ENERGY GUIDELINE

3rd EDITION

2004

MEDECINS SANS FRONTIERES

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Introduction

Energy exists in various forms. Think of heat and movement.
One of the most versatile forms of energy is electricity. It can be easily transformed into other forms: make hot water with a water heater or power a drill. That is the reason we use electricity for our appliances.

There are different forms of electricity: AC (Alternating Current) and DC (Direct Current).
We would like to have only one form, but unfortunately this is not possible in practice.

Why do these different forms exist and what are their properties and applications?
AC has the property that it can be easily transformed to a high (or low) voltage. This is important to limit the losses in the transport of the electricity from the plant to the consumer, and at the consumer to the (internally in the appliance) required voltage.

DC has the property that it can be stored relatively easy in batteries. We do not always produce the energy at the moment that it is needed (think of batteries for the radio).

There are appliances that convert AC to DC and the other way around.
From AC ⇒ DC is called a "battery charger" (for charging batteries) or a "power supply" (for direct powering of a radio, etc.)
From DC ⇒ AC is called an inverter.

When we use the term AC in this document, we mean AC with a voltage of 220-240. When referring to DC we mean 12 V (Volts).

Average circumstances and calculation of needs

The need for a consistent description of a common energy system is obvious, as many MSF projects struggle with the same questions over and over.

There are two main questions:

How much energy (read: electricity) do I need?
In what way will I produce it?

WHAT IS OUR DEMAND?
Calculate the total power the appliances need1. There will always be an ID plate showing the number of Watts, or sometimes the voltage (V) and the amperage (A).
E.g. 230V, 8.3A; the power consumption will then be 230 x 8.3 = 1909 W.
Or: Voltage x Amperage = Wattage (W = VA, so kW = KVA2).

On a lamp the number of watts is written on the bulb or tube.
If no details on power consumption can be traced, have a look at the reference list in annex II.
Let's look into the average MSF house where very limited or unreliable city power is available:

> ***Example 1:***
> *An average MSF house: 5 rooms, with each one 60W lamp, a radio cassette player (45W), a fridge with freezer (175 W). 3 rooms have a ceiling fan (50 W): 670 Watt in total.*

1 The unit for power is Watt. Do consider the possible increased need if the mission is relatively young.
2 The K stands for kilo, see annex I.

Example 2:
An average MSF office: 6 rooms with on 60 W lamps each, 5 ceiling fans (50W), 1 photocopier (1500W), 1 fridge/freezer (250W), 2 laptop computers (30W) and 1 printer (100W), 1 battery charger 12V/25A (500W), 1 electric water heater (1000W): 4020 Watt in total.

Reducing The Energy Demand

Let us focus on example 1 once more. There is a catch: a normal fridge will only function properly when it is powered for more than 12 hours/day. Properly means here that it will stay reasonably cold but not reliable enough for the storage of vaccines. For this purpose we need energy as much as 24 hours/day. There is even a second catch: most fridges need far more energy to start (up to 6 times its nominal consumption).

This will be very inconvenient (given we will have to produce it ourselves):
- in terms of fuel consumption
- in terms of wear on the engine of the generating set when running under low loads (the fridge has only intermittent energy demands)
- in terms of noise, especially at night.

The solution here is to install a different type of fridge, or we need reliable city power around the clock.
The type of fridge we advise is a so-called icelined fridge. This type of fridge will keep cold even with only as little as 5 hours of electricity/day (in average circumstances).
If you are lucky and there is city power available for at least 5 hours, you do not have to run a generator at all if you install a battery back-up system for the remaining equipment. As the electricity from such a system is expensive, it is a good idea to install CFL's or high efficient lights instead of the normal lamps.

If we focus now on example 2 again:

With the almost inevitable photocopier, we will have to choose for a diesel type generator. These are more reliable and fuel efficient, but only available for more than 2000 Watt.
A disadvantage is the higher noise level, and the fact that they will last relatively short when used with low loads (<30% of its capacity).
The selected, proven reliable and most economic choice is here the Hatz 3.2 KVA generator. It will produce max 3000 Watt continues output, what will do, if we careful in not using the photocopier and the water heater at the same time. There is no real motivation to reduce energy demands here, as this will not have many consequences.

