

## 關於本項目 About the Project

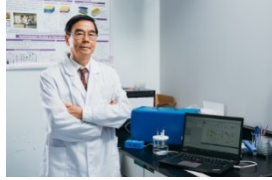
Total Project Fund 項目總撥款:



Project Team 研究團隊:



Project Coordinator 項目統籌:

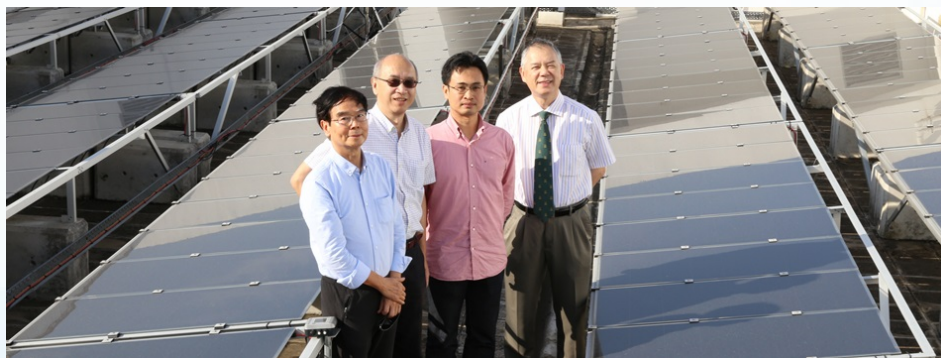


Prof. Ching-ping Wong 汪正平教授  
Dean of Engineering, The Chinese University of HK  
香港中文大學 工程學院院長

- 共包括六個子項目，各由一位資深教授領導
- 20 多位來自中大、香港理工大學、香港科技大學及香港大學跨學科、跨院校學者共同合作
- 項目自開始以來，已有超過 150 位研究人員及研究生參與
- Six sub-topics, each led by one senior professor
- More than 20 expert scholars from CUHK, HK PolyU, HKUST and HKU
- More than 150 research staff and students since project commenced in 2014.

## 太陽能電池組件及智能能源儲存之微電網實地應用

Field Demonstration of Microgrids  
with PV Modules and Smart Storage



自 2016 年中，本項目與香港中文大學和聲書院合作，在書院的北座及南座頂層設置示範基地，以驗證由本項目研發之再生能源電力系統的效益：

- 安裝了 396 塊 CIGS 太陽能板，共港幣 30 萬元，由主題研究計劃經費資助，最高容量達 35 kwp。
- 書院另外資助了約港幣 130 萬元於系統的基礎支架及電工安裝上。
- 於 2017 年 5 - 8 月的四個月內，由此系統生產的電力共 13,600 度 (北座 9,360 度及南座 4,240 度)，相當於電費約港幣 15,400 元。
- 由此推算，系統約可在一年內為書院節省約四萬元電費。
- 若以書院這四個月內的總用電量 (57 萬度電) 計算，系統供應的電量約佔書院總用電量的 2.4%。

Since mid-2016, the project collaborated with the Lee Woo Sing College of CUHK by establishing a field demo at the north and south rooftop of student hostel. The installation validating the performance of the renewable energy system derived from the project:

- Installed 396 pieces of CIGS solar panels (Around HKD 300,000), funded by TRS. Peak capacity reaches 35 kwp.
- The College invested another HKD 1.3 million for the mounting hardware and electrical work of the solar panels.
- During May – Aug 2017, 13,600 kWh of electricity was generated (North block 9,360 and South block 4,240), equivalent to around HKD 15,400.
- Hence, the system is expected to save around HKD 40,000 electricity fee per year.
- This amount is around 2.4% of the total power consumption (570,000 kWh) of the entire College.

## Contact Us

Project URL: <https://sse.org.cuhk.edu.hk/sse/>

Project Manager: Mandy Tse

Email: [mandytse@cuhk.edu.hk](mailto:mandytse@cuhk.edu.hk)

Tel: +852-3943-8450

## 合作 COLLABORATION

本項目現正尋找各種形式之合作機會，望能把科研成果轉化成高質素產品及服務，回饋社會，為環保及新能源應用科技作出貢獻。

We are seeking collaborative partners for various kinds of collaboration activities, with the ultimate goal of converting R&D into quality products and services, contributing the well-being of the society in applied technology in renewable and new energy.

### 基金申請 Funding Opportunities

香港政府設立了多個不同的科技基金，支持大學進行各種創新科技的研發及應用，旨在提升本地經濟活動的增值力、生產力及競爭力。

The Hong Kong Government established various kinds of technology funding to support R&D and applications of innovative technology, aims to increase the added value, productivity and competitiveness of our economic activities.

