Techno-economic tradeoffs of bioenergy recovery and system retrofitting: Expanded treatment service of anaerobic digesters

Anaerobic Digestion I, Room 1 Session IX

14:00 pm – 14:15 pm, 16 June 2022

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Energy and Environmental Sustainability Solutions for Megacities
A joint programme by Shanghai Jiao Tong University and National University of Singapore

Outline

- Background & Challenges
- Approach & Methodology
- Findings & Discussions
- Summary

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Energy and Environmental Sustainability Solutions for Megacities (E2S2-CREATE)

E2S2-CREATE:

To understand and model for policy formulation and technology development, while reaching down from the city-wide model and developing deeper into the implementations at solving specific urban megacity challenges.

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Background

- Urban Waste Management
  - High disposal costs and carbon emissions
  - Circular economy and a net-zero green future

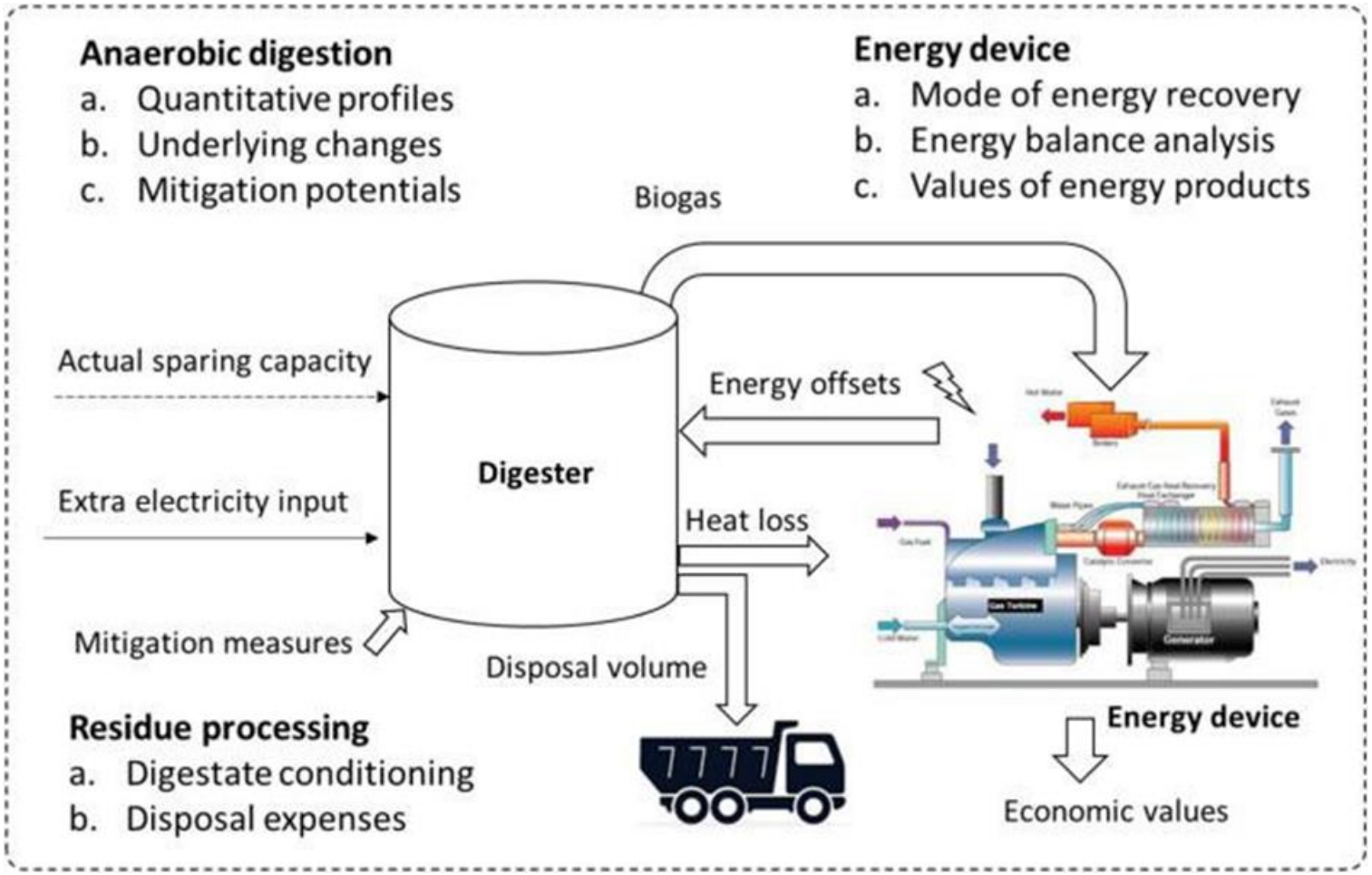
- Urban Constraints and Challenges
  - Fast-changing needs and complexity
  - Space, economic factors, etc.