MSF has the small Honda gasoline generatorset (including lighting), and the Hatz diesel generatorset in stock to supply to the field.
The two selected standard MSF generators are meant for an emergency setting.
After the initial period these generators should be replaced by more appropriate types for the specific circumstances: refer to the FSU for advise on the proper choice of generator or energy source.

Different Ways Of Producing Electricity

The two easiest ways to produce electricity are:

- Generator (diesel or gasoline)
- Solar panel

Another source of electricity is the mains or city power. We do not need to produce anything if this source is reliable.
A combination of these sources is possible.

The price per unit (Kilo Watt hour) is heavily depending on the proper choice of both producer and consumer. In general electricity produced by solar panel is far more expensive than when generated with a diesel engine.

Solar Energy Or PV Systems (Photo-Voltaic)

The main applications for solar energy in MSF projects are:

- the power supply for HF-radio base systems
- lighting for small remote houses and clinics

Solar systems are very expensive and when installation in for instance health centres is not backed up with training and maintenance, it is sure to be far more expensive than energy from a generator.
The average breakdown period of solar systems is about 4 years. This is in most cases the same as the total life expectancy of the complete system, as the local authorities cannot afford to buy and replace the broken components (battery and/or regulator).

If you do decide that solar energy has good perspectives for your program, take care in the designing process to incorporate maintenance and spin-off activities like commercial battery charging to enable future replacement of expensive parts.
Solar systems have two major advantages: silent and (almost) maintenance free. If we use energy efficient lights we can provide enough energy for a reasonable price.

Do not hesitate to ask for advice from the FSU.

Solar fridges are not the first choice for the storage of vaccines. Proper implementation is must to prevent maintenance problems after the end of the program.

Other applications of solar energy in MSF:
The portable solar 'logic' lantern and the SL48 solar lantern from BP.

Desktop Computers And Power Supply, Ups

To protect desktop computers, if present, we should install an Uninterrupted Power Supply (UPS). This will avoid damage to the computer and memory losses when the voltage drops or rises.

The UPS on the market are designed for western power systems, where only a few minutes of autonomy after a mains failure is needed. In our circumstances, we often want an extended autonomy period if we do not want to start the generator regularly.
A good solution for this and other situations (like a fax machine standby overnight, etc.) are the designed kits: the KPROMPOS600 or KPROMPOS500.

The KPROMPOS600 will give you on a recent desktop computer an maximum autonomy of 6 hours, and is designed for maximum protection. This option is to be used when mains quality is very poor.

The KPROMPOS600 will give you the same autonomy, but can handle a higher power: it can power more appliances at the same time (max 450W continues). When using the max output power, it has an autonomy of about 4.5 hours. Comparatively the kit is cheaper, and is designed for acceptable mains quality (or generator use).

An average computer with screen consumes about 250W.

For all your circumstances, these kits can be tailored to your needs, and we can design a system for any configuration of computers of other appliances.

For more information: Logistics catalogue.

If in doubt: contact the FSU.

Special Appliances: Air Conditioners

Airco's have a high power demand, most likely in the range of 1.2 – 3.5 kW. Therefor you need a powerful generator to make the use of airco's possible.

Example 3:
An airco needs 3000 W, so one would say this could still be powered with the 3.3 KVA Hatz generator. There are two reasons why this will not function.
First there are the other appliances, which will raise the total energy demand above its capacity. Secondly, but the most determining one: these kind of machines (like also: 'normal' fridges with compressor, electric water pumps, etc.) need much more energy to start than to run; we have to oversize the generator 2 to 3 times, so it requires at least a 6 KVA generator for only this airco. Depending on the brand of generator and airco this may be even 9 KVA. If more then one airco is powered: the addition of the starting energy (3 – 6 KVA) is sufficient for all, as they will not start at the same moment. Larger generators come often in so-called 'three phase' models.
Be aware that this calculation is valid only for one single phase! See annex 5 for more information.

