WHITE PAPER

Engine-driven Generators and their Criticality in Microgrids

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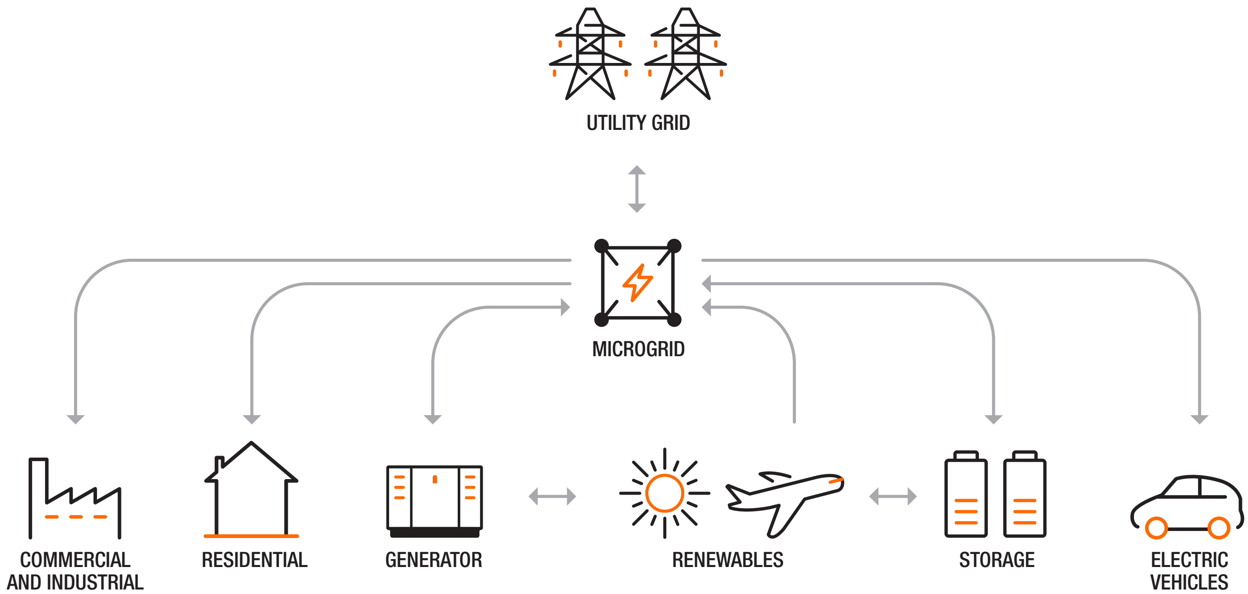
What is a microgrid today?

There is a buzzword in the industry today, and that is microgrid. Used with increasing frequency in webinars, case studies, conference presentations and more, the term microgrid has taken some metamorphosis in its meaning over the last 10 years. Today we see the term being used to describe almost any compilation of power generating technologies, which may or may not be grid-connected and have the ability to be islanded. Also, as creative minds continue to work on further developing more advanced technologies, like fuel cells and other renewable sources, we are sure to see this definition grow and change. The Department of Energy's Microgrid Exchange Group has officially defined a microgrid as "a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode." The Group goes further to list the many intended benefits of a microgrid as follows:

- Enabling grid modernization and integration of multiple smart grid technologies
- Enhancing the integration of distributed and renewable energy sources that help to reduce peak load and reduce losses by locating generation near demand
- Meeting end-user needs by ensuring energy supply for critical loads, controlling power quality and reliability at the local level, and promoting customer participation through demand-side management and community involvement in electricity supply
- Supporting the macrogrid by handling sensitive loads and the variability of renewables locally and supplying ancillary

So to react on the key points of the microgrid definition and benefits, we can confirm that a mix of power generation technologies can be present, a grid connection can be non-existent, temporary or omnipresent, the installation should have tangible financial or environmental benefits to the customer, and normally should integrate distributed energy resources with more historical sources (could be the grid) in order to provide a modernized and reliable source of supply. Microgrid applications certainly require an advanced overarching control system in order to manage and integrate diverse technology solutions, and optimize their usage for the customer for financial, environmental, and communal benefit for the customer or owner, including integration with the electric grid.

