Sustainable Polygeneration Systems for Off-grid Remote Communities

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1. Context

- In many cases, 'last-mile communities', especially in developing island nations, cannot be connected to the electricity grids.
- Aside from electricity, these communities also have other utility needs, e.g. heat, cooling, water.
- Polygeneration systems based on renewable energy sources may be a sustainable solution.

2. Aims

- To evaluate life cycle environmental, economic and social sustainability of different energy technologies for off-grid communities
- To develop future electrification scenarios for representative rural communities in the Philippines
- To assess the overall sustainability of polygeneration solutions identified in the scenarios

3. Methodology

Demand and Resource Estimation

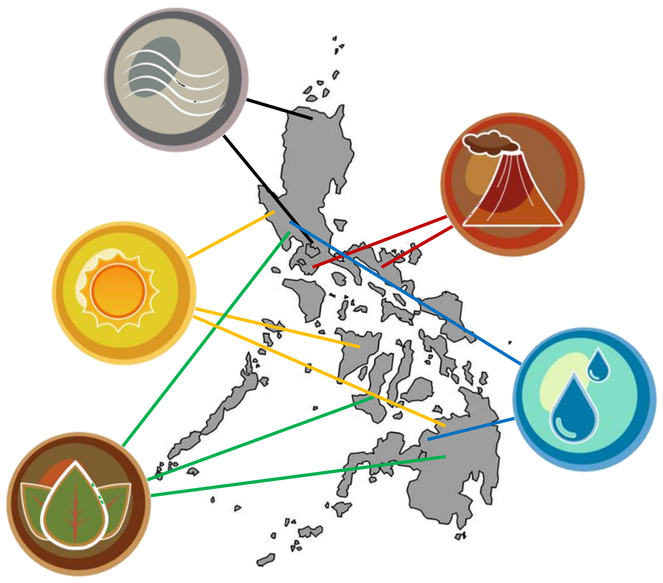

Fig. 1. Location of major renewable power plants in the Philippines

Polygeneration System Design

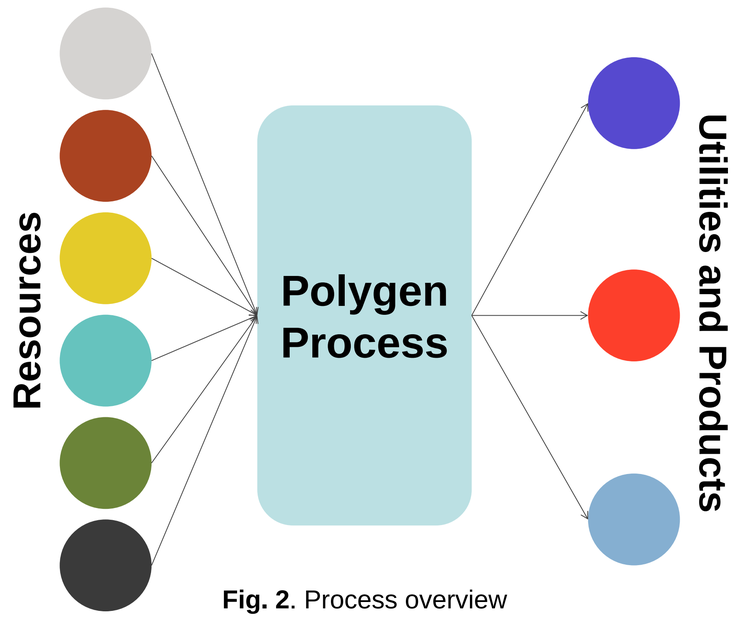

