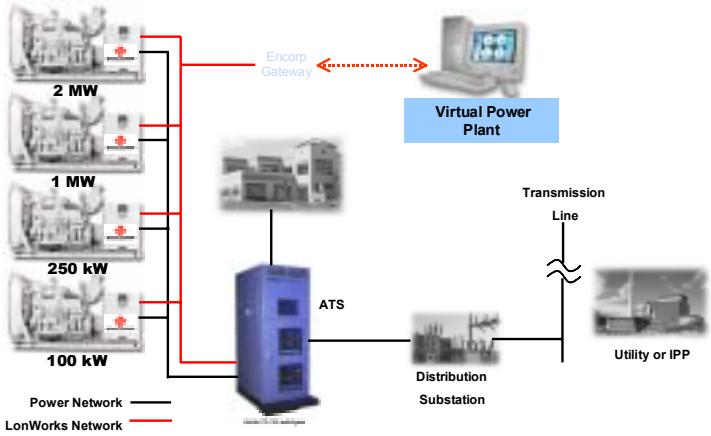
The Gas Technology Institute and Encorp Inc.

Innovative Interconnection and Control Systems

Goals

A significant need exists to make distributed power (DP) installations more compatible and cost-effective when interconnecting and integrating them with the utility grid and energy management systems. Efforts under way are returning demonstrable results toward providing total solutions through the delivery of high-value technology, information, and technical services. Key enabling hardware, control logic, and communications capabilities and features are being developed, built into system-level integrated solutions, and demonstrated and validated in conventional and emerging DP technologies and products.

The Gas Technology Institute (GTI), in partnership with Encorp Inc., is developing innovative interconnection and control systems for DP implementation.



Conceptual representation of technological enhancements for distributed power

The overall goals of the GTI/Encorp project are to:

- Develop cost-effective DP interconnection products, software, and communications systems to improve the economics for a broad range of DP systems
- Enhance the capabilities of DP products by providing operational benefits to the electric power system and advanced building energy management systems through DP integration and interaction.

To accomplish these goals, Encorp is developing new, technologically enhanced devices, including an advanced controller, a power sensor module, and revenue-grade meters. It is also developing communication capabilities. All of these were demonstrated during a DP systems interconnection demonstration and will be further tested in future demonstrations.

Current Results

Advanced Controller

To address the technical and market needs of the emerging distributed power market, GTI and Encorp are developing a significantly enhanced core controller technology. The controller is designed to provide flexibility and expandability to meet the needs of both small and large distributed generators. By being designed to accept several pulse inputs, it will have the capability to integrate and interface with multiple DP systems and multiple revenue-grade meters.

The resultant technical advancements — along with other product features — are helping meet the overall goals of improving DP economics by lowering total costs for interconnection while simultaneously providing added features and performance. This is all being accomplished in accordance with industry standards.

Power Sensor Module

The power sensor module (PSM) is a stand-alone intelligent module powered by high-power digital signal processor technology. The primary purpose of this module is to interface with multi-phase voltage and current transformer inputs. This module will perform extensive signal processing and management of the input information and transfer the resulting values to the controller module. This module will contain relay outputs, digital inputs, solid-state digital outputs, and software to perform several protective relay functions.

The protective relay functions comply with all the requirements of the P1547 standard. Further, the PSM will be able to incorporate additional protective functions as needed for specific design applications.

Communication Capabilities

A critically important element of this interconnection and control systems development project is the incorporation of an expanded set of communication capabilities. This includes communication pathways to intertie with existing and future energy management systems, electric utility command and control centers, independent system operators and regional transmission operator organizations, and other participants.

Given the breadth and complexity of the communications landscape, it is imperative that the new controller design incorporate sufficient capability and flexibility to accommodate historic communication protocols and practices as well as evolving developments. Encorp has identified a number of communications capabilities that

would allow interface with higher-level systems for uses such as monitoring, analysis, dispatch, and metering.

