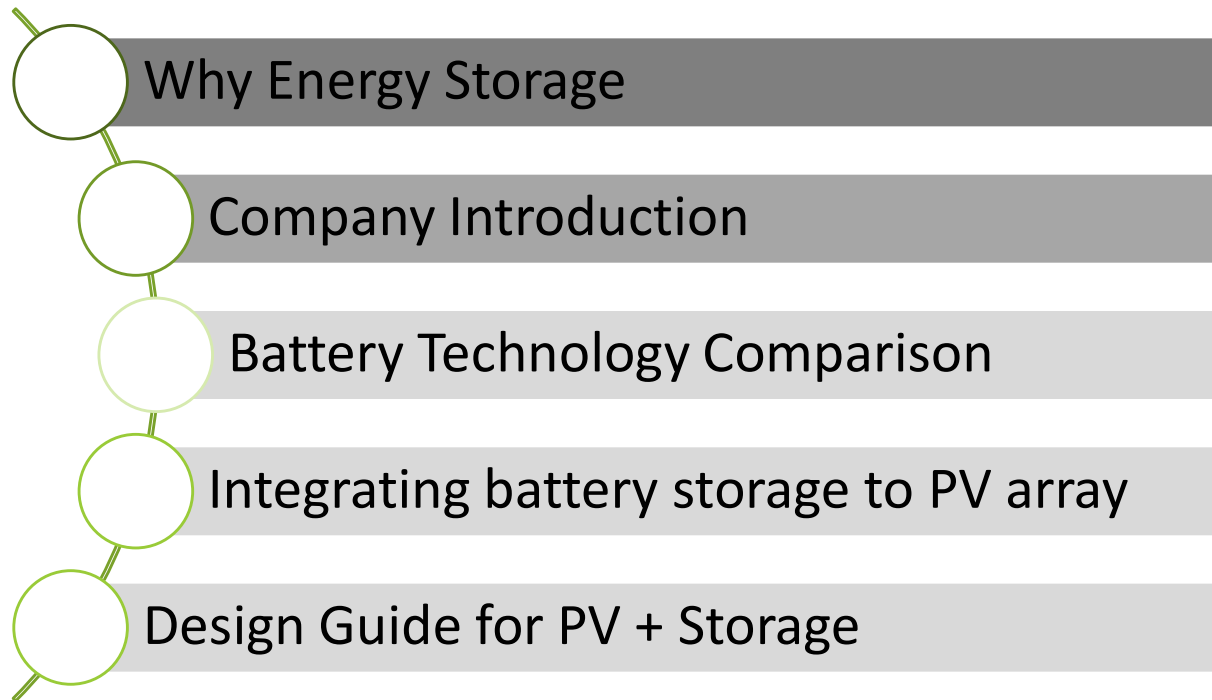




Fortress Power Webinar: *FAQ of Lithium Energy Storage*

Jing Yu
Managing Director

Topic





Why Energy Storage

Challenges with PV Grid-tie System



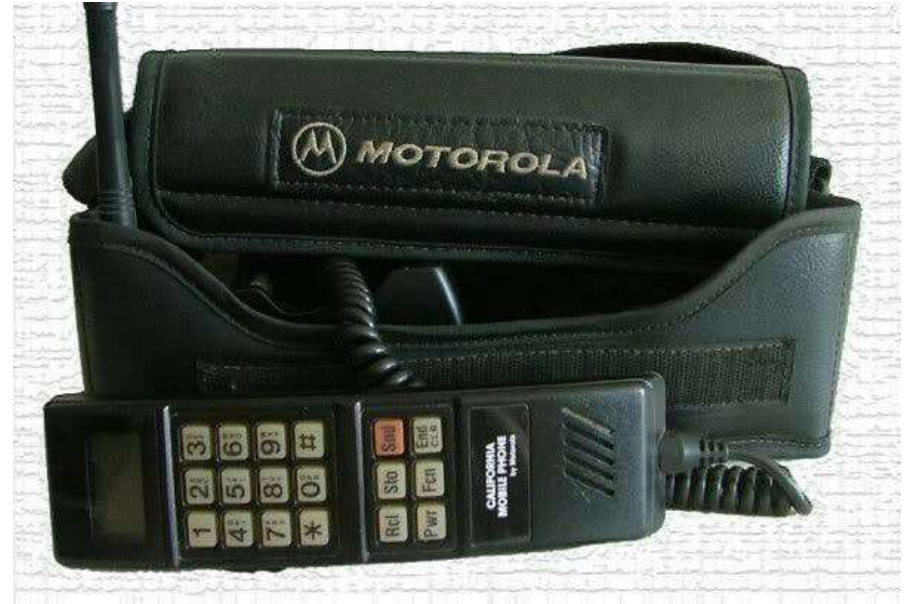
- Unbalanced Generation and Consumption
- No power during outages
- Back-feeding is prohibited in some regions.

