

Build Health International

PV Microgrids for Low and Middle-Income Countries




About Build Health International

Build Health International promotes global equity by developing high-quality health infrastructure to enable access to dignified and affordable healthcare in impoverished and resource-constrained regions of the world.



BHI Services for Healthcare Infrastructure

- Architecture, engineering, and construction planning for hospitals, clinics, labs, and medical education.
 - Project management and construction management for select projects.
 - Purchasing, procurement, logistics, & shipping for medical equipment and specialty construction materials.
 - Oxygen, medical gas, and biomedical engineering, training, installation, and advisory services.
 - Research, documentation, and knowledge sharing.
- 
- A person in a light-colored shirt and dark pants stands on a rooftop solar panel array, looking out over a hazy, mountainous landscape. The solar panels are arranged in rows, and the background shows rolling hills and a cloudy sky.

Where We Work



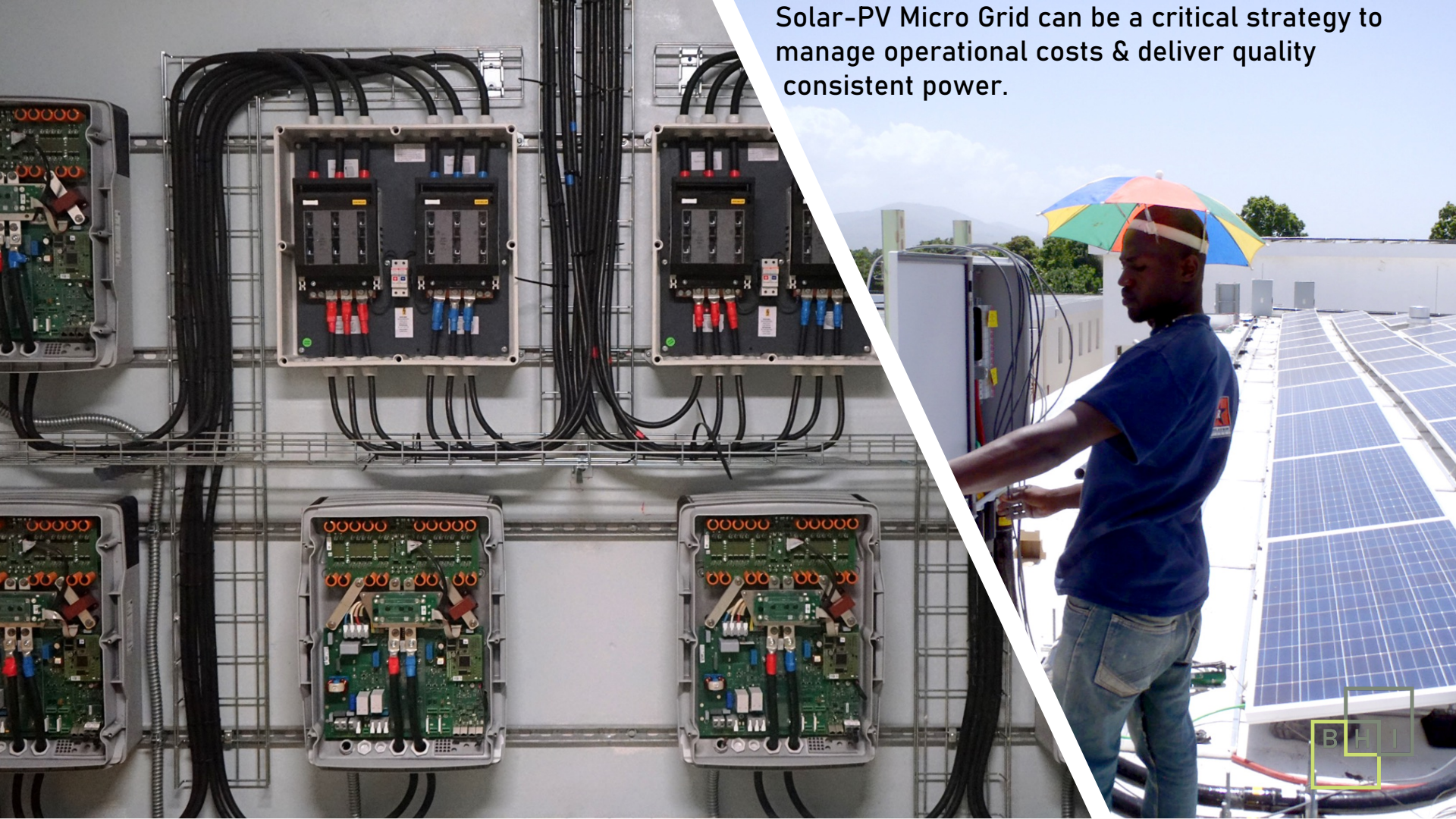
Since 2014, BHI has completed over 200 projects. Our global team of architects, engineers and specialists work to understand community challenges to be efficient, sustainable and effective.



