BAB V

PENUTUP

5.1 Kesimpulan

Setelah mengerjakan Tugas Akhir ini dapat diambil suatu kesimpulan mengenai pemanfaatan tenaga surya sebagai suplai daya penerangan di kapal Ferry Ro-Ro 500 GRT antara lain :

1. Jumlah panel surya yang bisa dipasang pada geladak anjungan dengan luasan 160 m^2 sebanyak 35 panel surya dengan mempertimbangkan aturan yang berlaku pada kapal Ferry Ro-Ro.
2. Dari total kebutuhan generator 80 kVA, sekitar 42 kVA dapat disuplai oleh 35 panel surya selama pemakaian beban penerangan 12 jam dan penghematan energi sebesar 52,5 %.
3. Dari tabel 4.2 dan tabel 4.3 terlihat bahwa biaya investasi sistem tenaga matahari lebih besar biayanya daripada generator tetapi untuk masa operasional dan perawatan selama jangka waktu 10 tahun, sistem tenaga matahari yang menguntungkan dengan biaya yang kecil dibandingkan generator.

DAFTAR PUSTAKA

1. Alloca, A. John, Emergency Power.
2. Biro Klasifikasi Indonesia. 2009
3. Fauzi, Farit. 2009. Pemanfaatan Sel Surya Sebagai Catu Daya Peralatan Penerangan Kapal Di Kapal Tanker.
4. Haesin, A. Nia, Listrik Dinamis.
5. Internet www.indonesiannoor.com/index2.html=www.fvenergy.com = www.kyocera.com=www.celcias.com=www.solarpowerindustries.com
6. Lunde, J. Peter, Solar Thermal Spce Heating and Hot Water System.
7. Matsushita Battery Indrustrial Co.,Ltd, Solar Cells Technical Handbook.'98/99.
8. Rahman. A, Ketrampilan Elektronika.

REFERENSI

DATA RADIASI PENYINARAN MATAHARI DI WILAYAH INDONESIA

Berdasarkan data penyinaran matahari yang dihimpun dari beberapa lokasi di Indonesia, radiasi surya di Indonesia dapat diklasifikasikan berturut-turut sebagai berikut: untuk kawasan Barat dan Timur Indonesia dengan distribusi penyinaran di Kawasan Barat Indonesia (KBI) sekitar 4,5 kWh/m²/hari dengan variasi bulanan sekitar 10%; dan di Kawasan Timur Indonesia (KTI) sekitar 5,1 kWh/m²/hari dengan variasi bulanan sekitar 9%. Dengan demikian, potensi angin rata-rata Indonesia sekitar 4,8 kWh/m²/hari dengan variasi bulanan sekitar 9%. Catatan: Pada tengah hari yang cerah radiasi sinar matahari di bumi mampu mencapai nilai 1000 W/m² = 1 kW/m² = 100 mW/cm²

WILAYAH	POTENSI RADIASI	VARIASIBULANAN
Kawasan Barat Indonesia (KBI)	4,5kWh/m² per hari	10%
Kawasan Timur Indonesia (KTI)	5,1 kWh/ m² per hari	9%
Rata2 wilayah Indonesia	4,5 – 4,8kWh/m² per hari	9.5%

(*sumber "http://theindonesiannoor.com/index2.html"*)

Emergency Power

Dr. John A. Allocca
WB2LUA
8/22/03

Emergency Power Requirement Estimate

Appliance	Rated Watts	xHours/day	Surge Watts	Surge Watts
Light Bulbs (75 watt each)	75 x number	_____	75 x number	_____
Compact fluorescent (25/100 watt)	25 x number	_____	25 x number	_____
Refrigerator/Freezer	500	_____	2000	_____
Sump Pump	800	_____	2000	_____
Water Pump (1/3 HP)	1000	_____	3000	_____
Furnace Fan (1/2 HP)	875	_____	2300	_____
Electric Blanket	400	_____	400	_____
Space Heater	1800	_____	1800	_____
Heat Pump	4700	_____	12000	_____
Dehumidifier	650	_____	800	_____
Attic Fan	300	_____	900	_____
Table Fan	800	_____	2000	_____
Window Air Conditioner	1200	_____	4800	_____
Central Air (10k BTU)	1500	_____	6000	_____
Central Air (24k BTU)	3800	_____	15000	_____
Central Air (40k BTU)	6000	_____	24000	_____
Computer	300	_____	300	_____
CD Player	100	_____	100	_____
VCR	100	_____	100	_____
Radio	100	_____	100	_____
Television	300	_____	300	_____

Receiver	420	_____	420	_____
Microwave	800	_____	800	_____
Blender	300	_____	900	_____
Coffee Maker	1500	_____	1500	_____
Electric Range (1 element)	1500	_____	1500	_____
Toaster (2-slice)	1000	_____	1600	_____
Dishwasher (Hot Dry)	1500	_____	3000	_____
Electric Oven	3410	_____	3410	_____
Steam Iron	1200	_____	1200	_____
Washing Machine	1150	_____	3400	_____
Gas Clothes Dryer	700	_____	2500	_____
Electric Clothes Dryer	5400	_____	6750	_____
Security System	500	_____	500	_____
Deep Freezer	500	_____	1000	_____
Hair Dryer	1200	_____	1200	_____
Garage Door Opener (1/3 HP)	750	_____	750	_____
Electric Water Heater	4000	_____	4000	_____
Total Per Day		_____		_____

Note: the generator must be able to handle the total surge power.

