SHOULD YOU CONSIDER A PARALLEL UNIT BASED POWER SYSTEM?

Connecting generators in parallel can increase the power capacity, control in load management, ease of maintenance, and redundancy. The process involves the physical connection of two or more electric generators, and the synchronization of their outputs.

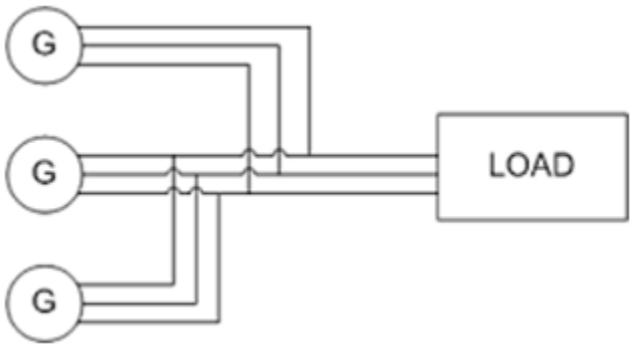
While a number of factors go into properly evaluating the pros and cons of a multiple paralleled unit power system versus a larger single unit, the purpose of this document is to provide a basic overview of the things to be considered.

Factors considered when paralleling generators

Capacity: Ability to add units by synchronizing additional units to the system based on load demand; bringing on a set to the bus when demand increases and taking it the bus when demand decreases. Knowing system load profile is important, some systems may run larger units during the night and during lower demand periods use a smaller unit.

Redundancy: ensuring a soft power transfer as the outgoing generator is switched off and the incoming one is powered on. The design should avoid a situation where the load is not powered or allowed to run on the UPS. System can be setup to respond an online units alarm conditions by replacing a suspect unit before a failure occurs.

Compliance: Multiple smaller units operating based off load profile instead of maximum required capacity may improve ability to comply with emissions regulation. System may require higher fault current availability than a single unit can supply in some cases. Gas fueled engine based system may require a diesel unit to act as a standby for emergency use or to meet transient response requires in certain load conditions. There may be other factors where a multiple unit system could be required with the electrical standards or local regulations in terms of safely, protection and operation.



Requirements for connecting generators in parallel

Ideally, any type of a generator can be paralleled together with another type as long as their frequencies and voltage are the same at the point of interconnection. However, there are some practical limitations such as incompatibility between older and newer models or when the cost of making them compatible is not justifiable.

Among the things to consider are,

- Speed control: The generator units may have equal or different engine speeds but must operate at the same rated system frequency. Engine governing must be compatible with real power load control and synchronizing controllers.
- Voltage regulation: The voltage regulators should have the same response and droop characteristics and be compatible with reactive power load control and synchronizing controllers.
- Load balance: The entire load should be shared proportionally by all the generators according to the capacity of the individual units.
- Synchronization: Synchronization is required to ensure that the resulting output is in phase, has the same frequency and voltage within allowable tolerances to safely connect a unit to the load bus.

Compatible generators

The easiest approach is to use similar generators or at least sets with the same alternator pitch, output voltage and frequency. Generators are said to be compatible when they share some properties such as compatible alternators, engines, speeds, real and reactive load sharing controls, interfaces to other control and monitoring systems, etc.

Incompatible generators

Paralleling generators with different characteristics can be complex. Apart from the compatibility issues, there are other system level problems that may come into play that can result in bus instability, poor transient response and circulating currents between generating units.

Load Management

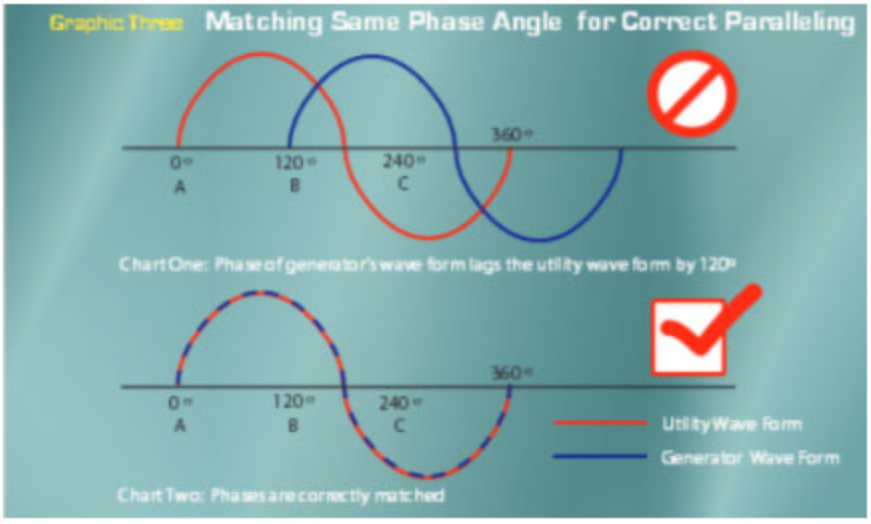
Most effective management of varying loads may require ability to load shed/load add bus loads, while this adds cost and complexity to overall system, may provide best possible solutions for economical and reliable operation. Fully understanding the load side of the system is required to design and implement an effective load management system.

Synchronizing parallel connected generators

This is the process in which the voltage and frequency of the generators are matched to provide a standard AC output waveform.

