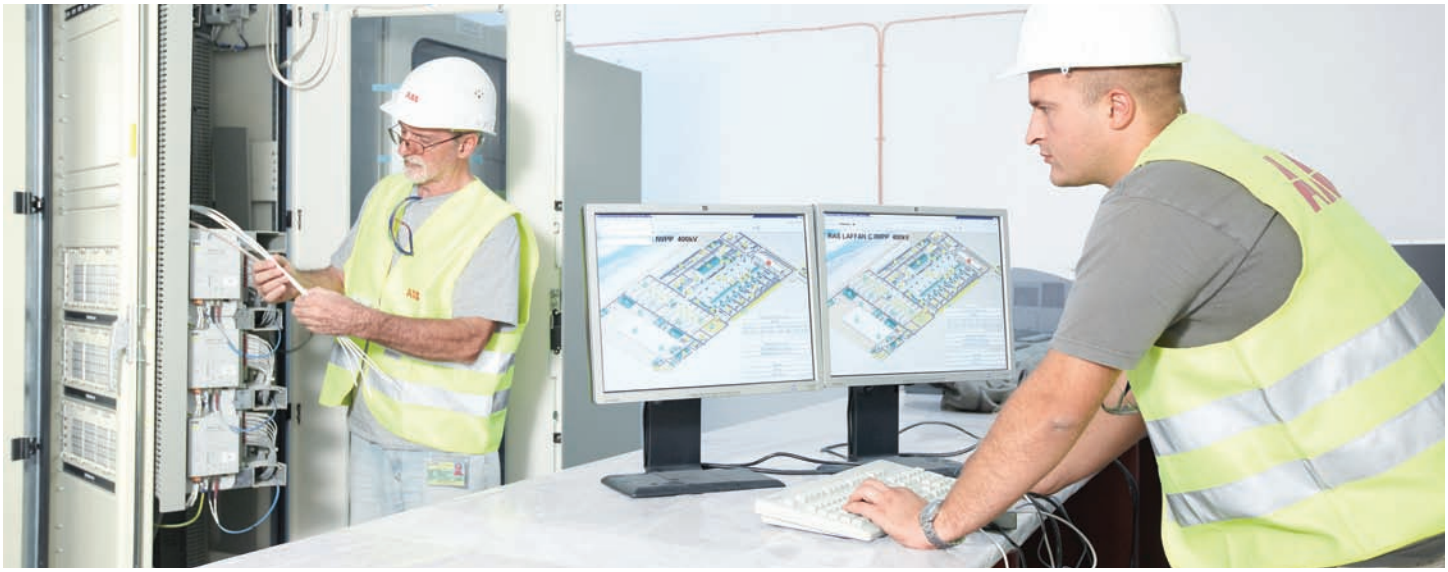
White paper

A leap in reliability
Why the dull and hardworking substation offers exciting opportunities for gains in data center reliability



If commerce makes the world go 'round, the data center has quickly become the hub of all commerce. In early 2012, the online magazine Data Center Knowledge (datacenterknowledge.com) cited a survey in which 92 percent of large companies indicated they would "definitely or probably" expand their data center footprint during the course of the year.

In turn, this growth is driving global demand for electricity. In a well-publicized disclosure in late 2011, Google indicated that its network of data centers requires a continuous draw of 260MW – enough to justify its own utility-grade power plant.

In a typical industrial company, a data center may account for 25 percent of the IT budget, according to Tarak Mehta, head of ABB's global low voltage products: "It is a significant amount of cost on an annual basis, it's a rather large investment and it's one you have to live with for an extremely long amount of time," he says.

According to Mehta, a 10 MW data center generates an annual electric bill in the range of $4 million.

That figure that will only increase as the electric grid becomes more unstable and energy prices more volatile, notes Jim McCray, Vice President of Marketing and Smart Grid Strategy for Power Assure, an ABB partner in developing data center solutions.

So the frenetic expansion of this industry segment is challenging data center managers to find new levels of reliability in all aspects of operation.

Much of that effort is being expended inside the four walls – improved utilization of servers, efficient and optimized cooling systems, and advanced management systems such as ABB's own Decathlon DCIM (Data Center Infrastructure Management) solution.

But working quietly just outside, often overlooked and forgotten, is the data center substation. It offers a critical opportunity to improve cost structures and overall reliability for new and existing data centers.

There are reasons substations are so easily overlooked, according to Mark Reed, Director of the North American Data Center Initiative at ABB. First, they don't represent a core area of expertise for the IT experts who are ultimately responsible for decision-making around data centers. Further, the transformers and other assets that comprise substations tend to be some of the most reliable and long-lasting equipment used in the industrial setting. And finally, this long-lasting equipment is expensive.

So once a substation has been built and put into use, there is little reason to give it another thought.

How substations deliver

For the reasons already cited, that view is changing. Substation designs are now being reevaluated for their ability to deliver significant returns on investment. Today, a substation must:

- Deliver power from the utility with the lowest risk of disruption;
- Facilitate the process of smoothing over brief disruptions;
- Allow seamless introduction of the various alternative power sources needed to manage the supply and cost of electricity – whether from diesel generators to battery energy storage systems to solar, wind and other distributed energy resources (DER);
- Provide flexibility to allow data centers to expand and grow.

