



Lithium Energy Storage

Topic

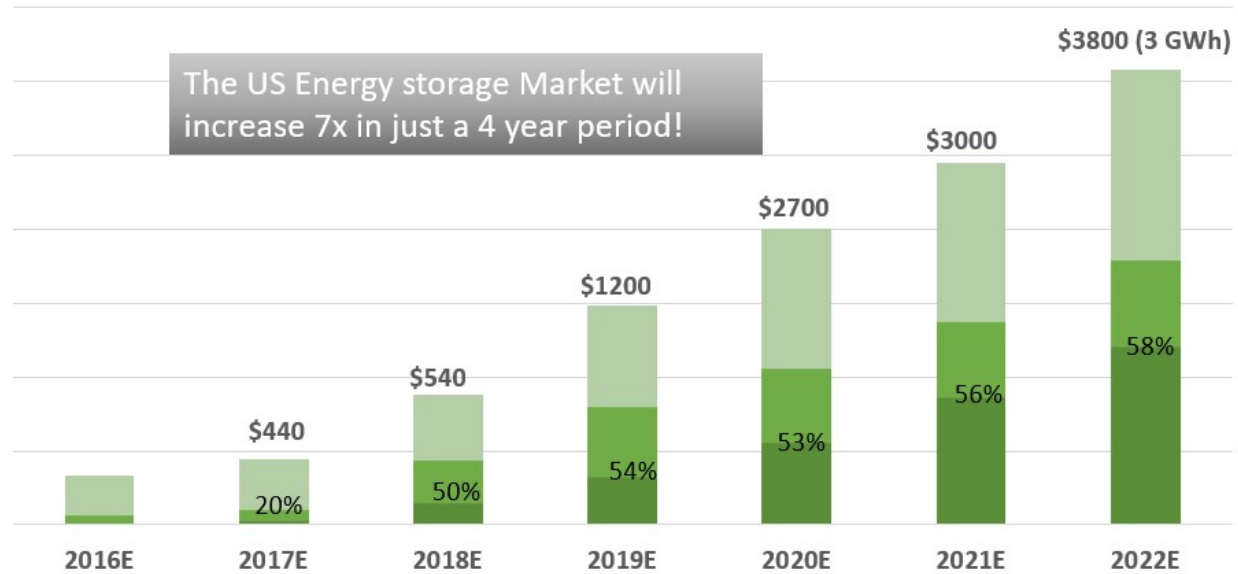
-
- Why Energy Storage
 - Company Introduction
 - Battery Technology Comparison
 - Integrating battery storage to PV array



Why Energy Storage

US Energy Storage Market

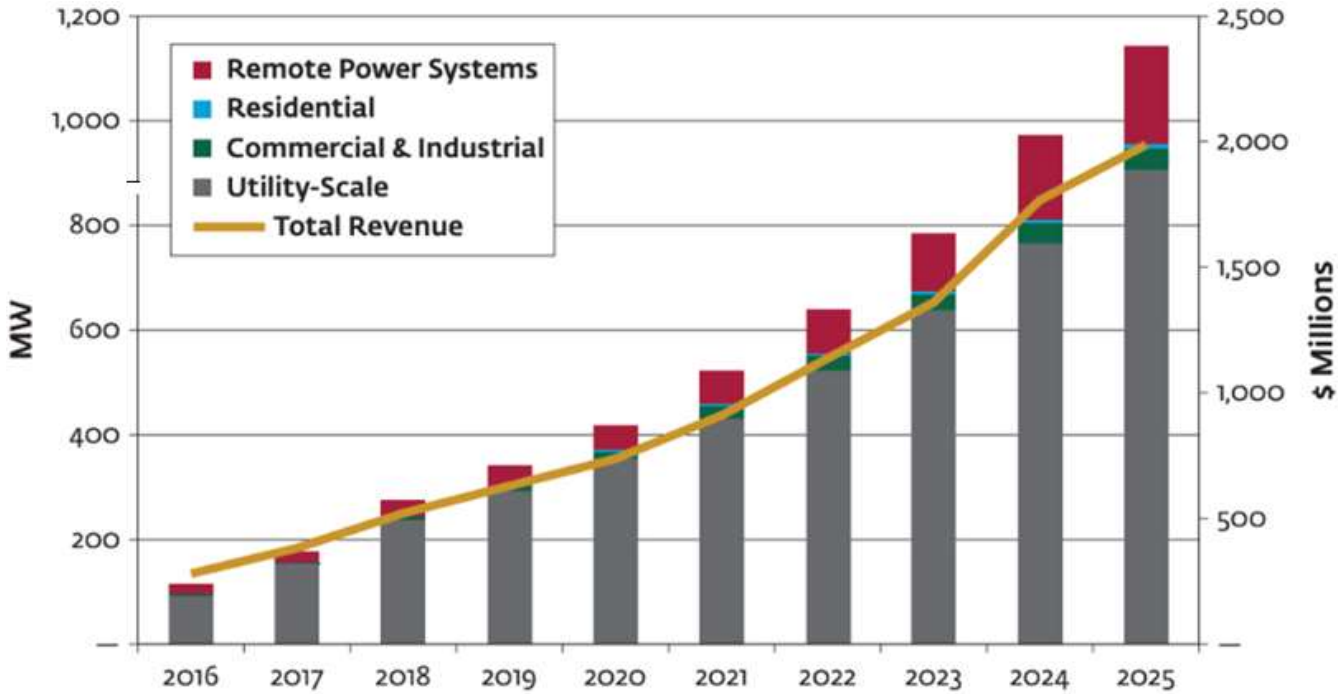
U.S Annual Energy Storage Market Size, 2016-2022E (Million \$)



