Zinc Whiskers

By Bruce Myatt and Bob Krizman

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Off-Grid Computing with On-Site Critical Cogeneration Power Plants

High availability data center and no grid

Over the last five years, the U.S. Department of Energy and the largest electrical utilities across the country have been working continuously to develop workable scenarios for meeting the future electrical power demand of our data centers. With the demand for IT increasing exponentially, many have concluded that our generating and transmission capacities are both stretched to the extent that we need to consider alternative and renewable sources of energy. Only in that way can our data center community do its part to reduce our reliance on foreign oil and postpone the obsolescence of our national grid.

Aerial view of the new TDC facility.

As the available capacity of our existing utility infrastructure continues to be depleted, our big internet and technology companies are forging ahead with plans that will lead the way for the rest of us to meet the expectations of the public. Continuing to think outside the box, Apple and eBay are planning to power their data centers with natural gas fuel cells. And Microsoft recently announced plans to power its data centers with methane off-gases from landfills and wastewater treatment plants. Even solar and wind energy are being seriously considered in new designs to supplement the demand for IT power, and other solutions are making the news too.

OFF-GRID COMPUTING

Recently, I had the privilege of leading the development of another model destined to help lead us to a better energy future. The patent-pending design, conceived by developer The Data Centers (TDC) combines best-in-class data center energy efficiencies with the efficiencies of on-site co-generation and tri-generation plants that can operate as an island without relying on the electrical grid as a backup. That means that critical power generation with gas turbines, steam turbines, and adsorption chillers back up one another to power and cool the data center while the owner sells excess power back to the grid. The concept provides for flexibility in site location, eases the strain on the local existing electrical grid infrastructure, and provides one of the most economical of alternative energy solutions available.

According to co-author Bob Krizman, president of TDC, "Our objective is to deliver an integrated power generation plant and managed services data center that will cost the least to build and to operate while providing the greatest level of operating reliability and uptime." The design project turned into a real exercise once we began to identify the multitude of variables involved with the efficient operation and power transition considerations of TDC's independently powered data center. A well-equipped and responsive design team analyzed about 30 different facility configurations to define the most favorable total cost of ownership (TCO) configuration for this world-class facility destined for a site on the Eastern Seaboard.

In the TCO analysis, costs of construction and costs

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of operations were considered along with sources of income, such as sales of electricity to customers, sales of electricity back to the grid, and sales of steam and chilled water to a local consumer. Since the design of the power plant is inextricably tied to the operation of the data center and third party off-takers of steam and water, our schematic planning required a detailed evaluation of capital and operating costs at multiple levels of facility occupancy. The TCO analysis closely assessed three key measures of success for the design of today's most advanced data center facilities, including efficiencies in operations, economies in the cost of construction, and flexibilities to accommodate future change.

A fundamental and important characteristic of both the data center and the power plant is the modular design and modular plan for deployment of each. The design allows the operator to continually optimize overall facility performance while meeting the power, space, and cooling requirements of the customer, which dramatically improves the efficiencies and economies of the facility as it is deployed over time or as operating economies change. The modular deployment of space provides exceptional flexibility in both the build out and the operations of the facility. As the demand for space evolves over time, each pod is built out only when needed. By using readily available components and waiting to the develop the white space in a "just in time" fashion, the owner can postpone the capital costs of expensive mechanical and electrical support equipment and also avoid unnecessary operating costs until the space is needed.

THE DATA CENTER

The TDC data center will be one of the largest data center facilities in the U.S., and probably the world, as measured by megawatts (MW) of computing power capacity. The facility is designed to provide a total of 112 MW of computing power in about 200,000 square feet (sq ft) of white space. Each of two modules will be made available in eight pods of 7 MW each and about 12,000 sq ft of white space per pod. The facility is designed to operate at very high computing densities while allowing for various levels of availability and power density within the same space and providing the flexibility needed for a variety of computing operations to co-exist side by side.

The data center's cooling systems are designed specifically for local weather conditions considering local temperature and humidity levels to achieve a maximum utilization of "free cooling" with outside air. Cooling systems that were considered and compared include chiller plants, cooling towers, air and water economizers, air and water-cooled packaged HVAC units, and DX refrigerant systems. The design allows for either direct or indirect air-cooling systems that will control the quantity and quality of outside air entering the computing spaces depending upon the requirements of the customer.

Backup DX cooling systems intended to trim or replace the outside air systems, when required by outside weather conditions, are designed to provide low (operating and capital) total cost solutions. Airflow controls and operating temperatures are designed for optimal operations with specialized enclosed racks that provide uniform air distribution to the IT while effectively segregating supply air and return air for maximum efficiency. This design, developed by TDC's CEO Gene Kern, will effectively provide a user-friendly work environment in the data center without requiring the installation of hot and cold aisle isolation barriers. On the other hand, the design is flexible enough to allow for the installation of chilled water systems with mechanical chillers, cooling towers, and piping that may be needed to support future operations with rack-level cooling systems such as rear-door heat exchangers, in-row coolers, or other water-cooled technologies as they are developed.

Electrical distribution systems are designed to provide energy efficient operations with 400-volt (V) and 575-V electrical distribution systems with 4,000 amp busways. Medium voltage transformers and power conditioning devices minimize power transients in the electrical power chain from the power plant to the data center modules. All components are sized for optimal performance while considering redundancies. Pathways of power cable and fiber are minimized in length to lessen construction costs and to maximize operating efficiencies.

A/B dual paths of electrical power are available to achieve Tier Level III or better performance from the technology (servers, etc.) to the high-quality bus serving the data center. Redundant systems and equipment are provided in a modular format to provide flexibility in operations, so that equipment can be deployed, as demand requires it. The same A/B levels of redundancy are also provided for the communications cabling throughout the design.

The combination of outside air and DX cooling systems, along with the medium-voltage electrical distribution systems and high-efficiency electrical equipment used in our design provide an annualized power utilization effectiveness (PUE) of less than 1.20 for the data center. This is a best of class level of performance for virtually any data center facility on the eastern seaboard.

The power plant design demonstrates even greater efficiencies in operations, economies in construction, and flexibilities in operations. Tune into the next Zinc Whiskers to see how it works. The modes of operations of this power plant will really impress you.

CRITICAL FACILITIES ROUNDTABLE

CFRT met on September 27th in Santa Clara to hear presentations by Bloom Energy, eBay, and PG&E about the merits and challenges of renewable energies for the data center and on-site generation utility incentives. CFRT is a non-profit organization based in the Silicon Valley that is dedicated to the open sharing of information and solutions amongst our members made up of critical facilities owners and operators. Please visit the website at www.cfroundtable.org or contact us at 415-748-0515 for more information. ■