Trojan
BATTERY COMPANY

Battery Selection for Different Microgrids

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Topics

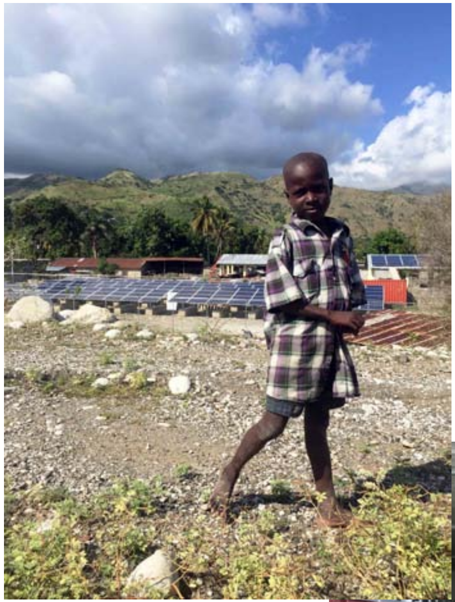
- Key considerations to plan a microgrid system
- Microgrids case studies:
  - EarthSpark/Zero Base in Haiti
  - GENSA/Hemeva in Colombia
- Key considerations to select a battery type for a microgrid.
- Typical charging behavior of a solar-diesel hybrid system.

Haiti Microgrid: EarthSpark International/ZeroBase

Town-sized, Solar-diesel hybrid grid is the first of its kind in Haiti. Smart grid serves residential and commercial customers, including agricultural processing facilities. 430 households and businesses. Town of Les Anglais

System components:

- Hybrid system: 90KW solar panel
- Inverter/chargers: Princeton Power Systems
- 400kwh battery capacity (152 Trojan VRLA 12V 200AH).
- Battery bank Voltage: 480V
- Emergency generator
- Grid: Medium-voltage line for future increase in consumption
- Funds: USAID Powering Agriculture Grant. The $1.1 million in grant funding will enable EarthSpark to expand the Microgrid and assist agribusinesses with upgrading to efficient electric mills to modernize local processing for rice, sorghum, coffee, and corn.
- Installed: 15 May 2015



Breadfruit crops

Haiti, Microgrid: EarthSpark International/ZeroBase

Prepayment system by SparkMeter. It enables customers to know the status of their use and recharge their account with prepaid credits from a local energy seller.

2012-
first pre-pay Microgrid the grid enabled the **14 pioneer customers** to light their homes, charge their phones and listen to music for an average US$1.50/month

In October 2013, EarthSpark expanded grid coverage to a total of **54 customers** including a school and several local businesses. New smart meter.

April 26, 2015, EarthSpark expanded service to **430 households** and businesses, which represent most of Les Anglais downtown area

Haiti, Microgrid: EarthSpark International/ZeroBase

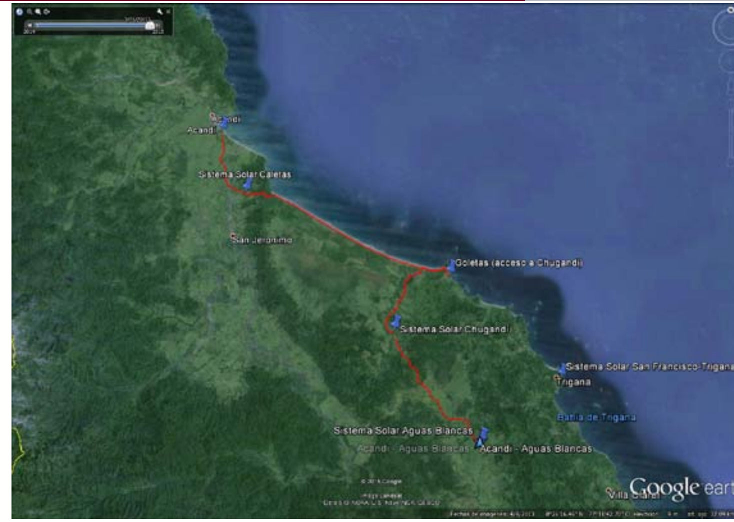
Colombia, 4 Microgrids: GENSA/Hemeva

The 4 microgrids were funded by the government to increase the coverage and satisfy the demand of energy in the “not interconnected areas”.

