



Fortress Power

Lithium Storage Systems

Training in San Juan

CARIBBEAN
ENERGY



PRESIDENT: BARRY MOORE



- 30 years as financial Executive at GMAC, Merrill Lynch
- Founding member of Moore Energy
- President of Fortress Power
- Public service as elected township supervisor
- Lifetime environmentalist

MANAGING DIRECTOR: JING YU



- Electrical Engineer at Hannover University in Germany
- MBA at Würzburg University
- 10 + years as Country Manager at solar module manufacturer
- Managing Director at Fortress Power

TOPICS

Growth Opportunity

Fortress Lithium Battery

Fortress Power Values

Integration Guide with Inverter/Charger

Fortress Energy Storage Sizing Tool

GROWTH OPPORTUNITY

Growth Opportunity

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MARKET OPPORTUNITIES

U.S Annual Energy Storage Market Size, 2016-2022E (Million \$)



FORTRESS LITHIUM BATTERY

Fortress Lithium Battery

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COMPANY INTRODUCTION

We are a world-leading battery manufacturer that brings high power density automotive Lithium Ferro Phosphate batteries to the energy sector.



U.S Headquarters
Southampton, PA



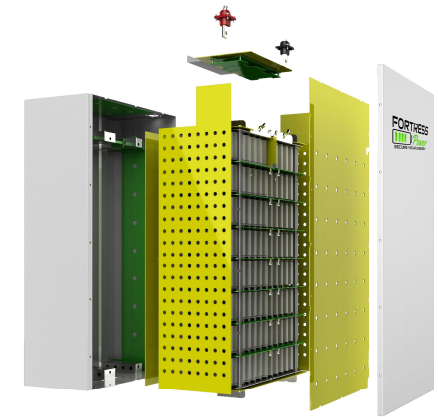
Manufacturing Facility
(since 2008)

LITHIUM FERRO PHOSPHATE TECHNOLOGY

We Use The Safest Lithium Technology – Lithium Ferro (Iron) Phosphate

	FORTRESS	Other Lithium Ion (e.g. Tesla, LG Chem)
Chemistry	Lithium Ferro Phosphate (LFP)	Nickel- Manganese -Cobalt (NMC)
Safety	✓	X
Eco-friendly	✓	X
Operating Temperature	-4 – 140 °F	14 – 113 °F
Life Cycles	6000	< 3000
Peak Power Output	10 KW	7 KW
Rate of Capacity Loss	LFP < NMC	

Search LFP vs. NMC nail test videos on YouTube



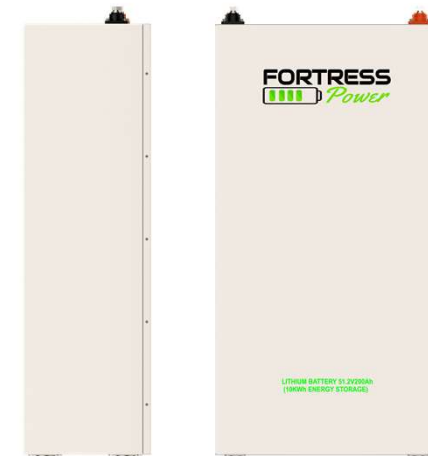
Fortress LFP Battery

FORTRESS BATTERY SPECIFICATION

SAFE • COMPACT • SLICK • AFFORDABLE

Size	LFP- 10	LFP- 15
Total Energy (kWh)	10.24	15.36
Capacity [Ah]	200	300
Max. Charge Current (Continuous) [A]	100	100
Max. Discharge Current (Continuous) [A]	100	100
Max. Pulse Current (for 10 sec) [A]	200	200
Voltage [V]	48 (51.2)	48 (51.2)
Dimension [H xW x D, inch]	33 x 16.4 x 9.4	33 x 16.6 x 13.4
Weight [lbs]	286	429
Depth of Discharge	100%	
Warranty	10 years	
Life Cycles	90% @ 3000; 80% @ 6000	
Stack-ability	2 batteries in parallel to 1 inverter	

Fortress LFP-10 Lithium Battery

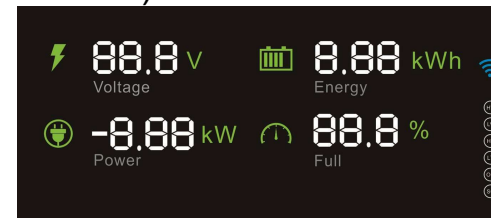


NEW GENERATION-EVAULT LFP-15

More Benefits:

- **High visibility:** LCD Display showing Voltage; Remaining capacity; AC output; State of Charge
- **More Power:** 8 batteries in parallel to 1 inverter (120 KWH)
- **35% Increase on Charge Current:** 135A
- **60% Increase on Discharge Current:** 160 A
- **20% Increase on Surge Power:** 12 KW (250A) for 10 Sec
- **More efficient battery cell** -> 11% less weight

New: Fortress eVault LFP-15 Battery



Available in Q2 2019!