Note: Compact fluorescent (25/100 watt) bulbs provide an equivalent of 100 watts of light and use 25 watts of power.

Generators

Generators are basically gasoline, natural gas, or propane powered. They usually generate substantial amounts of power. Portable generators commonly generate 1,000 to 5,000 watts continuously with a surge of about 1,300 to 6,500 watts. There are several disadvantages of gasoline powered generators. They require a constant refilling of gasoline and gasoline cannot be stored for long periods of time. Gasoline stations require electric pumps to supply gasoline and they may not have emergency generators. Natural gas is often available in many homes. Propane can be stored. Propane tanks are usually refilled by gas pressure, which eliminates the need for electric pumps.

Solar Power

Solar power is far more expensive than generator power. There are several advantages of using solar power. Sunshine is the source of power, which eliminates dependency on vendors for fuel. Solar power is clean and requires little maintenance. The disadvantage is initial cost. Typically, solar power is used to charge batteries, which are connected to an inverter.

A solar cell or photovoltaic cell (PV) is made of semiconductors, usually silicon. Ordinarily pure silicon is a poor conductor of electricity so impurities such as phosphorus and boron are added to create the semi-conductor. The addition of these impurities allows the silicon to conduct electricity. The semiconductor absorbs part of the light. The absorbed light energy knocks electrons loose, allowing them to flow freely. Metal contacts are placed on the top and bottom of the solar cell so that current can be drawn from it.

A solar electric panel consists of an aluminum framed sheet of highly durable low reflective, tempered glass that has had individual solar cells adhered to the inner glass surface. These individual solar cells are wired together in a series parallel configuration to obtain the necessary voltage and current. The back of the panel is protected by another sheet of tempered glass or a long lasting material such as Tedlar. The series parallel connections are passed through the protective backing and then wired to a weather proof junction box which is permanently mounted to the back of the panel where the panel's output connections are made. There are also flexible cells and panels, roof tile cells, etc.

Solar panels are rated as watts per hour. For example, in direct sunlight, a 50 watt solar panel will produce 50 watts per hour. It will produce 350 watts in 7 hours, and so on.

Batteries

When designing a marine deep cycle battery, manufacturers must keep in mind that the battery may be used for starting a boats engine. In order to start an engine, the battery must contain a lot of plates and plate area, which give the battery its high cranking capacity. In order to squeeze enough plates into a standard battery case, the plates must be made thin. The thinner the plates the shorter the life span of the battery when it is used in a deep cycle application. If cost is a major factor and the batteries will only be used occasionally during an emergency, a marine deep cycle battery may be adequate.

A much better choice for long-term continuous use is the golf cart battery. The plates are much thicker and designed to be deep cycled below 50% depth of discharge day in and day out, year after year. A properly maintained golf cart battery should last 3 two 5 years in a typical renewable energy application. A typical golf cart battery is available in a 6 volt 220 amp hour ratings. Two batteries will be required and they will need to be wired in series to produce 12 volts @ 220 amp hours. Golf cart batteries are considered the minimum type of battery that is used in renewable energy application. There

are larger batteries available in 6, 4 and even 2 volt configurations which have even larger plates and thus longer life expectancies.

When there is power available from the utility company, batteries can be charged from the power line. During emergencies, when there is no power from the utility company, batteries will have to be charged from the solar panel.

Calculating Battery Usage:

Amp Hour x Volts (Watts)
----------= Watts per Hour
Hours of Use

Amp Hour x Volts (Watts)
----------=Hours of Use
Watts per Hour

Example:
A 12 volt, 100 ah battery will provide:
100 amps in 1 hour (1200 watts in 1 hour)
14.3 amps for 7 hours (171 watts in 7 hours)
5 amps for 20 hours (60 watts in 20 hours)

Calculating the Load

Watt Hours = Load Watts x Hours of Use
Add 10 percent for battery losses.

Example: If a television draws 200 watts and runs for three hours (200x3 = 600) it will use 600 watt hours

Inverters

An inverter is an electronic device, which inverts DC energy AC energy. Most household appliances such as refrigerators, TVs, lighting, stereos, computer etc., all run off of AC electricity.

Modern DC to AC inverters are very reliable, quiet, and require virtually no maintenance. There are two different types of DC to AC inverters in common use today. The first type of inverter is known as a modified sine wave inverter. This type of inverter is very high in efficiency and produces a waveform, which is an approximation of the pure sine wave waveform.