Energy Storage: Balancing Energy Generation & Use

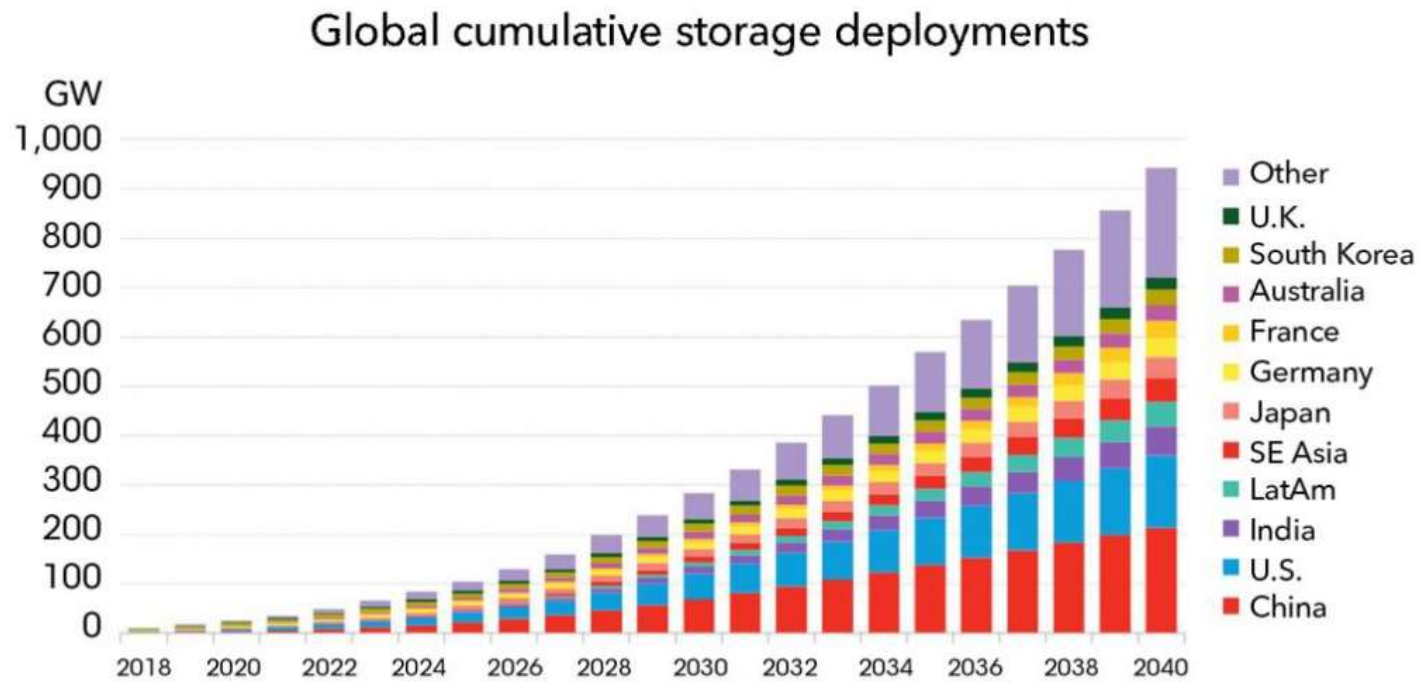


- Energy that is not used can be consumed later.
- Match the needs and demands
- Grid resilience
- Back up power during outages

Battery technology is rapidly changing.



