

Solar with Ruckus

Introduction

There are many instances where leveraging the advantages of solar to power a Ruckus access point is ideal:

1. **Remote locations lacking power** — Locations where there may be Ethernet connectivity but no power.
2. **Point to point bridging** — To supply power and connectivity to remote locations.
3. **Remote wireless surveillance** — Power an outdoor AP to forward PoE to a wireless IP camera in remote locations.

This guide will assist you with the necessary information to power Ruckus access points with solar.

Overview

For locations with enough sunlight, solar power is an economical power source alternative. This is particularly true of remote locations where AC power is not available and cannot be installed or is prohibitively costly. Solar power installations are usually standalone – i.e. they do not require much additional infrastructure to install or run.

Solar (and related technologies such as wind) can also be used as the primary power source or as backup power to supplement a primary power shortage.

Disadvantages of Solar Power

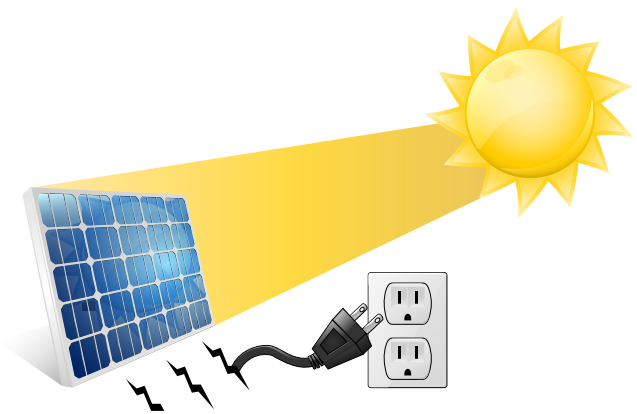
Solar power isn't always the perfect solution and can have drawbacks; the biggest is that when there is no sun there is no power. This sounds obvious, but it is the number one reason solar powered solutions fail. Since there is no terrestrial location that can guarantee 100% sunlight every day of the year, we need to store the power that is generated during daytime charging hours. The solution

is a battery — one large enough to store enough energy to power all equipment at all times.

How Solar Power Works

A solar power system typically has three main components: the solar panel, the charge controller, and the battery. The solar panel charges the battery and the charge controller manages the battery charging process. A fourth optional part can also be used – an inverter. This would only be required in cases where you need to convert the DC power to AC. However since all Ruckus outdoor APs and bridges can use direct DC power, this is typically not required.

FIGURE 1: Solar Power System



About Solar Panels

A solar panel is made up of an array of photovoltaic cells. The watt/amp rating of the panel will depend on the number of cells and their size. Photovoltaic cells are made of 2 layers of thin silicon wafers that are oppositely charged, and are connected together via a grid of very fine finger-like electrical contacts to channel the DC current to the output terminals.

Solar panels typically come in three varieties, each with a different orientation and/or collection of energy: concentrated collectors, horizontal flat plate collectors and tilted flat plate collectors. The type of panel used depends on the location and collection requirements.



Sunlight and Geographical Area

The amount of sunlight available per day varies based on the geographic location, time of year, nearby shade objects, etc. You need to know how many hours of peak sun are available in the installation area in order to correctly choose the right panel size and rating. Peak sun hours (insolation) are normally stated as kilowatts-hour per square meter per day (kWh/m²/d).

There are a wide variety of calculators and reference tools available to help you determine peak sunlight hours for your location. A good reference to begin with is the following simulator <http://rredc.nrel.gov/solar/calculators/PVWATTS/version.1> To use this calculator:

1. Click on your State
2. Click on the city nearest to your location
3. Change the DC rating from 4.0 to 100 (to simulate a single 100W panel)
4. Change the tile angle to whatever your panel is tilted at (ideal is equal to your latitude)
5. Confirm that your azimuth is correct (180 degrees, facing South, is optimal)
6. Click "Calculate"

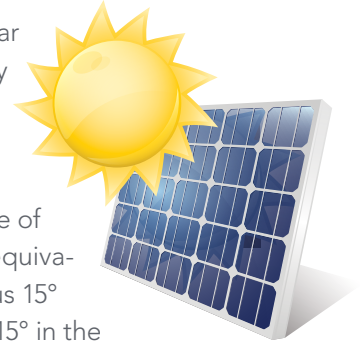
An important point to remember is that these tools provide estimates only. The actual number of sunlight hours can vary. Always allow for additional headroom (margin) in your calculations and sizing.