How To Position Generators, Solar Panels And Batteries

Generator should be placed in a room, shed, or anything that protects against direct sunlight; well ventilated for cooling and air intake of the engine; in some circumstances protected against thieves. For the diesel generator on a spot that reduces the (nuisance of the) noise.

Solar panels should be directed and inclined according to their geographical location. See appropriate reference books. It is important to position them on a spot where the chances of physical damage are low. Proper ventilation under the panels is needed to cool them. As they can and should last long, pay special attention to the quality of installation. The remaining problem for any solar system is that the batteries need proper maintenance and depending on quality, should be replaced after a certain period. This goes also for the regulator. Most counterparts will need proper training and instruction on the maintenance of these systems.

Batteries should be positioned in a cool and ventilated place and on a wooden platform to absorb moisture. Access should be easy to allow for inspection and maintenance.

How To Interconnect A Combined System

Example 4:
Generator with city power: The most common combination, and easy to connect: either a switch (double pole change over switch, MSF code PELESWIC315), or the easiest solution: two wall sockets, one connected to the city power and the other to the generator outlet. All appliances (or the original inlet of the house) connected to a plug, which can be inserted in only 1 socket.
See Annex V.

WARNING: NEVER CONNECT MAINS TO A GENERATOR OR VICE VERSA

Batteries And Charging

Batteries we use can be divided into two groups:

1. Car type batteries, in which we include batteries for radio and solar purposes.
2. Rechargeable (small) batteries ,Nickel cadmium or 'Nicad' , NiMH or Lithium batteries, as used in laptop computers and walkie-talkies.

The 'maintenance' of these two types is quite different.

1. **Car type batteries**: either they are completely sealed ('gel' type) or they are a so-called 'open' type.
   - Need to be charged as often as possible (also stored batteries!).
   - Consume some water (not applicable for a 'gel' type).
   - Use for filling new or 'dry charged' batteries only battery acid. Maintain fluid level (the 'plates' should be under the surface of the fluid) afterwards with only demineralised water or distilled water. If not available: melted ice from the fridge or clean rain water will do (not applicable for a 'gel' type)
   - Always use an 'automatic' charger (minimum charge characteristic: 'IU') A normal or cheap charger will overcharge the battery, reducing performance and causing high water consumption and explosive gases. The automatic type of charger can be left unattended.
     (Both MSF generators have a connection for battery charging. It can be used if you do not have another option. There is no regulator in, so it works as a 'cheap' charger.)
   - To check the state of charge use either:
     1. For 'open' batteries: a specific gravity meter: It will have an indicator with 'full', 'half' and 'empty'.
     2. For 'gel' type batteries: an accurate Volt meter: full battery should read 12.8 V, empty battery 12 V (measure only after at least 1 hour without charger or load attached).
   - To determine if a battery needs to be replaced:
     3. Obvious: when the battery is dead overnight, or when you encounter an 'old' battery with a voltage lower then 10 V.
     4. When the capacity is to low: charge the battery completely, and attach the 'normal' appliances to it. Monitor the battery voltage every hour, and stop when the battery voltage reaches 12.0V (for gelified Sonnenschein Batteries) or 11.6 volt for local 'car' batteries. Calculate the power consumption (see DC power consumption guide in annex II) and multiply by the number of hours you had the appliances attached. This gives you the real capacity of the battery in Ah (Amp hours). Most gelified MSF batteries have a capacity of 85 Ah when new. A battery should practically be replaced when its remaining capacity is down to 50% of its original capacity.

   Be aware when purchasing batteries locally, that quality is in general poor compared to the ones sent from Amsterdam. It is worthwhile to order these batteries from abroad.
   If you still decide to buy locally, remember that not only the capacity of a battery counts. The number of cycles (charge and discharge to a certain percentage of remaining capacity) it can handle will also determine the final battery life and costs. The standard MSF batteries are good for 500 cycles up to 80% discharge, where a local car battery will do only 30 cycles.
   For shallow discharge percentages, this ratio will be 1 on 5, so for the same purpose, you need in this example a five times bigger local battery.

