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Sustainability of Renewable Energy Implementations in Off-grid Communities

Center for Research in Energy Systems and Technologies
School of Engineering, University of San Carlos

Overview of CREST

- Established in 2015
- Multi-disciplinary research hub engaged in scientific and innovative studies on energy issues in the Philippines
- Actively engaged in R&D works related to energy, environment, and green systems; collaborations between academe, industries, government agencies, and other stakeholders
- Thrusts: **energy education**, **energy conservation**, **energy management**, and **renewable energy**

VISION | *A relevant research hub for developing innovative energy solutions for the good of humanity*

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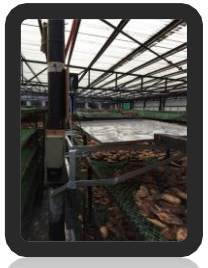
Previous and Ongoing Works

2015-2017

Newton-Fund Institutional Links on solar-powered greenhouse-type dryers with WSNs (Coventry Univ)



Newton-Fund Research Links on Sustainable Energy Ecosystems (with University of Southampton)

2017-2019

CHED-NF Institutional Links – Capacity Building in Research (with University of Southampton)

Project Enkindle with SEED4COM

SEECON Sustainable Energy Ecosystems International Conference

2019-2021

EU-ASEP Visayas Clean Energy Living Laboratory

(with Ateneo de Manila School of Governance)

MAX PLANCK GESELLSCHAFT

Testbeds for low cost ventilation systems for risk reduction of infectious aerosol/virus transmission

2021-present

AboitizPower A Better Future

Boiler tube leaks research

Commission on Higher Education

Curriculum development – green building technologies

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Research Milestones

❑ **Over 20 publications in refereed academic journals**

ELSEVIER

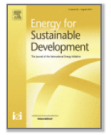
Renewable Energy
Volume 140, September 2019, Pages 905-911

Techno-economic analysis of a cost-effective power generation system for off-grid island communities: A case study of Gilutongan Island, Cordova, Cebu, Philippines

Lorafe Lozano [a], Edward M. Querikiol [b], Michael Lochinvar S. Abundo [c], Luzvisminda M. Bellotindos [d]

ELSEVIER

Energy for Sustainable Development
Volume 70, October 2022, Pages 32-44



Untangling the impact of socio-demographic factors on energy consumption: Why is energy access difficult to achieve in off-grid island communities?

Khrisydel Rhea M. Supapo [a, c], Lorafe Lozano [b, d], Ian Dominic F. Tabañag [a, e], Edward M. Querikiol [a, b, f]

ELSEVIER

Energy Policy
Volume 145, October 2020, 111715

Demystifying the authentic attributes of electricity-poor populations: The electrification landscape of rural off-grid island communities in the Philippines

Lorafe Lozano [a, b], Evelyn B. Taboada [a, c]

Open Access Article

A Backcasting Analysis toward a 100% Renewable Energy Transition by 2040 for Off-Grid Islands

by Khrisydel Rhea M. Supapo [1,2], Lorafe Lozano [3,4], Ian Dominic F. Tabañag [1,5] and Edward M. Querikiol [1,3,6,*]

Open Access Article

A Geospatial Approach to Energy Planning in Aid of Just Energy Transition in Small Island Communities in the Philippines

by Khrisydel Rhea M. Supapo [1,2,*], Lorafe Lozano [1,3,4], Ian Dominic F. Tabañag [1,5] and Edward M. Querikiol [1,3,6]