### 專利授權 Patent Licensing

如 貴公司希望取得我們的技術專利授權，詳情請向項目經理查詢。

If your company is interested in licensing our technology patents, please contact us for further information.

### 小型試驗計劃 Trial Site Testing

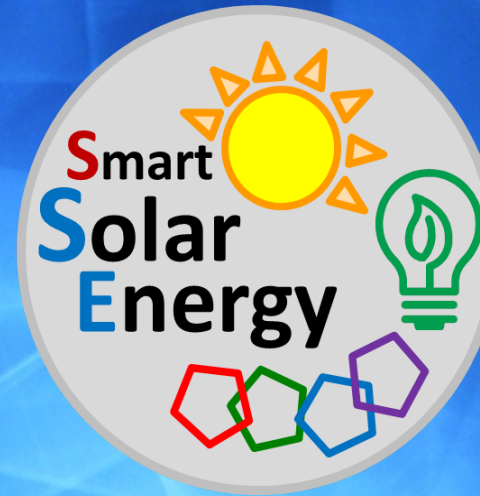
我們歡迎業界人士以小規模形式試用我們的技術，然後再洽談更多合作模式。詳情請向項目經理查詢。

We welcome related industry partners to try using our technology in small scale trial sites, followed by deeper collaborations in next phases. Please contact us for further information.

合作詳情  
About  
Collaborations



The Chinese University of Hong Kong



# Smart Solar Energy Harvesting, Storage, and Utilization

UNITE and EMPOWER  
Energy Technology Leaders

CONVENE

COLLABORATE

CATALYSE

CONVERT

... and BEYOND

### Partner Institutions:



The Hong Kong Polytechnic University



The Hong Kong University of Science and Technology



The University of Hong Kong



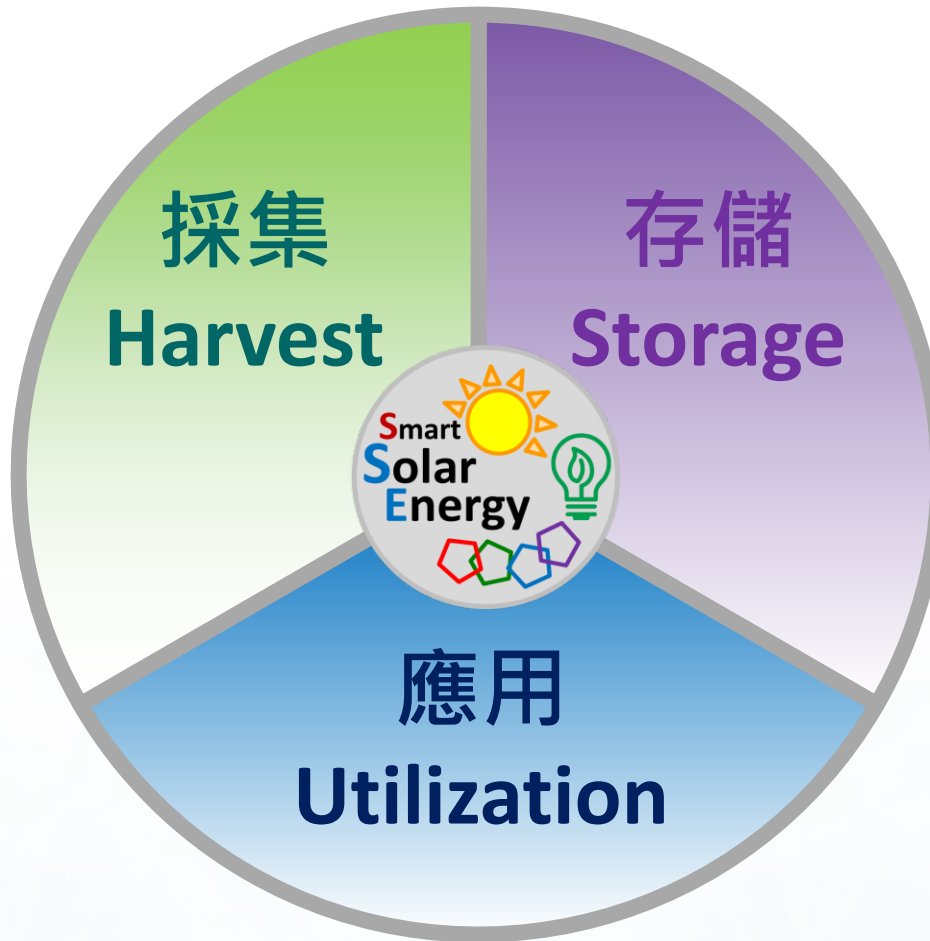
Funded by:

Theme-based Research Scheme (TRS), Research Grants Council (RGC),  
University Grant Committee (UGC), HKSAR (T23-407/13-N)



