Biocompatible Power as a New Source of Clean Energy

Without bulky chips and batteries, these devices are wireless and powered by clean energy. Prof. YU points out three ways to self-power the device: wearable solar cells, mechanical energy from the wearer's movements, and from the wearer's sweat. These three methods can be combined to offer sustainable energy sources at a very low cost.

Wearable sweat activated batteries and sweat sensors


Skin-integrated device for teleoperated robots

"We are developing biocompatible powering systems," he explains. "One way is to convert mechanical energy from body motions into power which can achieve over 100 W, strong enough to light LEDs."

Biofluids, such as sweat, can also be a power source. Prof. YU's team is developing "sweat-activated batteries" that can convert sweat into energy. "A little known fact is that we produce 500ml to 2 L of sweat per day," he says. "Sweat activated battery is like a bandage on your skin that can power the electronic device for 5 to 8 hours."

Skin VR Gives a Sensation of Touch

Prof. YU, together with his research team, is also a pioneer in "Skin VR" or "Touch VR", an advanced virtual reality experience that offers the sensation of touch in addition to sight and sound. Instead of bulky gloves and tangling wires, Skin VR is complete with ultra-flexible, lightweight, soft and wireless electro-tactile system, called WeTac, made of a skin-friendly hydrogel layer that sticks onto the users' palms akin to a second skin that collects personalized tactile sensation data to provide a vivid touch sensation in the virtual world.

Users can feel virtual objects in different scenarios, such as grasping a tennis ball in sports training, touching a cactus, or feeling a mouse running on the hand in social activities and virtual gaming. "Imagine you can FaceTime a person and the other person can feel your touch when you can touch the screen," he says.

Apart from communications, Skin VR can be applied to entertainment, online games, fitness trackers and health care.

This sensation of touch is a mechanical force or electrical force that can be expanded into medical treatment of, say, administering drugs through the skin. It can also measure the health status of the skin for diseases like skin cancer.

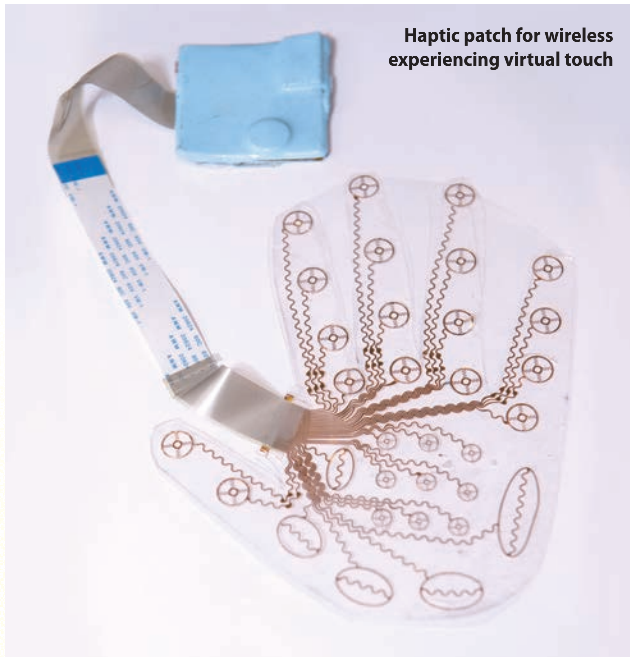

Skin electronics for tactile sensing

Remote Controlling Robots for Medical Use

Skin VR can also be applied to Robotics VR in which the user wears VR glasses to control a robot. The robot is wired with sensors while the user wears Skin VR. The users can see, hear and feel what the robot sees and hears and touches.

According to Prof. YU, Robotics VR started during the pandemic in Jan 2020 when healthcare workers in contact with patients was at high risk of infection, plus there were not enough medical staff. "The current technology was based on using a joystick, which needs a lot of new skills training and does not save time," Prof. YU comments. By using Robotics VR, medical staff can control a robot to do a simple procedure like a swab test for COVID sampling without contacting the patient. Tactile sensations were added to the robot so that the medical staff can feel the swab and will not push the swab too far into the nose. In addition, medical staff can be located far away from the patient, saving travelling time to remote places.

Other application areas of Robotics VR can be elderly care for Hong Kong's aging population, nursing care and cleaning, prosthetics especially artificial robotic limbs with a sense of touch by adding sensing and feedback devices.