Older and traditionally designed substations may fall short in any or all of these areas, Reed says. That's why many enlightened data center operators are now turning their attention to that unglamorous and forgotten enclosure just outside the facility.

"Nobody expects data center managers to do the work of electrical engineers, but there are a few things they need to know about substations," Reed says. "First, you can design your substation for a more reliable operation. Second, you can design your substation to take up less space and require less attention."

Third, he says, substations can now be designed for capacity expansion without ever having to be taken offline.

"If you're building a 40 MW data center, you don't typically build it out all at one time; you may build it in 10 MW or 20 MW increments. But conventional wisdom says you need to build all 40 MW into the substation right away, because it can't be expanded later without shutting it down for construction," Reed says.

"That's no longer true," he continues. You can design expandability into the substation, which allows you to reduce your up-front costs and spread capital costs over time."

Achieving lifetime reliability

Depending on the size and configuration of your existing substation, a small range of technologies can be applied to improve its reliability by a factor of 15 to 100.

"This isn't just wishful thinking," says Krassimir Kutlev, Ph.D. and principal consulting engineer in power system reliability for ABB. "If you're talking about a substation with overall MTBF (mean time between failures) of 0.5 – which is not atypical – you're going to see about two failures a year; you can reduce that to once every 30 to 200 years."

The same technologies serve to shorten the duration of outages. Whether it occurs at the utility or within the data center, an electrical interruption that might have lasted several hours may now last only a few minutes – a short-enough time that it can be covered easily with a battery energy storage system (BESS) or other short-term onsite power supply.

"Barring an extreme disaster like an earthquake," Kutlev says, "basically you won't have any interruptions at all. Ever."

The up-front price for such reliability may be 30 percent to 50 percent more than standard substation designs. But the return on investment of that expense has become easier to calculate. First, Kutlev notes, high-reliability design and new substation technology reduces maintenance and operating costs – in some cases by up to 90 percent.

Further, he emphasizes reliability is not an all-or-nothing purchase. It can be designed into the substation by degrees; the design vendor should be able to provide sophisticated modeling to decide exactly what level of reliability is cost-justified.

"Companies typically know how much it costs per minute or hour when power is interrupted to their data center. They know exactly how much money they're going to lose in an outage," Kutlev says. "We can provide them with a lifecycle cost analysis for the substation. It takes all the guesswork out of deciding whether to spend additional investment capital to improve reliability."

Air v. Gas

A primary technology for improving reliability is the use of gas-insulated substation (GIS) technology instead of traditional air-insulated (AIS) components.

Compressed SF6 gas is far more efficient as an insulating medium than air. It has long been used to insulate switchgear, but now it is being applied throughout the substation.

One benefit is that GIS substations are smaller – sometimes occupying just one-third the footprint of older designs. "If your data center is located in an urban area where land is expensive, or if your space is limited in some other way, the size of your substation becomes very relevant," Kutlev notes.

Further, enclosure of components in a sealed SF6 environment reduces environmental impact on substation equipment, eases maintenance and eliminates such periodic disruptions as animals getting into charged equipment. Overall reliability gains can reach 1,000 percent.

GIS technology is more costly to install than AIS. But because components are self-contained and connected through bus systems, they create a modular system that might be likened to Lego building blocks – enabling future expandability of the substation. As a result, capital investment to build a new substation can be limited to the cost of meeting current demand, with future being funded at the time it is actually needed.

Other reliability innovations

Another advance in substation design is the range of configurations used to join the substation to the electrical utility.

"The first thing to look at is how many utility connections there are," Kutlev says. "Typically they have only one connection, with a backup power supply for short disruptions. But you can improve reliability by having a second connection to the utility. Best is if you are connecting to two different utility substations – but of course that's not always possible."

There is a variety of ways to configure utility hookups – each with its own set of cost-benefit tradeoffs. "What's important is that they can be modeled. Deciding what's needed can be complicated but it is absolutely definable," Kutlev says.

Specific substation components also have been reinvented over the past decade to improve performance, flexibility and reliability. For example, Eric Olson, Control Technologies Product Manager for ABB's data center initiative, points to the use of an AC/DC power distribution bus to replace the automated transfer switch (ATS) and facilitate the use of distributed energy resources. "It allows on-site generation, participation in energy markets, and improved independence from utility-supplied power for scheduled durations,"[1] he said in a presentation with Mission Critical Magazine in early 2012.

Another specific equipment improvement that Kutlev points to is the hybrid disconnecting circuit breaker (DCB). Widely used in Europe and gaining acceptance in the United States, the DCB combines two separate components – circuit breakers and disconnectors – to increase reliability while reducing footprint and maintenance.

The main learning point, Reed says, is that no matter what innovations are applied inside the data center, nothing affects performance more than the cost-effective and reliable supply of electricity. And nothing has a greater impact on that than a data center's substation.

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Resources:
1. Olson, Eric, http://www.missioncriticalmagazine.com/events/625-improving-data-center-reliability--from-the-substation-to-the-breaker-and-the-battery

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