2. **Rechargebale (small) batteries**

NiCad and NiMH batteries

- Performance will reduce when they are charged as often as possible. Preferably they should be charged when almost empty (the indicator on the computer or walkie talkies will show that).
- It is a good idea to discharge a NiCad or NiMH battery once a month.
- NiCad and NiMH batteries should be stored discharged.

- Life expectancy in No of cycles NiCad: 1000; NiMH: 600
- Never discharge a Nicad or NiMH battery by means of a light bulb or the like; it could damage the battery!

Lithium batteries

- Performance will be reduced when charged constantly (take the battery out when you work with a laptop with the power supply always in!).
- It is a good idea to discharge (and charge!) a Lithium battery once a month.
- Li-ion batteries should be stored half full.
- Life expectancy in No of cycles Lithium: 400
- Never discharge a Lithium battery by means of a light bulb or the like; it could damage the battery!

Chargers for lead-acid batteries:

The standard MSF battery charger is now the Tecpro-II 25A. We stopped supplying more sophisticated (lightweight) chargers, as the return rate was too high.
Cheap, locally bought chargers, will limit your battery life to a large extend, and are advised against.
The Victron charger is designed for average ambient temperatures of 25°C, and needs an external temperature sensor, that automatically regulates charging, when used in high temperatures. This sensor needs to be ordered specifically.

- How long does it take for my empty batteries to be fully charged?
  The time it takes a battery to be charged depends on the sort and type
  of battery, and how long it took to be discharged (slow or fast).
  Rule of thumb is to divide the battery capacity by the maximum charge capacity and add 4 hours. For example: battery 85 Ah, battery charger 25A. The charge duration is 85:25 = 3 +4 = 7 hours.
- What is the allowed maximum output of the charger?
  Due to the good regulation, Victron, Tecpro and other good quality chargers are
  allowed up to 25% of the battery capacity for 'normal' batteries.
  For Gel-batteries up to 50%!
  E.G. a gel-battery of 85 Ah is allowed to be charged with a 42.5A. In practice this will be a 40A charger.
  For a normal car battery of 85Ah this is maximum 20A.

Wiring

The diameter of the wire determines the maximum current. This statement translates into:

- For AC (230 or 120 V) appliances that consume 1000 W or more: make sure you use a relatively thick cable (1.5 mm2 or more).
- For appliances that use 1500 W or more use a thick cable (2.5mm2 or more).
- For the radio transceiver: use only the supplied cable (6mm2), and make proper, tight connections to the battery poles.
- In general for all lights and appliances attached to the 12 V battery system: use 2.5mm2 or thicker, avoid long wires or extension wires.

(European) Colour code for AC (alternating current, 230 V):

- Neutral: blue
- Phase: brown or black
- Ground: green/yellow.

The neutral and the phase are the two connections for the electricity, the ground is for safety.
Do not rely on colour codes of existing wiring in houses or appliances!

Colour code for DC (direct current, battery):

+ = red
- = black

Protection Against Peaks

All apparatus with electronic components, nowadays very common, are very vulnerable, and can be damaged by too high voltage and too low voltages.

1. For this purpose MSF supplies in some kits as a standard a Voltage Protector or Mains Protection Unit (MPU). This will cut off the electricity when the voltage is not in the specified range. It is recommended that also a voltage protector is installed at the main switchboard (mains entrance of the electricity) in each house. There are voltage protectors for 110V and 220V (the 240V model is out of production).

The MPU, for technical specs see Annex VII.

2. Besides these MPU's, there are devices on the market to improve the quality of the mains (city power): voltage regulators. These lower or raise the supplied voltage to the standard within a specified range E.g. the voltage officially is 220V, but you measure an average of 190V. In that case, when the appliances do not function properly, you could install a voltage regulator (often bought locally). The price depends on the energy demand. The locally bought models may or may not protect your appliances against high voltage peaks! Do not count on it! The MSF supplied model (2005 version) does protect against high voltage peaks.

Safety

Working with electricity is as safe as cutting a slice of bread: if you do not know how to do it you can kill yourself. It seems a silly comparison, but in fact it is the truth.