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COMPATIBLE INVERTERS

FORTRESS BATTERIES CAN BE PAIRED WITH MOST 48V INVERTERS/CHARGERS

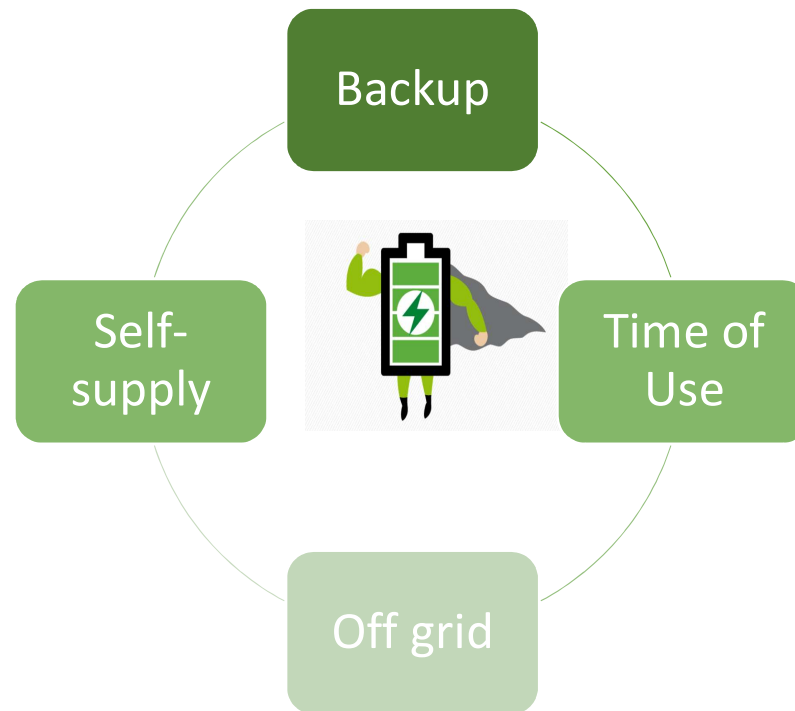
Brand	Inverter/Charger Mode	Configuration
Schneider	Conext XW MPPT charge controller; Conext XW+ series; Conext SW;	AC or DC coupled
Outback	FLEX max charge controller (48V), FLEXpower series (48V); Radian series (48V); FXR(A) and FXR (E) series (48V); GVFX and GVFX series (48V);	DC coupled
Magnum	MS 4448PAE; MS 4048-20B	DC coupled
SMA	SUNNY ISLAND 4548-US/6048-US	AC coupled
Sol-Ark	8 KW Inverter	DC coupled

FORTRESS POWER VALUES

Fortress Power Values

APPLICATIONS

ALL IN ONE SOLUTION



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BENEFITS OF ENERGY STORAGE



Back Up Your Facility

Power your facility when the grid is off



Save Money on your Electric Bill

Charge the batteries at off-peak times, and discharge them during the peak periods



Maximize Your PV Production

Keep the solar panels running during the outages; store the excess solar power for later use.



Tax and Incentives

30% ITC available if it's powered by solar; enjoy state and utilities rebates

BACKUP OPTIONS

	Fortress Lithium	Lead Acid	Generator
Applications	Backup power, time of use, self-use & off grid	Backup power	Backup power
Depth of discharge	100%	50%	N/A
Potential Harm	Safest technology	Risk of harmful gases	Environmental pollution
Life Cycles	6,000	500-1,000	N/A
Warranty	10 years	2-7 years	2 years
Fuel Cost	\$0	\$0	\$ 50-100/day
Maintenance	No	Every 6 months	Yes
Incentives	Yes	Yes	No

