

Energy Storage Opportunities and Challenges in Improvised Rural Micro Grids

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Assistant Professor

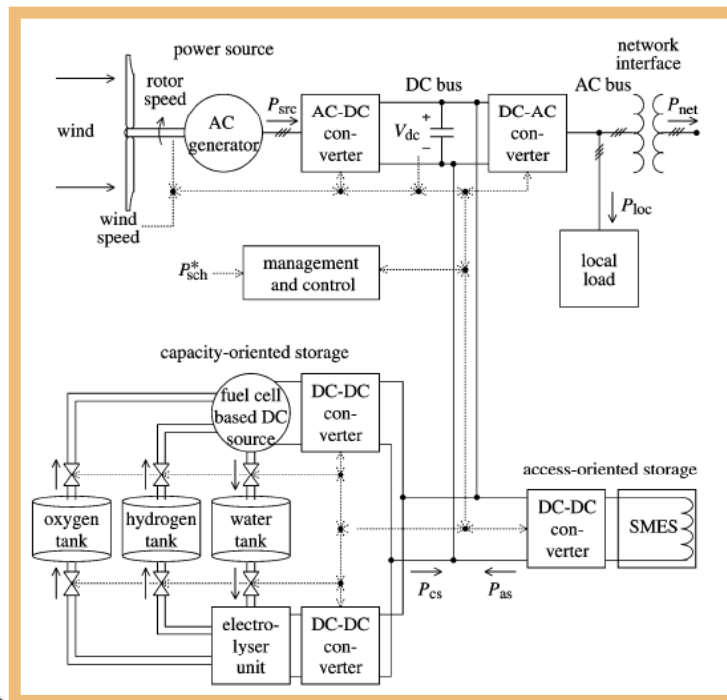
Seattle University

26 September 2012

Great Lakes Energy Symposium

Chicago, IL

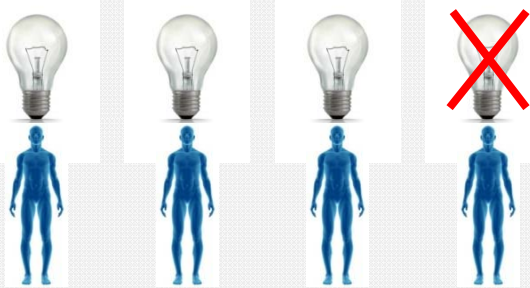
Nearly all designers make products for the richest 10 percent of the world. -paraphrased from Paul Polack



