

**ECONOMIC FEASIBILITY OF A HYBRID ENERGY  
SYSTEM FOR KALPITIYA PENINSULA FROM  
SELECTED TECHNOLOGIES**

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Degree of Master of Engineering

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Sri Lanka

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Thesis submitted in partial fulfillment of the requirements for the degree  
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## DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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Prof. R.A Attalage

## **ABSTRACT**

Economic feasibility of having a grid connected hybrid energy system, consist of wind, solar, biomass (rice husk) & municipal solid waste (MSW) technologies for Kalpitiya peninsula was studied. Four (04) different microgrid configurations were simulated in HOMER Pro (Hybrid Optimization of Multiple Electric Renewables) for a project life time of 20 years and the economics of each case was compared with the base case, where Kalpitiya peninsula is fed from fossil fuel based (i.e.: diesel) power transmitted through main utility grid. Electricity demand data of Kalpitiya peninsula in every 30 minute interval throughout a day were obtained for the days in calendar year (2018) from Puttalam grid substation (feeder 03) to derive averaged hourly load profile and to study the daily, monthly variation. Average electricity demand in April was found to be the highest of all months in the year and average load in a typical day was 125056.52 kWh with a daily maximum of 8320.5 kW. Considering the recent global market costs trends of installation, operation and maintenance of renewable energy resources as well as the availability of resources, in Sri Lankan context four (04) different configurations of microgrids were simulated in HOMER Pro with the motive of ensuring 100% power supply throughout the project lifetime of 20 years. Most economical option in a private investors' perspective was a microgrid with wind, solar, biomass (rice husk) & municipal solid waste (MSW) in the system which has a discounted payback period of 2.68 years. However, in the perspective of Ceylon Electricity Board, the most economical microgrid consist of wind, solar & biomass (rice husk), where annual cost saving against the base case of LKR 350.5 Mn equivalent to 'stop running' a 1 MW diesel generator for 353 days per year. Sensitivity analysis was performed limiting the grid sales for each microgrid configuration proved that net energy purchase was lowest when the grid sale capacity was 10000 kW. Any of microgrid combinations was not possible to operate in island mode due to the intermittency of renewable resources. However, it was evident that none of the configurations considered solar energy is significant due to the high dominance in wind, biomass & MSW resources.

**Key words: Kalpitiya, Microgrid, Renewable energy, HOMER Pro**

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## **LIST OF ABBREVIATIONS**

| Abbreviation | Description   |
|--------------|---|
| AC           | Alternating Current                                 |
| AGC          | Automatic Generation Control                        |
| AWLR         | Average Weighted Lending Rate                       |
| CAIDI        | Customer Average Interruption Duration Index        |
| CAIFI        | Customer Average Interruption Frequency Index       |
| CEB          | Ceylon Electricity Board                            |
| CCM          | Continuous Conduction Mode                          |
| DCM          | Discontinuous Conduction Mode                       |
| DC           | Direct Current                                      |
| DER          | Distributed Energy Resources                        |
| DG           | Distributed Generator / Distributed Generation      |
| GHI          | Global Horizontal Irradiation                       |
| GSC          | Grid Side Converter                                 |
| HOMER        | Hybrid Optimization of Multiple Electric Renewables |
| IEEE         | Institute of Electrical and Electronics Engineers   |
| IRENA        | International Renewable Energy Agency               |
| JICA         | Japan International Cooperation Agency              |
| LCLTGEP      | Least Cost Long Term Generation Expansion Plan      |
| LCOE         | Levelised Cost of Energy                            |
| LDC          | Load Duration Curve (LDC)                           |
| ERCOT        | Electric Reliability Council of Texas               |
| LSC          | Load Side Converter                                 |
| LVPP         | Lakvijaya Power Plant                               |
| MEM          | Microgrid Energy Manager                            |

|        |   |
|--------|---|
| MOSFET | Metal Oxide Semiconductor Field Effect Transistor |
| MPPT   | Maximum Power Point Tracking                      |
| MSW    | Municipal Solid Waste                             |
| NASA   | National Aeronautics and Space Administration     |
| NCRE   | Non-Conventional Renewable Energy                 |
| NPC    | Net Present Cost                                  |
| NREL   | National Renewable Energy Laboratory              |
| NSSWM  | National Strategy on Solid Waste Management       |
| ORE    | Other Renewable Energy                            |
| PC     | Point of Connection                               |
| PCC    | Point of Common Coupling                          |
| PI     | Proportional Integral                             |
| PMS    | Power Management Strategy                         |
| PUCSL  | Public Utilities Commission of Sri Lanka          |
| PV     | Photovoltaic                                      |
| PWM    | Pulse Width Modulation                            |
| RDF    | Refuse Derived Fuel                               |
| RSC    | Renewable Side Converter                          |
| SAIDI  | System Average Interruption Duration Index        |
| SAIFI  | System Average Interruption Frequency Index       |
| SCADA  | Supervisory Control and Data Acquisition          |
| SLSEA  | Sri Lanka Sustainable Energy Authority            |
| SSC    | Storage Side Converter                            |
| SWM    | Solid Waste Management                            |
| USA    | United States of America                          |
| VSC    | Voltage Sourced Converter                         |



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