Sustainable Hybrid AC UPS

By

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The Next Generation Critical Facility
Increased Reliability with Renewable Energy
While Maintaining Best Cost Practices

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SCTE is positioned as the go to resource for technical operations surrounding power and availability. We realize the importance of hardening our network to ensure communication availability. Taking the six sigma approach of striving to achieve the "5 - 9's" of availability for website, network, communications and services availability; SCTE began with the foundation of availability - power. Taking the forward thinking approach while performing a total cost of ownership analysis, SCTE selected to pioneer a hybrid power system in lieu of traditional diesel generator backup power. Case studies presented during SCTE's Smart Energy Management Initiative (SEMI) meetings provided overwhelming evidence that for the critical load level of less than 2kW; solar, battery and a hydrogen fuel cell would be the simplest, most reliable and certainly most sustainable selection for critical power backup needs. The following white paper reviews the engineering concepts of how the system supports the critical load in both day to day operations as well as during a grid outage.

Overview:
The SCTE is leading the industry by implementing a Sustainable Hybrid AC Grid tied emergency powering system to simultaneously serve dual purposes

(1) to provide Redundant power for Disaster Recovery
(2) to offset Utility Costs using Renewable Energy.

This particular solution is appropriate for Small to Medium sized 1 kW to 3.5 kW Critical Loads and Telecommunications Data Centers. The Powering System utilizes multiple integrated backup subsystems as described below. Other system designs can be sized with larger AC UPS Grid Tie inverters up to 8 kW to take full advantage of the 8 kW Fuel Cell system.

This Hybrid AC UPS system addresses disaster preparedness by providing a total autonomy of 96 hours (4 Days) + Solar Assist time during daylight hours. The Solar Assist time varies with seasons and solar availability so it should not be relied upon to extended runtimes but does offer upside to the 4 Day autonomy.


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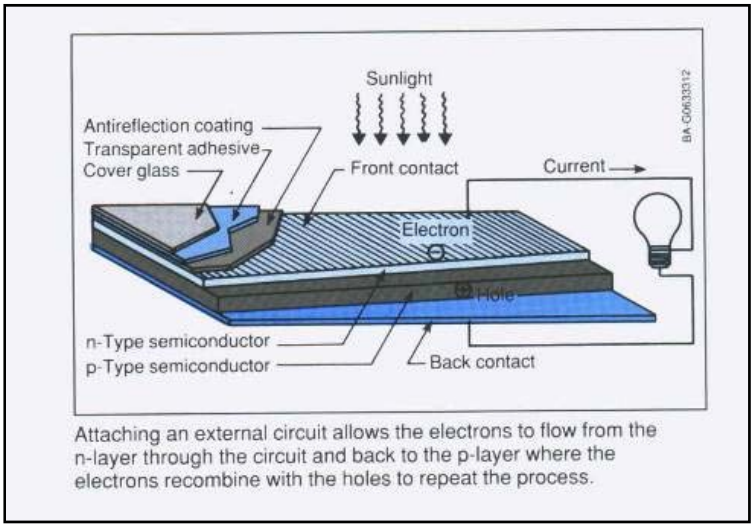
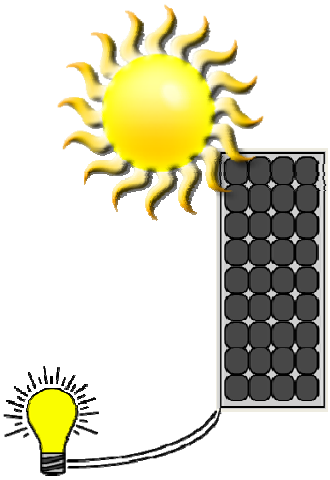
The Hybrid AC UPS system reduces operations expenses by supporting the critical load with the 2.88 kW solar array shown in the photo below. Sharp 235 Watt panels x Qty 12.