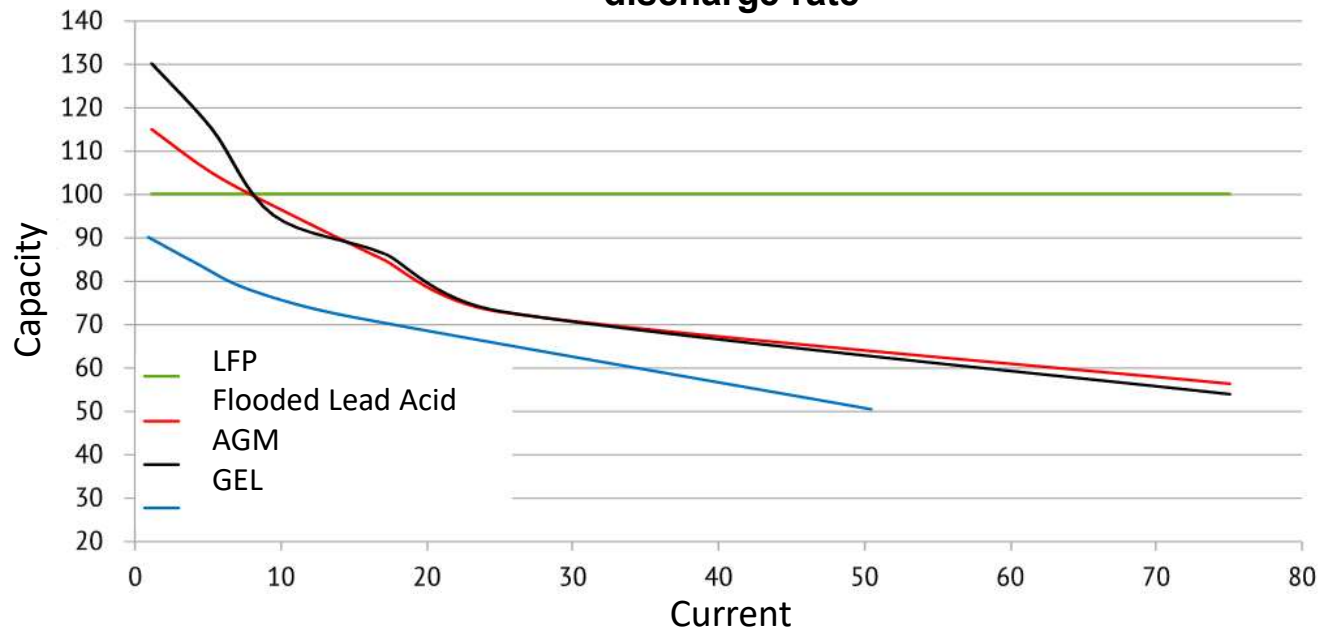
COST ANALYSIS

	Fortress Power + Schneider	Lead Acid	Generator (20 KW)
Total Installed Cost	\$13,800	\$13,600	\$10,000
30% ITC	\$4,140	\$4,080	N/A
Net Out-of-Pocket	\$9,660	\$ 9,520	\$10,000
Cost per Cycle	\$1.6 @ 6000 cycles	\$ 9.5 @ 1000 Cycles	N/A
Cost per Cycle (w/o ITC)	\$ 2.3 @ 6000 cycles	\$ 13.6 @ 1000 Cycles	N/A
Fuel Cost	\$0	\$0	\$ 50-100/day

- *Fortress system: Schneider XW+ 5848 + 10 kWh battery*
- *Lead Acid system: Outback GS 4048a + 20 kWh lead acid battery*
- *Total installed cost: the final sales price to home owners*

PERFORMANCE COMPARISON

LFP vs Lead Acid at various discharge rate



Further disadvantage of Lead Acid batteries:

- 3 times more space
- More cable cost and longer installation time

COMPARISON WITH OTHER LITHIUM SOLUTIONS

	Fortress Power Solutions	Tesla	Solaredge + LG Chem	Pika Energy	Sonnen
Configuration	AC or DC coupling	AC coupling	DC coupling	DC coupling	AC coupling
Battery Chemistry	LFP	NMC	NMC	NMC	LFP
Battery Cycles	6,000	2,800	2,500	2,800	10,000
Price level	Low	Low	Low	High	High
Cost per Cycle	Lowest	High	High	Highest	Medium
Maintenance	Easy	Hard	Easy	Easy	Hard

