Exploring Industrial-to-Grid Interoperability - An Overview

Dave Hardin
GridWise Architecture Council

Introduction

Industrial manufacturers are both major generators of electrical power and major consumers of electrical power. This dual role provides industrial facilities with an opportunity to adapt to grid modernization and rising energy costs through a combination of increased local distributed generation, improved energy management and demand response.

Local Distributed Generation

Expansion of local generation capacity can take advantage of the existing infrastructure to ease integration and reduce installation and support costs. This includes organizational support for addressing administrative and legal requirements such as the permitting process. On-site renewable sources could augment local power during normal operations but be diverted to peak-shaving when needed. The downside of these distributed energy sources is that they are usually dynamic and are easily influenced by external forces. This causes them to be unreliable and in some cases unpredictable. Such behavior is in stark contrast to the high reliability that the electric grid demands. A highly diversified solution consisting of conventional generators along with renewable generation could offer the needed reliability.

Demand Response

As the grid is modernized, changes will start occurring that make it economically advantageous for industrial facilities to adjust operations in near-real-time to market-driven energy prices and to respond in real-time to grid alerts.

Industrial plants consume power equivalent to residential loads and commercial loads. From an electrical point-of-view, the main difference is that there are fewer, but larger, industrial loads than commercial and residential. The ability to rapidly reduce electrical consumption in response to external grid events could allow a plant to conceivably reduce power demand that is equivalent to small reductions in a large number of homes. This is very dependent upon the specific manufacturing process and the level of automation and flexibility that the manufacturer has in shedding load and suspending operation. These can be complex decisions which must be made in real-time based on economic and manufacturing information.

Interoperability Revisited

Widespread adoption needs interoperability and standardization. The communications and control interface between real-time dispatching systems and field-installed automation systems needs to be defined in such a way that vendors can market installation-ready components. These would provide the proper high-performance communication interfaces and configuration capability to enable "plug and play" integration with the dispatching system over modern broadband networks.

It's important to understand that interoperability extends beyond just the selection of low-level communication protocols for basic and network connectivity. It requires interoperability at a systems level. The information messages that are exchanged must be defined syntactically and semantically. This means that both the structure and meaning of the information exchanged must be well-understood. But even this isn't enough. Most standards are based on a generic view of information and therefore must also account for the specific business environment that provides the real-world context for the information exchange. And this only covers technical and information aspects of interoperability. There must also be commercial and legal agreements and contracts in-place between the utility and owner of the remote generation resources. And without the local Public Utilities Commission and FERC/NERC approval, much of what has been discussed will remain just that, discussion. The bottom-line is that interoperability is complex.

As an aid, the GridWise Architecture Council (GWAC) developed the "GridWise Interoperability Context-Setting Framework". This document categorizes the many facets of interoperability and describes what is required in order for systems to achieve interoperability. These categories build upon each other into what is sometimes referred to as a "communication stack". The Interoperability Framework is available for download from the GWAC web at: http://www.gridwiseac.org/pdfs/interopframework_v1_1.pdf.

Industrial-to-Grid Interoperability

One way of exploring needs and requirements is a modeling technology called "Use Cases". "Use Cases" are used to build scenarios that describe how systems are envisioned to be used. These are then explored in detail so that more specific interactions and requirements can be identified. They are high-level by design but a great place to start exploring Industrial-to-Grid connectivity. Keep in mind that there are many complexities and uncertainties that need to be resolved before attaining COTS "plug and play" interoperability.

A few interaction scenarios for monitoring the status of different generation sources at a remote location might include:

1. Remote Site Diesel Generator Data and Alarm Monitoring
2. Remote Site Wind Farm Data and Alarm Monitoring
3. Remote Site Solar Array Data and Alarm Monitoring
4. Remote Site Fuel Cell Data and Alarm Monitoring

Scenarios for controlling various generation resources at a remote site might include:

1. Remote Site Diesel Generator Dispatching and Control
2. Remote Site Wind Farm Dispatching and Control
3. Remote Site Solar Array Dispatching and Control
4. Remote Site Fuel Cell Dispatching and Control

Scenarios for load shedding at a remote site might include:

1. Remote Site Grid Event Notification
2. Remote Site Load Monitoring

Scenarios for load management at a remote site might include:

1. Remote Site Grid Power Costs

Notice that each of these interactions needs a lot more definition, but the name alone does start the process of describing some functionality.

Drilling into the load management scenario, one could easily imagine a database server, located somewhere on the Internet, which contained retail and wholesale day-ahead hourly pricing. This pricing data could be published through a standardized, well-known Web Service interface. A site-located energy management system would be able to access this pricing data using an identification mechanism such as region, zip code or company ID. The pricing data would then be input to economic calculations and intelligent decision making after which control actions would be taken if needed. But what happens if pricing information is also made available at hour or 30 min intervals? It's important that there is a standardized way for different pricing mechanisms to be discovered by the energy management application without manual intervention. Different utilities will have different pricing capability and the interface needs to take this into account. What about time information. Can the application request the date/time format, discover it or is it a fixed? Should this information be openly available to everyone or should the interface be secured? How often will an application access this information? Will text-encoding provide sufficient performance?

The interface needs to take into account these issues and many more if it is to remain stable over time. This is a critical point. An interface that changes quickly becomes useless. The cost of changing software to track interface changes must be avoided. This requires that the interface be well thought-out, well-designed and well-defined.

As an example of this, the IEC 61850 Part 7-420 specification has already defined a logical model for the integration of Distributed Energy Resources into the IEC 61850 standard. Although IEC 61850 is primarily targeted toward transmission and distribution substation automation, many of the concepts are directly applicable to industrial automation systems. Grid operators would like distributed generation systems to "appear" the same, regardless of whether they are integrated directly through a distribution center or located on an industrial site such as a refinery. Where they are located and who owns them is important information for asset support and maintenance but these differences should not obstruct the operational view of the resources. This requires a common, cross-industry object and service model. Can this model be implemented as a standard OPC Unified Architecture information model? If it can, then industrial vendors of Programmable Logic Controllers can implement the model as part of the configuration system thus minimizing installation, configuration and commissioning cost while improving interoperability.

Achieving comprehensive, low-cost I2G interoperability needs a lot more analysis and will take time and effort. But there's no time like the present to start…