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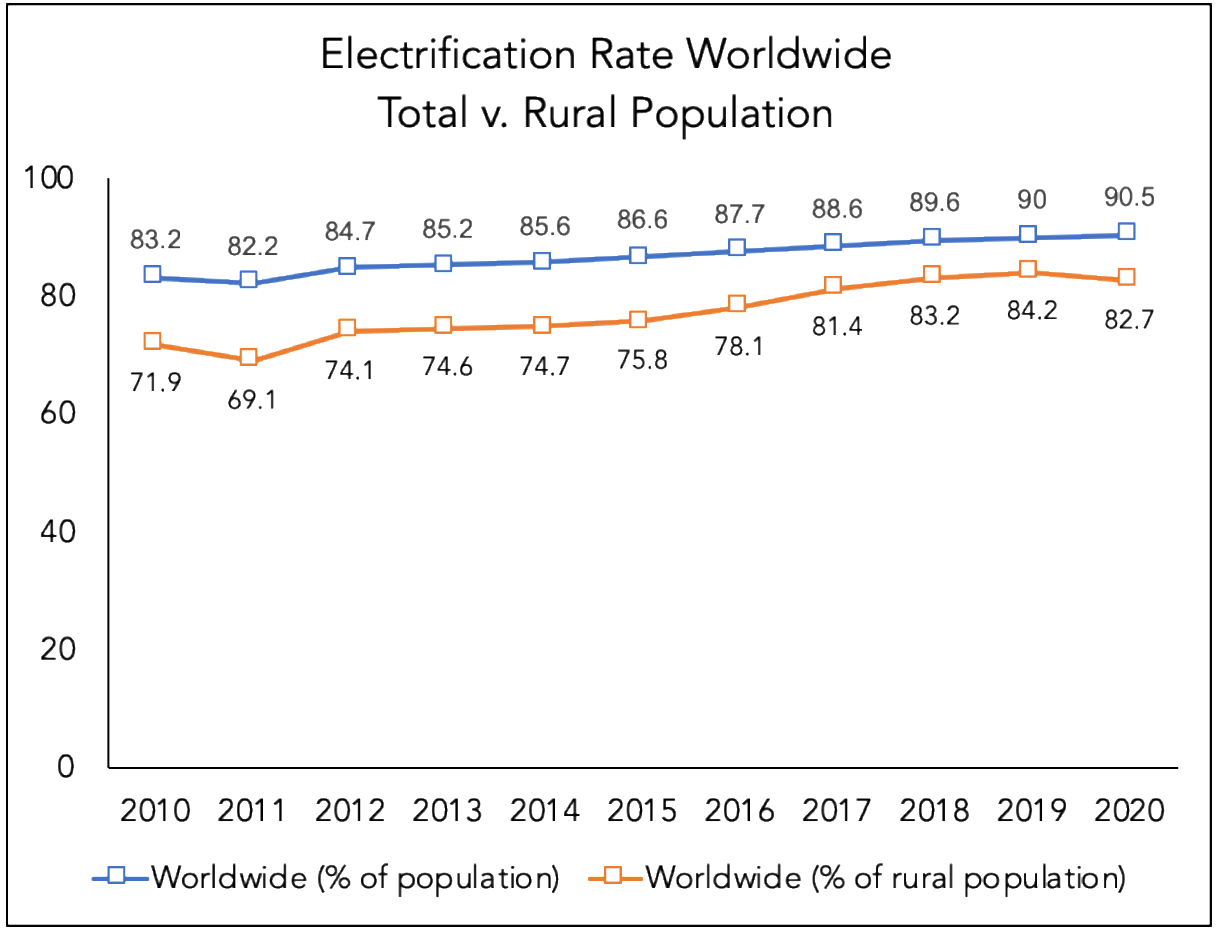