Revenue-Grade Meter Interface
It is important to incorporate features common to the most widely used electric demand meters while allowing for innovation in the development of revenue-grade meters. Encorp has developed a meter interface that can receive signals from Form C relays (also known as KYZ relays). A Form C relay changes state with each rotation of an electric demand meter disk. This output can be read by the interface, and the energy usage can be extrapolated from the number of meter-relay state changes.

Interconnected DP Device Demonstration
To establish, via firsthand experience, the interconnection and communications issues of DP systems, a case study was done on the Chowchilla II (Chow II) power generation station in Chowchilla, California. Encorp designed the controls and switchgear system for this plant.

Chow II included a prototype version of some of the features to be incorporated in production versions of the advanced controller. This prototype hardware was not integrated in the same manner as planned for the advanced controller, but it served as a model for those capabilities that are to be integrated into the advanced controller.

The Chow II power plant is a 25-MW facility powered by 16 Duetz natural gas-fueled generator sets operated in parallel with the local utility. Individual generator measurements were passed to the communications processing modules in each system, which passed them to remote monitoring and control facilities where the generators were controlled.

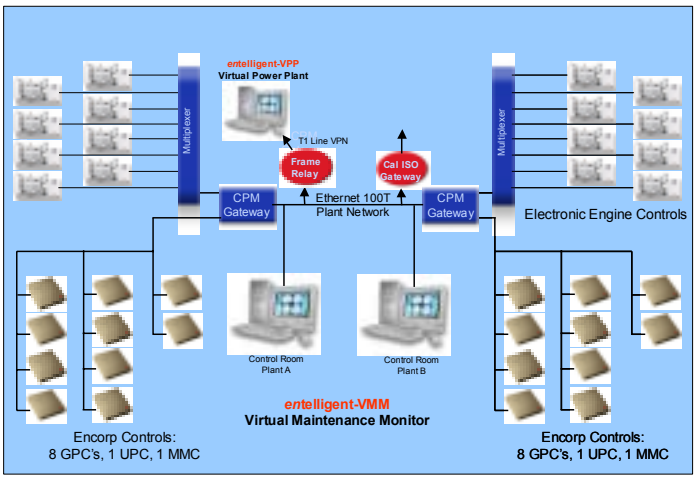


Diagram of Chowchilla's communications architecture

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Overall, the resultant work has achieved the following prototype advances:

- A 20-fold performance improvement through the use of a high-speed controller central processing unit and a high-speed digital signal processing chip
- A 40% reduction of the controller footprint/volume
- Reduced customer installation and maintenance costs through improved packaging with a simplified strategy for the wiring of terminals and connectors
- Manufacturing cost savings projected at 15%–20%
- Increased control capabilities through the design of an anti-islanding control scheme and a loss-of-synchronization control scheme
- Overall grid interconnect system capital and installation cost savings through the elimination of added system hardware that is now intrinsic to the advanced controller (i.e., improved firmware and communications capabilities)
- Increased design flexibility for compliance with current and projected industry standards for switchgear and interconnection devices
- Increased functionality available for the DP customer
- Demonstrated functionality (under the Chow II case study).

Distribution and Interconnection R&D (Formerly Distributed Power Program)

DOE's Distribution and Interconnection R&D supports the development of technologies and policies that enable distributed generation (e.g., photovoltaic systems, wind turbines, fuel cells, and microturbines), storage, and direct load control technologies to be integrated into the electric system. Through a collaboration of national laboratories and industry partners, DOE's Distribution and Interconnection R&D pursues activities in: (1) strategic research, (2) technical standards, (3) distribution system technology, (4) interconnection technology, and (5) mitigation of regulatory and institutional barriers.

Contacts
NREL Technical Monitor
Tom Basso (303) 275-3753
National Renewable Energy Laboratory
1617 Cole Blvd.
Golden, CO 80601

NREL DEER Technology Manager
Richard DeBlasio (303) 275-4333
National Renewable Energy Laboratory
1617 Cole Blvd.
Golden, CO 80601

DOE Manager
William P. Parks (202) 586-2093
U.S. Department of Energy
EE-2D/Forrestal Building,
1000 Independence Ave., SW
Washington, DC 20585

Additional Distributed Power Information
http://www.eren.doe.gov/distributedpower