Maximizing Sun Exposure

This is also dependent on the geographical area and varies with the season. Unless your panel changes orientation automatically to follow the sun, you probably can't assume you'll always get the maximum hours available.

¹ A charge controller can provide several benefits such as preventing overcharge, improve charge quality, and prevent battery discharge in low or no light conditions.

As a rule of thumb however, solar panels should be placed so they face south when installed in the northern hemisphere and face north when installed in the southern hemisphere. The angle of the solar panel should also be equivalent to your latitude plus or minus 15° depending on the season (plus 15° in the winter and minus 15° in the summer). These values help you account for the axial tilt of the planet.



Sizing a Solar Powered System

Before purchasing a solar power system, you need information to determine exactly what kind and type of equipment to purchase. This is known as sizing requirements. A system that works well in New York, for example, may not work as well in Singapore. The steps for sizing a solar power system are outlined below:

1. Determine insolation value (daily peak sun hours) for installation site
2. Determine daily equipment load requirements in Amp hours/day
3. Select battery based on Amp hours needed
4. Select solar panel size
5. Select solar panel installation method

Designing a Solar Power System Worksheet

The easiest way to learn is by example. Designing a solar system consists of 4 components and some assumptions:

1. Determining power consumption – take the AP power usage in watts and convert to watt hours used per day (X watts for one AP multiplied by 24 hours in one day equals X watt hours per day). This is necessary to determine the panel count.
2. Calculating panel count – take the panel wattage typically produced in one day. Note this is a largely variable item based on geography and the product purchased (wattage rating on the panel under optimal usage). Power consumption divided by panel wattage produced in one day results in panel count.

3. Optionally determining if an inverter is needed - (standard for Ruckus would be 100 W capacity if AC is required to power the AP) Note: It is recommended to use an inverter with a PoE power supply to ensure a consistent power feed to the AP.
4. Battery bank sizing – determined by geography and how much back up is required for the network uptime. Another consideration is the battery life desired which erodes quickly over time the more it is discharged. Take power consumption in watts (#1) divide by 12V to get AmpHours. Take Ah divided by .5 (this takes into consideration discharge is not less than half over the period required) and multiply by the number of days equaling the number of Ah required in the battery bank.

For most of the rest of this document we'll refer to an example and build upon it piece by piece. Our design is for a single ZoneFlex 7731 bridge that must be powered via solar. We would like to have enough headroom to deploy a second 7731 in the future, if needed, so we'll plan for that power now.

Example Design Values

Design Parameter	Example Values	
Equipment	1x 7731	
Up time (availability)	24 hours, 7 days a week, 365 days a year	
Sunlight available to charge (in hours)	Longest day – June 21st	8 hours
	Shortest day – December 21st	4 hours
	Average peak hours (Insolation)	6.28 kWh/m sq. ²
Tolerance (days of no sunlight)	3 days	
Maximum current draw (load)	1A (Amp hours) ³	
Headroom (future use)	1A (Amp hours)	
Total power requirement	2A (Amp hours)	

Maximizing Sun Exposure

Now that we have our basic operating parameters, we can think about the size of the batteries. Since there is no place on this planet that has sunlight 24 hours a day for the entire year, we need to have some sort of power

² This number is taken from RREX or a similar reference.

³ Assumes power draw of approximately 12.3W or less with heater and 7W without heater.

reserve to run the 7731 when there is no sunlight. The size of the battery is derived two ways: the amount of time it can run the 7731 without a recharge and the length of time/size of the solar panel required to recharge it.