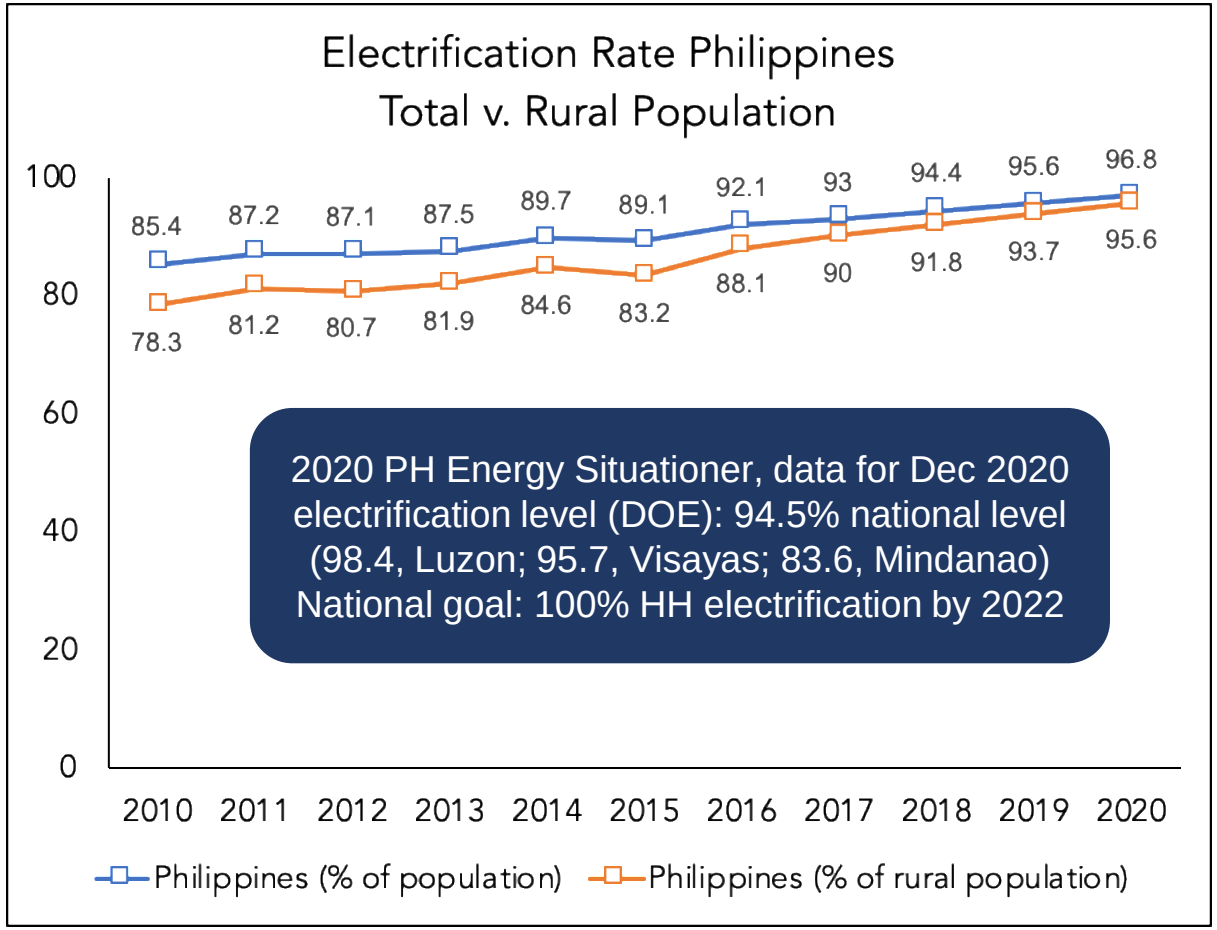
Current Electrification Rate





