Final Report Recommended Power Systems and applications

For Indonesia Decentralized Basic Education 2 (DBE2)

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Summary

The goal of the underlying report is to firstly establish recommended ICT (and some lighting) applications for the selected on-grid site Cluster Resource Center (CRC) “SDN50” at Banda Aceh and off-grid site, junior high school “SDN Pulo Bungon at Pidie Village, that are exceptionally energy efficient, durable (“rugged”) and suitable for its intended functional use and come at reasonable cost. Various options were considered and each sub-chapter ends with recommended application types. Examples of the recommended desk top computers and laptops in particular are given in Appendix 3 &4.

In chapter 3 anticipated power consumption levels at both the on and off-grid sites served as input data to re-calculate capacities of the required power systems. The on-grid site will be equipped with a 2 kVA, true on-line UPS system with a battery bank that covers outages of up to 4 hours. Moreover the UPS system will also significantly improve the quality of electricity to ensure the smooth daily operation while safeguarding long lifetime expectancy of the ITC equipment. Appendix 5 shows a US brand *rugged* UPS system that incorporates all qualities to do just this.

The off-grid system will be equipped with a 0.65 kW Array of Solar Panels and is designed to power both AC and DC applications. A simplified one line diagram was provided to serve as a base design for a more detailed design that is due after the in depth “Detailed Site Assessment” that will be implemented in March 2008.

Appendices 1,2,3 show printouts of the Homer® Micro-Power System Design Software, that allows us to input different load scenarios, converter efficiencies, battery types and capacities, solar radiation contingencies and many other variables. While Appendices 6 to 9 show recommended system components consisting of batteries, solar panels, charge controllers and inverters.

1 Introduction

As a part of the Aceh component added to the Indonesia Decentralized Basic Education 2 program in May 2006, and the planned use of ICT 's at identified CRC's, EDC requested the assistance from Winrock International to make an assessment of both power requisites and connectivity options for these ICT's. The initial assessment that was implemented in 2006 resulted in a Site Assessment Report that was completed on 16/06/2007. The request was made against the background of observed poor conditions of the connectivity as well as power network thus inhibiting the implementation of ICT for educational purposes.

The Site Assessment emphasized research into the power quality as found in the city of Banda Aceh focusing on two key issues, (1) Voltage fluctuation and (2) duration of black-outs. The data that was collected served as input data to determine the type and capacity requirement for the anticipated UPS system. The UPS system recommended both improves the quality of the line-power quality and provides back-up to cover blackouts up to 4 (four) hours.

Moreover a Renewable Energy Resource Assessment was made at one other location that lacked utility power altogether (Village of Pidie in the Sigli area). Knowledge of the extent to which solar radiation is available and the exact trajectory of the sun enabled consultant to design an autonomous solar system to power anticipated ICT's.

In this report Winrock aims to:

- Determine the ITC equipment and applications that are to be deployed at pilot project locations being SDN50 in Banda Aceh and SDN Pulo Bungong, Pidie.
- Make an accurate estimation of the anticipated operational use of the ITC's (in hours)
- Address power consumption and overall systems cost implications in selecting low-power desktops, laptops, and energy-efficient monitors
- Provide base design for recommended power systems for *both on grid (SDN50) and off grid (SDN Pulo Bungong) locations*

2 Anticipated appliances and estimated daily use (in hours)

2.1 Consultation with EDC

The initial Site Assessment report made notion of a number of appliances that would need to be powered at CRC's. Those mentioned were (1) Ambient Class Lighting, (2) Premises lighting, (3) Desk-top computers, (4) Laptop computers, (5) TV's (25 and 29 Inch), DVD players.

At a consultation meeting held at EDC in December Winrock and EDC's ICT and senior management staff attempted to narrow down the anticipated appliances within the programmatic objectives of the DBE2 arriving at a list of most likely appliances to be deployed at selected CRC in Banda Aceh and school in Sigli area Village of Pidie. The goal of the meeting was to establish a more accurate estimation of the applications and corresponding power consumption than assumed in the Site Assessment report. The deputy COP provided a number of examples of the kind of ICT activities had been implemented at a CRC Central Java; students being assigned to make a digital library / documentary using a handy-cam and a laptop. Moreover the deputy explained the possibility of the implementation of Intel Teach program which focused mostly on how to use a computer. In addition he highlighted the objective of active learning with ICT's, which focuses on the learning process rather than gaining computer literacy.

For the time being no internet applications are foreseen for selected locations and therefore associated hardware is not required to be considered in the reassessment. In the tables below anticipated appliances and operational hours are mentioned.

Appliance	Max number of units	Number of days operated per week	Number hours per session
Desk top computers	5	5	4
Printer	1	5	4
TV	1	5	2
DVD	1	5	2
LCD projector	1	1	2
Digital Still camera	1	1	4
Lighting	3	12	7

Table 1: Anticipated appliances and use at CRC SDN 50 (mains available)

The pilot at the currently un-electrified SDN Pulo Bungon, Pidie Village, is aimed at a trial of 'a very light use' of ICT's. The deputy envisions that one computer will be used exclusively by the teachers for purposes of administration and producing tutorial material and the like. In addition it is probable that once a week some ICT related program is executed, which could involve the use of a digital still camera, video camera or solely one personal computer. It seems practical that for this purpose a laptop computer is employed as mobility is a key issue as it is foreseen that the computer would be moved from class to class. Security and storage issues need to be considered if a laptop is to be deployed in this particular location.

Appliance	Max number of units	Number of days operated per week	Number hours per session
Desk top or laptop computers (I)	1	5	8
Desktop or laptop computers (II)	1	1	3
Printer	1	5	4
TV	1	5	2
DVD	1	5	2
Digital Still camera	1	1	4
Lighting	3	7	12

Table 2: ***Anticipated appliances and use junior high school SDN Pulo Bungon (off-grid)***

In chapter 3 we will calculate cumulative power consumption by multiplying the number of hours of appliance use by the power consumption of the appliances selected.

2.2 Appliances Choices and considerations

In order to optimize capacity requirements for both the off-grid and on grid power systems we here attempt to list these appliances once more focusing on energy efficient appliances.
Moreover we look at issues as ruggedness and suitability for the environment were the appliance will be operated on a daily bases. Our ultimate goal is to arrive at (1) optimized and durable power systems that have the capability to run a number of (2) energy efficient and highly durable appliance so that CRC's can reap their education benefits for many years to come. The text is partly adopted from the Winrock's publication: "Guide to Energy Options for Small-Scale Rural ICT Options".

2.2.1 Lighting

Considerations

Lighting is required at both pilot locations for reasons of security. It is advised that that the premises in the vicinity of the ICT equipment is sufficiently illuminated. The use of energy efficient lighting in both locations is essential but for different considerations. At SDN 50 lighting should not fail in case of /because of a black-out as it would provide a window of opportunity for break-ins. As low power consumption lengthens the autonomy time of the UPS system it is connected to, it is recommended to use energy efficient lighting. Energy efficiency is even more important for the off grid system; power consumption determines by and large the capacity of the solar system required. Taking in consideration that the delivered cost of off-grid power varies in the range of US$ 0.5 at the low end up to US$ 15 per kWh at the high end (as compared to the tariff applied by the utility company PT PLN (Persero) US$ 0.07 /per kWh on grid) it is essential to minimize power consumption where possible. CFL lighting is available for 220 VAC and 12/24 VDC. 12/24 VDC lighting comes at a premium price but omits the inverter requirement and therefore maybe considered

Recommendations

It's recommended that a minimum of 2 (two) and a maximum of 4 (four) Compact Fluorescent Lights in the range of 8 to 11 watts are deployed at both locations. Good quality units have a life-time of minimum 6000 burning hours and 55 lumens per watt output (55lm/watt). Hereunder some example pictures are given of well known brands Philips, Osram and GE that operate at 220 VAC. At the right side some examples of 12 VDC lighting of the Phocos and Labcraft brands. These units are build-to-last and claims by its manufactures of 10000 burning hours are not out of the ordinary.

Figure 1: Branded CFLs 220 VAC

Figure 2: Branded CFL 12 VDC

2.2.2 Computers monitors and displays

Considerations

Cathode Ray Tube (CRT) monitors have been the standard displays used in desktop computer systems, and CRT technology has also dominated the television market until recently. In some markets, liquid crystal display (LCD) monitors are increasingly displacing CRT monitors. In the average desktop computer system, 60% of the energy consumption is due to the cathode ray tube (CRT) monitor. The normal power requirements of 15” to 21” CRT monitors typically fall between **65 W and 120 W**. CRT monitors require a burst of energy upon startup equivalent to **2-5 times** normal operating power consumption. Liquid crystal display (LCD) monitors are built into notebook computers and are available as standalone, flat monitors for connection to desktop computers. The most common type of LCD is the thin film transistor (TFT) display, also known as an active matrix display. LCD monitors typically consume one third to one half the power of a comparably-sized CRT monitor. The 15” standalone LCD monitors reviewed, typically had a maximum power rating of about **30 W** and reported normal active power consumption of **20-25 W**. Although pricing in developing countries may be significantly higher due to import duties and other markups, it is worthwhile to keep checking local availability and prices because global manufacturing capacity for LCD displays has increased over the past several years and further significant declines in price are expected. A short survey held in Jakarta retail prices for 15 Inch LCD screens varied between IDR 1.6 Million and IDR 3.0 Million. LCD screen with build-in **DC to DC** power supplies for a DC power sources are usually significantly more expensive than standard AC voltage LCD screens as they are designed mostly for industrial appliances. Most of the standard units have a build-in AC adaptor (that supplies a regulated DC voltage of 12VDC and a current of 3 – 5 Amps). Those units that are powered by an *external* AC adaptor can potentially be powered by DC voltage from PV system without having to deploy (costly and inefficient) inverters. It should be noted though that a DC to DC regulated power supply is required to prevent DC voltage fluctuating which can be detrimental to the LCD.

Figure 3: Industrial type LCD monitor (9 - 30 VDC)

Recommendations

As power consumption savings are significant and start up currents lower Winrock recommends to use a LCD screen for desk top applications in both on-grid and off-grid situations. In most cases 14 or 15 Inch LCD screens should be sufficient for individual use. In on-grid situations the standard units (220 VAC input voltage) are the recommend choice. In off-grid situations 12 VDC units might be considered to lower the overall power consumption. In order to keep the cost within limits, standard units with external power supplies can be modified by deploying DC to DC converters (and thus not using the standard adaptor it comes with).

2.2.3 Computers

Considerations

Because computers consist of a wide variety of power-consuming components, power consumption varies substantially from one computer to another. To determine the size of an energy system for off-grid computing facilities, the key parameter that needs to be established is the average power consumption of the computer while running the types of software applications that will be used. Computer processing units are responsible for a significant percentage of a computer's power consumption. As the power of processors has increased with each new generation of chips, maximum CPU power has risen as well. Processors designed to be used in laptop / notebook computers typically consume much less power than those designed for desktop computers. While there is little published information about the power consumption of computers by the world's major manufacturers, there is even less information regarding "white box" computers assembled by local companies in developing countries. Locally assembled computers cost significantly less than imported models, and have come to dominate many local markets in terms of market share. Increasingly common and affordable options are smaller pre-manufactured computers, with local assemblers only adding RAM, optical drive, and in some cases hard drive. A number of these are available with low power consumption CPUs and in fanless configurations that are sealed against dust, rain, insects, and other environmental contaminants (see also Low-Power Desktop Computers).

