



Introducing Perfect Power at Illinois Institute of Technology

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**GALVIN
ELECTRICITY
INITIATIVE**

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Welcome and Introductions

Webinar Moderator:

Kurt Yeager

Executive Director

Galvin Electricity Initiative

Presenters

John Kelly

Vice President
Endurant Energy

Mohammad Shahidehpour, Ph.D.

Chair, Department of Electrical and Computer Engineering
Perfect Power at IIT Principal Investigator
Illinois Institute of Technology

Tom Tobin

Vice President, Research and Development
S&C Electric Company

Overview

In this presentation, you will discover:

- How Perfect Power arrived at IIT
- How Perfect Power works
- Why Perfect Power matters
- How Perfect Power will benefit IIT
- What innovations make Perfect Power unique and replicable
- What may be preventing Perfect Power from powering the country

Powering Digital-Age Businesses on 1950s Technology

You'd be sad, too, if your infrastructure was:



- Unreliable
- Inefficient
- Insecure
- Dirty

Galvin's Vision

“The perfect power system will ensure absolute and universal availability of energy in the quantity and quality necessary to meet every consumer's needs. It is a system that never fails the consumer.”

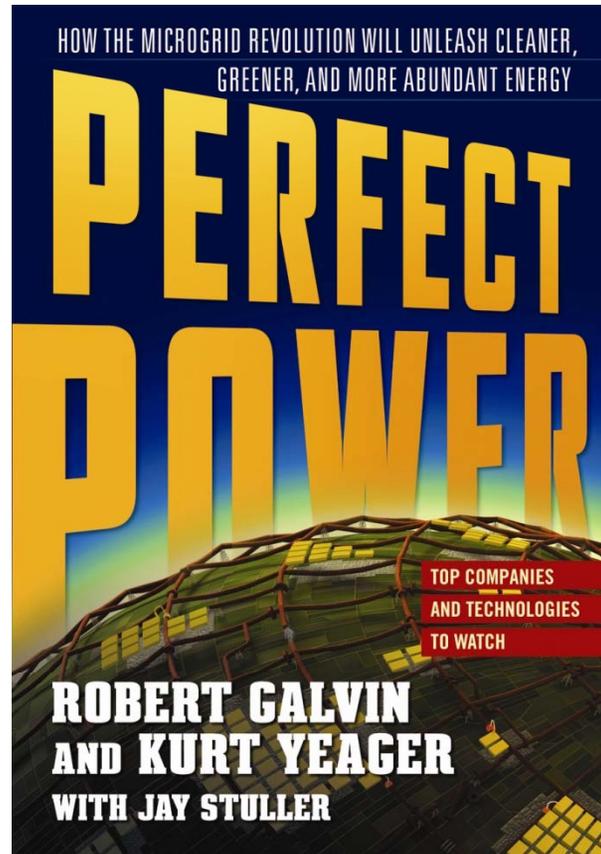
Bob Galvin
2005

Uncommon Partnership

To bring Perfect Power to IIT, the Galvin Electricity Initiative and IIT partnered with:

- Exelon/ComEd — Chicago local utility
- U.S. Department of Energy (DOE) — Invested \$7 million into project
- Endurant Energy — Illinois-based entrepreneurial electricity distribution developer
- S&C Electric Company — Chicago-based global provider of electric power systems

Perfect Power



What is Perfect Power?

PERFECT POWER

A ground-breaking approach to electricity distribution and management that meets consumers' electricity needs perfectly and never fails the end-user

Elements of the Perfect Power System

IIT's Perfect Power System features:

- **Redundant** distribution
 - Provides alternative supply
- **Self-healing** distribution
 - Rapidly detects, responds, restores, and communicates
- **Self-sustaining**, on-site generation, UPS, back-up power
- **Cost responsive/empower consumer**, improved procurement strategies
 - smart meters
 - hourly/real time pricing
 - demand response, etc.
- **Leverage lower carbon** generation sources
 - Solar PV, wind, biogas, natural gas

The Perfect Foundation: Smart Microgrids

Smart microgrids:

- are small, local, modernized versions of the electrical grid that carries bulk power across the country
- rapidly brings the economic and environmental benefits of modern grid technology to consumers
- engages entrepreneurial innovators and investors along the way
- includes smart technology
 - Allowing instantaneous, two-way flow of electricity and real-time pricing and demand information between utilities and consumers

Smart Grid, Smart Microgrid and Perfect Power System: What's the Difference?

Smart Grid

- Refers to a much-needed overlay of communications technology over our existing power grid using smart technology.

Smart Microgrid

- A small-scale version of the larger grid that features local power generation and smart grid technology.

Perfect Power System

- Based on a smart microgrid, but includes additional improvements to ensure that the system does not fail the end-user.