Haptic patch for wireless experiencing virtual touch

Unlocking Charge Energetics at the Atomic Level: State-of-the-Art Facilities for Energy Material Research in HKICE

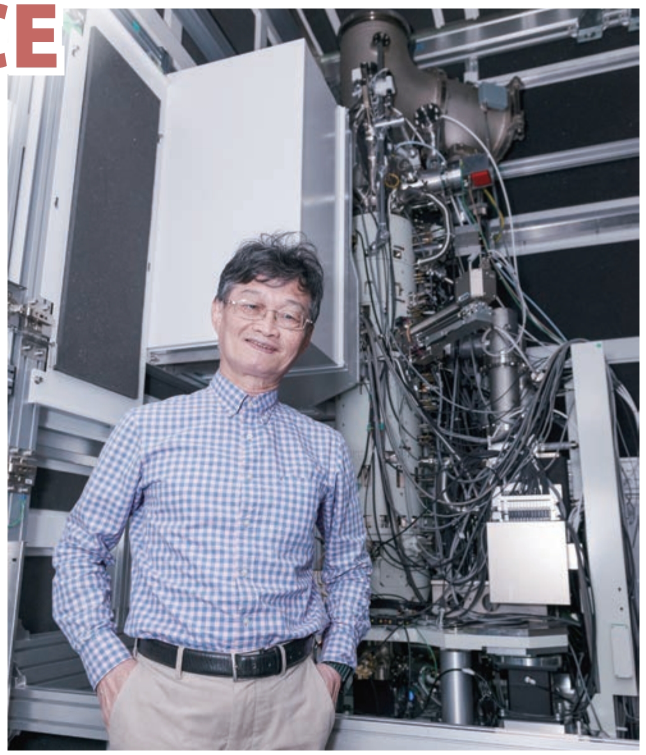
HKICE house two of the most advanced facilities in the field: the TRACE and Multifunctional Optical Spectroscopy and Imaging System. These facilities boast unique, custom-built systems that push the limits of both spatial and time resolution, allowing for in-situ studies on charge dynamics at the atomic level. These state-of-the-art facilities have far-reaching implications in different areas, such as aerospace and medicine. Witness the remarkable capabilities of these labs and the exciting advancements they are making in materials science and engineering.

TRACE: Time-Resolved Aberration-Corrected Environmental Transmission Electron Microscope

TRACE is the acronym for Time-Resolved Aberration-Corrected Environmental Transmission Electron Microscope, explained Prof. Furong CHEN, Chair Professor at and Department of Materials Science and Engineering, City University of Hong Kong.

This powerful microscope uses pioneering technology that allows Prof. CHEN and his researchers to be the first group of scientists to observe material properties at an atomic level – actually seeing the atoms moving very fast in 3D instead of 2D static images.

The cutting-edge technology in this microscope is twofold. Not only can it display atoms moving in 3D, but also allow the recovery of 2D images into 3D dynamics.



By gaining a better understanding of the structure of the materials under study, researchers can understand its physical properties to better develop new materials.

"All technology stems from new material innovation and this microscope can help us make better materials for clean energy," says Prof. Chen. "Special instrumentation is needed for innovations and here at CityU our microscope is unique."

This resonates with Nobel prize winner in physics Richard Feynman who said ' Is there no way to make the electron microscope more powerful by a hundred times ?'

The idea of the microscope was conceived by Prof. CHEN and his team which subsequently became a reality through a manufacturer in Japan.

Usually, the atomic resolution of materials can be revealed for crystalline materials along a few particular crystallographic orientations, breakthroughs have already been made in resolving in 3D atom dynamics at space-time resolution of 10^{-10} m.sec for helix materials including carbon nanotubes and single double strand DNA from the TRACE TEM in CityU. The highest space-time resolution of 3D atom dynamics can be achieved is 10^{-13} m.sec in a 2D material, graphene.

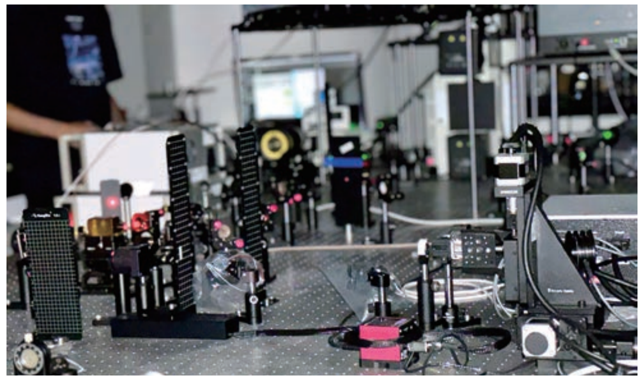
Apart from clean energy, numerous industries will benefit from new materials, including IC chips, aerospace, medicine, and daily necessities. For instance, new alloys with increased strength and toughness that can withstand extreme temperatures can be applied to the aerospace industry.

Prof. CHEN reveals that they are designing a small version of the microscope which will be available very soon. He compares the current microscope with bulky IBM mainframe computers that evolved into PCs and smartphones. With SpaceX and other exciting developments going on, he hopes that soon, a mini version of the microscope can be used in space missions and deep ocean explorations to find out the properties of new materials like space rocks and deep ocean soil.

Multifunctional Optical Spectroscopy and Imaging System

The lab of Prof. Dangyuan LEI, Professor at the Department of Materials Science and Engineering, City University of Hong Kong, is unique. It is one of a kind in Hong Kong because its multifunctional optical spectroscopy and imaging system is custom built – which he describes as "home-made facilities".

