

New Grid in Town: Perfect Power System Ramps Up IIT

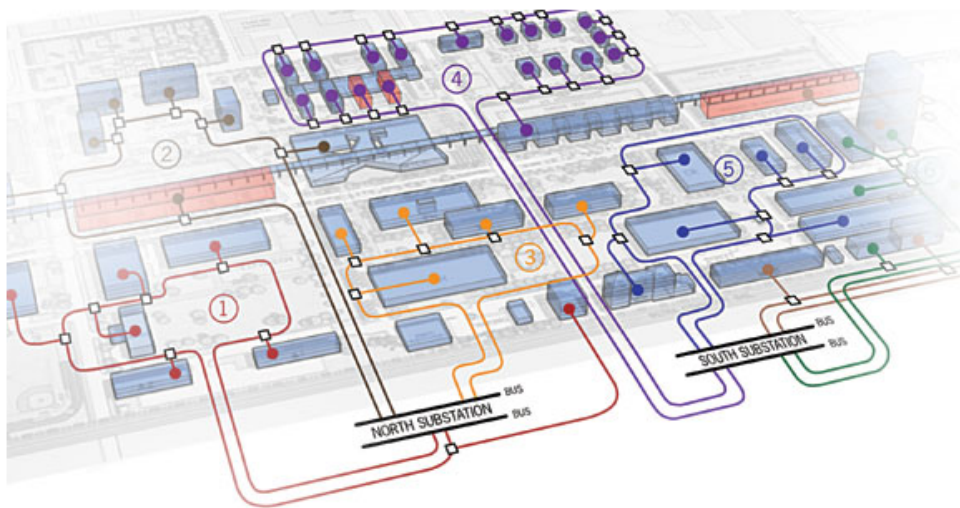
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The high-reliability distribution system of the IIT Perfect Power System; each numbered loop represents a redundant system designed to increase the security and reliability of energy delivery.

Illustration by Michael Meiners—Galvin Electricity Initiative

MAIN CAMPUS TO BECOME A PERFECT POWER SHOWPIECE

THE GREEK PHILOSOPHER ARISTOTLE IS CREDITED WITH AUTHORIZING THE EARLIEST DEFINITION OF THE WORD PERFECTION, WHICH HE SAW AS BEING COMPOSED OF THREE CONCEPTS: "THAT IS PERFECT—WHICH IS COMPLETE, WHICH CONTAINS ALL THE REQUISITE PARTS; WHICH IS SO GOOD THAT NOTHING OF THE KIND COULD BE BETTER; AND WHICH HAS ATTAINED ITS PURPOSE." IN DISCIPLINES FROM AESTHETICS TO ETHICS, HOW INDIVIDUALS DEFINE PERFECTION RANGES FROM BEING AN APPROXIMATE IDEAL TO SOMETHING SO AMBITIOUS AS TO BE UNATTAINABLE.

A group of energy visionaries comprising the [Galvin Electricity Initiative](#) (GEI) subscribe to Aristotle's bold and decisive definition in regard to perfect power and their innovative plan to reinvent the nation's electricity transmission, generation, and delivery network. Three years ago, GEI members and IIT faculty developed their idea to create a Perfect Power System on the university's Main Campus. The group then elicited help from the [United States Department of Energy](#) (DOE), creating a three-faceted partnership between government, education, and industry to make the Perfect Power energy-distribution system the first of its kind in the country.

"We own our own power plant, distribution systems, and wires throughout the campus," says [Mohammad Shahidehpour](#), professor and chair of the Department of Electrical and Computer Engineering (ECE), and Perfect Power principal investigator, of IIT's 120-acre Main Campus. "The university is like a city. So whatever we can do here can be replicated in cities and other large entities across the country."

The Perfect Power transformation will be completed in four phases over the next five years. Central to this conversion is a technology touchstone—a smart microgrid—that ultimately will be a model for revamping our nation's antiquated and outage-ridden power grid.