With Smart Microgrids, More Options

- **Renewable energy sources**
 - Smarter system can manage the fluctuations of cleaner sources of energy, such as solar and wind power
- **Plug-in hybrid vehicles**
 - Uses electricity to save money on travel costs and reduces vehicles' carbon emissions
 - Made to feed power back into the grid
- **Smart metering**
 - Allows consumers to control when and how they use electricity to power their homes and businesses through via real-time pricing

Why Perfect Power Matters: Solving the Energy Crisis at the Local Level

John Kelly

Vice President

Endurant Energy

The Model of Perfect Power

Perfect Power Systems, such as IIT's model, can be customized to meet the needs of its consumers and can be replicated in any system where the power infrastructure is locally owned and managed:

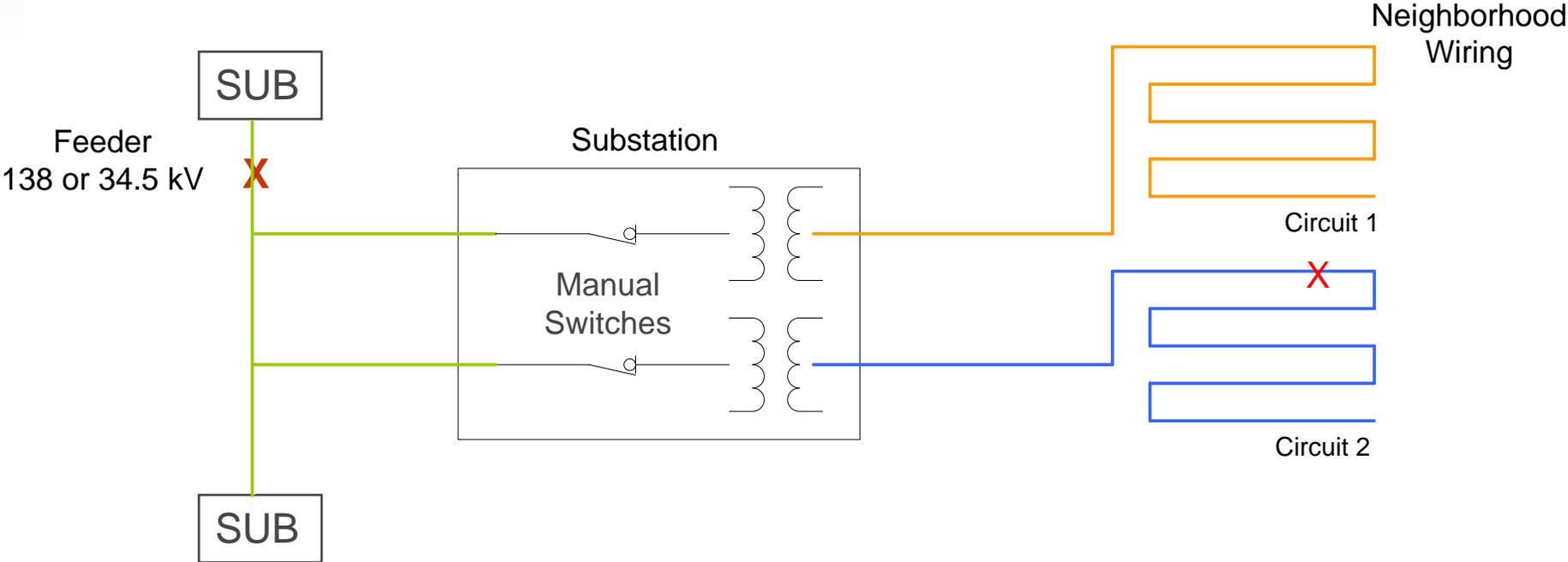
- Examples:
 - Universities
 - Municipalities
 - Office buildings
 - Office parks
 - Factories
 - Housing developments