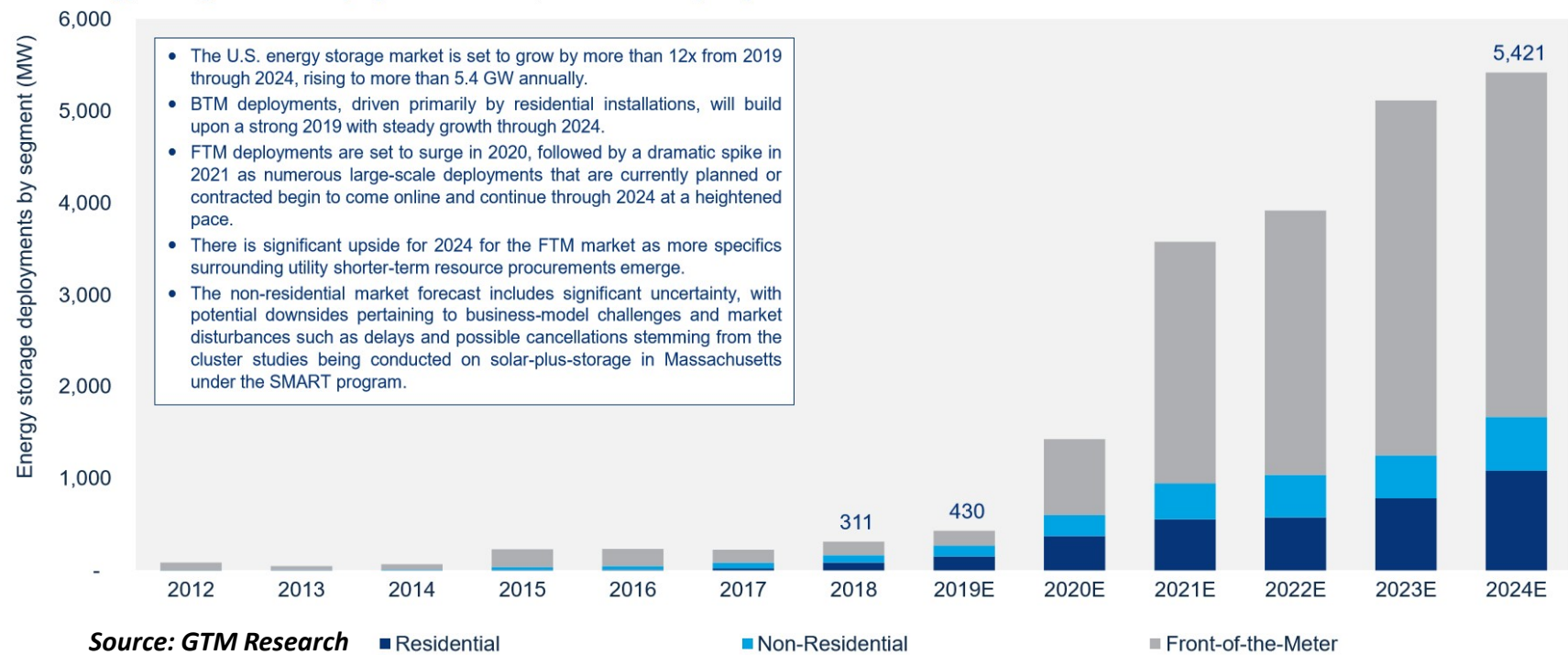
Global Energy Storage Market



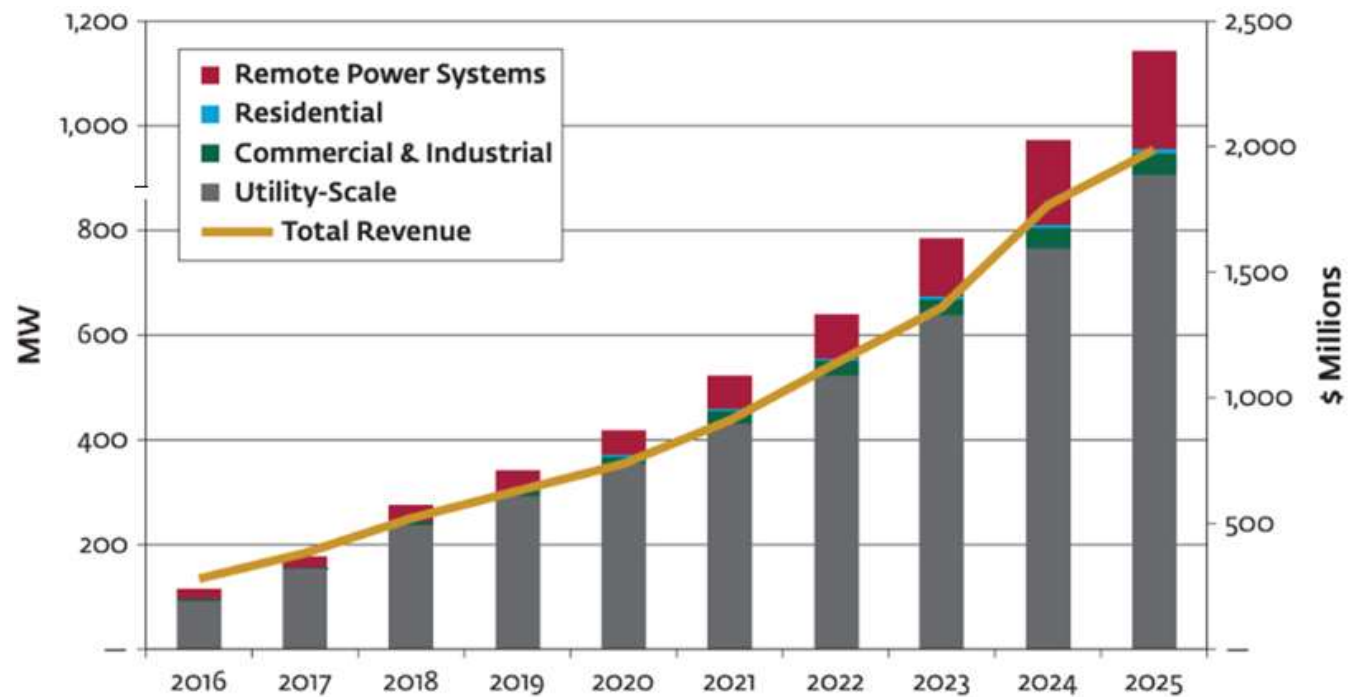
Source: BloombergNEF

US Energy Storage Market

U.S. energy storage annual deployment forecast, 2012-2024E (MW)

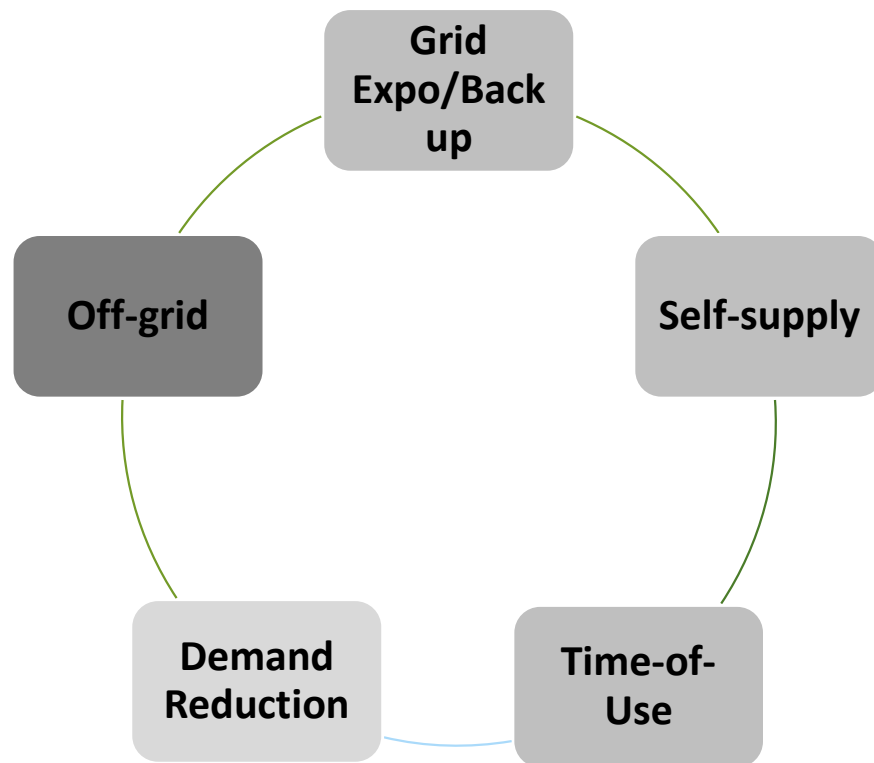


Central & Latin America Energy Storage Market



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.



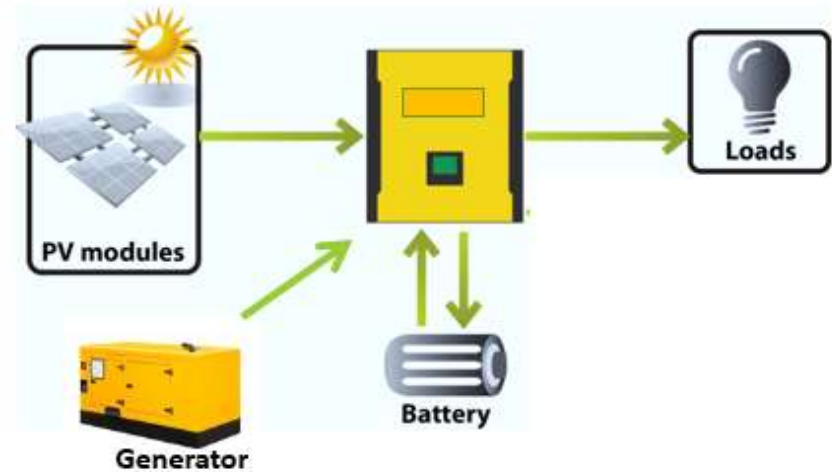
Tax and Incentives

26% ITC available if it's powered by solar; enjoy state and utilities rebates

Off-Grid Application

Stand alone PV + Storage System

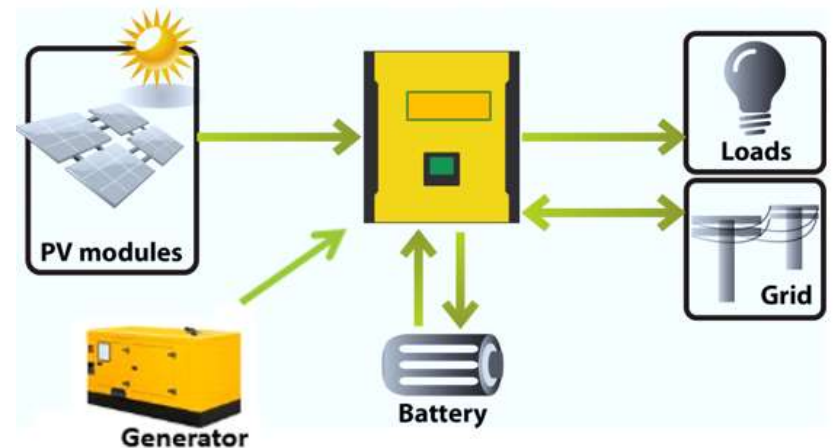
- a) No grid available. Power loads from PV or Battery
- a) Integrate generator, if needed



Grid Interactive Applications

Grid Export / Back up

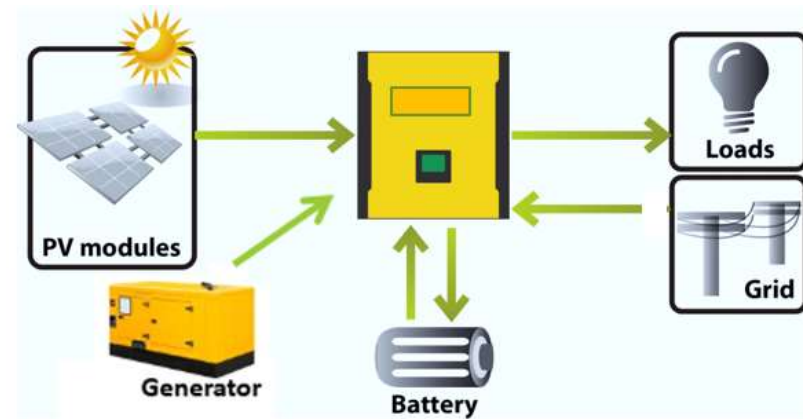
- a) When grid fails, the hybrid Inverter keeps the PV system operating, and powers loads from PV or Battery.
- b) During the day, when grid is connected, the excessive PV production feeds back to the grid



