Fortress Power

Energy Storage Systems

Jing Yu
Managing Director at Fortress Power

My Bio

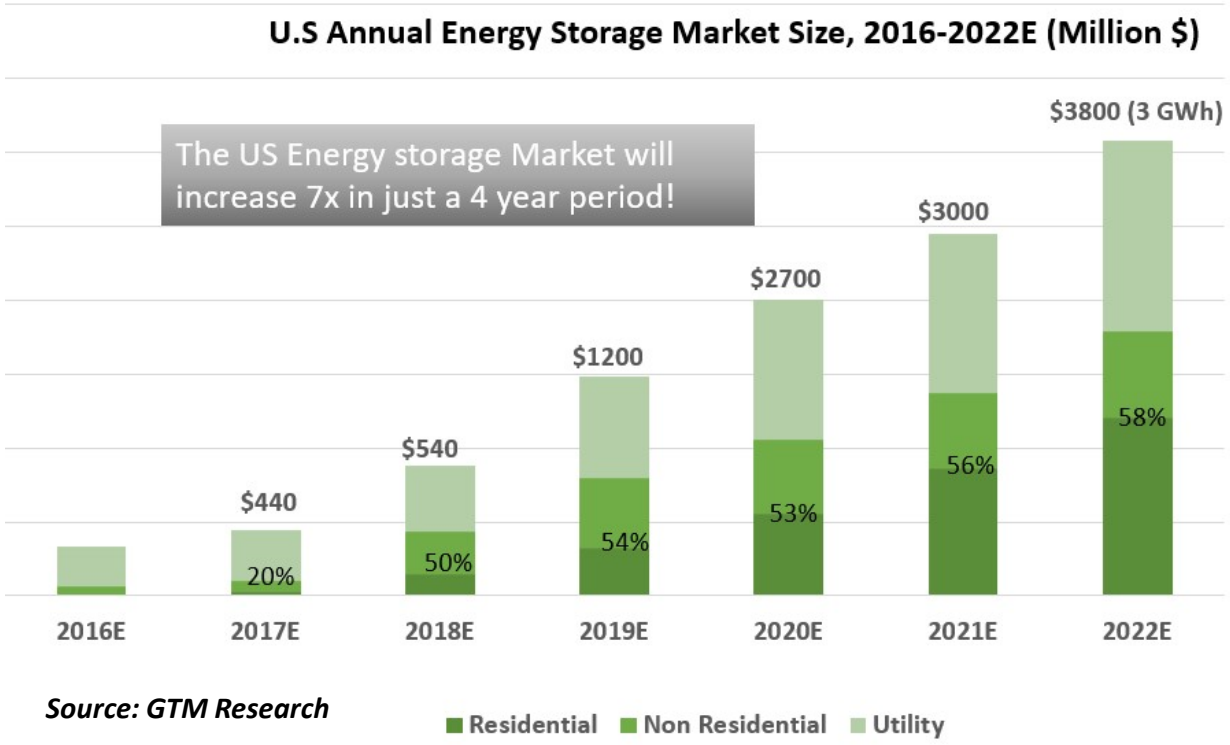
- *Graduated as Electrical Engineer at Hannover University, Germany*
- *Received MBA degree at Würzburg University, Germany*
- *10 + years as Country Manager for a solar module manufacturer*
- *Managing Director at Fortress Power since 2016*

Topic

- Growth Opportunity
- Company Introduction
- Fortress Lithium Battery
- Compatible Inverters
- Integration Guide
- Battery Technology Comparison
- Fortress Power Sizing Tool