Source: GTM Research

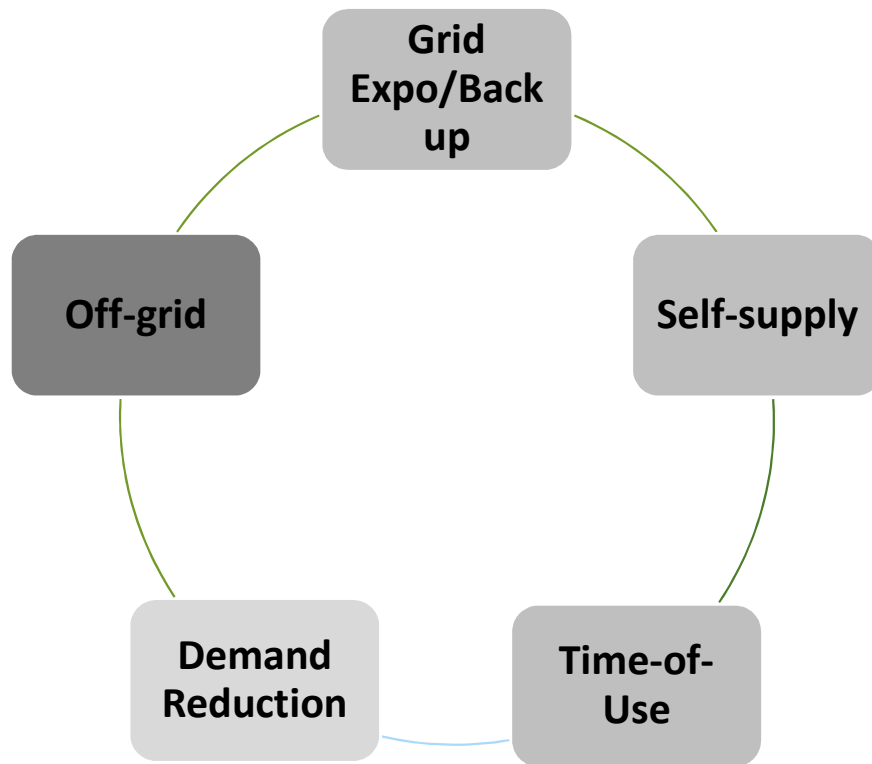
Residential Non Residential Utility

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. Run Generators more efficiently



Allows "Self Supply"

Install PV where grid prohibits back feed



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. Peak Shaving to lower demand.



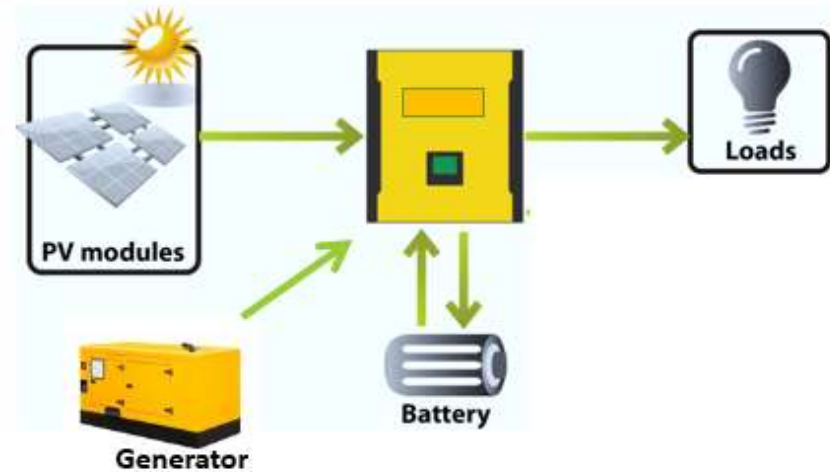
Tax and Incentives

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

Off-Grid Application

Stand alone PV + Storage System

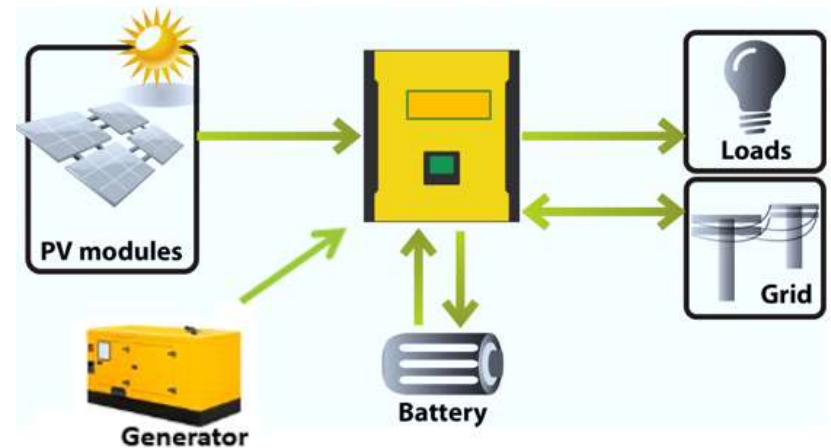
- a) No grid available. Power loads from PV or Battery
- a) Integrate generator, if needed



