Buckeye Power Sales
Reliable Power Professionals Since 1947

Until the 21st century, when referring to utility power, or the grid network, most people were referring to what is known today as the Macrogrid. The grid network is the electrical distribution network delivering power from a series of large power generation plants to utility customers across a wide geographical area, frequently crossing over central states, and in some regions of the world, several countries. Today, the term Macrogrid refers to what most people envisage when referring to utility power. More recently, another electrical distribution system is being referred to, particularly in the application of standby engine-driven generator systems, the Microgrid. This information sheet covers the differences between a Macrogrid and a Microgrid, where and why Microgrids are being adopted, and the application of engine-driven generator systems in each of the grid systems. (Continued over)

1.0 DEFINITION OF A MACROGRID:

For most power consumers, both domestic, industrial, and commercial, their utility power is supplied from the Macrogrid. At a local level, utility customers electricity is supplied at 480, 220, and 110 volts. Power originates from large power generation plants located many miles away, and quite often several states away. A system of overhead lines, (underground wires are normally only used for local supply) distributes power generated mostly from a combination of large fossil fuel plants (normally coal and gas), hydro-electric dam projects, and nuclear.

Explanation of Macro and Microgrid Systems

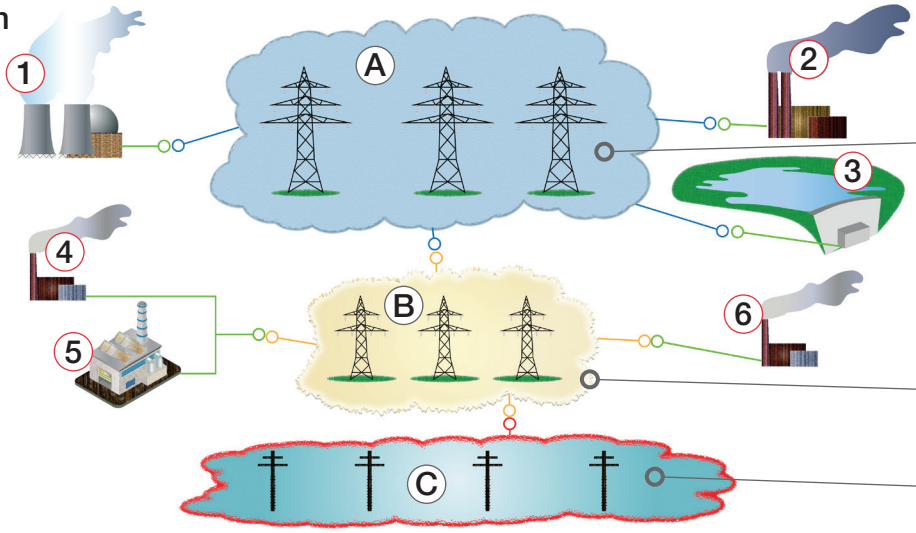
Macrogrid Diagram

Figure 1.

Macrogrid Voltages	
A	500,000
B	110,000
C	480/220/110

High Voltage Power	
1	Nuclear
2	Fossil Fuel
3	Hydro Electric

Medium Voltage Power	
4	Gas-fired
5	Diesel/Gas (CHP)
6	Fossil Fuel

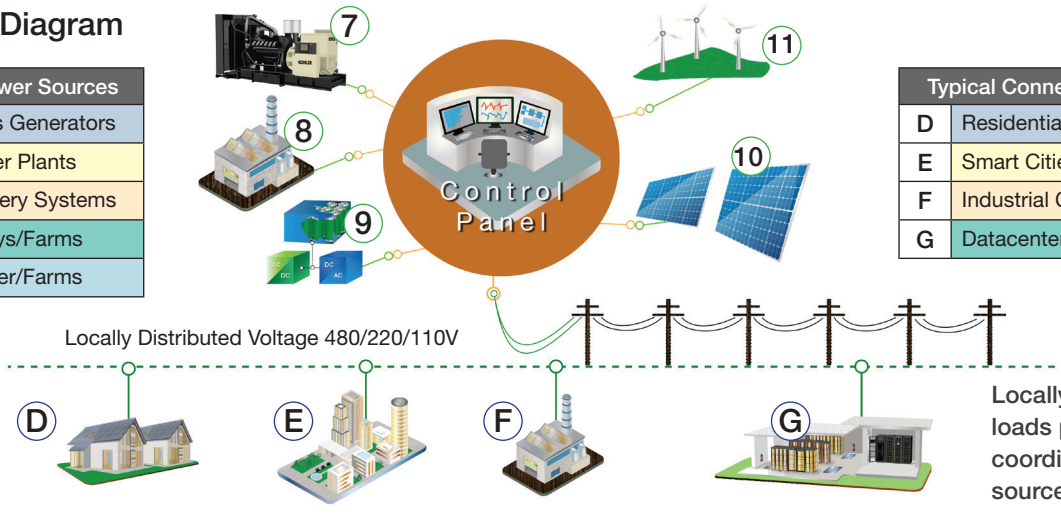


Microgrid Diagram

Figure 2.