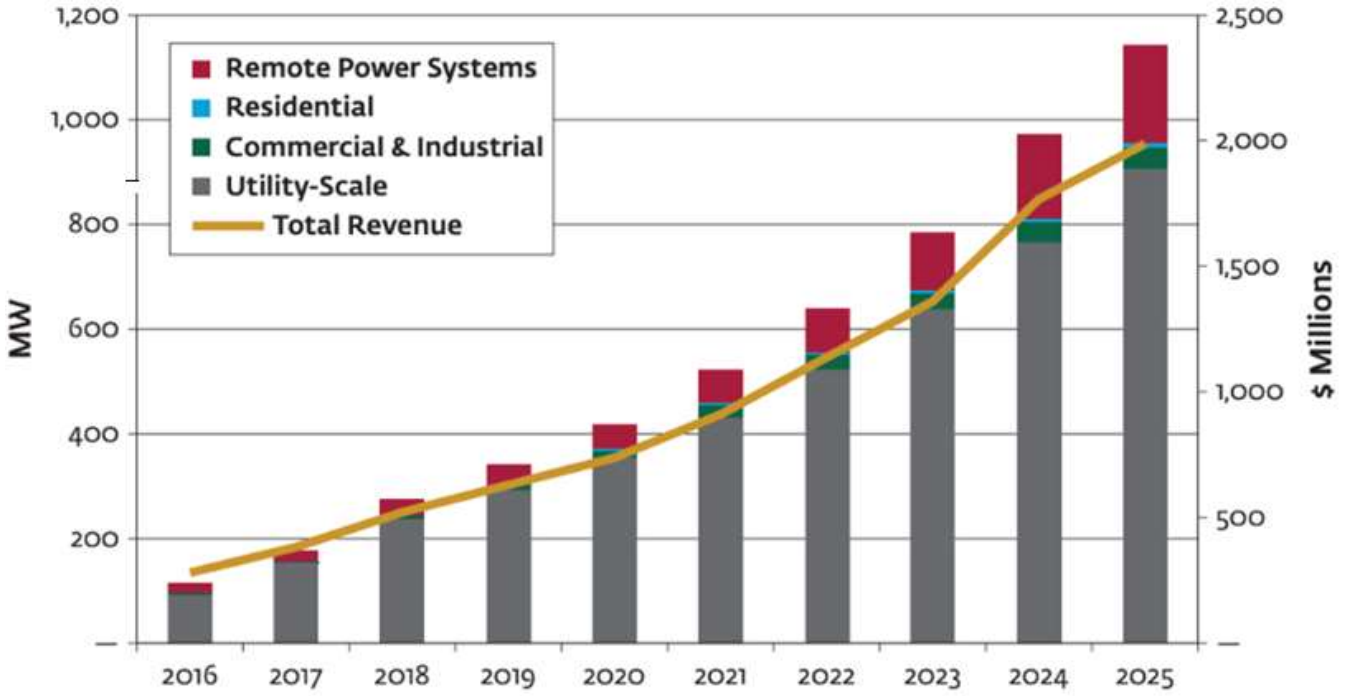
Growth Opportunity

US Energy Storage Market



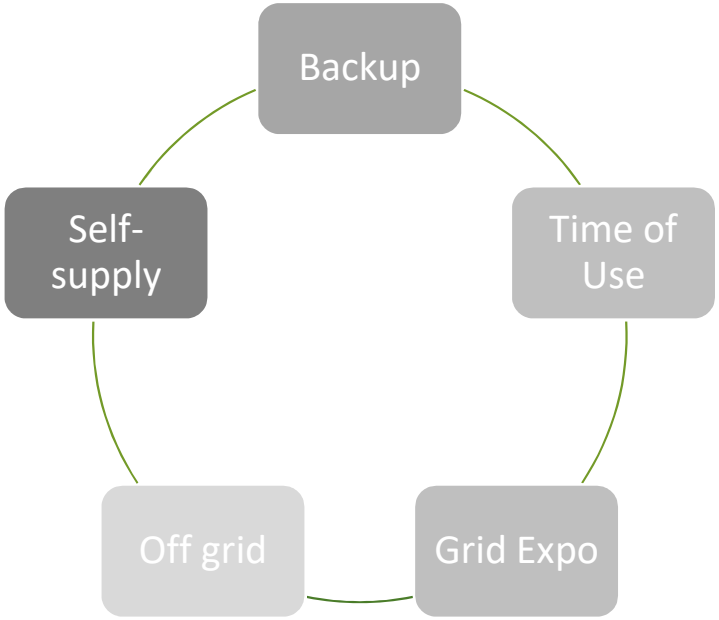
Source: GTM Research

Central & Latin America Energy Storage Market



Annual stationary Energy Storage Deployments by Segments Central & Latin America, (2016-2025); Source IFC ES Report

Energy Storage Benefits



Back Up Your Facility
Power your facility when the grid is off; keep solar panels running during outages.

Maximize Your PV Production
Store excess solar power for later use.

Save Money on your Electric Bill
Charge the batteries at off-peak times; discharge them during peak periods.

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

Company Introduction

Mission Statement

"Our mission is to provide clean and affordable energy to millions of homes and businesses."

-Barry Moore, President

Company Introduction

A world-leading manufacturer who brings automotive Lithium Ferro Phosphate batteries to the energy sector

U.S Headquarters, Southampton, PA
(30,000 Sqf)

Manufacturing Facility, Shenzhen China
(since 2008)

Fortress Lithium Battery

Lithium Ferro Phosphate Technology

We incorporate the safest technology available into our batteries.

	Fortress Power	**Tesla, LG Chem, BYD**
Chemistry	Lithium Ferro Phosphate (LFP)	Lithium Ion Nickel- Magnesium -Cobalt (NMC)
Safety	✓	X
Eco-friendly	✓	X
Life Cycles	6000	< 3000
Operating Temperature	-4 – 140 °F	32 – 113 °F
Degradation Rate	LFP < NMC	

Search LFP vs. NMC nail test videos on YouTube

Lithium Ion Safety Concerns

Terrifying moment 35 firefighters struggle to tackle an enormous blaze after a Tesla Model S crashes in Austria and turns into an INFERNO

- The fire started after the 19-year-old driver crashed into a motorway barrier
- 35 crew members battled the blaze while wearing special breathing equipment
- Electric car fires are especially hard to put out because the often relight
- The battery must be cooled enough to cut the power supply

Tesla Spontaneously Catches Fire, Burns Down During Test Drive In France

by Tyler Durden
Mon, 08/15/2016 - 10:36

0
SHARES

After Tesla's latest problem involving a Model S crash in Beijing while in autopilot mode (which has since prompted the carmaker drop remove "autopilot" from its Chinese website), Elon Musk may have to return to a more familiar problem plaguing his vehicles: spontaneous combustion.