Six Sigma Perfection

"Perfection—and let me define that as we have defined it for GEI—is that every consumer of electricity, large or small, can be absolutely assured of getting the quantity and quality of electricity that they need at the fairest price without any concern about it ever failing. That is, in our judgment, a very achievable goal," said Kurt Yeager, GEI executive director, at a press conference announcing the launch of **Perfect Power at IIT**. The conference was held November 19, 2008, in Siegel Hall, the first building that will be reconfigured in the Perfect Power plan.

At the conference, Yeager was joined by IIT President John Anderson; GEI founder and IIT University Regent Robert W. Galvin, former chair and CEO of Motorola, Inc.; representatives from project partners **Commonwealth Edison (ComEd)**, **Endurant Energy**, and **S&C Electric Company**; and Shahidehpour. Perfect Power at IIT is one of nine projects that received DOE funding for smart grid research. In addition to the \$7 million DOE grant, Perfect Power received \$5 million in funding from the university.

Galvin told conference attendees that he was inspired to form GEI after his wife, Mary, became one of the estimated 40 million Americans affected by a blackout that shut down cities in eight Northeastern states in the summer of 2003. During his tenure at Motorola, Galvin was instrumental in significantly improving quality standards through implementation of Six Sigma, a business philosophy that values defect prevention over defect detection. According to the GEI, the nation's current electricity system accounts for at least \$150 billion lost each year on power outages and interruptions. Smart grid technology could ramp up system reliability to 99.99 percent.

The application of Six Sigma quality principles, coupled with the support of IIT's electricity supplier, ComEd, in the goal of achieving a perfect system sets the university's smart microgrid project apart from power conversions taking place at two other schools. After attending Six Sigma training courses, IIT team members established a basis for the microgrid by developing electricity system performance metrics based on consumers' needs, applying error proofing to the IIT electricity system design, and developing cost-effective means to lessen failures and system shortcomings.

Wanted: A System for Twenty-First Century Needs

IIT's Main Campus averages three power failures each year at a cost of \$500,000 annually in restoration expense, lost productivity, and ruined experiments. IIT is currently operating at capacity and in order to accommodate the increasing power requirements and digital demands, a new \$5 million substation has been considered for the east side of campus to supplement two existing substations. Although Main Campus has the capability to generate essential power if there is a ComEd failure, its cogeneration plant is only cost effective at producing hot water, not the hot water, steam, and electricity it was originally meant to generate.

"Perfect Power consists of more than just the infrastructure upgrades that we are currently implementing on campus; however, the infrastructure improvements provide the foundation for every other electrical energy project that we will pursue over the next decades," says Joseph Clair (M.S. MAE '95), director of campus energy and sustainability.

The nation's century-old electric grid, hailed by the National Academy of Engineering as "the most significant engineering achievement of the twentieth century," is dominated by central generation through largely fossil fuel-driven power plants, which deliver electricity via a system of regional grids that are owned or run by utility companies. Its 300,000-mile network of transmission lines, subject to weather conditions and physically sagging under the burden of increased usage demands, crisscross the country on their way to delivering electricity to homes and businesses.

According to the DOE, since 1982, growth in peak demand for electricity needs has exceeded the construction of new transmission lines by 25 percent. When an outage occurs, large populations of grid users can be left without power, sometimes for days at a time. Additionally, the centrally located design of the grid leaves it more vulnerable to terrorist attack. More numerous microgrids supplying power to cities and essential buildings would make such an attack far less widespread.

Some Powerful Statistics

- 41 percent more outages affected 50,000 or more consumers in the second half of the 1990s than in the first half of the decade.
- If the grid were just 5 percent more efficient, the energy savings would equate to permanently eliminating the fuel and greenhouse gas emissions from 53 million cars.
- In 2000, the one-hour outage that affected the Chicago Board of Trade resulted in \$20 trillion in delayed trades.

Source: U.S. Department of Energy



[Left to right] John Kelly, Mohammad Shahidehpour, Bob Galvin, John Anderson, Rita Stols, Tom Tobin, and Kurt Yeager at the conference launching the Perfect Power System