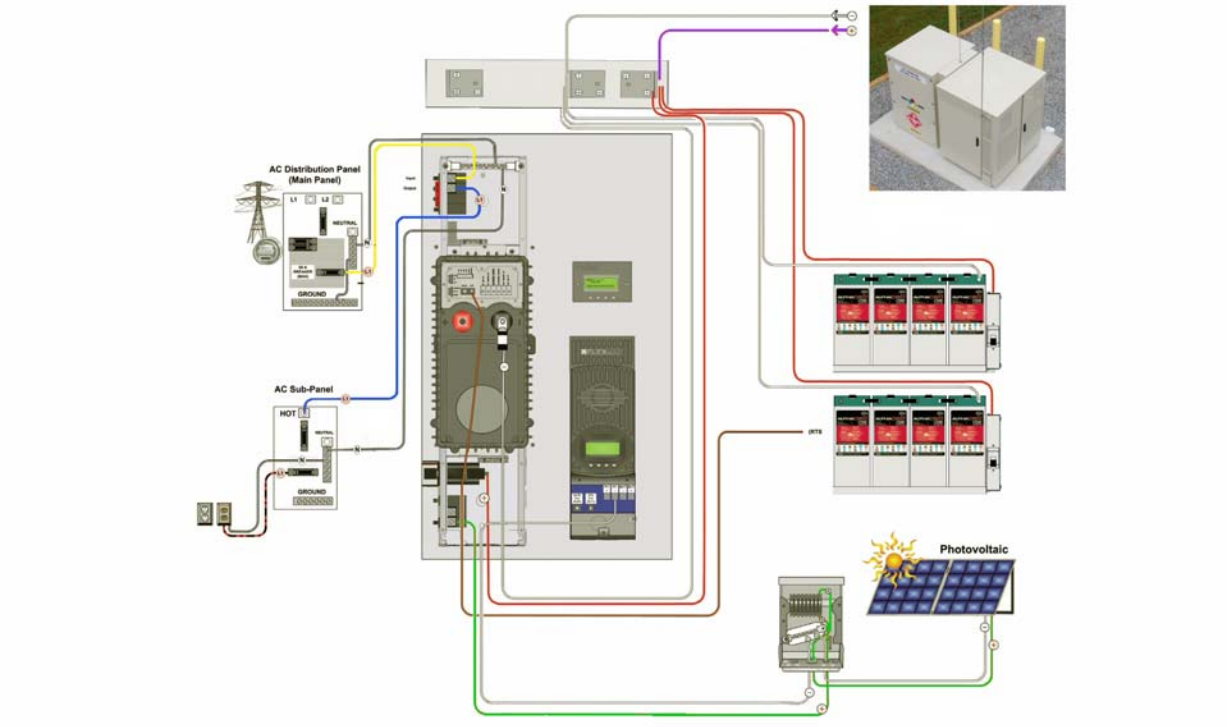
PV modules convert light to electricity at an atomic level, there are no moving parts. Solar Panels (PV modules) are designed to generate electricity for thirty years or more.



Attaching an external circuit allows the electrons to flow from the n-layer through the circuit and back to the p-layer where the electrons recombine with the holes to repeat the process.



Hybrid Grid Tie AC UPS with Fuel Cell, Battery and Photo Voltaic (PV) Subsystems



Normal Utility No PV Present
Power Flow *– Yellow → Blue*

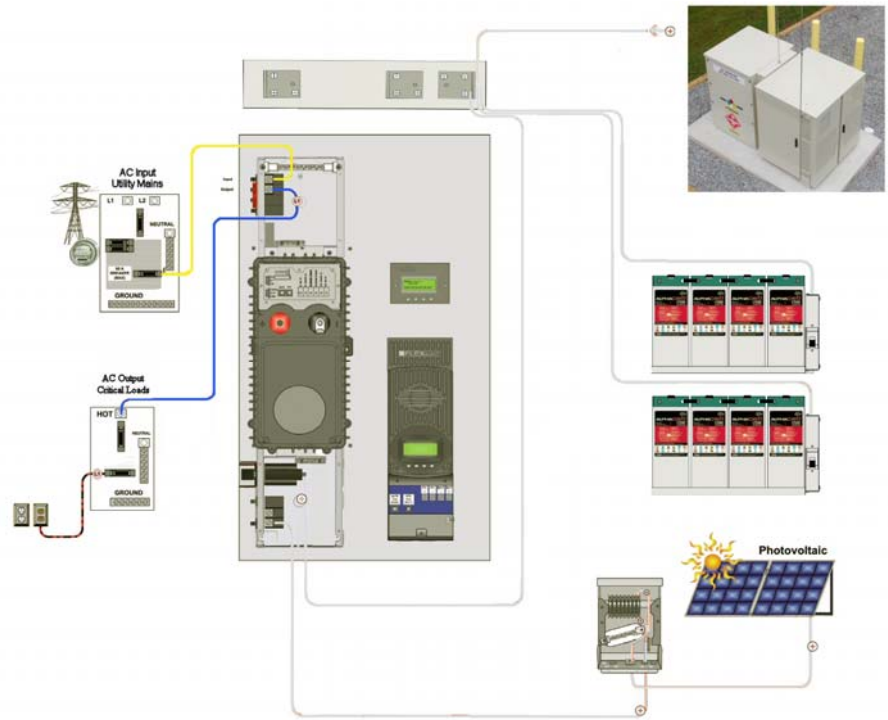
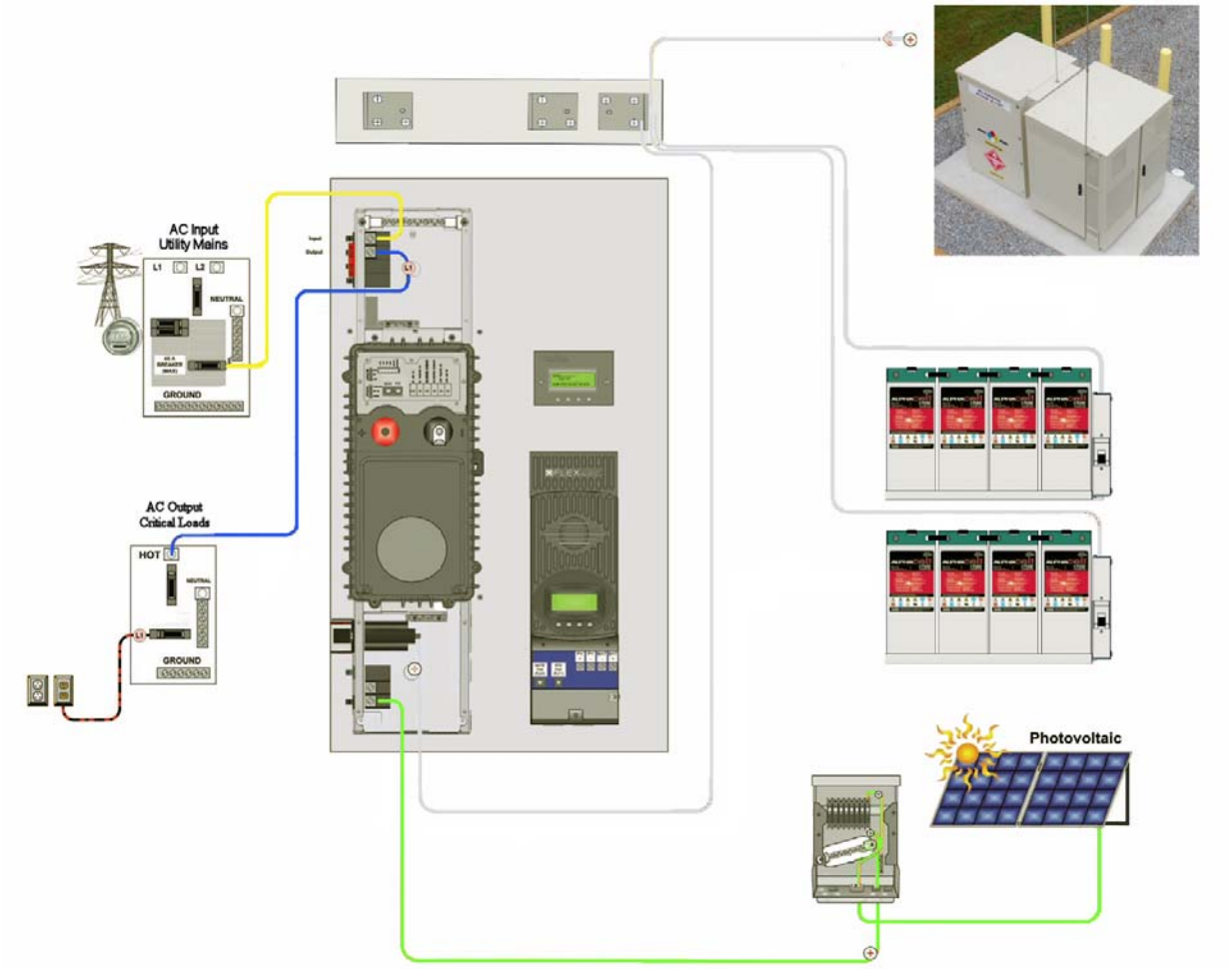