Master Controller Adds Intelligence to System

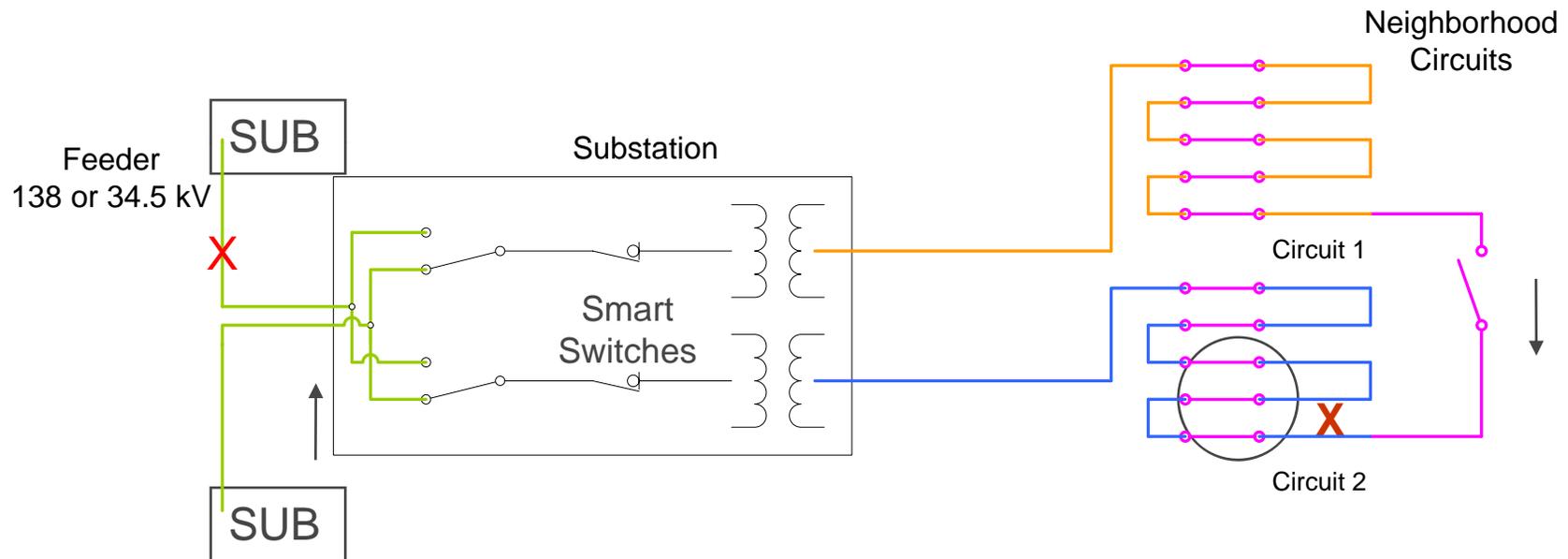
Master controller is designed to optimize the Perfect Power Systems' performance.

- Reconfigures system to respond to threats and economic conditions
- Remotely configures system to maintain power stability
- Interfaces with market real time pricing signals to lower electricity costs
- Interfaces with electric system operator and provide ancillary services

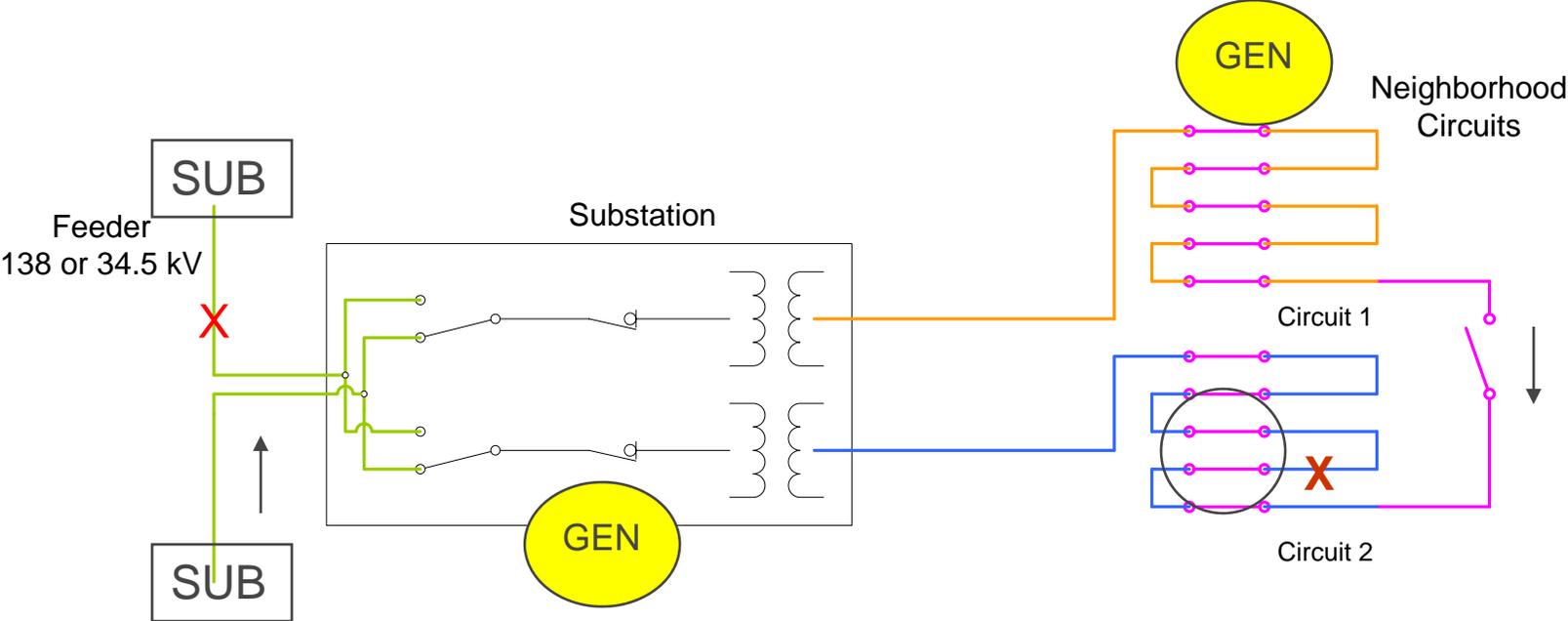
Removing 20th Century Manual Switches ...