Advanced wind turbine + hydrogen storage + SMES system

Energy Poverty

1.6 billion people without regular access to grid



Cellular phones, radios, etc. proliferation rates surpass electrification rates



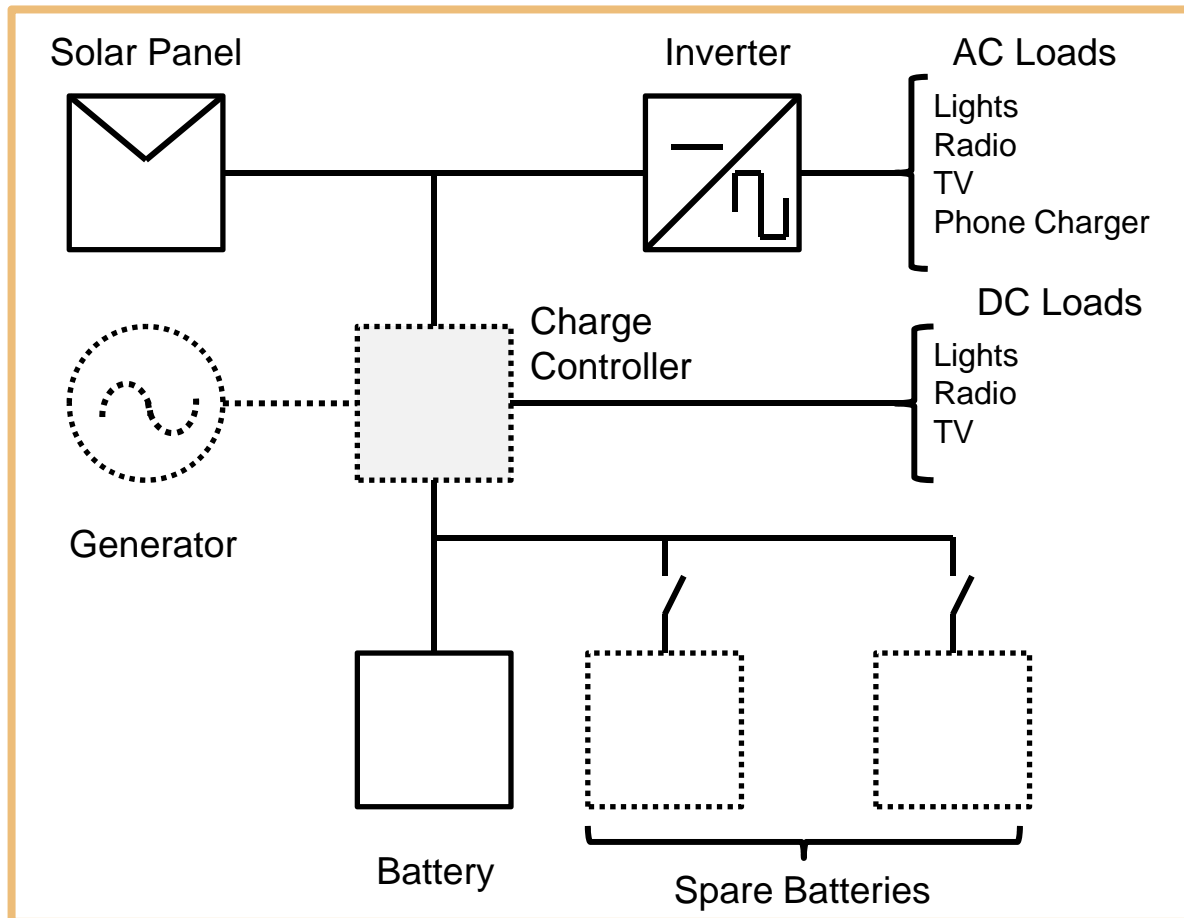
Fees to charge batteries are ~1000 times \$/kWh in the US