For the generators to be paralleled and synchronized correctly, each of the sets should have the below characteristics,

- Frequency: the rated frequencies must be the same, some systems perform better with “slip frequency” vs “phase match” synchronizing to allow for differing load response characteristics between units.
- Voltage: The generators should produce or be set to produce the same voltage. Some systems can be set to allow a larger voltage tolerance window to allow for faster sync, while some systems may require tighter voltage variations before breaker close.
- Phase number: The generating units must have the same number of phases, either three or single phase.
- Phase rotation: For three phase systems, each of the three phases must be matched. This prevents excessive mechanical and electrical stresses.
- Voltage Phase angle: The waveforms should be matched such that they rise and fall together. There should be no angle difference and the potential difference between the phases should be zero.
- Winding pitch: The stator winding pitch should be the same between all connected machines, while some winding pitches can be successfully paralleled, they do result in circulating currents that may impact system capacity and reliability. In some cases there are solutions to make different pitch machines parallel compatible, but these solutions add cost and system complexity.



Advantages of Parallel generator systems

Increased reliability and redundancy: Improving reliability and redundancy for both critical and non-critical loads. The system ensures that there is always constant power to critical loads, and if one of the generators fails, the load is supplied by the other one or more paralleled units.

Low initial cost of power generation: Cost of generation increases with generator size and is more for ratings above 600KW. This is mainly due to the market for smaller engines being larger, with more are manufactures, usually resulting in lower cost. Using several smaller generators can more economical than a single large generator.

Service and Maintainability: The ability to take a unit out of service to perform maintenance or repairs without impacting entire system in many cases is a positive benefit. If the system is providing intermittent or standby service this may not be a major issue, however if the system supports a remote site or critical facility that this can be a great benefit.

Decreased light loading of the generator prime mover: In most installations, the load varies over time and it is common to have a generator running well below its rated capacity when the load is low. This may cause wet stacking. The efficiency of the prime mover is normally higher when the load is between 65% and 100%, If the units are required to comply with air quality regulations, maintaining proper load levels to allow emissions control equipment to operate properly may require a multiple smaller unit system.

More control and savings on generating costs: The total amount of power supplied from several small generators is equal to the power supplied by one large unit. However, there is more control and balancing in the smaller generators. One can balance the load over the different circuits and decide on the power to generate at any particular time based on the load.

Expandability and flexibility: The use of several generators makes it possible to supply a varying load without piling up costly units or spending too much on a big generator whose full capacity is rarely used. Generators can be added gradually as demand increases.

Mixed fuel systems: Many sites look to the ability to utilize mixed fuel supplies, diesel and natural gas being the most common. While spark ignited and compression ignition engines have different response and stability characteristics, a properly designed and implemented load control system can provide very good system operation.

Disadvantages of Parallel generator systems

While many systems operate quite well in parallel operation, there are disadvantages of these type systems as well, some of these are,

System complexity: A single generator integrated into a utility supplied system with an open transition transfer switch (ATS) is by far the simplest solution to many customers site requirements, the technical expertise and capabilities are usually well within the abilities of the supplier of the generator set and ATS. Parallel systems require more complex and integrated control systems and requires skilled and experienced technicians to perform proper startup, commissioning and ongoing maintenance to paralleled unit systems. And units operating in parallel require additional electrical protections to prevent problems that could be associated with reverse real or reactive power flow.

System costs: A system with smaller paralleled smaller units may actually cost as much or more than a single larger unit. This mainly due to control system costs since the cost of modern generator controls systems per unit as typically as much when used on a 2MW unit as they are for a 200kW unit. Also the additional costs associated with required electrical protections for paralleled systems can be quite due to both equipment and engineering costs involved.

Availability of smaller parallel capable gensets: Readily available smaller generator sets, typically below 300kW are usually not parallel operation suitable for a number of reasons, mainly their governing and voltage regulation systems do not offer a droop option or ability to interface with a paralleling/load control system. Have also found that getting required generator electrical data for smaller units is in many cases very difficult. Many manufacturers do offer parallel capable smaller units, but usually in a packaged group or system.

Technical Support: Setting up parallel generator system can be a complex procedure that requires a qualified electrical team, consisting of proper engineering and technical field service. Newer control systems and manufacturer provided systems reduces some of the complexity, but overall these type systems require more technically capable service people to properly maintain over the entire life of these systems.

Conclusion

A well designed system provides backup power and a variable output. Newer control systems automated load demand start/stop functions, options for remote monitoring and setpoint changes, maintenance indicators and many other features. Using the correct paralleling switchgear helps the consumer to achieve the maximum output when the power demand is at its peak while providing the minimum output when the load requirements are low.

Smaller systems going into new or facilities undergoing retrofit may benefit from manufacturer solutions, usually offered as “power blocks”. Existing systems requiring additional backup power, load demand management or changes in utility service may require a more customized solution.

There are no “one size fits all” solutions, and in many cases you can go to different suppliers or engineers and get varying opinions on how you should proceed with meeting your needs. So to be sure you get the right solutions, make sure of these things,

- Does the system supplier ask a lot of questions about your current system, your types of load, load profiles and your expectations?

- Does the supplier have direct experience in the types of generators and parallel systems that apply to your requirements?

- Are you aware of all the regulatory requirements involved in installing and operating your proposed system?

- Can you get qualified service, maintenance and technical support for the proposed system in a timely manner, and does the service support have multiple persons available to take care of your needs.

- Try to avoid “proprietary” systems, you should get all documents, programs, settings files and drawings pertaining to your system. Companies, even the big ones, change over time, lose people or go away. You need to make sure the system you choose can keep you in business as long as you need it too.