There are several circumstances in which you must be extremely careful: working in wet conditions with AC (Alternating Current, in practice 120 or 220 V, the 'normal' mains) with the risk of getting an electric shock, and

when working with high currents (in practice: when making short circuits with a 12 V car battery) with the risk of getting burns.

To work carefully:

- Check if insulation and connections of wiring is O.K. (intact, no cracks and clean).
- Check if the main switch is 'off' when performing repairs.
- Provide sufficient ventilation for batteries,

If you take care and concentrate on the job, no danger is to be expected.

Lightning Protection

Lightning can cause serious damage to especially electronic equipment such as fax machines, radio's, inverters, computers, solar system components, etc. Even when lightning strikes relatively far from you, it may still induce very high voltages and destroy appliances. To avoid this, grounding of all apparatus, either via the AC system or direct (radio, solar panels and battery) will reduce this risk.
There are simple lightning protective devices on the market, especially for fax machines and telephone exchanges, price approx. 90 euro.
A complete lightning protection is very complicated and expensive. Refer to the FSU for more information and appropriate advice.

See for grounding the next chapter.
To protect your radio remove the antenna cable from the radio or install a lightning arrestor in the antenna cable.

Grounding

Grounding your electrical system will prevent the danger of electrical shocks from malfunctioning appliances. This is only a valid statement if you connect a ground pin to the generator or the ground connection of the wiring system of the house and make sure that all appliances that need to be grounded (fridges, lights and other appliances with an earth connection on the plug) are grounded.

It may in fact be more dangerous to ground a system improperly that not to ground it at all!

Effective grounding may have many different designs: rods of steel or iron (most common) shall be at least 5/8" in diameter (16 mm). Rods of non-ferrous materials (aluminium, copper) shall not be less than 1/2" (13 mm) in diameter. These rods should, as far as is practical, be embedded below permanent moisture levels in the soil. Pipes and rods should be driven at least 8 ft (2.5 m). Where rock is encountered at a depth less than 4 ft, the rod, pipe (at least 8 ft) or plate (at least 2 square feet = 0.1 m^2) may be buried horizontally in a trench.
Use a clamp or solder the copper wire to the rod, and use a size at least the maximum size of the wiring in the house, preferably twice the size.

Fuses

Fuses are another safety guarantee. They are meant to blow when a failure occurs. The generators have an incorporated main switch/fuse, which can be reset after the failure is detected and solved.

Conventional fuses have to be replaced when blown; make sure that the amperage is appropriate for the appliances.

General Considerations and MSF Policy

Remember:

- Generators and (to a smaller extent) batteries need maintenance.
- Keep records of the maintenance you do and refer to the owner's manual for details.
- Changing oil and filters is far cheaper and far better than having a broken down electrical supply system.

MSF deliberately selected only two types of generators for our kits, the Honda EX 7 (gasoline) and the Hatz 3.2 KVA (diesel). They have proven their reliability in numerous projects and can be bought at a competitive price.

In special circumstances you may need another type. Always contact the FSU department first before you order or purchase. When ordering electric appliances, the logistics department will supply 230 V models unless explicitly stated otherwise. Inform yourself on the supplied voltage in your location.
Keep in mind that in this paper we only addressed simple (single phase) electrical systems. For a bigger house or a hospital these considerations do not apply.

Always use the standard MSF battery charger and good quality batteries, preferably maintenance free 'gel' types. Far too often a good maintained and managed electrical system breaks down after the 'replacement' of a good logistician. Try to train local personnel as much as possible, and make them responsible for the systems.

Always use an MSF voltage regulator for expensive electronic devises. Order them from Europe.

Contact the FSU for all other questions.

Annex I - Explanation Of Used Symbols And Units

K = kilo (1000 x)
U = Voltage or tension, unit: volt (V)
I = Amperage or current, unit: ampere (A)
W = Wattage or power, unit: watt (W)
Hz = Hertz, the frequency of AC systems, in practice: in the America's: 60 Hz (often linked with 110V systems) and elsewhere: 50 Hz (linked with 230V systems). Referred to as c or cycles as well. Not many practical implications.

