

# Ample Power Company

## Evaluating AC Power Generation Methods

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### Introduction

Power on demand requires storage of some sort. DC energy can be stored in batteries. How is AC stored?

Storing AC directly isn't easy . . . a large flywheel would be necessary. Indirectly, AC can be stored as fuel to run an engine when AC is needed.

Starting and stopping an engine to generate AC on-demand is not the kind of treatment engines thrive on. Neither is running an engine for long periods with little or no load. Engines prefer to operate from 50 to 85% of their rated horsepower.

Short duration loads such as microwave ovens, coffeemakers, toasters, hair dryers and other such devices can be operated from a DC-AC inverter that gets stored energy from a battery bank.

When is an inverter sufficient for all AC loads, and when should an AC generator be considered? To answer these questions, some background information is necessary.

### AC Start-Up Loads

Many AC loads require an in-rush of current to get started. For instance, a motor that will run on 1000 Watts of energy may take 5000-7000 Watts to get started. This starting surge will depend on the motor used, as well as the device being driven by the motor. Some air conditioning compressors require the motor to start the compressor under full load, requiring a healthy surge rating from the AC source, be it a generator or an inverter.

### The AC Generator

AC generators come in all sizes and models are available to run on gasoline, natural gas, propane, and diesel. Small gasoline operated units can be amazingly inexpensive. We'll call these generators, gas-gens. Such units are found as emergency power sources, and may be used by contractors for light duty needs as construction sites. The gasoline engine on gas-gens is not designed to operate for many hours, and may be fickle to operate soon after it's new. Because gas-gens are built for light weight, capability to start heavy loads is limited . . . perhaps as low as 1.2 times its steady-state capability.

Natural gas and propane engines are first cousins of the gas-gen, although typically higher quality engines are used, and

they may have larger flywheels to accommodate higher surge demands. They are generally easier to start, and burn cleaner so that spark plug maintenance is lessened.

Diesel fuel is the safest of all fuels to store and won't lose its volatility over time as does gasoline. Diesel engines are built heavier and will run longer than other engines. They are more efficient fuel-wise. Offsetting these advantages is higher initial cost.

Many people have a general prejudice regarding diesels because they aren't as familiar as the engine under the hood of most cars. And, diesel does have a smell that many people find objectionable. This is made worse by the fact that small diesel leaks are more often tolerated because the hazard of explosion isn't immediate.

Besides more rotating mass in a diesel engine that can supply surge power to start AC loads, diesel engines also have more torque for an equivalent horse power than do gasoline of gas engines.

Except for very rare intermittent use, the gas-gen isn't a good choice. If it's only to be used in an emergency, then fresh fuel must be available as well. This creates a storage and recycling problem.

Choosing between a propane or natural gas unit and a diesel unit may hinge on fuel storage. If there is already a supply of propane available, and propane costs are reasonable, then a propane fired engine makes some sense. Propane engines will definitely start better in sub-zero weather than a typical diesel, even one with glow plugs.

Diesel is the logical choice for many stationary applications, as well as in vessels and vehicles where economical operation and safety are major considerations.

### The DC-AC Inverter

The DC-AC inverter is an electronic way to produce AC. Today's inverters can be efficient, and most of them have surge capacities that are over twice their steady-state ratings. This means that inverters can start much larger AC loads than they can run indefinitely.

Naturally, any long term AC load requires a battery bank that may not be reasonable in size or cost, so the inverter is generally limited in application to available battery power.

## The Engine/Alternator DC System

One way to provide DC power to the inverter is to recharge the battery bank while the inverter is operating. Ample Power has made the Genie since 1989 with this purpose in mind. Presently sold in a 12-volt unit capable of a sustained 150 Amps, a larger unit is now available. The Genie-4024 unit is able to provide 175 Amps continuously for a 24-volt system. As such, it can supply over 4000 Watts of continuous AC through an appropriate DC-AC inverter such as the TRACE SW4024 sinewave inverter.

### Pattern of Power Usage

At this point, AC can be obtained with an engine/generator, an inverter/battery system, or with an engine/alternator combined with a battery system. Depending on your pattern of AC usage, one of these methods will be most appropriate.

If your need for AC is intermittent, and no loads run for long periods, then an inverter makes the most sense. There needs to be some way to charge batteries, however. If you're not fortunate to live by a fast flowing stream, near a wind tunnel, or in a place the sun shines abundantly, then an engine of some sort is probably also required.

