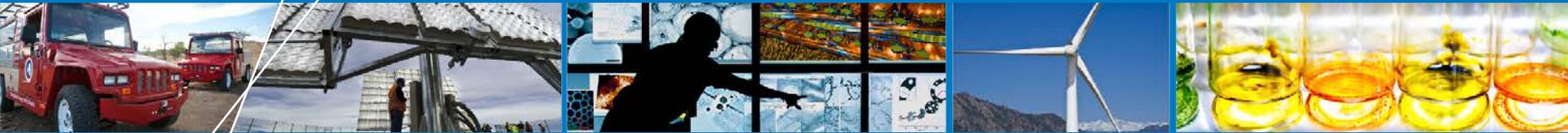


Off-Grid Hybrid Power Generation Systems



Tribal Energy Webinar

Robert Butt, P.E.

29 April, 2015

Remote Community Minigrids

Small, Simple Power Systems

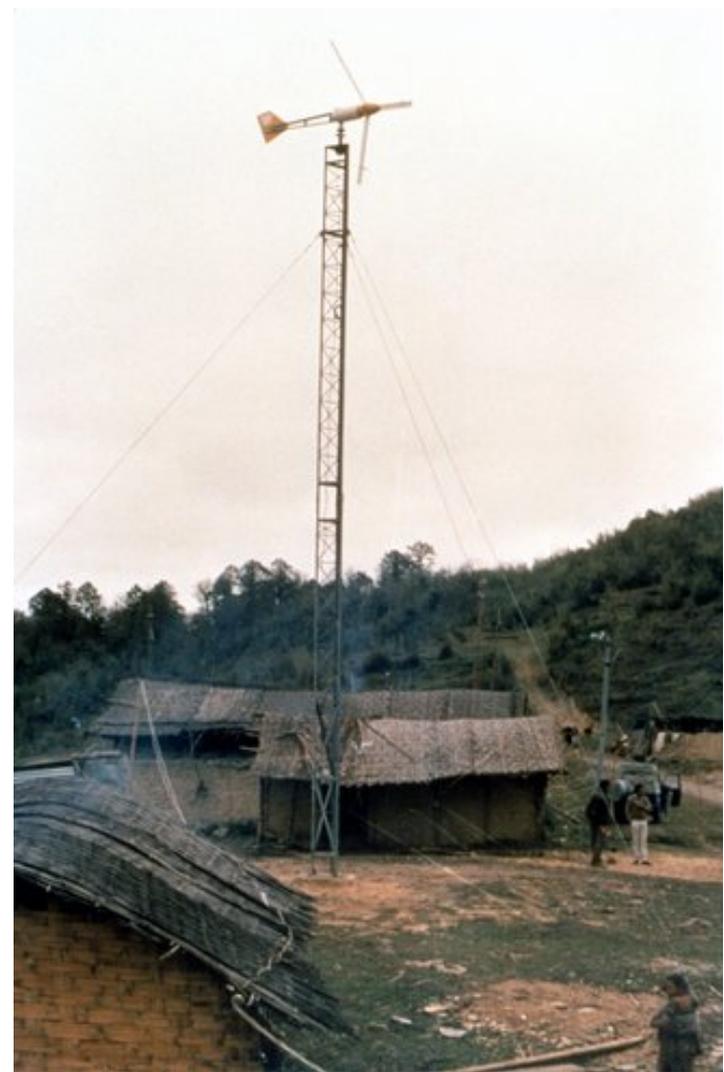
- Supply communities with small daily electrical loads
- Power generation components may include wind, solar PV, miniature hydro, biomass, and batteries
- Use of batteries to store excess renewable energy for use at night or low renewable energy availability
- Mature market
- Design very dependent on renewable resources, cost of equipment and fossil fuel supply, life cycle costs, etc.