High frequency units take the incoming 12 Volts DC and will step up that voltage to approximately 200 volts DC through a high frequency DC to DC converter circuit and then will take the 200 Volts and will wave shape it into a modified sine wave using a using a device called a high voltage H-bridge. The high voltage H-bridge is basically a group of field effect transistors that are arranged in such a way as to form the necessary half cycles that create the modified sine wave at the 60 Hz frequency required for US appliances. By utilizing high frequency, the need for a large iron core output transformer is eliminated and much smaller transformers can be used. As a result of this, high frequency inverters tend to be much lighter but do have a lower surge capacity because they lack the fly wheel effect found in heavy iron core output transformer based inverters.

Low frequency units take the incoming 12 Volts DC and converts it into AC, using a multivibrator or microprocessor based circuit. The AC is kept at a low voltage and is converted into a 60 Hz signal

before it is fed to the iron core transformer. Wave shaping and the increased current that is needed to drive the transformer is performed again by an H-bridge which is a group of field effect transistors that are arranged in such a way as to feed high current pulses to the primary windings of the transformer at precise moments of each wave form half cycle. The transformer converts the lower voltage which was fed to its primary windings into 120 Volts AC at its secondary windings using simple transformer step up principles involving a 10 to 1 ratio, converting 12 Volts AC to 120 AC. This type of inverter is more durable than the high frequency inverters, and has a much higher surge capacity. Low frequency units tend to cost two to five times more than do high frequency units and often weigh four times more.

The second type of inverter is known as a pure sine wave inverter. This type of inverter produces pure sine waves, but at the cost of some efficiency loss and at a much higher price. Most pure sine wave inverters are typically priced at least 75% higher than the modified sine wave counterparts and in some cases do not have as high of a surge capability as do modified sine wave units.

A 3,000 Watt, 120 VAC, Output Solar System

The Batteries will need to supply 3,600 watts of electricity per hour, 86,400 watts per day. The inverter efficiency is about 71 percent. Therefore 3,600 watts DC will be needed to convert to 3,000 watts AC. The solar panels will need to charge the batteries with 86,400 watts during sunlight (about 7 hours per day) at the rate of 12,342.9 watts per hour. The system will require a space of about 30 feet x 30 feet, weigh more than 7,000 pounds, and cost over $60,000.

Calculate Time of Battery Use:

$$\frac{\text{Amp Hour x Volts (Watts)}}{\text{Watts per Hour}} = \text{Hours of Use} = \frac{\text{400 ah x 6 volts x 36 batteries}}{\text{3600 watts per hour (150 a x 24 v)}} = 24 \text{ hours}$$

Calculate Time ofBattery Recharge from Solar Panels:

$$\frac{\text{Amp Hours x Volts (Watts)}}{\text{Solar Panel Watts}} = \frac{\text{400 ah x 6 volts x 36 batteries}}{\text{66 x 185 watts per hour}} = 7.1 \text{hours}$$

The system consists of:

Sixty Six 185 watt, 24 v solar panels, 62" x 32.5" x 1.8", 38 pounds, (about $50,000)
Connected in parallel (923.6 square feet [30' x 30'], 2,508 pounds)

3,600 watt output, 24 volt - 210 amp input (150 amp input at 3000 watt output), modified sine wave inverter (about $1,800)

Three 60 amp charge controllers (about $600)

Thirty six 400 ah, 6 volt, 127 pound batteries connected in series and parallel for 24 v (about $7,700 and 4,572 pounds)

Miscellaneous cables, etc.

Can a PV system be installed on my building?

The most important questions to consider in deciding whether or not a PV system can be installed on a building and what type of system should be installed are:

- is there a suitable place on the building where the solar array could be mounted (taking into account orientation, shade, and available area)
- what type of photovoltaic system would be suitable
- is planning permission required

Photovoltaic modules can be placed on almost any building surface which receives sunshine for most of the day. Roofs are the usual location for PV systems on houses but photovoltaic modules can also be placed on facades, conservatory or atrium roofs, sun shades, etc.

The surface on which the PV array is mounted should receive as much light as possible. The more light the solar array receives the more electricity will be generated. The three issues which affect how much light a surface receives are:

1. Orientation: Due south is the best possible orientation. If the PV is to be mounted on a vertical façade the orientation should preferably be between South East and South West. If the PV is to be mounted at a tilt a wider range of orientations will still give a reasonable energy yield. North facing orientations should be avoided.

2. Tilt: A tilted array will receive more light than a vertical array. Any angle between vertical and 15o off horizontal can be used. A minimum tilt of 15o off horizontal is recommended to allow the rain to wash dust off the array. The optimal tilt angle is 30o - 60o for a south facing array in Europe. Shallower tilt angles are better for east or west facing arrays.

3. Shadowing: Shadows cast by tall trees and neighbouring buildings must also be considered. Even minor shading can result in significant loss of energy. If shading is unavoidable, your system designer can advise on how to minimize the effect of shade on the amount of electricity produced.

The area required for mounting a PV array depends on the output power desired and the type of module used. An area of around 8 m2 will be required to mount an array with a rated power output of 1kW, if monocrystalline modules are used (the most efficient modules type). If multicrystalline modules are used an area of around 10 m2 will be required for a 1kWp system and if amorphous modules are used an area of about 20 m2 will be required. These areas can be scaled up or down depending on the output power desired. 1 - 3 kWp is a typical power output for a domestic system, although smaller or larger systems can be installed.