Desktop computers

Standard desktop computer systems consist of two main parts: the central processing unit (CPU) and other hardware components enclosed in a case with the motherboard, and a monitor or display device. Since these two parts of a desktop system are typically separate standalone devices, we consider their power consumption requirements separately. This section discusses the power requirements of the computer without a monitor. In 2001, a study by the Lawrence Berkeley Laboratory (LBL) estimated that the average desktop computer excluding monitor – consumed 50 to 55 W during normal activity, 25 W in low power mode, and 1.5 W when off (Kawamoto et al, 2001). As the power of processors has increased with each new generation of chips, maximum CPU power has risen as well. For example, the Intel P4 desktop processor, which is available at clock speeds ranging from 1.3 to 3.2 GHz, consumes significantly more power than the previous generation of desktop chips. Moreover the white box desk tops are likely to have higher power consumption as they apply standard power supplies that accommodate for a wide range of computer specifications (estimated at 60 – 80 watts).

Low-Power Desktop Computers

This guide considers low-power desktop computers to be those models with low-power CPUs and average power consumption between 20 W and 40 W, excluding the monitor. All-in-one desktops, in which the motherboard and an LCD monitor are integrated into a single casing, provide additional energy benefits because the LCD monitor uses the same power supply as the computer and therefore consumes less energy. Low-power desktops often include custom-built and off-the-shelf models based on the Mini-ITX or VIA EPIA series main boards. These computers are designed for industrial appliances and tend to be more expensive than standard desktop computers (both white box and branded ones). On the other hand for certain type they are available with a DC power supply making them suitable to power directly from batteries without the need to include an inverter. They can be built and customized to rugged type specifications. Fanless types include a large heat-sink that allows passive cooling and as such they use less power and are less prone to failure. Moreover, these computers are usually offered optionally to be outfitted with "extreme environment" spinning hard disks types to be able to withstand higher temperatures, or solid-state flash drives, which are particularly suitable options in the environment as found at the Aceh sites. In **Appendix 3** we list a number of *examples* of recommended types. These units can be ordered and configured **on-line** to customers' specifications. All units displayed in Appendix 3 are fanless and are specified to run Windows XP Professional as requested by EDC.

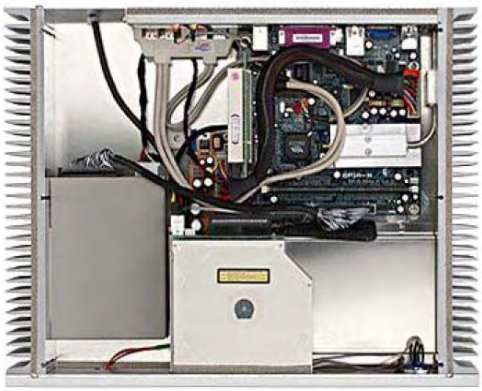


Figure 4: Inside a low power desk top (source: Hush Technologies)

Notebooks/Laptops

Notebook computers consume much less power than desktop systems. First, notebook computers use energy-saving LCD monitors. Second, the CPU, components and software in a notebook computer are designed to conserve power so as to maximize battery operation times. Third, notebooks use external power supplies that are much more efficient than the power supplies used in most desktop systems. When describing the power consumption of notebook computers, the power consumption of the monitor is automatically included because the display is integrated into the unit. The average power consumption of new notebook computers nowadays spreads over a range, from about 10 W to 50 W. Particular notebook models and power-saving technologies change rapidly in the fast-moving computer.

Notebooks based on Intel's Pentium M – which includes those labeled as Centrino technology advertise 4 to 5 hours on their main batteries. Using two batteries, some notebooks advertise battery life of up to 10 hours. Recent generations of mobile processors reduce power consumption by clocking down the processor frequency and stepping down the supplied voltage when battery life needs to be extended. When the system is idle or when the applications running on the notebook don't require maximum processor performance. When this happens the drain on the battery is reduced. Notebook power-saving technologies are frequently subject to user modification through the computer's power management settings. The user can choose settings that guarantee maximum processor performance, maximum battery life, or settings in between.

Especially in a rural setting in developing countries ample consideration should be given to the reliability requirements of laptops. Standard laptops are designed to operate in indoor environments where temperatures seldom exceed 30 Degrees Celsius and potential dust accumulation in-side the computer is a minor consideration. For rural applications ruggedness becomes a major consideration as service points are usually far and away. Most branded computers offer rugged types however at a premium. As these particular laptops are built to be used in both outdoor and indoor settings (and certainly not as a desktop replacement) they usually are efficient in power consumption as indicated by long autonomy times (examples of recommend types: **Appendix 4**)

Recommendations on-grid location SDN50

Winrock recommends fan-less, low power desktop computers with LCD screen for on-grid location "SDN50" for on the following grounds:

1. ***Its relatively low start up currents:***
   - Low capacity grid connection is adequate hence lower monthly fixed subscription cost
   - Lower capacity UPS system required hence lower UPS System capital cost

2. ***Its efficient use of power (average 40-50 watts)*** *:*
   - Total power consumption in kWh modest hence lower monthly variable electricity bill
   - Smaller battery capacity sufficient hence lower UPS system cost

3. ***Its Rugged and durable design:***
   - Changes of failure modest and as a result minimal down-time, maximum education up-time
   - Lower running cost

4. ***Its Desktop functionality:***
   - Stationary in one place and therefore more easy to secure than laptop / notebook

Recommendations off-grid location "Pulo Bungon"

Winrock recommends, one fan-less, low power desktop computers with LCD screen for off-grid location on following grounds:

1. ***Relatively low start up currents:***
   - Low capacity inverter is adequate hence lower system capital cost
   - Available in DC version and thus inverter could be omitted altogether

2. ***Efficient use of power (average 40-50 watts) :***
   - Total power consumption in kWh modest hence lower system *capital* cost
   - Smaller battery capacity sufficient and therefore lower system capital cost

3. ***Rugged and durable design***
   - Suitable for SDN 50 Pulo Bungon site which is hot, dusty and close to the sea
   - Chances of failure modest hence minimal down-time, maximum educational up time
   - Reliability is of paramount important especially in remote locations

4. ***Desktop functionality***
   - Stationary in one place hence much more easy to secure than laptop / notebook
   - Mobility not required for unit for teachers room to be used for Admin and preparation of lesson material

Winrock recommends also <u>one Laptop / notebook of the rugged type</u> for off-grid location on following grounds:

1. ***Very efficient use of power (average 20 watt) :***
   - Total power consumption in kWh modest hence lower system *capital* cost
   - Smaller battery capacity sufficient lower system capital cost

2. ***Rugged and durable design***
   - Suitable for SDN 50 Pulo Bungon site which is hot, dusty and close to the sea. Furthermore the unit will be moved around from class to class and therefore a strong and rugged design is highly desirable
   - Chances of failure modest hence minimal down-time, maximum educational up time
   - Virtually no maintenance and therefore low running cost

3. ***Laptop functionality***
   - Mobile with internal battery in line with planned activities require that the computer is used by all classes and there mobility is a key requirement

2.2.4 Printers

Considerations

The power consumption of devices in this category varies greatly by capacity and speed of printing/copying, type of technology and quality of output. As a general rule, ink jet printers typically consume significantly less energy than laser jet printers. Kawamoto et al (2001) reported stock-wide average power consumption of 17 W – 20 W for ink jet printers compared to 30 W for residential laser printers and 77 W for commercial laser printers. As with all consumer ICT devices, one must check the power consumption specifications for each particular model.

Recommendations

Winrock recommends to deploy ink jet printer to be deployed at both the on-grid as well as the off grid location primarily because of their low power consumption. With the many cartridge refill stations in Indonesia they are relatively cheap to run too. The standby current of the ink jet printer is a concern in the case of the off grid system and therefore clear guidelines should be provided denoting that the unit is only to be turned on when printing is required.

2.2.5 Television sets

Considerations

Television sets have no internal moving parts and are therefore very reliable. Although conventional television sets are built on the same CRT technology as standard computer monitors, television sets contain in-built tuners to receive and decode the television signals whereas computer monitors do not. Most standard television sets operate with AC power, although there are also television sets that operate directly on DC. Of the main TV display technologies, LCD televisions usually consume the least energy for a given screen size, followed by CRT tube displays, flat screen CRTs, plasma televisions, and LCD rear projection displays. Television sets with CRT picture tubes are by far the most common and least expensive units. In the table provides Winrock's recommendations for the level of power consumption by CRT color television sets that are appropriate for off-grid use. Turning on a TV set demands two or three times more power than is used during normal operation. If the inverter does not have enough starting capacity, it may be difficult to start up the television. Many television sets continue to consume electricity when they appear to be turned off, particularly those that have a remote control. One option is to use an inverter with a switch that cuts the power to the whole load. Most television sets have a "hard off" switch on the main body of the unit that disconnects the device from the external power supply, even though the TV power cord remains plugged in to the outlet.

Screen Size	Standard	Low Power Range
21 Inch	NTSC	60 – 70 Watt
26 Inch	NTSC	75 – 90 Watt
29 Inch	NTSC	100 – 120 Watt

Table 4: CRT Television sets and power consumption range

Recommendations

Winrock recommends a 29 Inch Television set to be deployed at the grid connected CRC "SDN 50" and a 26 Inch Television set at the off grid school "Pulo Bungon". It is furthermore recommended to measure the power consumption in stores to select a model with the lowest power consumption

2.2.6 Other Appliances

Considerations

The current drawn by Digital Still Cameras, DVD players are small and there is little variation from brand to brand. LCD projectors have high power consumption but as they are estimated to be used once a month their power consumption only marginally influences system requirements

Appliance	Estimated Power Consumption
Digital Still Camera's	5 - 10 Watt (for battery charging)
DVD players	15-25 Watt
LCD Projectors	200 - 300 Watt

Table 5: Other appliances, estimated Power Consumption

Recommendations

Winrock recommends all branded types Still Camera's, DVD and LCD projector and preferably those that have a service point in Banda Aceh.