Grid Interactive Applications

Grid Export / Back up

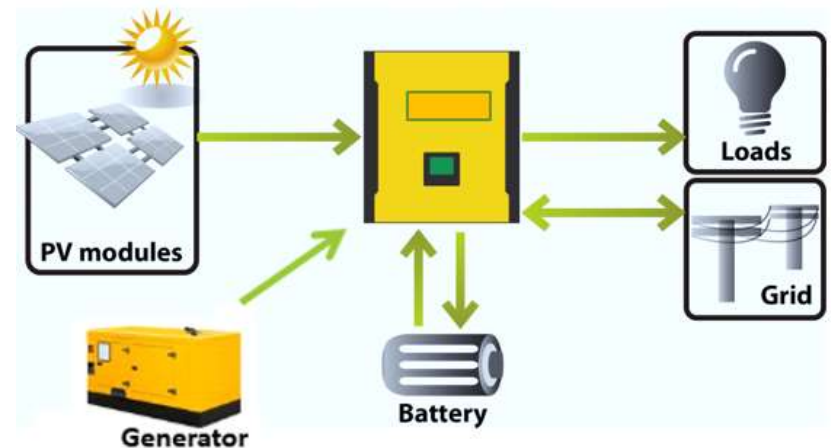
- a) When grid fails, the hybrid Inverter keeps the PV system operating, and powers loads from PV or Battery.
- b) During the day, when grid is connected, the excessive PV production feeds back to the grid



Grid Interactive Applications

Grid Export / Back up / Time-of-Use / Demand Reduction (CA)

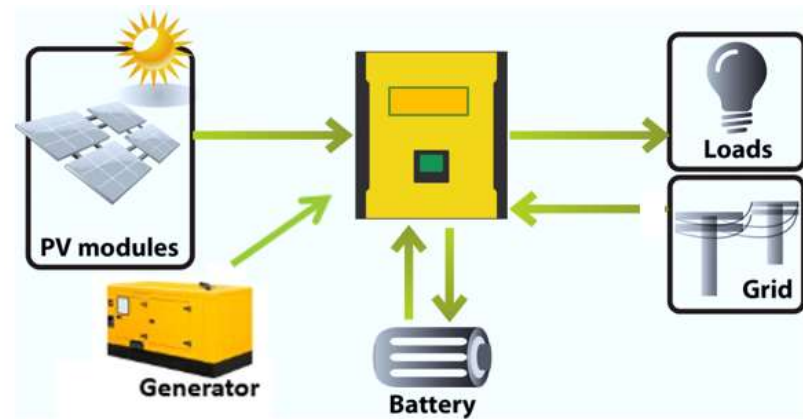
- a) Peak shaving: Block out times for purchasing grid power (ie. high tariff times) and re-charge batteries at low-cost times.
- b) Demand reduction: reduce KW-Charger for commercial clients, require a smart control unit



Grid Interactive Applications

Self-Supply Application (HI, AZ & Caribbean)

- a) Grid Available for Purchase but Sale is prohibited
- b) PV power charges batteries during day and discharges them at night.
- c) When Battery Charge low, power bought from grid to supply loads and/or charge batteries.





Company Introduction



US Headquarter

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

- ❑ U.S. Headquarter: Southampton, PA
- ❑ 30,000 Sqf Facility for R&D, Sales and Logistic
- ❑ Logistic Centers in California and Florida
- ❑ Over 35 MWH Installs Worldwide
- ❑ Exclusive Battery Supplier for the PA railway company



Manufacturing Facility



- ❑ Manufacturing Facility in Shenzhen, China
- ❑ ISO and OHSAS Certified
- ❑ Produce Lithium Batteries since 2008
- ❑ Supply Batteries to Automotive Companies
- ❑ 800 MWH Production Capacity

Fortress Lithium Iron Phosphate Batteries

eVault 18.5 kWh



LFP-10 kWh



LFP-5 kWh

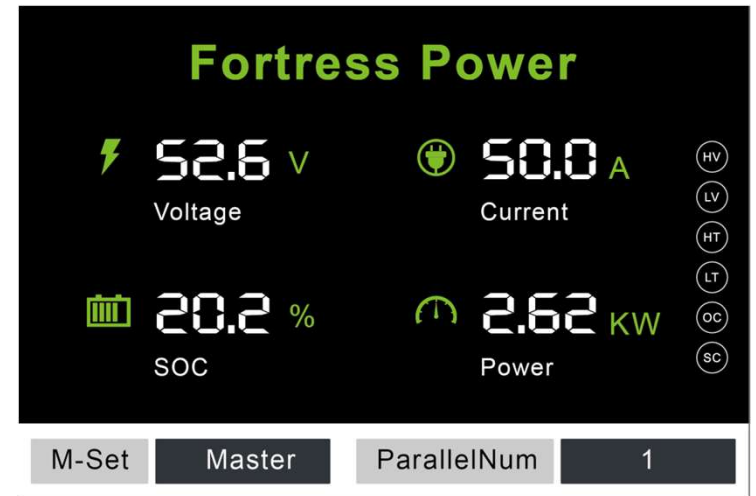


Battery Management System (BMS)

