An Integrated Multi-Effect Distillation and Adsorption Desalination-Biomass Pyrolysis Approach for Sustainable Water Supply

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Abstract: The polycrisis* has disrupted the energy-food-water nexus in the Asia-Pacific region and effectuates new stresses on the already derailed SDG achievement in the region [1]. With this, innovation** can offer sustainable and cost-effective solutions to meet energy, food, and water needs and ensure an equitable distribution especially to marginalized and vulnerable people in the region [2]. For instance, in the Philippines, Zamboanga del Norte is the top 3 province with the least access to basic service-level drinking water (BSLDW) [3]. The town of Jose Dalman, albeit with an inaccessibility to BSLDW [4], has abundant coconut production with ~2,283 tons/month harvested in 2022 [5] yielding 1,392 tons/month of residue. This can be valorized as a renewable energy source for a novel, less energy-intensive desalination system to address the energy and BSLDW insecurity while not affecting the food value of coconut. Thus, a Multi-Effect Distillation and Adsorption Desalination (MEDAD) system interfaced with a biomass pyrolysis system is proposed (Fig. 1).

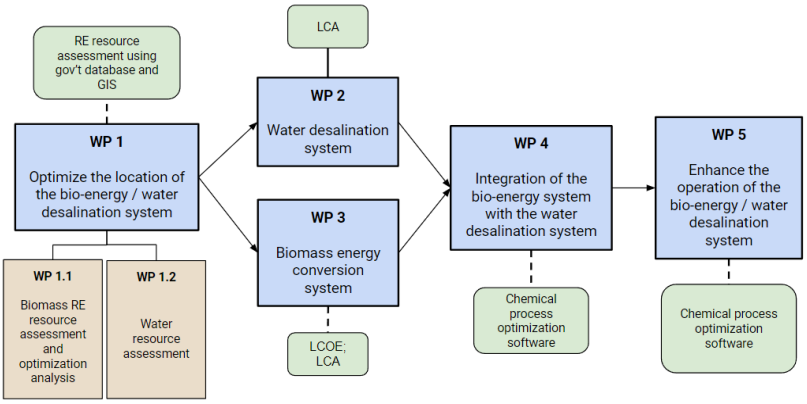

Fig. 1. The conceptual framework of the proposed project divided into work packages (WP).

In this work, technological assessment will be done by matching the energy generation from the pyrolysis products vis-a-vis the MEDAD energy requirements; while economical assessment will be done by levelized cost analyses. The facility location will be optimized by minimizing its distance to farms, the sea, and settlements. The number of distillation units will also be optimized based on system efficiency. The heat from pyrolysis products, bio-oil and syngas vapors will be used to evaporate feed water to generate steam (80 °C) for desalination. The combustion of the vapors will supply the MEDAD with electricity. Finally, the fresh water output will be calculated. Thus, this study demonstrates the process and system design of an integrated MEDAD-biomass pyrolysis system to supply clean drinking water in rural locations with poor access to BSLDW.

Keywords: Resilient Water Solution, Water Scarcity, Biomass Renewable Energy; Multi-Effect Distillation and Adsorption Desalination, Thermal Desalination, Slow Pyrolysis, Coconut,

Related SDG Goals: SDG6, SDG7, SGD 3, SGD 9, SGD 11, SGD 12, SGD 13

References:

* Polycrisis: refers to the current overarching global economic and social crisis.[1] It is comprised of multiple simultaneous crises whose impacts compound each other at the societal and global level. The current "polycrisis" encompasses the longstanding but increasingly severe climate change crisis, the aftermath of the COVID-19 pandemic, and the impacts of the Russian invasion of Ukraine.

[1] Lawrence, M.,et al., "What is a global polycrisis?". Cascade Institute, Technical Paper #2022-4, (September 2022); United Nations Development Programme, "RBAP Foresight Brief: Polycrisis and Long-term Thinking", (2022).

** Innovation: includes new technologies, business models, policy frameworks, and social advances

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[3] Philippine Statistics Authority, "2020 and 2022 Annual Poverty Indicators Surveys"
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[5] Philippine Coconut Authority Zamboanga del Norte Provincial Office "Copra Production/Trend" (2022)