Off-grid improvised systems with energy storage are common



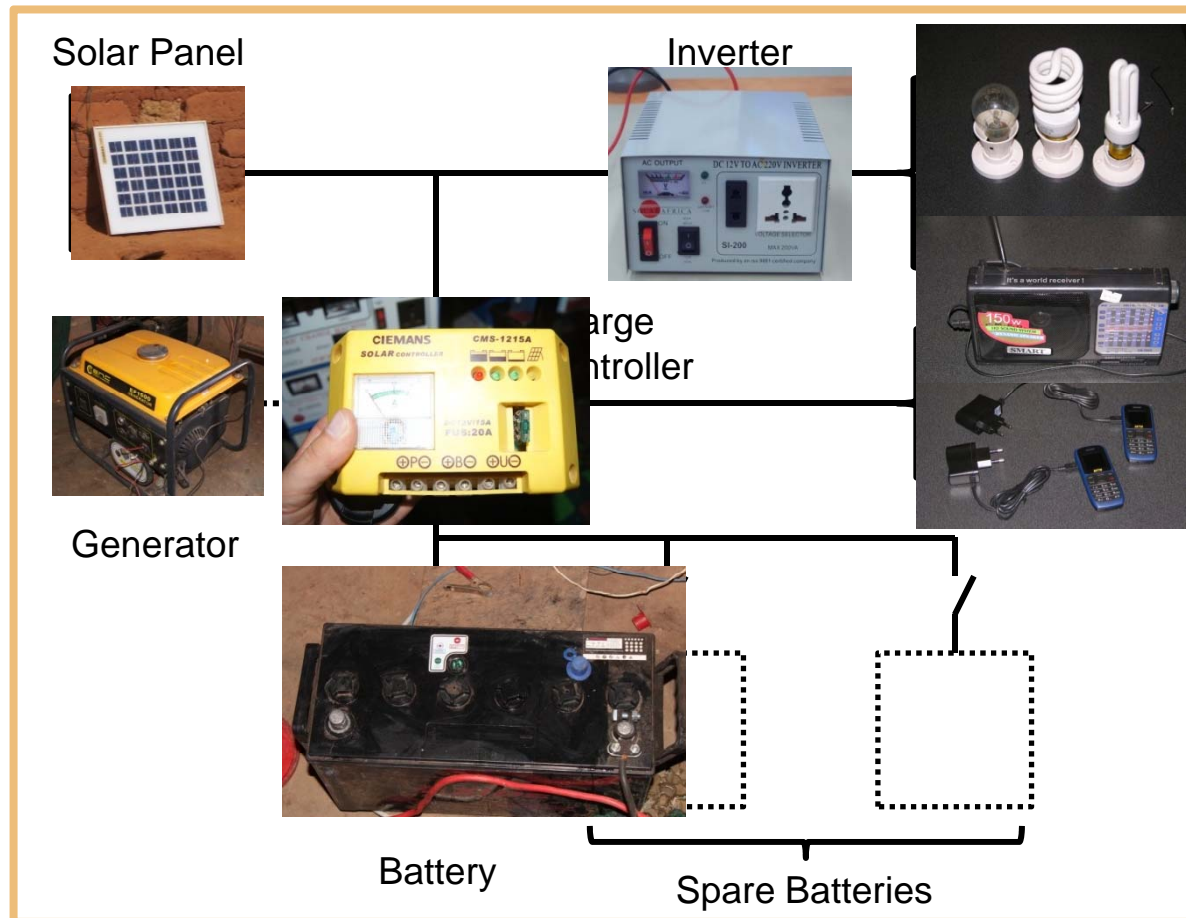
Improvised Rural Micro (pico?) Grid Systems



Characteristics

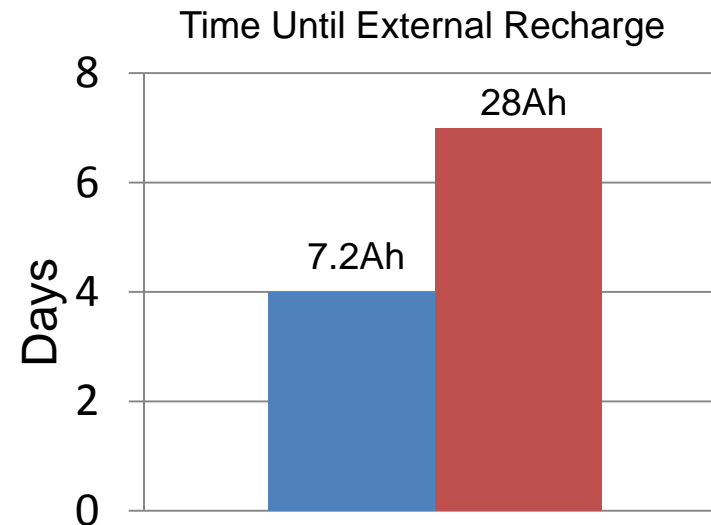
Modified sine wave inverter
Lead acid battery <70Ah
<30 W Solar panel
No meters, fuses