Combinations:

Ah = Ampere-hour, in practice: the unit for power in 12V DC systems.
DC = Direct current, in practice: the 12V system with a car battery.
AC = Alternating current, in practice: what we produce with our generator or from the mains, mostly 110 or 230V.
Wp = Watt peak, the laboratory performance in watt of a solar panel, in practice: 0.7 times this figure is more realistic.
KVA = Kilo Volt Ampere, is used for generators for the indication of the maximum load under certain conditions. In practice: 0.8 times the stated KVA will be the maximum load in watts.
Example: The 3.3 KVA generator will most likely be able to produce 3.3 x 0.8 = 2.7 kW (kilo watt) = 2700 watt. The labour factor (referred to as cos phi) for all appliances with coils or condensers incorporated (fridges, electric motors, luminescent tubes, welding equipment, transformers, etc.) does not equal 1, and the lower it is, the more difficult for the generator to power it.

Annex II - Power Consumption Guide AC

Power in Watts:	Start..... Normal
Air conditioner	4000 1500
Ghetto blaster	 60
Refrigerator, household type	1000 150
Freezer, large	1500 300
Coffee machine	1000
Kitchen water heater	1500
Heater	2000
Television	 150
Computer desk top colour screen	 250
Computer laptop	 70
Printer	 40
Laserprinter	 400
Photocopier	1200
Iron	1000
Workshop welder 140A	4000
Washing machine	2500 650
Charger for batteries 25A	 500
Fax machine	5
Domestic water pump	2000 500
Ceiling fan	 50

POWER CONSUMPTION GUIDE DC

Power in Amps	talk ..... stby/normal
Mini-M transceiver only	0.7..... 0.4
Codan radio	7 ..... 0.4
VHF base	12..... 0.6
ICOM handset charger.....(when charging only)	1
Inverter Victron 12/600 stby	..... 0.5
Inverter:	AC power delivered (in W) divided by 15
8W FL armature	1

GENERATOR FUEL CONSUMPTION

Hatz 3.2 KVA	: at 50% load	: 1.2 L/hour
Honda EX 7	: at 100% load	: 0.5 L/hour
Diesel generator (6 KVA and up)	: at 80 % load	: 0.3 litre/KW/h

Annex III - Estimate Prices of Equipment

(unit: euro)

Battery charger 25A (three stage charger, automatic)	300
Temperature sensor for charger 25A	30
Inverter 500W=600VA (continues).....	400
Charger (50A)/inverter (800W=1000VA continues) combination	950
Voltage protector (MPU)	75
Voltage regulator 2000W (locally bought, for non-expensive equipement)	200
Voltage regulator MSF with over-voltage&lightning protection (2000W) .	425
Lead-acid gel (deep cycle, maintenance free) battery 85Ah	150
Lead-acid solar (deep-cycle, open) battery 85Ah	100
Lead-acid car battery 85 Ah.....	50
Solar panel 55Wp.....	250
Solar regulator for max 2 panels	60
Solar Lantern (Logic lantern)	60
BP solar lantern (SL48)	400

PRICES OF GENERATORS:

Gasoline 0.7 KVA (Honda EX7), super silenced (86 LWA).....	750
Diesel 3.2 KVA* including extension cabling (102 LWA).....	2400
Diesel 6 KVA (hand start, air cooled) (99 LWA).....	2500
Diesel 11 KVA* (3000 rpm, hand- and el start, air cooled) (99 LWA).....	4500
Diesel 11 KVA (1500 rpm, el start, water cooled, (silenced = 90 LWA) ...	6800
Diesel 11 KVA, 1500 rpm, super silenced (87 LWA)	9000
Diesel 20 KVA (water cooled, silenced = 90 LWA)	8200
Diesel 20 KVA (water cooled, super silenced = 87 LWA)	11000

* = in kit with spares, extraction fan and flexible exhaust

'Silenced' and 'Super silenced' are vague terms; noise reducting is expensive!
Check sound levels before you buy!

sound units comparison
LWA -/- 12 = dBa at 1 m
LWA -/- 20 = dBa at 4 m
LWA -/- 25 = dBa at 7 m
LWA -/- 28 = dBa at 10 m

