1.1 billion people around the world have little to no access to reliable electricity. Electricity access is essential to economic growth and development, but cost and physical barriers make it such that connection to the central grid is years away for many rural communities. As shown in Figure 1, many areas in South Africa are still unelectrified. Microgrids can bring power to these communities at a smaller scale, giving them the economic benefits of electricity access without the costs of connecting to the larger grid. Powering the many areas in South Africa are still unelectrified.

Figure 1) through the implementation of a microgrid. HOMER, a program developed by the National Renewable Energy Laboratory (NREL), models microgrids' physical behaviors and costs, was the main tool used in evaluating different microgrid configurations. This analysis proposes three different microgrid configurations and assesses their technical and economic feasibilities.

**Introduction**

<table>
<thead>
<tr>
<th>Community Size (households)</th>
<th>Electric Load (kWh/day)</th>
<th>Peak Load (kW)</th>
<th>PV (kW)</th>
<th>Wind (kW)</th>
<th>Biogas Generator (kW)</th>
<th>Storage (kW)</th>
<th>Converter (kW)</th>
<th>Cost of Energy</th>
<th>Net Present Value (25 years)</th>
<th>Operating Cost</th>
<th>Initial Cost</th>
</tr>
</thead>
<tbody>
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<td>83.1</td>
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</tr>
</tbody>
</table>

**Model Assumptions**

- Electric Load: linear increase with community size
- Cattle Waste: linear increase with community size, 2.5 Cattle/Household, 15kg waste/cattle/day, 25% waste reclaimed
- Annual electric load increase of 1.5% (Multi-Year Model)
- Inflation = 6.5%, Nominal Discount Rate = 8%
- Controller capital, replacement, and operation and management costs unknown; assumed zero
- Conversion rate: 1 USD: 0.07 ZAR
- Average household income: USD $1080.4
- Does not consider cost of transmission infrastructure

**Environmental Impacts**

- <0.01% CH4 reduction per year
- Potential 25% N2O reduction per year
- Minimal negative battery impacts
- Spatial impacts of the wind and solar resources could affect agriculture in the area

**Conclusion**

Rural microgrids using combinations of wind, solar PV, and biogas combustion for this region of South Africa are technologically feasible, but will require subsidization from government or NGO sources to be economically viable. However, all three models produce high quantities of excess electricity given their dependence on variable wind and solar coupled with storage. If communities were able to take advantage of unpredictable excess electricity through flexible manufacturing operations that generated income, the systems may become economically viable without subsidization. Likewise, the high likelihood of grid connection throughout SA within 25 years presents opportunities for communities to sell excess electricity to the grid, increasing the economic viability of the systems.

**Sensitivity:** All models are highly sensitive to the availability of cattle waste. In areas that have concentrated livestock operations, the higher availability and lower cost of biomass alter the composition of energy resources to favor biogas combustion, lowering the system cost.

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