3 Power System's design for on-grid and off-grid sites

3.1 Un-interruptible Power Supply System for SDN50

3.1.1 Load scenario and capacity design considerations

The Un-interruptible power supply system for SDN-50 assumes that the following appliances are to be backed up (as per recommendations):

- Four (4) CFL's with a power consumption of **11 watts**
- Five (5) **low power** desktop computers & LCD screen. Power consumption, maximum **70 watts**
- One (1) Ink Jet Printer with a power consumption of **20 Watt**
- One (1) 29 Inch color Television, with a power consumption **120 Watt**
- One (1) DVD player with a power consumption of **20 Watt**
- One (1) LCD projector, with a maximum power consumption of **300 Watt**
- One (1) Digital Still camera with a maximum power consumption of **10 Watt**

Load Factor Assumptions			Operational Hours during the day & load factor in (kW)											
Appliances	Power consumption kW / Unit	Number of Units	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 AM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM
Ambient Class Lighting, CFL	0.011	4	0	0	0	0	0	0	0	0	0	0.04	0.04	0.04
Desk Top Computers	0.070	5	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0	0	0
Ink Jet Printer	0.020	1	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0	0	0
TV, 29 Inch	0.120	1	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0	0	0
DVD Player	0.020	1	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0	0	0
LCD Projector	0.300	1	0	0	0	0.3	0	0	0	0	0	0	0	0
Still Camera	0.010	1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0	0	0
Input Scenario for Hourly Load factor (kW):			**0.52**	**0.52**	**0.52**	**0.82**	**0.52**	**0.52**	**0.52**	**0.52**	**0.52**	**0.04**	**0.04**	**0.04**

Table 6: Load scenario on grid site SDN50

UPS Sizing table				
No	**Description**	**Value**	**unit**	**Remarks**
1	Nominal Load	0.82	kW	Peak load of all applications (max load scenario)
2	Start up Surge factor	1.50	Max	Due to degaussing of CRT screen & inrush power supplies
3	Required Power capacity	1.23	kW	Equals Nominal load x Surge factor
4	PF of Applications ICT	0.65	Lagging	Result of switching power supplies on appliances
5	Capacity Requirement	1.89	kVA	Required Power Capacity / minimal input Pf
6	Back up requirement	4	hours	Covers the majority of power outages in Aceh
7	Max Dept of Discharge	70	%	Deeper discharge shortens battery life-time
8	Battery Capacity Ah requirement	195	Ah	Takes factors 1, 6, 7 into account and assumes **24 VDC**

Table 7: UPS Sizing

Conclusions and additional considerations:

1. With an safety factor of 10% a UPS capacity with 2000 VA capacity is recommended (PF out > 0.6)
2. To determine the required PLN connection capacity (in Amps rating) we need to take the lowest main voltage in account (+/- 160). The max current drawn then is 2000/160 = 12.5 Amps. In case a black-out has occurred, the UPS will need to re-charge batteries and at the same time maintain the load. If we assume that the UPS' rectifier current does not exceed 10% of the Ah battery capacity then an additional current of ((200 Ah*10%) * (24 VDC/160 VAC)) = 3 Amps. A total current of 12.5 + 3 = 15.5 Amps needs to be anticipated in the electrical installation.
3. A 24 VDC battery bank with a capacity of 195 Ah will provide a long autonomy of 4 hours at the assumed load. If the actual load is lower than then than obtained autonomy will become significantly longer (non linear discharge curve).The relative Depth Of Discharge (or DOD) has a profound influence on the cycle life of the batteries. It is expected that the batteries the batteries life time can last up to 10 years if blackouts are less frequent and for period short than it autonomy design (in this case 4 hours) .
4. Recommended batteries are Lead Acid, Industrial type vented, **deep-cycle** batteries (as opposed to stand-by type of batteries) are the cycle-life of these batteries is far superior from batteries designed for standby applications (these types of batteries are suitable in areas that have less frequent outages). All other types of batteries are less suited to tropical temperatures and would required air conditioning to ideally cool ambient temperature of 24 degrees Celsius.

Find below a simplified one line diagram of the UPS system proposed by Winrock for the CRC SDN50 at Banda Aceh.

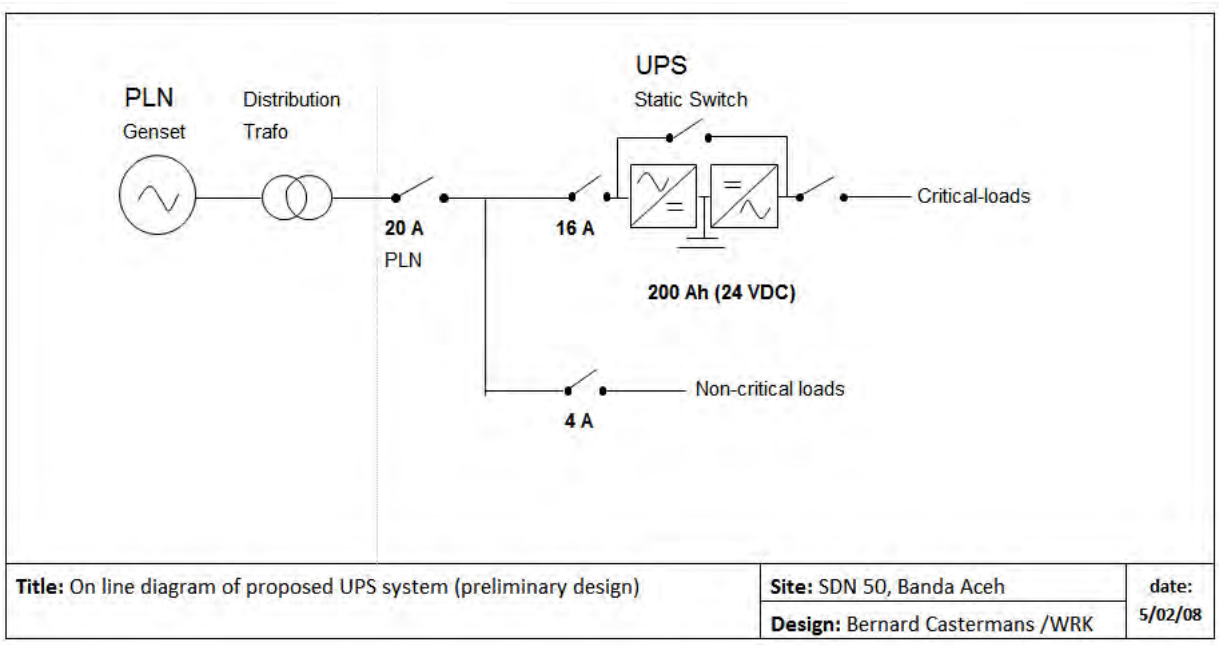


Figure 5: One line Diagram On-Grid System

3.1.2 UPS Type

There is little doubt that an **on-line type of UPS** is the right choice of Banda Aceh, prolonged brown-outs being the foremost reason. In addition it provides a formidable protection from other main pollutions (spikes in particular). The UPS type should be ruggedly build and able to withstand temperature up to 35 Degrees Celsius. For further discussion on the type of UPS, we refer to Site Assessment report (p29-32).

3.2 Designing an Photovoltaic Power Supply System for SDN Bungong

3.2.1 System design methodology using HOMER®

In order to achieve an optimal system a number of load scenarios are run with help of System Design Optimization software. The package that is used here is HOMER® that was developed by National Renewable Energy Laboratory (http://www.nrel.gov/homer/). It allows us to input different load scenarios, converter efficiencies, battery types and capacities, solar radiation contingencies and many other variables. In chapter 2 we looked at optimizing the load scenario by focusing on low power appliances. In this chapter power consumption and load scenarios are combined with the objective to design an optimized Solar Power Supply for SDN Pulo Bungon.

3.2.2 Optimized Load scenario

The table below shows the optimized load scenario as anticipated at the SDN Pulo Bungon. It is unlikely that the actual use of ICT's will follow this exact scenario; especially in the inception phase of the introduction of ICT most likely ICT use will be less intensive than portrayed here. As such it should be a safe (but not overly safe) approach to system design.

The methodology here is identical to the followed in the Site Assessment report. It only differs in the sense that the input data is more refined in terms of appliances used and respective power consumption figures. The load data obtained in this way has been loaded to the HOMER Simulation. APPENDIX I summarize the input data comprising (1) Load Scenario, (2) Component sizing to consider (3) Solar Resource (4) Economics (5) Constraints.

3.2.3 Homer Optimized System

The overall results can be found in Appendix 2. In the table below the proposed system specifications are outlined. Build to the specifications as below the system should run without power shortages throughout the whole year, provided that the load scenario is followed as outlined in table 8.

The overall results show that the configuration outlined in table has the lowest COE (Cost of Energy) and thus represents the optimum design at given inputs.

Load Factor Assumptions			Operational Hours during the day and load factor in (kW)											
Appliances	Load kW / Unit	No. of Units	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 AM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM
Premises Lighting & Other, CFL	0.009	3	0	0	0	0	0	0	0	0	0	0	0	0.03
Desk Top Computers w. LCD	0.070	1	0	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0	0	0
Laptop Computer	0.030	1	0	0	0	0.03	0.03	0.03	0	0	0	0	0	0
Other (1) Printer	0.020	1	0	0	0	0.02	0	0	0	0	0	0	0	0
TV, 26 Inch	0.090	1	0	0	0	0.09	0.09	0	0	0	0	0	0	0
DVD Player	0.015	1	0	0	0	0.02	0.02	0	0	0	0	0	0	0
Other: Digital Still Camera	0.010	1	0	0	0.02	0.02	0.02	0.02	0	0	0	0	0	0
Input Scenario for Hourly Load factor (kW):			**0**	**0.07**	**0.09**	**0.24**	**0.22**	**0.12**	**0.07**	**0.07**	**0.07**	**0**	**0**	**0.03**

Table 8: Load scenario off grid site Pulo Bungon

no	Component	Proposed Capacity	Estimated Cost /unit	Total cost
1	PV (Photovoltaic)	0.65 kW	US$ 6,500/kW	US$ 4,225
2	Batteries	12 Units/200 Ah/2V	US$ 360/unit	US$ 4,320
3	Inverter	0.5 kW	US$ 500/unit	US$ 500
4	Other (Balance of System)	-	-	US$ 3,000
	Total cost (estimated)			**US$ 12,045**

Table 9: Off grid Photovoltaic power system, capacity and estimated cost

Find below a simplified one line diagram of the autonomous Photovoltaic system as proposed by Winrock for the school SDN50 at Pidie Village.

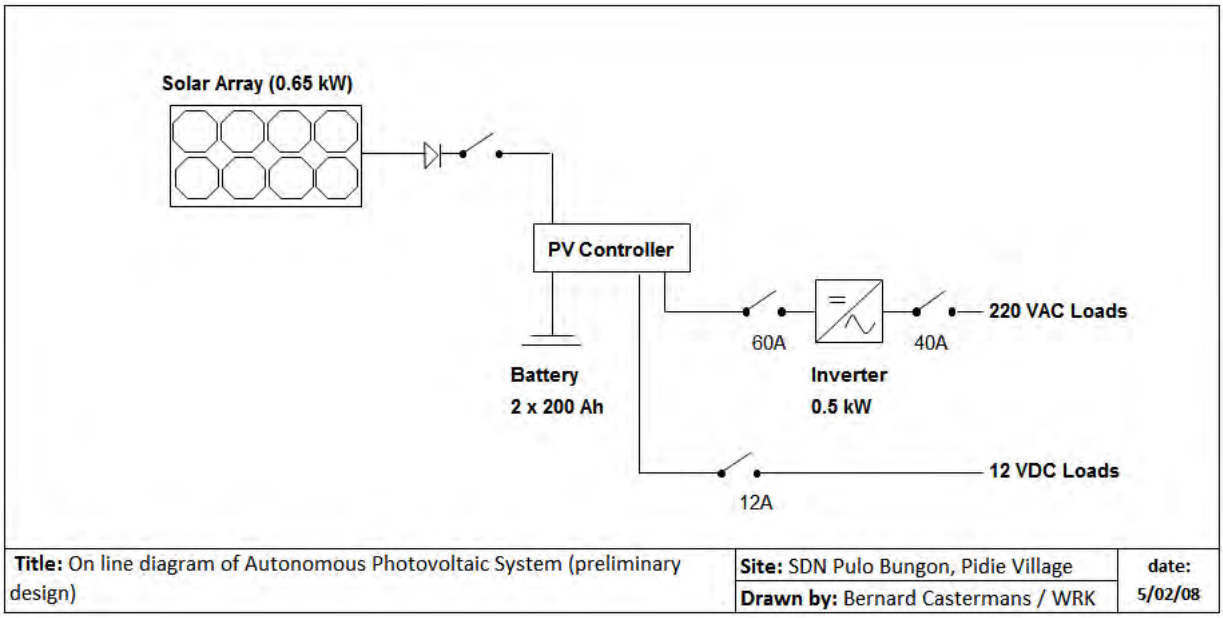


Figure 6: One line diagram Off-grid system

3.2.4 Component Specifications, detailed design and follow-up reporting

This report has focused mainly on system capacity optimization based on load assumptions and only modest attention was given to detailed component specifications (although examples of recommended applications and components were given in the appendices). The main objective of this report is to serve as a solid base for further detailed systems design that will go more into depth on the selection criteria for components that form bases for the tender documents.