The users had access to electricity, powered by diesel, only for 4 hours before the hybrid systems were installed.

Location: Acanci, towns: San Francisco-Triganá (293 households), Chugandí (40 households), Caleta (45 households), Aguas Blancas (28 households).

Each households has a meter and pay a monthly invoice to the existent utility company.



Colombia, 4 Microgrids: GENSA/Hemeva

Systems configurations:

	San Francisco	Chugandi	Caletas	Aguas Blancas
Estimated Consumption	818kwh/day	99Kwh/d	99kwh/d	45Kwh/day
Solar Pv	126 Kwp (60% of the demand)	21Kwp (80% of the demand)	21Kwp (80% of the demand)	15Kwp (100% of the demand)
Battery bank	12 banks of 48V 2015AH (IND29-4V)	4 banks of 48V 2015AH (IND29-4V)	4 banks of 48V 2015AH (IND29-4V)	4 banks of 48V 2015AH (IND29-4V)
Inverter/ charger	SMA Sunny Island	SMA Sunny Island	SMA Sunny Island	SMA Sunny Island

Colombia, 4 Microgrids: GENSA/Hemeva

Colombia, 4 Microgrids: GENSA/Hemeva

Key considerations to plan a Microgrid system

The following steps need to be taken into account to plan a microgrid in order to ensure the sustainability of the project.

- Feasibility study based on economics, physical infrastructure and community objectives: population density, ability to pay for energy, etc.
- Governmental support to set up a utility/concession.
- Load-demand management
- Planning typical load demand growth
- Energy efficiency
- Payment method
- Community participation
- Clear organization scheme to operate and maintain the system
- Find Partners to operate the system, to install the system, etc.

Key considerations to select a battery type for Microgrids

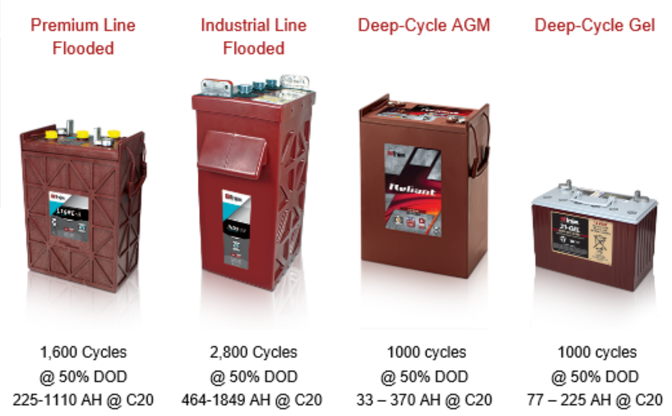
An analysis of the economics of the project, the batteries' technical characteristics, the existent infrastructure and the logistics.

- Capital budget.
- Life of the battery and other features such as ability to perform at partial state of charge
- Maintenance level: minimize maintenance when local staff are not trained electricians mainly when you are working with High-Voltage systems.
- Space limitation: using a container for the batteries vs building a house for them
- Transportation issues to remote areas: how to transport heavy batteries?

Batteries improve the reliability of Microgrids; reduce fuel consumption, cost of fuel transportation and maintenance cost of diesel generators.