2020 PH Energy Situationer, data for Dec 2020 electrification level (DOE): 94.5% national level (98.4, Luzon; 95.7, Visayas; 83.6, Mindanao)
National goal: 100% HH electrification by 2022

Source: https://data.worldbank.org

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Philippine Electricity Situation

- Electric Power Industry Reform Act (RA 9136)
- Significantly changed the rural electrification landscape of the Philippines (gov't-initiated v. private sector participation)
- Three general strategies to increase sustainable electricity access (from MEDP):
  (1) Improve private sector participation in missionary areas
  (2) Improve operations and services in missionary areas
  (3) Rationalise the electricity subsidy (UCME)
- Need to consider all the stakeholders at play; no specific grassroots contribution to strategise implementation of energy access in rural communities

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Philippine Electricity Situation

Areas in blue are on-grid

Areas in yellow are off-grid

- 2.7 million Filipino households unelectrified (2016)
- Archipelagic nature of the country = “energy isolation barrier” for small off-grid islands
- Small islands – mostly poor populations with low energy demand; anticipated to have no sustainable market

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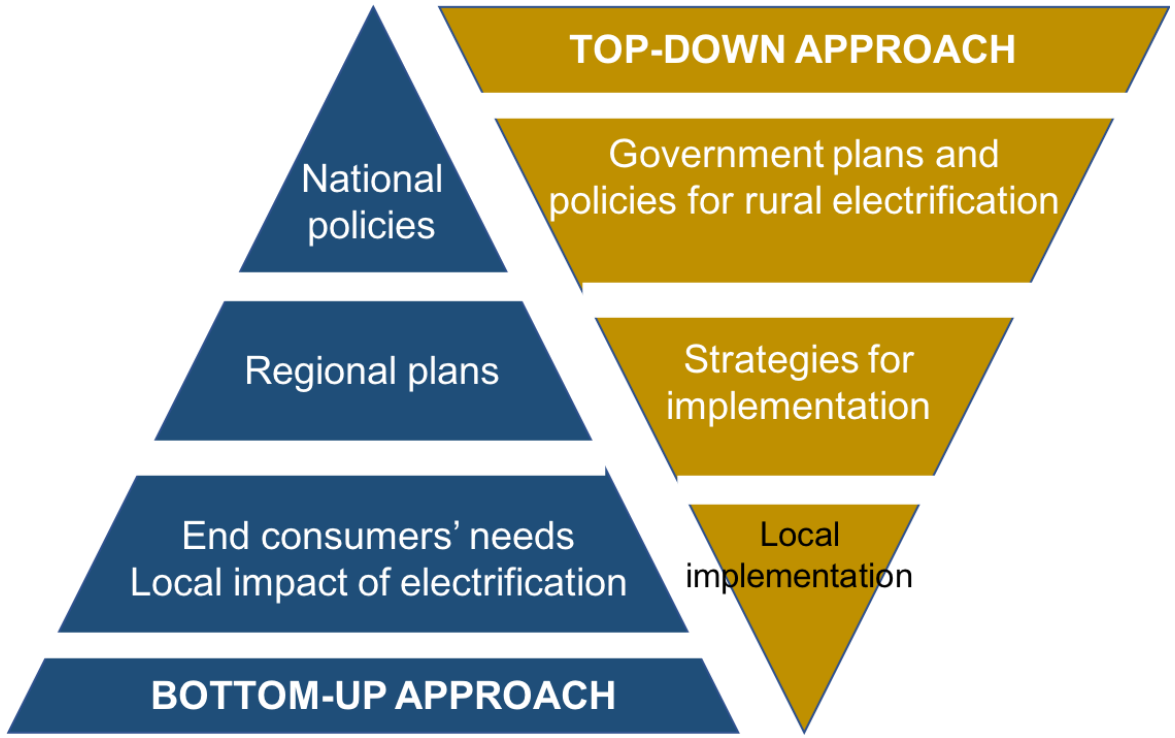
Sustainable Rural Electrification

- Need to incorporate human behaviour and social factor in planning for electrification projects
- Need to look at particular needs of rural consumers rather than plan only from technical and economic perspectives of the project
- Sustainable energy solutions must address energy poverty and foster for socio-economic growth at grassroots level



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Sustainable Rural Electrification

- Barriers to sustainable rural electrification requires us to look further into factors that directly affect rural communities

- A more holistic view of sustainable electrification especially in rural areas where populations have low income and low electricity demand

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Energy Access vis-à-vis Energy Poverty

- Merely being connected to an electricity source is not indicative of the level of electricity access enjoyed by consumers
- Issues on:
  - Affordability
  - Reliability
  - Sustainability
- Question on improvement in socio-economic conditions

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Energy Access vis-à-vis Energy Poverty

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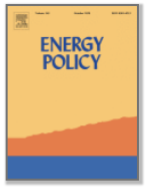

Demystifying the authentic attributes of electricity-poor populations: The electrification landscape of rural off-grid island communities in the Philippines

Lorafe Lozano [a, b], Evelyn B. Taboada [a, c]

[a] Center for Research in Energy Systems and Technologies (CREST) and Engineering Graduate Program, School of Engineering, University of San Carlos, Cebu City, 6000, Philippines
[b] Department of Industrial Engineering, University of San Carlos, Cebu City, 6000, Philippines
[c] Department of Chemical Engineering, University of San Carlos, Cebu City, 6000, Philippines

- Level of electricity access based on World Bank's ESMAP Framework
- Access is assessed based on five tier levels considering six attributes
- Increased access with productive uses of electricity increases tier level of off-grid island communities