***AC coupling requires an additional PV inverter and has at least 5% more power loss*

COMPETITIVE ADVANTAGE

✓ SAFE

✓ COMPETITIVE PRICED

✓ LOWEST COST PER CYCLE



✓ ALL IN ONE SOLUTION

✓ MORE EFFICIENT

✓ EASY INSTALL/MAINTENANCE

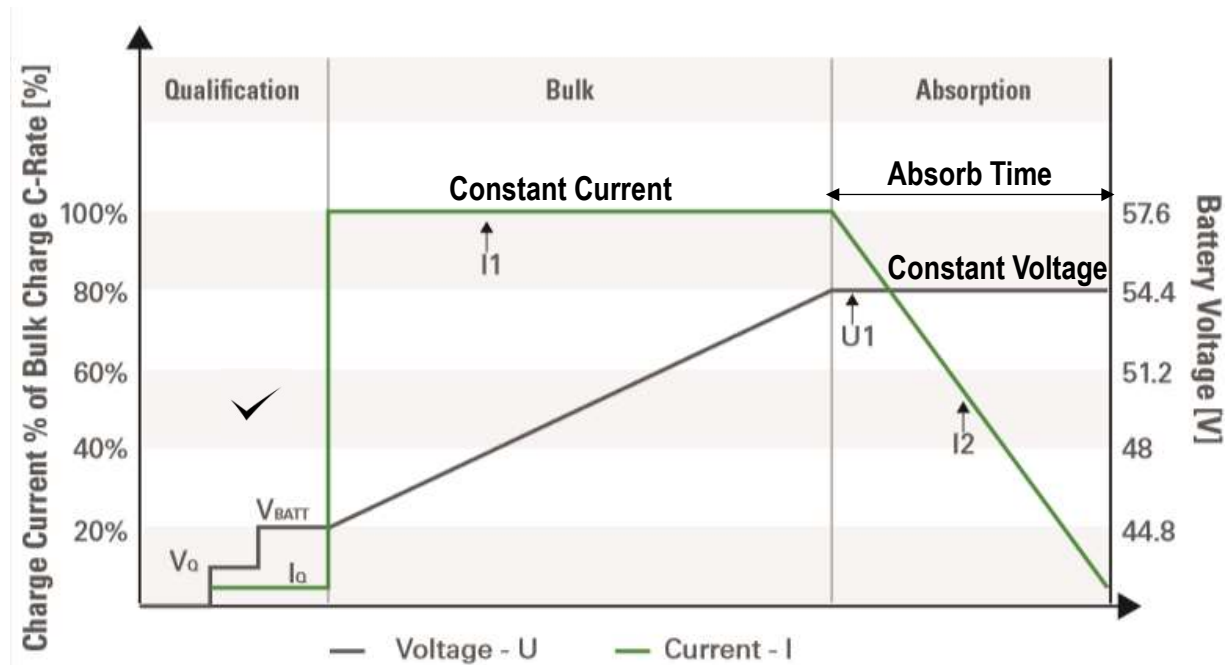
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INTEGRATION GUIDE WITH INVERTER/CHARGER

Integrate Guide with Inverter/Charger

CHARGING STAGES



	Lithium Ferro Phosphate	Lead Acid
Absorb time	6 min	120min
Float Charge	N/A	✓

INTEGRATION GUIDE-INVERTER/CHARGER SETTING

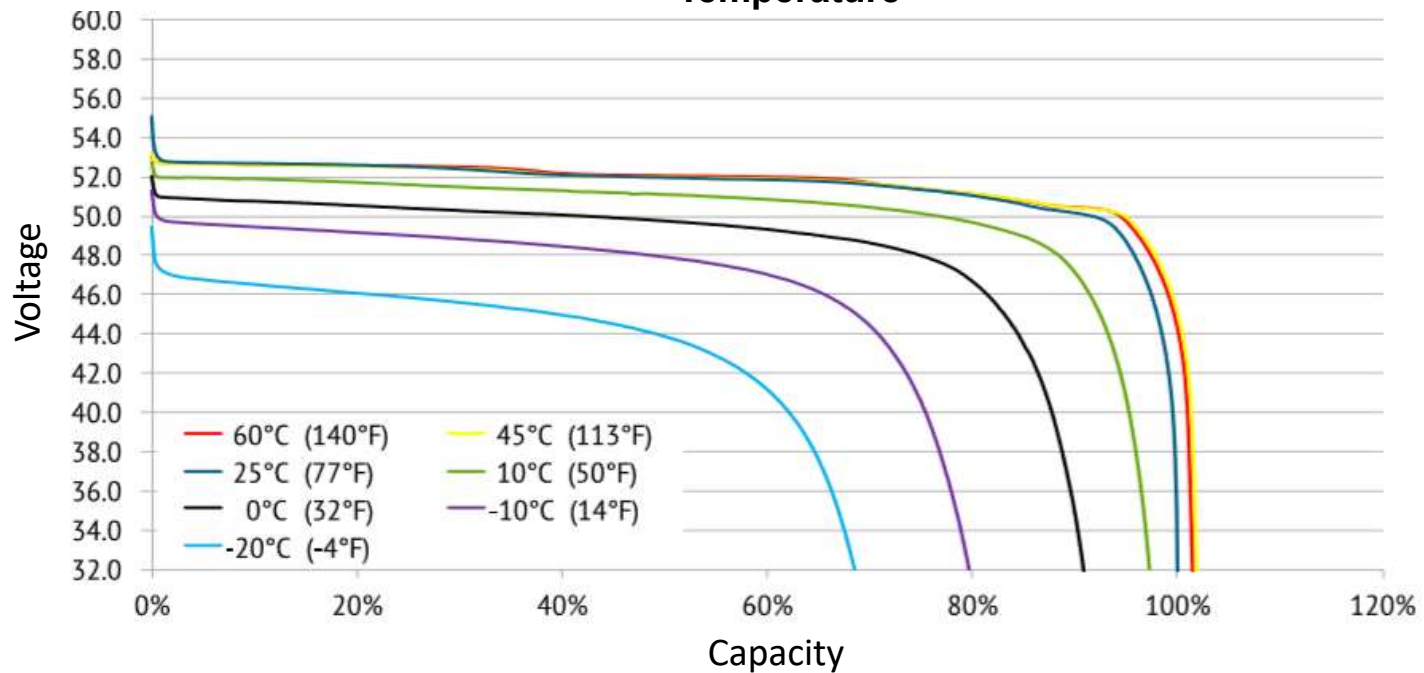
Charger/Inverter configuration recommendation for best Performance:

Schneider/SMA/Outback/Sol-Ark	3000 Cycles	6000 Cycles
Equalized Support	Off	Off
Capacity Limit	LFP-10:200 Ah / LFP-15:300 Ah	
Equalized Voltage	Off	Off
Recharge Voltage	47V	49V
Bulk Voltage	57.6V	55.4V
Absorb Voltage	57.6V	55.4V
Low Battery Cut Out Voltage	48.4V (48V)	50.7V (48V)
High Battery Cut Out Voltage	58V	56 V
Float Voltage	OFF/unless use as back up 54.4V	
Max Charge Current	100A per battery	50A per battery

The Battery Parameter Setting Guides with Schneider and Outback Inverters/Chargers are available to download on www.fortresspower.com/Resource

TEMPERATURE IMPACT ON PERFORMANCE

Discharge Voltage of LFP in Relation to Temperature



3000 Cycles

6000 Cycles

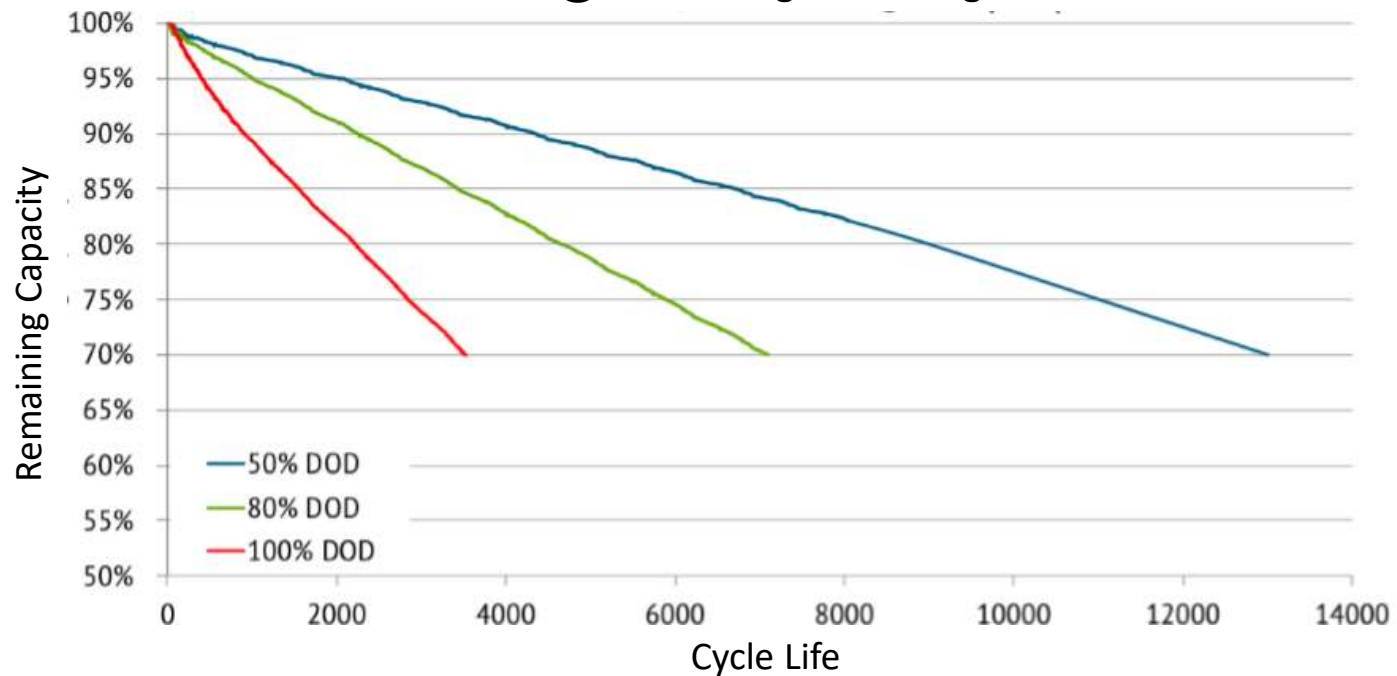
Temperature