Key considerations to select a battery type for Microgrids

	Space limitation	Maintenance	Transportation	Life of the battery in RE systems (IEC 61427)	Partial state of charge (PSOC) applications	Initial Cost
Monoblock GEL/ Relaint AGM	Good fit for Container's solution	No requires maintenance	Lighter weight	3-5 years	NA	Medium
Premium Line - Flooded	Mostly used in a built infrastructure or a well ventilated container	Requires watering	Lighter weight	8-9 years	With Smart Carbon for PSOC	Medium
Industrial Line - Flooded	Mostly used in a built infrastructure	Requires watering	Heavy weight	17 years	With Smart Carbon for PSOC	High



A Focus on Innovation

Key Innovations in batteries for Renewable Energy & Backup Power

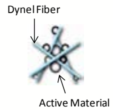
AGM
Reliant™ Line
with C-Max Technology™

- Trojan's Reliant™ Line of U.S.-made Absorbed Glass Mat batteries are the only *true* deep-cycle AGM battery on the market today. Reliant is engineered with an advanced technology feature set that provides **outstanding sustained performance and total energy output.**

Flooded
Premium Line & Industrial Line
with Smart Carbon™

- Trojan's renewable energy Industrial and Premium with Smart Carbon™ Technology batteries are optimized for maximum cycle life when operating in partial states of charge for extended periods of time. Smart Carbon helps to **increase the life of the batteries over 15% under PSOC conditions.**

Alpha Plus® Paste



- Proprietary, high-density paste formulation engineered to deliver outstanding battery performance. **Sustained battery performance over a longer period of time.**

Maxguard® Separator

- Creates a more robust battery with **increased protection against failures** caused by separator degradation.

T2 Technology™

- T2 metal agent delivers maximum operating performance with more sustained capacity and **higher total accumulated ampere-hours**.

Typical charging behavior of solar diesel hybrid: Battery State of Charge

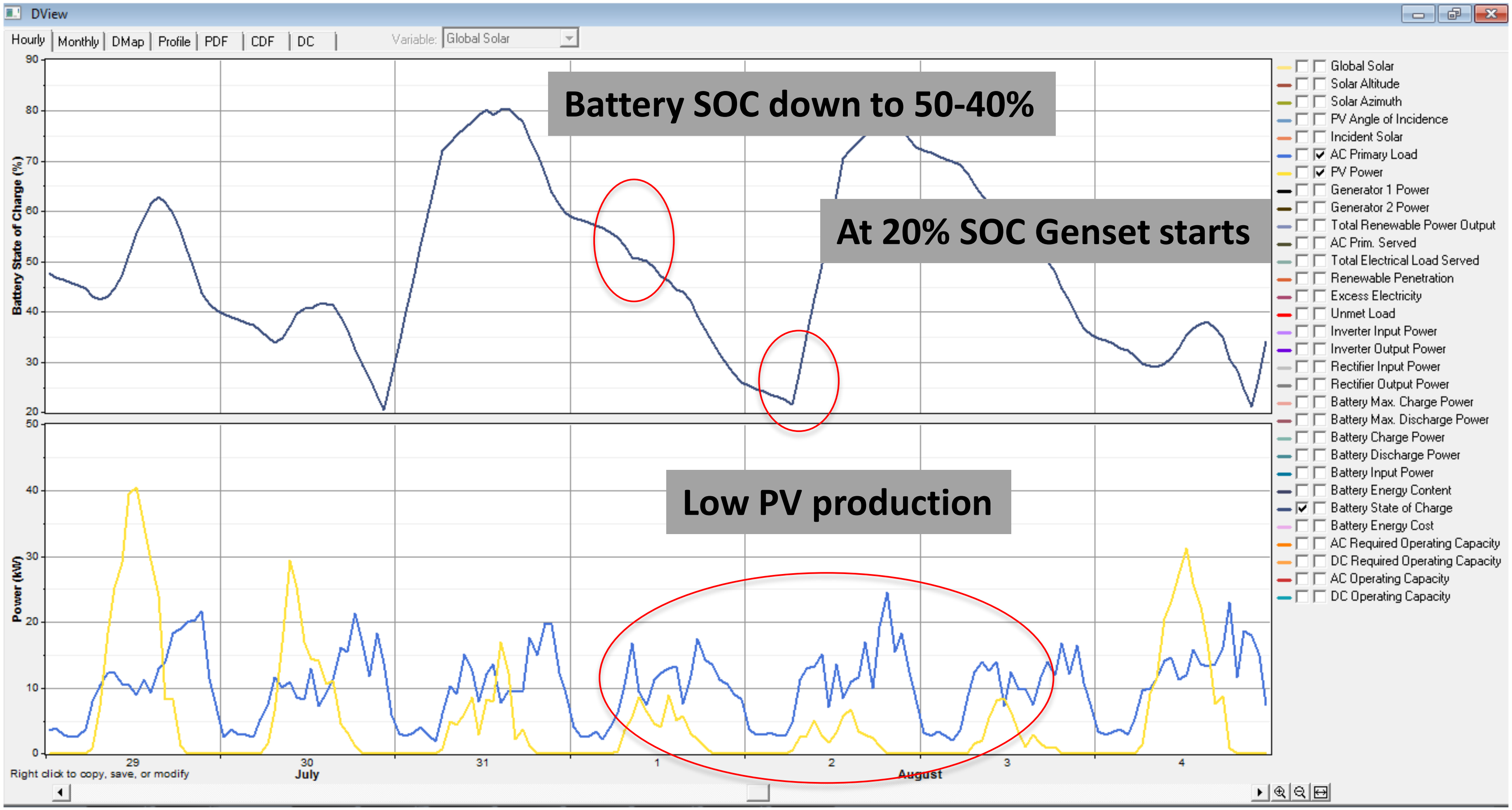
In the rainy season, May to September, batteries are mostly in PSOC

