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Reliable Power Professionals Since 1947

For many years, the application of reliable and inexpensive rural electrification has proven to be more challenging than the electrification of urban and suburban areas. For decades, the primary population growth has been in urban and suburban areas, but even so, one in six Americans lives in rural communities. The digital age, characterized by advancements in communication, agricultural automation, internet connectivity, and the transition to electric vehicles, has increased the dependence of all communities on electrical power, including rural communities. Rural electrification cooperatives were created to provide electricity to rural customers, as urban power suppliers didn't see the economics of supplying remote areas. Advances in renewable energy sources are being considered as a solution for rural communities' power requirements to make them less reliant on large remote utility grids. This information sheet discusses rural communities' adoption of renewable energy sources, microgrids independent of the macro grid. And how backup engine-driven generator systems can bridge the gap in energy supply when renewable sources cannot run at full capacity.

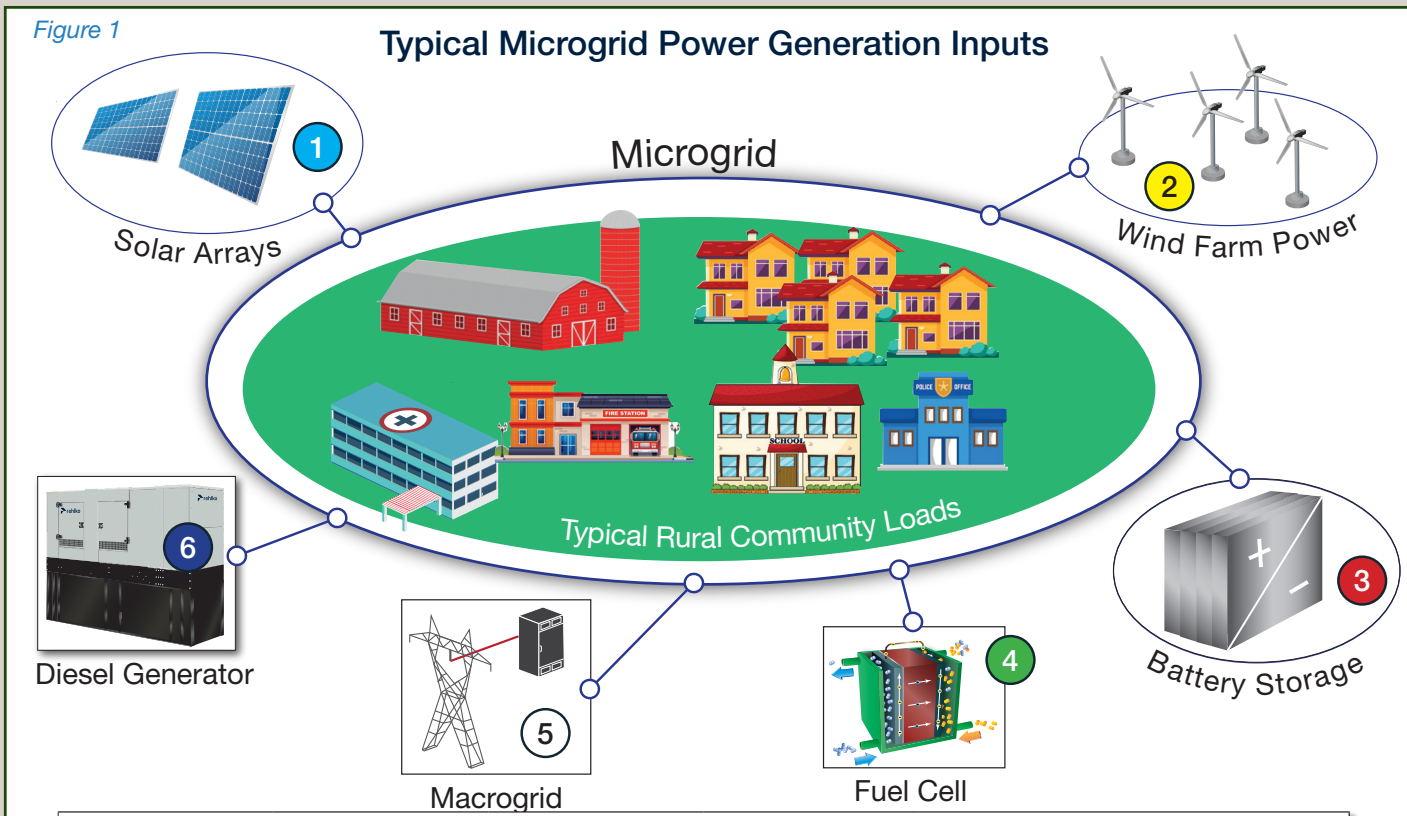
1.0 CHALLENGES TO PROVIDING RELIABLE POWER TO RURAL AREAS:

Rural communities, by the nature of their size and remoteness, do not have the economies of scale that large urban areas have. A larger electrical consumer base encourages competition and a more robust electrical distribution structure. Rural communities have a greater exposure to:

2.1 WEATHER RELATED POWER OUTAGES – Being rural, they tend to be situated at the end of a major utility supplier's distribution lines. When power goes out in major urban areas, the power supplier can reroute power from other sources; this is not always an option for rural power consumers being supplied from one source. Remoteness is also an issue for bringing power back online. It can be challenging to reach the source of the interruption.