These details will be outlined in a follow-up report that will be compiled after a second site survey is implemented by the Winrock Project team consisting of the project leader and an electrical engineer.

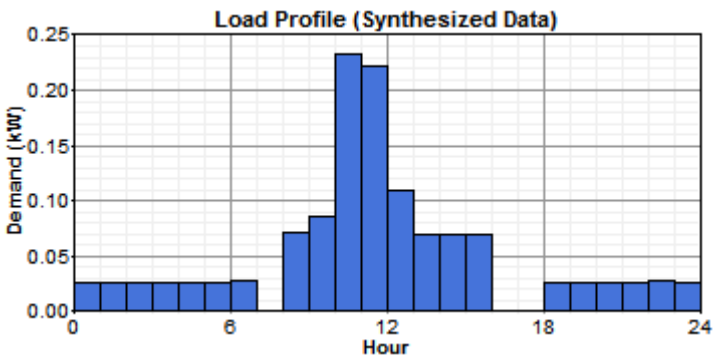
APPENDIX 1 (Homer Input Summary)

HOMER Input Summary

File name:	SND-Bungong-ReAss1min.hmr
File version:	2.63 beta
Author:	Bernard Castermans
Notes:	Optimized Load Scenario: - Low Power Desktop (8 hrs/d) - Printer (1 hrs/d) - Laptop (2hrs/d). - TV, DVD player; 2 hrs/d - Lighting of the premises 3 units of 9 watt/12 hrs

AC Load: Load Scenario

Data source:	Synthetic
Daily noise:	10%
Hourly noise:	25%
Scaled annual average:	1.28 kWh/d
Scaled peak load:	0.413 kW
Load factor:	0.129



PV

Size (kW)	Capital ($)	Replacement ($)	O&M ($/yr)
1.000	6,500	6,500	0

Sizes to consider:	0.25, 0.40, 0.50, 0.60, 0.65, 0.70, 0.80 kW
Lifetime:	20 yr
Derating factor:	90%
Tracking system:	No Tracking
Slope:	6 deg
Azimuth:	0 deg
Ground reflectance:	0%

Solar Resource

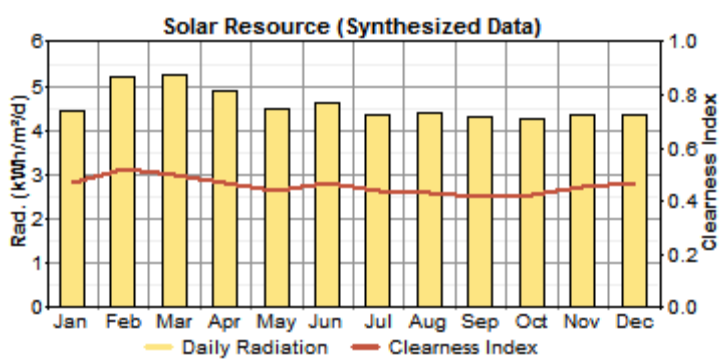
Latitude: 5 degrees 23 minutes North

Longitude: 95 degrees 54 minutes East

Time zone: GMT +7:00

Month	Clearness Index	Average Radiation
		(kWh/m^2/day)
Jan	0.470	4.449
Feb	0.522	5.208
Mar	0.503	5.234
Apr	0.472	4.917
May	0.443	4.471
Jun	0.467	4.603
Jul	0.437	4.345
Aug	0.429	4.387
Sep	0.416	4.296
Oct	0.426	4.281
Nov	0.456	4.354
Dec	0.468	4.332

Scaled annual average: 4.57, 3.50 kWh/m²/d



Battery: Hoppecke 4 OPzS 200

Quantity	Capital ($)	Replacement ($)	O&M ($/yr)
1	360	360	0.00

Quantities to consider: 6, 12, 24, 48, 72

Voltage: 2 V

Nominal capacity: 200 Ah

Lifetime throughput: 680 kWh

Converter

Size (kW)	Capital ($)	Replacement ($)	O&M ($/yr)
0.400	400	400	0
0.500	500	500	0
1.000	1,000	1,000	0
2.000	2,000	2,000	0

Sizes to consider: 0.3, 0.4, 0.5, 0.6, 0.7 kW

Lifetime: 10 yr

Inverter efficiency: 90%

Economics

Annual real interest rate: 15%

Project lifetime: 10 yr

Capacity shortage penalty: $ 0/kWh

System fixed capital cost: $ 3,000

System fixed O&M cost: $ 500/yr

Generator control

Check load following: No

Check cycle charging: Yes

Setpoint state of charge: 80%

Constraints

Maximum annual capacity shortage: 0%

Minimum renewable fraction: 0%

Operating reserve as percentage of hourly load: 10%

Operating reserve as percentage of peak load: 0%

Operating reserve as percentage of solar power output: 0%

Operating reserve as percentage of wind power output: 0%

APPENDIX 2 (Homer Overall Results)

PV (kW)	Batt	Conv(kW)	Initial cap	Operating cost ($/yr)	Total NPC	COE ($/kWh)	Renewable fraction	Batt. Lf. (yr)
0.65	12	0.5	$ 12,045	290	$ 13,498	5.759	1.00	20.0
0.65	12	0.6	$ 12,145	290	$ 13,598	5.802	1.00	20.0
0.70	12	0.4	$ 12,270	282	$ 13,683	5.836	1.00	20.0
0.65	12	0.7	$ 12,245	290	$ 13,698	5.844	1.00	20.0
0.70	12	0.5	$ 12,370	282	$ 13,783	5.879	1.00	20.0
0.70	12	0.6	$ 12,470	282	$ 13,883	5.921	1.00	20.0
0.70	12	0.7	$ 12,570	282	$ 13,983	5.964	1.00	20.0
0.80	12	0.4	$ 12,920	266	$ 14,253	6.079	1.00	20.0
0.80	12	0.5	$ 13,020	266	$ 14,353	6.121	1.00	20.0
0.80	12	0.6	$ 13,120	266	$ 14,453	6.164	1.00	20.0
0.80	12	0.7	$ 13,220	266	$ 14,553	6.206	1.00	20.0
0.60	24	0.4	$ 15,940	191	$ 16,900	7.208	1.00	20.0
0.60	24	0.5	$ 16,040	191	$ 17,000	7.250	1.00	20.0
0.60	24	0.6	$ 16,140	191	$ 17,100	7.293	1.00	20.0
0.65	24	0.4	$ 16,265	183	$ 17,184	7.329	1.00	20.0
0.60	24	0.7	$ 16,240	191	$ 17,200	7.335	1.00	20.0
0.65	24	0.5	$ 16,365	183	$ 17,284	7.371	1.00	20.0
0.65	24	0.6	$ 16,465	183	$ 17,384	7.414	1.00	20.0
0.70	24	0.4	$ 16,590	175	$ 17,469	7.451	1.00	20.0
0.65	24	0.7	$ 16,565	183	$ 17,484	7.457	1.00	20.0
0.70	24	0.5	$ 16,690	175	$ 17,569	7.493	1.00	20.0
0.70	24	0.6	$ 16,790	175	$ 17,669	7.536	1.00	20.0
0.70	24	0.7	$ 16,890	175	$ 17,769	7.578	1.00	20.0
0.80	24	0.4	$ 17,240	159	$ 18,039	7.693	1.00	20.0
0.80	24	0.5	$ 17,340	159	$ 18,139	7.736	1.00	20.0
0.80	24	0.6	$ 17,440	159	$ 18,239	7.779	1.00	20.0
0.80	24	0.7	$ 17,540	159	$ 18,339	7.821	1.00	20.0
0.50	48	0.4	$ 23,930	-6	$ 23,902	10.194	1.00	20.0
0.50	48	0.5	$ 24,030	-6	$ 24,002	10.236	1.00	20.0
0.50	48	0.6	$ 24,130	-6	$ 24,102	10.279	1.00	20.0
0.50	48	0.7	$ 24,230	-6	$ 24,202	10.322	1.00	20.0
0.60	48	0.4	$ 24,580	-22	$ 24,472	10.437	1.00	20.0
0.60	48	0.5	$ 24,680	-22	$ 24,572	10.479	1.00	20.0
0.60	48	0.6	$ 24,780	-22	$ 24,672	10.522	1.00	20.0
0.65	48	0.4	$ 24,905	-30	$ 24,757	10.559	1.00	20.0
0.60	48	0.7	$ 24,880	-22	$ 24,772	10.565	1.00	20.0
0.65	48	0.5	$ 25,005	-30	$ 24,857	10.601	1.00	20.0
0.65	48	0.6	$ 25,105	-30	$ 24,957	10.643	1.00	20.0
0.70	48	0.4	$ 25,230	-38	$ 25,041	10.680	1.00	20.0
0.65	48	0.7	$ 25,205	-30	$ 25,057	10.686	1.00	20.0
0.70	48	0.5	$ 25,330	-38	$ 25,141	10.722	1.00	20.0

APPENDIX 3 (Recommended Low Power Desktop Computers)

1. Logic Supply (US Brand)

PRODUCT(S)	MODEL	DESCRIPTION	QTY.	TOTAL
	SystemGS-L08	**SolidLogic GS-L08 Fanless Pico-ITX System** *** *- Mainboard: EPIA PX10000G 1 GHz* *- Case: Serener GS-L08 Fanless Pico-ITX Case - Black* *- Memory: DDR2 667 SODIMM 512MB* *- Hard Disk/Flash: 2.5" Seagate EE25 Extreme Environments 5400rpm 40GB* *- A/C Adapter (brick): A/C Power Adapter 60W (PW-AC 60W)* *- Operating System: Windows XP Pro (requires hard disk)* *- Build and Test: Build & Test: Fanless - Standard (3-5 full business days)*	1	**$867.00**

Sub-Total: $867.00

Supplier Data:

Business Development
harold.skorstad@logicsupply.com
802.861.2300 ext. 426
802.660.2898 (fax)
www.logicsupply.com
35 Thompson Street
South Burlington, Vt. 05403

