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A Functional Microgrid for Enhancing Reliability, Sustainability, and Energy Efficiency

The Illinois Institute of Technology's Perfect Power project has converted its Chicago campus to a microgrid, providing a glimpse into the future of electricity innovation in an urban community. The microgrid demonstrates that cost-effective electric power can be delivered to the consumer precisely as that consumer requires it, without fear of failure and without increasing costs.

Mohammad Shahidehpour and Joseph F. Clair

I. Earlier Infrastructure before Microgrid

The Illinois Institute of Technology sits about 2.5 miles south of downtown of Chicago, bounded by 35th Street on the south, Michigan Avenue on the east, 29th/30th Street on the north, and the Metra Rock Island line on the west. As of 2006, IIT received electricity feed from the local utility – ComEd – at two substations located on the west end of campus: South Substation at 3400 South Federal Street and North Substation at 3200 South Federal Street. These substations shown in **Figure 1** receive electricity via three feeders from ComEd, one unique to each substation and one shared by the substations. The feeders carry a nominal capacity for the campus of 20 MW; however, due to ComEd requirements, the campus

 1040-6190/$–see front matter http://dx.doi.org/10.1016/j.tej.2012.09.015

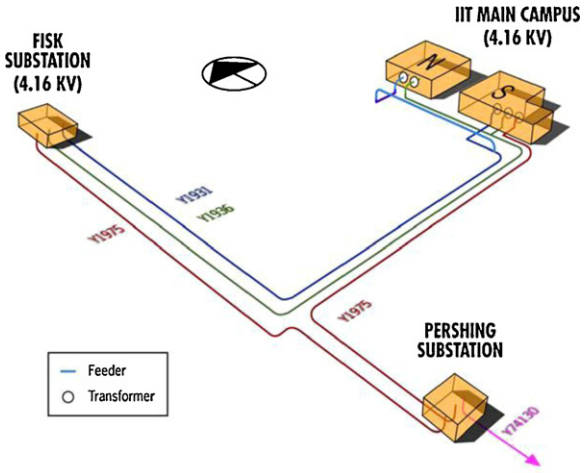

Figure 1: IIT Microgrid-Utility Interconnection

can draw no more than 14 MW from the combined service. If campus demand exceeds 14 MW, the utility will require the university to build a new substation.

Starting at the substations, IIT owns and manages electricity distribution to almost all campus buildings. The original substations and the technology within them dates back to the implementation of the Mies Van Der Rohe campus plan in the 1940s and 1950s. Execution of that plan placed almost all of the electrical distribution underground or within a building. A cross-tie feeder runs between the substations to allow for operation of one from the other in the event of a utility failure in the shared feeder and one of the individual feeders, or operation of the North Substation from the on-site generation present adjacent to the South Substation.

The underground placement protected the electrical infrastructure from storm damage and similar threats from exposure; however, given the campus's proximity to Lake Michigan and the height of the water table, the underground manholes and duct banks come into regular contact with groundwater. This, combined with the age of the equipment, led IIT in 2003 to begin the process of renovating the electric grid on campus by refitting the North Substation with modern equipment and controls, during which time ComEd also upgraded its equipment at the substation. Prior to the implementation of the microgrid, any scale of outage response required the IIT maintenance mechanic to visit the affected area directly, armed with no information about the condition of the equipment or affected feeders.

For the decade preceding the implementation of the IIT microgrid, the university received sporadic reliability both from the campus infrastructure and the utility feeds to the campus. Also, without very detailed and expensive surveys and testing, the university could not identify the most troubled feeder segments and prioritize replacements. During that period, IIT experienced varied and sporadic outages, bringing consequences to the services provided by the university. Several buildings lost power to laboratory or space conditioning equipment, resulting in lost experimental data and subjects. Equipment in all areas of the campus required repair or replacement due to undervoltage on the incoming utility service. Most costly, feeder damage on the residential side of campus caused outages that required the temporary relocation of campus residents to nearby hotels, at a steep cost to the university. The IIT community had little faith in the reliability of the system, and the university administration did not have resources to address the myriad issues associated with the aging infrastructure.

II. The Promise

The Perfect Power microgrid designed and implemented at IIT has resulted in an intelligent power system that will not fail the end user. The microgrid consists of a loop system and redundant electricity supply. It offers IIT the opportunity to eliminate costly outages, minimize power disturbances, moderate an ever-growing demand, and curb greenhouse gas emissions. The IIT microgrid would specifically:

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