Multilevel Safety Concept for Highest Reliability

- ✓ Voltage and Temperature Monitoring
- ✓ Overcharge and Deep Discharge Protection
- ✓ Over-heat Protection
- ✓ Over Current Protection (DC Breaker)
- ✓ Cell Monitoring and Balancing

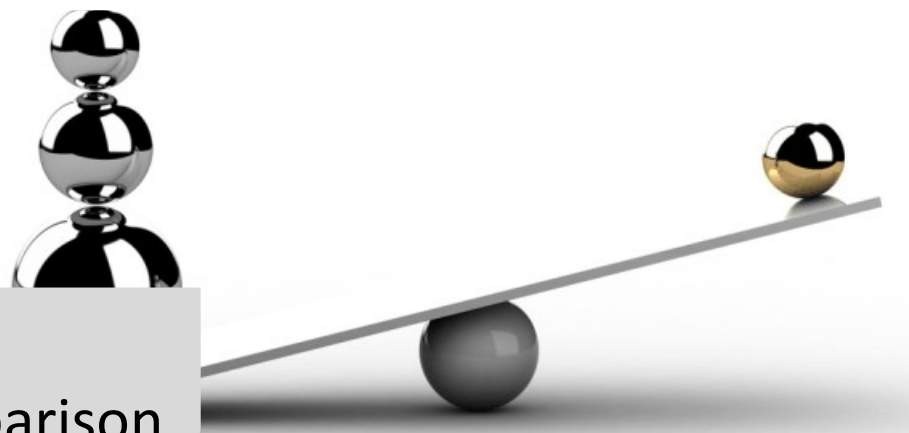
eVault LCD Display



Technical Specification

	eVault 18.5	LFP-10	LFP-5
Total Energy [KWH]	18.5	10.2	5.1
Capacity [AH]	360	200	100
Battery Voltage [V]	48V		
Max. Charge Current (Continuous) [A]	160	80	80
Max Discharge Power (Continuous) [KW]	9 (180A)	5 (100A)	4 (80A)
Peak Output [KW]	12 (240A)	7.5 (150A)	7.5 (150A)
Parallel Stacking	12	2	2
LCD Monitoring	Yes	No	No
Communication	CAN/RS485	N/A	N/A
Breaker	250A	150A	125A
Warranty	5/10 years; up-to 6,000 cycles		

Battery Technology Comparison



LFP vs NMC vs LiPo

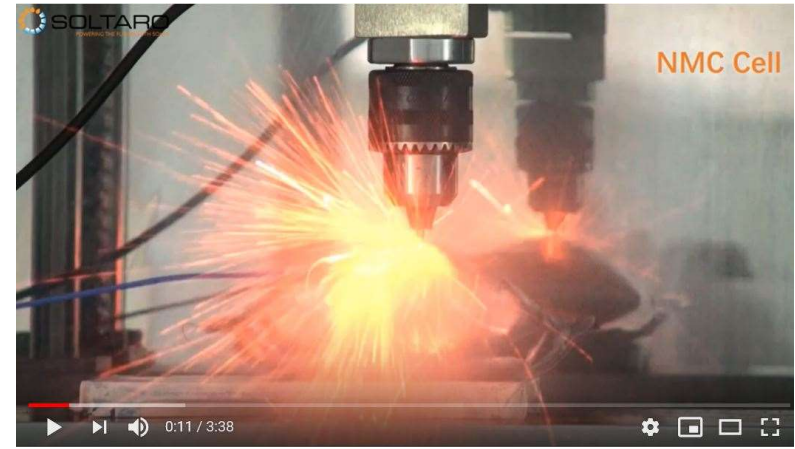
We incorporate the safest technology available into our batteries

	Fortress Power	Tesla, LG Chem, Panasonic	Humless
Chemistry	Lithium Ferro/Iron Phosphate (LFP) or LiFePo4	Lithium Ion or Nickel- Magnesium - Cobalt (NMC)	Lithium Polymer or LiPo
Safety	✓	X	X
Eco-friendly	✓	X	X
Thermal Stability	✓	X	X
Life Cycles	6000	< 3000	< 1500
Degradation Rate		LFP < NMC < LiPo	
Energy density		LFP < NMC < LiPo	

Highest Safety Standard



Lithium Iron Phosphate Technology (Fortress Power)