2. AAEON (Taiwan)

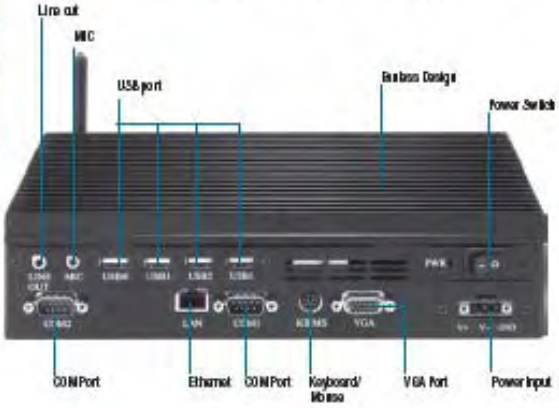
TKS Chassis Series

TKS-G20

AAEON®

Computing Platform Service Partner

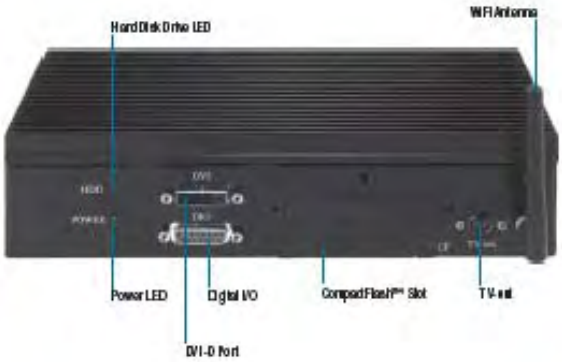
Fanless Chassis Kit for SubCompact Boards



Features

- *Fanless Design*
- *VGA/ DVI (Optional)/ TV-out (Optional)*
- *2.5" Hard Disk Drive and CompactFlash™*
- *802.11b/g WiFi (Optional)*
- *2 COM/ 4 USB/ 8 Digital I/O*
- *Built-in AC-in or DC-in Power Supply*
- *Desktop or Wallmount (Optional)*

CE FC



Specifications

System		
CPU Board Support		GENE-9510 with Low Power Processor / GENE-8510
Display	VGA	D-Sub 15 x 1
	TV-out	S-Video x 1 (optional)
	DVI	DVI-D x 1 (optional)
Storage	SSD	Type II Compact flash ™ slot x 1
	HDD	2.5" Hard Disk Drive Bay x 1
LAN	Ethernet	RJ-45 x 1
	Wireless	802.11b/g WiFi Kit (optional)
System I/O	PS/2 Port	PS/2 x 1 for keyboard and mouse through Y-cable
	Serial Port	D-Sub 9 x 2
	USB Port	USB Type A x 4
	Digital I/O	8-bit programmable (optional)
	Audio	Line-out, Mic
LED Indicator		Power LED x 1, HDD LED x 1
Power Supply	DC Input	AT or ATX type, -48V ~ +30V Input
	AC Input	AT type, 100V ~ 240V Input
System Cooling		Fanless
Mechanical & Environmental		
Operating Temperature		32°F ~ 104°F (0°C ~ 40°C)
Vibration		0.5g rms/5~500Hz/random operation
EMC		CE/FCC class A
Dimensions		10" x 5.75" x 2.48" (254mm x 146mm x 63mm)
Construction		Heavy duty steel
Mounting		Desktop or Wallmount (Optional)
Color		Black

Ordering Information

- TF-TKS-G20-8310-002-DX/DT/AT
  Fanless Chassis Kit, GENE-8310-A11, Celeron M 1.0GHz (DX: DC-ATX / DT: DC-AT / AT: AC-AT)
- TF-TKS-G20-8310-003-DX/DT/AT
  Fanless Chassis Kit, GENE-8310-A11, Celeron M 1.3GHz(DX: DC-ATX / DT: DC-AT / AT: AC-AT)
- TF-TKS-G20-8310-004-DX/DT/AT
  Fanless Chassis Kit, GENE-8310-A11, Celeron M 1.5GHz (DX: DC-ATX / DT: DC-AT / AT: AC-AT)

Optional Accessories

- 9761G50000
  Wallmount Kit
- 9741666646
  802.11b/g Wireless LAN Kit

PT. MOSCADS EXOUSIA
Jl. P. Jayakarta 135 No. C5
Jakarta Pusat 10730
Phone: +62 21 6259441
Fax: +62 21 6595277

Url: www.moscads.co.id

3. Orbit Supply (US Brand)

NICE 3100 Industrial Fanless Pentium M System with Dual Video Output and PCI Expansion
Part Number: NICE 3100(LP)

Price as Configured
$1,183.40

Corporate Office
Orbit Micro Corporation
1302 Exchange Dr. Suite #100
Richardson, TX 75081
Phone: US 1-877-722-1116
International 1-469-916-8318

Overview | Specifications | Gallery

NICE 3100

Highlighted Items are Optional

Processor & Chipset	
CPU Socket	Micro-FCPGA 478 Socket
System Bus	400 MHz system bus
Processor	Intel Celeron M 600MHz processor w/ 512KB L2 Intel Pentium M 1.6GHz Processor Intel Pentium M 1.5GHz Processor
Number of CPUs (std/max)	1/1
Processor Cooling	Fanless
Chipset	• Intel® 852GME • Intel® I/O Controller Hub 4 (ICH4)
Memory	
Memory Capacity	Up to 2GB of unbuffered, non-ECC Dual Channel DDR 200/266MHz SDRAM memory
Memory Sockets	2x 184pin DIMM socket
DIMM Sizes	128MB, 256MB, 512MB, 1GB
Standard / Integrated Devices	
Graphics	• Intel® 852GM integrated graphics solution w/ Intel® Extreme Graphics 2 technology, Up to 64 MB of dynamic video memory allocation • DB-15 connector for Analog VGA display Resolution up to 1600 x 1200 • External DVI interface (DVI controller Chrontel CH7009) Internal 1x 34-pin box header Resolution up to 1600 x 1200 • LVDS interface: 1 x DB44 connector for external connection Support 18/24/36bit panel up to resolution 1600 x 1200 • TV-out interface: (TV controller Chrontel CH7009) 1 x 7-pin Mini-Din Resolution up to 1024 x 768
Network Controllers	2x Intel 82551QM 10/100 Fast Ethernet controllers, supports PXE LAN Boot
Audio	AC' Codec Realtek ALC655
Digital I/O	4-bit TTL input, 4-bit TTL output (TTL level: 0 - 5 V)

BIOS	• Award System BIOS • 4 Mbit flash ROM
System Monitor	Monitoring of voltage, 3 x temperature and 3 x fans
Watchdog Timer	Watchdog timeout can be programmed by software from 1 second/min. to 128 Sec/min. (from GAL)
I/O Ports	
Front Panel I/O Ports	2x USB 2.0 Port
Rear Panel I/O Ports	1x PS/2 Keyboard 1x PS/2 Mouse 4x USB 2.0 ports 2x Ethernet interface (10/100 BASE-T RJ-45) 1x DB-44 connector with external cable to convert to 4 serial COM ports (Three RS232 and One RS232/422/485) 1x Parallel Port 1x DB-15 VGA port 1x DVI interface 1x S-Video TV-Out 1x 1/8" analog Speaker out jack 1x 1/8" analog line Mic-in jack 1x 2-pin connector output for external power on/off switch
Internal I/O	1x 44-pin IDE port 1x Floppy Connector 1x CompactFlash Socket GPIO: 4-bit TTL input, 4-bit TTL output (TTL level: 0 - 5 V)
Expansion Slots	
Supported Bus Interface	1x 32-bit 5V PCI Slot Max Card Length is 160mm with notebook hard drive Max Card Length with no hard drive is 240mm
Storage and Media	
Number of hard drives supported	1x 2.5" IDE Notebook Hard Drive
Interface type supported	IDE
Storage Controllers	Intel 852GM
Solid State Storage	One Compact Flash Slot Available
Chassis and Power Supply	
Case Material	Aluminum chassis with fan-less design
Form Factor	Nano System
Total # of Drive Bays	Internal 2.5" Bays 1
System Cooling	Processor cooled by chassis enclosure
Chassis Dimensions (w x h x d)	195mm x 80mm x 268mm 7.78" x 3.15" x 10.55"
External Power Adapter	Input 100 to 240V AC Output 24VDC
Internal DC Power Convertor	Input Voltage 12 - 30 VDC Output Power 120W
Environment	
Operating temperature With Air Flow	0° C to 40° C (32° F to 104° F) 10% to 90% relative humidity, noncondensing

APPENDIX 4 (Recommended Laptop Computers)

1. Dell ATG Rugged Laptop (US Brand)

capability for additional bandwidth & performance, reduced power consumption and scalability to help increase performance with processor & chipset bus architecture.

Maximum Memory:
Supports up to 4GB DDR SDRAM shared[6] 667MHz

The GMA X3100 graphics core is an intelligent and responsive graphics engine built into the chipset that is on the motherboard. This integration provides incredible visual quality, faster graphics performance and flexible display options.

Chassis Ports

Front: Power, WiFi, HDD, Bluetooth & battery status Indicators, keyboard status indictors, volume Controls

Left Side: Security lock, Headphone/Speaker out, 1394 port, PCMCIA slot, Smart Card Reader slot, WiFi Cather, Primary HDD

Right Side: 2 USB 2.0, Media bay supports Latitude D/Family devices pr secondary battery

Back: RJ45, RJ11, 2 USB 2.0, Serial, VGA, DC Power In

Battery: Primary 6-cell/56 WHr "Smart"Li-Ion battery featuring ExpressCharge™, Primary 9-cell/85 WHr "Smart"Li-Ion battery Secondary 6-cell/56 WHr "Smart"Li-Polymer battery featuring ExpressCharge™

Dimensions: 1.74"/44.09mm x 13.46"/342mm x 9.44"/240mm

Weight: 6.34lbs[3] with 6-cell battery and CD-ROM (depends on configuration and manufacturing variability) –preliminary weight

Additional Features

POWER:
Power Supply:
65 Watt or 90 Watt AC adapter with cord wrapping
Batteries featuring ExpressCharge™ :
Primary 4-cell/32 WHr
Primary 6-cell/56 WHr
Primary 9-cell/85 WHr with 90 watt AC adapter
Secondary 6-cell/48 WHr "Smart" Li-Polymer battery

WEIGHT & DIMENSIONS:
Starting at: 6.34 lbs/2.71 kg
Width: 13.16"/342mm
Depth: 9.44"/240mm
Height: 1.74"/44.09mm

CONNECTIVITY:
Wired:
Wired: 56K v924 Internal Modem 10/100/1000 Gigabit[4] Ethernet network interface adaptor
Wireless:
Dell Wireless 5520 Mobile Broadband (Tri-band HSDPA 3.6) Mini-Card with service from AT&T (US) and Vodafone (select countries in Europe) Dell Wireless 5720 Mobile Broadband (EVDO Rev A) Mini-Card with service from Verizon Wireless (US) and Sprint (US)
WLAN
Dell Wireless 1390 (802.11g); Dell Wireless 1490 (802.11a/g); Dell Wireless 1505 (802.11a/g/Draft n); Intel PRO/Wireless 3945AG (802.11a/g); Intel PRO/Wireless 4965AGN (802.11a/g/ Draft n) Mini-Cards, Dell Wireless 360 Bluetooth 2.0 internal wireless card (upgradeable to Bluetooth 2.1 EDR) (optional).

