Some thoughts about a GenSet

When thinking over the power system of our S/Y Regina, we also considered the possibility of installing a diesel generator, be it an AC Genset or a DC Genset. Here are some thoughts on the subject.

I believe the question regarding a diesel generator is very dependent on the size of the boat (i.e. main engine) and your needs. Also, there seems to be a tradition of being more in favour for a diesel generator in USA compared to Europe.

In any case, a second engine on board certainly means increased service and "problems" and we hear a lot about sailors investing a lot of time to keep their diesel generator (AC or DC) running.

My personal reference is John Neal, who first sailed a Hallberg-Rassy 31 Monsun, then a HR42 Ketch and now a HR46 Kutter and has logged almost 200 000 miles. On their current HR46, they have no Genset and when discussing the issue with him lately, he asks rhetorically "why should you?".

My answer to that question is:

> You should have a Genset if...
>
> 1. You have need for a lot of 230V, i.e. an air-conditioner
> 2. You lay still for long periods without shore power at places where you can not run the main engine for any reason
> 3. Your engine is so big that it should be avoided to run, since it has high diesel consumption, is loud and suffers from running with too little load

Worth noting is the fact that HR36, HR40 and the HR43 all have the same engine: Volvo-Penta D2-55. This is a a relatively small engine (55 hp). Instead, it has a greatly improved torque. The engine itself is, thanks to engineering and Hallberg-Rassy's installation and isolation, running very quietly. So point 3 above should not give us any headache. Generally, I have heard that modern diesel engines under approx. 80 hp do not suffer as much as previous engines when running for charging purposes only. But then again, it is never optimal for a diesel engine to run with too little load.

Admittingly, we also run by engine far more than we ever believed we would, since we all are *sailors*, aren't we?! Too often we have found ourselves put into the ultimate choice of either staying offshore sailing slowly in very weak winds or tacking against, *or* starting the engine getting to our destination quicker. Since we are doing family sailing, the thought of getting into port quicker is tempting as long as you have a nicely running and quiet engine, believe me! Water and electricity is being produced as a side effect at the same time.

When designing your electrial system onboard, you have to do one big choice, namely if you go for a **AC system** or an **DC system**.

Let me explain:

1. AC System

The 230V AC system builds on the assumption that a diesel generator generates the *maximum* effect needed. If you have an air-conditioner or a washing machine using 2 or 3 kW, your diesel generator needs to produce 230V and these 2 or 3 kW – at least. For 3 kW, this means 13 A at 230V (equivalent to 250 A at 12V). Now this is a lot of electrical power, which only is needed when you actually are using these hungry 230V AC applications (air-conditioner, washing-machine etc). If you have an air-conditioner running for many hours, an AC diesel generator is the right answer, but if you want to use your diesel generator for charging the batteries, here is a point often forgotten. The AC system makes "shore power" which is led into your 230V shore power charger onboard. When you are connected to shore power, it is most often expected that you are connected for a long period of time (i.e. at least 6 hours, which is the absorption time programmed into our Matervolt shore power charger). Therefore, shore power chargers are seldom charging more than 60A for your 12V batteries. So your AC diesel generator needs to be running with its high effect (3 kW!) only charging with 60A into your batteries, thus only utilising a quarter of the power generated! Your AC diesel generator needs to run for a long time, e.g. 4 hours per day to charge your daily consumption of 200 Ah. Also, please note that each time you need 230V, even for the shortest time, you need to start your AC diesel engine!

2. DC System

Now to the DC system. Here, the philosophy is that the 230V is taken care of by an inverter, not needing to start the generator just to use your 230V electrical kitchen tool. If you need a maximum of 2 kW with 230V, you buy an inverter taking the effect from the battery bank. We normally need 1 kW for say 15 minutes (water cooker, vacuum cleaner) draining our batteries with some 20 Ah or 10% or our daily 12V consumption.

The batteries are then being charged by some means. Here, you have several options ranging from solar panels, wind generators, towing generators, your main engine or a 12V DC diesel generator. The idea is that the charging facility does not need to produce your *maximum* power (2 kW) but enough for your daily use (200 Ah in our case).