Photo Voltaic (PV) Panels using an advanced MPPT (Maximum Power Point Tracking) Charge Controller technology which provides 97% solar harvest efficiency to provide a renewable energy output of 48 Volt DC power to feed the Grid Tied/DC Backed Inverter.

Normal Utility with PV Offset

Power Flow = Green → Blue (feeds the inverter supporting the load)
Green → Yellow (excess PV back feeds the Utility Meter)



2.88 kW Array produces
12.67 kW/ Day in the Summer
8.04 kW/ Day in the Winter

In cases of an extended grid power outage, SCTE has installed a CommScope hydrogen fuel cell to provide yet another layer of reliable and cost effective backup power. This solution offers many benefits to both the society and the environment – quiet, clean and sustainable energy.

Hydrogen fuel cells are devices that enable a direct electro-chemical reaction, without mechanical conversion so often associated with electrical generation. The CommScope fuel cell deployed by SCTE utilizes Proton Exchange Membrane (PEM) fuel cell technology. Hydrogen is applied to the anodic side of a catalyst layer where it is ionized, allowing the protons to pass through the membrane while the electrons travel to the cathode, completing a circuit. On the cathodic side, the hydrogen is combined with oxygen from the air, forming pure water as a by product.

The hydrogen fuel cell deployed is located in an outdoor CommScope cabinet, so it does not consume valuable environmentally controlled indoor area. In the case of MSO facilities, the fuel cell can replace large and costly UPS systems, freeing space for revenue generating equipment or simply reducing the HVAC load on critical facilities.