14 F to 130F (-5 °C to 49°C)

32 F to 110 F (0°C to 43°C)

CYCLE LIFE vs DEPTH OF DISCHARGE

Cycle Life in Relation to Depth of Discharge (DoD)
@ 0.5C charge/discharge



Depth of Discharge	3000 Cycles	6000 Cycles
	90%	80%

INTEGRATION GUIDE WITH SCHNEIDER XW+

Integrate Guide with Schneider XW+

SCHNEIDER XW+ IN AC & DC COUPLED CONFIGURATION

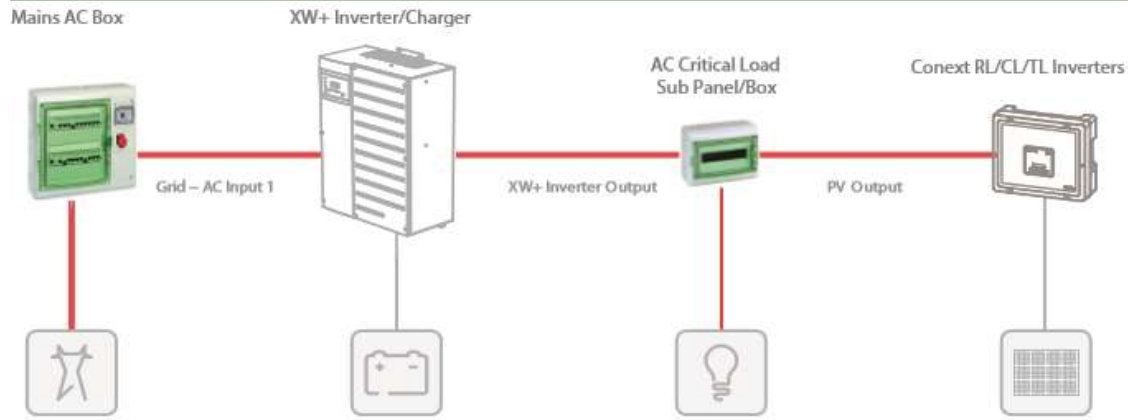


Figure 1 AC-Coupled System Diagram

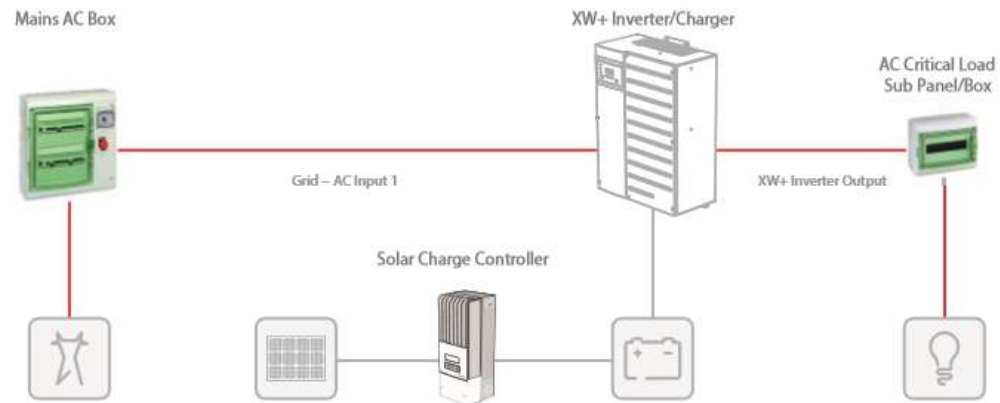


Figure 2 DC-Coupled System Diagram

SCHNEIDER XW+ IN DC COUPLED APPLICATION

- Inverter/Charger: 1 x Schneider XW+ 6848
- Charge controller: 1 x Conext 80-600
- Storage: 1x Fortress LFP-10 (10 kWh)
- Application: Back up
- Licensed Installer: Zona Solar, PR