There are various ways in which a PV array can be mounted on a building. The various options offer different appearances and vary in cost. The commonest way of mounting an array on a house is to place it on the roof either with modules mounted in a frame above the existing roof tiles or integrated into the roof. If the array is to be integrated into the roof PV roof tiles may be used instead of modules.

PV arrays can also be mounted on flat roofs, on walls, in conservatory roofs, on sun shades or on other structures such as pergolas or car parking bays.

FVG ENERGY srl - Via San Giorgio, snc - 33050 Carlino (UD) – ITALY- IT02476220302
www.fvgenergy.com Fax. +39 0431 68558 e-mail: energia@fvgenergy.com

ROLLS MARINE BATTERIES – TECHNICAL SPECIFICATIONS

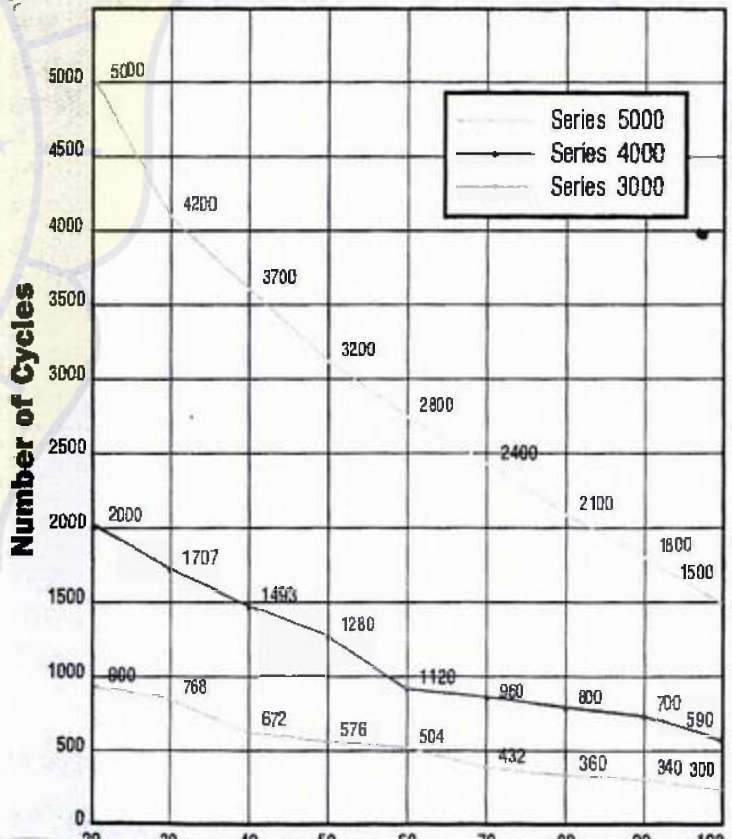
Part No.	Capacity@ 20 Hr	Reserve Minutes	CCA	Dimensions (mm)	Weight (Kg)
Series 4000 – 12Volt – 'Dual Container' Heavy Duty Marine Deep Cycle					
12 EHG 210PM	210	390	875	527 x 222 x 314	62.6
12 HHG 325BSM	325	650	1350	622 x 381 x 330	90.7
12 HHG 325PM	325	650	1350	552 x 337 x 287	90.7
12 EHG 375PM	375	775	1530	552 x 337 x 319	104.3
12 MD 325PM	325	650	1350	464 x 383 x 281	90.7
12 MD 375PM	375	775	1530	464 x 383 x 310	104.3
Series 5000 – 2Volt – 'Dual Container' Premium Marine Deep Cycle					
2 KS 33PM	1766	4915	4952	392 x 211 x 630	94.3
Series 5000 – 4Volt – 'Dual Container' Premium Marine Deep Cycle					
4 CS 17PM	546	1083	1689	365 x 210 x 464	66.7
4 KS 21PM	1104	3575	3095	400 x 238 x 629	121.1
4 KS 25PM	1350	4290	3714	400 x 270 x 629	142.9
Series 5000 – 6Volt – 'Dual Container' Premium Marine Deep Cycle					
6CS 17PM	546	1083	1357	559 x 210 x 464	100.2
6 CS 21PM	683	1353	1740	559 x 248 x 464	122.9
6 CS 25PM	820	1624	2088	559 x 286 x 464	144.2
Series 5000 – 8Volt – 'Dual Container' Premium Marine Starting / Deep Cycle					
8 NS 23PM	430	716	1520	718 x 210 x 464	109.8
8 CH 23PM	582	969	1866	718 x 210 x 464	116.1
8 NS 33PM	625	1042	2204	718 x 286 x 464	159.7
8 CH 33PM	846	1410	2648	718 x 286 x 464	187.8
Series 5000 – 8Volt – 'Dual Container' Premium Marine Deep Cycle					
8 CS 17PM	546	1083	1351	718 x 210 x 464	133.4
8 CS 25PM	820	1624	2027	718 x 286 x464	192.3
Series 5000 – 12Volt – 'Dual Container' Premium Marine Deep Cycle					
12 CS 11PM	357	677	845	559 x 286 x 464	123.4