EXPANDABILITY:
PC Card:
One Type I or Type II
Supports 34mm ExpressCard via USB interface through PCMCIA adapter
Ports:
Serial, docking connector, 4 USB, VGA, headphone/speaker out, RJ-11, RJ-45, AC power, integrated microphone
Docking:
D/Port, D/Dock, D/View Notebook Stand, D/Monitor Stand
Modular Options:
DVDROM, 24X CD-ROM, 8X DVD +/-RW[5], 24X CDRW/DVD, Floppy Disk Drive, Secondary 6-cell battery, 80GB[1] Hard Drive or Travel Lite Module

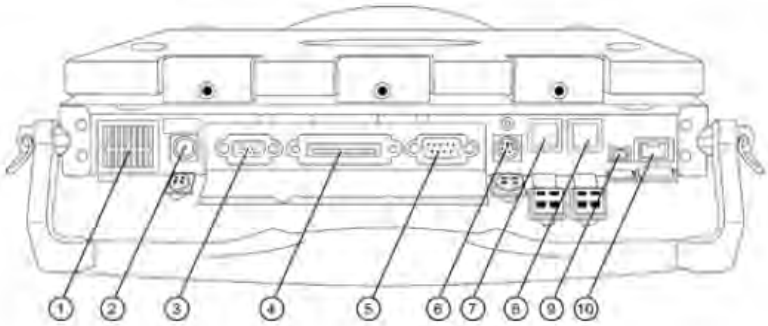
SECURITY:
Physical Security:
Cable Lock Slots, Media Module and Hard Drive Locks.
User & System Security:
Integrated Smart Card Reader, Trusted Platform Module 1.2 and optional UPEK™ finger print reader. Wave Embassy® Trust Suite by Wave Systems security software.
Network Security:
802.11 WiFi Protected Access (WPA), 802.11i (WPA2), 802.1x with EAP modes, Single Sign On and compatible CCX 4.0

PT. Mitra Integrasi Informatika
Wisma Metropolitan I, 16th floor
Jl. Jend. Sudirman Kav. 29-31
Jakarta 12920
DID 021-5754977
Ph. 021-2511360 ext. 2465
Mobile 08129171500
Fax 021-2512748
Email Daisy.Taslim@metrodata.co.id

2. Hewlett Packard Rugged Laptop (US Brand)

HP nr3610 Rugged Notebook PC

Overview



1. Cooling Fan
2. Power Jack
3. 15-Pin VGA Port
4. 68-Pin Multi-IO Port
5. 9-Pin Serial Port
6. PS2 Port
7. RJ-11 Modem Jack
8. RJ-45 Network Jack
9. IEEE 1394 Port
10. USB 2.0 Port

NOTE: This document covers features which could potentially be found in this notebook platform, please see sku specific information on what specific features are found in the standard models that HP offers.

At A Glance

- Genuine Windows XP Professional Edition.
- Die-cast magnesium for all structural components.
- 12.1" TFT XGA Outdoor transmissive display with Touchscreen.
- Shock mounted standard 40GB Ruggedized removable hard disk drive.
- Mobile Intel® Pentium® -M Processor 745 (1.8 GHz clock speed, 2MB L2 cache, and 400MHz FSB.)
- Up to 3 RF modems can be integrated at one time. Combinations of GPRS, Wireless WAN (CDMA, EDGE), Wireless LAN, or Bluetooth.
- 512 up to 2048MB PC2700DDR SDRAM supported in two SODIMM slots.
- GPS optional - mounted in the top edge of the display for optimum performance.
- Swappable media bay accepts internal 24X CD-ROM, 8X DVD-ROM, DVD/CDRW combo, second battery or 3.5" floppy disk drive.
- ATI MOBILITY™ RADEON™ 9000 with on chip 64MB DDR SDRAM and 128 bit memory bandwidth.
- 56K Kbps high speed fax/modem MDC module and 10/100M bit Ethernet LAN standard.
- Complete set of system ports.
- Multi I/O port allows for system expansion with docking solutions (parallel, serial, USB, 10/100Mb LAN.)
- Weighs 8.2 lb (3.7 kg) (Base Configuration.)
- Protected by a three-year warranty - certain restrictions and exclusions apply.

What's Special

- Meets the rigid military standard (MIL STD 810F) and complies with Ingress Protection rating of IP54 for dust and rain.
- Common Radio Module Architecture (CRMA™) with fully integrated, rugged, user replaceable radio modules. Supports PCMCIA and OEM radio modules.
- Fully waterproof NiteVue® glow-in-the-dark keyboard, constructed from phosphorescent plastic.
- Vehicle docking, power, and antenna solutions.
- Two integrated pointing devices include passive Touchscreen and Touchpad.
- Backlit keyboard with adjustable brightness (optional.)

PT Hewlett-Packard Indonesia
Menara Danamon 23th Floor
Jl.Prof.Dr.Satrio Kav E4/6 - Mega Kuningan
Jakarta 12950
Phone: 62-21-57991088 / 8777
Fax: (021) 57991578

APPENDIX 5 (Recommended UPS Systems)

1. Acumentrics Rugged UPS (US Brand)

Acumentrics
Trusted Power Innovations

Rugged-UPS™ 2500Ri
International Model

INTERNATIONAL RUGGED SERIES

The Acumentrics **Rugged UPS™ 2500Ri (International Model)** is designed for worldwide deployment in harsh physical and electrical environments.

Our **Rugged UPS™ 2500Ri** is uniquely suited for use in demanding remote and mobile applications.

The **Rugged UPS™ 2500Ri** provides 2500VA of nominal 230VAC / 50Hz output from an input range of 80-265 VAC / 47-400Hz. This wide voltage and frequency tolerance enables users to power up with field generators in any international power standard. Customers can also choose a 24VDC output option.

Our durable and versatile UPS system contains advanced on-line technology to provide highly reliable power back-up and conditioning for the most sensitive electronic devices.

FEATURES:

Flow Through Design
A unique heatsink tunnel design provides maximum cooling while sealing components from the damaging effects of moisture, airborne particles, and other contaminates in the operating environment.

Power Factor Corrected, Wide Input
The **Rugged-UPS™** accepts a wide range of voltage and frequency inputs while providing seamless active power-factor correction and clean, reliable AC power.

On-line
This true on-line, double conversion uninterruptible power supply continually creates a pure sine wave AC output from a DC bus, thus protecting sensitive equipment from surges, spikes, brownouts, blackouts, and noise.

User-Replaceable Battery Pack
Zero-maintenance, valve-regulated lead acid batteries are enclosed in a user-replaceable battery pack for rapid, hot-swap field replacement.

Aluminum Chassis
The **Rugged-UPS™** is housed in a compact, lightweight chassis. All aluminum, welded construction allows overall weight of the unit to be minimized while still maintaining high durability.

Wide Operating Temperature Range
A rated operating temperature range of -18°C to +50°C (0°F – 122°F) makes this UPS the product of choice for extreme environments.

Acumentrics Corporation
20 Southwest Park
Westwood, MA 02090
Tel: 800-332-0277
FAX: 781-461-1261
www.acumentrics.com

APPENDIX 6 (Recommended Batteries)

1. Exide Marathon (US/European Brand)

MARATHON™

Industrial Batteries – Network Power
Marathon L
Reliable and safe energy in long-term storage.

Specifications

EXIDE TECHNOLOGIES
INDUSTRIAL ENERGY

Type	Part number	Nominal voltage	Capacity			Length* (l)	Width* (b/w)	Height* (h)	Weight	Internal resistance acc. to IEC 896-2	Terminal
			C_{20} 1.8 V/C 20°C	C_{10} 1.8 V/C 20°C	C_1 1.6 V/C 20°C						
	Standard	V	Ah	Ah	Ah	mm	mm	mm	approx. kg	m Ω	
L12V15	NALL120015HM0MA	12	14.4	14.0	9.9	181	76	167	6.5	14.00	M-M6
L12V24	NALL120024HM0MA	12	24.0	23.5	15.8	168	127	174	9.5	10.00	M-M6
L12V32	NALL120032HM0MA	12	33.0	31.5	21.4	198	168	175	13.5	8.00	M-M6
L12V42	NALL120042HM0MB	12	44.0	42.0	29.4	234	169	190	18.5	7.00	M-M6
L12V55	NALL120055HM0MB	12	58.0	55.0	36.0	272	166	190	22.0	5.80	M-M6
L12V80	NALL120080HM0MA	12	84.0	80.0	51.2	359	172	226	30.0	4.20	M-M8
L6V110	NALL060110HM0MA	6	118.0	112.0	75.5	272	166	190	23.0	1.60	M-M8
L6V160	NALL060160HM0MA	6	170.0	162.0	111.5	359	171	226	31.5	1.30	M-M8
L2V220	NALL020220HF0MA	2	236.0	220.0	150.0	208	135	282	16.0	0.35	M-M12
L2V270	NALL020270HF0MA	2	289.0	270.0	183.0	208	135	282	18.3	0.28	M-M12
L2V320	NALL020320HF0MA	2	346.0	320.0	225.0	208	201	282	24.2	0.22	2xM-M12
L2V375	NALL020375HF0MA	2	404.0	375.0	262.0	208	201	282	26.5	0.18	2xM-M12
L2V425	NALL020425HF0MA	2	456.0	425.0	291.0	208	201	282	28.8	0.15	2xM-M12
L2V470	NALL020470HF0MA	2	507.0	470.0	324.0	208	270	282	32.6	0.14	2xM-M12
L2V520	NALL020520HF0MA	2	559.0	520.0	357.0	208	270	282	35.0	0.13	2xM-M12
L2V575	NALL020575HF0MA	2	618.0	575.0	394.0	208	270	282	37.3	0.11	2xM-M12

* +/-1mm

Discharge figures are also valid for UL 94-V0 version. Change "H" to "V" in the part number.
E.g.:
Standard *NALL120015HM0MA*
UL 94-V0 *NALL120015VM0MA*

Container, terminal and torque

Container: UL 94-HB
= Polypropylene (PP)

UL 94-V0
= Polypropylene (PP)

6 Nm 8 Nm 20 Nm

2. Exide Classic OPzS Vented (US/European brand)

Classic™

Industrial Batteries – Standby Power
Classic OPzS
Energy storage for economical safety.

Specifications

EXIDE TECHNOLOGIES

Type	Part number Standard	Nominal voltage V	Capacity C_{20} 1.8 V/C 20°C Ah	C_{10} 1.8 V/C 20°C Ah	C_1 1.6 V/C 20°C Ah	Length* (l) mm	Width* (b/w) mm	Height* (h) mm	Weight approx. kg	Internal resistance acc. to IEC 896-2 m Ω	Terminal
L12V15	NALL120015HM0MA	12	14.4	14.0	9.9	181	76	167	6.5	14.00	M-M6
L12V24	NALL120024HM0MA	12	24.0	23.5	15.8	168	127	174	9.5	10.00	M-M6
L12V32	NALL120032HM0MA	12	33.0	31.5	21.4	198	168	175	13.5	8.00	M-M6
L12V42	NALL120042HM0MB	12	44.0	42.0	29.4	234	169	190	18.5	7.00	M-M6
L12V55	NALL120055HM0MB	12	58.0	55.0	36.0	272	166	190	22.0	5.80	M-M6
L12V80	NALL120080HM0MA	12	84.0	80.0	51.2	359	172	226	30.0	4.20	M-M8
L6V110	NALL060110HM0MA	6	118.0	112.0	75.5	272	166	190	23.0	1.60	M-M8
L6V160	NALL060160HM0MA	6	170.0	162.0	111.5	359	171	226	31.5	1.30	M-M8
L2V220	NALL020220HF0MA	2	236.0	220.0	150.0	208	135	282	16.0	0.35	M-M12
L2V270	NALL020270HF0MA	2	289.0	270.0	183.0	208	135	282	18.3	0.28	M-M12
L2V320	NALL020320HF0MA	2	346.0	320.0	225.0	208	201	282	24.2	0.22	2xM-M12
L2V375	NALL020375HF0MA	2	404.0	375.0	262.0	208	201	282	26.5	0.18	2xM-M12
L2V425	NALL020425HF0MA	2	456.0	425.0	291.0	208	201	282	28.8	0.15	2xM-M12
L2V470	NALL020470HF0MA	2	507.0	470.0	324.0	208	270	282	32.6	0.14	2xM-M12
L2V520	NALL020520HF0MA	2	559.0	520.0	357.0	208	270	282	35.0	0.13	2xM-M12
L2V575	NALL020575HF0MA	2	618.0	575.0	394.0	208	270	282	37.3	0.11	2xM-M12

