

## Capstone Turbine

Location – USA

**Project Introduction:** Capstone Turbine Corporation is the world's leading producer of low-emission microturbine systems and was the first to market commercially viable microturbine energy products. Capstone Turbine has shipped more than 4,000 Capstone MicroTurbine® systems to customers worldwide. These award-winning systems have logged millions of documented runtime operating hours.

Capstone C600, C800 and C1000 turbines are the latest additions to Capstone's line. These turbine packages provide a single control point interface, single fuel connection, and deliver 600kW, 800 kW or 1 MW of power output through one power connection. These packages feature a new Capstone custom control system with full-featured 12" touch screen graphical user interface and specialized control algorithms that deliver power as required by the application. The new connections maximize overall efficiency, sequencing maintenance intervals and coordinate changes in power demand. A full- featured HMI on the updated Capstone controls package greatly simplifies operation for the end-users and provides more insight into the operation of Capstone's microturbine power generation package.

### **System Requirements:**

Earlier versions of Capstone Microturbines and ancillary products used custom-designed controllers. In later years, these initial designs created several issues that Capstone needed to overcome, including:

- Processor and memory space restrictions.
- Incompatible with newer technologies (TCP/IP, Open Protocols).
- Parts obsolescence.
- Time-to-market for new features.

To overcome these issues, Capstone developed APS, an earlier version of the C1000 controller, on a standard off-the-shelf platform. The standard platform for the APS pretested well and included several pre-qualified standard utilities and software features. It was designed to replace a customized platform developed in-house, which behaved as a master to multiple microturbines. APS also allowed Capstone to incorporate features from several ancillary products into the one device. Although, the porting and redesign of software to run on the new platform took significant effort, it greatly reduced the time to market for new feature enhancements.

Compared to previous generation product, the new C1000 turbine controller has additional requirements, including new software algorithms, a bigger screen and more processing power. Capstone's earlier decision to use a standard platform allowed the company to port APS software to the newly selected C1000 controller platform in only a few weeks. Capstone then developed new algorithms which is Capstone's core technology.

The standard platform allowed Capstone to successfully leverage all APS work into developing the C1000 controller.

Because the Operating System is a key component of the standard off-the-shelf platform, Capstone had several requirements for the C1000 controller.

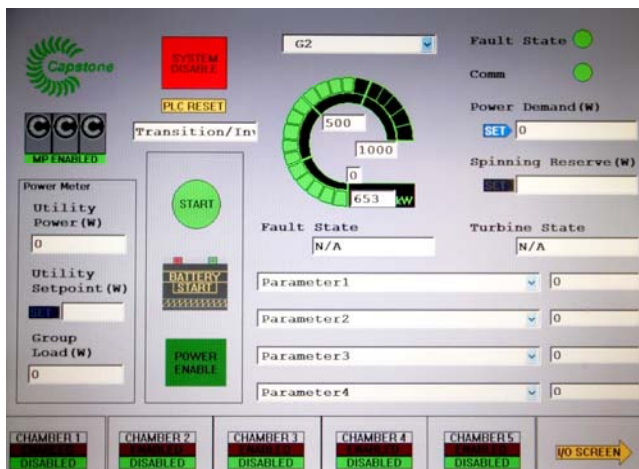
- Support several hardware platforms from multiple vendors.
- Ability to port existing application software between various platforms to avoid hardware obsolescence issues.
- Standard software that can be interfaced to a wide range of hardware devices.
- Availability of standard software utilities, including 3<sup>rd</sup> party software.
- Availability of software utilities, including 3<sup>rd</sup> party software and development tools.
- High reliability and low cost.
- Well established operating system that is familiar to software engineers.

The Windows CE operating system easily satisfied all requirements. Capstone even realized other unanticipated benefits – particularly during field deployment and maintenance of the C1000 controller. Familiarity with the interface made these tasks easier for Capstone field personnel.

Capstone prides itself on providing their customers with a reliable, easy to use system. Fortunately, the intuitive GUI used on the Windows CE platform for the C1000 controller provides a high level of detail in a clear and easy to use manner. Also, the larger 12” screen – the one visible part of the controller – an excellent marketing benefit.

### Project Implementation:

- TPC-1270



## **System Description:**

The C1000 controller is the main controller for the C1000 turbine product. It monitors and controls the various electronic modules which, in turn, manage the turbine's multiple power modules. This is accomplished by incorporating several control algorithms that allow for maximum system efficiency and accommodate customers' specific application needs. The controller also provides HMI for end-users to interact with and the means to interface the microturbine with such existing systems at the customer site, such as, SCADA, DCS, and BMI (Building Management Interface).

The main controller requires various kinds of hardware interfaces to communicate with and control the turbine's electronic modules. Off-the-shelf PC platforms, along with other off-the-shelf converters, provide all the required interfaces without the need for lengthy hardware development. Additionally, the Windows CE platform comes with required drivers, which reduces software development efforts. The C1000 controller was designed with scalability and flexibility in mind. It allows for easy expansion of customer required I/O, through the addition of low-cost, off-the-shelf I/O hardware – again, without in-house development.



Flexibility is further achieved through configuration files which, if necessary, can be read and edited on PC's

and moved between the controller and PC using standard PC-based tools like Excel and FTP clients. Further, its modular software design, which uses modern Windows-based technology, allows addition of features through creation and loading of new software modules onto fielded systems without major interruptions.

There was an initial concern R&D would be slower with the change in brand and size of touch screen HMI. The portability of the Windows CE platform, combined with the large product line at Advantech, allowed Capstone's Advantech representative to select a model substantially similar in build to Capstone's previously used component, which allowed the company to minimize this R&D delay.

### **Conclusions:**

Initial production units of the C1000 controller are working well. Capstone's customers and distributor have enthusiastically accepted the new GUI and larger 12" color touchscreen (versus the older 8" monochrome touchscreen). In addition, the company brought the C1000 controller to state-of-the-art with minimal cost and R&D impacts. Capstone will roll out the larger 12" color touchscreen on other control products in the near future.

In addition, the company will consider larger touchscreen sizes and HMI-only displays for integration with PLC based controls solutions.