Choosing the right battery for your particular application will save you money and give you years of trouble-free service

- Robust construction to handle the largest inverter systems
- Numerous sizes and voltage configurations to suit your requirements
- Enhanced proven technology assures long cycle life

Series 3000
(4 year warranty)

Cycle Life



Rolls Batteries Online

CAUTION ONE MEAN BATTERY

6VFS-Series (Motive Power) | 12V FS-Series (Motive Power) | 6VFS-Series (Marine) | 12VFS-Series (Marine)
Series 4000 Monobloc (Solar) | Series 5000 Dual Container | AGM Series

Rolls Series 5000 Deep Cycle Dual Container Battery Range

Features:

- 10 year manufacturing warranty
- 3200cycles @ 50% depth of discharge
- 4volt (special order), 6volt, 8volt (special order) and 12volt
- Dual container - minimal risk of spillage
- Individual cells can be removed
- High capacities means fewer batteries in your system
- Hydro cap option available

The Rolls definition of a deep cycle battery is one that is designed for maximum reliability. Maximum reliability is achieved by utilizing heavy positive and negative plating, dense active material, reinforced grid design, premium insulation which usually includes a thick woven glass mat, cell protector, rubber container, heavy intercell connections and on larger batteries multi-cell construction.

Hydrocaps

Rolls 2KS 33P Deep Cycle Battery

2v 1766ah Series 5000 Deep Cycle Battery — Price: £725.12 Inc. VAT — 1 Buy — more info...

Rolls 4CS17P Deep Cycle Battery

4v 546ah Series 5000 Deep Cycle Battery — Price: £449.61 Inc.VAT — 1 Buy — more info...

Rolls 4KS25P Deep Cycle Battery

4v 1350ah Series 5000 Deep Cycle Battery — Price: £1,112.16 Inc.VAT — 1 Buy — more info...

Rolls 6CS21P Deep Cycle Battery

6v 683ah Series 5000 Deep Cycle Battery — Price: £848.52 Inc. VAT — 1 Buy — more info...

Rolls 12CS11P Deep Cycle Battery

12v 357ah Series 5000 Deep Cycle Battery — Price: £887.40 Inc. VAT — 1 Buy — more info...

Rolls 2 YS 31P Deep Cycle Battery

2v 2430ah Series 5000 Deep Cycle Battery — Price: £1,044.73 Inc. VAT — 1 Buy — more info...

Rolls 4KS21P Deep Cycle Battery

4v 1104ah Series 5000 Deep Cycle Battery — Price: £909.35 Inc.VAT — 1 Buy — more info...

Rolls 6CS17P Deep Cycle Battery

6v 546ah Series 5000 Deep Cycle Battery — Price: £677.81 Inc. VAT — 1 Buy — more info...

Rolls 6CS25P Deep Cycle Battery

6v 820ah Series 5000 Deep Cycle Battery — Price: £1,012.46 Inc. VAT — 1 Buy — more info...

OutBack PowerSystems

OutBack MPPT Charge Controller

MPPT Charge Controller

The OutBack MX60 Maximum Power Point Tracking (MPPT) charge controller enables your PV system to achieve its highest possible performance. Rated for up to 60 amps of DC output current, the MX60 can be used with battery systems from 12 to 60 VDC with PV open circuit voltage as high as 140 VDC. The MX60's set points are fully adjustable to allow use with virtually any battery type, chemistry and charging profile. The MX60 allows you to use a higher output voltage PV array with a lower voltage battery. This reduces wire size and power loss from the PV array to the battery / inverter location and can maximize the performance of your PV system.

The MX60 comes standard with an easy to use and understand display of the PV system's performance. The four line, 80 character, back-lit LCD display is also used for programming and monitoring of the system's operation, including built-in data logging with 64 days of memory.

The MX60 can also be connected to the OutBack MATE system controller and display to allow monitoring of up to eight MX60 controllers from a location up to 1000 feet away. The MATE also includes an opto-isolated RS232 port for connection to a PC for data logging and system monitoring. See page 89 for more information on the MATE

MX60

Model Number	MX60
Part Number	**55295**
Price	**$649.00**
Output Current Rating	60.0 Amps DC Maximum at 12, 24, or 48 VDC
Nominal Battery Voltage	12, 24, 32, 36, 48, 54, or 60 VDC
PV Maximum Open Circuit Voltage	140VDC
Standby Power Consumption	Less than 1 Watt typical
Charging Regulation Methods	Five Stage: Bulk, Absorption, Float, Silent, Equalization
Charging Regulation Set Points	13 - 80 VDC
Equalization Voltage	Adjustable 1.0 to 5.0 VDC above Bulk Setpoint
Temperature compensation	Programmable slope -2.0mV/oC/Cell to -5.0mV/oC/Cell
Voltage Step-Down Capability	Can change a 12 or 24 VDC battery from a 48V nominal PV array
Power Conversion Efficiency	99.1%@40A, 97.3%@60A
Digital Display	4 line 80 character backlit LCD Display
Remote Interface	RJ45 Modular Connector CAT 5 Cable 8 wire
Operating Temperature Range	-40 to 60 °C Power derated above 25 °C
Environmental Rating	Indoor Type 1
Conduit Knockouts	Two 3/4 -1" on the back; One 1"-1 1/2" on each side; Two 1" 1/2" on the bottom
Warranty	Two years parts and labor/ optional extended warranty
Dimensions (HxWxD) (in)	Enclosure: 14.5 x 5.75 x 5.75 / Shipping Box: 17.75 x 10 x 7
Shipping Weight (lbs.)	15.0

