

AMERESCO SOLAR
Green • Clean • Sustainable

Off Grid Power Solutions

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Introduction to Ameresco Solar

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Experience

- 30 years experience with design, engineering and integration of standalone solar, hybrid and CDC power systems
- Core personnel average 20+ years experience in renewable energy industry
- Core markets are providing renewable energy power solutions for the global telecommunications and oil & gas industries
- Technology and equipment neutral
- Instrumental in establishing IEEE Standards for the Design of Photovoltaic systems
- Ameresco Corporation listed on NYSE (AMRC)
- 2013 Revenue of $574 million (Ameresco Corp)

Worldwide Services

- Client Consultation
- Technical Specification Writing
- System Design & Engineering
- System Integration
- Site Survey
- Installation Services
- Training
- Troubleshooting

System Solutions

- Standalone Photovoltaic
- Photovoltaic / Diesel Genset Hybrid
- Photovoltaic / Wind Hybrid
- Photovoltaic / Diesel Genset / Wind
- Photovoltaic / Fuel Cell Hybrid
- CDC (Cycle Charge)

Hybrid Power System



Standalone Power System





Off Grid Power Technologies

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Common Engineering Mistakes – Off Grid

- Awareness of IEEE Standards
  - IEEE Std 1561 & 1562
- Engineering upon Watt Hour Method as Opposed to Amp Hour
  - Must engineer for Amp Hour generation
- Reliable Irradiance Data
  - Data such as NASA is extrapolated and may be only 85% accurate
- Proper Battery Autonomy
  - Sufficient battery autonomy is critical to system operation and minimizing OPEX
- Benefits of MPPT Controls
  - MPPT benefits are limited in warm and hot environments

Technology Engineering Guidelines

Stand-Alone

- Loads from 1W to 800W (Small Cells, Microwave, VSAT)
- Engineer referencing IEEE Std 1562™ -2007
- Dimension solar array for worse case month and load
- Amp Hour, not Watt Hours to be referenced in system engineering
- Solar array provides 100% of the energy for the load. No auxiliary generator required
- Typically 5 days autonomy. Batteries discharge 10%-15% DOD nightly with ability to 80% DOD.

Hybrid

- Loads from 800W to 5000W (BTS Sites)
- Engineer referencing IEEE Std 1561™ -2007
- Dimension solar array for maximum annual output
- Amp Hour, not Watt Hours to be referenced in system engineering
- Solar array typically provides between 40% and 60% of the energy for the load
- Typically 2-3 days autonomy. Batteries frequently discharge to 50% DOD before being recharged (every 1-3 days) by fossil fuel generator
- Target 15% or less annual duty cycle on generator

