NEWSLETTER

Issue 18
April 2022

ST Engineering Group CTO Dr LEE Shiang Long visits E2S2

Dr LEE Shiang Long, the Group CTO of ST Engineering was invited to visit E2S2 in March 2022. We were honored to host the meeting discussion on potential collaborations and conduct a lab tour to him and the other delegates from ST Engineering.

During the meeting, Prof Tong Yen Wah, Prof Wang Chi-Hwa and Dr Goh Shin Giek presented on E2S2 programme in terms of the background information, achieved research outcomes so far, existing industrial collaborations, etc. Dr Lee expressed his interest in some of the E2S2 research areas and proposed to assign some experts from ST Engineering for discussions and explorations with E2S2 on potential commercialization of some technologies and systems developed by E2S2 .

During the lab tour, Prof Tong and Prof Wang accompanied Dr LEE and other delegates viewing E2S2's laboratory facilities and experiments. It started with the introduction given by Dr LI Xian (ES-1 Senior Research Fellow) on the concentrated solar fuel lab and high-flux Solar Simulator. Dr Sanjeeb MOHAPATRA (ES-2 Research Fellow) demonstrated the LCMS instrument for the analysis of emerging contaminants. Dr Jerome KOK (ES-2 Research Fellow) showed the YSI multiparameter sonde to measure variables (i.e. depth, temperature, pH value, etc) at the same time and explained the process of the algal growth study in E2S2 constant temperature room.

Apart from learning about the laboratory facilities, Dr LEE also interacted with E2S2 researchers by asking many questions regarding the latest on-going research activities in E2S2.

Dr Sanjeeb MOHAPATRA is demonstrating the LCMS instrument for the analysis of emerging contaminants.

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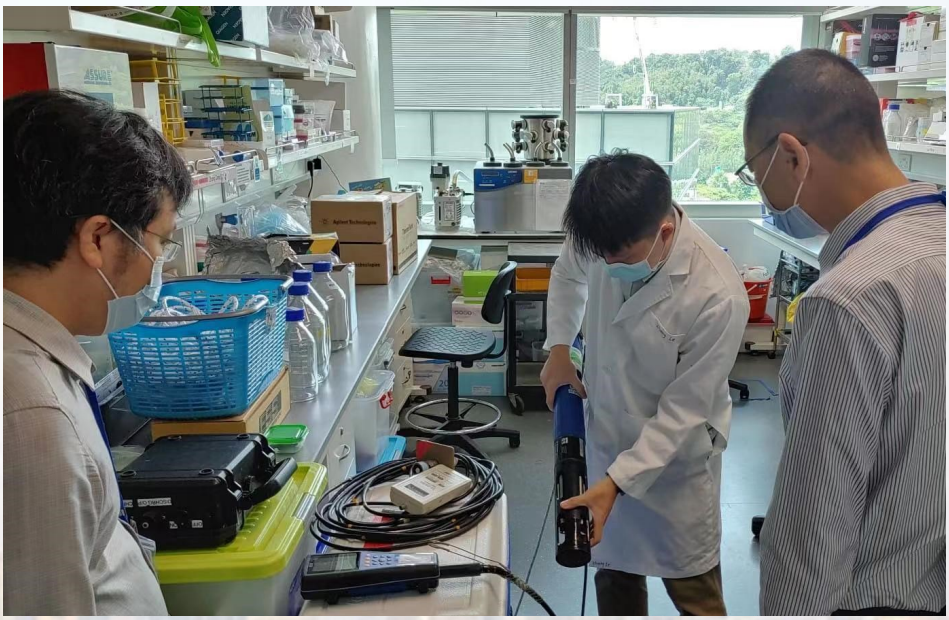
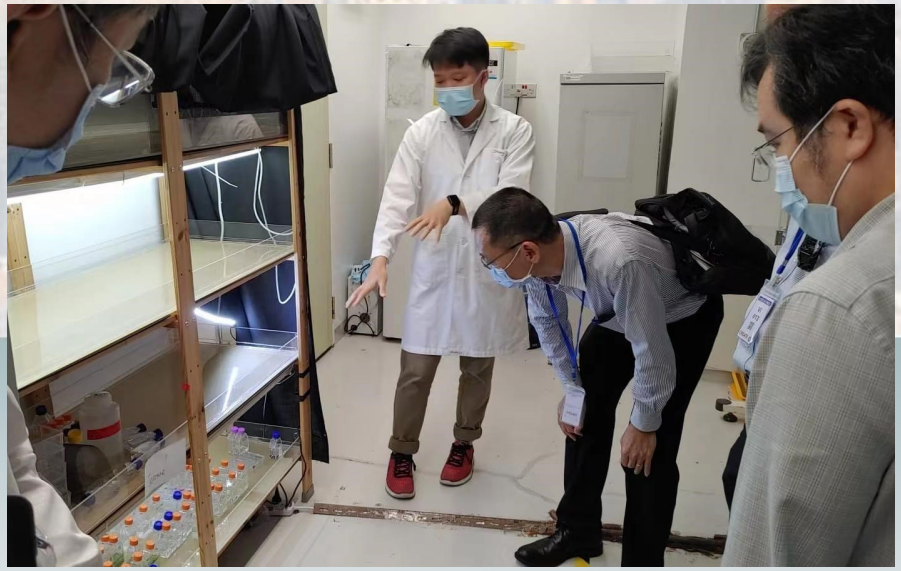
Dr LI Xian is demonstrating the concentrated solar fuel lab and high-flux Solar Simulator.