There is a wide range of batteries available; for this type of application, a battery type known as **deep cycle** is preferred. Although there is no set standard, these batteries can be roughly grouped by the following designations:

FIGURE 2: Common Deep Cycle Battery Groups⁴

Group 24	70-85 Amp hours	12 volts
Group 27	85-105 Amp hours	12 volts
Group 31	95-125 Amp hours	12 volts
4-D	180-215 Amp hours	12 volts
8-D	225-255 Amp hours	12 volts

From the worksheet we created earlier, we know we want to support a total power draw of 2Ah for the system – 1Ah for the 7731 and a second amp hour for future growth. This makes our total power load 24 hours x 2Ah = 48Ah per day. Based on this, the above table would yield the following run times from the battery alone⁵:

- Group 24 = 1.13 – 1.34 days
- Group 27 = 1.34 – 1.64 days
- Group 31 = 1.49 – 1.95 days
- 4-D = 2.81 – 3.36 days
- 8-D = 3.52 – 3.98 days

The larger the battery and the longer run time, the more expensive it is. Battery selection is often a tradeoff between all battery run time and cost. If we truly need a battery than can power 48Ah for a total of three days (our days of no sunlight value), then we need either a 4-D or 8-D battery if we want a single battery. We could also go with a battery bank and use multiple smaller batteries either in parallel or series.

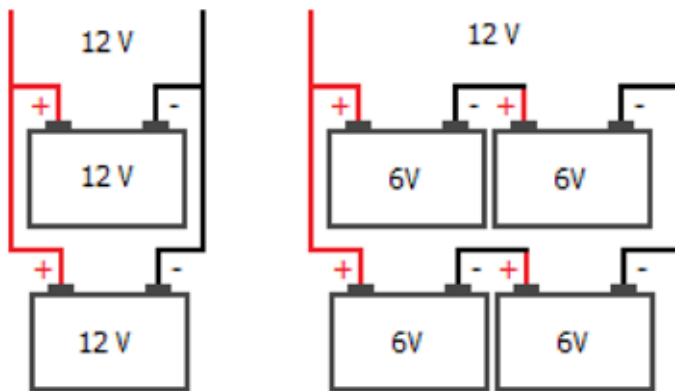
Multiple batteries can be connected increasing Amp Hour storage capacity. 12V is typically what is called for

⁴ The ratings shown here are approximate – always check the manufacturer's specifications and recommendations first!

⁵ The numbers reflect 75% of total available run time power. Most manufacturers do not recommend drawing down a battery more than 50%-75% without a recharge.

in a preconfigured system, and this can be accomplished by either 12V or dual 6V batteries in a series. See below:

It is important to note that battery life is contingent upon the size of the battery bank and how much is typically discharged before charge. For example, a battery that is discharged 50 percent a day will not last as long a battery that will be discharged only 20 percent a day.



Solar Panels

The last thing we need to consider is the size of the solar panel. There are many different sizes and configurations available; not all are suitable for all locations. Always check the manufacturer's recommendations first before selecting a panel.

A solar panel's job is to capture enough sunlight to run your equipment for the day as well as recharge the batteries. In general, a battery will only be used (and therefore need to be recharged) after a period of no sunlight such as an overcast or rainy period. Since wintertime usually has the shortest number of charging hours per day (and is most likely to have long periods of overcast/dark skies) we use this number for our calculations. From the worksheet earlier, we determined our average charging hours in the winter is 4 hours.

For our example design, we need a solar panel that can capture 24 hours' worth of power, or 48Ah or 576W.

The solar panel will need to be able to capture enough solar power to run your equipment for the day, as well as recharge your battery bank following a rainy or overcast period. It also needs to be able to do this during winter.

So if the example has 4 hours of sunlight to capture 24 hours' worth of power (348 watts), that's a basic requirement of an 87 watt solar panel. ($348 / 4 = 87$ watts per hour)

Now we need to factor in the recharging after a rainy or overcast period. If it rained for 4 days, and on the 5th day it was sunny, that's 5 days' worth of power that needs to be captured. In the example that's 1,740 watts worth of power. We also need to capture this power as fast as possible before it rains again. So to capture 1,740 watts of power during 4 hours of sunlight, that means we need a 435 watt panel. If we wanted to, we could set a goal of recharging the batteries over 2 days. That means we have 8 hours to capture 6 days' worth of power - which a 260 watt panel would be able to do. If you decide to set a longer recharge period, you can save some money on solar panels, but will need to spend more on adding more capacity to your battery bank in case you only get one sunny day and it returns to rain.

It is also probable that if you have an average of 4 hours of sunlight per day in winter, that also means half the days will be rainy or overcast, and the other half would be sunny. This means that on the sunny day, there could be up to 8 hours to capture the required power instead of the 4 assumed above. It is best to oversize your panels just in case, so you should not rely too much on extra average sunlight hours from rainy days.