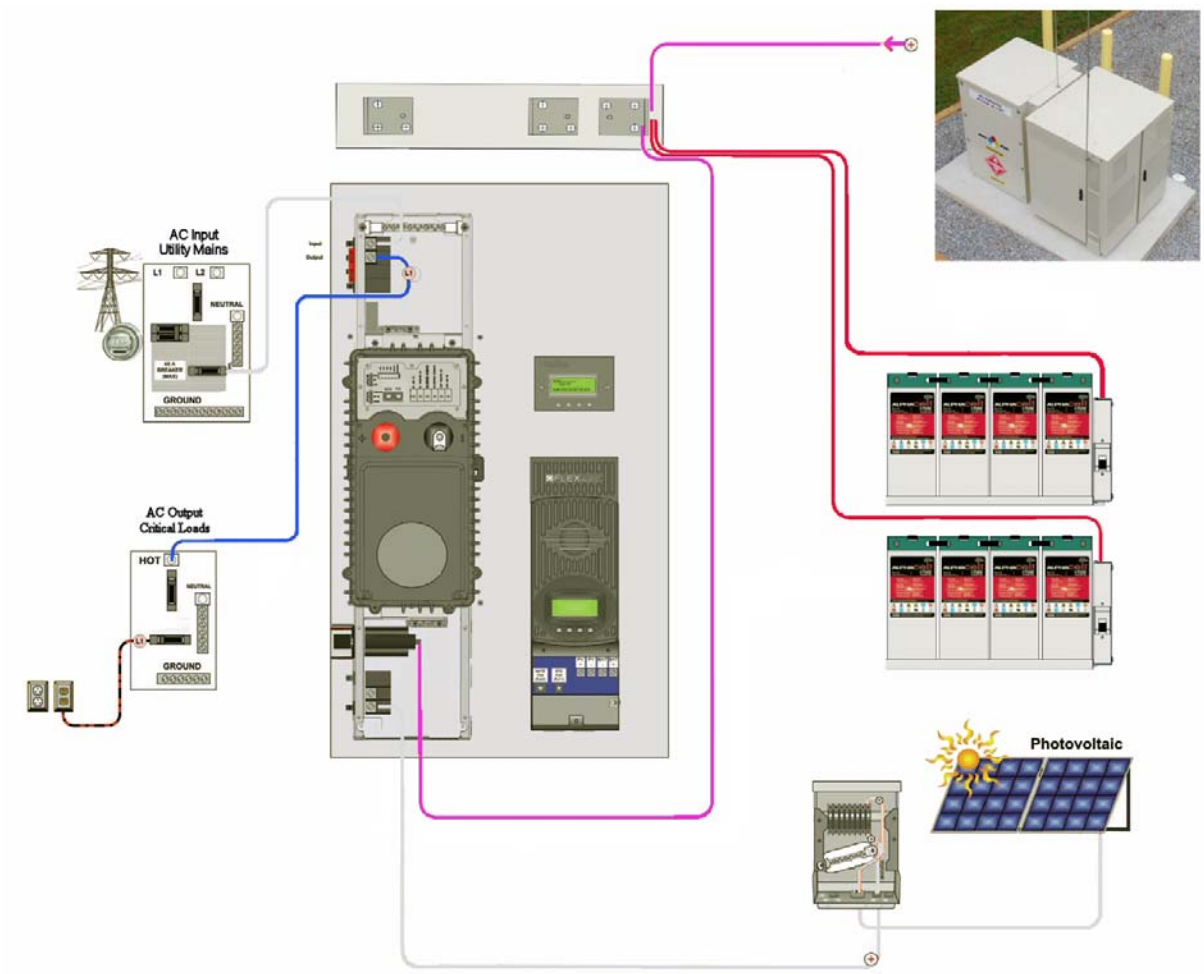
The CommScope fuel cell output is -48VDC. This output feeds the DC backed inverter which supports the critical AC load. When the CommScope fuel cell's system controller detects a battery voltage drop combined with the absence of grid power, the fuel cell switches on by opening the supply of hydrogen to the fuel cell stack.

Given a steady supply of hydrogen, the fuel cell can run continuously for as long as an outage occurs. For an 8kW load, 8 cylinders of hydrogen will last 8 hours. In this case, SCTE has a lower load requirement of 1.5 kW, the fuel cell with (16) hydrogen cylinders running without solar assist will last approximately 85 hours. Given the presence of solar assist and batteries, the availability of the system is much longer.