As we also see a stronger shift to electrification of transport, microgrids will make a stronger case for regional grid build out vs. standard centralized power plant construction. This additional strain on an already stressed national electrical grid is requiring all regional transmission organization (RTO) members to consider additional sources of supply that meet their customer's requirements to be sensitive to environmental and societal impacts. This is also supportive of the recent passing of FERC Order 2222 on Distributed Energy Resource Aggregation, which will act to push the industry to further consider microgrids. There are a variety of microgrid configurations that can meet this need in almost all climates and emissions constraints. It is actually the variety of technologies used in a microgrid that aids in their application flexibility, and will ensure this approach to distributed generation can be successful for decades to come.



Importance of the engine-driven generator in microgrid designs

As already discussed, the purpose of the microgrid solution is to provide cleaner, more efficient, and locally-created power when compared to utility-scale distributed power typically based on coal or nuclear. The benefits have been well documented in industry. Microgrid designs today typically start with a focus on the renewable aspects of the power solution. A recent study by global consulting firm Woods Mackenzie found that although a record number of microgrid systems were installed in recent years, most of these installations relied on power distributed from the burning of fossil fuels. A lot of energy and focus is placed on the solar, wind power, and necessary aspects of battery storage in the microgrid, and while these are of critical importance, one cannot and should not overlook the strategic importance of a backup source of power with high reliability. This is critically important in islanded or interruption-prone applications where residential, commercial and industrial power consumers cannot go without power for any extended time period. Adding the resiliency of fossil-fueled, engine-driven backup generation as a key component of the microgrid solution makes projects more feasible in almost all possible scenarios.

Engine-driven generators burning a variety of fossil fuels can provide a last-step resiliency for the microgrid that is not and cannot be offered by wind, solar, battery storage, or any other renewable source of power. It is a time proven approach and technology deployed in hundreds of different types of applications in millions of individual installations across the globe. These generators are required to ensure complete resiliency for today's microgrid, which has become and is further growing dependent on intermittent renewables.

Generator fuels of choice: diesel vs. vs. natural gas vs. propane

Once the microgrid project developer has confirmed their decision to include the resiliency of an engine-driven generator in the microgrid, the next discussion required is around the potential fuel supply options, and the advantages and disadvantages of each. For most applications there would be three main fueling options typically considered in stationary industrial generators: diesel, natural gas, and propane. Other fuel choices like biogas, renewable natural gas bifuel, heavy fuel oil, and hydrogen are or will continue to be niche offerings for the foreseeable future. The project specific options for fuel choice and logical solution set can be quite varied for each project and are influenced by such things as capital expenditure, fuel tank rental, fuel maintenance requirements, availability of natural gas pipeline, resiliency or total runtime required, site storage options, equipment maintenance, and exhaust emissions aftertreatment needs. A site with access to a natural gas pipeline has a very different project plan than one where stored fuel like diesel or propane is needed. Also, the cost of achieving and maintaining ultra-low emissions on a diesel engine, such as tier 4f final technology, can be different from a natural gas engine. Potential usage of the generator in economic dispatch mode can also have an impact on the fuel choice, as in many markets this would drive a diesel from EPA tier 2 compliance to tier 4f standards. Capital and operating expenditure considerations now just got a lot more complex!

When considering the general emergency standby market, the industry has seen a very strong move away from liquid fuels to natural gas for its clear benefits on emissions ,operating expense, and maintenance. The combination of these performance aspects, when combined with the unlimited operation provided by the reliable natural gas distribution system, will continue to drive the market in this direction. Recent shipment studies by the firm Frost & Sullivan have tabled the North America total generator set market (all application types and sizes) at about 40% natural gas, with a year over year increase in that percentage by 1-2%.

This increase has been the historical trend going back 10+ years, and market drivers like running costs, emissions regulations, and application flexibility will continue to favor natural gas over diesel if it is available. It is important to consider all aspects of the performance requirements on the generator before assuming one particular solution is the only way to go. These same trends that have affected the emergency generator market will have similar impacts on microgrids.

Two great examples of this approach are recent projects in which Generac Industrial Power generators have been utilitized. The first such case is the Kahauiki Village microgrid in Honolulu, Hawai'i. This microgrid is primarily powered by solar with battery storage, but will rely on a propane-fueled generator as an option (in addition to the grid) to charge the batteries if there is insufficient solar. This aspect is key in areas where storms are possible that could knock out the grid as the back up source of electricity, as well as to help avoid expensive demand charges that can be received when pulling grid power during high strain times. The second example is the Sagehen microgrid in Truckee, California, which was constructed to alleviate concerns around high-tension lines and their potential influence on sparking wildfires. In this application a remote microgrid was constructed to provide power to the local residents through a combination of solar and battery storage. However, due to the potential of low sun & high snow conditions, and limited battery storage, the containerized solution was designed with a propane stationary generator to provide a reliable source of standby power to charge the batteries as needed.


