# Paralleling of Generators – Is the sum of the parts greater than the whole?

- In case of paralleling of generators, sum of the parts can be less than or equal to and even greater than the whole. In the following article and the ones those follow in sequence, we would show why and how. First, we shall describe what is paralleling, and why is it required.

## Why Paralleling of Generators is considered?

- Paralleling in electrical generator terms is the combination or synchronization of two electrical inputs by matching the output-voltage waveform of one electrical system with the voltage waveform of another system. Synchronization can be between two or more generator systems or between generator systems and a utility supply. The Designer of an electrical system particularly above 500kW must consider the merits of a parallel generator system over that of a single generator system.

- Your choice of a generator depends primarily on the amount of backup power that is required for your specific application. It is not always possible to find a generator that matches your requirements exactly. Sometimes the output power capacity of standard generator units available in the market may greatly exceed your minimum requirement or fall short of your maximum requirement. This is where paralleling generators come handy. In this regard, ESL can be of immense service to you because of its tremendous experience in performing jobs of similar nature for highly reputable customers using state of the art and the only of its kind controllers from Woodward, GmbH.

## Basic Principles:

1. Automatic synchronizing of a generator consists of electrically "coupling" the generator output to another source of electrical energy and operating the generator such that its output adds to the other source.
2. Automatic synchronizing can encompass a wide variety of conditions such as:

   a. Two or more equal or similar-sized generators which, when paralleled to each other, will operate as though they were one larger generator. This is the most common application and reason for parallel operation.
   b. Two or more unequal-sized generators, which are operated in parallel as though they were one larger generator. This is also a common condition.
   c. Generator systems (which may consist of two or more individually paralleled generators) which are operated in parallel with another electrical system which, by comparison, is infinitely large. This is the case of operation in parallel with the normal electrical utility source.

## Types of Systems:

- There are two types of paralleling systems:

### a. Sequential paralleling

- In sequential paralleling, the engine/generator sets are connected to the bus in a predetermined order. The lead engine is connected to the bus first. When the engine/generator selected as number 2 is ready to be connected, a synchronizer is connected between the output terminals of generator 2 and the bus. Then the generator is in synchronism, its paralleling circuit breaker is closed, connecting it to the bus. Usually, a restriction is imposed to limit the time the controls will consume in attempting to synchronize and parallel a set to the bus before reconnecting the controls to the next set in sequence.

### b. Random paralleling

- Random access permits simultaneous synchronizing of each set to the bus. The random access method is faster than sequential paralleling but more expensive. Codes mandating emergency loads to be reconnected within ten seconds may require the method of operation. With diesel or natural-gas-driven engine/generator sets, it is reasonable to expect that the emergency bus will be established within the ten-second limit in a random access system, because any one of the generators can be first on line.

### c. Utility paralleling

## Benefits of parallel power generation systems over single large generator units:

- Parallel standby power systems have always been significantly advantageous over single large generator units. However, implementation of such systems has historically been limited to large projects or mission critical applications due to the constraints of higher cost, space, and the high level of complexity involved to setup and maintain. Until recently, many businesses both large and small have refrained from parallel operation of generator sets. With the introduction of sophisticated integrated digital control technologies, it has now become much easier to operate systems in parallel and secure following advantages:
  - **Reducing light loading of the prime mover**

    - Loads do not remain at a constant level in most installations. Variations in power demand can cause a single larger generator to run at loads below 30% of capacity, which could cause wet stacking. Prime movers are designed to run most efficiently

at approximately 75% of full load.

- **Prime mover options are limited above 2000kW:**
  - Most manufacturers above 2000kW do not offer generator sets. If higher loads are required, paralleling smaller generator sets achieves much more than 2000kW with the added advantage of redundancy. It also avoids having to drop down to the lower 1000rpm 50Hz speed of larger generator sets.
- **Reliability**
  - The redundancy inherent in parallel operation of multiple generators provides greater reliability than is offered by single generator unit for critical loads. If one unit fails, the critical loads are redistributed among other units in the system on a priority basis. In many environments, the critical loads that need the highest degree of reliable backup power usually account for only a fraction of the overall power generated by the system. In a parallel system, this means that the most critical elements will have the redundancy necessary to maintain power even if one of the units goes out.
- **Expandability**
  - When sizing generators to match you load requirements, it is often difficult to accurately project increases in load and adequately plan for anticipated additional requirements. If load projections are aggressive, your initial investment in a generator may be higher than necessary. On the other hand, if load projections are inadequate, you may be left without reliable standby power or may have to resort to expensive generator upgrades, or even purchasing another unit altogether.

    By operating systems in parallel, it is easier to allow for variations in load without overrunning your budget or piling up expensive units that rarely get used. As long as you have enough physical space, generators can be added for additional power supply when required. Similarly, redundant generators can be detached from the unit and can be used separately at other sites.
- **Flexibility**
  - Using multiple units in parallel offers greater flexibility than using a single large-sized generator of a high capacity. Multiple smaller generators operating in parallel do not need to be grouped together and can be located in a distributed fashion lessening the need for one very large footprint for a single, larger generator.
  - Rooftop installations or setting up small-sized generators in limited areas are just a few ways you can creatively find ways to make them fit. Since the units do not require a collective large space that have to be side by side, these can often be installed in small facilities or whenever space is a restricting factor.
- **Ease of maintenance and serviceability**
  - If a generator in the system breaks down or requires maintenance, individual units can be dismantled and serviced without disrupting the functioning of other units. The redundancy inherent in a parallel system provides multiple layers of protection and ensures an uninterrupted supply of power for critical circuits.
- **Cost-effectiveness and Quality Performance**
  - Individual units operating in parallel are typically of smaller capacities. The engines used in these generators are usually industrial, on-road or high-volume engines designed with advanced manufacturing technology that gives them a high degree of reliability and low cost of generation per unit of power.
- **Cost of generation in terms of $ per kWhe:**
  - Not only that some manufacturers claim the $ per kW of generator sets exceeding 600kW are higher than those in the 400kW to 600kW range because more engines are manufactured in the lower kW band, resulting in lower unit costs, the fuel consumption is also optimized. Smaller gensets when paralleled together, allow operators to optimize usage. In situations where loads are small, one smaller generator can be run at close to its advertised rating rather than one big sets at reduced loads. This ensures optimum fuel consumption, which, in the context of Pakistan, constitutes almost 90% of the total cost of generation.