... Adding 21st Century Smart Switches

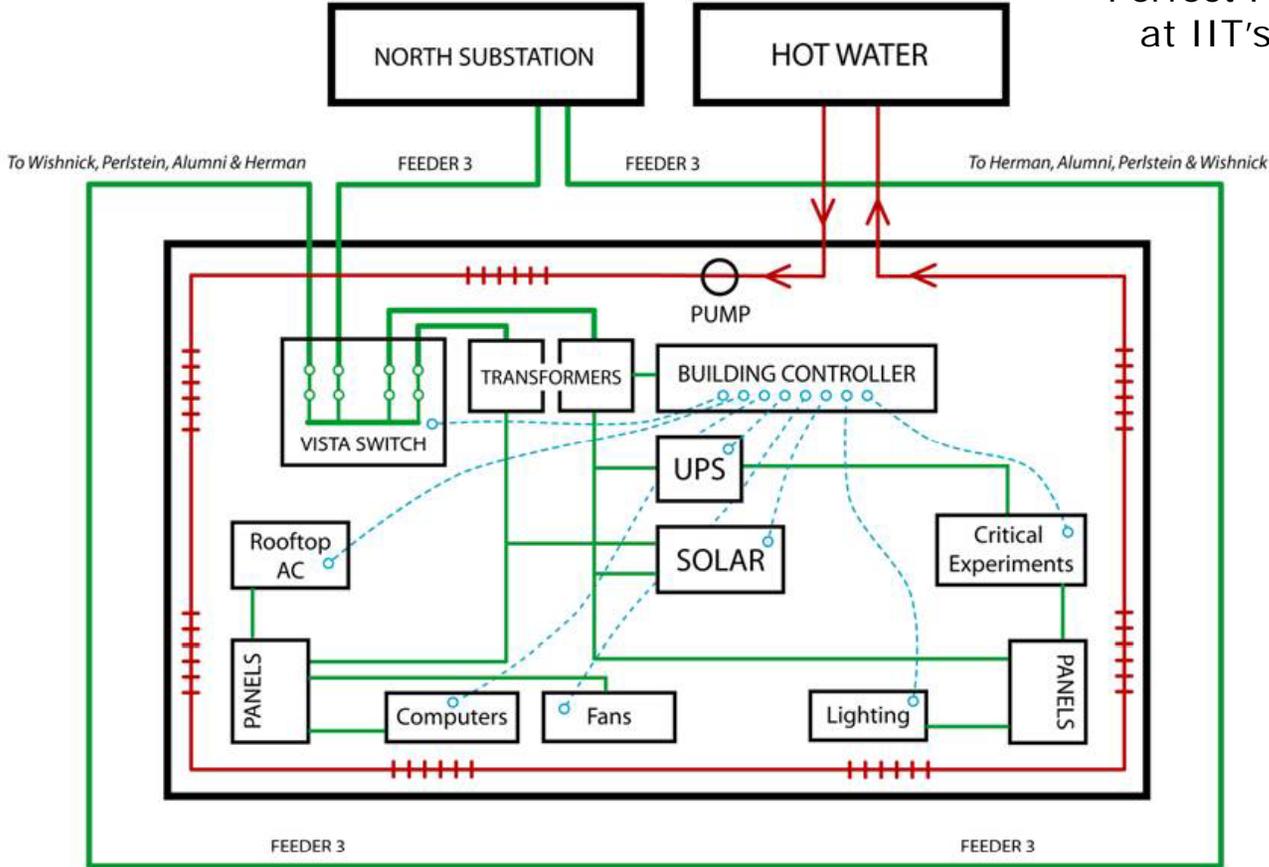


On-Site Power Generation and Storage



The Look of Perfect Power at IIT

Perfect Power System at IIT's Siegel Hall



How Perfect Power Will Benefit IIT

Mohammad Shahidehpour, Ph.D.

Chair, Department of Electrical and Computer Engineering
Perfect Power at IIT Principal Investigator
Illinois Institute of Technology

Why IIT Needs Perfect Power

- At least three power outages per year
 - Costs = up to \$500,000 annually in restoration costs, lost productivity and ruined experiments
- Electricity costs have risen dramatically, from roughly \$2 million to nearly \$4 million
- Infrastructure is old and critical components need to be upgraded or replaced
- Electricity demand is growing with increased campus population
- Addition of two new resident halls by 2010 requires more power
- Installation of new equipment in buildings is adding to energy needs
- Renegotiating wholesale electricity contract in 2009 will allow for real-time pricing

Benefits to IIT

With Perfect Power, IIT will reap benefits that include:

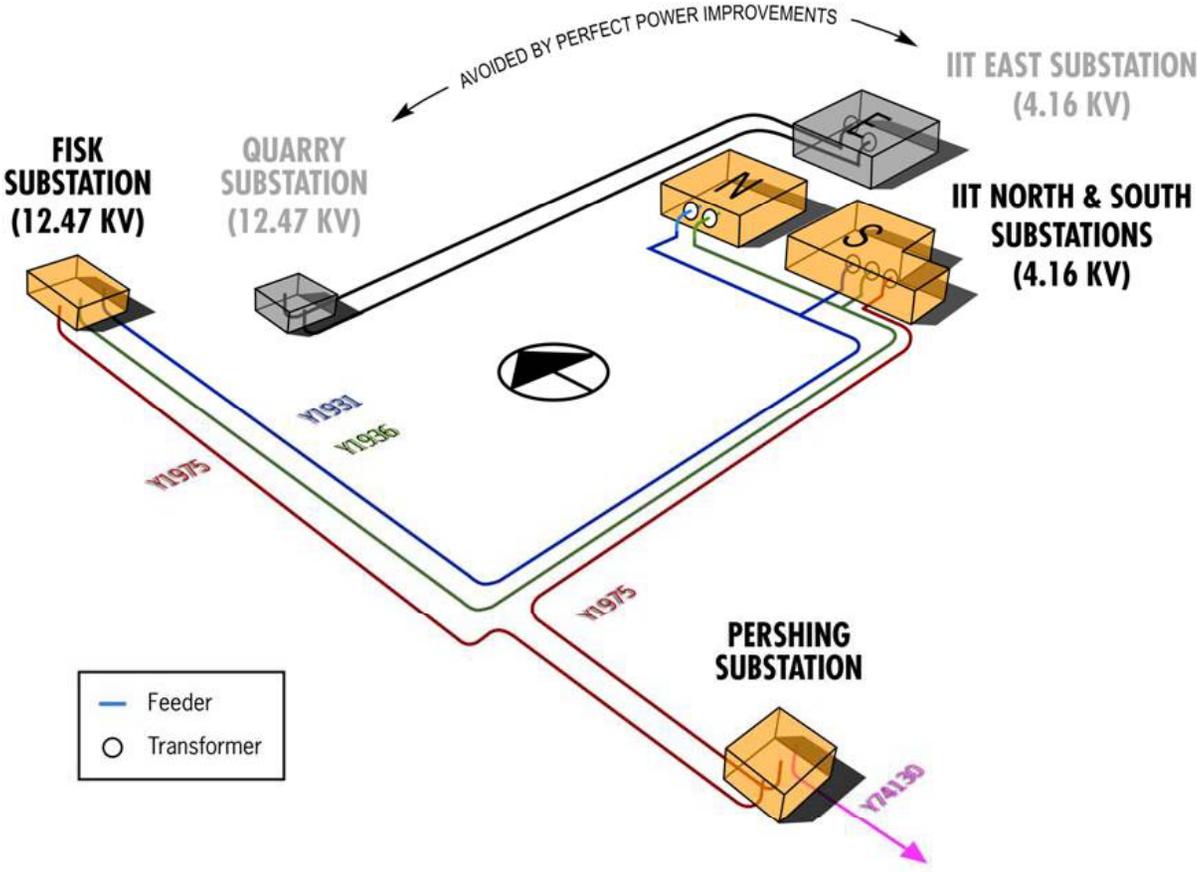
- **Reduced energy costs**
- **Improved power reliability and quality**
- **Reduced need for scheduled upgrades**
- **Achieving Strategic Objectives in the IIT Energy Action Plan and reducing its carbon footprint**
- **Cost and infrastructure benefits for ComEd**
- **Positioning IIT as an electrical engineering innovator**
- **Expanded research, fundraising and education grant opportunities**
- **Improved campus safety and security**

Savings Outweigh the Lifecycle Costs

PERFECT POWER COSTS	
BENEFIT	COST
Redundant cabling	\$1.5M
Intelligent switches and meters	\$5M
Solar PV, UPS, storage	\$600,000
On-site generation	\$1M
Communications and controls	\$1.4M
Substation recommissioning and automation	\$2.5M
TOTAL SYSTEM COSTS	\$12M

IIT SAVINGS/COST AVOIDANCE		
BENEFIT	PERIOD	SAVINGS
Avoided IIT distribution upgrades	One time	\$5M
TOTAL ONE-TIME SAVINGS		\$5M
Electricity cost reduction • Real-time pricing	Annual	\$600,000
Demand response	Annual	\$400,000
Outage costs	Annual	\$300,000
Capacity payments	Annual	Later
TOTAL ANNUAL SAVINGS		\$1.3M
Simple payback period		5 years