OutBack Charge Controller Accessory

Product Name and Description	Part Number	Shipping Weight (lbs.)	Price
RTS - Outback Remote Temperature Sensor w/ 20' cable	55300	1.0	$29.00

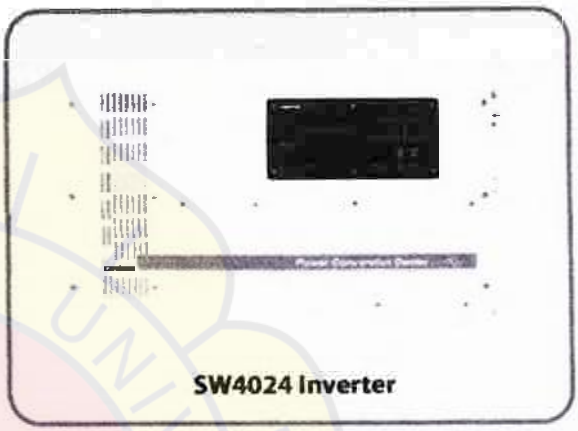
xantrex

Sine wave (SW) Inverters

; inverter/charger can be configured as a simple stand-alone unit, work in conjunction with your generator to handle loads too e for the generator alone, or function as a utility interactive inverter, with use of the GTI option, sending excess power back into the power grid.

More Features

- Adjustable search mode can reduce idle power to 1 watt
- Current compensated, adjustable low battery cut-out volt ages and high battery cut-out protection.
- Protection circuitry guards against over-current, short circuit, over temp, low battery and high battery conditions.
- Battery charger design allows the use of smaller back up generators at high efficiencies.
- Three stage, temp. compensated, adjustable, battery charger, with remote temperature probe to maximize battery life.



SW4024 Inverter

e Grid Tie Interface (GTI) is an integrated assembly used with the Xantrex SW Series II Inverter / Charger with Revision 4.2 tware. This new device provides active anti-islanding detection along with side benefits such as reducing voltage and current al harmonic distortion (THD) below the test requirements. Anti-islanding and THD testing is described in the IEEE-929-2000 and -1741-2000.

e SW units are certified to meet UL spec. 1741, and includes a powerful battery charger, a 60 amp AC transfer switch, automatic nerator start function and three built-in programmable auxiliary relays for operating loads and/or charging sources. Two year arranty.

Model					
art Number	50187	50188	50189	50901	50932
rice	$2750.00	$2750.00	$3450.00	$3495.00	$4099.00
put Voltage	24VDC	48VDC	48VDC	24VDC	48VDC
utput Power (Watts)	4000	4000	5500	3300	4500
ontinuous (Amps)	33	33	46	14	20
urge Power (Amps)	78	78	78	34	34
fficiency - Peak	94%	95%	96%	94%	96%
utput Voltage / Regulation	120 VAC/ +/- 2%			230 VAC/ +/- 2%	
requency / Regulation	60Hz/ +/- 0.04%			50Hz/ +/- 0.04%	
put Requirements					
Min. Search Power	1 watt				
On Mode (No Load-Idle) (Amps)	16.0	16.0	20.0	16.0	20.0
Input Voltage (VDC)	20.0 to 34.0	40.0 to 60.0	40.0 to 68.0	22.0 to 33.0	44.0 to 66.0
istortion	3 to 5%				
ower Factor Allowed	-1 to 1				
lax. Charge Rate (Amps)	120.0	60.0	75.0	100.0	60.0
utomatic Transfer Relay (Amps)	60.0				
pecified Temperature Range	32°F - 113°F (0°C - 45°C)				
eries Operation with 2nd Unit	Yes, 240VAC				
utomatic Low Battery Protection	Adjustable				
orced Air Cooling (4 speed fan)	Thermally Activated				
emp. Comp. Probe	Yes				
Veight - Inverter Only (lbs.)	35.0 (16 kg)				

Inverter/ Generator Backup Mode

The SW Series II includes a powerful battery charger and a 60 amp AC transfer switch. When utilizing the charging circuitry, we typically program the unit to activate the battery charger, and switch all AC loads to generator power via a pre-programmed low voltage set-point.

