What is a microgrid controller, and do I really need one?

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"Does your firm make a microgrid controller?"

I have been asked that question many times. I am often tempted to respond, "Yes, it is on the shelf just below the CHP plant controller, to the right of the chiller plant controller." But alas, instead I always offer some guidance that a microgrid, like any other complex integrated process, requires a well-designed microgrid control system, not simply a controller (or magical "flux capacitor").

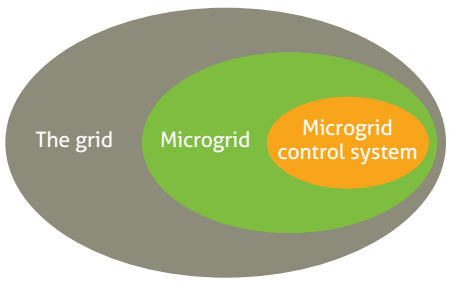
We define a microgrid as a group of interconnected loads and distributed energy resources that acts as a single controllable entity with respect to the grid. A microgrid has the ability to disconnect from the grid (operate in island mode) or operate in conjunction with the grid (parallel mode). In order to be operated safely and effectively, and transition from one mode to another, a microgrid needs some type of intelligent control.

Let's back up a bit. Way back to our college days. One of my favorite classes in engineering school was Set Theory. You may recall that a set is characterized by a well-defined collection of objects. Think about it: The electrical grid could be considered the ultimate infinite set. A never-ending collection of generation and consumption assets (or "objects," as we call them in set mathematics). A microgrid and its objects can be considered a subset of the grid (fig. 1). There are many of these microgrid subsets within the grid. A single microgrid is composed of many objects including generation equipment, loads, distribution equipment and a control system. A control system you say? Yes, a collection of objects that is a subset of the microgrid. The objects in this set may include intelligent protection relays, power meters, time synchronization equipment, operator interfaces, data collection equipment and a logic controller to execute a sequence of operation. The logic controller is just one object in a microgrid control system set.

WHAT DOES A MICROGRID CONTROL SYSTEM DO?

A microgrid control system can provide safety interlocks as well as remote control and monitoring of loads, breakers and equipment. It can provide supervisory control and data acquisition including operator interfaces, dashboards, historical data collection, reporting and alarming.

FIGURE 1. Microgrid Venn diagram.



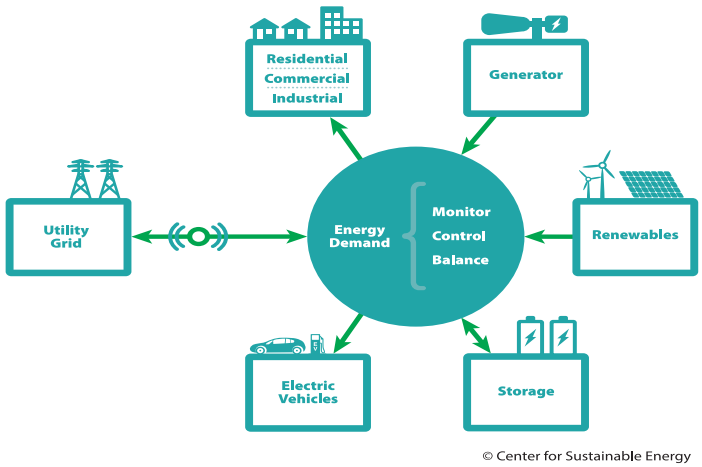
Source: David Musto, Thermo Systems LLC.

The microgrid control system can provide the interface to the local utility for transfer, trip and remote monitoring; further, it can provide automatic load shedding and load restoration. And more sophisticated systems may also provide demand response, frequency response, import/export control, time synchronization, sequence of events forensics and even economic dispatch to take advantage of ever-changing loads, electric rates and fuel prices.