NREL PIX 6501

Small or Simple Power Systems

- Used for very small electrical loads (lighting, battery chargers, small appliances) which do not require a backup generator to ensure power supply
- Very simple architecture:
 - Solar PV and/or wind turbine
 - Batteries (optional)
 - Power system infrastructure (fuses, cables, plug-in points, etc.)
- Primarily PV-dominated for small loads, wind or combination at larger loads



NREL PIX 1477

Remote Community Minigrid Characteristics

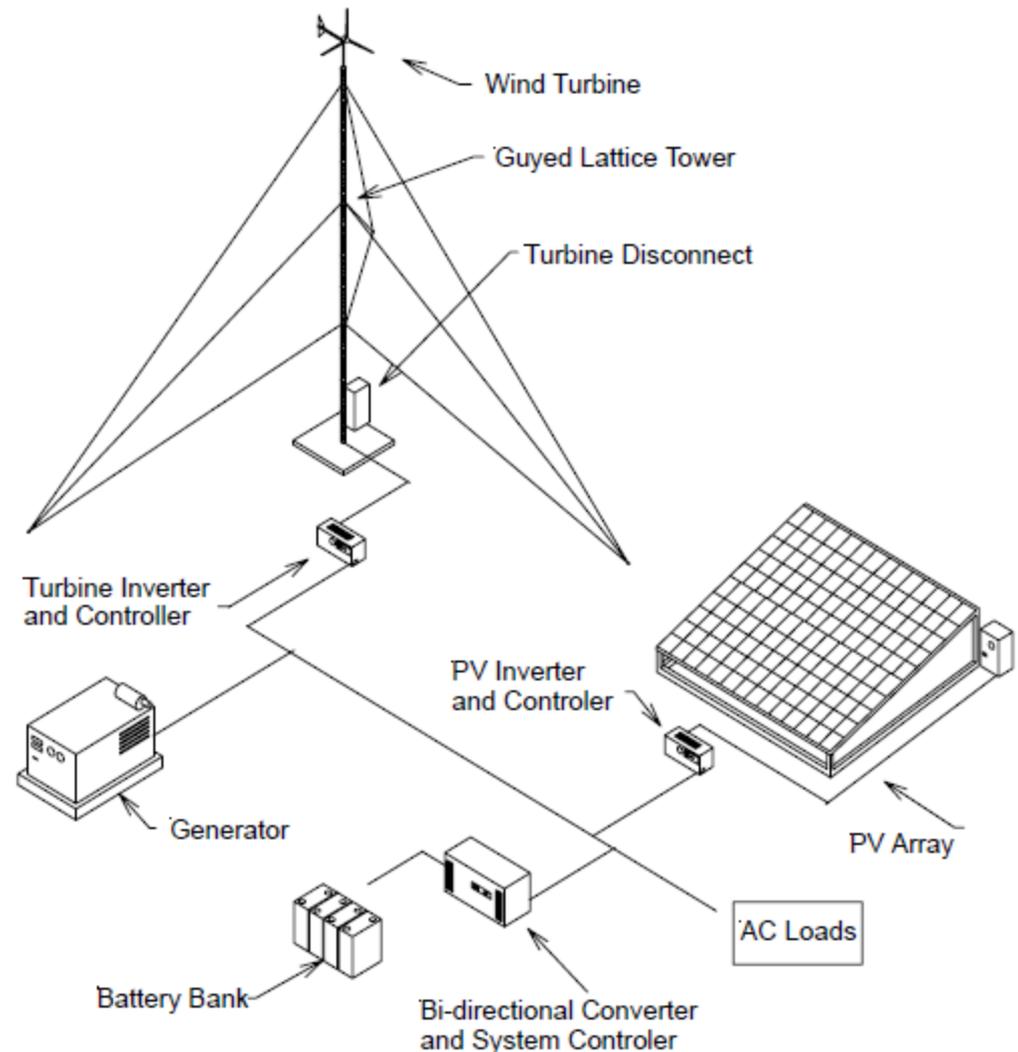
- Small systems (typically <10 buildings)
- Harsh environments
- No connection to, or long distance from nearest bulk power grid
- Limited fuel and equipment availability
- Lack of adequate O&M
- Poor power quality & reliability