Improvised Rural Micro (pico?) Grid Systems

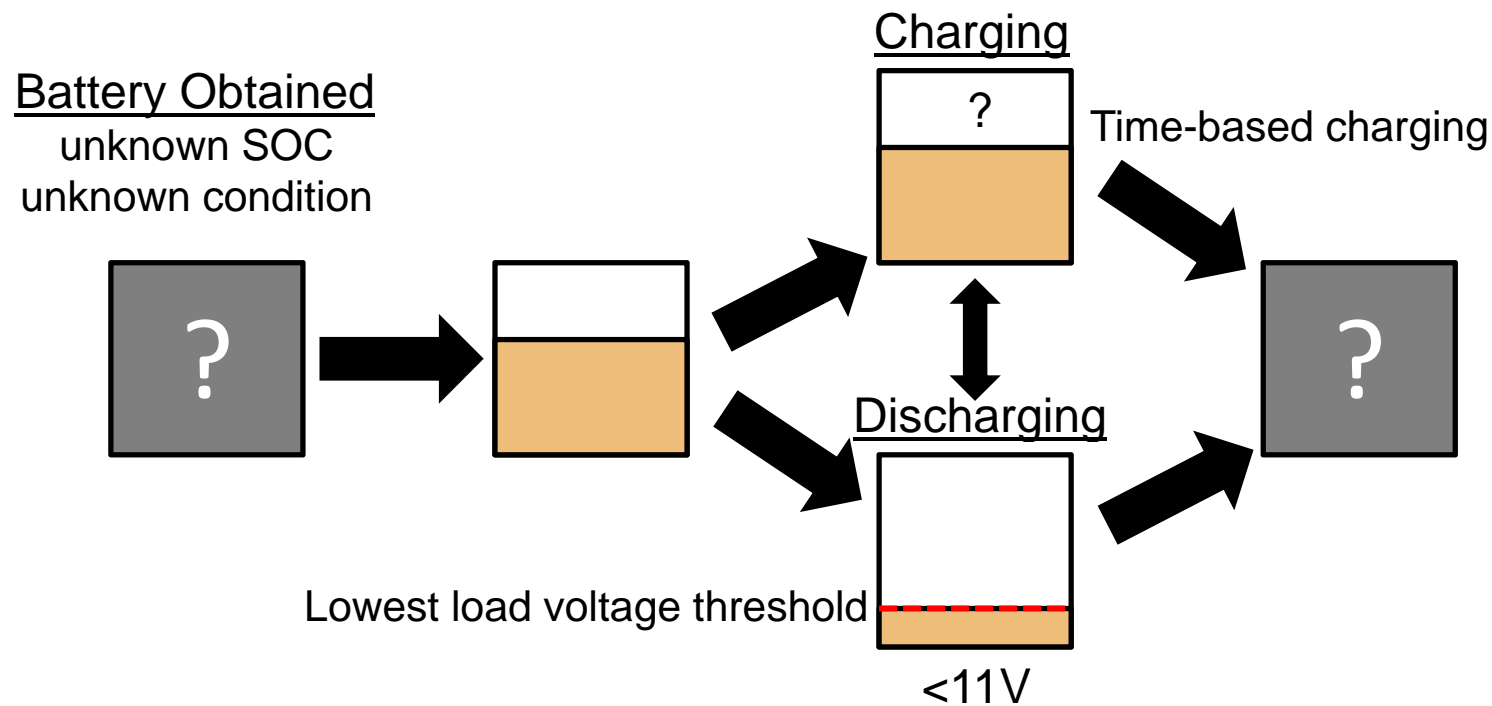


Energy Storage Characteristics

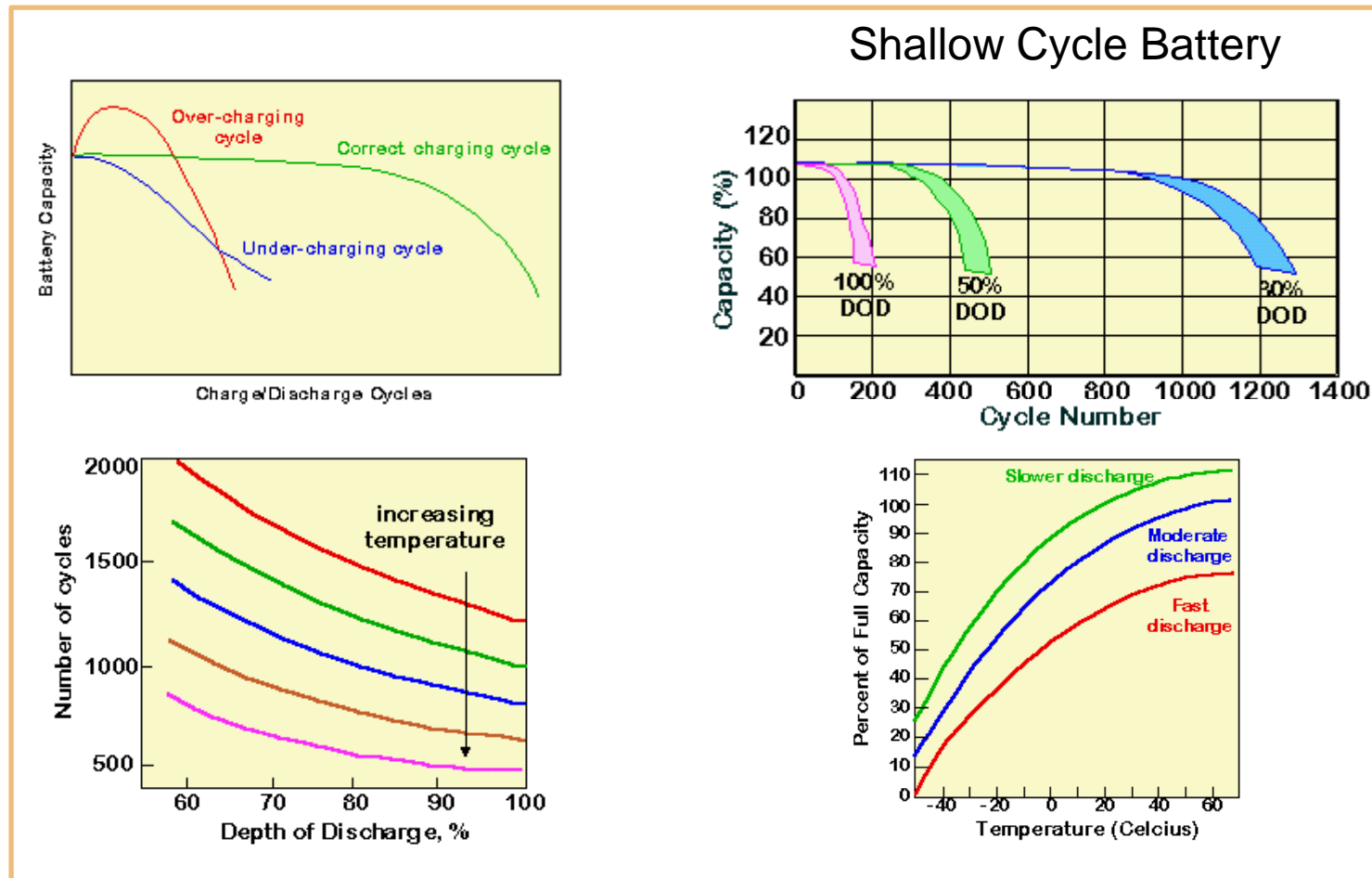
- 12V systems
- Flooded lead-acid
 - Sometimes VRLA
- Repurposed automotive batteries (shallow cycle)
- Typical size < 30Ah (360Wh @ 20hr rate)
- Temperature not controlled