Grid Interactive Applications

Self-Supply Application (HI, AZ & Caribbean)

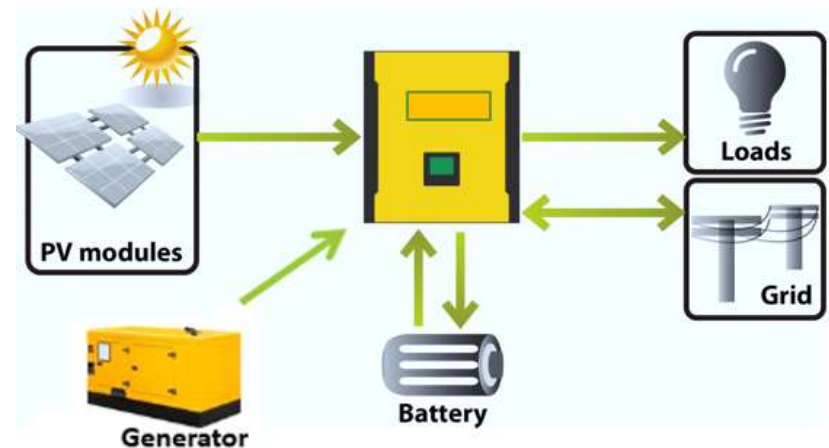
- a) Grid Available for Purchase but Sale is prohibited
- b) PV power charges batteries during day and discharges them at night.
- c) When Battery Charge low, power bought from grid to supply loads and/or charge batteries.



Grid Interactive Applications

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

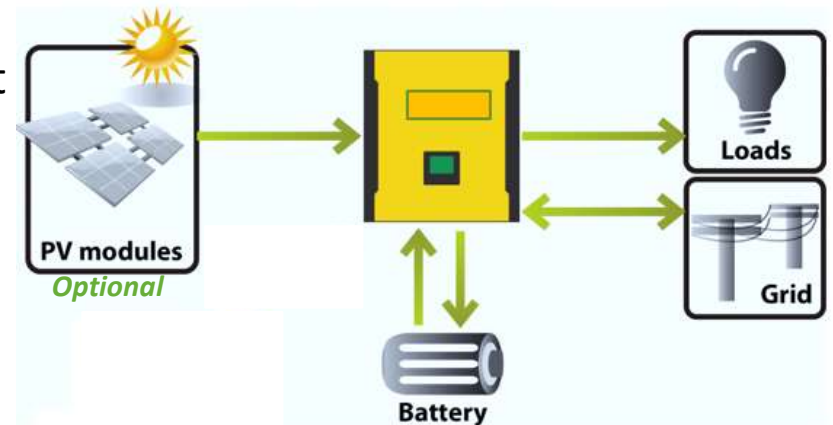
- a) Peak shaving: Block out times for purchasing grid power (ie. high tariff times) and re-charge batteries at low-cost times. It works without Solar.



Grid Interactive Applications

Demand Curtailment

- a) Reduce KW-Charger for commercial clients, require a smart control unit. It works without Solar.



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 45 MWH Installs Worldwide
- ❑ Exclusive Battery Supplier for a local railway company



Manufacturing Facility



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

Fortress Lithium Iron Phosphate Batteries

eVault 18.5 kWh



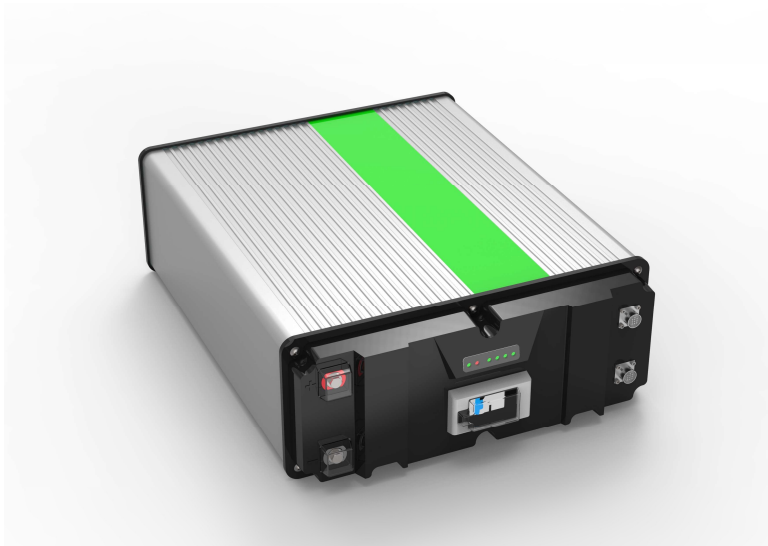
LFP-10 kWh



LFP-5 kWh



New Product-eFlex 5.4



Available in Q2 2020

New Features:

- ✓ SD card for data storage
- ✓ WiFi remote monitoring
- ✓ Wall-mounting, Floor-standing & Racking Solution

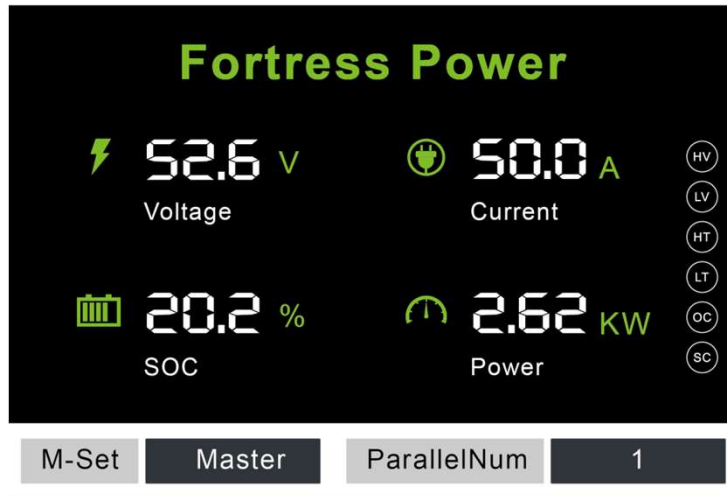
Technical Specification

	eVault 18.5	eFlex 5.4	LFP-10	LFP-5
Total Energy [KWH]	18.5	5.4	10.2	5.1
Capacity [AH]	360	105	200	100
Battery Voltage [V]	48V			
Max. Charge Current (Continuous) [A]	160	100	80	80
Max Discharge Power (Continuous) [KW]	9 (180A)	5 (100A)	5 (100A)	4 (80A)
Peak Output [KW]	12 (240A)	6.6 (130A)	7.5 (150A)	7.5 (150A)
Parallel Stacking	12	10	2	3
LCD Monitoring	Yes	No	No	No
Communication	CAN/RS485	CAN/RS485	N/A	N/A
Breaker	250A	125A	150A	125A
Warranty	5/10 years; up-to 6,000 cycles			