With the design requirements and information above, and assuming units run-time is 24 hours per day (unit in service for 24 out of 24 hours per day), the table below will help us size the batteries and solar panels. From the table, we can compute how many amps per day are used, what kind of battery is appropriate size, and what kind of solar panel can re-charge the battery. So from left to right, here's how to read the first row, for example:

7731 draws 1A, over 24 hours that is 24 Ah.

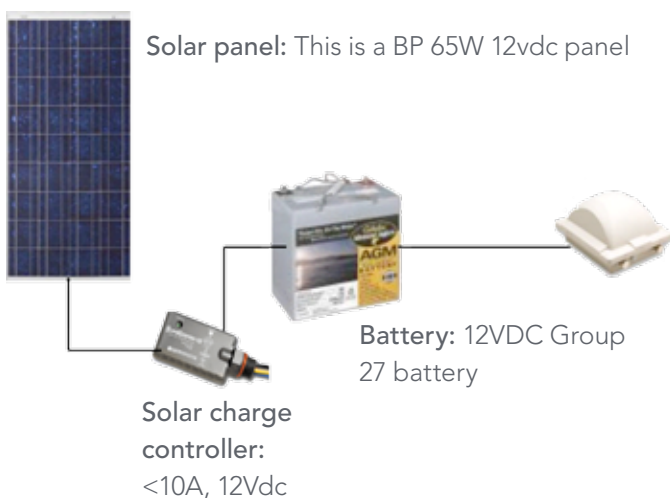
For a Group 24 battery, with up to 75% drain allowed (75% of 70-85 Ah), it will be able to keep the unit powered and running for 2 whole days, even if no sun.

If we used the 65W panel, which can put back 36A over a 10 hour sun period in a day, we could re-charge up to 1 day's battery charge loss, in approx. ½ day.

Our sample system design is shown on the next page. Also provided are links to vendors who manufacture the different components. The solar charge controller is recommended to prevent over-charging the battery. The vendor links are repeated on the last page of this document.

Product	Unit current drain "dcA"	Run time "Hours"	Amps per day usage	Deep cycle battery types, current per cell "amp hours" @ 24 Hours, Backup power if no sun @ 75% drain			Solar panel size/number of hours of charging time		
				Group 24 70-85Ah \$99 avg	Group 27 85-105Ah \$160 avg	Group 31 95-125Ah \$200 avg	80W, 4.6A max \$450	65W, 3.7A max \$400	
2741/7731	1A	24	24	2 days of no sun @ 85Ah	3 days of no sun @ 105Ah	4 days of no sun @ 125Ah	10 hours 46A day	10 hours 36A day	Full sun on system, it will recharge in 1/2 a day
7762	1.5A	24	36	1 day of no sun @ 85Ah	2 days of no sun @ 105Ah	3 days of no sun @ 125Ah	10 hours 46A day	10 hours 36A day	Full sun on system, it will recharge in 3/4 of a day
NOTE:	Based on back panel info, but might be less	How many hours unit will run a day, typical is 24 hours	Take max current* the number of hours	Not good to take deep cycle batteries below 75% discharge, also depends on type of batteries, see MFG instructions, above is worst case. Much larger batteries are available, 4-D and 8-D have up to 225Ah			Lots of different types and outputs. Note product's DC voltage limits, high and low, to ensure product is not damaged		

Sample System



Finally, some additional issues and recommendations:

Our products list max current, general usage is lower

Wide range of performance vs. cost per system, understanding where to spend the money is critical

Shade can reduce a solar panels output by 50%, so doing a site survey is a must

High quality solar charger will keep voltages under control; keep from damaging batteries and Ruckus units.