Quantity	Value
String size	12
Strings in parallel	6
Batteries	72
Bus voltage (V)	48

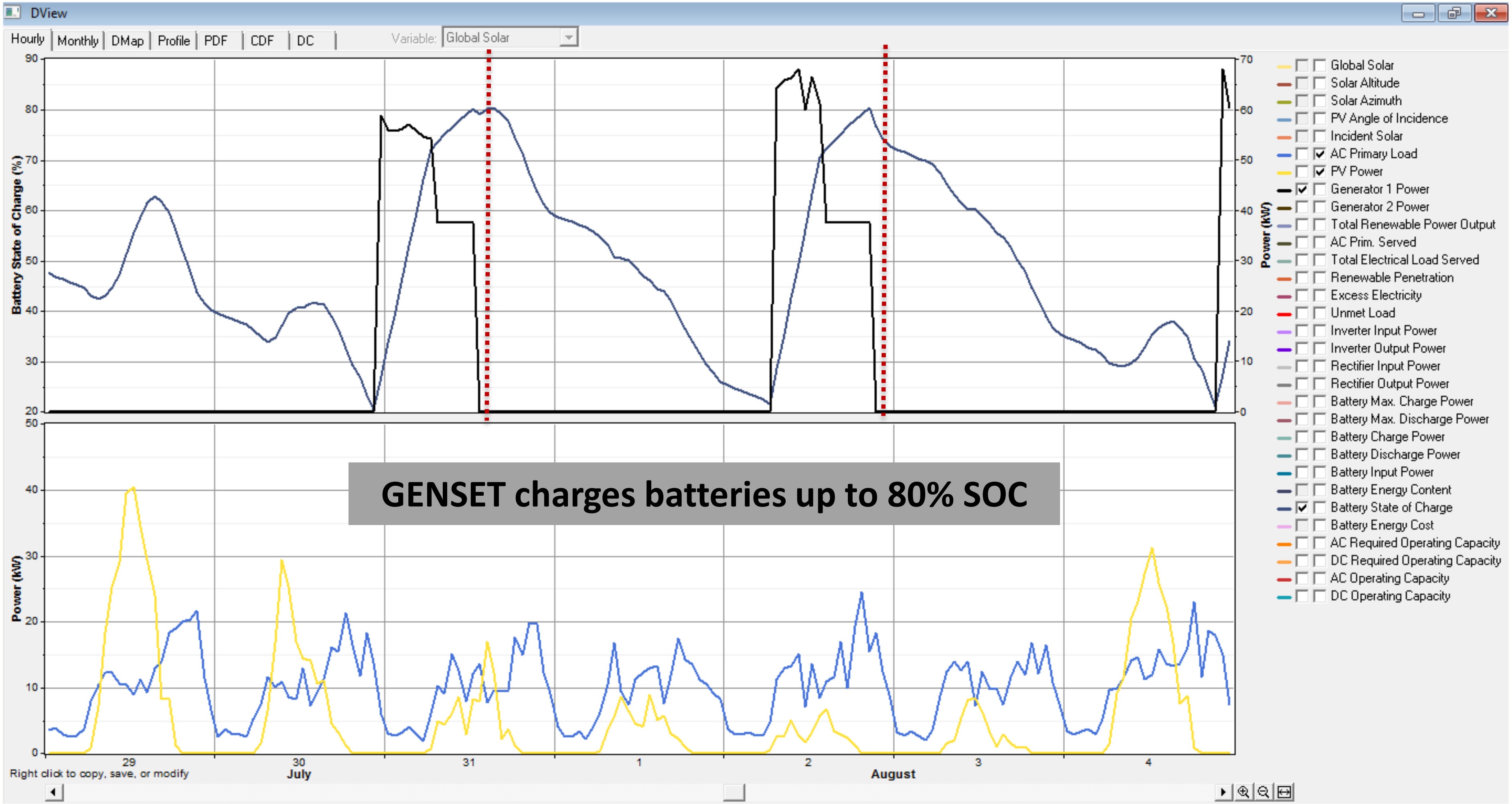
Quantity	Value	Units
Nominal capacity	466	kWh
Usable nominal capacity	373	kWh
Autonomy	44.7	hr
Lifetime throughput	784,800	kWh
Battery wear cost	0.140	$/kWh
Average energy cost	0.014	$/kWh

