Disrupting the National Electrical Code

By Mike Anthony and Paul Kempf

"Enough is abundance to the wise"—Euripides

While much of the educational industry engages in marquee sustainability projects like solar panels and wind turbines, a rather unflashy code change driven by APPA's Standards and Codes Council (ASCC) will exceed the benefits of them all. When fully realized, the changes driven into the 2014 National Electrical Code (NEC) by the ASCC to "rightsize" electrical switchgear (according to actual load) will save our industry $1 billion to $10 billion annually—with each APPA member institution sharing in the benefit proportionately. Here's why.

For the past 60 years, electrical engineers have designed lighting circuits according to prescriptive rules that appear in Table 220.12 of the NEC. When the 2014 NEC is adopted, engineers will now have an *exception* that permits circuit sizing based upon power densities that are limited by the energy code. The disparity between the old NEC rules and the new energy codes is not small, as can be seen in Figure 1. Keep in mind that in higher education, the dominant occupancy class is classified as office space.

Given that lighting is typically about 30 percent of the electrical load in most buildings, medium voltage service transformer kVAs may be reduced about 15 percent. Downstream distribution transformers that supply lighting only can be reduced about 60 percent. The practical effect of this change is as follows:

1. In borderline cases in which demand calculations indicated a 1000 kVA substation by "rounding up for future load growth," this substation may be specified at 750 kVA with a forced air rating to accommodate demand peaks.
2. Lower kVA nearly always results in reduced flash hazard.
3. Lower kVA reduces the size of medium voltage switchgear rooms.
4. Lower kVA means lower heat losses and smaller HVAC systems and ductwork for cooling.
5. While relatively rare, 150 kVA dedicated "lighting" transformer may now be specified at 50 kVA requiring a smaller electrical "closet."
6. A 400A copper lighting feeder of 1000 FT that used to cost about $6,300 for copper could be now designed as a 300A aluminum feeder for about $1,700.
7. Farther up on the grid, avoided no-load losses at medium voltage is $43,860 per year for every 10,000 kVA of connected load.
8. Universities that cogenerate will see a reduction in reactive (kilovar) load. One or two percent higher power factor could save hundreds of thousands of dollars per year.

Occupancy	2014 NEC Table 220.12	ASHRAE 90.1	2012 IECC
Office	3.5	0.82	0.90
Hospital	2.0	1.05	1.10
School	3.0	0.87	0.99

Figure 1. Comparison of lighting power densities in watts per square foot.

WE ARE DISRUPTING THE NEC BY LOADING TRANSFORMERS ABOVE THE 50 PERCENT CAPACITY RATING.

There are cases where transformers with redundant capacity are necessary. Double-ended substations are common in healthcare facilities, laboratories, and critical processes; and in high-rise facilities large fire pumps may require larger transformers to protect contingencies. These are a minority of cases, however, and many of those transformers already have significant short-time overload capability.

The requirement for an energy management system to control the lighting load may not be necessary, but the conditional exception was what the committee needed to keep the change within its risk tolerance. We are disrupting the NEC by loading transformers above the 50 percent capacity rating, whereas for the past 60 years we have loaded them well below 50 percent. It may be wise to see how this change moves through and is integrated into the culture of the electrical industry (*see sidebar*).

The NFPA (National Fire Protection Association) is a safety organization—not an energy conservation organization. Until the ASCC presented arguments that flash hazard safety was undermined by bringing in too much energy into a building in the first place, the Chapter 2 committee was not going to move on arguments on the basis of energy economics alone. Professor Tom Harman at the University of Houston, as chair of the task force that evaluated the ASCC proposals, was a significant contributor to the effort and needs to be recognized here.

The consortia of like-minded electrical engineers affiliated with 30 APPA member institutions that drove this into the 2014 NEC did not get everything it asked for—only about half. We will approach the Chapter 2 committee again during the 2017 revision cycle and present more data to support a case for following:

1. Removal of the requirement for the energy management system.
2. Reduction in the NEC 220.14 per-outlet design requirement to 120 VA from the present 180 VA.
3. Demand factors for sizing supply switchgear for buildings with multiple HVAC units.

From the data that the ASCC gathered a pattern emerged: *we have been designing buildings for 15 watts/square-foot while our electric bills are telling us that we are consuming only about 5 watts/square-foot*. A strong case can be made that most of the buildings on our campuses today could be supplied from low voltage services, thereby eliminating many medium voltage substations altogether. We would expect another $1 billion to $10 billion per year in avoided cost to accrue from these changes to the NEC.

For APPA executives, this change should immediately set in motion project financing architectures that draw from sustainability and safety resources to fund electrical upgrades. Older, higher loss medium voltage transformers installed in the 1970s and '80s that never saw more than 25 percent of rated capacity would be good candidates for replacement with an 800-ampere, 480V service instead. Anecdotes are accumulating that some owners in the private sector are replacing oversized copper feeders with rightsized aluminum feeders and pocketing a "profit."

These upgraded, smaller services might release some enterprise space—or at least make non-compliant installations compliant with NEC workspace safety rules. The money saved in the ASCC's authentic "green" achievement might be used to help pay for some of the headline-grabbing energy conservation projects that will never pay for themselves by any benchmark of classical energy economics.

Rightsizing

As real-time metering and monitoring algorithms are implemented to increase electrical system efficiency we also have the opportunity to "rightsize" our designs. As protection schemes improve and the need for safeguards increase we can take some of what in the past was a reasonable measure of safety factor out of our designs, thus lowering incident energy levels for increased worker safety.

Rightsizing will continue to move the electrical distribution industry in the direction of sustainability as our system designs reduce energy losses, conserve space, save energy, and reduce capital expenditures. Sustainability is good business for all, and at the University of Notre Dame we see the move toward sustainability as an opportunity to embrace the future, follow the right course, and present a challenge to our engineering talents to hone our craft.

In this day and age information is king, and the electrical distribution market has the tools and expertise to use information about our systems for multiple benefits. We have long known that many of our services and supply circuits have been conservatively designed. Our campus data across nearly 10 million square feet of space in over 150 buildings demonstrates maximum historical demands is on the order of 50 percent of installed power delivery capacity.

As this article details there are opportunities to reduce power density assumptions to be more in line with utilization. Having a back stop to prevent overloading as the code transitions to these changes is a prudent approach that will ensure safety while allowing for the benefits of the changes to be realized.

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