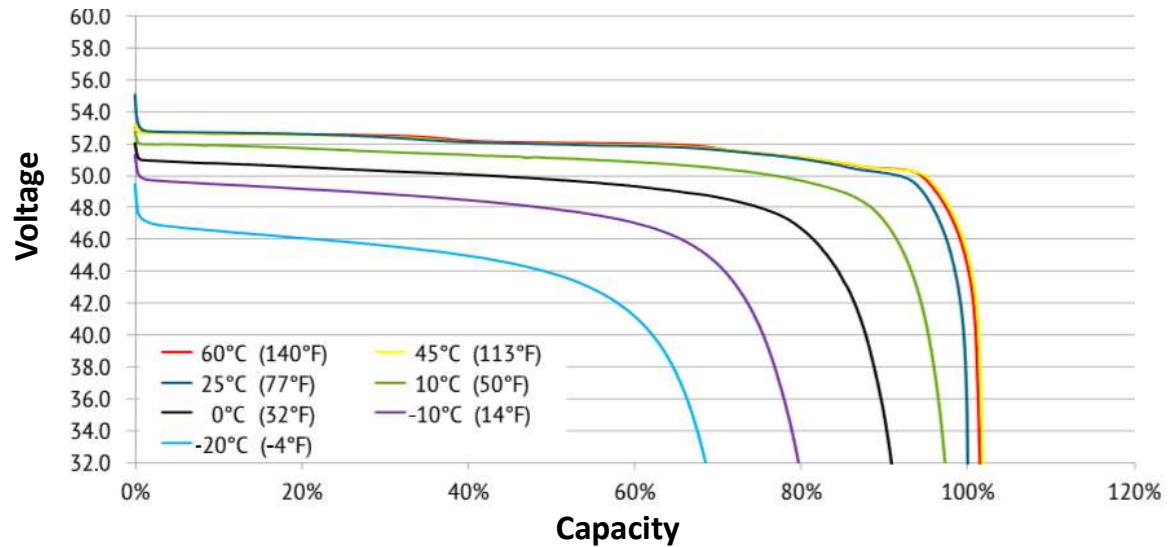


Nickel-Manganese-Cobalt Technology (Tesla)

View [LFP vs. NMC nail test video](#) on YouTube

Temperature Impact on LFP Performance

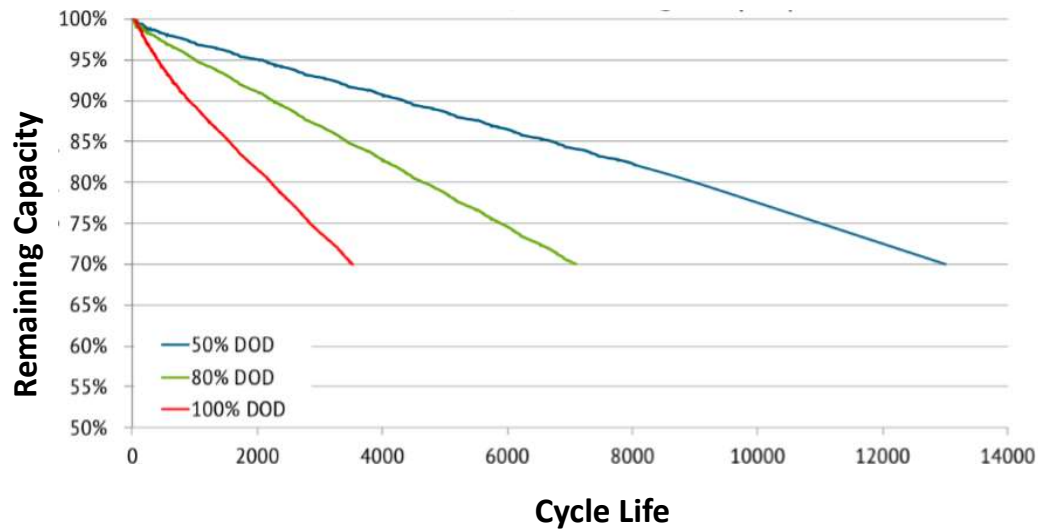
**Discharge Voltage of LFP in Relation to Temperature
@ 0.5C discharge rate**



	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)

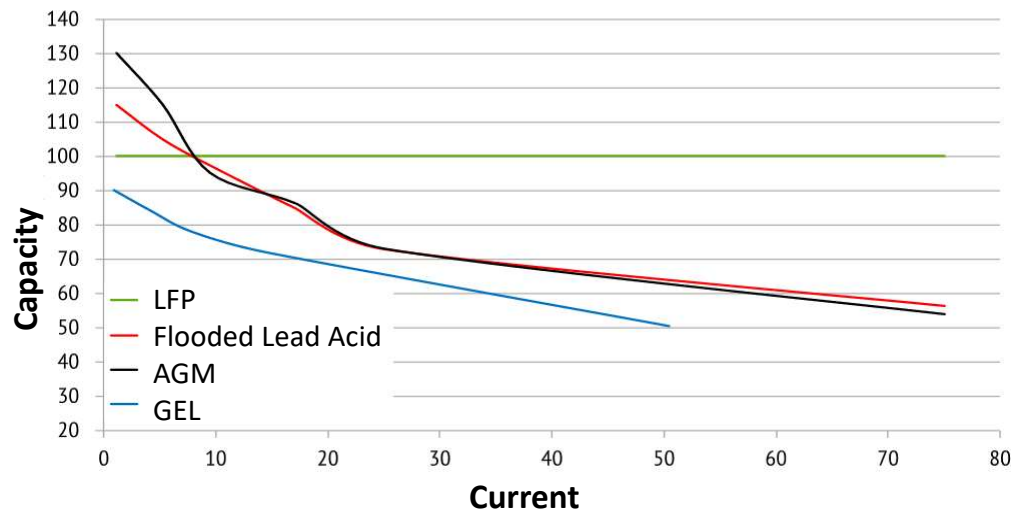
LFP Cycle Life vs Depth of Discharge

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



	Cycle Life	3000 Cycles	6000 Cycles
Depth of Discharge		90%	80%

Performance Comparison: LFP vs Lead Acid



LFP advantages:

- LFP Actual Capacity = Nameplate Capacity
- Lead Acid allows only 50% DoD, Actual Capacity = $0.5 \times$ Nameplate Capacity
- Lead Acid Capacity is affected by Discharge Rate, Temperature, and DoD at much higher rates than LFP.

