The generation of domestic solid waste (DSW) is rising rapidly. As waste accumulates, its decomposition produces methane, a greenhouse gas significantly more potent than carbon dioxide (CO_2). This situation exacerbates numerous health and socio-economic challenges, highlighting the urgent need for effective waste management. DSW can be transformed into energy through thermochemical processes and compost through biological methods. However, techniques such as aerobic and anaerobic digestion, fermentation, and the use of soldier flies may not be suitable for Hong Kong due to its dense environment and limited agricultural sectors.

Given these challenges, our research is focused on in-place conversion of organic and plastic waste that can be completed in minutes within confined spaces. These methods reduce transportation and management costs while prioritizing health and safety. Our goal is to address the pressing DSW issues following the temporary suspension of solid waste charging.

To achieve this, we have developed an innovative dry carbonisation method utilising microwave or inductive heating. Both techniques have been successfully tested in laboratory conditions with limited oxygen, achieving over 90% reduction in weight and volume without generating toxic gases like dioxins. Combining microwave heating, which heats the entire volume, with inductive heating, which targets surfaces, could yield even better results. However, the requirement of a ferrous substance for inductive heating would upset the effectiveness of microwave heating. The reflective properties of container shapes, material compatibility, and temperature control will be optimised.

We employ numerical simulations of electromagnetic-thermal multi-physics and computational fluid dynamics (CFD) to optimize various parameters, enhancing temperature distribution in the reactors and maximizing byproducts such as syngas, biofuel, and charcoal. Byproducts are collected through a process of slow condensation for biofuel and rapid separation of syngas and char using cyclone technology.

Our project aims to create prototypes for schools with approximately 1,000 students. Biomass, wood, fabric, and plastic can be converted without the need to separate them for central processing. For wet DSW, we first apply a centrifugation drying process before conversion. The resulting byproducts can be used as cooking energy on-site or converted to pet food. Beyond combustion, the char produced offers benefits for soil amendment, water filtration, carbon sequestration, construction materials, animal feed additives, and odour control. Preliminary energy balance calculations indicate that converting 10 kg of potatoes requires 10 MJ of processing energy, yielding a total output of 280 MJ—a net gain of 270 MJ.

Following the trial runs, we will comprehensively assess the environmental, economic, and social impacts of these in-place conversion technologies to ensure their sustainability and viability to be used in small districts. We aim to disseminate our findings and promote the adoption of these technologies among local authorities, waste management companies, and the public in Hong Kong and other regions facing similar waste management challenges.