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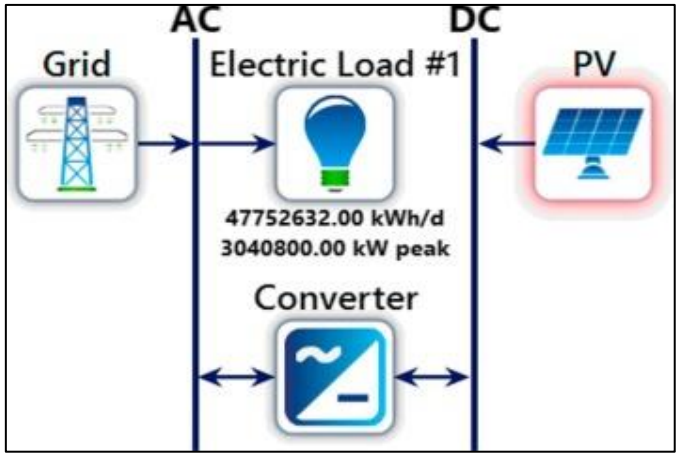
Viability of increasing electricity access in off-grid island communities

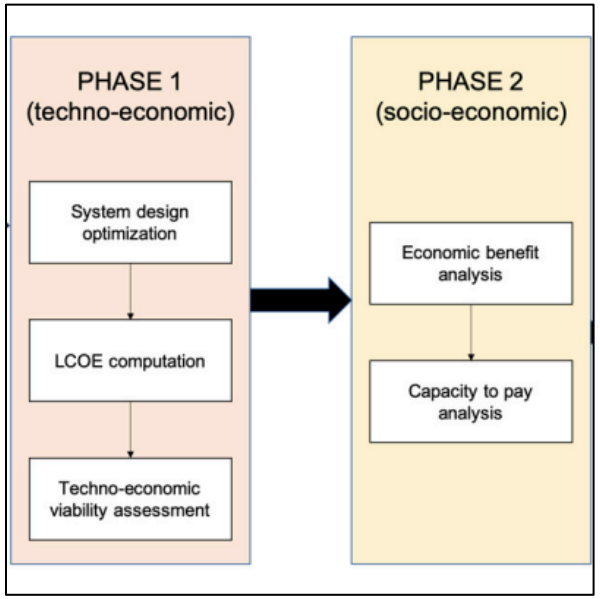


Techno-economic viability analysis

- *Optimisation of system design*
- *Optimum financial results*

Socio-economic viability analysis

- *What is the economic benefit of increased electricity access?*
- *Do the consumers have the capacity to pay?*



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Viability of increasing electricity access in off-grid island communities

- High capital investment for RETs has better pay-off when there is higher demand for electricity
- Consumers receive higher economic benefit as they consume more electricity
- Low income of rural consumers strains their capacity to pay
- Engagement in more economically-productive uses of electricity is necessary

energies

MDPI

Article

The Viability of Providing 24-Hour Electricity Access to Off-Grid Island Communities in the Philippines

Lorafe Lozano [1,2,*], Edward M. Querikiol [1,3] and Evelyn B. Taboada [1,4]