“Flying Blind” Operation



Black Boxes of Chemicals



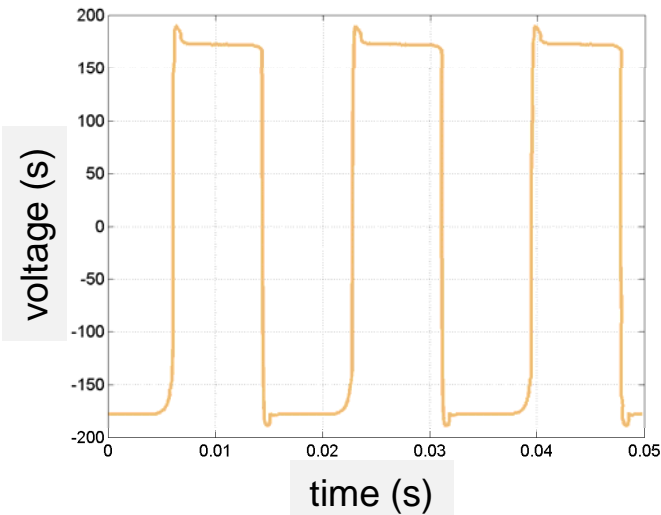
<http://pvcdrom.pveducation.org/BATTERY/charlead.htm>