Fortress Lithium Batteries

LFP-10 & 15

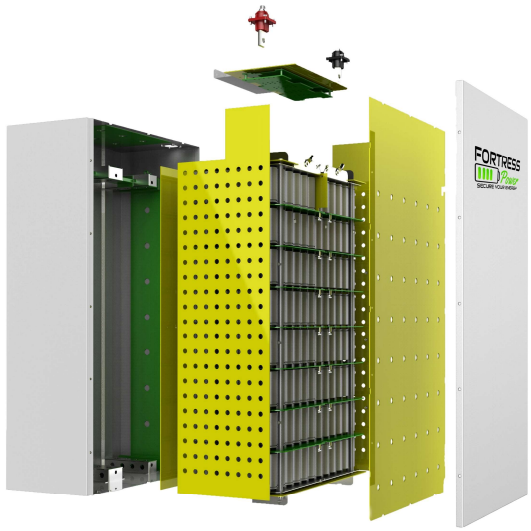
- ✓ ***Smart Battery Management System***
- ✓ ***Large Capacity for Easy Installation***
- ✓ ***98% Round Trip Efficiency***
- ✓ ***Fast Charging***
- ✓ ***Large Current Output***
- ✓ ***Compact & Slick design***
- ✓ ***Lowest Cost Per Cycle***

eVault 16.5

Smart Battery Management System (BMS)

Multilevel Safety Concept for Highest Reliability

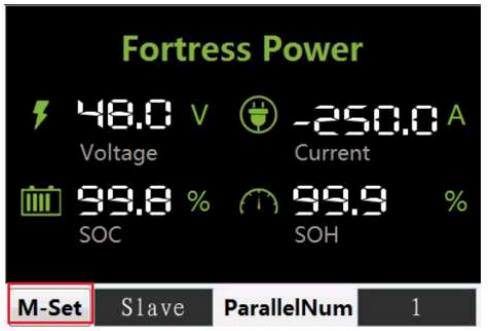
- ✓ Overcharge and Deep Discharge Protection
- ✓ Over-heat Protection
- ✓ Over Current Protection
- ✓ Cell Monitoring and Balancing
- ✓ Voltage and Temperature Monitoring

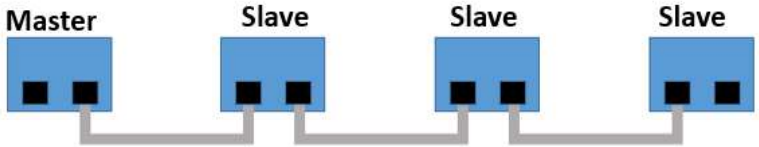


LCD Monitoring of eVault 16.5

Information on LCD Display:

- ✓ Voltage
- ✓ Current Output
- ✓ State of Charge
- ✓ State of Health
- ✓ Safety Warning: Over-charging & -discharging; Over Current; Over-Heat
- ✓ Voltage of slave units





Technical Specification

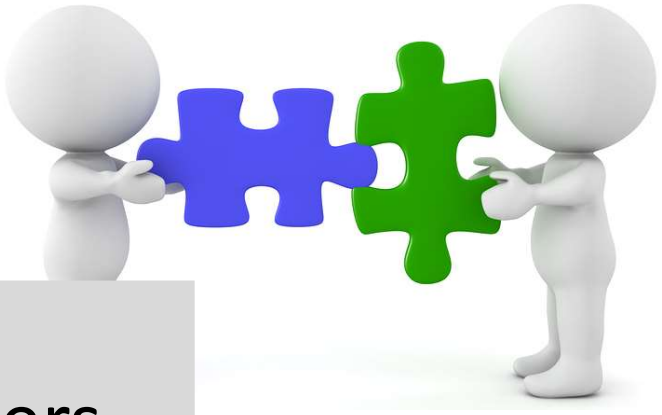
	LFP-10	LFP-15	eVault 16.5
Total Energy [KWH]	10.2	15.4	18.5
Usable Energy [KWH]	10.2	15.4	16.5
Capacity [AH]	200	300	360
Battery Voltage [V]		48V	
Max. Charge Current (Continuous) [A]	100	100	150
Max Discharge Power (Continuous) [KW]	5 (100A)	5 (100A)	8.2 (160A)
Peak Output [KW]	7.5 (150A)	7.5 (150A)	12 (240A)
Parallel Stacking	2	2	8
LCD Monitoring	No	No	Yes
Communication	N/A	N/A	CAN/RS485
Warranty		10 years; up-to 6,000 cycles	

Comparison Chart of Various Lithium Batteries

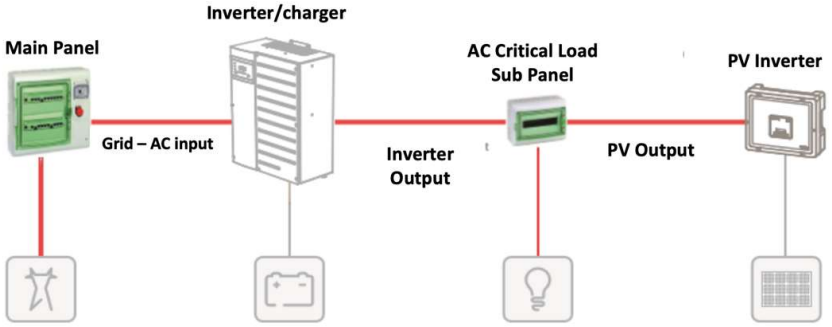
	Fortress Power	Simpliphi	Discover	LG Chem	Panasonic
Battery Chemistry	LFP	LFP	LFP	NMC	NMC
Safety	Y	Y	Y	N	N
Usable Power	10/15/16.5 kWh	2.5/3.5 kWh	6.6 kWh	9.3 kWh	2 kWh
Roundtrip efficiency	98%	98%	98%	94.5%	96.5%
LCD Display	Yes	No	No	No	No
Guaranteed Battery Cycles	6,000	10,000	5,000	2,500	2,800
Off-Grid years	16	27 **	13.6	6.8	7.7
Price per kWh	Low	High	High	Low	Low
Installation time	Low	High	High	Low	High
Cost per Cycle	Lowest	Mid	Mid	High	High