* +/-1mm

Discharge figures are also valid for UL 94-V0 version. Change "H" to "V" in the part number.
E.g.:
Standard NALL120015HM0MA
UL 94-V0 NALL120015VM0MA

Container, terminal and torque

Container: UL 94-HB
= Polypropylene (PP)

UL 94-V0
= Polypropylene (PP)

6 Nm 8 Nm 20 Nm

3. Hoppecke (German brand, manufactured in Indonesia under license)

Telecom/IT Battery Systems
AGV Battery Systems
Motive Power Systems
Railway Battery Systems
Power Supply
Standby

OPzS
Vented lead-acid battery

Product features
➪ customer benefits

- ❑ Tubular plate
  - ➪ long life in cyclic operation
- ❑ DIN product of up-to-date design
  - ➪ compatibility with existing installations
- ❑ Composite terminal / system connector
  - ➪ no corrosion
  - ➪ prevents short-circuits even during installation
- ❑ AquaGen® recombinator
  - ➪ extremely long intervals between topping-up with water, even total freedom from maintenance

Applications

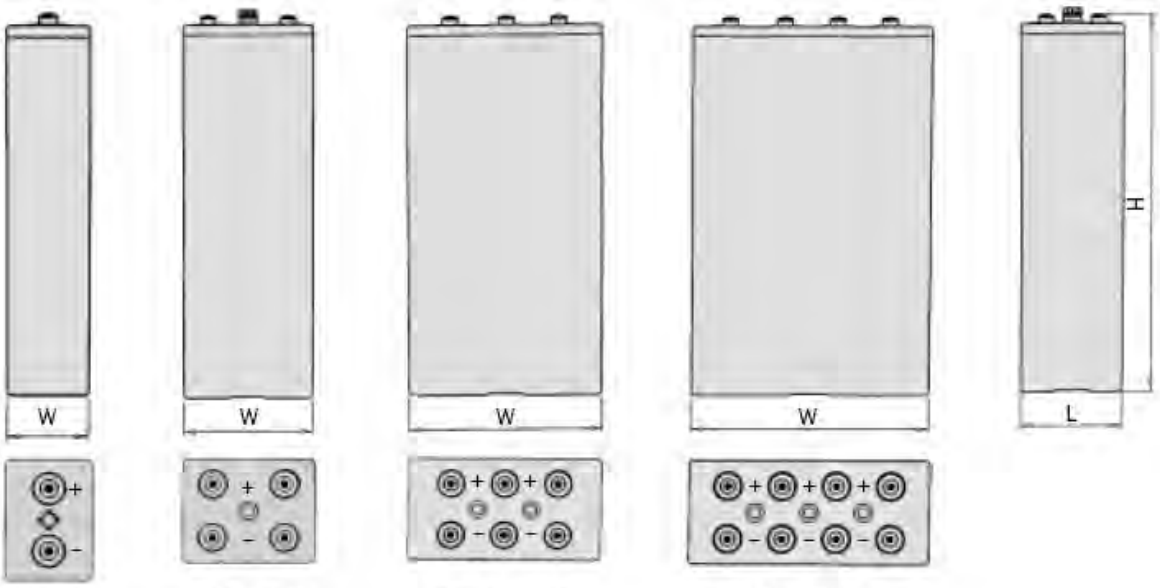
- ❑ IT/Telecom
- ❑ Security lighting
- ❑ Solar

HOPPECKE
POWER FROM INNOVATION

OPzS Type Overview

Capacities, Dimensions and Weights

Type	C_{10}/1.80 V Ah	C_5/1.77 V Ah	C_3/1.75 V Ah	C_1/1.67 V Ah	Weight kg	Weight of electrolyte (density 1.24 kg/l) kg	Length L mm	Width W mm	Height H mm
4 OPzS 200	200	174	150	107	17.2	4.9	208	105	420
5 OPzS 250	250	221	189	135	20.8	6.1	208	126	420
6 OPzS 300	300	262	225	161	24.3	7.2	208	147	420
5 OPzS 350	370	318	270	195	26.9	7.9	208	126	535
6 OPzS 420	450	385	324	234	31.5	9.4	208	147	535
7 OPzS 490	520	446	378	273	36.1	10.9	208	168	535
6 OPzS 600	610	523	453	324	44.8	12.9	208	147	710
8 OPzS 800	810	698	603	432	61.3	16.9	215	193	710
10 OPzS 1000	1010	872	753	541	74.6	21.1	215	235	710
12 OPzS 1200	1210	1047	903	649	88.0	25.5	215	277	710
12 OPzS 1500	1530	1313	1146	796	114.3	34.2	215	277	855
16 OPzS 2000	2030	1749	1527	1061	151.5	48.0	215	400	815
20 OPzS 2500	2540	2185	1908	1326	193.0	68.0	215	490	815
24 OPzS 3000	3050	2621	2289	1591	246.0	76.0	215	580	815



4 OPzS 200 - 6 OPzS 600 | 8 OPzS 800 - 12 OPzS 1500 | 16 OPzS 2000 | 20 OPzS 2500 - 24 OPzS 3000

Life expectancy: up to 15 years
Suitable for cycling: up to 1500 discharges 80% DOD

Sales and Administration
HOPPECKE Batterien GmbH & Co. KG
P.O.Box 1140 · D-59914 Brilon
Bontkirchener Straße 1 · D-59929 Brilon-Hoppecke
Phone + 49 29 63 61-3 74 · Fax + 49 29 63 61-2 70
www.hoppecke.de · info@hoppecke.com

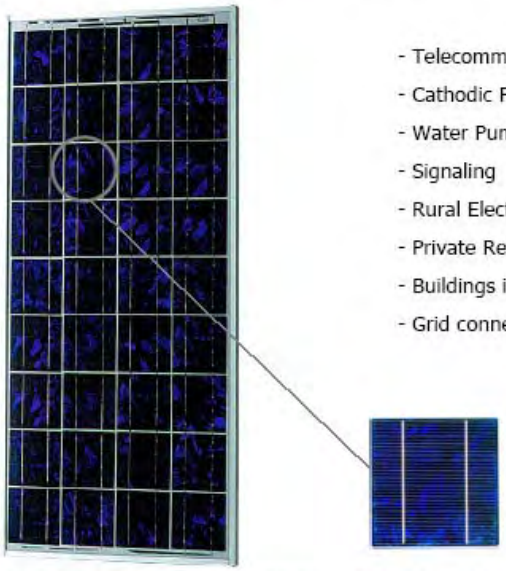
HOPPECKE
POWER FROM INNOVATION

APPENDIX 7 (Recommended Solar Panels)

1. Photowatt PW750 (US Brand)

Matrix Solar Technologies Inc. — Solutions for natural power —

PW750-12V
LARGE SCALE POWER
PHOTOVOLTAIC MODULE –JBox



- Telecommunications
- Cathodic Protection
- Water Pumping
- Signaling
- Rural Electrification
- Private Residences
- Buildings integration
- Grid connected

The PW750 is made with 4 X 9 high efficiency (up to 15%) polycrystalline 5 inch cells (125mm X 125 mm), with a silicon nitride anti-reflective coating

The PW750 glass/Tedlar construction minimizes weight while providing a durable, protective environment for the solar cells. This product is configured for 12Volts system operation and meet the requirements of all photovoltaic applications.

The PW750 module uses Photowatt' s multicrystalline technology. The solar cells are individually charecterized and electronically matched prior to interconnection. Encapsulation beneath high transmission tempered glass is accomplished using an advanced, UV resistant thermal setting plastic. The encapsulant, ethylene vinyl acetate, cushions the solar cells within the laminate and protect the cells from etching. The rear surface of the module is completely sealed from moisture and mechanical damage by a continuous high strengh polymer sheet.

This module is available in double glass technology with the PWX750, with an optimum configuration that fulfills marine and tropical environments. The PWX750, more heavy than the PW750, benefits from excellent mechanicals properties and reliability thanks to its glass both sides.

EFFICIENCY WARRANTY : 25 YEARS * **PRODUCT WARRANTY : 5 YEARS***

PW750		12 V Configuration		
Typical power	W	75	80	85
Minimum power	W	70,1	75,1	80,1
Voltage at typical power	V	17	17,3	17,6
Current at typical power	A	4,4	4,6	4,8
Short circuit current	A	4,7	5	5,2
Open circuit voltage	V	21,5	21,6	21,6
Maximum system voltage	V	600V DC		
Temperature coefficient		α = +1,46 mA/°C ; β = -79 mV/°C ; γ P/P = - 0,43 % /°C		
Power specifications at 1000 W/m² : 25°C : AM 1,5				

*According to general warranty conditions

Datas subject to evolutions – Last update : September 2003

2. Evergreen Solar Spruce Line (US Brand)

evergreensolar
Think Beyond.

SPRUCE LINE™
photovoltaic modules

New 195W module

- Highest power and efficiency yet
- Best available tolerance -0 / +2.5%

A range of high quality poly-crystalline solar panels for on-grid markets offering exceptional performance, extraordinary versatility and industry-leading environmental credentials based on our cutting-edge String Ribbon™ wafer technology.

- Best-in-class performance ratings proven by field installations
- 98% of rated power guaranteed for 180, 190W product; 100% guaranteed for 195W product
- 5 year workmanship and 25 year power warranty for ultimate peace of mind*
- More installation versatility with our extensive range of mounting options
- Higher strength with wind and snow loads guaranteed up to 80 lbs/ft^2
- Qualified to all major industry certifications and regulatory standards
- Smallest carbon foot-print leading the fight against global warming
- Quickest energy payback time for the maximum energy conservation
- Cardboard-free packaging for minimal on-site waste and disposal cost

APPENDIX 8 (Recommended Charge Controllers)

1. Morningstar (ProStar)

MORNINGSTAR corporation

Product shown with optional meter.

Morningstar's ***ProStar*** is the world's leading mid-range solar controller for both professional and consumer applications. This second generation ProStar:

- Adds new features and protections using highly advanced technology
- Provides longer battery life and improved system performance
- Sets new standards for reliability and self-diagostics

Standard Features:

- Versions available: 15 or 30 amp
  12 / 24 or 48 volt
  negative or positive ground
- Estimated 15 year life
- PWM series battery charging (not shunt)
- 3-position battery select: gel, sealed or flooded
- Very accurate control and measurement
- Jumper to eliminate telecom noise
- Parallel for up to 300 amps
- Temperature compensation
- Tropicalization: conformal coating, stainless-steel fasteners & anodized aluminum heat sink
- No switching or measurement in the grounded leg
- 100% solid state
- Very low voltage drops
- Current compensated low voltage disconnect (LVD)
- LED's indicate battery status and faults
- Capable of 25% overloads
- Remote battery voltage sense terminals

Electronic Protections:

- Short-circuit — solar and load
- Overload — solar and load
- Reverse polarity
- Reverse current at night
- High voltage disconnect
- High temperature disconnect
- Lightning and transient surge protection
- Loads protected from voltage spikes
- Automatic recovery with all protections

2. Xantrex C series (US Brand)

C Series Controllers

xantrex

Charge, Diversion, or Load Controllers

C40 & C60 C35 CM

A charge controller is an important system component that regulates the voltage generated from your renewable energy system and properly maintains your batteries. It protects your batteries from being over and under charged, and ensures maximum battery life. Considered to be the best in the industry, Xantrex Charge Controllers offer a variety of features. The C Series offers three models, the C35, C40, and C60, designed for 35, 40, and 60 amps of DC current.