- <u>Expanded Service of Anaerobic Digesters</u>
  - Decentralized/ Centralized Designs; Spare capacity for longer lifespan
  - Expanded service of WWTPs in recent year e.g. Food waste
  - Lesson learnt: Slow adoption process under existing policy cycles

Challenges

- Benefits and concerns of expanded service
  - Enlarged bioenergy recovery
  - Needs of digestate handling and/ or system retrofitting
- Barriers for decision making (i.e., a system inefficiency)
  - Uncertainty (Probability distribution functions of variables)
  - Consolidation of multiple tradeoffs between gains and inputs
- An evaluation framework (to incentivize market actions)
  - Translating experimental findings into economical context
  - Reasonable pricing mechanism between stakeholders
  - Accelerated regional matching of digesters and disposal needs

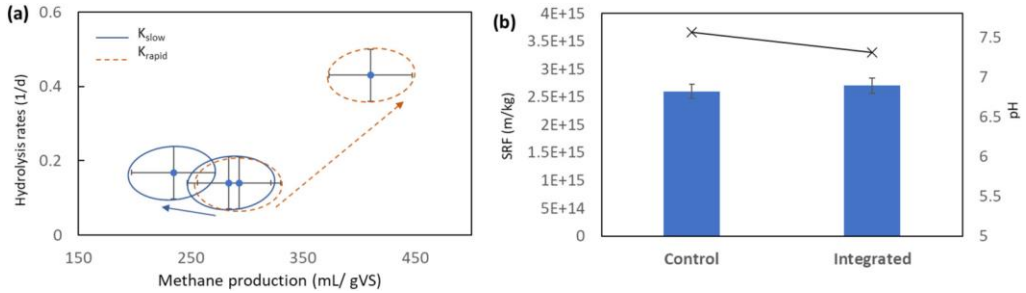
Approach & Methodology

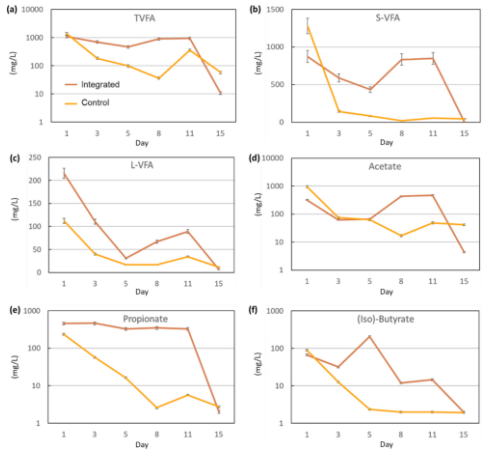


Tsui, T. H., Zhang, L., Zhang, J., Dai, Y., & Tong, Y. W. (2022). Methodological framework for wastewater treatment plants delivering expanded service: Economic tradeoffs and technological decisions. Science of The Total Environment, 823, 153616.

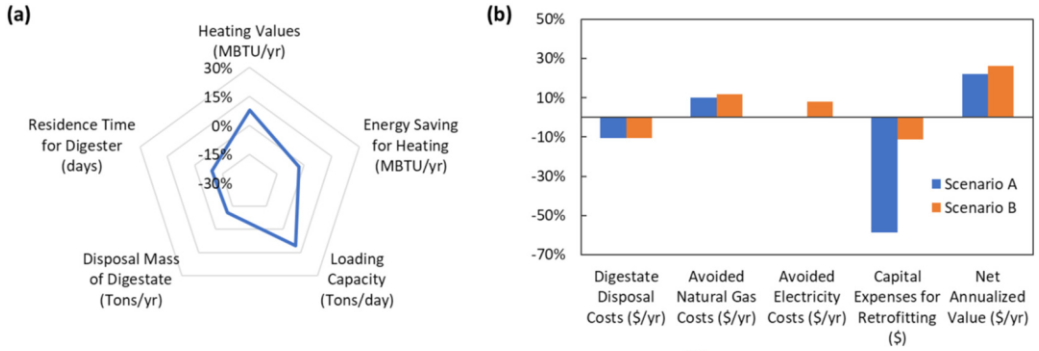
Findings & Discussions

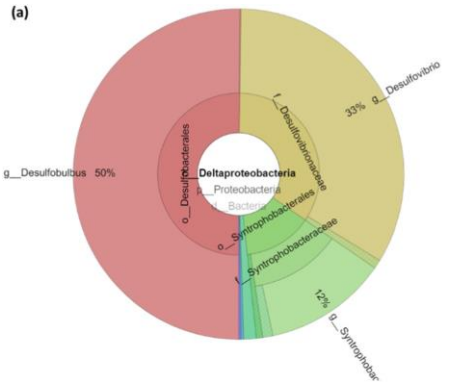
- Step1: Collection of local data (e.g. Demand, Pricing)
- Step2: Experimental validation (=> Quantitative inputs)





- Step3: Potential needs of system retrofitting
  - E.g., Unexpected biochemical electron loss against theoretical value
- Step4: System simulation and uncertainty analysis





Summary

- An approach aims
  - to deal with decision complexity by stakeholders
  - to encounter dynamic changes in urban environments
- Experiment-derived simulation under proposed framework
- Monte Carlo analysis to deliver statistical confidence
- Next: Regional complexity and life-cycle consideration
  - From a dot to network simulation (involving logic trees)

Thank you!

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