** Simpliphi uses low-cost MOSFET based BMS, which only lasts 10-15 years.

Compatible Inverters



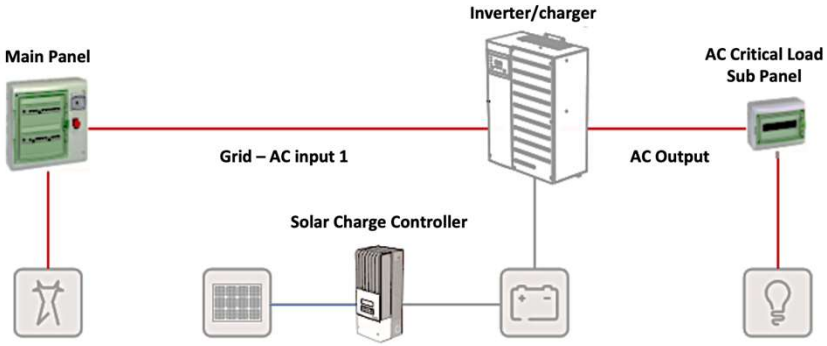
AC vs DC Coupled Solution



AC-Coupled System Diagram

Application for AC coupled solutions

- *When retrofitting to existing PV systems*
- *For new installations that require module level rapid shutdown*



DC-Coupled System Diagram

Application for DC coupled solutions

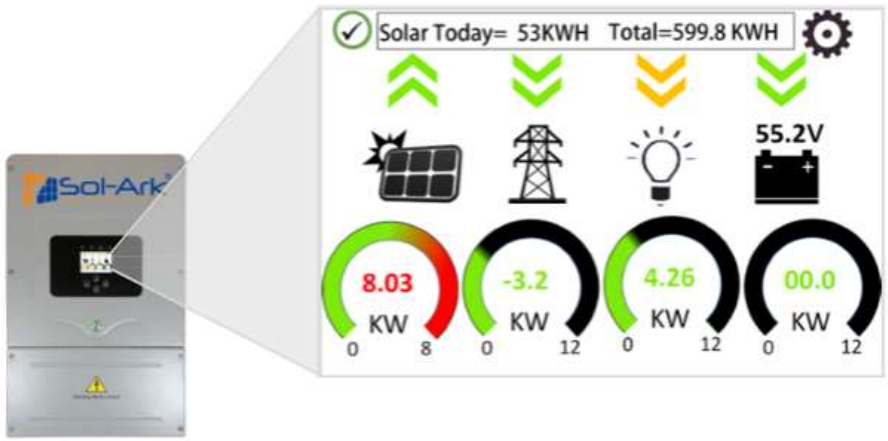
- *For new installation*
- *No additional PV inverter*
- *More efficient*

Compatible Inverters

COMPATIBLE WITH MOST 48V CHARGERS AND HYBRID INVERTERS!

Brand	Inverter/Charger Mode	Configuration
Sol-Ark	8 KW Inverter	AC or DC coupled
Schneider	Conext XW MPPT charge controller; Conext XW+ series; Conext SW;	AC or DC coupled
Outback	Skybox, 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	AC or DC coupled
SMA	SUNNY ISLAND 4548-US/6048-US; SUNNY ISLAND 3.0M/4.4M/6.0H/8.0H	AC coupled
Victron	Phoenix VE.Direct Inverter; MultiPlus and Quatro Inverter/Charger; Skylla-TG Charger; General; Color Control or Venus GX	DC coupled
Morning Star	TriStar MPPT 600V; TriStar MPPT; Tristar PWM	DC coupled
Midnite Solar	Solar Classic 150, 200 & 250; Solar Classic 150, 200 & 250-SL	DC coupled

FORTRESS + SOL-ARK 8KW (AC & DC Coupling)



Available in our stock!

Key features:

- *All in one unit (Off-Grid; Time-of-Use; Self-Supply; Back-up; Grid export)*
- *Extreme Compact & Easy Installation*
- *DC Coupled & Transform-less*
- *The best Roundtrip efficiency: 93%*
- *High Surge Power: 20KW*
- *Auto-Gen Start included*
- *Allows to use Gen Output to AC couple to an existing PV array*

Technical Specification

	Output to the Critical Load		**Output to the Grid**
	On Solar or Battery (Back-up)	With Grid or Generator Present	Pass-through
AC Output Power	8 KW	12 KW	12 KW
Surge power	20 kW (5 Sec)		
AC Output Voltage	120/240 V & 120/208V		
UPS Grid Failure Transfer time	12 kW auto-transfer relay at 2ms		
PV Array	Max 11 KW in DC-Coupling/Max 7KW in AC-Coupling		
PV Array in AC & DC	Max 11 KW in DC & Max 3 KW in AC (total 14 KW)		
Module-level rapid shutdown Compliance	Adding Tigo Optimizers		
Storage capacity	10/15/16.5 KWH per unit; scalable to 132 KWH		

Fortress + Schneider XW+ (AC & DC Coupling)

Key features:

- *Over 10 years in operation*
- *All in one unit (Off-Grid; Time-of-Use; Load shifting; Back-up; Grid export)*
- *Allows DC & AC coupling*
- *Single or three phase systems from 7 kW to 102 kW*
- *Performs in hot environments up to 70°C*
- *Auto-Gen Start optional*

Technical Specification

	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)
Storage capacity	10/15/16.5 KWH per unit; scalable to 132 KWH	
UPS Grid Failure Transfer time	Built-in 60A auto-transfer relay at 8ms	
Compatible PV Inverters	AC-coupled to Enphase, AC modules, Solaredge, SMA, Fronius 10 kW+, etc.	
Stack-ability	▪ Max. 4 in 1-Ph (120/240V) ▪ Max. 9 in 3-Ph (120/208V): 3 units per phase	
Requirement	▪ PV Watts or PV inverter size ≤ exceed XW+ system watts ▪ PV Watts or PV inverter size/48V = __A should be ≤ Battery Max Charging Current **	