Power Outage with Fuel Cell Backup

Power Flow = Purple → Blue **

***** Red shown as Bridge for 90 seconds until Fuel Cell starts***



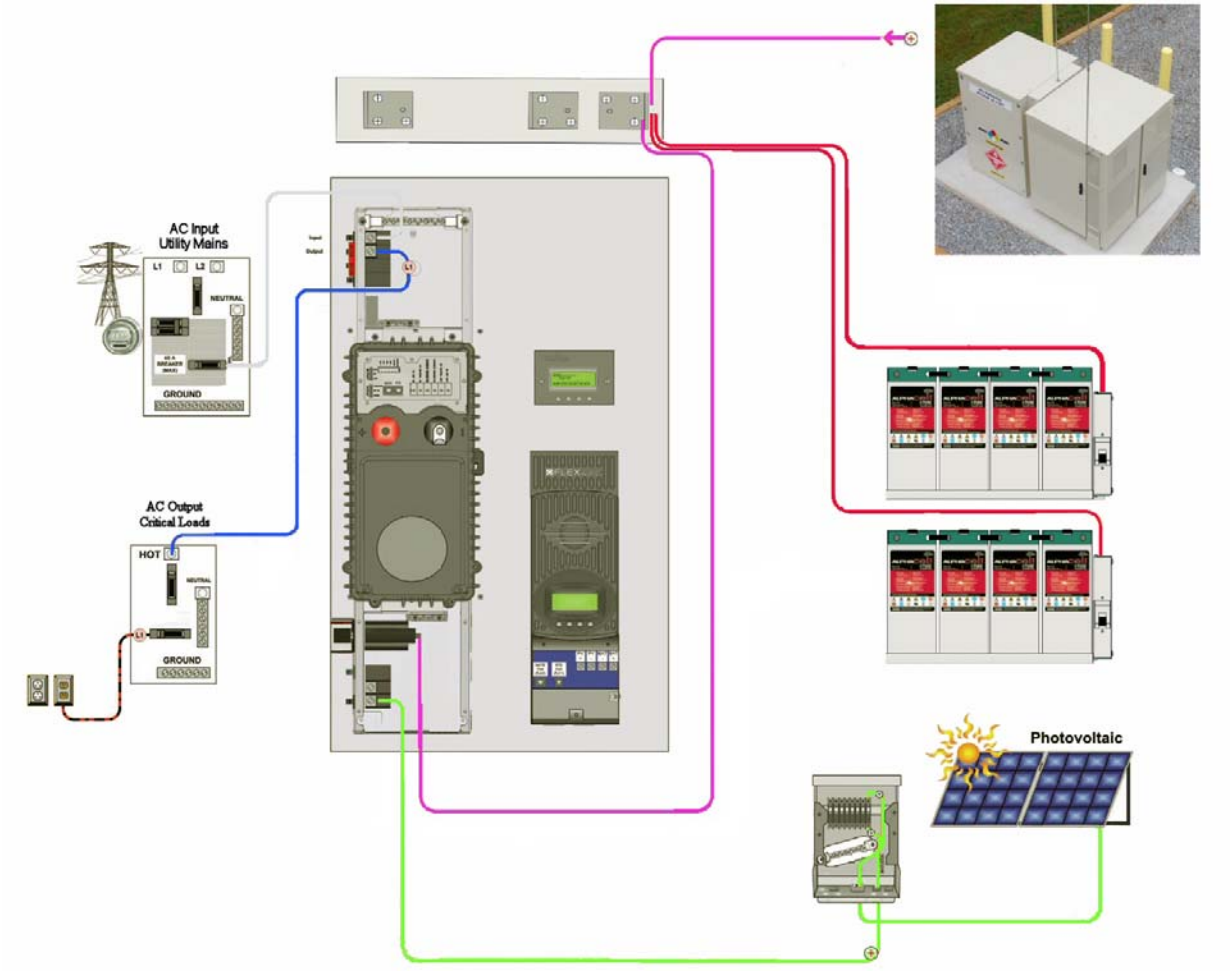
A Dual 48V String of AlphaCell RE batteries provides a 90 second bridge for the Hydrogen Fuel Cell to start. *(Power Flow = Purple + Red → Blue)*. Once started the Hydrogen Fuel Cell supplies the first stage emergency backup in unison with solar assist if present (Power Flow = Green + Purple → *Blue)*. If the Hydrogen source is exhausted then the batteries provide an additional last line of runtime defense providing an additional 11 hours of emergency backup runtime *(Power Flow = Green + Red → Blue)*.

Power Outage with Fuel Cell Backup and PV Offset

Power Flow = Purple → Blue **

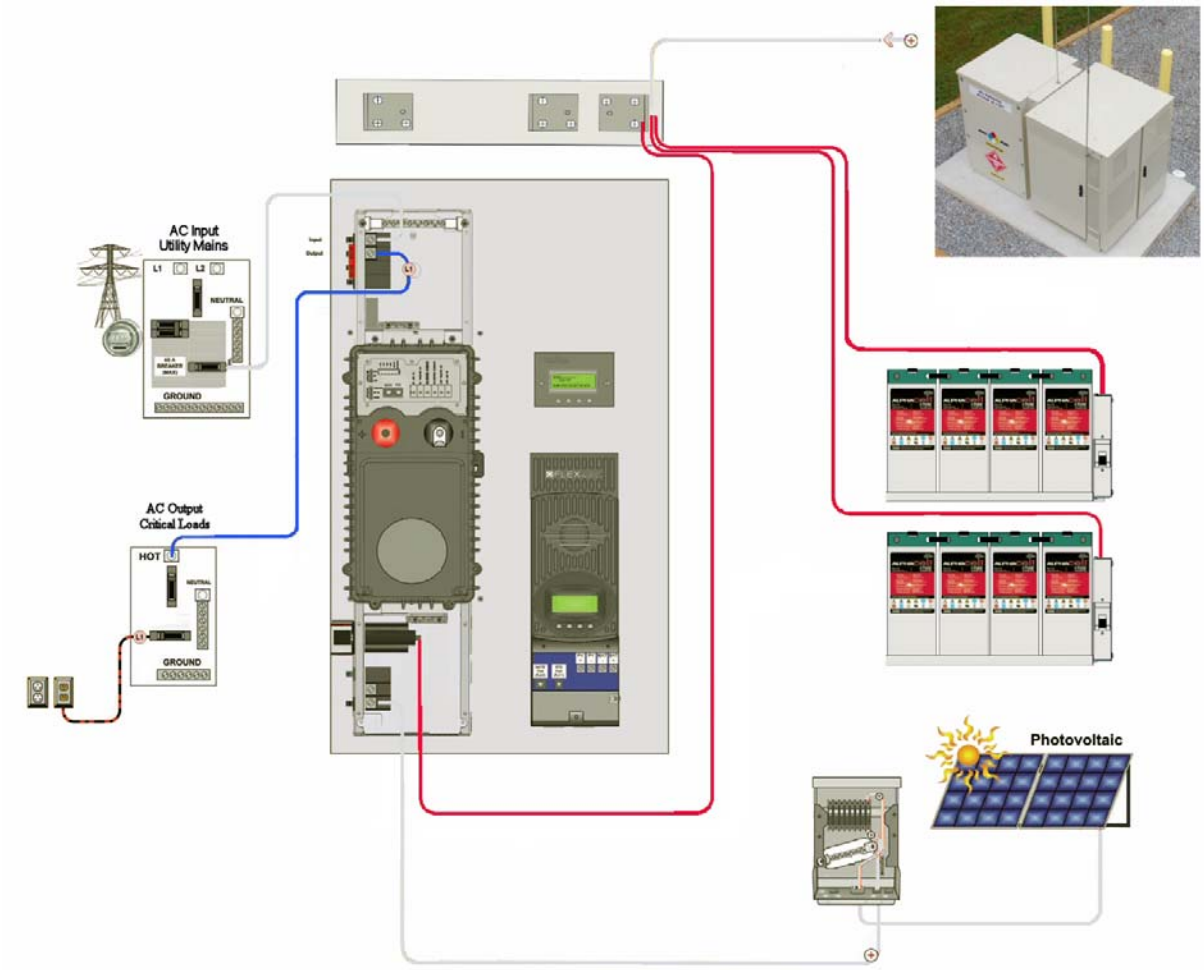
***** Red shown as 90 second Bridge for Fuel Cell starts***