Fig. 2. Process overview

Life Cycle Sustainability Assessment

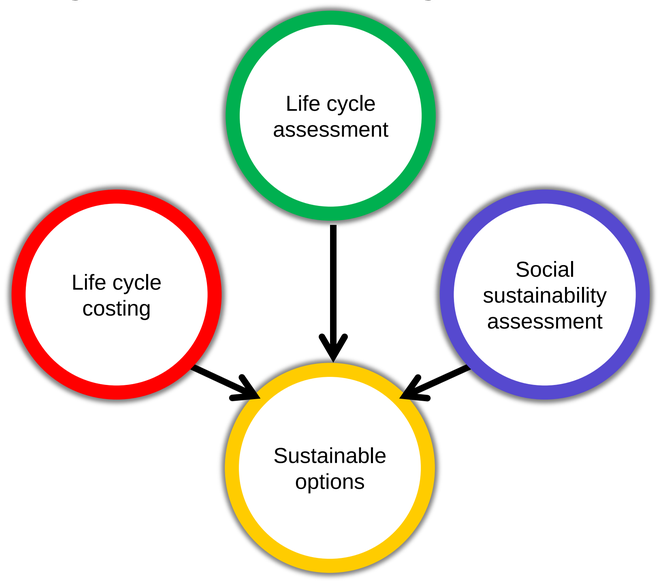

Fig. 3. Life cycle sustainability assessment

4. Results: Life Cycle Environmental Sustainability of Electricity Systems for Polygeneration

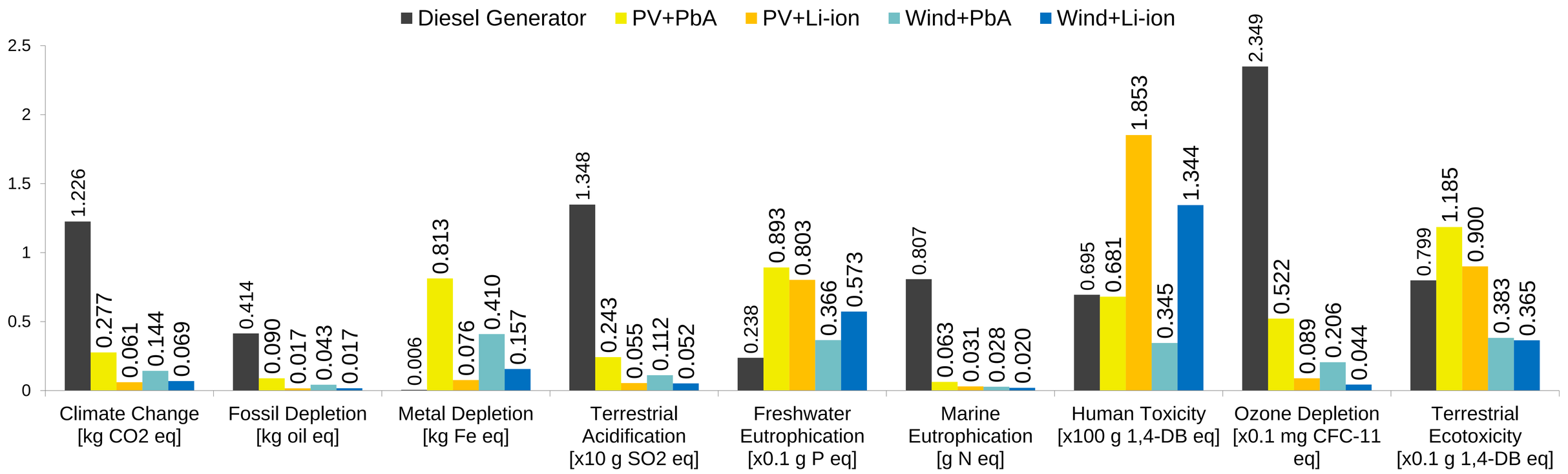

Fig. 4. Selective life cycle environmental impacts (per kWh) of electricity systems for polygeneration

5. Conclusions and Future Work

- Diesel generators are the worst option for nine out of 18 impacts considered in this work.
- Systems with Li-ion batteries are environmentally more sustainable than lead-acid batteries for all but two impacts.
- Batteries can offset some environmental benefits of renewable technologies relative to diesel generators.
- Future work:
  - micro-hydropower, biomass, fuel cells, organic Rankine and Stirling engines, geothermal heat pumps
  - economic and social sustainability assessment, optimisation of system design.

www.sustainable-systems.org.uk

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