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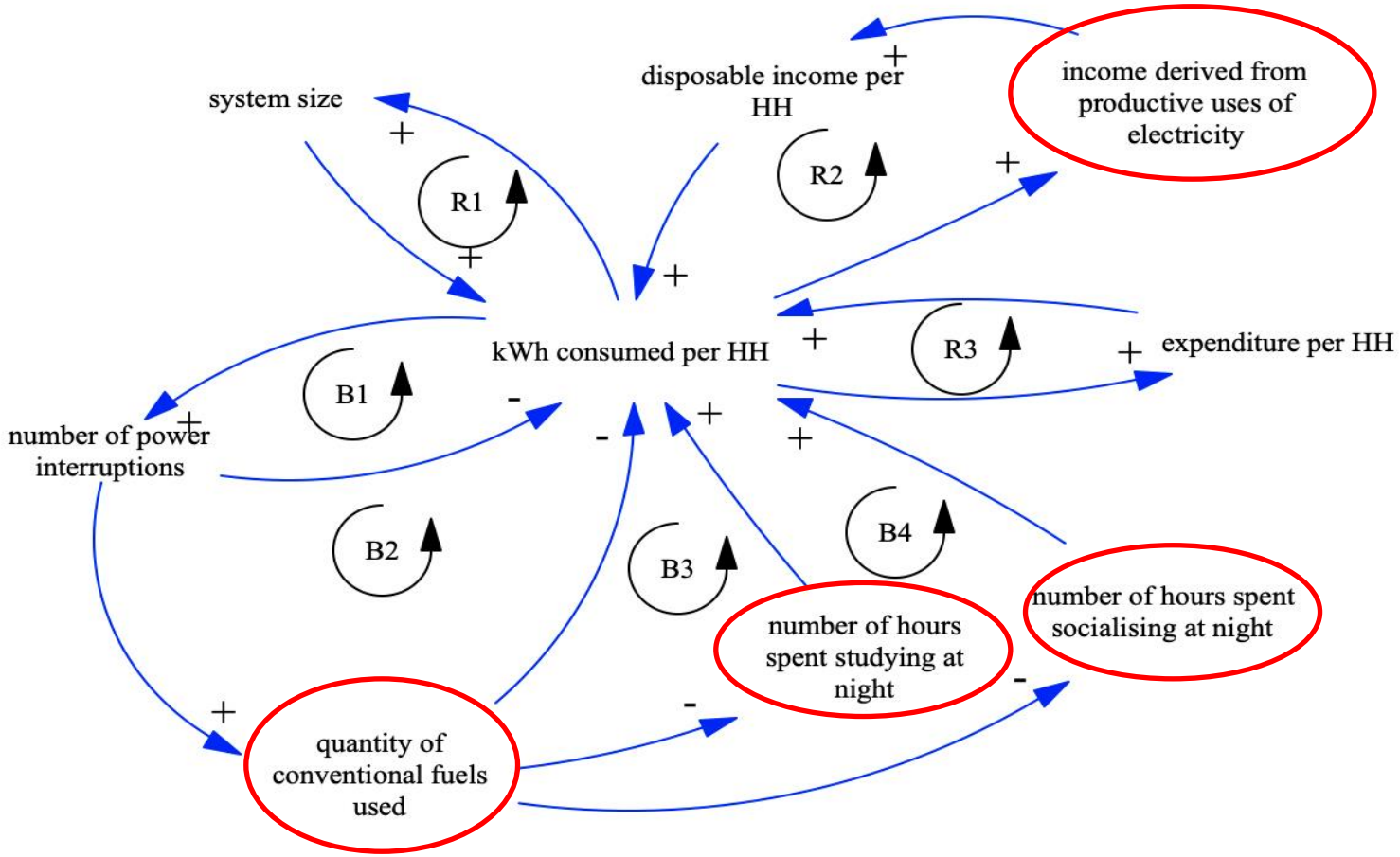
Socio-economic development in off-grid rural communities



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Conclusions and Policy Implications

Improve private sector participation

- Financial viability of projects necessary for private investments **BUT** socio-economic impacts must also be considered
- Longer electricity access paves way for more sophisticated uses but should also promote socio-economic development and advance the livelihood of communities to support affordability of tariff

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Conclusions and Policy Implications

<u>Improve operations and services in missionary areas</u>

- Multi-faceted nature of rural electrification requires strategic approaches in terms of technology options, financing, and institutional scaffolding
- “No single electrification plan fits all”
- Understand where communities are weak in terms of electricity access in order to effectively and efficiently strategise new projects or improve current ones

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Conclusions and Policy Implications

Rationalise electricity subsidy (UCME)

- More holistic and integrated strategy to justify UCME distribution – affordability, duration, quality and reliability of electricity access (both for on-grid and off-grid areas) should not be compromised

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Future Works

SwarmGrids (interconnected microgrid clusters for off-grid island communities)

- DOST-PCIEERD funding
- Power sharing device and algorithm

Business models for renewable electrification of basic services of rural island communities in the Philippines

- Collaborative research with the University of Applied Sciences and Arts Northwestern Switzerland
- Funded by ETH Zurich

Implementation of interconnected microgrids

- Proposal submitted with the Einstein Project of Yonsei University

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