6.8 kW/30 kWh ESS

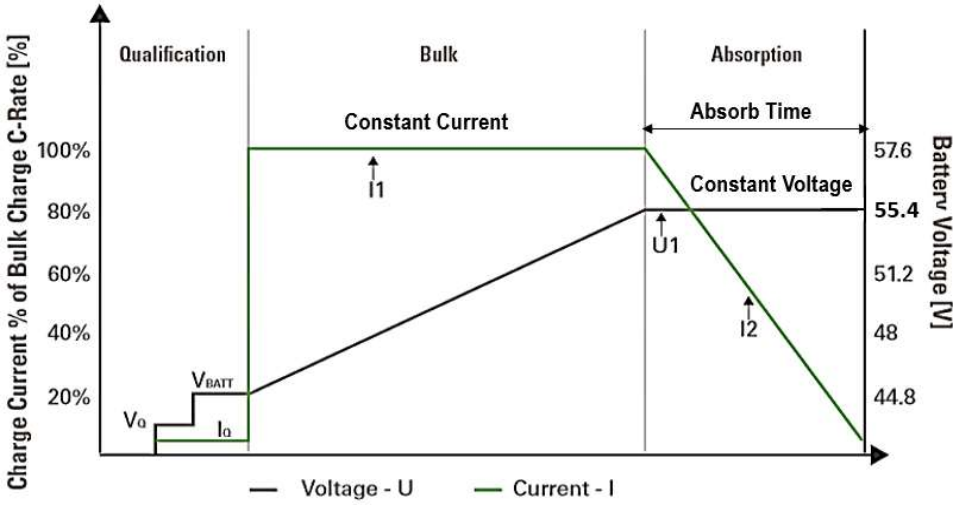
***Example: 7.5 KW PV array /48V = 156 A*

Comparison Chart of Various ESS

	Fortress Power +Sol-Ark	Fortress Power + Schneider	SolarEdge + LG Chem	Tesla Powerwall	Sonnen eco 16	Pika Energy X7600+Habor 5
Low Material Cost	Yes	Yes	Yes	Yes	x	x
Low Cost Easy Install	Yes	x	x	x	x	x
Lowest Cost per Cycle	Yes	Yes	x	x	x	x
Require Additional PV inverter	x	x	x	Yes	Yes	x
AC coupling to Micro/String inverters	Yes	Yes	x	Yes	Yes	x
Round trip efficiency (PV -> Batt -> AC losses)	93%	88%	79%	87%	75%	85%
INVERTER SPECIFICATION						
AC output/Grid-tie	12KW	6.8 KW	7.6 KW	5 KW	8 KW	8 KW
AC output/Back-up	8 KW	6.8 KW	5 KW	5 KW	7.2 KW	8 kW
Surge Power	20 KW	12 kW	6.6 kW	7 KW	12 KW	12 KW
No. of Parallel Stacking	x	4	x	10	x	x
3-phase system	Yes	Yes	x	x	x	x
UPS Grid Failure Transfer Time	2ms	8ms	2000ms	2000ms	16ms	1000ms
BATTERY SPECIFICATION						
Battery Chemistry	LFP	LFP	NMC	NMC	LFP	NMC
Safety	Yes	Yes	No	No	Yes	No
Usable Power	LFP: 10/15 KWH eVault 16.5	LFP: 10/15 KWH eVault 16.5 KWH	9.3 KWH	13.5 KWH	16 KWH	17.1 KWH
No. of Parallel Stacking	LFP-10/15:2 eVault 16.5:8	LFP-10/15:2 eVault 16.5:8	2	10	x	4
Guaranteed Battery Cycles	6,000	6,000	2,600	2,800	10,000	2,800
LCD Display	Yes	Yes	x	x	x	x