Dr Jerome KOK is demonstrating the YSI multiparameter sonde to measure variables (i.e. depth, temperature, pH value, etc) at the same time.





Dr Jerome KOK is explaining the process of the algal growth study.

Recent accepted/published papers from E2S2:

1 Life cycle climate change mitigation through next-generation urban waste recovery systems in high-density Asian cities: A Singapore Case Study

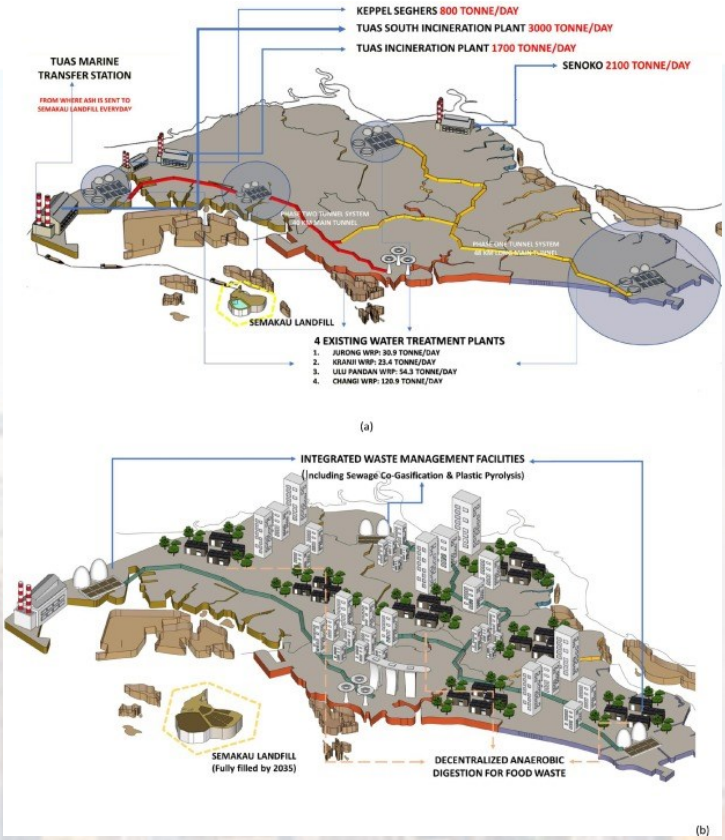
Journal: **Resources, Conservation and Recycling**

Authors: **Harn Wei Kua, Xin He, Hailin Tian, Abhimanyu Goel, Tingting Xu, Wen Liu, Dingding Yao, Srikkanth Ramachandran, Xiao Liu, Yen Wah Tong, Yanjun Dai, Yinghong Peng, Chi-Hwa Wang**