If your needs for AC are almost constant, then an AC generator makes sense. The generator may run continuously except for some well planned intervals for maintenance. This need for constant AC might result from operating a remote business with a large power demand such as air conditioning.

If the need for AC can be satisfied from an inverter, such as is the case for most vessels, vehicles, and remote homes, and the need for AC power is typically not for long periods, then the most economical device to deliver power to the inverter for extended periods will be the engine/alternator system.

### System Tradeoffs

Assuming that there are batteries and an inverter in the system, what are some of the tradeoffs in choosing between the engine/alternator and the engine/generator?

The engine/generator can be used during the time that demand for AC is heavy and continuous. At the same time, batteries can be charged through the inverter/charger, or a separate battery charger. One drawback of this setup is the limited surge capacity available from the generator. How big a generator is really necessary to start the AC load? Getting realistic surge ratings for generators is not always easy, so they are often specified with more power than actually needed.

A second drawback of the system is the inefficiency of battery charging in general, and the additional losses incurred with the AC operated charger. It takes a large generator to drive most chargers at their current limit. Considering that the AC generator is loaded with another appliance, charger performance will not be as high as most expect it to be unless

the generator is massively oversized. An oversized generator is not an elegant solution to the power equation.

With high capacity inverters, and high capacity battery banks, the engine/alternator is a good choice for extended engine charging and AC generation. Load distribution is automatic. That is, the alternator can run at its maximum rating; the inverter draws what it needs to power the load, and the rest of the alternator output is battery charge current.

Surge specifications for inverters can be quite accurate, and the surge capability of the system is predominately that of the inverter assuming a reasonable battery bank. That means an inverter can be specified that is not grossly overrated for the AC loads.

The engine/alternator doesn't need to be rated for the AC start-up requirements . . . if necessary, the inverter can 'dip' into the batteries for surge power. An engine/alternator system can be sized for the average AC load resulting in less engine horsepower, less noise, and lower operating costs.

Since the engine/alternator is normally used to charge batteries and/or power longer term AC loads, it is operating under a greater load when it does run compared to an AC generator. This type of operation is easier on the engine, and also results in less total fuel consumption.

What is the drawback to the engine/alternator? The battery bank will be larger than a system that makes minimal use of DC power in favor of long hours of AC generator time. In many situations, however, a large battery bank is required for DC storage anyway. Inverter reliability also is a factor in system resiliency. With an AC generator, if the inverter/charger fails, then there is still AC available from the generator. You may not be able to charge batteries, however.

With the engine/alternator system, an inverter failure eliminates AC power, but not battery charging capability. An alternator failure knocks out battery charging, and eventually AC power when the batteries are discharged. Alternators are readily available in most areas, and just about anyone can change out an alternator . . . this failure is more easily fixed than either a failed inverter or an AC winding for the generator. It's also easy to operate two alternators from the engine, so that a spare is already running.

While no clear cut answer can be given to the reliability/resiliency issue, the engine/alternator with an inverter for AC needs has much merit, especially when DC is the primary power and AC needs are intermittent. When AC loads are continuous, but moderate, the engine/alternator may be the best choice, particularly if battery charging is also done by renewable resources such as solar and wind.

One way to illuminate the argument further is to rate both AC and DC power consumption. If DC power needs prevail, then the engine/alternator is favored. If AC power needs

are greatest, then the issue is how many engine hours are expected on a yearly basis from either the AC generator or the engine/alternator. The latter will be more economical to operate, and will charge batteries faster, so expect fewer hours unless AC needs are significantly higher than DC needs.

### **What about the Main Engine**

Vessels and vehicles have a main engine that can also supply electrical power to charge batteries. Typically, it is difficult to get AC power from the main engine because the RPM varies. An AC generator needs to be rotated at a fixed RPM. The DC alternator can operate over a wide RPM range, although available power is dependent on RPM and may be very little at low RPM.

Where there is a main engine, then the auxiliary engine/alternator makes good sense. Both the main and auxiliary can be equipped with the same alternator. Not only

does this provide redundancy, but it keeps system engineering down. Implementing two identical systems is also less costly than two different systems.

With both main and auxiliary systems producing DC for battery charging and inverter use, the same amount of AC can be available at all times. Users will find this more friendly since there is only one set of limitations to live with . . . maximum inverter load.

### **And the Winner Is You**

Choices can sometimes create anxiety . . . fear of making a bad choice strikes everyone at some time. However, a choice implies that one selection is better than another for any given set of circumstances. Who doesn't want to choose the best? We hope the information presented here will let you make the best choice.