

Projects that could be performed in Rwanda for 5 Years between CSU and ACE-ESD/UR:

The following project list was developed in conjunction with Jerry Duggan, Daniel Zimmerle, Kurt Barth Walajabad Sampath of CSU in Partnership with Prof. Etienne Ntagwirumugara from African Center in Energy for Sustainable Development. The list represents an initial list of projects that could be performed using the laboratory at UR/CST either independently, or in conjunction with CSU.

1. Microgrid Control Topics
 - a. Developing growth strategies to grow grid from “bottom up.” How to connect multiple microgrids to do regional power systems.

2. Load Development & Configuration
 - a. Developing motor systems (e.g. compression, water pumping, etc) that are compatible with microgrid power systems.
 - i. Examples: Testing for multiple parties
 - ii. Development of low-cost soft-starters or VFD for small equipment
 - b. Integrated metering, voltage shifting, and protection
 - i. Use next generation power electronics to reduce the cost and improve performance of customer end-point systems
 - ii. Integrated metering: Customer billing meters that are integrated into the power shifting equipment.
 - iii. Distance protection for small systems to reduce cost of breakers and fuses
 - c. Power requirements & solutions for small enterprises
 - i. Example: Find small business applications that require power and develop specific, packaged solutions, that make these operations more efficient + allow them to work on renewable, low-cost energy
 - ii. Artisan mining operations: Pumping, screening, etc.

3. Generation Device & System Development
 - a. Pico-hydro systems
 - i. Developing efficient, low-cost, small, hydropower turbine systems that can work well with a range of heads and water flow rates
 - ii. Sized for African mountain conditions, stream flow rates, proximity to villages, etc.
 - iii. Tolerant to silt loads common in Rwandan streams
 - iv. Field study / survey to determine the needs and current capabilities
 - v. Laboratory testing + field testing in special locations
 - b. Locally-specific solutions / improvement to PV deployment, balance-of-plant, and maintenance.



- i. Improved PV cleaning solutions for panels mounted at low angles (essentially horizontally)
 - ii. Mounting systems that appropriate for village environments – on roofs, in village squares, how to protect inverter or converter equipment, improved cooling for power electronics, etc.
- 4. Techno-Economic Studies
 - a. Improve the sizing of PV, or PV-engine-hybrid, systems for a variety of practical applications
 - i. Villages
 - ii. Schools
 - iii. Clinics
 - iv. Small enterprises or agricultural processing
- 5. Testing and Certification of Devices
 - a. Rwanda/Africa-specific testing of key devices, such as PV panels, inverters, etc.
 - b. Potentially working with Rwanda standards boards or East African standards efforts.
 - i. Fast testing for basic certification
 - ii. In depth testing to develop or refine standards

Additional, lower-priority options

- 6. Sensor networks for microgrid control or environmental sensing
 - a. Develop and deploy low-cost sensor arrays for variety of environmental sensing applications



Acknowledgements:

ACE-ESD of Rwanda

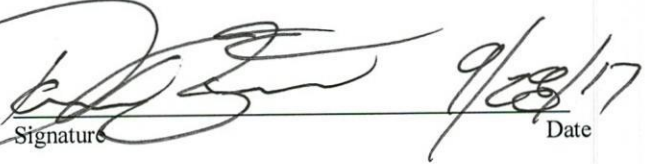

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