CDC

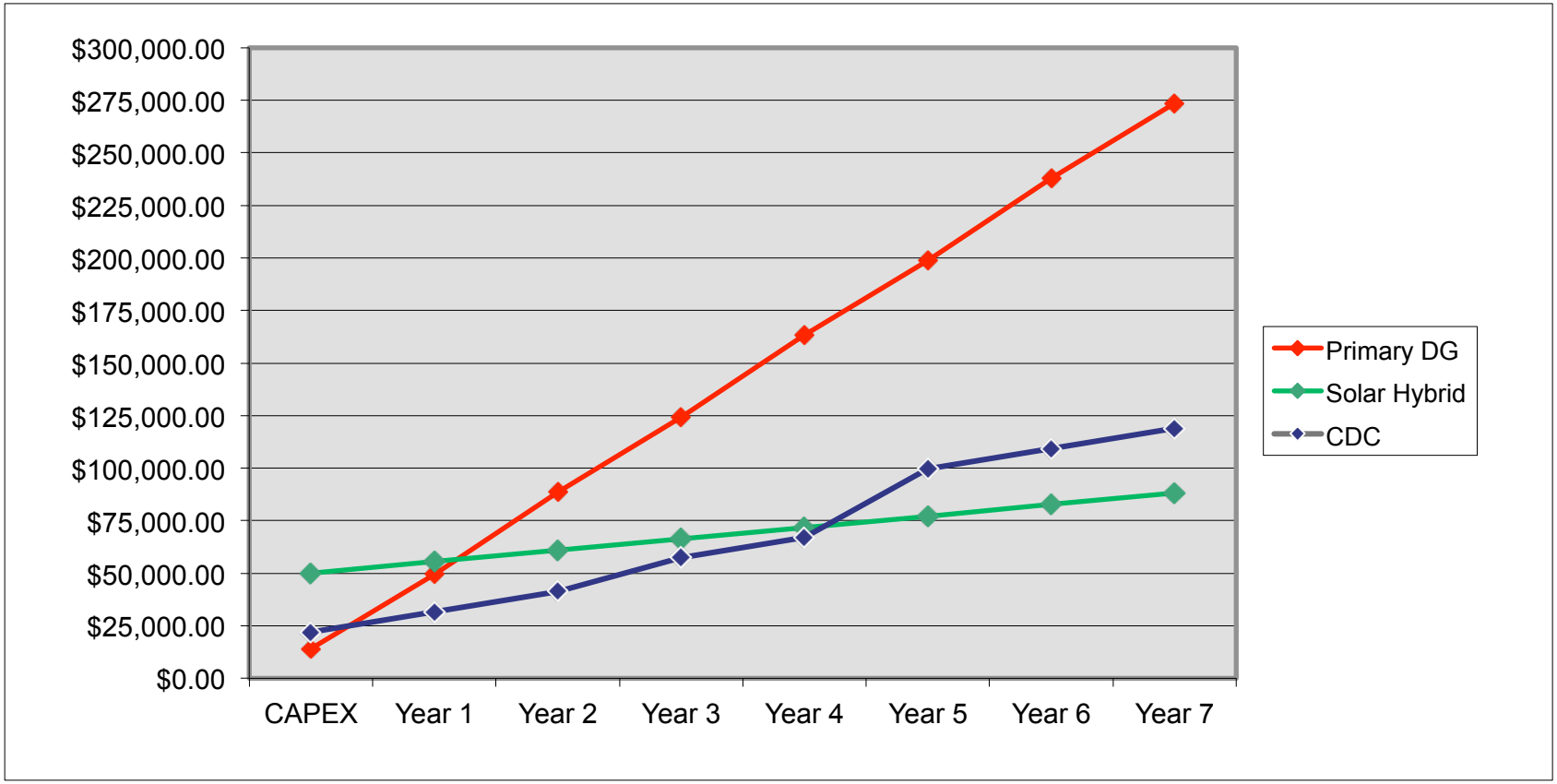
- Loads from 800W to >5000W (BTS Sites)
- No renewable energy on site. Relies on fossil fuel generator to recharge battery bank
- Typically 24 hour battery autonomy to minimize OPEX and extend battery life
- Design for maximum 50% DOD to ensure longest battery life
- Limit generator to 1x cycle per day to extend generator life and minimize OPEX
- Target 30% or less annual duty cycle on generator to minimize OPEX

Technology Comparison

Characteristic	Prime Power Generator	CDC	Hybrid	Stand-Alone
Size range	**Most suitable for consistently high kWh/ day loads**	**Suitable for variable, mid- high kWh/day loads**	**Suitable for variable, mid-range, low and high kWh/day loads**	**Most suitable for low kWh/day loads**
Reliability	**Single source power generation. Dependent upon fuel deliveries and generator operation**	**Single source power generation. Dependent upon fuel deliveries and generator operation; however, battery storage adds reliability**	**Less dependent upon fuel deliveries and generator operation. Benefits from two or more power generation resources**	**No dependence upon generator. Single source power generation dependent upon renewable resource**
Battery Life (2V, industrial deep cycle)	**N/A**	**3-5 years**	**6-8 years**	**8-10 years**
Maintenance	**High generator maintenance**	**Moderate generator maintenance**	**Minimal generator maintenance**	**No generator maintenance**
CAPEX	**Relatively low**	**Moderate**	**Moderate to high**	**Relatively high**
OPEX	**High**	**High - Moderate**	**Moderate**	**Low**
Fuel Consumption	**High**	**Moderate**	**Moderate – Low**	**N/A**

Typical TCO / ROI – Myanmar 2.5kW BTS

System Type	CAPEX	OPEX							7 Year Totals
	Equipment	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	
Primary Diesel Generator	$14,000	$35,583	$39,083	$35,583	$39,083	$35,583	$39,083	$35,583	$273,582
Solar Hybrid	$50,000	$5,447	$5,447	$5,447	$5,447	$5,447	$5,447	$5,447	$88,132
CDC	$22,000	$9,636	$9,636	$16,136	$9,636	$32,636	$9,636	$9,636	$118,952



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Thank You