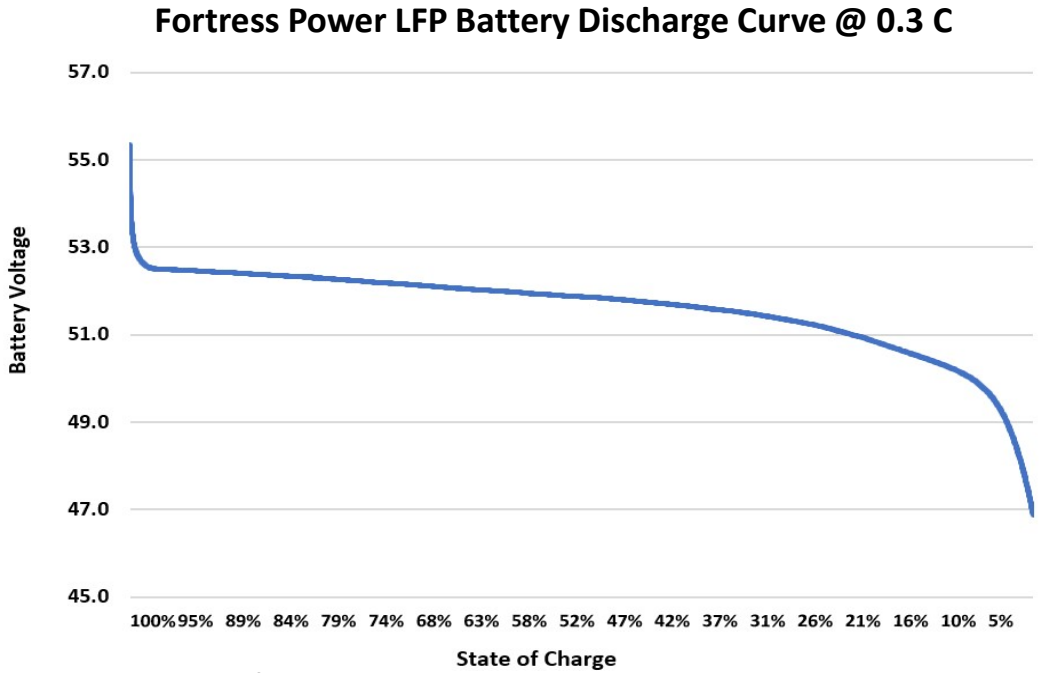
Integration Guide

Fortress LFP Battery Charging Curve



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

Discharging Curve of LFP Battery



C rate of LFP-10: 200 A; 0.3 C = 60A discharge current

C rate of LFP-15: 300 A; 0.3 C = 90A discharge current

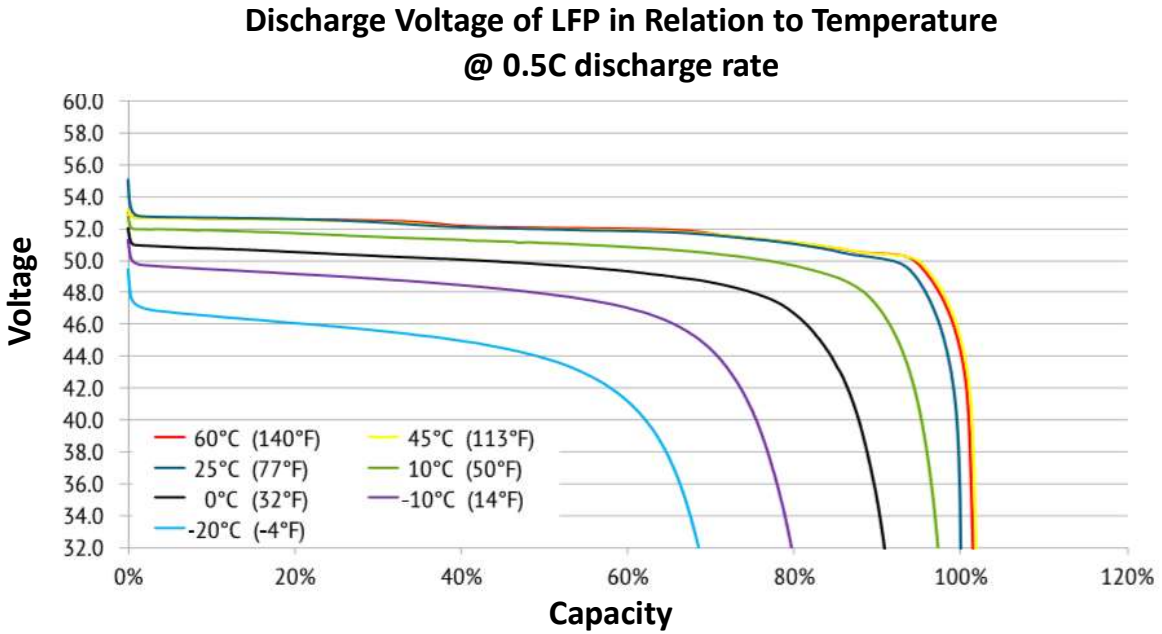
Integration Guide-Inverters/Charger Setting

Charger/Inverter configuration recommendation for best performance:

	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

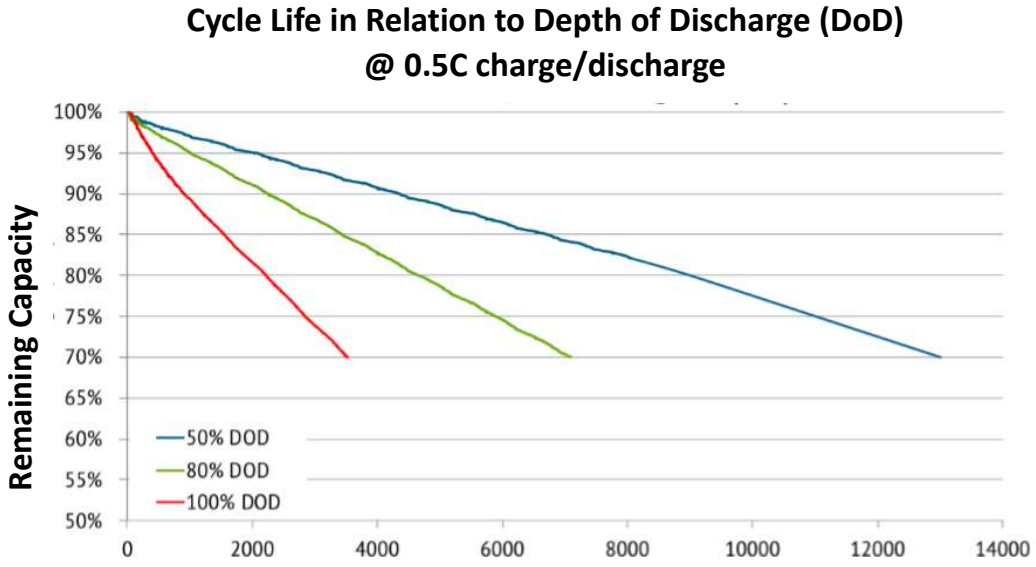
The Battery Parameter Setting Guides with Schneider, Outback and SMA inverters are available to download on www.fortresspower.com/Resource

