News Article for RISUD Interdisciplinary Research Scheme

		Name	Department
1.	**Principal Investigator**:	Prof. Yang Hongxing	BEEE
3.	**Project Title:**	Data-driven solutions for decarbonizing transportation sector by coupling renewable energy, energy storage and smart EV-charging	

4. **Annual Progress/Achievement (***in layman's language, no more than two A4 pages, pls attach a few figures***)**

In the nearly one year of research on the project, we have conducted in-depth research on building photovoltaic potential prediction, transportation transformation analysis, photovoltaic layout optimization and other aspects, and published 12 high-level research papers.

We have developed multiple advanced machine learning models to improve the accuracy of predicting the potential for installing solar panels on urban buildings. One of our innovative models, called GenPV, uses a technique called deep learning to accurately identify and separate photovoltaic (PV) panels. GenPV learns different features of PV panels at various scales and combines information from multiple resolutions to handle differences in image quality and ensure accurate segmentation of PV panels. To further improve the identification of PV panels in satellite images, we created a specialized computer network that pays close attention to the details. This network incorporates advanced deep learning techniques and innovative features. For example, it includes a Split-Attention Network that focuses on important areas, a Dual-Attention Network combined with Atrous Spatial Pyramid Pooling that considers different aspects of the image, and a Point Rend Network that fine-tunes the prediction of PV panel boundaries. These enhancements make our network highly effective at identifying and precisely delineating PV panels in satellite imagery. Moreover, we developed a better approach to accurately identify PV panels in remote sensing images using advanced deep learning techniques.

Our approach includes two key improvements. First, we introduced a colour-based method that uses our knowledge of colour patterns to refine the predicted regions. This ensures that the correct colours are assigned to PV panels, even when there are similar objects that could cause confusion. Second, we incorporated a shape-based method that calculates multiple layers of shape targets. This refines the initial segments and maintains precise edge information of the predicted regions. These improvements significantly enhance the accuracy of PV panel segmentation in remote sensing images. Using these advanced models, we have improved the accuracy of identifying the potential for solar panel installations. Some of our research findings are depicted in Fig. 1 and Fig. 2. Building upon these prediction models, our next step is to assess the photovoltaic potential in Hong Kong.