Two type of Battery Management Systems

	LFP-5 &10	eVault 18.5 & eFlex 5.4
BMS Type	Mosfet-based	Contact-based
Overcharge and Deep Discharge Protection	✓	✓
Over-heat & Low Temp. Protection	✓	✓
Over Current Protection	✓	✓
Short Circuit and Open Circuit Protection	✓	✓
Cell monitoring and balancing	✓	✓
Communication with Inverters		✓
Communication between units in parallel		✓
Remote monitoring		✓
Cell Type	Cylindrical	Prismatic

eVault 18.5 Local LCD Display



Safety features:

HV: High Voltage

LV: Low Voltage

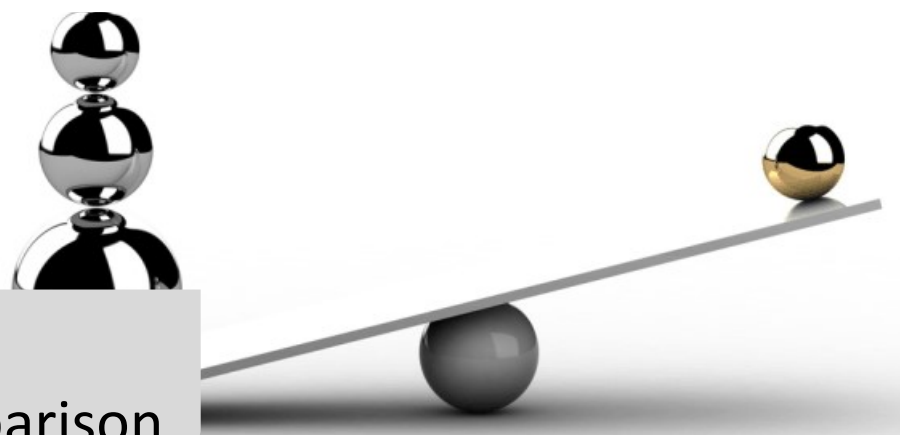
HT: High Temperature

LT: Low Temperature

OC: Open Circuit

SC: Short Circuit

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)

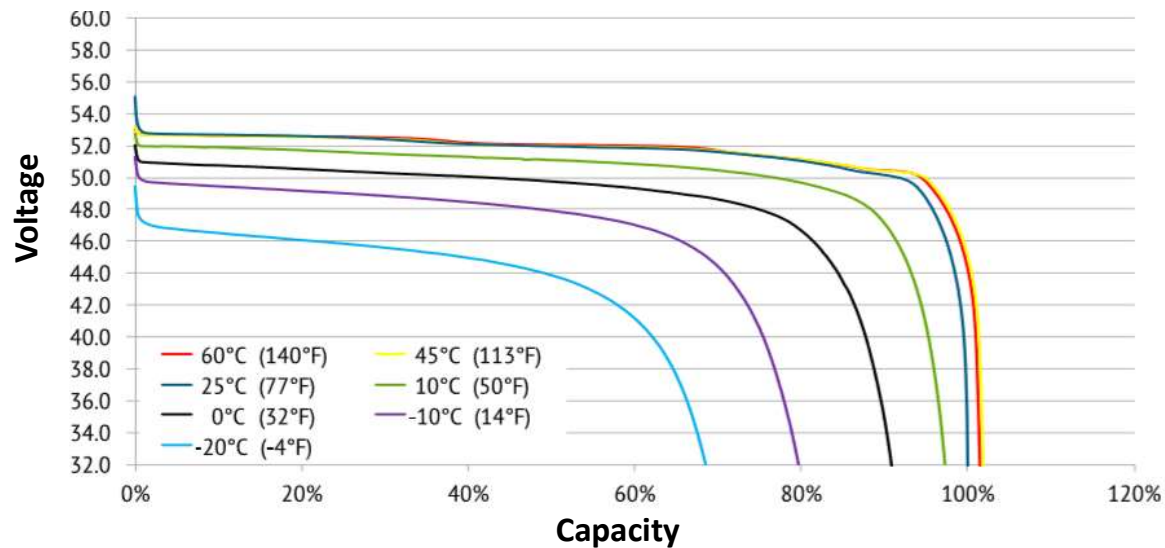


Nickel-Manganese-Cobalt Technology (Tesla)

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

Temperature Impact on LFP Performance

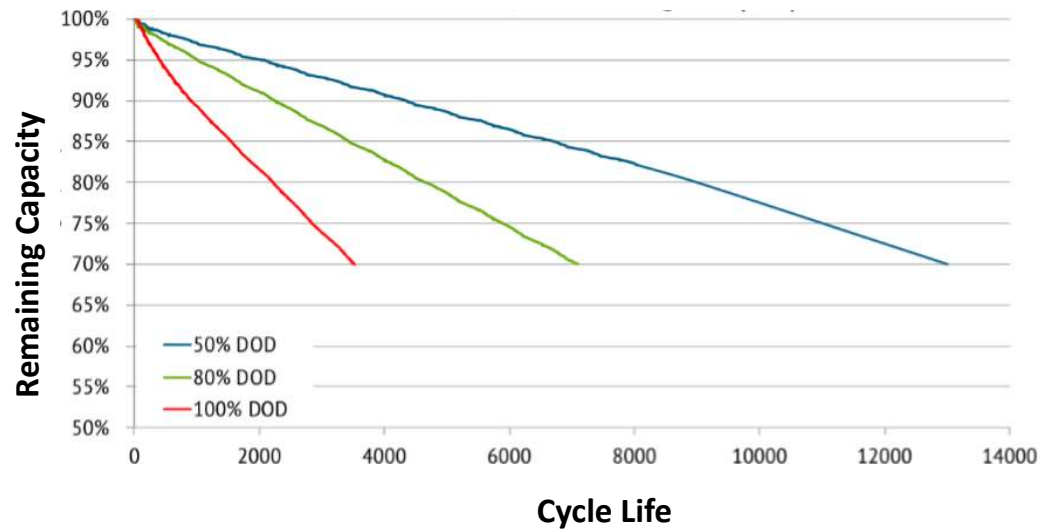
Discharge Voltage of LFP in Relation to Temperature
@ 0.5C discharge rate



	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



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

Why over 90% Global ESS Installs are Lithium?