The lab specializes in photonic materials and clean energy research including low-dimensional quantum materials, radiative cooling building coatings, smart windows, perovskite solar cells, charge dynamics in batteries and other optoelectronic devices. It contains equipment such as femtosecond laser pump-probe ultrafast spectroscopy, single-particle dark-field scattering imaging and spectroscopy, low-temperature time-resolved photoluminescence spectroscopy, single-photon autocorrelation-function measurement system, and scattering-type scanning near-field optical microscope etc.



"Most of the measurement systems in our lab are home-built," he explains. "We designed the whole system by ourselves and assembled them together for multiple functionalities yet at the lowest cost possible." Its capabilities include giving measurements in extreme spatial resolution and extreme temporal resolution.

This facility may be the only one in Hong Kong that can perform nanoscale optical imaging and ultrafast spectroscopic measurements of materials simultaneously. Prof. LEI sums up its features in two words: "small and fast".

"Not only can we measure optical properties of tiny objects down to 10 nanometres (1nm,10^{-9} m or 1/1000000000 metres), but also the ultra-fast dynamics of the materials at a time scale as fast as several tens of femtoseconds (1 fs, 10^{-15} or 1/1 000,000,000,000,000 of a second)," he says.

In the case of perovskite solar cells, researchers are striving to enhance their power conversion efficiencies. They need to understand optical properties of the nano-scaled material and its ultrafast dynamics of their new materials under sunlight illumination, and this facility can fulfill such a specific needs.

In summary, our advanced optical systems allow for performing microscopic absorption/ scattering, reflection/ transmission, fluorescence and Raman spectroscopies at the single-particle level, with functionalities ranging from near- to far-field, linear to nonlinear, steady state to time-resolved and ultrafast regimes.

Commercial systems, on the other hand, can only perform individual functions with limitation on both spatial- and time-resolutions the same time.

The facility received both internal and external support with a sizable funding from CityU two years ago and a large research grant last year from the University Grants Committee of Hong Kong to further enhance the functionality and capability of this central facility.

CityU Croucher Advanced Study Institute ASI 07-09 DEC 2021

Croucher ASI, the first-ever highlight event organized by HKICE, was held from 7-9 December 2021. It brought together 750 researchers in the fields of fundamental chemistry, device physics, materials synthesis, advanced device processing, prototype development, and large-scale industrial manufacturing throughout the 3-day live-streaming program. The Conference also featured keynote lectures by experts across the world to share their latest research and inspire collaboration.

HKICE organized its first-ever conference on "The Frontier of Organic Semiconductors: From Challenges to Opportunities" which is held at CityU in Dec 2021.

The Conference began with the opening address of President Way KUO of CityU, followed by welcoming remarks of Professor Michael YANG, Vice-President (Research and Technology), and Professor Alex JEN. The program featuring dialogues among research scholars, young scientists, investors, and business executives on the topic of global significance - carbon neutrality.

All international and local active researchers and attendees participated in fruitful discussions, ranging from the momentum of cutting-edge researches development to the challenges and future prospects, including how to design and synthesize functional organic semiconductors, understand the underlying mechanisms for their chemical structure-property relationships and utilize them in applications that need improved stability, and mechanical strength without sacrificing their device performance. In addition, the exhibit booths connected CityU's dedicated professionals with attendees through innovation by putting breakthrough research into real-life practice.

The event concluded successfully with the Young Scientists Special Panel Discussion in which 24 young talents were offered opportunities to discuss their recent work and share their future goals.This event marked a significant milestone for the HKICE and demonstrated its commitment to advancing research and technology toward the clean energy technologies development.

Welcome remarks from President Way KUO, Professor Michael YANG, Vice-President (Research and Technology) and Professor Alex JEN HKICE's Director

Renowned Keynote Speakers of Croucher ASI 2021.

Croucher ASI 2021 was held in a hybrid mode with online and on-site participants.

Special Discussion session with exhibit booths showcased breakthrough research put into real-life practice.

HKTech Forum on Carbon Neutrality and Sustainable Environment CNSE 05-08 OCT 2022

The Hong Kong Institute of Carbon Innovation (HKICE) hosted a special panel discussion on "Opportunities in Achieving Carbon Neutrality in Hong Kong" ahead of the Forum on Carbon Neutrality and Sustainable Environment (CNSE). Distinguished guests from the HKSAR government and leading organizations gathered to discuss deep decarbonization, net-zero electricity generation, energy saving, green buildings, green transport, and waste reduction. The CNSE featured more than 30 prominent professors from prestigious universities worldwide, attracting around 380 participants in person and more than 4,000 online, providing valuable insights on the latest clean energy technologies.