- 0 tot 20 dBa : almost inaudible
- 30 dBa : silent sleeping quarters in a city
- 50 dBa : normal voice conversation
- 60 dBa: supermarket, office
- 80 dBa : maximum constant noise level; annoying, sound level in factory, station or the like
- > 85 dBa : sound level that will –when exposed to it for a longer time- trigger problems in humans
- 130 dBa : sound level that will definitely cause hearing problems

Annex IV - How To Use A Multimeter

A multimeter can be used for measuring (AC & DC):
1. Voltage
2. Resistance
3. Current

1. VOLTAGE

* For measuring voltage, make sure that the test wires are inserted in the correct slots: one in the COMMON, and the other one in the V/R (Voltage/Resistance) slot.
* Make sure that the multimeter selector and range are set correctly, according to the expected voltage, and the type: AC ~ or DC =
  (not relevant for the Fluke multimeter, that features automatic range).

Voltage measurement for AC can be relevant:

- Voltage fluctuations from the mains (city electricity) or generator.
- Presence of voltage at a certain socket or switch-box.

Voltage measurement for DC can be relevant:

- Measuring state of charge of batteries.
- Determining if a battery charger functions.
- Determining if a solar panel functions.

2. RESISTANCE

* When measuring resistance, make sure that the test wires are inserted in the same slots as for Voltage measurement.
* Make sure that the multimeter selector is set to R or Ω.
* You can only measure resistance of a disconnected component or appliance, to prevent mistakes caused by influences of other parts.

Remember:
* You are only able to measure DC resistance, which can be completely irrelevant for AC purposes.
* When measuring resistance, the internal battery of the multimeter acts as the power source.

Beware:
* Resistance measuring is not considered a good tool to determine problems, besides one: determining if a conductor or wire is O.K.
  For this purpose you put the test wires on either sides of the wire, and the reading should be almost zero (0.02). The other option on most multimeters for this test is switching to the Ø sign, where a beep will be heard when the wire is O.K.

3. CURRENT
* When measuring current make sure that the test wires are inserted in the correct slots: one in the 'common', and the other one in current (10A) slot.
* Make sure that the multimeter selector is set correctly: AC ~ or DC =
* When measuring current, you have to cut the circuit, use the multimeter in series, and then power the circuit.

Beware:
* Do not forget to take the test wire out of the Amp slot, and put it back in the V/R slot after your measurement; often the internal fuse is blown, because people forget to do so.

Current measurement for AC can be relevant:
- Determining power consumption of appliances (e.g. standby power).

Current measurement for DC can be relevant for:
- Measuring the output of a battery charger.
- Measuring output of solar panels.
- Measuring power consumption of appliances.

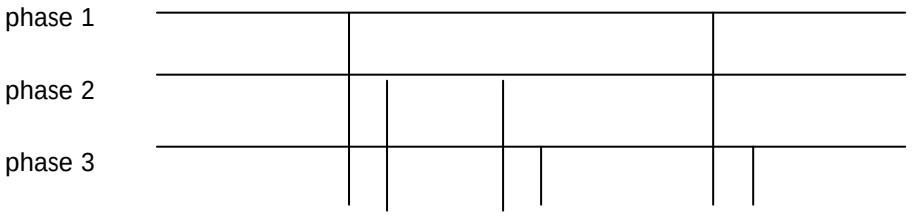
Annex V - How To Connect A Three-Phase System

You will encounter in large houses a three-phase mains connection. Depending on the country this will be a 3 or 4 wire system.

The 3 wire system:

* If you measure with a multimeter two of these wires, all readings will be 230V (115V for America's).