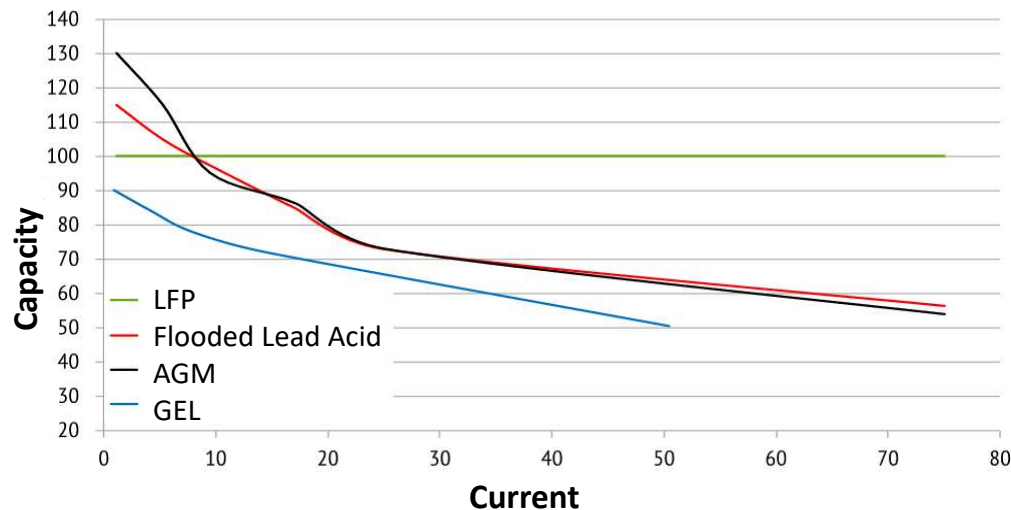
Comparison of different Battery Technologies

	LFP	Lithium Ion	Li-Polymer	Flooded LA	AGM	Nickel Iron
Round trip efficiency	98%	95%	95%	80%	88%	65%
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
The Homeowner Cost of 10 kWh	6,900	6,500	4,500	1,200	2,200	18,000
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.

Energy Throughput=Nominal capacity x DoD x Efficiency x Cycle Life

Performance Comparison: LFP vs Lead Acid



LFP advantages:

- a) LFP Actual Capacity = Nameplate Capacity
- b) Lead Acid allows only 50% DoD, Actual Capacity = $0.5 \times \text{Nameplate Capacity}$
- c) 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)

LFP Technology Advantage



Superior Safety



High Throughput



Long Duration

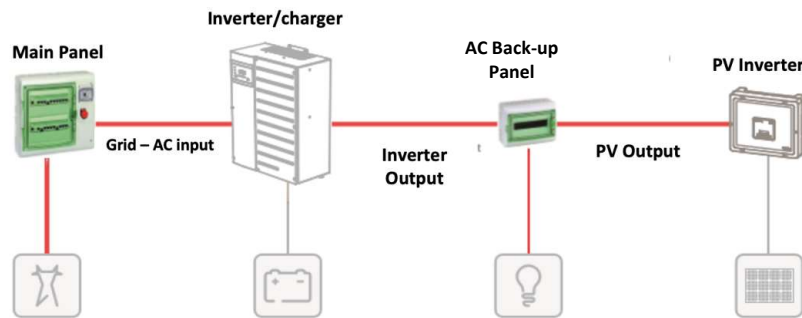


Low Energy Cost

Integrating battery
storage to PV array



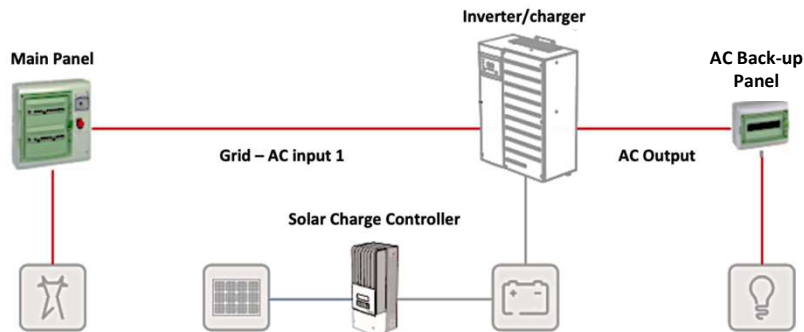
AC vs DC Coupled Solution



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
Schneider **	Conext XW MPPT charge controller; Conext XW+/XW pro series;	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 & 12 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 close-loop communication with those inverters!

Fortress + Schneider XW+ and XW Pro (AC & DC Coupling)

Key features:

- ❑ *Over 10 years in operation*
- ❑ *Stacking up-to 4 in 120/240V*
- ❑ *Stacking up-to 9 in 120/280V*
- ❑ *Component system with many features (Off-Grid, Time-of-Use, Load shifting, Back-up, Grid export)*
- ❑ *Allows DC & AC coupling*
- ❑ *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	5/10/18.5 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	