Guest Speakers for the Opportunities in Achieving Carbon Neutrality in HK

Barry KWONG Director, Sustainability, Hong Kong Science & Technology Parks Corporation, HKSTP

Hon Chung, Harry LAI Principal Advisor/Carbon Neutrality Electricity and Energy Efficiency Branch, Electrical & Mechanical Services Department, EMSD

Yuk-Shan WONG PhD, SBS, BBS, JP. Chairman, Research Grants Council, RGC

Chaired by Prof. Michael YANG, Vice-President (Research and Technology), the discussion was initiated by the introductory talk from Prof. Alex JEN, Director and founder of the HKICE, followed by sharing talks from Ir. Harry LAI Hon-chung, Principal advisor on Carbon Neutrality in the Electrical & Mechanical Services Department (EMSD), Prof. Yuk-Shan WONG, Chairman of Research Grants Council (RGC), and Mr. Barry KWONG, Director of Sustainability in Hong Kong Science & Technology Parks Corporation (HKSTP). This event successfully attracted approximately 50 CityU faculties attending on-site and 70 participants joining online from local universities, companies, and local organizations.

The sharing session in the morning concluded with an in-session discussion of advancing clean energy technology through interactive dialogues among all speakers and participants. HKICE demonstrates leadership in connecting clean energy solutions and the latest research technologies for market adoption. We target innovative solutions with ecosystem perspectives that operate in synergy, driving potential collaborations and partnerships with the aim of translating all research outcomes into tangible progress on the ground.

The CNSE Opening Ceremony was held on 5 Oct with guest-of-honour including Prof. Yuk-shan WONG (5th from right), Chairman of the Research Grants Council, Ms. Rebecca PUN Ting-ting (4th from right), Commissioner for Innovation and Technology, HKSAR Government, Ir. Harry LAI Hon-chung (2nd from left), Principal Advisor/Carbon Neutrality, Electrical & Mechanical Services Department, HKSAR Government; Mr. Roger CHEN (3rd from right), Senior Director- Nuclear, CLP Holdings Ltd; and Ms. Elizabeth TAI (2nd from right), Director, Corporate Affairs (Business Operations), CLP Power Hong Kong Ltd.

The Opening Ceremony of the Forum on CNSE was then held in the afternoon of the same day. Prof. Alex JEN, the Organizing Chair and the Director of HKICE, kick-started the event by extending his warm welcome to all distinguished guests, speakers, scholars, and participants for being part of the community push to reinforce the sustainability efforts and cut our carbon footprint.

The Forum is honoured by the presence of Prof. Dong SUN, Secretary for Innovation, Technology, and Industry (SITI) of the HKSAR Government, who officiated at the opening ceremony. He highlighted in his opening remarks, "I congratulate CityU for establishing the Hong Kong Institute for Clean Energy (HKICE) last year, which functions as an international hub for talents and provides such dynamism to generate new knowledge and innovative solutions to improve the quality of life in the community." President Way KUO of CityU expressed, in his opening address, the University's appreciation for the contribution of each and every speaker for sharing their scientific findings and advanced achievements, which create essential pathways for achieving carbon neutrality and a sustainable environment.

Other guests attending the ceremony included Prof. Yuk-shan WONG, Chairman of the Research Grants Council; Ms. Rebecca PUN Ting-ting, Commissioner for Innovation and Technology, HKSAR Government; Ir. Harry LAI Hon-chung, Principal Advisor/Carbon Neutrality, Electrical & Mechanical Services Department, HKSAR Government; Mr. Roger CHEN, Senior Director- Nuclear, CLP Holdings Limited; and Ms. Elizabeth TAI, Director, Corporate Affairs (Business Operations), CLP Power Hong Kong Limited.

The first lecture of the forum featured Prof. Jeffery D. SACHS, winner of the 2022 Tang Prize in Sustainable Development for Leading Transdisciplinary Sustainability Science and the University Professor at Columbia University. His visionary talk addressed the geopolitics of climate change and sustainability, and the need for international collaboration in unprecedented times of change and uncertainty. He further highlighted the multilateral strategic plans and actions taken among countries and governments worldwide, inspiring all participants, and leading a fruitful discussion on the very unique roles of researchers, country leaders, local governments, and industrial organizations on the monumental project of carbon neutrality and sustainability development.

This four-day forum gathered more than 30 prominent professors from prestigious universities in Asia, Europe, and North America for cross-disciplinary discussions on hot topics such as Scalable Solar Energy, Energy Storage, Hydrogen Generation/Solar Fuels, Energy Saving Applications, Environment/ Carbon Capture, Energy Distribution/Smart Grids, and Innovative Nuclear Energy. Valuable insights and perspectives on the recent trending technologies in clean energy applications and development were shared. Around 380 participants attended in person and more than 4,000 tuned in remotely in the course of the forum.

Professor Sun delivered a speech at the opening ceremony of the CNSE.

International Conference on Clean Energy for Carbon Neutrality

07-10 MAR 2023

The International Conference on Clean Energy for Carbon Neutrality (ICCECN-2023), co-organised by HKICE of CityU and the French Academy of Sciences (FAS) from 7 to 10 March 2023, gathered top experts, world-wide scholars and industry leaders for multi-disciplinary discussions on the globally important topics related to future energy and sustainable development.