# 智能化太陽能技術 - 採集、存儲及應用 Smart Solar Energy Harvesting, Storage and Utilization

## 創新突破 Innovative Breakthroughs



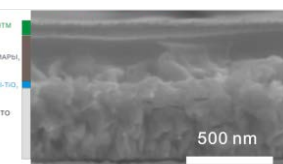
01



團隊研發之產品：卷軸式薄膜太陽能充電寶 Rollable Thin Film Solar Power Bank developed by the team

團隊創立的公司註冊資本達人民幣 5,200 萬，現時擁有的**柔性 CIGS 薄膜太陽能電池**生產線，是全中國第一、全球第二家。這種電池重量輕，而且可以折疊、捲曲，甚至黏貼在其它物體的表面，例如汽車玻璃，衣服等。The company founded by the team has a registered capital of RMB 52 million, currently has the first in China, the second in world production line of **flexible CIGS thin film solar panels**. This kind of solar cells is light, foldable and bendable, and even can be struck onto the surface of different objects e.g. vehicle windows or clothes.

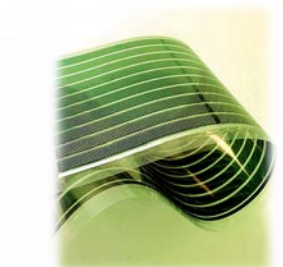
02



研發高結晶性大尺寸 ( $5 \times 5 \text{ cm}^2$ ) **晶粒鈣鈦礦太陽能電池薄膜**，濕度及熱穩定性由一星期大幅延長至兩個月，向商業化生產所要求大大邁進一步。

Developed **highly crystalline large-grain size ( $5 \times 5 \text{ cm}^2$ ) perovskite solar cell thin film crystals**. Humidity and heat stability was significantly boosted from 1 week to two months.

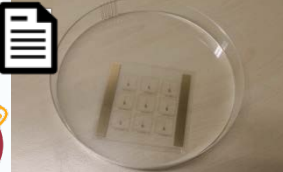
03



研發新型的**薄膜有機太陽能電池**，輕薄可捲曲及能做**半透明**，效能達世界最高的**11.5%**，並獲美國能源部國家再生能源實驗室 (NREL) 正式確認為主要科技突破，並刊登於國際知名的「最佳效能研究電池圖表」上。

Developed a new type of **thin film organic PV, light weight, bendable and can be semi-transparent**, with a **record efficiency of 11.5%**, which has been officially certified as a major technological breakthrough in the renowned National Renewable Energy Laboratory (NREL) (US Dept of Energy) chart of "best research-cell efficiencies".

04



成功研發**全球精確度紀錄最高之卷對卷多印刷技術**，準確度達 **100 nm**。

The team successfully developed a **world record technology in precision R2R printing, realizing continuous printing on 4" web with 100 nm resolution**.

05



團隊發現了一種新型材料 - **微纖維紅磷**，暴露在陽光下，就能把水分解，製造產生氣泡狀的氫 -- 一種容量很高的潔淨燃料。它的產氫效率是目前所有非金屬類的光催化劑當中最高，而且，紅磷蘊藏量豐富，取之不竭，容易開採。

The team discovered a new material **micro-fibrous red phosphorus** which can evolve hydrogen when exposed water to sunlight. Its efficiency is the highest among all non-metal-based photocatalysts. Also, hydrogen has a high fuel capacity and creates more energy than other chemical fuels. Red phosphorous is abundant in the earth's crust and can be extracted fairly easily.

06



團隊研發了一種新型的**稀土敏化轉換材料**，能夠把紅外光直接轉化為可見光，能量轉換效率高達**16%**，相比傳統的納米上轉換材料效率提升一倍以上。The research team invented an innovative **lanthanide-sensitized oxide**, reaching a maximal power upconversion efficiency of 16% for infrared light, which is at least double the efficiency of traditional nano-upconversion materials.

07



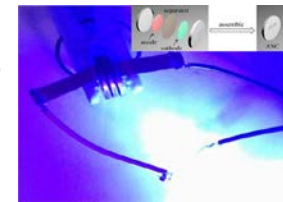
團隊結合了脈衝電鍍法及微細加工，在溫度差 **52.5 K** 之下製出功率密度高達 **9.2 mW cm<sup>-2</sup>** 的**熱電發電機**，是文獻紀錄中**電鍍微型熱電發電機**之中最高。

The team developed thermoelectric generators (TEGs) by combining pulsed electroplating with microfabrication processes. It achieved a **power density as high as 9.2 mW cm<sup>-2</sup>** at a temperature difference of 52.5 K, **which is the highest value reported so far** for the electroplated micro-TEGs in the literature.