Figure 1

Typical Microgrid Power Generation Inputs



Features and Benefits of Various Power Inputs to the Microgrid

1 Solar Power	2 Wind Power	3 BESS	4 Fuel Cells	5 Macrogrid	6 Generator
Renewable Energy requires energy storage to supply the load when solar power is not being generated. Uses inverters and rectifiers to input AC power.	Renewable Energy requires energy storage to supply the load when wind power is not being generated. Uses inverters and rectifiers to input AC power.	A Battery Energy Storage System (BESS) is there to store the renewable energy not used by the load. The size of the BESS can be reduced by using a generator.	Fuel cells are an efficient converter of energy, but only environmentally friendly green hydrogen (made from electrolysis) is used.	Some Microgrid systems are designed to feed surplus power into the Macrogrid and use Macrogrid power should it be required for some reason.	A diesel generator can store a lot of energy in its fuel tanks. Stored fuel can reduce the requirement for BESS, and energy can come online quickly.

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1.2 COST OF POWER – Lack of competition not only increases the kW hour costs of electricity, but also the incentive to maintain a more robust power distribution. This in itself leaves the distribution system subject to more outages

1.3 MEETING INCREASED ELECTRICAL DEMAND – Technological advances that increase society's reliance on a stable and increased power supply also impact rural consumers. Remote work, which relies on the internet, the automation of agriculture, the application of technology in community hospitals and schools, and the growing demand for electric-powered vehicles are all contributing to increased power demand, mirroring the demand from urban areas.

2.0 SOLUTIONS BEING CONSIDERED TO BRING MORE RELIABLE POWER TO RURAL COMMUNITIES:

As the nation's reliance on electric power has grown, new technologies and systems have been adopted to provide alternatives to fossil-fueled power stations and the outdated utility grid Network. Specific large power consumers with zero tolerance for power outages, such as data centers and telecommunication networks, have been drivers of more reliable power that also offers more "Green Power" solutions. These solutions, as it happens, also address the issues rural communities face in obtaining more cost-effective, reliable power solutions, examples of which are:

2.1 MORE THAN ONE SOURCE OF POWER – When remote and dependent on one source of electricity, your level of exposure to power outages is very high, and your ability to control costs is low. Data centers began to take control of their own power destiny by migrating to their own Microgrid systems. See the information sheet on Microgrids. A typical microgrid is designed to supply an extensive application or group of electrical consumers with an independent power system away from the Macrogrid utility power.

The Microgrid utilizes multiple power sources to meet its total power requirements, offering diverse options when one source goes offline or cannot meet the total demand. Also, having integrated power sources reduces reliance on a single large solution to meet all power needs; instead, you have multiple solutions in case one fails. Rural communities are shifting their focus from the Macro to Microgrids with the ability to use various power inputs.

2.2 RENEWABLE ENERGY – Advances in the adoption of renewable energy, particularly Wind and Solar, have attracted the designers of Microgrid systems. Since renewable energy systems do not always generate maximum power output simultaneously with maximum power demand connected to the Microgrid, it is necessary to implement Battery Energy Storage Systems (BESS).

2.3 INDEPENDENT BACK-UP POWER – While there is a preference for the primary power to be derived from renewable energy sources, the sun doesn't always shine, and the wind doesn't always blow; therefore, an independent Microgrid needs a stored energy source that can supply with no interruption any shortfall in power from the renewable energy sources.

While BESS energy storage is the first line of UPS backup, many critical applications, such as data centers, rely on large engine-driven generator systems to offset the cost of much larger BESS installations. The energy stored in a diesel fuel tank is sized to meet the worst-case scenario should primary power systems go offline.

Interestingly, in the early days of the electrification of small towns and rural communities, the solution was local engine-driven power stations. But as energy demand increased, utilities started to concentrate on larger power stations using hydro power plants, and steam power generation from fossil fuels (mainly coal), and later nuclear energy. This led to the development of the utility Macrogrid electrical distribution network, which connects large remote power generation centers to users across the country. Many rural communities shut down their independent generation centers and relied on the nationwide Macrogrid.

2.4 ALTERNATIVE ENERGY SOURCES – Since early electrification of rural communities, hydroelectric power has been a consideration; however, on large-scale hydro plants, much of the energy is prioritized for large urban users. Fuel cells are now being used as a clean energy source, when using green hydrogen, to power rural facilities such as medical centers.

3.0 SOLUTIONS BEING CONSIDERED AND ADOPTED TO BRING MORE RELIABLE POWER TO RURAL COMMUNITIES:

Rural communities that currently rely on a single source of power from the Macrogrid are transitioning to a Microgrid system. In some cases, the Microgrid is independent of the Macrogrid, but in others, power is shared between the two grid systems. See ***Figure 1*** depicting a typical Microgrid powering a rural community.

Challenges to implementation of a Microgrid include:

1. **Funding -** While the long-term cost savings of renewable energy, coupled with the benefits of a more reliable power supply, are well defined, an initial investment has to be made. FEMA the Federal Emergency Management Agency) has supplied funding in recognition of the out-of-proportion impact disaster scenarios have on rural communities. Other sources of funding can be at the State level, and in some cases, private investors.
2. **Backup to Renewable Sources -** Wind and Solar require BESS to ensure enough energy is stored for connected load during periods when the solar and wind energy are not available. Data center Microgrid applications calculate the cost benefit for less BESS when coupled to additional energy stored in an engine-driven generator's fuel tank.
3. **Green Hydrogen for Fuel Cells -** While applications such as rural hospitals are already using hydrogen, the challenge is to find green hydrogen. Some applications are looking into electrolysis from surplus power in the Microgrid. *See the information sheet on Fuel Cells.*

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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