Keywords: **Waste recycling; Pyrolysis; Co-digestion; Anaerobic digestion; Integrated waste management**

Author's words:

The potential of implementing waste recovery strategies on three kinds of waste – food, sewage, and plastic – in reducing waste-related greenhouse gas emissions in Singapore was evaluated using life cycle assessment. It was found that the proposed strategies are capable of reducing 1,087.80 kgCO2-eq per tonne of plastic waste, 53.00 kgCO2-eq per tonne of food waste, and 43.86 kgCO2-eq for the combination of one tonne of sewage waste and one tonne of food waste. When uncertainties of the three waste streams were considered in sensitivity analysis and projections of waste quantities to 2025 were performed up to a 95% confidence level, it was found that the proposed strategies could reduce about 37.13% of the GHG emissions from the business-as-usual disposal waste technology (that is, incineration). This corresponds to an average reduction of 0.53 million tonnes CO2-eq per year, which is equivalent to the annual GHG emissions from electricity consumptions of 256,322 households in Singapore.



Highlights:

- The potential of implementing management strategies in reducing waste-related greenhouse gas emissions was evaluated.
- Three kinds of waste – food, sewage, and plastic were analysed was evaluated using life cycle assessment.
- By diverting plastic waste away from incineration, the reduction in GHG emission is 61%.
- By diverting food waste away from incineration, GHG emission amount is reduced to 54.69 % of the emission from BAU method.
- The GHG emission of sewage sludge and food waste co-digestion reduces the current emission (incineration) by 64.3%.

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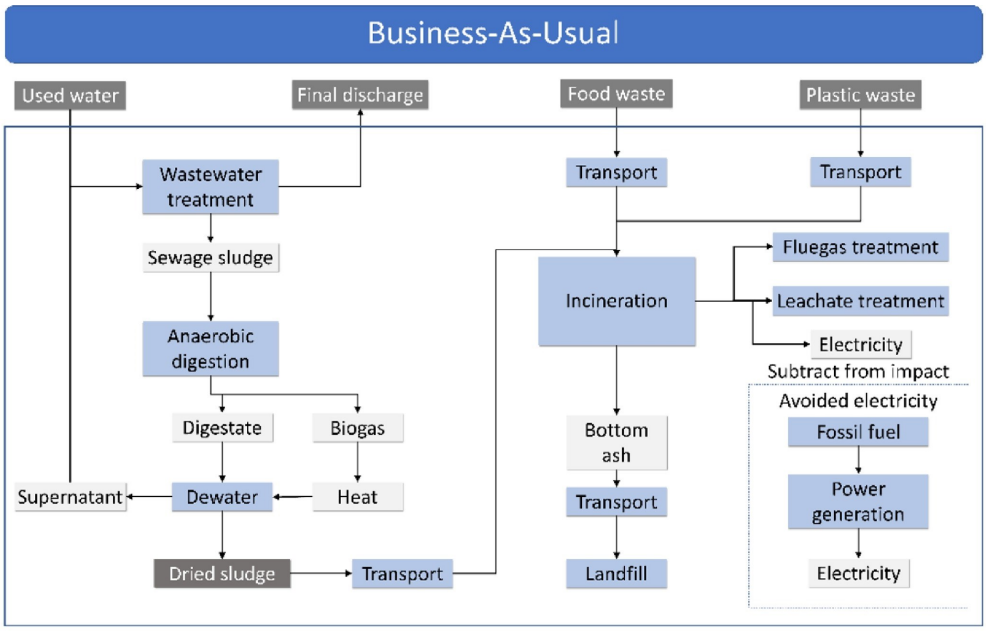
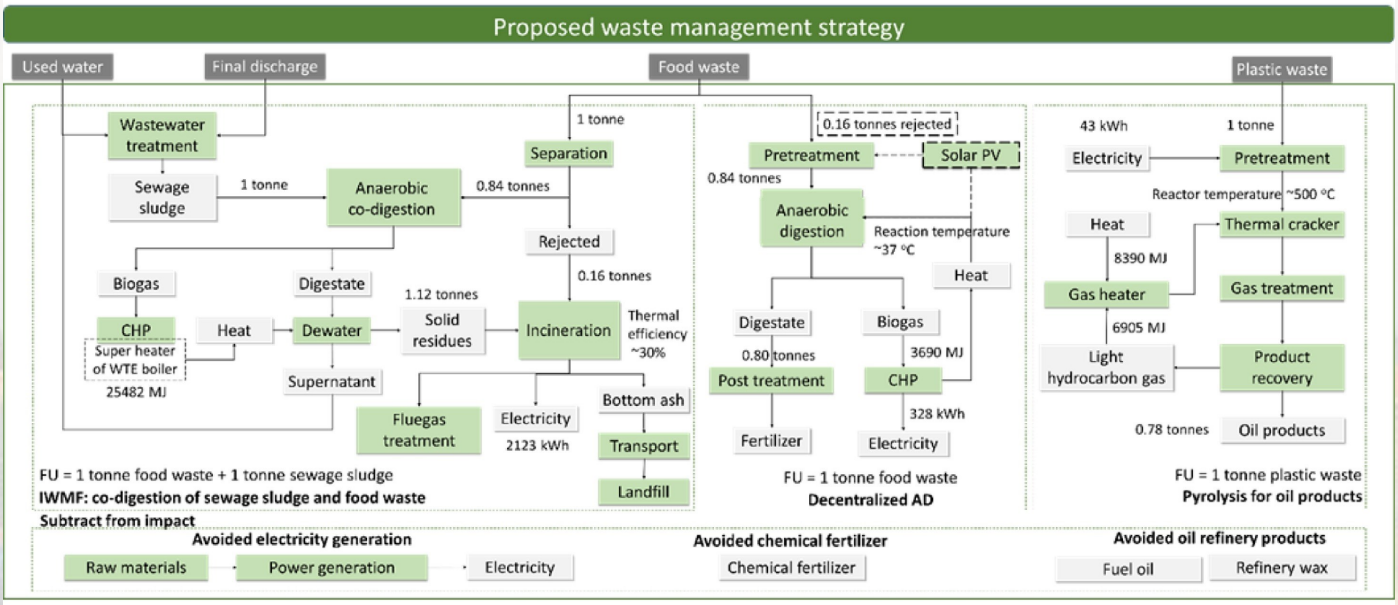