Features

- Silent, pulse width modulated (PWM), high efficiency operation.
- Three-stage battery charging (bulk, absorption, and float) with optional temperature compensation.
- Automatic overload protection in both active and passive modes.
- PV array short circuit and reverse polarity protection.
- Durable construction.
- Microprocessor controlled.

As a Solar Charge Controller

- When used as a solar charge controller, the C40 can control 12, 24, or 48 VDC array operation and the C35 and C60 can control 12 and 24 VDC array operation.
- All units offer selectable settings for NiCad, flooded lead acid, gel, or absorbed glass mat batteries.

As a DC Load Controller

- As a DC load controller, the C Series has a low voltage disconnect warning indicator and field adjustable set points that govern automatic low and high voltage disconnect.
- Manual reset switch for emergency low voltage operation.

As a Diversion Controller

- The C Series automatically directs extra power to a dedicated load, such as an electric water heater, and ensures batteries are never over-charged.

Options

- Plug-in remote temperature sensor (BTS) for increased charging precision.
- Cumulative amp-hour meter (CM) that can be installed on the face of the controller, or remotely (CM/R), up to 100 feet (30 m) away.

Xantrex Technology Inc.
Headquarters
8999 Nelson Way
Burnaby, British Columbia
Canada V5A 4B5
800 670 0707 Toll Free
604 420 1591 Fax

5916 195th Street NE
Arlington, Washington
USA 98223
360 435 8826 Telephone
360 435 2229 Fax

APPENDIX 9 (Recommended Inverters)

1. Morningstar SureSine300 (US Brand)

MORNINGSTAR corporation

SURESINE™

PURE SINE WAVE INVERTER

The ***SureSine*** inverter has been developed using Morningstar's power electronics expertise and 25 years of experience with remote off-grid photovoltaic (PV) systems. This product is a pure sine wave inverter designed specifically to meet the needs of rural PV electrification requiring AC power including solar home systems, schools, community centers and health clinics. This inverter is also a good choice for small PV systems for telecom, remote cabins and weekend homes, and RV/caravans and boats.

The SureSine's combination of performance, features and competitive price provides the best small inverter value on the market. It is highly reliable, having no internal cooling fan or other moving parts prone to failure.

Key Features and Benefits:

Improved Load Operation

Pure Sine Wave – *Provides quality AC equivalent to grid power. A sine wave will extend the life of the household appliances (lights, TV, fans) and improve load performance.*

Toroidal transformer design – *Generates good wave form throughout the range of input voltages.*

Outstanding Surge Capability – *Handles a 200% surge during load start-up, to a maximum of 600 watts.*

More Power Available

High Efficiency – *A high peak efficiency will reduce heating and make more solar energy available for powering loads.*

Low Self-Consumption – *The SureSine consumes 450mA while powering loads. During no load conditions, solar energy is not wasted because the SureSine automatically powers down to stand-by mode, reducing self-consumption to one tenth of operating consumption.*

Extremely High Reliability

Extensive Electronic Protections – *The SureSine has extensive electronic protections that will automatically protect against faults and user mistakes such as short circuit, overload, high temperature and low voltage disconnect. Recovery from most faults is automatic.*

No Internal Cooling Fan – *A key design objective since fans often fail in harsh environments and are noisy, consume power and blow dirt into the electronics.*

Tropicalization – *The SureSine uses epoxy encapsulation, conformal coating, stainless steel hardware, and an anodized aluminum enclosure to protect against harsh tropical and marine environments.*

Other Features

More Information – *The two LEDs provide important information to the user about system status and any fault conditions. An optional digital meter may be connected to the SureSine to display additional system information.*

Remote On/Off – *Improves safety by making it easy to install the SureSine in an inaccessible location or enclosure. Reduces system cost by avoiding the need to add an AC safety disconnect to the system.*

Adjustability – *Four DIP switches provide easy adjustability of several system parameters. Additional adjustability is possible via RJ-11 to RS-232 adapter to a personal computer and using Morningstar's PC software.*

2. Studer AJ Series (Swiss Brand)

Sine wave inverters
(with optional built-in solar charge controler)

AJ 500-12
AJ 600-24
AJ 700-48

Technical data

Model: AJ	500-12	600-24	700-48
Nominal input voltage	12V	24V	48V
Input voltage range	10.5 – 16V (24V max.)	21 –32V (44V max.)	42 –64V (64V max.)
Continuous power @ 25°C	400VA	500VA	500VA
Power 30 min. @ 25°C	**500VA**	**600VA**	**700VA**
Power 5 min. @ 25°C	575VA	675VA	900VA
Power 5 sec. @ 25°C	1000VA	1200VA	1400VA
Max asymmetrical load	250VA	300VA	300VA
Short circuit current 2s (output)	5.2A (10.4A*)	5.7A (11.4A*)	7A (14A*)
Output voltage	True sine 230Vac (115Vac*) 0 / -10%		
Frequency	50Hz (60Hz*) ± 0.05% (Crystal control)		
Distortion THD (on resistive load)	< 5% (@ Pnom)		
Consumption in « Stand-by » mode	0.3W	0.4W	1W
Consumption « ON » @ no load	3.8W	8.5W	10W
Maximum efficiency	93%	94%	94%
Max continuous Cos φ	0.1 – 1 up to 400VA	0.1 – 1 up to 500VA	0.1 – 1 up to 500VA
Load detection	Adjustable: 1 → 20W		
Overheating protection (+/-5°C)	Shut down @ 75 °C – Auto-restart @ 70°C		
Overload protection	Automatic disconnection with 2 time restart attempt		
Short circuit protection	Automatic disconnection with 2 time restart attempt		
Reverse polarity protection	Protected by internal fuse		
Back feed protection	Not protected		
Battery deep discharge protection	Shut off @ 0.87 x Unom – Automatic restart @ Unom		
Over voltage shut down	Shut off @ >1.33 x Unom - Automatic restart @ < Umax		
Acoustic warning	Before low battery or overheating disconnection		
Cable length(Battery / AC out)	1.5m / 1m		
Noise	> 45 dB (Ventilation)		
Operating temperature	-20°C up to +50°C		
Approx. output power derating	-1.5%/°C since +25°C		
IP protection index	IP 30 conforms to DIN 40050		
Forced ventilation	From 45°C ± 5°C		
Required battery capacity	> 5 x Pnom/Unom (recommended value in Ah)		
Weight & dimensions	4.5 kg – 142mm x 240mm x 84mm		
Warranty	2 years		
E norm	ECE-R 10 (E24) certification for 12 and 24V models		
EC conformity compliance	EN 61000-6-1, EN 61000-6-3, EN 55014, EN 55022, EN 61000-3-2, Dir. 89/336/EEC, LVD 73/23/EEC		

* 115Vac/60Hz available on simple request.

3. ASP (Swiss Made)

asp
advanced solar products

TOP CLASS «DOMINO III»

Sinewave Inverter

Profi-Line

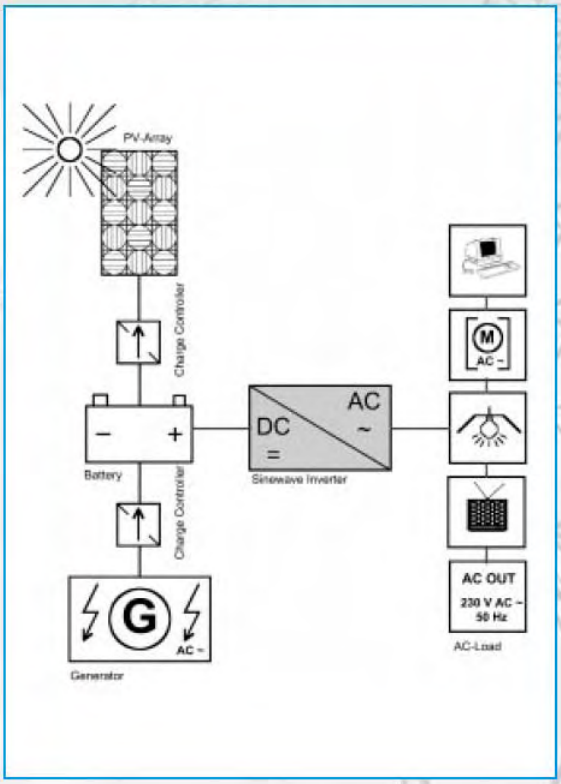
TC05/12 and TC07/24

- Solar
- Industry
- Public Services (rescue vehicle)
- Housing
- Yachting / Boating
- Lorries / Service-vehicle
- Railway
- Camping, leisure-time activities
- Turbine DC (wind, water)
- Grid-Connection

- Battery supervision
- True Sinuswave
- Short circuit and overload security
- Standby identification

TC05/12 and TC07/24

Stand alone application



TOP CLASS «DOMINO III»	TC05/12	TC07/24
Inverter		
Rated Voltage UDC_{IN}	12V	24V
Input Voltage Range	10.5 ... 16.0V DC	21.0 ... 32.0V DC
Dynamic Low Voltage Cut Off (depending on load)	10.5 ... 9.0V DC	21.0 ... 18.0V DC
Rated current IDC_{IN}	50A	35A
Current IDC_{IN} max.	160A	150A
Rated Power P_{10} (10 min at TA=20°C)	675VA	1300VA
Rated Power P_{30} (30 min at TA=20°C)	620VA	1100VA
Continuous Power PD	550VA	710VA
Rated Output Voltage UAC_{OUT}	230V AC, ± 2% (short circuit proof)	
Output Frequency	50Hz, ± 0.5% (true sinewave)	
Rated Output Current IAC_{OUT}	2.1A	3.0A
Short Circuit Current IAC_K (max. 0.5s)	6A	8A
Allowable CosPhi	0.3 ... 1	
Efficiency Factor max.	93%	94%
Adjustable Standby Level (logarithmic)	2 ... 40W	
Consumption Standby/OFF	ca. 1.5W (Test impulse every 800ms) / 10mA	
Consumption 230V AC OK	5W	8W
Reset after Short Circuit	every 60s	
Reset after Overload	every 60s	
Reset after Overtemperature	automatically after reaching semiconductor temp. +45°C	
Reset after Battery failure	automatically after reaching UDC_{IN}	
General data		
Ambient Temperature range	-25°C ... +60°C (max. 95% rH, not condensing)	
DC- Breaker / fuse	63A	63A
Remote control ON / OFF	no	no
Status indication	LED	LED
Alarm contact (insulated Relay contact)	no	no
Toroidal Transformer (galvanically isolated)	IEC742, VDE0551	
Temperature and Load controlled fan	ON 55°C / OFF 45°C, PD >80%	
RS-232 Interface	no	no
Dimensions (L x W x H)	275 x 155 x 96 mm	
IP Protection	IP20	
Standards	CE	
Included in delivery	connector for non-heating apparatus	
Weight	5.1 kg	6.8 kg
Warranty	2 years	

Technical changes reserved (02/2003)

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