6.8 kW/10 kWh ESS

SCHNEIDER XW+ IN AC COUPLED APPLICATION

	Technical Specification	
Inverter AC output	5.5 KW	6.8 KW
Surge power at backup	7/9.5 kW (30 min/60 sec)	8.5/12 kW (30 min/60 sec)
Transfer Switch	60 A auto-transfer relay at 8ms	
Compatible PV Inverters	AC-coupled to SolarEdge, Enphase, SMA, Fronius 10 kW+ , AC modules	
Requirement	<ul style="list-style-type: none"> PV Watts (or PV inverter size) \leq exceed XW+ system watts PV Watts/48V = __A should be \leq Battery Max Charging Current ** 	
Stack-ability	<ul style="list-style-type: none"> Max. 4 in 1-Ph (120/240V) Max. 9 in 3-Ph (208V): 3 units per phase 	

****Example: 7.5 KW PV array /48V = 156 A**



13.6 kW/30 kWh ESS

INTEGRATION GUIDE-INVERTER/CHARGER SETTING

Advanced Setting > Inverter Settings		
	80% DoD, 6000 cycles	90% DoD, 3000 cycles
Low Battery Cut Out Voltage	48V (50.7V recommended)	48 V (48.4V recommended)
LBCO Hysteresis	2.0 V	
LBCO Delay	10 Sec	
High Battery Cut Out Voltage	58 V	
Search Watts	Default	
Search Delay	Default	
Charger Setting > Custom Setting		
Battery Type	Lithium Ion	
Control	2StgNoFloat	
Bulk Voltage	55.4 V	57.6 V
MaxBulkCurrent	50A per battery	100A per battery
Max Discharge Current	100 A	100 A
Max Discharge Timer	10 Minutes	
Battery Capacity	LFP-10: 200A / LFP-15: 300A per battery	
Max Charge Rate	LFP-10: 25% (50A per battery) LFP-15: 17% (50A per battery)	LFP-10: 50% (100A per battery) LFP-15: 33% (100A per battery)
Default Battery Temperature	Warm	
Recharge Volts	50.5 V	
Absorb Time	6 Minutes	
Charge Block Start	Default	
Charge Block Stop	Default	

Please reassess capacity and charge/discharge current settings, when Fortress battery quantities change.

INTEGRATION GUIDE-MPPT CHARGE CONTROLLER SETTING

Advanced Setting > Charger Setting		
Battery Type	Custom	
Custom Setting		
	80% DoD, 6000 cycles	90% DoD, 3000 cycles
<u>Eqlz</u> Support	Disable	
Bulk Voltage	55.4 V	57.6 V
Absorb Voltage	55.4 V	57.6 V
Float Voltage	54.4 V	
Battery Temperature Compensation	0mV/C	
Battery Capacity	LFP-10: 200A / LFP-15: 300A per battery	
Max Charge Rate	LFP-10: 25% (50A per battery) LFP-15: 17% (50A per battery)	LFP-10: 50% (100A per battery) LFP-15: 33% (100A per battery)
Charge Cycle	Warm	
Recharge Volts	50.5 V	
Absorb Time	6 Minutes	
Default Battery Temperature	Warm	
Battery Voltage (Auto-detected)	48V	
Aux Settings		
...	Default	

Please reassess capacity and charge/discharge current settings, when Fortress battery quantities change.

INTEGRATION GUIDE-CONEXT BATTERY MONITORING SETTING

Setting	Value
Capacity	LFP-10: 200A / LFP-15: 300A per battery
Discharge Rate	20 Hrs
Nominal Temperature	68 (20 °C)
Shunt Amps	500
Shunt mV	50
Self-Discharge	1%/Month
Discharge Floor	20%
Float Voltage	54.0
Float Amps	2 %
Auto Sync Time	240 Sec
Temperature Unit	Celsius
Back Light Timer	30 Sec
Peukert Expo	1.05
Charge Eff Mode	Automatic
Temp Coefficient	0.5 % Ah/degree C
Default Temperature	77 F (25 °C)
Sync Sensitivity	5
Time Rem Filter	Faster

Please reassess capacity and charge/discharge current settings, when Fortress battery quantities change.