FORTRESS POWER ESS-Residential & Commercial



12 kW/18.5 kWh

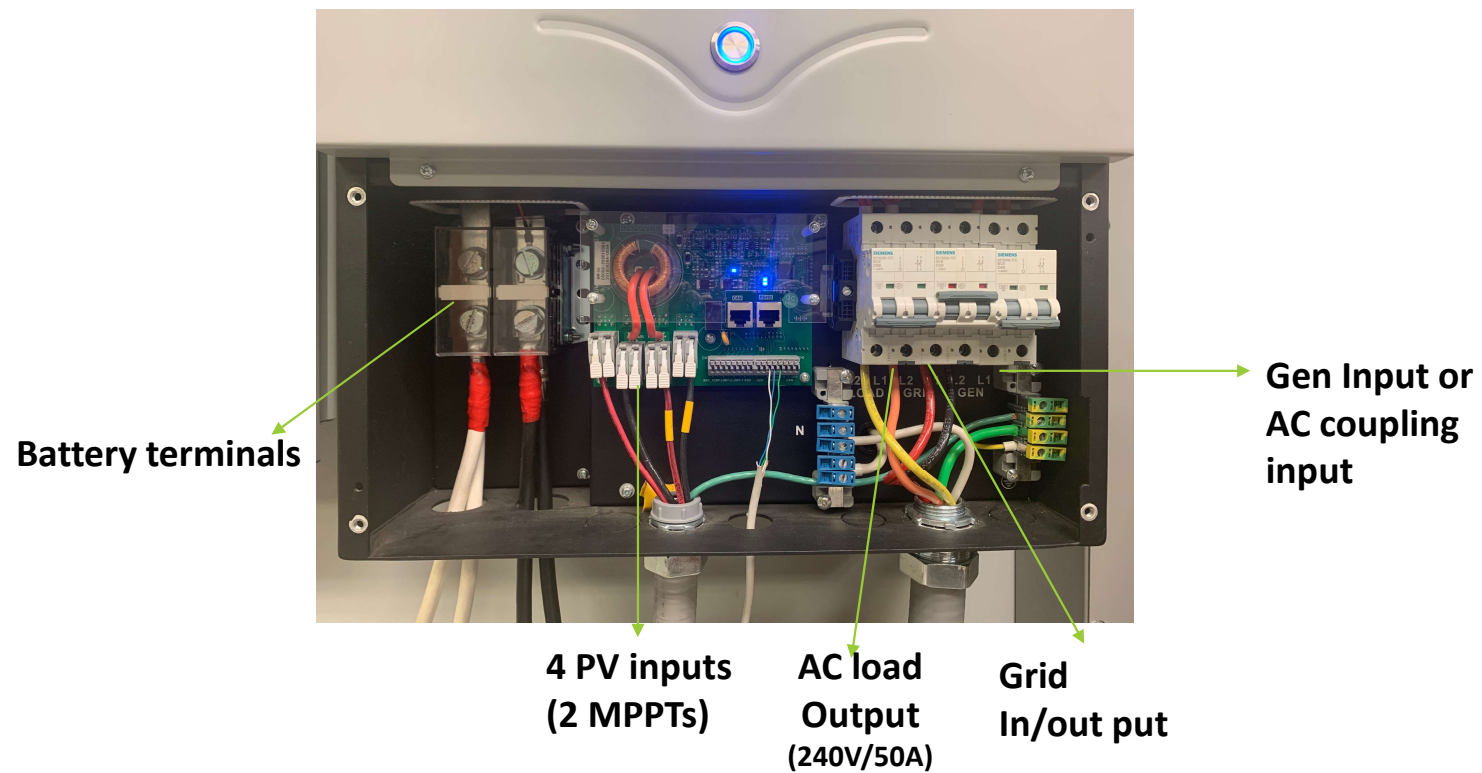
Key features:

- ❑ Stacking up-to 3 in 120/240V
- ❑ Stacking up-to 6 in 120/280V
- ❑ 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)*

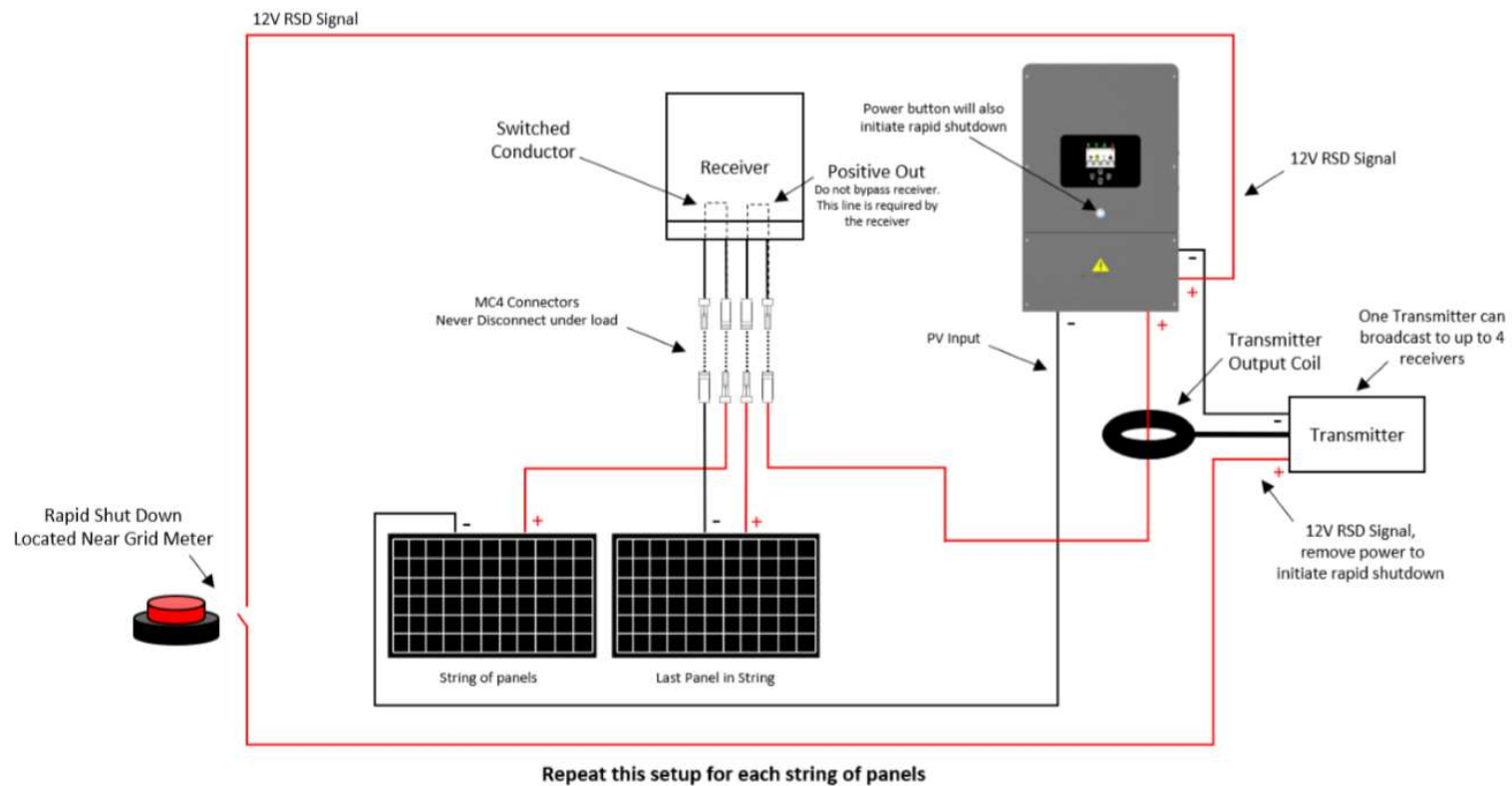
Technical Specification

	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	8 KW	12 KW	12 KW
Storage Capacity	5/10/18.5 KWH per unit; scalable to 222 KWH		
Surge Power	20 kW (5 Sec)		
Critical Load Panel	50A @ 240V		
Response Time (Grid-tie to Off-grid)	4ms		
PV Array Size	Up-to 13 KW in DC Coupling; Up-to 7.6 KW in AC Coupling		
Compatible PV Inverters in AC coupling	AC-coupled to Enphase, AC modules, SolarEdge, SMA, Fornius and etc		
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 		
Warranty	10-year standard warranty		