Temperature Impact on Performance



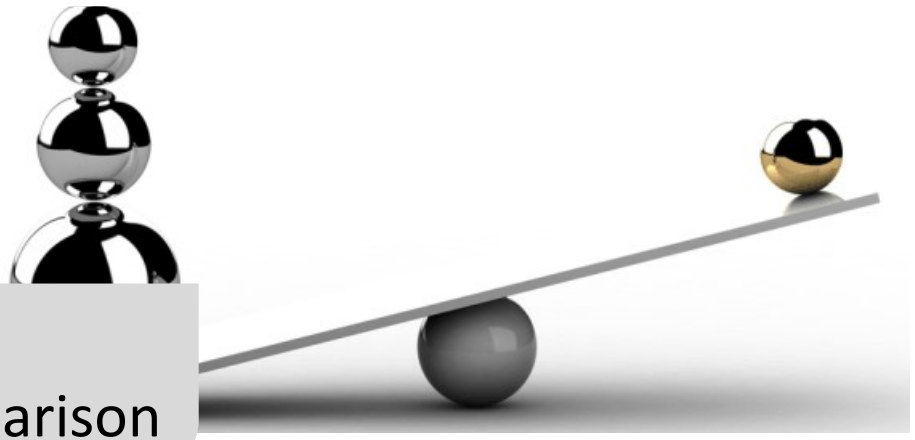
	3000 Cycles	6000 Cycles
Temperature Range	32 F to 130F (0 °C to 49°C)	10 F to 110 F (0°C to 43°C)

Cycle Life vs Depth of Discharge



	3000 Cycles	6000 Cycles
Depth of Discharge	90%	80%

Battery Technology Comparison

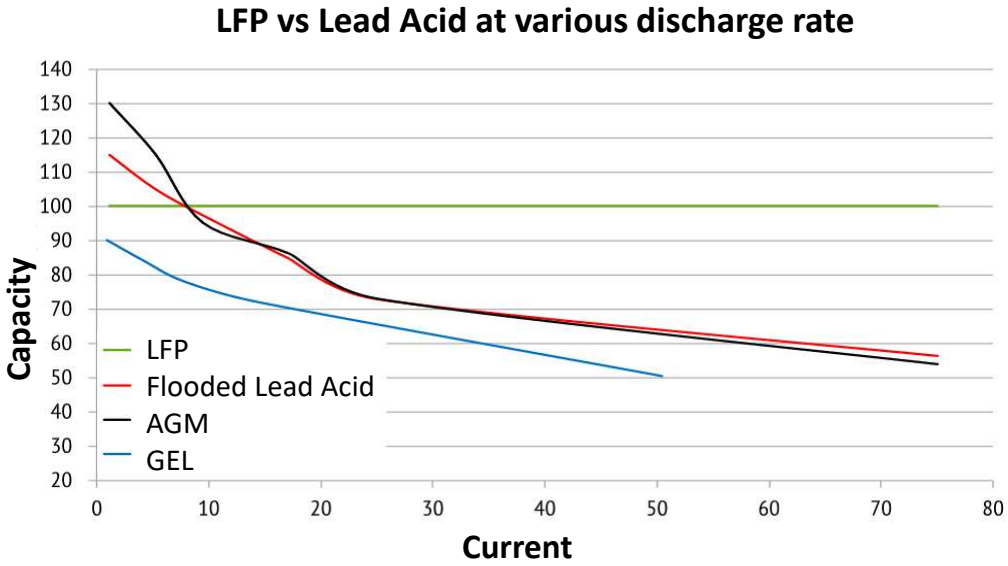


Comparison of different Battery Technologies

	Fortress LFP	Lithium Ion	Li-Polymer	Flooded LA	AGM	Carbon AGM	Nickel Iron
Round trip efficiency	98%	95%	95%	80%	88%	94%	65%
Cost of 10 kWh Usable Power (MSRP)	6,900	6,999	4,500	2,800	3,600	5,000	18,000
Cycle Life	6,000	2,500	1,500	600	750	2,400	8,000
Off Grid Years	16.4	6.8	4	2.7	2	6.5	21.9
Cost per kWh Cycle	0.11	0.28	0.30	0.46	0.48	0.21	0.23
Safety	Yes	No	No	No	No	No	Yes
Free Maintenance	Yes	Yes	Yes	No	Yes	Yes	No

*** Additional $ 1000 may apply to Flooded LA – Nickel Iron batteries**

Performance Comparison



Disadvantages of Lead Acid:

- *Capacity drops significantly when output current increases*
- *6 times more space*
- *Higher cable cost and longer installation time*

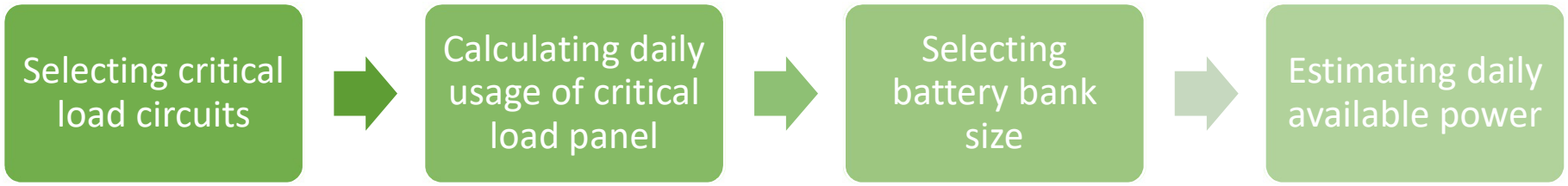
Our Product Advantages

- ✓ **Safe**
- ✓ **Competitively priced**
- ✓ **Lowest cost per cycle**
- ✓ **Long lasting**
- ✓ **Best round-trip efficiency**
- ✓ **Easy installation**
- ✓ **Maintenance-free**