Extensive automatic generator start features are standard and user programmable. Gen start can be triggered by battery voltage, load size in amps or time of day. "Quiet time" can be set during which the generator is not allowed to start unless a "must start" override voltage is reached. "Warm-up seconds," max cranking seconds," and "max charge amps and/or gen amps AC"

P1-156-190W AARA
190-Watt Module

DATA SHEET

Key Features

- Module contains 54 series connected 156×156 mm square
- Polycrystalline silicon solar cells
- Designed to accommodate remote battery charging or grid connected application
- Tolerance of ± 3% ensures that you receive the power that you purchase
- Advanced processing technology and automated production facilities with high quality standards
- Aluminum anodized frame and tempered glass laminate provides for maximum protection in rugged applications
- Junction box with "Plug-n-Play" leads provides ease of installation
- Three bypass diodes for additional cell protection
- UL 1703 and IEC 61215 certification
- Limited Peak Power Warranty for 25 years

ctrical Specifications at STC

W/m², 25°C, AM1.5

pical Power	190 W
ltage at Typical wer	27.0V
rrent at Typical wer	7.01 A
pen Circuit Voltage	32.0V
ort Circuit Current	7.42 A

Mechanical Specifications

	Metric	English
Length	1482 mm	58.35 in
Width	992mm	39.06 in
Depth	50mm	1.97 in
Weight	17.9kg	39.55 lbs

SOLAR POWER INDUSTRIES

SOLAR POWER INDUSTRIES, INC.
440 JONATHAN WILLEY ROAD
BELLE VERNON, PA 15012
P: 724-379-6500
F: 724-379-4028
WWW.SOLARPOWERINDUSTRIES.COM

PHOTOVOLTAIC MODULES

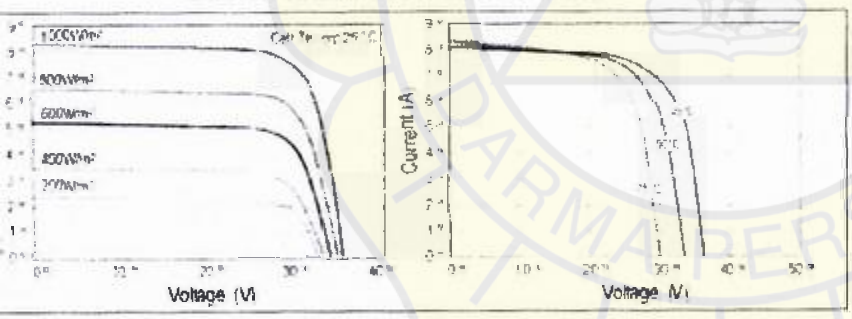
FVG ENERGY www.fvgenergy.com

ECTRO-OPTICAL CHARACTERISTICS

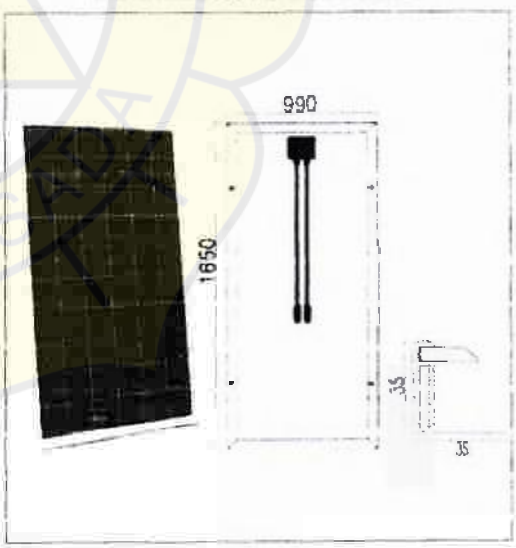
de	Type	Model	Module Efficiency	Cell Efficiency	Power Peak (W)	Vm (V)	Im (A)	Voc (V)	Isc (A)	Power Tolerance
30	FVG 60 - 156	FVG 200P - MC	12.20%	1370%	200	28.70	6.97	3600	7.75	+/-3%
31	FVG60-156	FVG 205P - MC	1250%	14.05%	205	29.20	7.05	36.20	7.81	+/- 3%
32	FVG60-156	FVG 210P - MC	1280%	1440%	210	29.70	7.10	36.40	7.86	+/-3%
33	FVG 60 - 156	FVG 215P - MC	13.10%	1475%	215	29.75	7.25	3660	7.93	+/-3%
34	FVG60-156	FVG 220P - MC	13.40%	15.10%	220	29.80	7.39	3680	8.00	+/- 3%
35	FVG 60 - 156	FVG 225P - MC	1370%	1545%	225	3000	750	37.00	807	+/- 3%
36	FVG 60 - 156	FVG 230P - MC	14.00%	1580%	230	30.30	7.60	37.20	8.14	+/-3%
37	FVG60-156	FVG 235P-MC	14.30%	1615%	235	3040	7.75	37.40	8.21	+/- 3%
38	FVG 60 - 156	FVG 240P - MC	1460%	1650%	240	3050	7.88	37.60	8.28	+/-3%

and Connection	Polycrystalline silicon - 60 in series
Series Fuse	11A
Temperature Coefficient	-045%/°C
Temperature Coefficient	-035 %/°C
emperature Coefficient	005 %/°C
Condition	STCAM=15 1000W/m², Cell Temperature 25°C
T	47± 2°C
System Voltage (VDC)	1000
ating Temperature / Storage Temperature	-40~+85°C
ectric Insulation Voltage	3000 VCD max