Lead Acid capacity drops significantly when output current increases!

Space Comparison: LFP is 1/3 size and 1/3 weight of AGM



AGM Batteries
48V, 250AH
(6 kWh usable power)

Fortress eVault
48V, 360AH (18.5
kWh usable power)

Comparison of different Battery Technologies

	LFP	Lithium Ion	Li-Polymer	Flooded LA	AGM	Nickel Iron
Round trip efficiency	98%	95%	95%	80%	88%	65%
The Homeowner Cost of 10 kWh	6,900	6,500	4,500	1,200	2,200	18,000
Cycle Life @ 80% DOD	6,000	2,800	1,500	300	500	8,000
Off Grid Years	16.4	6.8	4	1	1.4	21.9
Energy Throughput in MWH	47	21.5	11.5	1.9	3.5	41.6
Cost per kWh	0.14	0.30	0.40	0.74	0.57	0.19
Safety	Yes	No	No	No	No	Yes
Free Maintenance	Yes	Yes	Yes	No	Yes	No

Energy Throughput: The total amount of energy a battery can be expected to store and deliver over its lifetime

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	5/10/18.5 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 kWh	Lowest	Mid	Mid	High	High

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

LFP Technology Advantage



Superior Safety



High Throughput



Long Duration

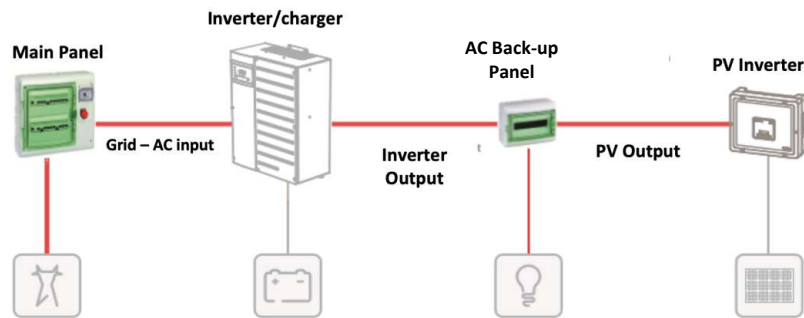


Low Energy Cost

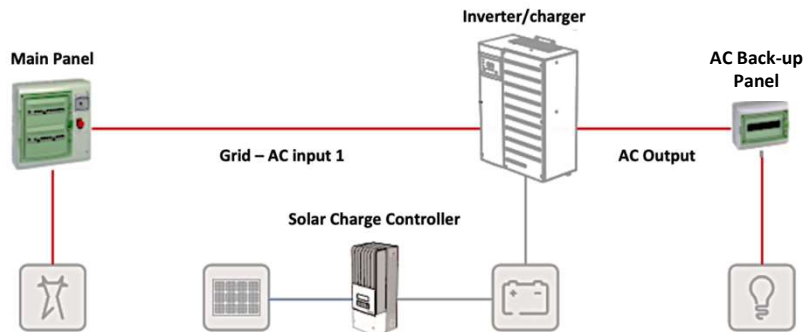
Inverter Comparison



AC vs DC Coupled Solution



AC-Coupled System Diagram



DC-Coupled System Diagram

Application for AC coupled solutions

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

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
Schneider **	Conext XW MPPT charge controller; Conext XW+ & XW pro 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);	AC or 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
Sol-Ark**	8 KW Inverter	AC or DC coupled
Victron **	Phoenix VE.Direct Inverter; MultiPlus and Quattro 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

** we're establishing communication with those inverters!

FORTRESS POWER ESS



12 kW/18.5 kWh

Key features:

- ❑ 12 KW full load capacity
- ❑ Storage Capacity 10 - 222kWh
- ❑ 93% roundtrip efficiency (PV->Battery->Load)
- ❑ Auto-Gen start included
- ❑ Allows DC & AC coupling
- ❑ All in one unit (Off-grid, Time-of-use, Self-supply, Back-up, Grid export)

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	9 kW	12 kW	12 kW
Storage capacity	10/18.5 KWH per unit; scalable to 222 KWH		
Surge power	20 kW (5 Sec)		
UPS Grid Failure Transfer time	12 kW auto-transfer relay at 4ms		
Compatible PV Inverters	AC-coupled to Enphase, AC modules, SolarEdge		
PV Array in DC Coupling	Up-to 13 kW		
PV Array in AC Coupling	Up-to 7.6 kW		
PV Array in AC & DC Coupling combined	Total max 13 kW		
Stack-ability	<ul style="list-style-type: none"> ▪ Max. 3 in 1-Ph (120/240V) ▪ Max. 6 in 3-Ph (120/208V): 3 units per phase 		