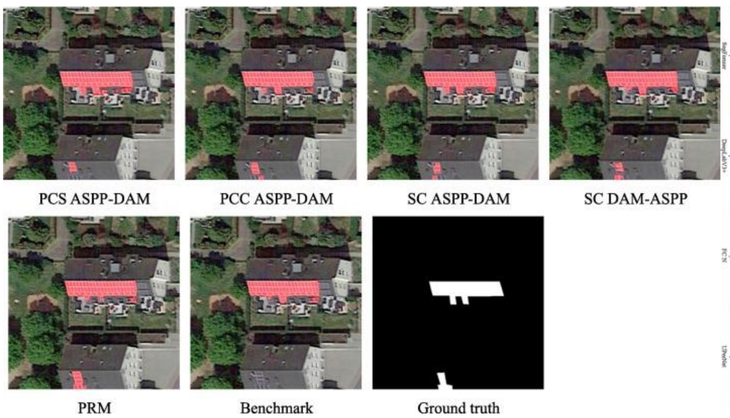

Fig.1 Segmented PV areas in the red color obtained from different models

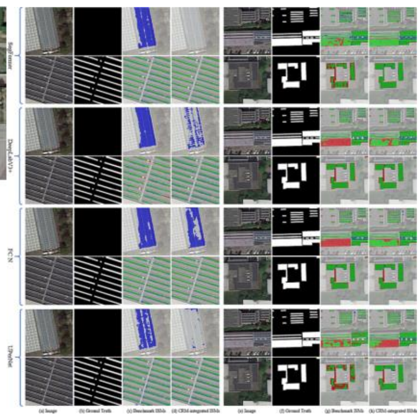

Fig.2 Comparison of results of benchmark ISMs and CRM-integrated ISMs

We also investigated ways to transform transportation in Hong Kong, starting with the feasibility of electrifying the metro system. The diagram in Fig. 3 illustrates the concept of subway electrification. Our research proposes energy flexibility solutions to improve the battery-powered net-zero metro railway system without increasing costs. The findings show that achieving a net-zero metro railway system is both technically and economically feasible. Additionally, we explored how to transform public transportation in Hong Kong, considering the limited availability of land. To address this challenge, we developed a model called Integrated Vehicle Scheduling and Refueling of Mixed Fleets with Multiple Depots. The aim was to minimize operational costs. The results indicate that a mixed fleet consisting of battery electric buses and hydrogen buses tends to be a more cost-effective solution for Hong Kong.

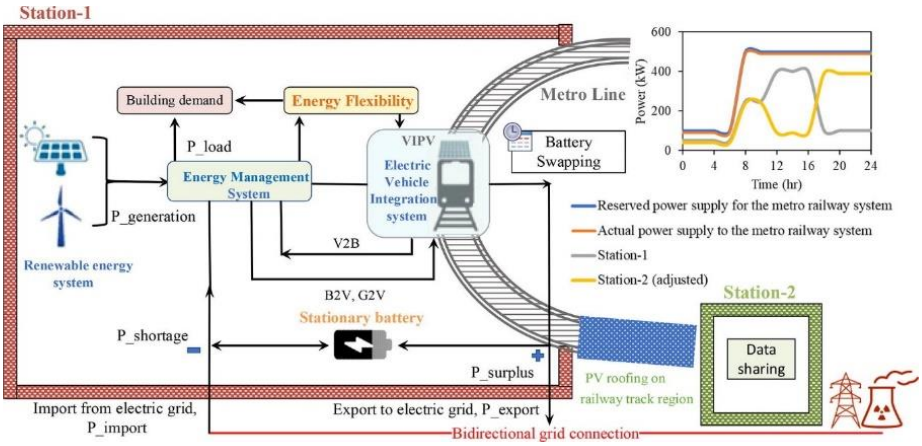

Fig. 3 A battery-powered metro railway system

In our study on optimizing the placement of solar panels, we have developed a framework (as shown in Fig. 4) that considers multiple objectives. The framework aims to maximize the potential of solar energy generation, minimize the area needed for solar panels, and ensure the appropriate duration of shade on complex urban surfaces. To achieve this, we used a geographic information system (GIS) and an analysis approach that considers both the spatial and temporal aspects of the problem. We applied this approach to three different planning scenarios: (i) aligning the solar panels parallel to the ground, (ii) tilting them at an angle equal to the local latitude, and (iii) dynamically rotating them to face the sun directly. This research has the potential to support solar energy adoption in cities worldwide and contribute to the expansion of renewable energy sources. Our next step will be to utilize this method to analyse the photovoltaic design options specific to Hong Kong.

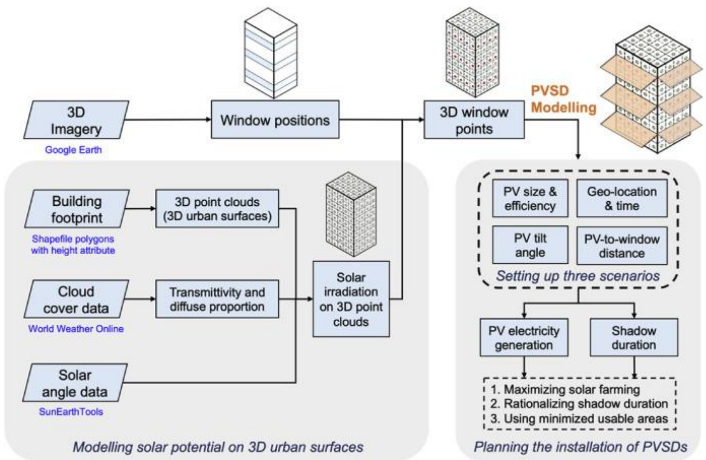

Fig. 4. A flowchart of modelling the Photovoltaic-integrated shading devices