Fortress Storage Sizing Tool

Fortress Energy Storage Sizing Tool

4 Steps to Size Up Energy Storage for Backup



Select Critical Load Panel

	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	Kitchen	Microwave Oven-650 Watts	1	1000	1000	0.1	100
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	2	500
	STANDBY POWER	**Schneider XW+6848NA**	**1**	8	8	**24**	**192**
			Totals	**8098**	**5940**		**20182**

Inverter Type	Quantity**	Watthours/Day	Surge Power	Running Watts
Schneider XW+6848NA	1	**20182 Watts**	3902 Watts Available	860 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
Microwave Oven-650 Watts	100
Cell Phone Charger	200
TV-Flat Screen-46"	760
Computer-Laptop	500
Inverter Standby Power	192
TOTAL	**20182 Wh/Day**

Select Battery Bank Size

Fortress Power Battery	**LFP -10**
System Size:	10,240 Wh
Battery Quantity	2
Depth of Discharge:	90%
Available Power:	18,432 Wh

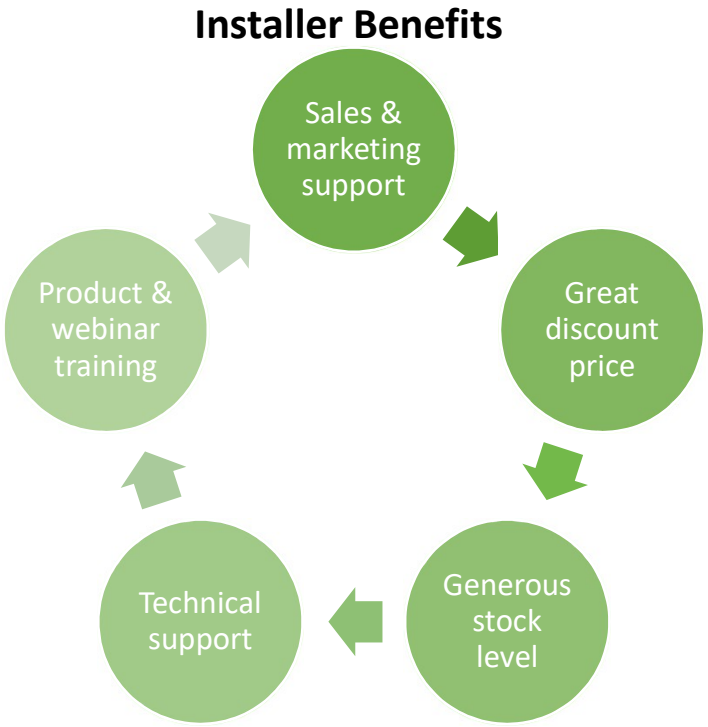
Estimate Average Daily PV Production

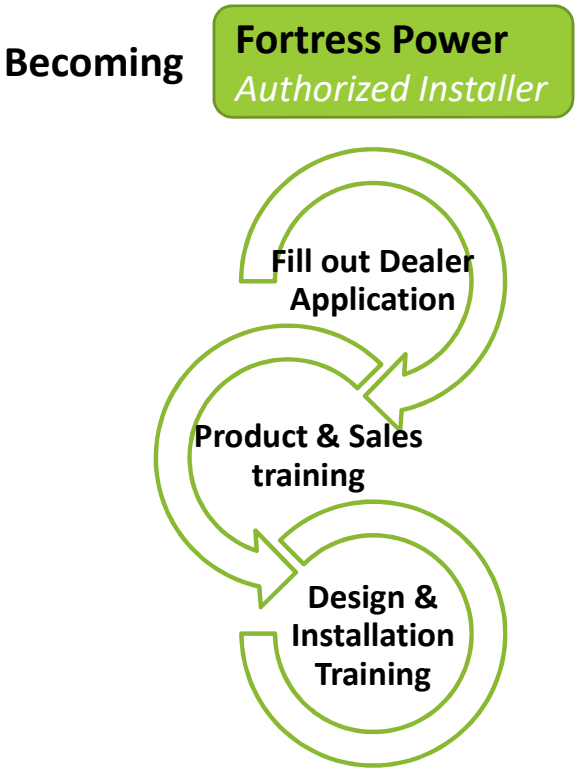
	Solar Radiation	AC Energy	Energy Per Day (watthours)	Full charge on battery	avail. Energy after battery charged
January	3.8	751	**24,226**	(18,432)	**5,794**
February	4.28	746	**26,643**	(18,432)	**8,211**
March	5.23	986	**31,806**	(18,432)	**13,374**
April	5.91	1,039	**34,633**	(18,432)	**16,201**
May	6.32	1,132	**36,516**	(18,432)	**18,084**
June	6.74	1,106	**36,867**	(18,432)	**18,435**
July	6.36	1,090	**35,161**	(18,432)	**16,729**
August	5.78	1,004	**32,387**	(18,432)	**13,955**
September	5.19	886	**29,533**	(18,432)	**11,101**
October	5.08	926	**29,871**	(18,432)	**11,439**
November	4.14	749	**24,967**	(18,432)	**6,535**
December	3.38	646	**20,839**	(18,432)	**2,407**

WHAT TO EXPECT

Available power in Battery at 90% DoD	18,432 Wh	0.9 Days
Lowest average daily available PV Power:	20,800 Wh	
Highest average daily available PV Power:	36,800 Wh	

Authorized Installer Benefits





Thank You & Contact Us

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