Power Quality

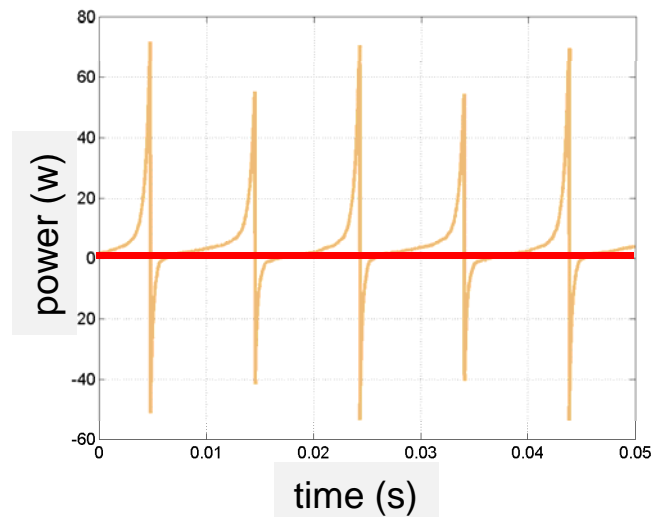
Inverters



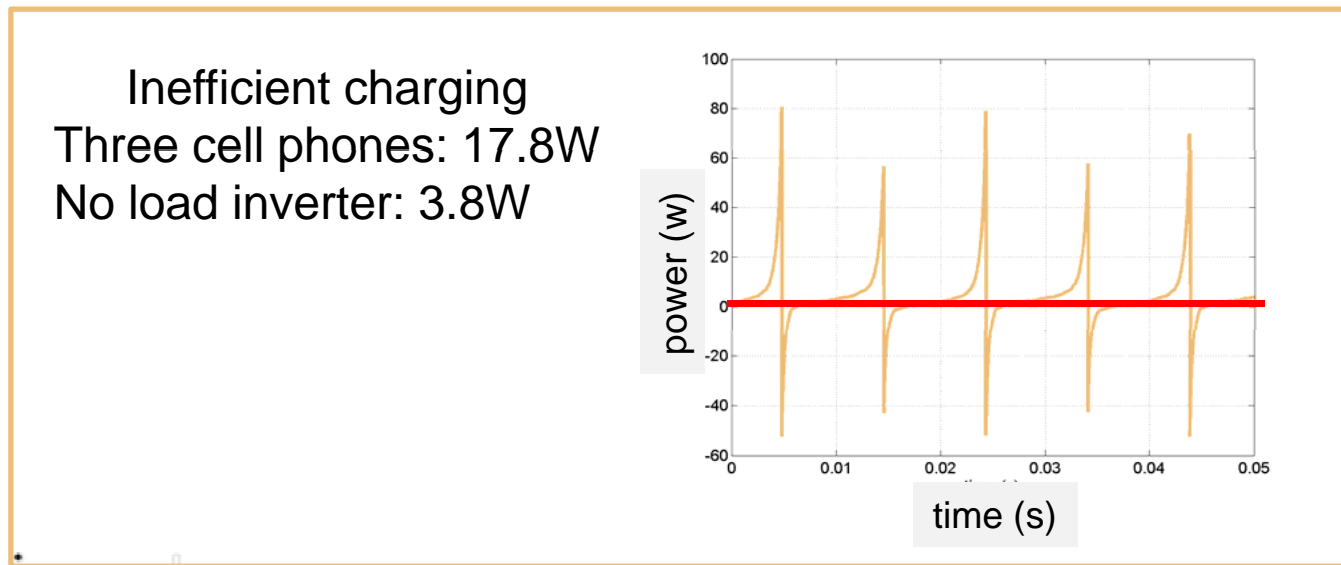
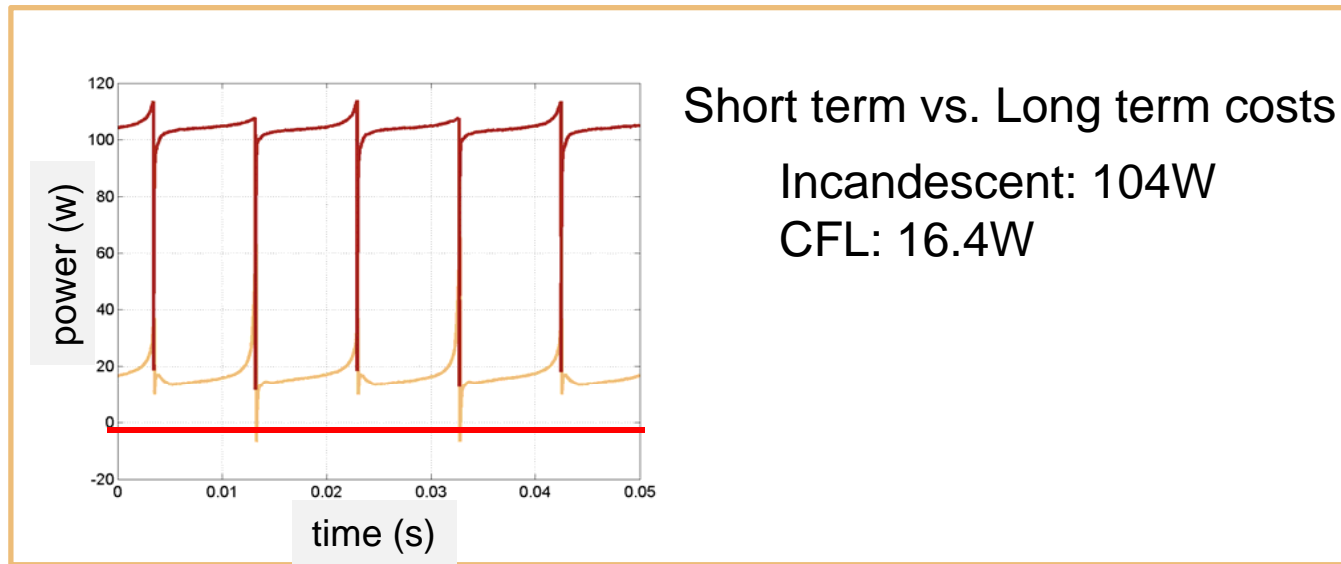
Modified Sine Wave
Output: 220V
Power: 200VA
Cost: ~\$22



Large harmonic content.
Harmonic effects on
battery, components?



No -load power: 3.9 W



Areas for Innovation

Diagnostics

Battery SOC indicator
 Voltmeters
 Watt and Wh meters

Alternative Energy Storage

Battery designs
 Pumped water



Battery Charging Technology

Battery reconditioner
 Simple bulk charger
 DC/DC converters



Education

Battery maintenance
 Battery safety
 Concepts of energy