FVG 60 CELLS- POLYCRYSTALLINE



DIMENSIONS AND PACKING

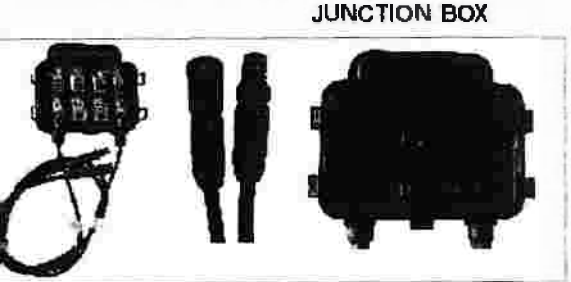


WARRANTY

EARS LIMITED ON PV MODULES AND 25 YEARS LTD ON POWER OUTPUT
power output values shall be those measured under FVG Energy standard
isurement conditions as follows:
ight spectrum of AM 1.5;
rradiation of 1,000W per m²;
cell temperature of 25°C.

more information ask your local dealer or FVG Energy directly
w.fvgenergy.com) for the full document of Warranty.

JUNCTION BOX



Junction box with cables and waterproof connectors.
With 6 bypass diodes.
Cable length cm 90.
Line 3 type connectors.

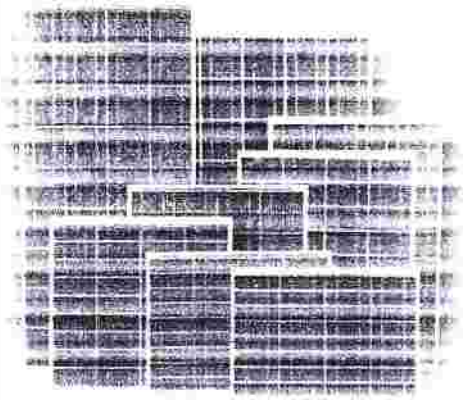
Module Dimensions: mm 1650 x 990 x 35
Module Net Weight: kg 2150
Carton Dimensions: about cm 172 x 108 x h8
Pallet Dimensions: about cm 176 x 109 x h180
Pallet Net Weight: kg 900
1 carton = 2 modules
1 pallet = 20 cartons = 40 modules

Container Loading Capacity
20ft: 240 Pcs (6 pallets)
40ft: 480 Pcs (12 pallets)

Kyocera Solar Modules (KC)

Kyocera's advanced cell processing technology and automated production facilities have produced a multi-crystal solar cell with an efficiency of over 15%. All modules are constructed using a tempered glass front, EVA pottant and a PVF backing to provide maximum protection from the most severe environmental conditions. The entire laminate is framed in a heavy duty anodized aluminum frame to provide structural strength and ease of installation. Because Kyocera modules are so efficient less space is required than other solar modules of equal output. This translates to both more wattage per square foot and lower mounting structure cost.

KC190GT



KC Module Family

Features

- KC65T-KC190T modules have a +10/-5% power tolerance, KC40T-50T: +15/-5%
- UL listed
- Low iron, tempered glass, EVA encapsulant and anodized aluminum frame construction
- 25 year output warranty on KC Series modules
- Weather resistant junction box (KC40T-KC125TM) or multi-contact connectors (KC125GT, 170GT, & 190GT)

Quality Assurance

Kyocera multi-crystal photovoltaic modules exceed government specifications for the following tests:

- Thermal cycling test
- Thermal shock test
- Thermal/Freezing and high humidity cycling test
- Electrical insolation test
- Hail impact test
- Mechanical, wind and twist loading test
- Salt mist test
- Light and water exposure test
- Field exposure test

Part Number	119002	117002	112502	112512	108511	106511	105511	104011
Rated Power (Watts)	190.0	170.0	125.0	125.0	85.0	65.0	55.0	40.0
Series Fusing (Amps)	11.0	11.0	11.0	11.0	11.0	6.0	6.0	6.0
Current at Max. Power (Amps)	7.28	7.27	7.20	7.20	4.75	3.64	3.08	2.24
Voltage at Max. Power (Volts)	26.1	23.4	17.4	17.4	17.9	17.9	17.9	17.9
Short Circuit Current (Amps)	8.08	8.03	8.0	8.0	5.15	3.97	3.35	2.43
Open Circuit Voltage (Volts)	32.5	29.0	21.7	21.7	21.8	21.8	21.8	21.8
Length (Inches)	56.2	50.8	56.0	56.0	39.6	29.6	25.2	20.7
Width (Inches)	39.0	39.0	25.7	25.7	25.7	25.7	25.7	25.7
Depth of frame (Inches)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Depth including j-box	1.4	1.4	1.4	2.2	2.2	2.1	2.1	2.1
Shipping Weight (lbs.)	40.7	35.3	33.0	33.0	24.0	18.0	16.0	13.0

All specification at 25°C cell temperature, 1.5 AM and 1000W/m². Wattage ratings are + 10% or – 5% (KC40T +/- 5%). KC"T" and "TM" modules have a conduit ready junction box. "GT" modules have multi-contact connectors.

See Appendix A for module dimensions and shipping information.