Photos: Ted Spooner,
UNSW Australia

Hybrid Power Systems

- Hybrid power systems are more complex and made up of separate pieces of equipment that are brought together to form a cohesive electrical system
- Balance of both generation and load is challenging
- Hybrid power systems can be used to limit or reduce the dependence on costly diesel fuel and provide reliable power to remote communities



Intermittent Renewable Generation Solution

Agricultural Water Pumping

Livestock watering at the Bledsoe Ranch Colorado, USA

Hybrid Wind/PV Systems

- Provides more energy than a single source
- Lower cost per watt than diesel or single source
- Diversity of resources - solar PV, wind and diesel backup combination solves problems with seasonal variations in energy resources



NEOS Corporation

Hybrid Systems Supplying Aboriginal Communities in Remote Australia

- Solar is an intermittent resource, and diesel generators compensate for clouding activity
- Battery systems further reduce diesel fuel consumption
- Generation must match load

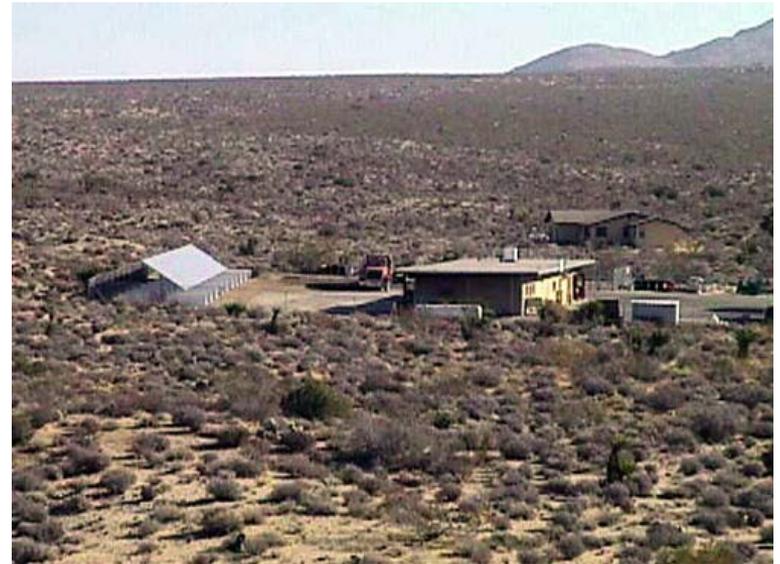


Bushlight Project,
Alice Springs, Australia

Photos: Ted Spooner, UNSW Australia

Joshua Tree National Park's Cottonwood Campground

- Provides power for a NPS visitor center, three houses, a duplex, a maintenance building, two small offices, and two pads for campground hosts.
- 20.5 kW PV array, 250 kWh battery bank, 30kW inverter and a 30 kW backup propane generator.
- Replaced two 32 kW diesel engines using ~10,000 gal/y
- Cost ~\$273k to implement but expected to save ~\$45k/year in operating expenses but also greatly reduced air emissions

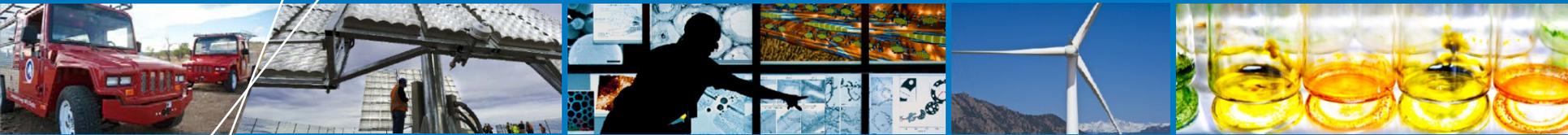


Intermittent Renewable Generation

Dangling Rope Marina, Utah

- Remote National Park Service ranger and support center in Glen Canyon NRA
- Powers ranger station, restrooms, boat fuel and service station, supply store and communications
- Excellent solar resource
- 160 kW PV / Propane generator hybrid system





Thank You!

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