Reliable Electricity is Essential for Care Delivery



Solar-PV Micro Grid can be a critical strategy to manage operational costs & deliver quality consistent power.



Baseline for Electrical Energy Systems for Health Care

- Energy source must be consistent and dependable.
- Quality of electricity must be stable so equipment is not damaged.
- Cost per kWh must be affordable given the resources.
- There must be redundancy for critical care.
- System must be able to be maintained by local resources.
- Energy source should have a minimal carbon footprint.



Why BHI focuses on PV Systems

- Hydro- is still most cost efficient of renewable systems, but requires optimal conditions, highly specialized construction, and large scale capital investment.
- Wind turbines require consistent wind source, very sophisticated maintenance, and large scale capital investment.
- PV (photo voltaic) is relatively flexible in terms of location, easily scalable for capital investment, and requires very basic maintenance.





Energy Costs Can Be a Significant Barrier to Care

- USA Hospital Expense Model:¹
 - Wages and benefits: 56%
 - Professional fees: 11.9%
 - Other products, such as food, medical equipment, etc. – 11.2%*
 - Prescription drugs: 6.7%
 - All other: labor intensive: 5.7%
 - All other: non-labor intensive: 5.5%**
 - Professional liability insurance: 1.2%
 - Utilities: 1.8%
- Secondary or District Hospital in Haiti Expense Model

¹ Source: “U.S. hospital costs by type of expense in percent 2016”, Frederic Michas 2019



PV Microgrid Design Considerations

- Isolated or Grid Tied?
 - Grid tied systems require careful study and extensive engineering.
- Battery Storage?
 - Balance between amount of battery storage/cost vs. percent solar penetration.
- BHI is battery manufacturer agnostic.
 - Important factors are cost vs. longevity and compatibility with charging and control system.

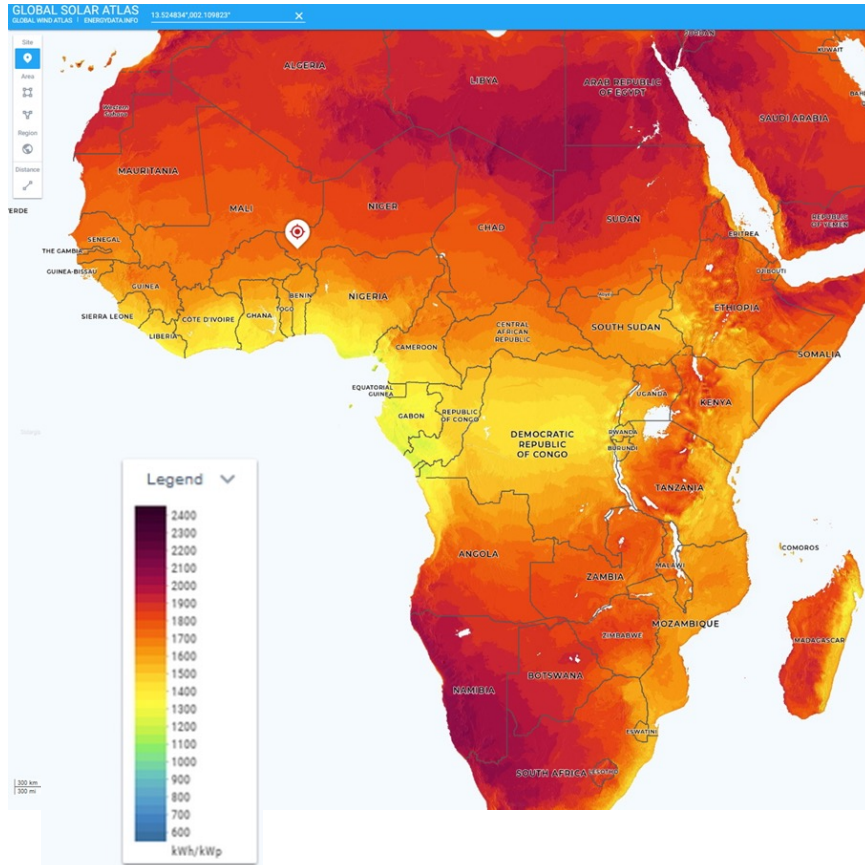








Africa's Incredible Solar/PV Potential



Niamey





13.524834°, 002.109823°
Niamey, Niger
Time zone: UTC+01, Africa/Niamey [WAT]