= Green → Blue (PV Assist to Augment Runtime)



Power Outage with Battery Backup Only

Power Flow = Red → Blue



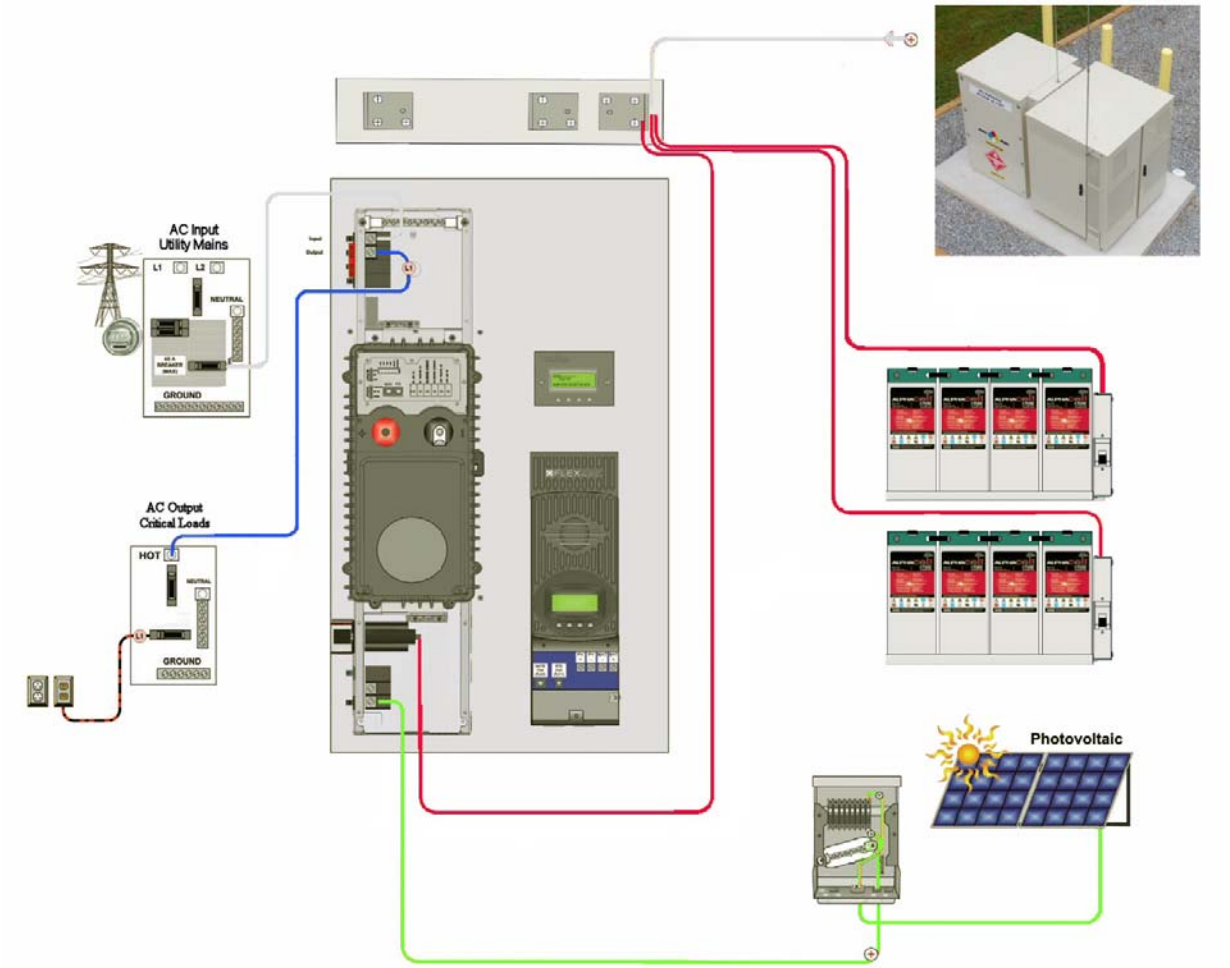
QQty 2 – 48 VDC Strings of AlphaCell 170 RE Batteries
provide 11 hours backup time to the 1.5 kW Critical Load