Mastervolt is currently being engaged on our boat in adding a second alternator onto our main engine allowing for 130A charging of the batteries plus the old 60A Volvo alternator (see our electrical plan). The main engine needs thus to run for 1 or possibly 1.5 hour daily, which we often do, anyway.

Further to the main engine, you have the option of a separate 12V DC diesel generator. This DC diesel generator looks very similar to the above mentioned 230V AC diesel generator. However, not needing to produce 3 kW, it can be built simpler and less expensive with less fuel consumption. Still, it charges a lot better than the expensive 230V AC diesel generator! Instead of the above mentioned 60A shore power charger, a 12V DC diesel generator charges with - for example - 150 A, thus very much faster than an

AC diesel generator! More than 150A is not requested in our case, anyway, since you may not charge wet lead-acid batteries with more than 25% (in Amps) of the total amount of Ah available. Thus for our 560 Ah bank, the charging should not be grater than 140 A not to harm the batteries. For gel-batteries this amount is 50%, thus 280 A charging would be OK.

A special type of DC diesel generator is the sterling engine, running very quietly and reliable. This quietness, however, comes to a price, since the WhisperGen sterling engine is quite expensive.

Most DC gensets do not warm water, while the Whispergen does so by its nature and AC gensets by using the 230V system of the water heater. Charging with the main engine warms the water by the engine's cooling water system going through the heat exchanger in the water boiler.

Since we have no need for long time 230V use, like for an air-conditioner, we have opted for the DC-system with an inverter giving the 230V needed. For next season, we will see if the charging via 130A + 60A on the main engine gives us the needed charging power. If not, we will seriously consider a 12V diesel generator. In the mean time, I will investigate the available DC diesel generators on the market.

One of these DC gensets is the WhisperGen. Reinout Vader of Victron Energy producing the WhisperGen has written an interesting article on electrical power on boats here.

A short summary of the article by Reinout Vader:

After explaining various details on types batteries, monitoring the batteries and how you should charge them, he comes to the most interesting part when he suggests some electrical systems for different types of boats/crews.

Rightly, he does not look at the maximum effect (in kW) needed, but rather on the total energy (in kWh or Ah) needed on a day. By installing batteries (together with an inverter) as a buffer between electrical source and electrical need, it works fine to use high effect for a short period of time, even though the electrical source does not have this rated effect.
An example: If you have a washing machine, which needs 2.2 kW for a limited time period for heating up the water, you do not need an electrical source (e.g. AC diesel generator) which can deliver these 2.2 kW. Instead, for the short period of time, the washing machine gets the needed 2.2 kW via an Inverter from the DC battery bank. Then, when the washing machine has done its job heating up the water, not so much effect is needed any longer and there is plenty of time to re-charge the batteries. He calls this a "DC-system".

With such a "DC system", you just need to deliver the average energy demand, not the maximum effect. The WhisperGen, having an effect of only 0.75 kW, works fine in such a system.

The most interesting part of this article is chapter 9 through 12, where he divides the boats/crews into 4 different categories depending on how much power they need per day. For the size of boat I am talking about, the categories "**up to 4kWh need**" and "**up to 14 kWh need**" are of interest.

The "**4kWh Crew**" needs electricity to powering up the following:

- Navigation Instruments - *5 Ah per day*
- GPS - *5 Ah per day*
- VHF - *3 Ah per day*
- Refrigerator (air cooled) - *50 Ah per day*

- Autopilot - *30 Ah per day*
- Radio - *3 Ah per day*
- Cabin Light - *10 Ah per day*
- SSB - *7 Ah per day*
- Radar - *24 Ah per day*
- Microwave oven (which we don't have) - *25 Ah per day*
- Heater - *5 Ah per day*
- Watermaker (150 L per day) - *50 Ah per day*
- Plus some smaller extras

Less than 300 Ah per day is being used, corresponding to 4kWh.

This " 4kWh crew" would need a battery bank of approx 500 - 600 Ah. The charging facility of this battery bank would, according to Reinout Vader, ideally be:

- 60A standard alternator on main engine
- High Output Alternator (HOA)
- Solar cells *and/or*
- Wind generator

Interestingly enough, Reinout Vader, selling the WhisperGen, does not suggest a diesel generator for this constellation.

However, going to the next category, namely the "**14kWh Crew**", the situation is different.