Pictures of the Kahauiki Village microgrid, where a propane generator is integrated with photovoltaic solar panels and battery storage.

Alternative uses and return on investment through economic dispatch

Alternative purposes for the generator and the type of revenue and return on investment that can be achieved, are often overlooked in the study of the microgrids. Generators are most often assumed to only be there in case of emergency, to be used in standby mode in case of complete failure of the solar/battery/wind technologies. It is becoming increasingly popular to enroll these normally dormant standby assets in such highly profitable utility support programs that go by names such as multiple peak reduction, global adjustment, demand response, daily dispatch, and others. These programs are all forms of economic dispatch, whether it is behind or in front of the meter. There are different regional programs that can be followed, where the engine-driven generator as deployed in the microgrid can be used for additional purposes beyond emergency support. Traditional peak shaving can also be conducted if such a system were installed at a business or manufacturing facility, the economics of such would be very site and utility rate specific.

Each opportunity to participate in such programs requires a deeper study around the project financials to determine its feasibility, payback analysis and return on investment. Many if not most applications will find a financial return that can be complementary to other cost avoidance that may have been included in the initial project proposal. A key point to be considered here is the influence on emissions and fuel choice, as there are regulations and expenses to be studied and fully considered when taking the engine-driven generator from a standby use case to now a “beyond standby” application, which may consume more fuel, operate more hours, reduce allowable engine specific emissions, and change the maintenance requirements on the engine. The other aspect to consider is that running more hours burns more fuel, which can require a different fuel storage and refill plan if it is a fixed fuel storage unit like diesel or propane than if the generator was connected to an unlimited fuel supply like a natural gas pipeline.

The utility scale microgrid

There is an additional trend in the distributed generation space where engine-driven generators can be cost effective aids to the local grid, and that is the utility scale microgrid. With the overall aging of the grid and increasing dependence on intermittent renewables, the grid today is facing great challenges to reliability and resiliency. In many parts of the country, these challenges have boosted opportunities for demand response programs and other forms of economic dispatch. And while actions like demand response are normally discussed at the end customer level and in the form of load curtailment, there is a growing opportunity to address these issues with purpose-built utility scale power plants. These plants can be configured with natural gas generators and offer a cost-effective means of addressing the market power gap without concerns for fuel supply limitations. An example of such a project was recently commissioned in PJM and shown in the included picture.

A 10 MWe utility scale microgrid recently commissioned in the midwestern U.S. consisting of 16 x 625kWe natural gas generators.

This project utilizes large industrial natural gas generators from Generac to provide several benefits to the grid and local power consumers. During times of grid supply shortage, the generators can be quickly started and tied to the grid to push power into the local network and ensure adequate supply coverage. This ensures no chance of rolling brownouts or other grid interruptions, as well as serves as another example of demand response at a larger scale than an end customer. A secondary benefit of this site is its ability to act as a local source of reliable power in the event of a grid emergency that takes out power to the local city. Such an outage is typically the result of weather-related events as most of the local transmission and distribution is provided by above ground poles and wires.

So what does this all mean?

The microgrid and related approach to distributed generation is a growing trend in the power generation space – this cannot be argued! The technologies used in these solutions are ever changing and driving ingenuity in the control schemes used to provide seamless operation and transition within the power station. However, for the foreseeable future, there will continue to be a need for reliable and resilient solutions to ensure that power is always available. The solution for now and for the coming decade will continue to be a fossil-fueled, reciprocating engine-driven generator, which enables ultimate application flexibility to have the microgrid operation available whenever it is needed. Also further consideration for turning that asset into a revenue generator, and not just a power generator, should not be overlooked.

About the Author

Joining Generac in July of 2017 and based out of its Waukesha, WI, headquarters, Corey is the Sr. Director tasked with growing the Industrial group's market reach with gaseous generator and beyond standby applications. His focus has been around developing go-to-market partnerships that open doors to microgrid and similar installations where the generator is used as more than a stranded asset. Prior to joining Generac, Corey had over 20 years of engineering and commercial expertise in the field of large industrial natural gas engines and generators. Corey is a graduate of the University of Wisconsin with a B.S. in Mechanical Engineering, and a Masters of Engineering of Engineering Management/ Professional Practice. He is a licensed Professional Engineer in the State of Wisconsin.

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