(a)



(b)

Fig. 3. (a) The BAU method of management plastic, sludge and food waste is compared to (b) our proposed integrated waste management framework that channels the recycled by-products into multiple uses.

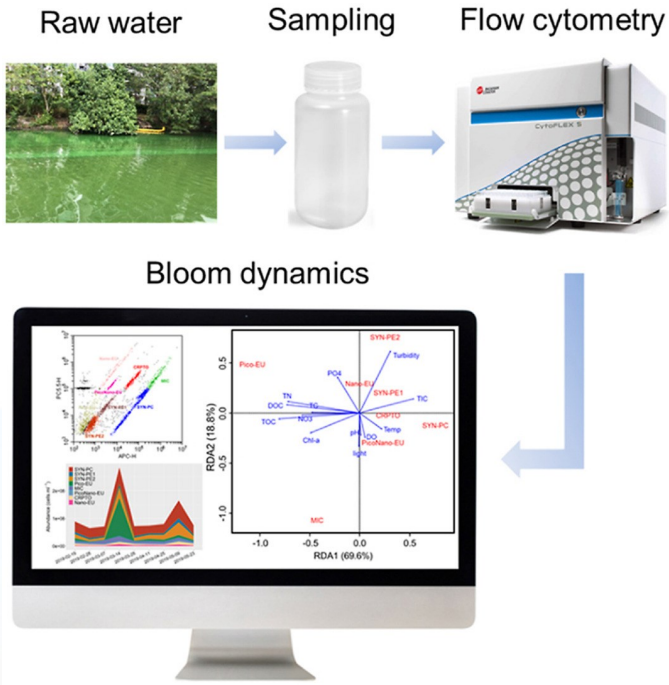
Recent accepted/published papers from E2S2:

2 Phycocyanin-rich Synechococcus dominates the blooms in a tropical estuary lake

Journal: **Journal of Environmental Management**

Authors: **Feijian Mao, Wenxuan Li, Zhi Yang Sim, Yiliang He, Qiuwen Chen, Karina Yew-Hoong Gin**

Keywords: **Flow cytometry; Algal blooms; Estuary lake; Nano- and pico-phytoplankton; Abiotic variables**



Author's words:

Cyanobacterial blooms challenge the safe water supply in estuary reservoirs. Yet, data are limited for the variation of phytoplankton dynamics during an algal bloom event at refined scales, which is essential for interpreting the formation and cessation of blooms. The present study investigated the biweekly abundances and dynamics of pico- and nano-phytoplankton in a tropical estuary lake following a prolonged bloom event. Flow cytometry analysis resolved eight phenotypically distinct groups of phytoplankton assigned to nano-eukaryotes (nano-EU), pico/nano-eukaryotes (PicoNano-EU), cryptophyte-like cells (CRPTO), Microcystis-like cells (MIC), pico-eukaryotes (Pico-EU) and three groups of Synechococcus-like cells. Total phytoplankton abundance ranged widely from 2.4 × 104 to 2.8 × 106 cells cm−3. The phytoplankton community was dominated by Synechococcus-like cells with high phycocyanin content (SYN-PC). Temporal dynamics of the phytoplankton community was phytoplankton- and site-specific. Peak values were observed for SYN-PC, SYN-PE2 (Synechococcus-like cells with low levels of phycoerythrin) and Pico-EU, while the temporal dynamics of other groups were less pronounced. Redundancy analysis (RDA) showed the importance of turbidity as an abiotic factor in the formation of the current SYN-PC induced blooms, and Spearman correlation analysis suggested a competitive relationship between SYN-PC and Pico-EU.

Highlights:

- Flow cytometer resolved eight clusters of phytoplankton.
- The phytoplankton community was dominated by SYN-PC.
- Bloom dynamics were resolved for the eight identified phytoplankton.
- Competitive relationship was identified between SYN-PC and Pico-EU.

E2S2 joint PhD student

- Chu Peng

E2S2 joint PhD student

Chu Peng

Chu Peng obtained his bachelor's degree in Energy and Power Engineering focusing on the study of waste heat recovery and utilization in cooling and heating system. Now he joins in the E2S2 project as a joint PhD student of Shanghai Jiao Tong University and National University of Singapore, supervised by Prof. Yanjun Dai (SJTU) and Prof. Chi-Hwa Wang (NUS).

In NUS, he participates in the research project entitled "Gasification based cogeneration of heat and cooling by using solid waste", on which E2S2 CREATE collaborates with Mursun Pte Ltd. In this research collaboration, the waste heat from the MAGS is utilized as an energy source for the E2S2 CREATE's desiccant dehumidification air conditioning system to upgrade the value of energy products and investigate the overall performance of the integrated system. The feasibility of scaling up the desiccant dehumidification air conditioning system for other applications is evaluated. The project involves the use of municipal solid waste (MSW) conversion to energy and resources through the gasification and dehumidification system. It is common knowledge that high energy consumption and our carbon footprint exacerbates environmental issues. The system aims to rectify this through the elimination of municipal solid waste (MSW) to generate power as well as enhance the strength of mortar. The discoveries subsequently reduce the reliance on concrete imports as mortar incorporated with biochar is a suitable replacement. Hence, the carbon footprint will be lessened. Power can also be more available at a lower cost to the environment.

In summary, the potential benefits reaped from this experiment conducted on a larger scale will have a tremendous impact in terms of power generation and even mitigate environmental issues. This will make strides towards Singapore's goal of Net-Zero Waste.

Paper: P. Chu, Q. Hu, J. Chen, C.Y.-A. Loh, A. Lin, X. Li, et al. Performance analysis of a pilot-scale municipal solid waste gasification and dehumidification system for the production of energy and resource. Energy Conversion and Management. 258 (2022).