No Additional Substations— Thanks to Perfect Power



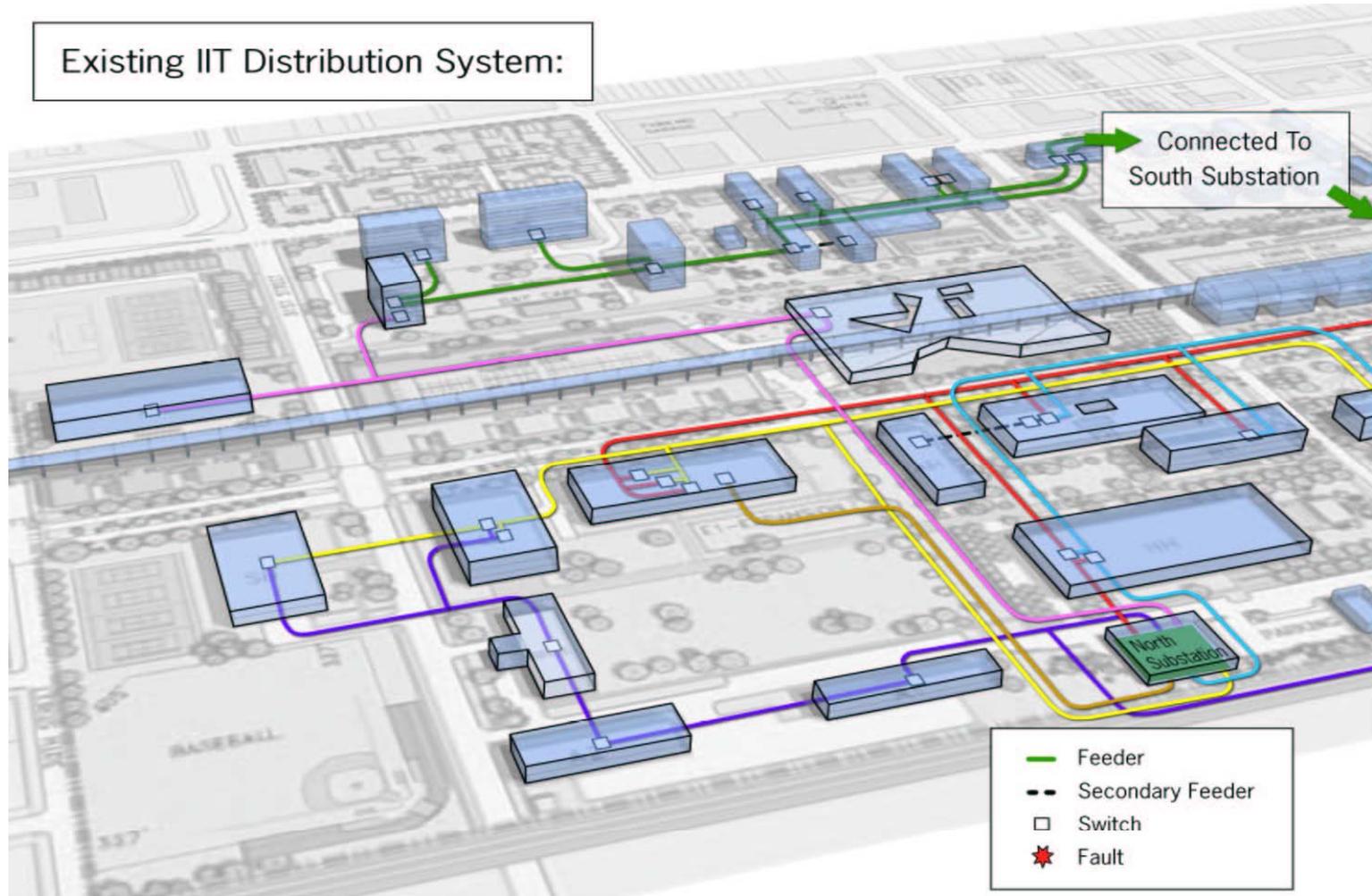
Perfect Power: Blacking Out Power Interruptions