[Open detail](#) [Bookmark](#) [Share](#) [Reports](#)

SITE INFO

Map data		Per year
<input checked="" type="checkbox"/> Specific photovoltaic power output	PVOUT specific	1678.5 kWh/kWp
Direct normal irradiation	DNI	1544.7 kWh/m ²
Global horizontal irradiation	GHI	2126.5 kWh/m ²
Diffuse horizontal irradiation	DIF	995.9 kWh/m ²
Global tilted irradiation at optimum angle	GTI _{opta}	2199.0 kWh/m ²
Optimum tilt of PV modules	OPTA	17 / 180 °
Air temperature	TEMP	29.6 °C
Terrain elevation	ELE	209 m

CHOOSE PV SYSTEM TO CALCULATE ENERGY YIELD

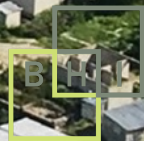
 Small residential Choose	 Medium size commercial Choose	 Ground-mounted large scale Choose	 Floating large scale Choose
--	---	---	---

[Open detail](#)



Hôpital Universitaire de Mirebalais (HUM)

Haiti Teaching Hospital: 400 Beds



PV Micro Grid Design Examples:

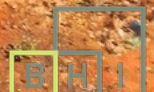
Islanded with 78% SP

- Islanded system with extensive battery storage
- 1,350 kWp of roof mounted PV panels producing avg 5,950 kWh/day.
- 2,324 kWh of Tesla lithium ion battery storage with integrated inverter/charger and cooling. 90% DOD. 15 year warranty.
- Anticipated solar penetration with load growth of 78% with diesel gen providing 22%. *(Gen set to be optimized by Tesla controller)*
- Energy conservation upgrades of \$296,500
- System cost per kW, \$2,984. Annual cost saving \$880,000. ROI- 4.6 years.
- Estimated completion May 2023.





**Niger Children's Pediatric
Hospital – 93% SP
Islanded w/ Generator & Grid**



Niger Hospital - 93% SP:

Islanded w/ Generator & Grid Back Up

Children's Pediatric Hospital: Niger

- Islanded system with battery storage.
- Energy consumption Curve: 85% during day.
 - Generator runs 3-4 times per week to top off batteries.
 - 120 kWp of roof mounted PV panels producing avg 455 kWh a day.
 - 389 kWh of Sonnenschein gel. 50% DOD. 5 Year Warranty.
- SMA Multi Cluster Inverter/charger.
- System cost per kW, \$3,532.
- ROI: 5.2 years
- Completed April 2019.





Zambia Children's Hospital

Grid Tied System w/ Battery Storage

Example of Grid Tied Microgrid

- Islanded system with battery storage.
- System to be charged by both grid & generator.
- 237 kWp of ground mounted PV panels producing avg 455 kWh/day.
- Riello hybrid charger/ 250kVA.
- Cegasa Lithium-LFP batteries, 268 kwh. 90% DOD.
- System cost per kW, \$2,966.
- ROI- 8.2 years.
- Completion Fall 2023.





Challenges in Developing LMIC Microgrids



Select Challenges in Developing LMIC Micro-Grids

- Most projects must start with investment in existing electrical infrastructure.
- Finding local or international partners who understand how to design micro-grids in low resource settings is often challenging.
- Properly trained installers can be difficult to source.
- Panel arrays & battery banks must be properly designed for harsh environmental conditions.
- Capital is scarce and hard to raise despite the rapid ROI.







BHI Best Practices for Success



BHI Best Practices for Micro-Grid Development in LMIC's

1. Start with energy conservation before embarking on PV.
2. 100% Solar penetration is still not cost effective.
3. First fix the electrical infrastructure- don't invest in PV without it
4. Anticipate and plan for growth in overall electrical load after project.
5. Batteries and inverters must be in environmentally-controlled spaces.
6. Look carefully and realistically at lifespan of batteries.
Be conservative on discharge depths.
7. Pay attention to matching batteries with inverters/chargers.
8. Do not move ahead without a long term strategic energy plan.







“Who lives and who dies depends
on staff, space, stuff, and systems.”
-Dr. Paul Farmer



Questions?