Power Outage with Battery Backup and PV Assist Added Runtime

Power Flow = Red → Blue

= Green → Blue

= Green → Red (PV feeds load and could recharge batteries)



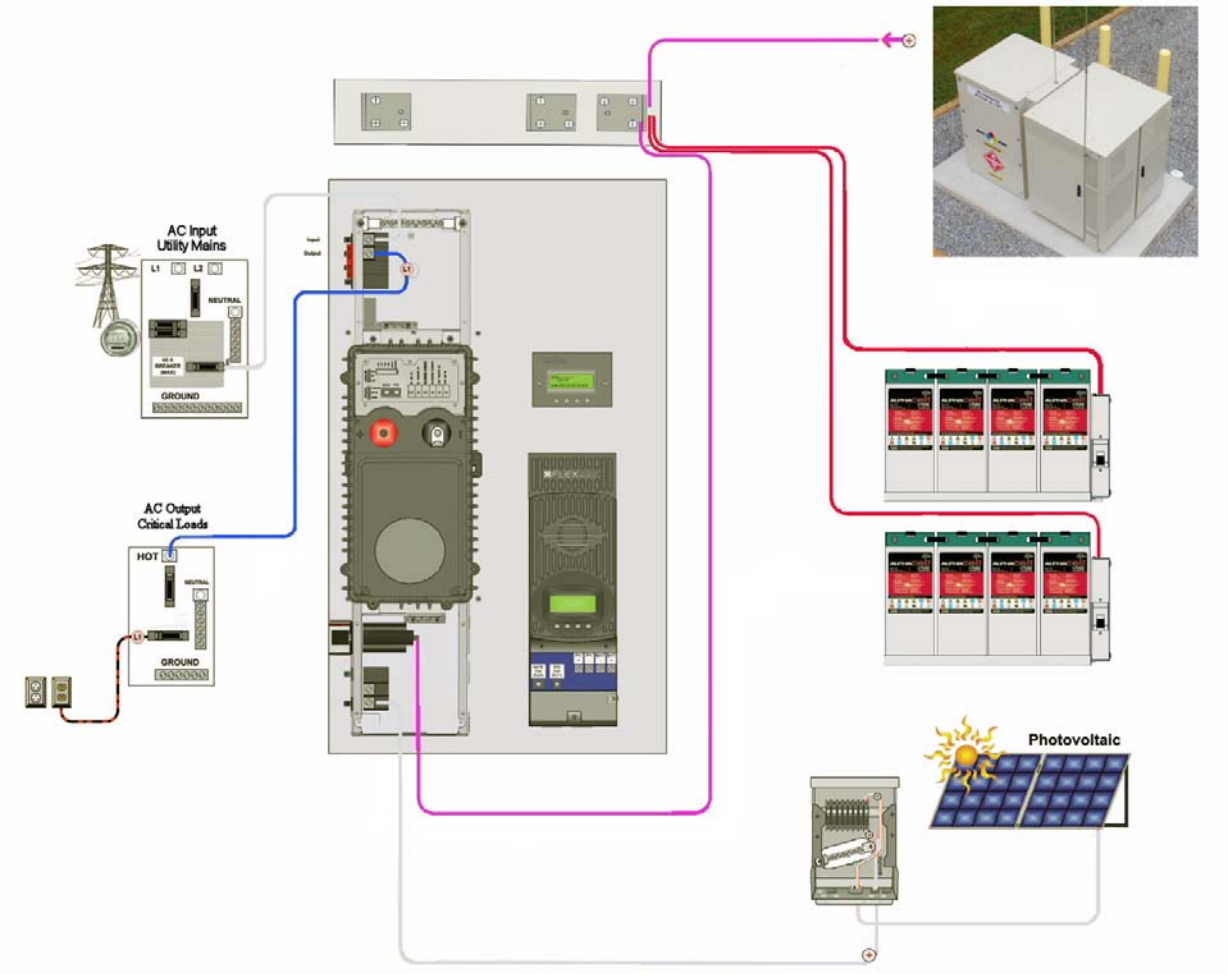
2.88 kW Array Generates :
Summer - 12.32 kWh/Day
= + 7.8 Hours Runtime @ 1.5 kW
Winter – 7.97 kWh/Day
= + 5.2 Hours Runtime @ 1.5 kW

Qty 2 – 48 VDC Strings of AlphaCell 170 RE Batteries
provide 11 hours backup time to the 1.5 kW Critical Load

A CommScope Cabinet based Hydrogen Fuel Cell subsystem located outside of the building which provides emergency backup power during AC Utility Mains failure by converting Hydrogen to a 48 Volt DC. This output feeds the DC Backed Inverter which supports the critical load. The current load of 1.5 kW will be supported for 85 hours with fully filled Hydrogen tanks and no solar assist. The Battery backup adds 11 hours for a total of 96 hours – 4 Days backup.