Guest Speakers for the Industrial Session

Daniel FUNG Head of Strategy & Innovation and Commercial – HK Utility, The Hong Kong and China Gas Company Ltd. Towngas

Raymond LEUNG Chief Technology Officer, Huawei International Co. Ltd.

Yi PAN Senior Manager, BYD Subsidiary FinDreams Battery Co., Ltd.

Wei SUN Senior Engineer and Technical Director, Tianneng Saft Energy Joint Stock Company

Xixiang XU Vice President, LONGi Central R&D Institute (China)

Professor Alex JEN Kwan-yue, Director of HKICE of CityU, kick-started ICCECN-2023 and welcomed attendees. "Combining the Academy's and the Institute's unique knowledge and experience, I believe this conference will provide an excellent platform to connect the clean energy community for best practices in research and offer access to the forefront of technological innovations and global networking," said Professor Jen.

In his welcome address, Professor Way KUO, President of CityU, stressed that there are only 27 years left to reach the global net-zero emissions goal set by the Paris Agreement of 2015 (COP21) to avoid catastrophic climate change. "CityU is actively involved in conducting innovative research to facilitate this transformation to a carbon-neutral economy and in promoting research and development in technologies that will drive net-zero carbon innovations. The University is committed to the education of leaders and professionals who will help shape our world's future," he said.

Professor Marc Pierre FONTECAVE, member of the FAS, and President of the Energy Committee of the French Academy, and the organising chair of the event, underlined how the conference inspired a more creative pathway to carbon neutrality, "This offers a great perspective for all of us and also for the young generation that we must continue to invest in scientific education and to get into research and industry jobs to contribute to the success of this global project."

The Opening Ceremony was joined by Mrs. Christile DRULHE, Consul General of France in Hong Kong and Macau, who also underscored the pressing need to accelerate the global energy transition.

The Industrial Session held on 10 Mar marked another conference highlight with industrial experts and leaders of prominent companies exploring the latest trends and advancements in the renewable energy sectors. The session created a globally networked discussion for industry innovators, academics and researchers to share their insights on topics such as the latest technological achievement in solar cell development, advanced batteries technologies for safe and reliable applications, the cutting-edge development in smart grid and power electronics, etc. The discussion shed new light on the challenge and the opportunities in future clean energy deployment.

Promoting innovation, sustainability and cross-disciplinary collaboration, ICCECN-2023 offered a unique perspective on the latest research technologies and provided insight into the knowledge transfer for clean energy deployment. It has also attracted high-profile interest in the future of energy.

ICCECN-2023 focused on carbon energy technologies and applictaions for carbon neutrality and sustainable future.

The ICCECN-2023 Opening Ceremony was held on 7 Mar with organising committee, guest-of-honour and speakers. Professor Jen (5th from left), Director of HKICE and the Organizing Chair, kick-started the event, joined by Mrs. Drulhe (6th from left), President Kuo (7th from left), and Professor Fontecave (8th from left)

Professor FONTECAVE and Mrs DRULHE delivered a speech at the opening ceremony of the ICCECN-2023

Get Inspired

HKICE Distinguished Lectures

HKICE Distinguished Lecture Series is a prestigious lecture series that brings together prominent speakers who have made significant contributions to the energy communities. These speakers are world-renowned leaders in their respective fields with well-recognized expertise and experience. The HKICE Distinguished Lecture Series covers an extensive range of topics related to energy research and technology, such as renewable energy conservation, energy storage, smart grids, and the implementation of clean energy transitions. The lectures are meticulously crafted to initiate the timely sharing of valuable insights and perspectives among the communities and to foster cross-disciplinary discussions on significant issues facing the energy industry.

It is a high-level event that aims to advance knowledge and shape the future of clean energy development. It has fostered collaborations and driven innovative solutions to the challenges facing the industry

HKICE Lecture Series

HKICE Lecture Series is a more specialized lecture series that focuses on a selected theme or topic within the clean energy research and industry. The series features speakers who are experts in the chosen field and covers a range of subtopics related to the main theme. The lectures not only highlight growing trends and innovations in the energy industry but also provide an excellent opportunity for attendees to network with experts and peers in the field and nurture their passion for the energy industry. This Lecture Series plays a vital role in fostering a network between research and industry. It has been attracting a diverse range of attendees from sectors, including academia, government, and private enterprise.

HKICE Seminar Series

Last fall, the 1st HKICE Seminar from Prof. Mandy Meng FANG was held with highlighted topic "A New Episode in the Never-ending Solar Trade Clash? UFLPA and International Trade Regulation". In this seminar, Prof. FANG led the in-deep discussion on the trade restrictions imposed on Chinese solar exports, as well as the legality measures by applying international trade rules as administered by the World Trade Organization (WTO).

This exciting lecture successfully brought together a broad array of faculties and students to explore the possible options China has to advance its industrial efforts in the solar sector during an era when economic nationalism is on the rise while multilateralism is under siege. As a connecting hub housing various scholars and researchers, HKICE looks forward to organizing more seminars covering diverse topics on clean energy development.