When designing, or specifying, a microgrid control system, I recommend using the same good engineering practices you would employ in any project endeavor. Start by defining your user requirements – at a high level of focus on safety, compliance, reliability and efficiency. In that order. The safety of plant personnel, equipment and bystanders is paramount. Compliance with the local authority having jurisdiction (AHJ), utility and your operating permits is next. Reliability and then efficiency, in both dollars and environmental impact, must also be considered.

Next, dive into the detailed requirements. What functions does your microgrid control system need to execute? Be specific. What does your microgrid control system need to be able to do during normal operations? How about during upset or emergency conditions? And what does it not need to do – both now and in the future? Remember the control system design must be developed in concert

FIGURE 2. Microgrid control functions.



Source: Center for Sustainable Energy (https://energycenter.org/self-generation-incentive-program/business/technologies/microgrid).

with the overall electrical design of the microgrid (fig. 2).

Microgrids by definition have the ability to connect and disconnect from the grid. This requires the use of industry-standard communications protocols. Your local grid operator will have very specific requirements in this area that you must meet. An example is DNP (Distributed Network Protocol) 3.0, which is widely used by Con Edison. Your design will need to capture these needs.

Other standard protocols to become familiar with include IRIG-B (Inter-Range Instrumentation Group), which is an industry-standard time synchronization protocol. Time synchronization is often accomplished using GPS antenna-based equipment to synchronize the computer clocks in all the major equipment. The microgrid control system administers and distributes the time sync. Another standard to become familiar with in your design is IEC 61850 – a part of the International Electrotechnical Commission's (IEC) Technical Committee 57 reference architecture for electric power systems. Many electrical equipment manufacturers are adopting the IEC 61850 standard for substation communication and automation.

I recommend to my colleagues to stick with nonproprietary solutions using industry-standard protocols. You can choose to select a complete suite of components from one manufacturer, including the metering, relays and application controller. Or you can select the best fit from multiple manufacturers for each need. A well-designed microgrid control system using industry-standard protocols will seamlessly integrate the many objects in your system subset for a harmonious operation. And nonproprietary solutions offer you flexibility before, during and after construction.

WHAT DOES A MICROGRID CONTROL SYSTEM LOOK LIKE?

Microgrid control systems, like their district energy and combined heat and power control system cousins, come in many different shapes, sizes and colors. Many of the major electrical equipment manufacturers all make control systems hardware and software to support microgrids. The brain of a microgrid control system is an intelligent microprocessor-based controller that can be programmed to execute a custom sequence of operations to carry out the functions defined in the user requirements. This control function may be inherent and executed within a larger plantwide distributed control system. Or it may be a standalone programmable logic controller that specifically handles the microgrid functionality. You may also see the term "PMCS," or power monitoring and control system. Often, the PMCS will communicate with the plant control system in a CHP or district energy application to provide integrated control and information sharing for the execution of the plant operation.

NOT JUST A NIFTY CONTROLLER

The microgrid control system is a collection of objects within the microgrid. The controller is just one of the objects in this subset. Selecting a good microgrid control system is not at all like picking out a sports car. Don't just select the shiny, fast, red one from the catalog. Take the time to develop a good user requirements specification. Next, develop a detailed design around nonproprietary hardware and software solutions that leverage industry-standard protocols. Coordinate the microgrid control system design with your overall electrical design.

Success – meeting the goals of your user requirements – will require more than just selecting a controller. It will come from designing and deploying a well-thought-out integrated system of components.

***David Musto** is the president and CEO of Thermo Systems LLC, a control systems integration firm that he cofounded in 1998. At Thermo Systems he leads a team of over 100 professionals in the design, construction, commissioning and support of industrial process control systems for microgrids, district energy systems and manufacturing facilities. Musto served two terms as an IDEA board member and is a current board member of the Microgrid Resources Coalition. A graduate of Rensselaer Polytechnic Institute, he is now focused on the recruitment and development of the next generation of engineers into the district energy business. He may be contacted at david.musto@thermosystems.com.*