Power Outage with Fuel Cell and Battery Backup

Power Flow = Purple → Blue
= Red → Blue



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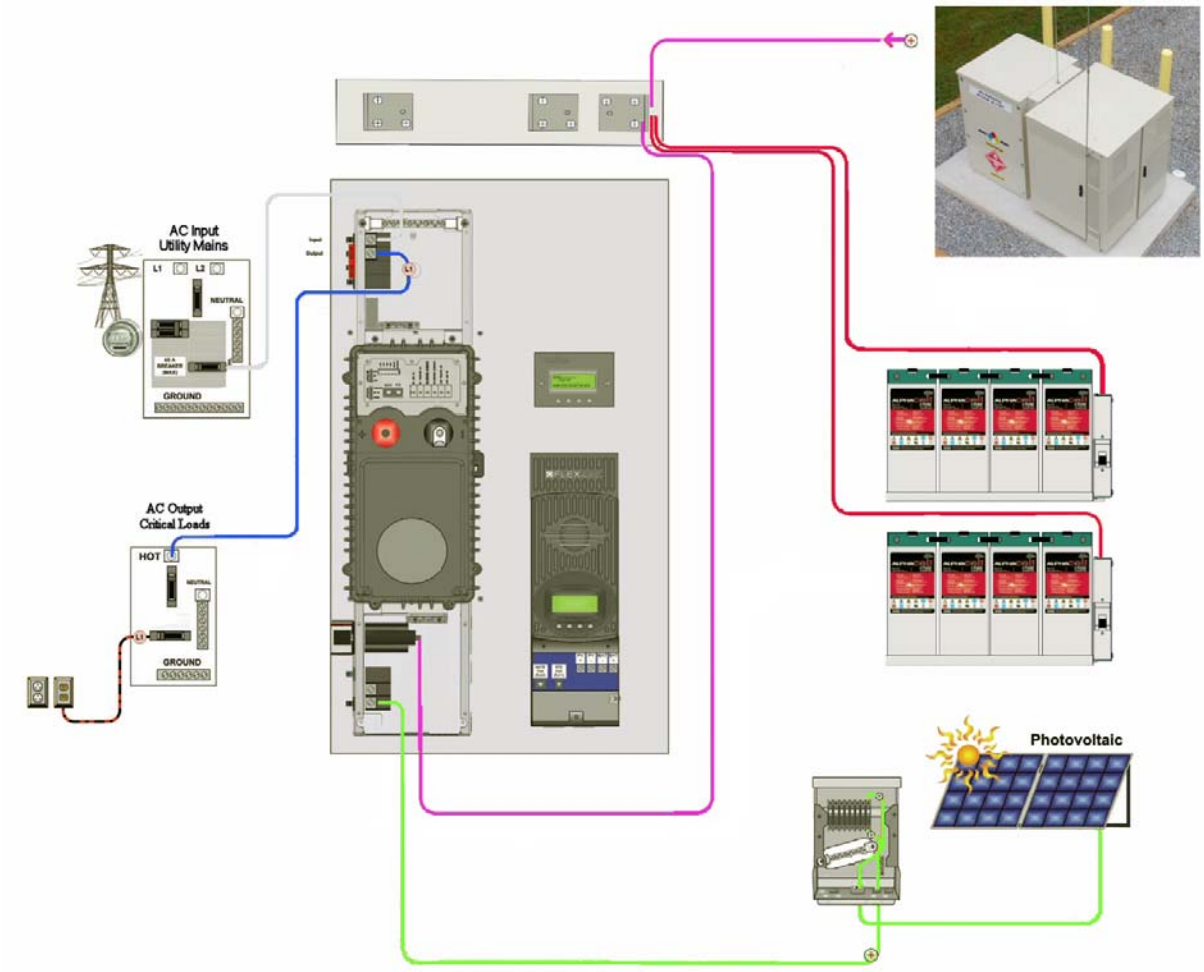
provide 11 hours backup time to the 1.5 kW Critical Load

A CommScope Cabinet based Hydrogen Fuel Cell subsystem located outside of the building which provides emergency backup power during AC Utility Mains failure by converting Hydrogen to a 48 Volt DC. This output feeds the DC Backed Inverter which supports the critical load. The current load of 1.5 kW will be supported for 85 hours with fully filled Hydrogen tanks and no solar assist. The Battery backup adds 11 hours for a total of 96 hours – 4 Days backup.
During the Summer the 2.88 kW PV system will add approximately 19.8 hours.
During the Winter the 2.88 kW PV system will add approximately 8.34 hours.

Power Outage with Fuel Cell, Battery Backup and PV Assist

Power Flow = Purple → Blue
= Red → Blue
= Green → Blue



Sustainable Hybrid AC UPS

This system address Disaster Preparedness by providing a total autonomy of 96 hours (4 Days) + Solar Assist time during daylight hours and it reduces Operation Expenses (OpEx) by utilizing renewable energy sources in the primary powering infrastructure. Longer runtime is achievable if solar assist and/or hydrogen supply remain available.

Summary

CommScope 8 kW Hydrogen Fuel Cell (up to 85 hours of run time under 1.5 kW load)

2.8 kW Photo Voltaic Sharp Panels provide offset to utility costs and augments backup runtime

3.5 (kW) Outback DC to AC Grid Tied Inverter supports critical load

FM80 (80 Amp) Outback Charge Controller regulates PV input to the DC bus

Qty 8 Alpha Cell 170 AH RE Batteries providing 11 hours of runtime under 1.5 kW load

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