Shape Future Talent

HKICE Young Scientist Seminar Series

With its intellectual focus, HKICE takes advantage of initiating the monthly seminar series for young researchers and leaders to share their latest findings and cutting-edge research output in global energy development. With joint support from our faculty members and researchers, this event successfully promotes cross-disciplinary dialogue on innovative ideas and solutions for the various challenges and difficulties facing. This regular event brought up tight connections among various research groups within the Institute.

The seminar series was found as a collaboration boost that has initiated several joint projects whilst many has been aspired to collaborate interactively, though it's been run just for a few months.

Drive Sustainable Change Through Research, Collaboration, and Community

HKICE is at the forefront of the clean energy revolution, striving to nexus between cutting-edge research technologies and society. Our footprints serve as benchmarks for our continuous achievements. With continuous community engagement and collaboration, we promote the development of research and outreach strategies that truly aligns with the pressing demand for net-zero ambitions. Working closely with community members, we ensure that our research efforts align with their needs and values and that our findings have a positive impact on the world. We are excited to continue making significant contributions to the clean energy revolution and promoting sustainable solutions for a better world.

Government Agencies and Departments:

HKICE has had the honor of receiving esteemed delegations from various government agencies and departments, who have visited us to gain insights into the latest research and development efforts in the field of clean energy. These visits have been instrumental in promoting sustainable solutions and driving sustainable changes. Over the past two years, we have had the pleasure of hosting visits from the following units:

- *The Department of Science and Technology of Hunan Provinces*
- *The Dongguan Science and Technology Bureau*
- *The Electrical and Mechanical Services Department, EMSD*
- *The Global Ocean Capital Promotion Council of Shenzhen*
- *The Qingdao West Coast New Area*
- *The Shenzhen Science and Technology Innovation Committee*

These visits have provided a valuable platform for sharing knowledge and expertise, and have contributed significantly towards advancing the cause of clean energy and sustainable development.

Visit from the delegates of the Electrical and Mechanical Services Department EMSD

Visit from the delegates of the Global Ocean Capital Promotion Council of Shenzhen

Visit from the delegates of the Shenzhen Science and Technology Innovation Committee

Visit from the delegates of the Dongguan Science and Technology Bureau

Academic Scholars, Industry Professionals, and Organizations:

We place great emphasis on promoting timely dialogue on the latest technologies and research achievements in the field of clean energy development. We actively engage in practical outreach efforts to different academic scholars, industry professionals, and organizations, promoting local clean energy development in Hong Kong.

Through the organization of public forums, discussion sessions, workshops, and project collaborations, we have had the privilege of hosting several distinguished guest speakers from leading industrial companies, organizations, and financial supporting agencies. We have also had the opportunity to visit and build connections with various industry partners.

We had the privilege of hosting several distinguished guest speakers, including:

Academics:

- **Tobin J. MARKS**, Charles E. and Emma H. Morrison Professor of Chemistry, Professor of Materials Science and Engineering, Vladimir N. Ipatieff Professor of Catalytic Chemistry, Northwestern University
- **Peng WANG**, King Abdullah University of Science and Technology, Thuwal, Saudi Arabia
- **Tae-Woo LEE,** Seoul National University, South Korea

Industrial Companies:

- **Daniel FUNG**, Head of Strategy & Innovation and Commercial – HK Utility, The Hong Kong and China Gas Company Ltd. Towngas
- **Raymond LEUNG**, Chief Technology Officer, Huawei International Co. Ltd.
- **Yi PAN,** Senior Manager, BYD Subsidiary FinDreams Battery Co., Ltd.
- **Wei SUN**, Senior Engineer and Technical Director, Tianneng Saft Energy Joint Stock Company
- **Xixiang XU**, Vice President, LONGi Central R&D Institute (China)

Government Parties and Organizations

- **Barry KWONG**, Director, Sustainability, Hong Kong Science & Technology Parks Corporation, HKSTP
- **Hon Chung Harry LAI,** Principal Advisor/Carbon Neutrality, Electricity and Energy Efficiency Branch, Electrical & Mechanical Services Department, EMSD
- **Yuk-Shan WONG**, Ph.D., SBS, BBS, JP., Chairman, Research Grants Council, RGC

These efforts have allowed us to foster collaborations, knowledge exchanges, and innovative solutions for local development in clean energy and the advancement of sustainable development in Hong Kong. We remain committed to providing access to the latest research and development efforts in the field of clean energy, while also leveraging the expertise and resources of our partners to promote knowledge-sharing and collaboration.

Our ultimate goal is to advance the cause of clean energy development in Hong Kong and to contribute to the global effort to promote the global mission of carbon neutrality.

Apart from talk seminars, we valued the strong connections and networks with various different companies and organization with timely discussion and visit.

- **A-Grade Energy Ltd.**
- **Mondo Green Energy Ltd.**
- **The Hong Kong and China Gas Company Ltd., Towngas**
- **The Hong Kong General Chamber of Commerce, HKGCC**

Visit to A-Grade Energy Ltd.