Three wire system (230V countries)

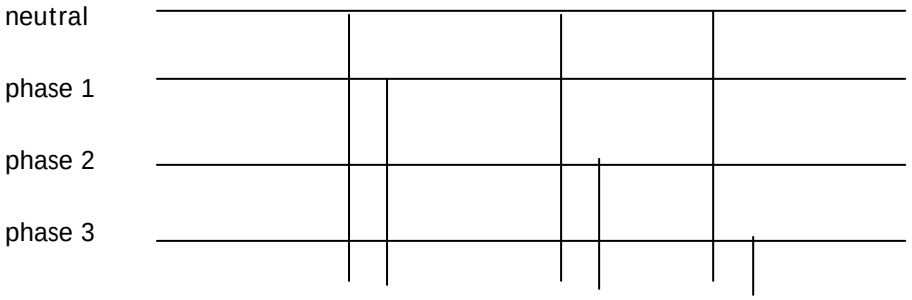


single phase power supply | single phase power supply | single phase power supply

The 4 wire system:

* If you measure with a multimeter two of these wires, you will read either 230V (115V) or 400V (200V). The one wire with which all reading show 230V is called the neutral or common (normally colour code: blue).

Four wire system (230V countries):



single phase power supply | single phase power supply | single phase power supply

Annex VI - How To Connect A Generator To A Three-Phase System

For the Honda: do not attempt to do so. The capacity of the Honda is too small.
For the Hatz 3.2KVA: this generator is a single-phase type, so only 1 of the 3 phases can be powered.

For the three-wire system and the Hatz 3.2KVA this translates into:

* From the house: take any set of two wires and connect them to a normal plug.
* From the city power: connect any 2 wires to a wall socket.
  WATCH OUT FOR LIVE WIRES!!
* From the generator: install an extension wire with a wall socket near the city power wall socket.
* Now choose the power source by inserting the plug into one of the two wall sockets.
* Take care not to overload the generator.

For the four wire system and the Hatz:

* From the house: take the neutral and any of the remaining wires and connect them to the plug.
* From the city power: and connect the neutral and any of the remaining wires to a wall socket. WATCH OUT FOR LIVE WIRES!!
* From the Hatz: install an extension wire with a wall socket near the city power wall socket.
* Now choose the power source by inserting the plug into one of the two wall sockets.
* Take care not to overload the Hatz generator.

The alternative is to make a complete new emergency wiring system with extension wires.

For larger generators:
These will most likely be three phase generators.
* Connect them with a three phase change-over switch (positions: city - 0 - generator). MSF code: PELESWIC425

ANNEX V - Mains Protection Unit (Mpu)

Operation: Under circumstances where long power lines are used, variations in loads lead to large line voltage variations. When these voltages vary out of limits, this can lead to damage of appliances in operation.
The MPU will sense conditions of high and low voltage and disconnect the appliance to be protected.
When in 'Automatic' mode the MPU will automatically reconnect the appliance to the power source (mains, generator) when this voltage enters the connecting range.
In 'Manual' mode the MPU will not reconnect until manually reset. Manual reset will only reconnect when the power source' voltage is within the connecting range.
An indicator lamp shows when the MPU is connecting the appliance to the mains voltage.

Technical specifications (since 11/95):

Nominal voltage		: 220V
Disconnecting voltage	High	: 265V
	Low	: 170V
Reconnecting voltage	High	: 260V
(automatic or manual with push button)	Low	: 185V
Maximum current		: 10A

WARNING:

- When in 'Automatic' reset mode frequently repeated on/off switching of the MPU could lead to damage to the MPU or the connected appliance
  Switching to 'Manual' mode avoids this risk.

Annex VIII - Maintenance

MAINTENANCE HONDA EX 7

	daily	first month or first 20 h	every 3 months or 50 h	every 6 m or 100 h
Engine oil check	*			
Engine oil change		*		*
air cleaner elt. clean			*	
spark plug maintenance				*

MAINTENANCE Hatz 3.2 KVA

	daily	first 25 hours	every 100 hours	Every 250 hours	every 500 hours
engine oil check	*		*		
engine oil replace		*		*	*
oil strainer clean					*
air cleaner elt clean			*	*	
air cleaner elt replace			when needed		*
discharge water from fuel filter	when needed		*	*	*
fuel main filter replace					*
Fuel pre-filter replace				*	*
Check/adjust valve clearance					*

Life expectancy of Honda EX 7 : 1000 hours
Life expectancy of Hatz 3.2KVA : 2000 hours
Minimum time before overhaul for bigger (1500/3000rpm) generators : 5000 hours