Fortress + Schneider XW Pro (AC & DC Coupling)

Key features:

- *Over 10 years in operation*
- *Can be paralleled (4 in 1 phase, 9 in 3 phase)*
- *Component system with many features (Off-Grid, Time-of-Use, Load shifting, Back-up, Grid export)*
- *Allows DC & AC coupling*
- *Single or three phase systems from 7 kW to 62 kW*
- *Performs in hot environments up to 70°C*
- *Auto-Gen Start optional*

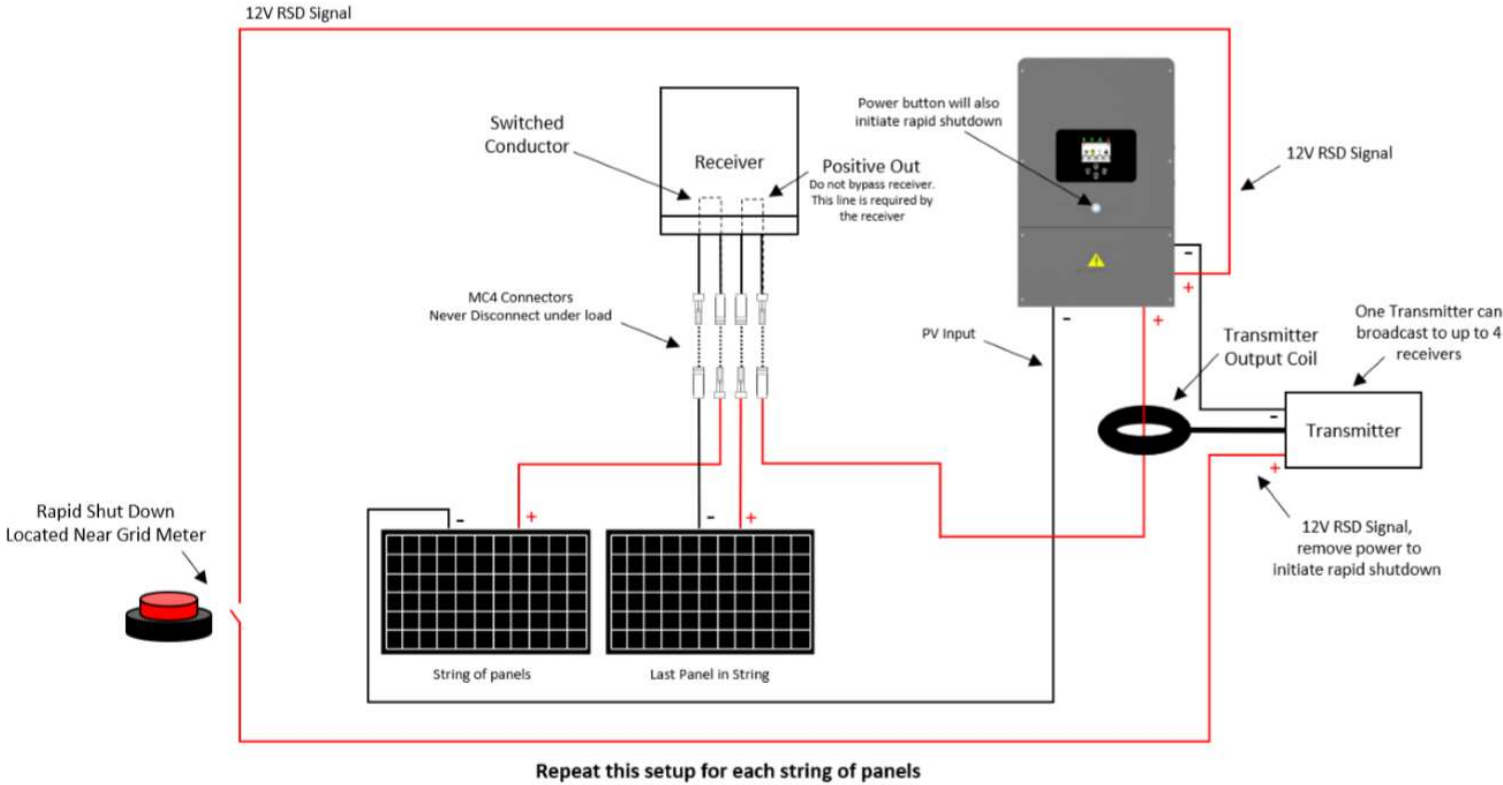


13.6 kW/74 kWh

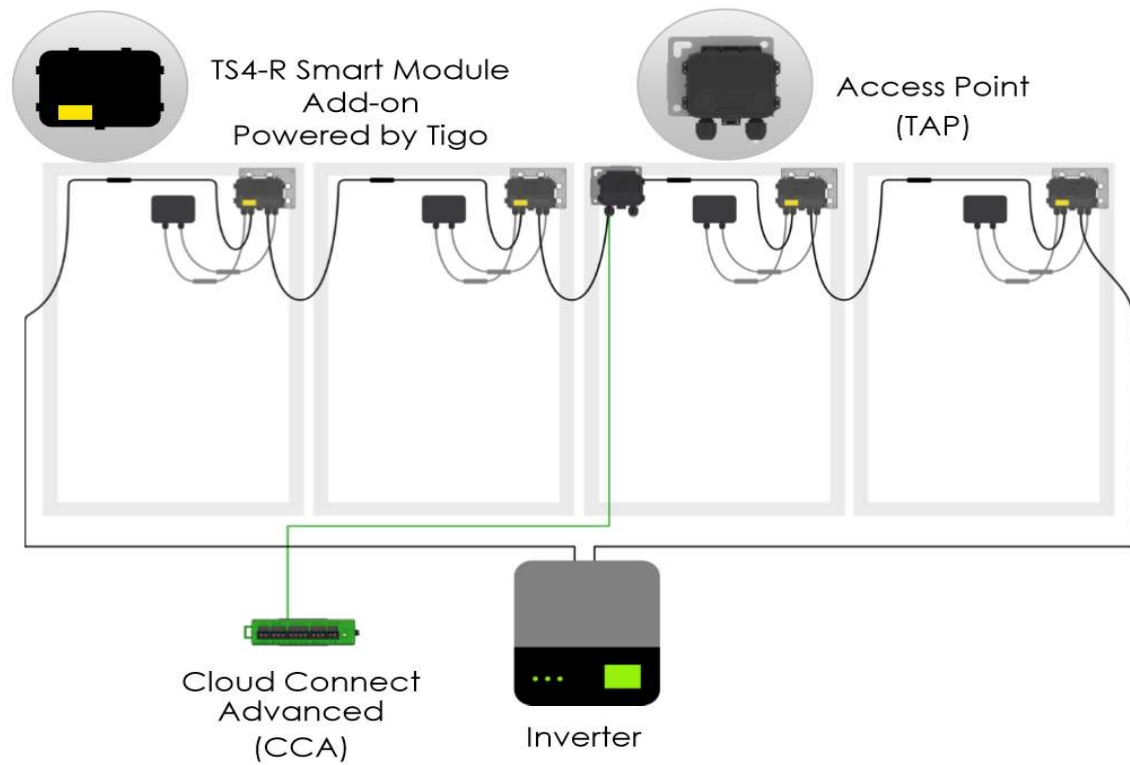
Technical Specification

	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	10/18.5 KWH per unit; scalable to 222 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	<ul style="list-style-type: none"> ▪ Max. 4 in 1-Ph (120/240V) ▪ Max. 9 in 3-Ph (120/208V): 3 units per phase 	

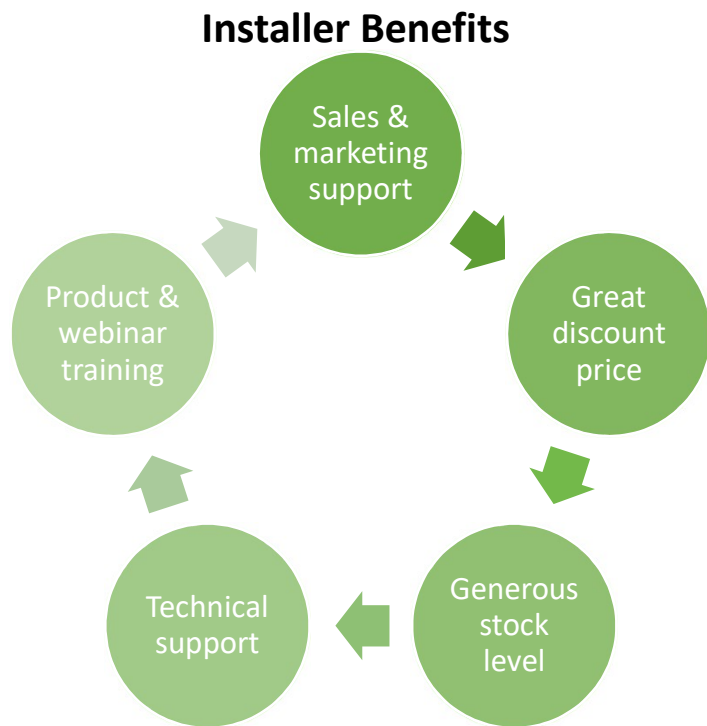
Integrating Midnite for String Level Rapid Shutdown



Integrating Tigo for Module Level Rapid Shutdown



Authorized Installer Benefits



Becoming

Fortress Power
Authorized Installer



Upcoming Webinar



Subject: How to design and install Lithium storage system

Time: Wed, 11/20th, 1 PM

Webinar link: <https://attendee.gotowebinar.com/register/6508505607390835981>

We will be covering the topics as below:

- How to design the lithium battery bank for your projects
- How to properly install lithium batteries
- How to properly program the inverters and charge controllers

Holiday Promotion



Time Period: starting Nov 1st to Dec 23rd, 2019

* With your purchase of two or three LFP-5s, you will receive \$ 250 discount on the 2nd and 3rd unit respectively.

** With your purchase of two LFP-10s, you are eligible for \$ 500 discount on the 2nd unit and free shipping within the US.

Please use Promo Code: [#Gogreen11](#)

Thank You & Contact Us

**If you want to go fast, go alone;
if you want to go far, go together!**



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