Visit from the Hong Kong and China Gas Company Ltd., Towngas

Visit from the Hong Kong General Chamber of Commerce, HKGCC

Public Education and Communities

We dedicated to nurturing future leaders in the field of clean energy development and applications. Through engagement with educational institutions and students, we aim to inspire and empower the younger generation to become advocates for sustainable practices and play an active role in driving clean energy development. We actively participate in public talks, seminars, news interviews, and social media coverage to promote awareness of clean energy and sustainability practices. Some of our recent activities include:

- *Public seminars in Hong Kong Science Museum, Green I&T Day 2022*
- *Exhibitions at the CityU Employers' Luncheon 2023 and the Hong Kong Sustainable Campus Consortium*
- *STEM Talks for secondary school students in the InnoCarnival 2022 and the STEM Carnival 2022*

We believe that by investing in the education and development of future leaders in this field, we can create a more sustainable future for Hong Kong and beyond. Our commitment to this cause remains unwavering, and we will continue to work towards nurturing the next generation of clean energy pioneers through our public education initiatives.

Talk sharing in Green I&T Day 2022

Exhibition at the Hong Kong Sustainable Campus Consortium

Exhibitions at the CityU Employers' Luncheon 2023

Roll of Honor: Recognizing the Achievements towards Sustainable Future

Prof. Jinlian HU - The National Academy of Inventors (NAI) Fellow 2022

Prof. Alex JEN and Prof. Zonglong ZHU - The President's Awards (TPAs) 2022

Highly Cited Researchers 2022 [Source from Clarivate Analytics]

Prof. Zhanxi FAN (Cross-Field);

Prof. Jr-Hau HE (Materials Science);

Prof. Alex JEN (Materials Science);

Prof. Yun Hau NG (Cross-Field);

Prof. Andrey L. ROGACH (Materials Science),

Prof. Chaoliang TAN (Chemistry);

Prof. Angus YIP Hin Lap (Materials Science);

Prof. Xiao Cheng ZENG (Cross-Field);

Prof. Hua ZHANG (Chemistry; and Materials Science);

Prof. Qichun ZHANG (Materials Science);

Prof. Chunyi ZHI (Materials Science);

Prof. Zonglong ZHU (Cross-Field)

Top 2% Most Cited Scientists in the world by the Stanford-Elsevier Indicators (Asterisk * mark those with "Career-Long Impact")

Prof. Alicia AN Kyoungjin (SEE);

Prof. Yun CHI* (MSE);

Prof. Henry CHUNG Shu Hung* (EE);

Prof. Walid A. DAOUD* (SEE);

Prof. Zhanxi FAN (CHEM);

Prof. Jr Hau HE* (MSE);

Prof. Johnny HO C. (MSE);

Prof. Jinlian HU* (BME);

Prof. Alex JEN* (MSE);

Prof. Chaoqiang JIANG (CHEM);

Prof. Denvid LAU* (ACE);

Prof. Chun Sing LEE* (CHEM);

Prof. Dangyuan LEI (MSE);

Prof. Michael LEUNG K.H. (SEE);

Prof. Carol LIN Sze Ki* (SEE);

Prof. Chunhua LIU* (SEE);

Prof. Qi LIU (PHY);

Prof. Jingdong LUO* (CHEM);

Prof. Yun Hau NG* (SEE);

Prof. Andrey L. ROGACH,* (MSE);

Prof. Chaoliang TAN* (EE);

Prof. Michael TSE Chi Kong* (EE);

Prof. Edwin TSO Chi Yan (SEE);

Prof. Cheng WANG (EE);

Prof. Feng WANG* (MSE);

Prof. Ru Quan YE (CHEM);

Prof. Angus YIP Hin Lap* (MSE & SEE);

Prof. Xinge YU (BME);

Prof. Hua ZHANG * (CHEM);

Prof. Kaili ZHANG* (MNE);

Prof. Lin ZHANG (SEE),

Prof. Qichun ZHANG* (MSE);

Prof. Wenjun ZHANG* (MSE);

Prof. Chunyi ZHI* (MSE);

Prof. Zonglong ZHU (CHEM)

Prof. Hua ZHANG – CityU Outstanding Research Awards 2022;

Prof. Edwin TSO Chi Yan, and Prof. Xinge YU– CityU Outstanding Research Awards for Junior Faculty 2022.