FORTRESS ENERGY STORAGE SIZING TOOL

FORTRESS ENERGY STORAGE SIZING TOOL

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FORTRESS ENERGY STORAGE SIZING TOOL

How to size the Energy Storage System For Backup

1. Estimate average daily PV production
2. Selecting critical load circuits
3. Calculating daily usage of critical load panel
4. Selecting battery bank size

Available for our authorized Installer

ESTIMATE AVERAGE DAILY PV PRODUCTION

PV Production of A 6 KW PV Array in San Juan

	Solar Radiation	Monthly AC Energy (kWh)	Avg. Energy Per Day (kWh)
January	6.02	841	27.1
February	6.59	827	29.5
March	6.74	932	30.1
April	6.26	834	27.8
May	5.75	792	25.5
June	5.83	781	26.0
July	6.11	848	27.4
August	5.99	826	26.6
September	6.18	818	27.3
October	5.88	802	25.9
November	5.5	735	24.5
December	5.8	809	26.1

SELECT CRITICAL LOAD CIRCUITS

	Category	Item	Quantity	Starting Watts	Running Watts	Hours/Day	Watthours/Day
1	Essential	Refrigerator/Freezer-Energy Star	1	1200	200	8	1600
2	Essential	Incandescent Light Bulb-60 Watt	6	360	360	4	8640
3	Essential	Incandescent Light Bulb-60 Watt	4	240	240	4	3840
4	Essential	Sump Pump-1/3 HP	1	1300	800	0	0
5	Essential	Water Well Pump-1/3 HP	1	1400	750	3	2250
6	Kitchen	Electric Range-8" Element	1	2100	2100	1	2100
7	HVAC	Central AC-10,000 BTU	1	2200	1500	4	6000
8	Personal Electronics	Cell Phone Charger	2	50	50	2	200
9	Personal Electronics	TV-Flat Screen-46"	1	190	190	4	760
10	Personal Electronics	Computer-Laptop	1	250	250	3	750
	STANDBY POWER	Schneider XW+6848NA	1	8	8	24	192
			Totals	9298	6440		26332
	Inverter Type	Quantity**	Watthours/Day	Surge Power		Running Watts	
	Schneider XW+6848NA	1	26332 Watts	2702	Watts Available	360	Watts Available

SELECT BATTERY BANK SIZE

Critical Load Consumption Report

Load Consumption Report

Item	Watthours/Day
Refrigerator/Freezer-Energy Star	1600
Incandescent Light Bulb-60 Watt	8640
Incandescent Light Bulb-60 Watt	3840
Sump Pump-1/3 HP	0
Water Well Pump-1/3 HP	2250
Electric Range-8" Element	2100
Central AC-10,000 BTU	6000
Cell Phone Charger	200
TV-Flat Screen-46"	760
Computer-Laptop	750

TOTAL 26140 Wh/Day

Select Battery Bank Size

Fortress Power Battery	LFP -15
System Size:	15,360 Wh
Battery Quantity	1
Depth of Discharge:	90%
Available Power:	<u>13,824 Wh</u>

WHAT TO EXPECT

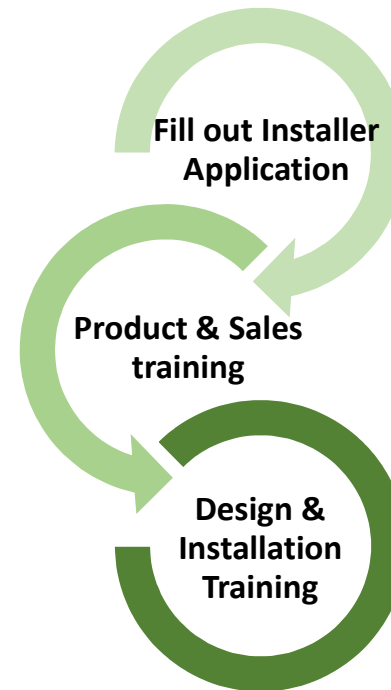
Available power in Battery at 90% DoD	13,824 Wh	0.5 Days
Lowest average daily available PV Power:	24,500 Wh	
Highest average daily available PV Power:	30,065 Wh	

INSTALLER BENEFITS

Installer Benefits



Becoming an Authorized Installer



THANK YOU & CONTACT US

Andrés Salcedo Hernández

Sales Manager

andres@cedpr.com

(787) 750- 5566

www.caribbeanenergycorp.com

Jing Yu

Managing Director

jingy@fortresspower.com

(877) 497- 6937

www.fortresspower.com

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