This crew uses electrical power for the above equipment, as well as for the following

- Fridge and Freezer (water cooled) - *38 Ah per day*
- Water Kettle, 6 L per day - *25 Ah per day*
- Electrical cooker - *50 Ah per day*
- Air Conditioner - *350 Ah per day*
- Watermaker (total 200 L per day) - *60 Ah per day*
- Small washing machine used every second day - *56 Ah per day*
- Small dishwasher used daily - *42 Ah per day*
- Additional pumps - *10 Ah per day*

Looking at the power requirements for the above equipment, it is seen that a Freezer could well fit into the "4 kWh Crew" if it was water-cooled instead of the less efficient air cooled. I am glad to say that both fridge and freezers installed by Hallberg-Rassy are not only very well insolated, but are also all water cooled!

As seen above, the Air Conditioner is the piece of equipment that uses the most enegery and so do the washing machine and the electrical cooker. All pieces of equipment we have not on our boat.

According to Reinout Vader, this "14kWh Crew" would need a battery bank of 800 - 1000 Ah as well as a diesel generator, preferably the WhisperGen (of course...).

This article has confirmed my previous thoughts on our family's power needs. We are clearly within the "4kW range". But if we ever will have any more need for power, we will definitely have a closer look at the WhisperGen.

So, in our case, we have opted for an ample battery bank (as much as fits into a HR40) as well as a 2kW Inverter to get 230V AC. This is also much less service intensive than a second diesel engine, weighing less and taking up less space.

In the future, either a DC genset or also a wind generator, towing generator

or solar panels are of interest, mainly to have a second source or electricity should the main engine fail to work.

Generally with wind-generators, I have often read testimonials like "gives a lot of electricity in gale", but when sailing downwind in the trades or anchored at a sheltered anchorage, they do not give enough electricity.

The most efficient wind-generator seems to be the AirX Marine. I say "seems to be" since I have seen many of these "switched off". The reason being that it makes a quite annoying sssssssshhhh-sound and owners might prefer having it switched on when not onboard. At least I am avoiding berthing next to a boat wit han AirX Marine installed. But yes, it makes a lot of electricity when there is enough wind.

I have read much more positive testimonials about towing water generators. These give approximately the same amount of Amps as you sail in knots, so with 6 knots of speed, you charge 6 Amps. The resistance is said to be neglectable on larger sailing boats (40') sailing on hull speed in the trades anyhow. Lighter boats and in lighter winds you might loose maximum half a knot.

The best thing about towing generators is that some of these are easily transferred into a wind-generator, in case you are mored in a windy spot or you leave your boat and need to float charge the boat while you are away. These wind-mills might not be as efficent as the AirX Marine but much more silent. The traditional combined towing generators and wind generators are the Aquair 100 by Ampair and the Aqua Aerogen 4 sold in Sweden by Awimex.

A new type of combined wind and water generator is the DuoGen. Instead of having a long towing line, the DuoGen has a pole that either is vertically facing up for wind-generation or tilted down into the water as a towing generator. The exchange of blades between water and wind is said to be done within 5 minutes without the hassle of towing a long line, interfering with your fishing gear and possibly being mixed up as a towing hook by a large fish!

The following power generation from the combined Aqua/Aerogen 4 may represent an example of the charging to be expected:

Wind Speed (Aeorgen4)	**Effect (W)**	**Charged Ah per 24h**
10 kts	12 W	24 Ah
12 kts	20 W	36 Ah
15 kts	36 W	72 Ah
20 kts	72 W	144 Ah

Boat Speed (Aquagen4)	**Effect (W)**	**Charged Ah per 24h**
5 kts	48 W	96 Ah
6 kts	96 W	190 Ah
7 kts	120 W	240 Ah

The AirX Marine is more effective than the here given figures (and louder!),

but my message remains: it needs some considerable (relative) wind speed to charge efficiently, and I claim you seldom have this when sailing downwind or are anchored in a sheltered bay.

At the same time, it can be seen that a towing generator gives ample power, starting already at 5 kts of speed, while we typically cruise at 6 to 7 kts.

Solar panels are also an option, but these need to be of large size and preferably tilted 90 degrees to the sun as well as not being shaded (not even partly, since the voltage drops then). Solar panels are thus great for float charging, but less practical for bulk charging.

Back to Equipment.