Prof. Alicia AN and Prof. Chunhua LIU - RGC Research Fellows 2022-23

Prof. Tony FENG Shien-Ping - The HKIE Innovation Awards 2022 (Category I – An Invention)

Prof. Michael TSE Chi Kong - IEEE CASS Charles A. Desoer Technical Achievement Award 2022

Top Scientists ranking in Research.com

Top Scientists Ranking in Chemistry

Prof. Alex JEN (National: 5; World: 94)

Prof. Qichun ZHANG (National: 5; World: 94)

Top Scientists Ranking in Electronics and Electrical Engineering

Prof. Michael TSE Chi Kong (National: 13; World: 146)

Prof. Jr-Hau HE (National: 24; World: 248)

Prof. Henry CHUNG Shu Hung (National: 25; World: 253)

Top Scientists Ranking in Materials Science

Prof. Hua ZHANG (National: 7; World: 32)

Prof. Alex JEN (National: 10; World: 64)

Prof. Andrey ROGACH (National: 20; World: 137)

Prof. Chun-Sing LEE (National: 21; World: 138)

Prof. Chunyi ZHI (National: 67; World: 335)

Prof. Wenjun ZHANG (National: 92; World: 433)

Awards in Inventions Geneva Evaluation Days (IGED) 2022

Two Gold Medal

Prof. Edwin TSO Chi Yan:
"Intelligent Thermo-responsive Window for Indoor Thermal Management and Energy Saving in Buildings";

Prof. Xinge YU:
"Touch VR e-Skin for Metaverse";

Four Silver Medal

Prof. Michael LEUNG KH:
"Nano-Photocatalytic Marine Antifouling/ Anticorrosion Paint (NanoMA2P)";

Prof. Jinlian HU:
"Super-tough Artificial Spider Silk";

Prof. Jinlian HU:
"JanusLean Electrospun Nano Fibre Sheet Mask";

Prof. Chunyi ZHI:
" Safe Flexible Batteries and Their Applications"

Prof. Cheng WANG - Innovators Under 35 (China) by MIT Technology Review

Prof. Hua ZHANG and Prof. Qi LIU - The President's Awards (TPAs) 2021

Prof. Alex JEN - Outstanding Research Award 2021;

Prof. Dangyuan LEI - Outstanding Research Awards for Junior Faculty 2021

Highly Cited Researchers 2021 [Source from Clarivate Analytics]

Prof. Zhanxi FAN (Cross-Field);

Prof. Jr-Hau HE (Cross-Field);

Prof. Alex JEN (Materials Science);

Prof. Yun Hau NG (Cross-Field);

Prof. Andrey ROGACH (Materials Science);

Prof. Chaoliang TAN (Cross-Field);

Prof. Angus YIP Hin Lap (Materials Science);

Prof. Hua ZHANG (Chemistry; Materials Science);

Prof. Qichun ZHANG (Cross-Field);

Prof. Chunyi ZHI (Materials Science)

Prof. Henry CHUNG Shu Hung - 2021 IEEE PELS R. David Middlebrook Achievement Award

Making Strides in Clean Energy Research

82 FUNDED PROJECTS

TOTAL APPROVED FUND
APPROXIMATELY
183,069,600.00 HKD

52	22	3	4	1	1
GRF/ECS	ITF	GTF	CRF	CREG	SZ-HK GOV

Industrial Collaborators

ALTA Scientific Inc. Ltd.
ASM Technology Hong Kong Ltd.
Century Elite Technology Ltd.
Changchun Changguang Yuanchen Microelectronic Technology Co., Ltd.
Chun Wo Construction and Engineering Co. Ltd.
CSG Holding Co. Ltd.
Daxin Electric Co. Ltd.
DuctPro Engineering (H.K.) Ltd.
Enli Technology Co., Ltd.
Ever View Technology Ltd.
Jones Lang Lasalle Ltd.
Laiou Technology Co. Ltd.
LinkSense Corporation
Mondo Green Energy Ltd.
ProVista Technology International Ltd.
Shanghai Chushan Technology Ltd.
Shenzhen HuaYu WPT Tech. Co. Ltd.
Shenzhen Huineng Material Technology R&D Center (Limited Partnership)
Shenzhen Topray Solar Co., Ltd.
Shuixiongchong Technology Co. Ltd.
SUEZ NWS R&R (Hong Kong) Ltd.
Taiwan Chinsan Electronic Industrial Co., Ltd.
TAL Apparel
Techskill (Asia) Ltd.
The Hong Kong Electronic Industries Association Ltd.
Tiinlab Corporation
Xiantong Electric Co. Ltd.
Zhejiang Zhenn Technology Co. Ltd.
Zhuhai Debiao Optoelectronics Technology Co. Ltd.

Collaborating Institutes and Universities

Building Energy Research Center, Guangzhou HKUST
Changchun Institute of Optics, Fine Mechanics and Physics, Chinese Academy of Sciences (Mainland Partner)
Fok Ying Tung Research Institute
Nankai University (Mainland Partner)
Peking University
Shanghai University (Mainland Partner)
Shenzhen Graduate School
Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Shenzhen University
South China University of Technology
The Hong Kong University of Science and Technology
The University of Hong Kong

Supporting Organizations

Civil Engineering and Development Department
Drainage Services Department
Electrical and Mechanical Services Department
Federation of Hong Kong Industries
Hong Kong Productivity Council
Marine Department
Water Supplies Department

Information obtained from the websites of the funding bodies as of 30 June 2023