Tom Tobin

Vice President, Research and Development
S&C Electric Company

IIT Before Perfect Power

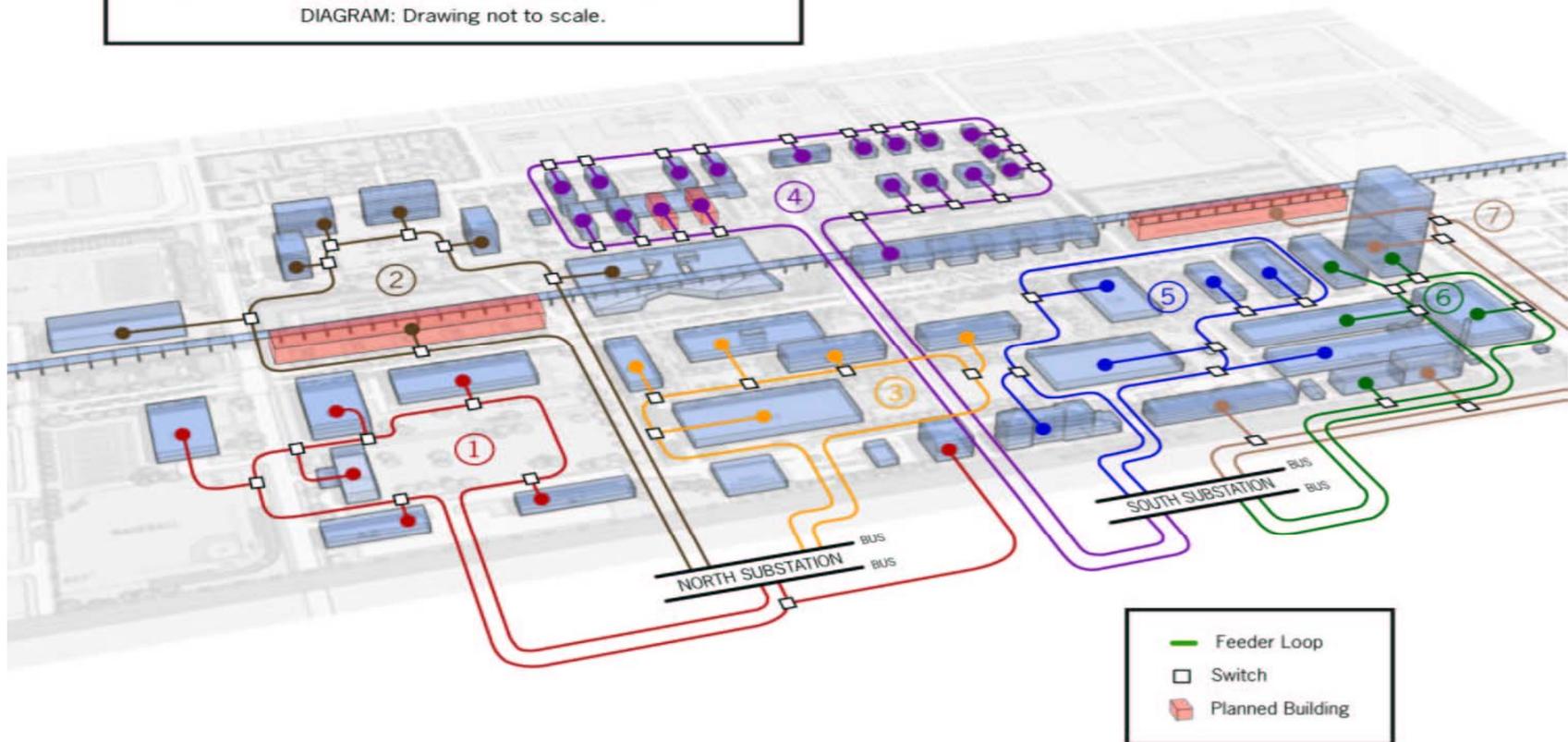
Existing IIT Distribution System:



IIT with Perfect Power

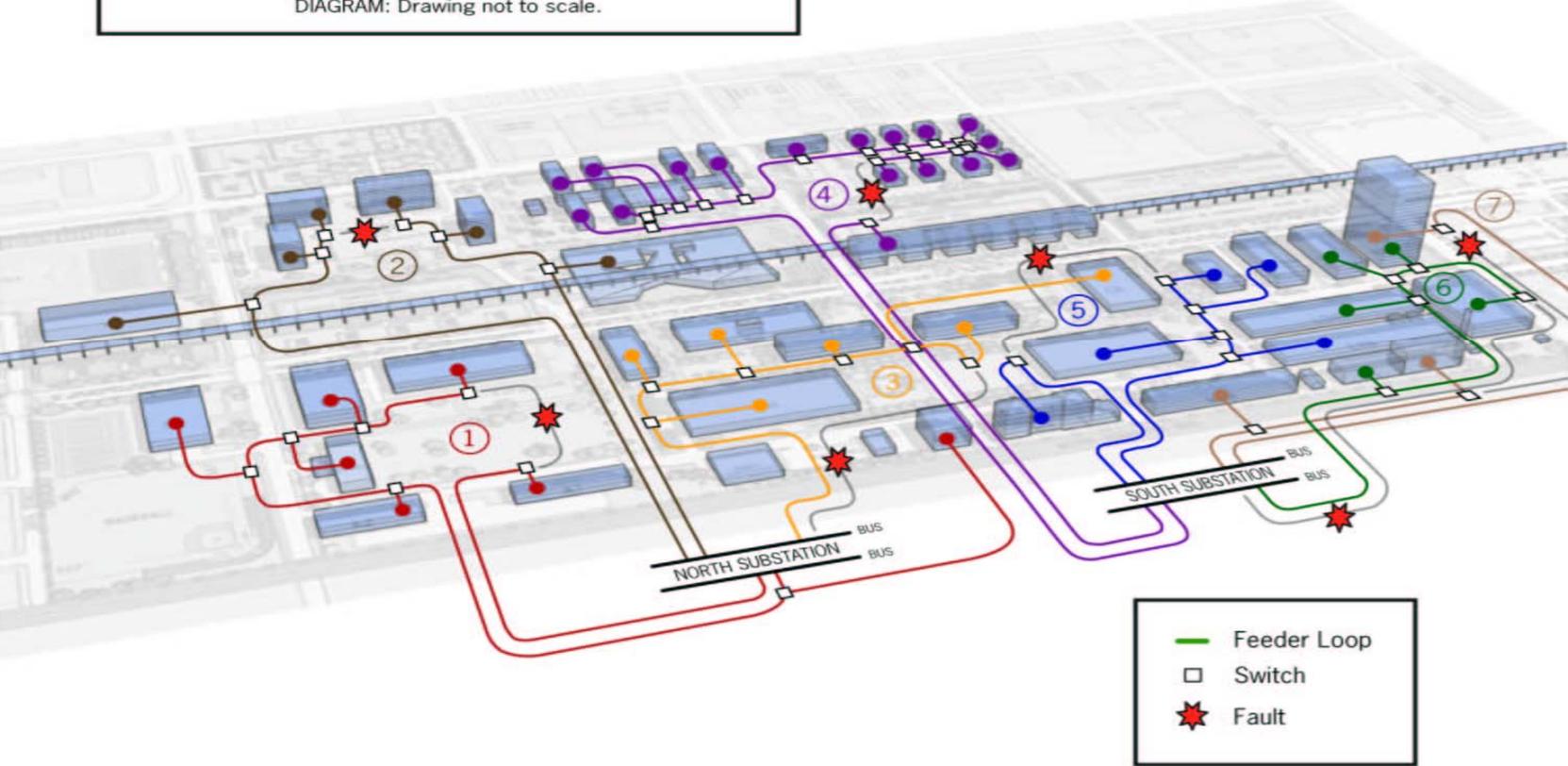
High Reliability Distribution System:

DIAGRAM: Drawing not to scale.



Even with Faults, Perfect Power Stays On

High Reliability Distribution System:
DIAGRAM: Drawing not to scale.



Smart Switches Respond Automatically— Isolating Problems, Eliminating Power Outages



Policies & Regulations: Iron Curtain between Perfect Power and Consumers

Kurt Yeager

Executive Director

Galvin Electricity Initiative

Removing Barriers to Perfect Power

These are the policy principles needed to produce a more consumer-focused electricity system.

- **Principle 1:** Allow free, competitive retail markets for electricity service.
- **Principle 2:** Enable municipalities to access and make investments in the grid infrastructure within their jurisdiction, and give them a say in how funds collected for improvements are spent.
- **Principle 3:** Compensate utilities for reliability, efficiency and customer service, not just for the amount of electricity they sell.

Removing Barriers to Perfect Power

- **Principle 4:** Incent utilities to provide customers with time-of-use rates.
- **Principle 5:** Pave the way for smart microgrids.
- **Principle 6:** Require higher reliability standards for the electric grid.
- **Principle 7:** Enact new energy efficiency standards to conserve power.
- **Principle 8:** Change tax codes to foster grid innovation.

Final Thought

“Often, the counter-intuitive leads us to the solution . . . I am not concerned about being the minority . . . Things don’t get changed unless the leaders of the minority view take charge.”

Bob Galvin

Questions?

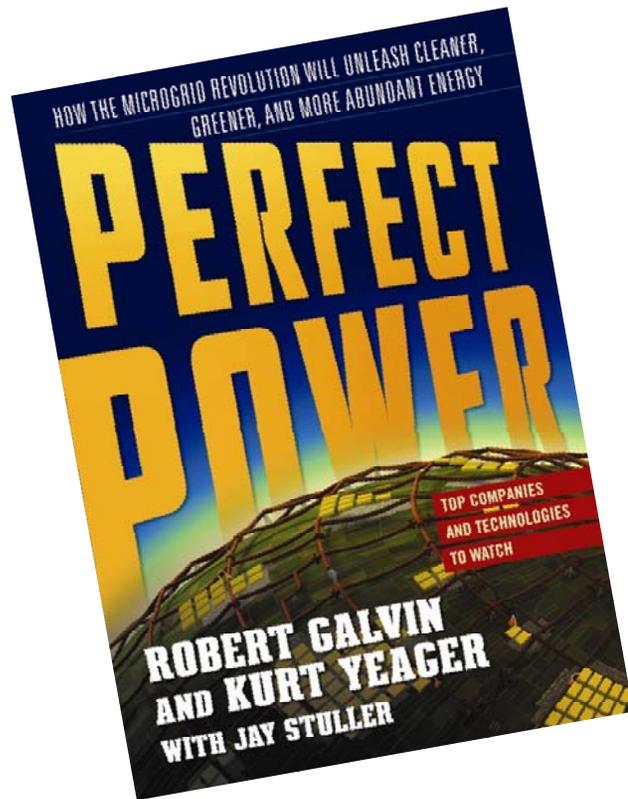
To Learn More about Perfect Power

For reports and additional information about Perfect Power and the Perfect Power at IIT model, visit:

www.galvinpower.org

www.iit.edu/engineering/ece/

Perfect Power: The Book



Learn how the microgrid revolution will unleash cleaner, greener, and more abundant energy in:

“Perfect Power”
by Bob Galvin and Kurt Yeager
with Jay Stuller

Available now
at local and online booksellers