- 在太陽能科技研究上研發**五項全球最佳效能科技**，令香港在再生能源技術上領先全球。
- 5 world-record performance technologies** achieved by the team, putting Hong Kong on the map.
- 已取得或正在申請**十一項技術專利**。
- 11 patents** obtained and / or application in progress.

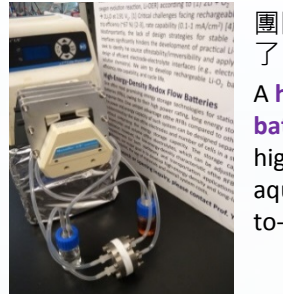
08



團隊開發了一種可以自支撐的**三維多級孔泡沫碳電極**，主要表現為高的能量密度和高功率密度，分別為 **93.9 Wh kg<sup>-1</sup>** 和 **21.1 kW kg<sup>-1</sup>**，是**全球文獻記錄中最高效能的非對稱性超級電容器**。

A hierarchically carbon-based free-standing 3D electrode was fabricated, which showed excellent electrochemical performance with a high energy density of 93.9 Wh kg<sup>-1</sup> and a high power density of 21.1 kW kg<sup>-1</sup>, among the **highest reported values for asymmetric supercapacitors**.

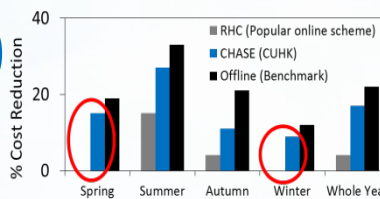
09



團隊研發了一種**高能量新型鋅-碘溴液流電池**，刷新了目前水系液流電池能量密度的紀錄 (**101 Wh L<sup>-1</sup>**)。A **high-energy-density zinc/iodine-bromide redox flow battery (ZIBB)** has been developed. It achieved the highest reported energy density for aqueous redox flow batteries to-date (**101 Wh L<sup>-1</sup>**).

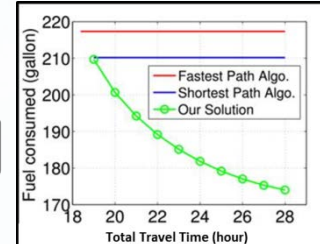


10



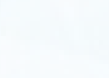
團隊研發的 **CHASE** 理想調度追蹤算法，在沒有或極少預測信息的情況下為微電網帶來約**20%的成本節省**，成效顯著。The team developed an online algorithm called **CHASE**, which **was able to bring about remarkable 20% cost saving for microgrids**.

11



團隊設計的高效能演算法能為**重型卡車節省高達 17% 油耗**，同時滿足運輸期限的要求。The highly-efficient algorithm solution is able to **reduce the truck's fuel consumption by up to 17%**, while meeting the deadline constraint.

12



團隊設計了一個公平成本攤分方法，以鼓勵微電網的合作規劃從而令社會成本減至最低。結果表明，**合作規劃方案能夠節省投資成本達 35.9%**。The team designed a fair cost-sharing scheme to split up total investment cost, which incentivizes proactive participation of microgrids toward socially optimal planning of renewable generation. **Such a cooperative planning method can save the total investment cost by 35.9%**.

13



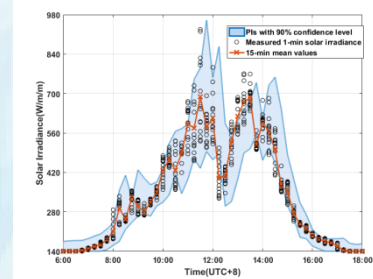
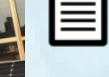
為中大和聲書院設計了**智能化在線能源管理網上系統「和聲 Power」**，為所有 300 個宿生房間提供實時回饋以鼓勵節能，並為管理者找出節能機會及方案，成功提升宿生對個人用電量的關注及節能意識。Build a smart online energy management platform "**Woo Sing Power**" which provides instantaneous feedback to all 300 dormitory rooms in CUHK LWS College to encourage energy conservation, and to administrators to find opportunities and policies to save energy.

14



建成了**光伏發電及儲能為本智慧型微電網實驗室**，是**全港首個先進微網控制實驗平台**，總容量達 4 kw。A **first of its kind microgrid platform** in Hong Kong dedicated for scientific experiment and practical implementation of advanced microgrids control algorithms.

15



團隊與香港天文台合作，開發了性能優秀的**粒化概率區間預測技術**，能應用於太陽能及其他可再生能源的微電網上。A novel **optimization based probabilistic interval prognosis method** for solar and other renewable energies in MG (in collaboration with Hong Kong Observatory).

16



成功研發**本港首個智慧型電氣負載控制器**之理論設計及硬件製作，能應用在不同家居電器，回應電網頻率或電壓變化。A **first of its kind smart demand controller** in HK (both theoretical design and hardware implementation) enabling frequency/voltage response from various home appliances.