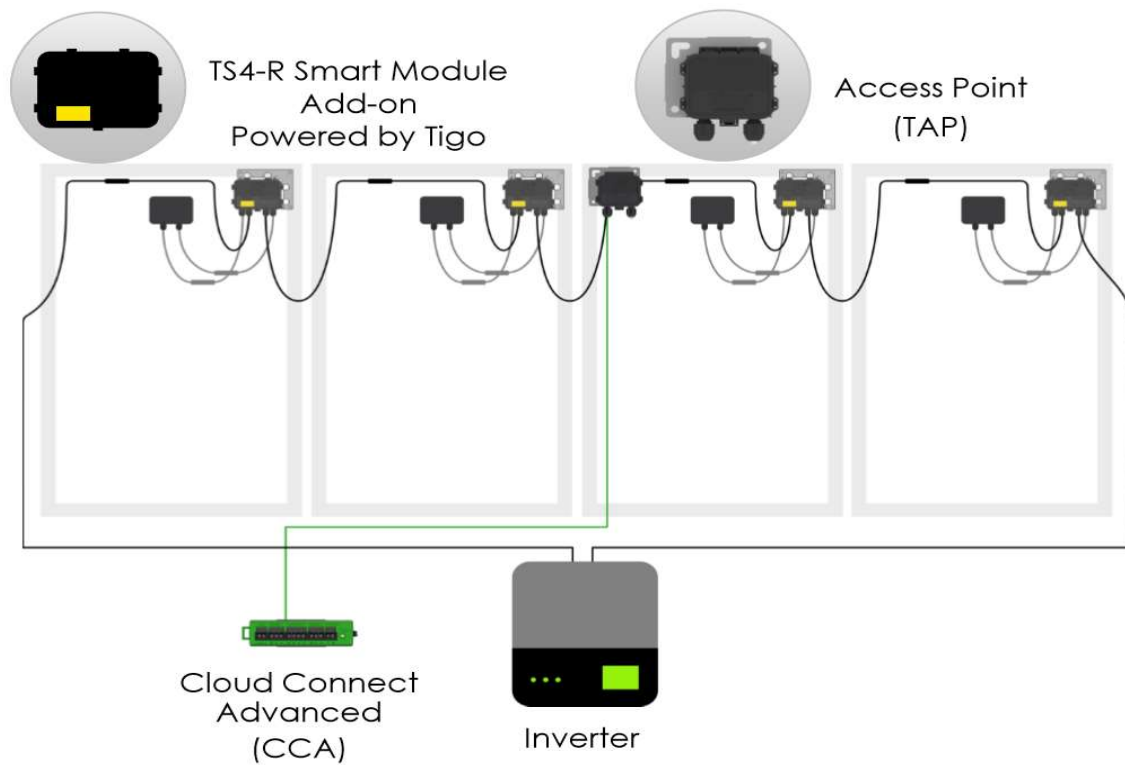
System Wiring



Integrating Midnite for String Level Rapid Shutdown



Integrating Tigo for Module Level Rapid Shutdown

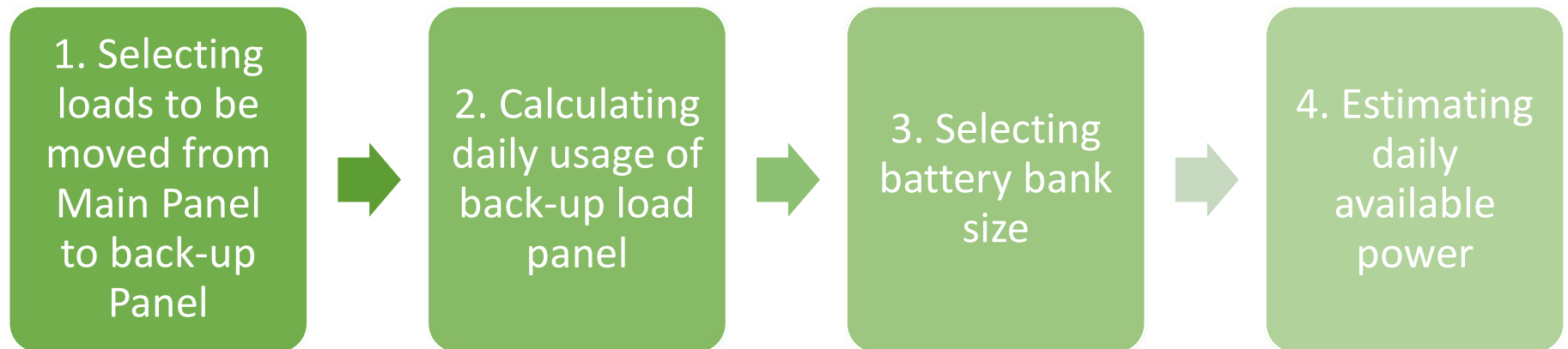




Design Guide for PV + Storage

Fortress Energy Storage Sizing Tool simplifies battery size design

Automatically size Up Energy Storage for Backup



Available to our authorized installers

Fortress Energy Storage Sizing tool Example

	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	4	240	240	4	3840
3	Essential	LED Light Bulb-60 Watt Equivalent	6	48	48	4	1152
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-6" Element	1	1500	1500	1	1500
7	Kitchen	Microwave Oven-650 Watts	1	1000	1000	0.1	100
8	Personal Electronics	TV-Flat Screen-46"	1	190	190	6	1140
9	Personal Electronics	Cell Phone Charger	1	25	25	2	50
10	Personal Electronics	Computer-Laptop	1	250	250	2	500
11	HVAC	Window AC-10,000 BTU	1	1400	1200	3	3600
12	HVAC	Furnace Fan-gas/oil-1/4 HP	1	1000	600	1	600
	STANDBY POWER	Sol-Ark 8 kW	1	60	60	24	1440
Totals				9613	6803		17772

Inverter Type	Quantity**	Watthours/Day	Surge Power	Running Watts
Sol-Ark 8 kW	1	17772 Watts	10387 Watts Available	1197 Watts Available

Monthly PV/Day Production and Energy Available to Charge Batteries

**9 KW PV array
+
9KW/20 KWH**

	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	

Other Applications: (T-O-U, Self Supply, Demand Curtailment)

Send your project information

to

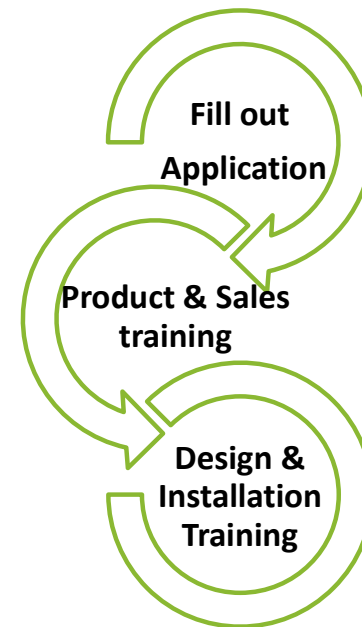
sales@fortresspower.com

Authorized Dealer Benefits



Becoming

Fortress Power
Authorized Dealer



Thank You & Contact Us

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



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