Quantity	Value	Units
Energy in	50,807	kWh/yr
Energy out	41,400	kWh/yr
Storage depletion	116	kWh/yr
Losses	9,292	kWh/yr
Annual throughput	46,000	kWh/yr
Expected life	17.1	yr

Primary Loads and PV Production vs Battery State of Charge



Primary Loads and PV Production vs Battery State of Charge and Diesel Generator



Conclusions

- Follow the best practices to plan a Microgrid.
- Select the battery technology that fits your project.
- Trojan batteries with Smart Carbon for Partial State of Charge deliver an increased performance in Renewable Energy applications.

Renewable Energy, Hybrid Systems & Backup Power

RE

Markets

OFF-GRID REMOTE POWER
- Off-Grid Residential
- Solar Home Systems
- Rural Community Buildings
- Micro-Grids
- Solar Street Lighting

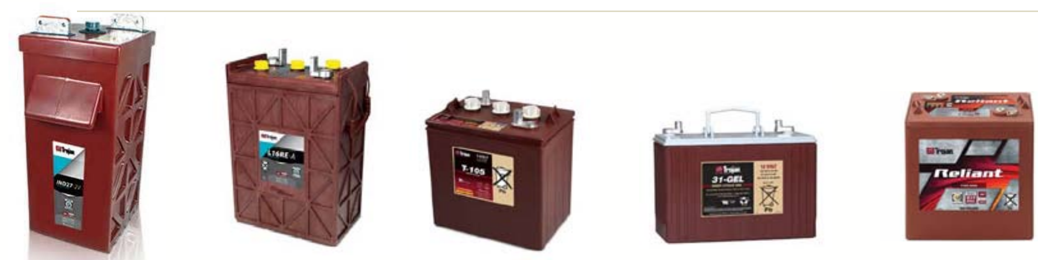
INDUSTRIAL MARKETS
- Telecom Networks
- Oil and Gas
- Communications
- Security
- Monitoring

GRID BACKUP
- Emergency Backup
- Inverter Backup

RE

Product Families

2V 2V Batteries | 4V 4V Batteries | 6V 6V Batteries | 12V 12V Batteries



INDUSTRIAL | PREMIUM | SIGNATURE | GEL | AGM

Headquartered in California with 4 USA manufacturing facilities in the USA & global distribution & offices

Sales presence in 120+ countries globally

Thank you for your attention!

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