See the below power calculations for Ruckus outdoor products:

Category	Outdoor						
Model	ZF 2741	ZF 7731	ZF 7761-CM*	ZF 7762	ZF 7762-S	ZF 7762-AC	ZF 7762-T
Power consumption (peak)	10W	12W	25W/60W	15W	15W	14W	15W
Wh/day	240Wh	288Wh	600WH/1440Wh	360Wh	360Wh	336Wh	360Wh
Pannels needed	1	1	2;5	1	1	1	1
Battery bank (1day)	10Ah	12Ah	25Ah/60Ah	15Ah	15Ah	14Ah	15Ah
Battery bank (2days)	20Ah	24Ah	50Ah/120Ah	30Ah	30Ah	28Ah	30Ah

Assumed: 1 pannel = 100W, 1 pannel produces avg. 300Wh/day

Vendors	Model #	Kit-Volume	Watt/Panel	Price \$	Web
Grape Solar	GS-S-100-Fab36	panel	100W/panel	\$199.00	http://www.homedepot.com/catalog/pdfimages/56/569c0adb-7a4b-484f-8ada-ef3178655821.pdf
Grape Solar	GS-100-KIT	panel,30 Amp digital charge controller,cables	100W/panel	\$399.00	http://www.homedepot.com/Electrical-Alternative-Energy-Solutions-Solar-Power/Grape-Solar/h_d1/N-5yc1vZbm18Z8p9/R-203505908/h_d2/ProductDisplay?catalogId=10053&langId=-1&storeId=10051#.UBaxIbSe6vs
Solartech	SPM100P-TS	panel	100W/panel	\$355.08	http://www.ecodirect.com/Solartech-SPM100P-TS-100W-17V-PV-Panel-p/solartech-spm100p-ts.htm
SunWize	SW-S110P	panel	110W/panel	\$328.95	http://www.ecodirect.com/SunWize-SW-S110P-110W-17V-PV-Panel-p/sunwize-sw-s110p.htm
Solartech	SPM120P-WP	panel	120W/panel	\$388.95	http://www.ecodirect.com/Solartech-SPM120P-WP-120W-33V-PV-Panel-p/solartech-spm120p-wp.htm
ET Solar	ET-P636125	panel	125W/panel	\$324.95	http://www.ecodirect.com/ET-Solar-125-Watt-18-Volt-Solar-Panel-ET-P636125-p/et-p636125.htm
EcoDirect	VLS-125W	panel	125W/panel	\$338.95	http://www.ecodirect.com/EcoDirect-VLS-125W-125W-18V-Solar-Panel-p/ecodirect-vls-125w.htm

Vendors	Model #	Use with	Use with a max.	Price \$	Web
MorningStar	SHS-6	lead-acid batteries	100W	\$29.95	http://www.ecodirect.com/Morningstar-SHS-6-6A-12V-Charge-Controller-p/morningstar-shs-6.htm
MorningStar	SG-4	lead-acid batteries	30V	\$24.05	http://www.ecodirect.com/Morningstar-SunGuard-SG-4-12-Volt-4-5-Amp-p/morningstar-sunguard-sg-4.htm
MorningStar	SHS-10	lead-acid batteries	170W	\$36.15	http://www.ecodirect.com/Morningstar-SHS-10-10A-12V-Charge-Controller-p/morningstar-shs-10.htm

Vendors	Model #	Output	Price \$	Web
Samlex	SAM-250-12	250W	\$23.75	http://www.ecodirect.com/Samlex-SAM-250-12-250W-12V-Inverter-p/samlex-sam-250-12.htm
Samlex	SA-150-124	150W	\$152.95	http://www.ecodirect.com/Samlex-SA-150-124-150W-24V-Pure-Sine-Inverter-p/samlex-sa-150-124.htm
Samlex	SAM-450-12	450W	\$32.75	http://www.ecodirect.com/Samlex-SAM-450-12-450W-12V-Inverter-p/samlex-sam-450-12.htm

Vendors	Model #	Amp Hours	Price \$	Web
Concorde	PVX-1040T	104 AH	\$289.50	http://www.ecodirect.com/Concorde-PVX-1040T-p/concorde-pvx-1040t.htm
Concorde	PVX-2240T	220 AH	\$325.95	http://www.ecodirect.com/Concorde-PVX-2240T-p/concorde-pvx-2240t.htm
Hawker	6-75EL-09	369 AH	\$3,379.95	http://www.ecodirect.com/Hawker-6-75EL-09-12V-369AH-Sealed-Gel-Battery-p/hawker-6-75el-09.htm

Ruckus Wireless, Inc.

880 West Maude Avenue, Suite 101, Sunnyvale, CA 94085 USA

(650) 265-4200 Ph \ (408) 738-2065 Fx