Macrogrid Power Sources	
7	Diesel/Gas Generators
8	CHP Power Plants
9	Large Battery Systems
10	Solar Arrays/Farms
11	Wind Power/Farms

Typical Connected Loads	
D	Residential Areas
E	Smart Cities
F	Industrial Complexes
G	Datacenters



1.0 DEFINITION OF A MACROGRID: *(Continued from page 1.)*

Macrogrid power must be distributed over large distances. However, electricity flowing through a wire loses its power between the two points as the wire becomes longer. Early on in electrification, Macrogrid systems throughout the world adopted Alternating Current (AC) power, primarily because AC can be easily changed, through a transformer, to another voltage. To overcome power losses over long distances voltage from large power plants is stepped up to as much as 500,000 volts; then at the consumer end it is transformed down to 480/220/110 volts, (China is considering Ultra-High voltages of 1,000,000).When converted from the very high-volts to low-volts, the percentage of electric power loss in the wire over a long distance is minimized. (See figure 1)

2.0 ADVANTAGES OF A MACROGRID:

When electrification of towns and rural areas commenced, most power was generated at a local level. However, as the quantity of electrical consumers increased it became more practical to meet power requirements by building large decentralized power plants with the associated advantage.

2.1 SUPPLY WIDE AREAS THROUGH HIGH TENSION LINES - High tension, means high volts, lines can distribute to millions of customers from large power plants built for economies of scale. The larger the power plant the lower the unit of kW cost.

2.2 LOGISTICAL LIMITATIONS - Not many communities want a local nuclear plant or large fossil fuel plant. Hydropower is frequently generated in remote areas.

3.0 DISADVANTAGES OF A MACROGRID:

While the advantages of Macrogrid power generation system still apply, the primary disadvantages are:

3.1 UNRELIABILITY - Advances in technology, particularly our reliance on the internet and data-driven transactions/communication, result in a zero tolerance for power outages. The Macrogrid distribution lines/systems is frequently antiquated, suffer from lack of maintenance, and have become more exposed to extremes in weather a climate change occurs.

3.2 NOT A SMART GRID - Unlike other countries, the US never developed a truly connected smart grid system that could switch power automatically to many consumers over a wide area from many power sources, including renewable energy. In fact, some states such as Texas have made a point of disconnecting themselves from a national grid system.

3.3 WIDESPREAD POWER OUTAGES - When any part of the Macrogrid fails, or is overloaded, particularly at the source of power, a large area of power consumers lose power. Lack of investment is increasing susceptibility to power outages.

3.4 ENVIRONMENTAL - While hydro and nuclear are very low sources of emission, fossil fuel power generation plants are high emitters of greenhouse gases, particularly Carbon Dioxid (CO_2).

4.0 DEFINITION OF AND ADVANTAGES OF MICROGRIDS:

A Microgrid is a smaller grid or distribution system. Instead of large, decentralized power generation plants, power is now generated and distributed at a local level. (See figure 2) Several applications such as datacenters pioneered the adoption of Microgrids after determining their business model could not withstand the level of reliability of the Macrogrid.

While Microgrid systems lose the advantages of scale that Macrogrids can provide, they do offer the following advantages:

4.1 GREATER RELIABILITY - Most Microgrid systems use more than one source of power that is generated locally. (See figure 2) They are designed to easily switch from one source to the other as one power source goes offline. When Texas experienced wide power outages on its Macrogrid, not one Texas datacenter operation on a microgrid lost power.

4.2 ABILITY TO ADOPT SMART GRID TECHNOLOGY - As the distribution systems are local, and not spread across many states, smart grid technology is easier to apply with the ability to switch between several local power sources. Several cities are looking to adopt smart grid systems to increase renewable power input and adopt batteries for backup and peak power management.

4.3 AVOID HIGH TENSION DISTRIBUTION LINES - As microgrids serve local power demand it's not necessary to step up to high transmission voltages to avoid power losses over large distances. Fewer transformers are required and inverter AC output from renewable DC input sources can be accomplished at consumer voltages.

5.0 MICROGRID TYPES AND APPLICATIONS:

Microgrids have long been used in remote areas to power off-grid villages, military operations, or industrial projects. But increasingly they're being used in cities or towns, in urban centers, on university or corporate campuses, in hospitals, or at data centers. According to the U.S. Department of Energy, a microgrid is a group of interconnected loads and distributed energy resources (DER) within clearly defined electrical boundaries that act as a single controllable entity with respect to the grid.

There are three main types of microgrids: remote, grid-connected and networked.

5.1 REMOTE - Remote microgrids are referred to as operating in Island Mode, being physically isolated from the Macrogrid and always operating independently. Island mode systems can have several engine-driven generator systems, operating as prime or standby in coordination with renewable energy and battery power systems for lower emissions and greater efficiency.

5.2 GRID-CONNECTED - These microgrids have a physical connection to the utility grid via a switching mechanism at the point of common coupling (PCC), but they also can disconnect into island mode and reconnect back to the main grid as needed.

5.3 NETWORKED - Also known as nested, these microgrids consist of several separate DERs and/or microgrids connected to the same utility grid circuit segment and serve a wide geographic area.

6.0 ENGINE GENERATOR SYSTEMS WITHIN MICROGRIDS:

While Microgrids will switch between various energy sources, frequently, an engine-driven system is the preferred source of final power in the event renewable energy and battery storage is no longer able to supply the connected load. Also, combined heat and power (CHP) is often used to distribute cooling and exhaust heat to local sources for greater efficiency within the served grid.

To fulfill our commitment to be the leading supplier in the power generation industry, the Buckeye Power Sales team ensures they are always up-to-date with the current power industry standards as well as industry trends. As a service, our Information Sheets are circulated on a regular basis to existing and potential power customers to maintain their awareness of changes and developments in standards, codes and technology within the power industry.

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