Introducing
Perfect Power
at Illinois Institute of Technology

November 19, 2008
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
“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

How the Microgrid Revolution Will Unleash Cleaner, Greener, and More Abundant Energy

Robert Galvin and Kurt Yeager

With Jay Stuller
What is 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 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
Redundancy Sets Perfect Power Apart

Not a Perfect Power System
- Power feeds to and from one substation

Perfect Power System
- Creates self-healing, loop power system
- Adds capability to feed from two directions at substation
Removing 20th Century Manual Switches ...

Feeder 138 or 34.5 kV

Substation

Manual Switches

SUB

Neighborhood Wiring

Circuit 1

Circuit 2

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... Adding 21st Century Smart Switches

Feeder 138 or 34.5 kV

Neighborhood Circuits

Circuit 1

Circuit 2
On-Site Power Generation and Storage

Substation

Feeder 138 or 34.5 kV

GEN

Circuit 1

Circuit 2

Neighborhood Circuits
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

<table>
<thead>
<tr>
<th>PERFECT POWER COSTS</th>
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<tr>
<td>BENEFIT</td>
<td>COST</td>
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<td>Redundant cabling</td>
<td>$1.5M</td>
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<td>Intelligent switches and meters</td>
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<td>Solar PV, UPS, storage</td>
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<tr>
<td>On-site generation</td>
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<td>Communications and controls</td>
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<tr>
<td>Substation recommissioning and automation</td>
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<td>TOTAL SYSTEM COSTS</td>
<td>$12M</td>
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<tr>
<th>IIT SAVINGS/COST AVOIDANCE</th>
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<tr>
<td>BENEFIT</td>
<td>PERIOD</td>
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<td>Avoided IIT distribution upgrades</td>
<td>One time</td>
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<td>TOTAL ONE-TIME SAVINGS</td>
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<tr>
<td>Electricity cost reduction</td>
<td>Annual</td>
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<td>• Real-time pricing</td>
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<td>Demand response</td>
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<td>Outage costs</td>
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<td>Capacity payments</td>
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<td>TOTAL ANNUAL SAVINGS</td>
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<td>Simple payback period</td>
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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.

[Diagram of a high reliability distribution system with various components and labels for North Substation, Feeder Loop, Switch, and Planned Building.]
Even with Faults, Perfect Power Stays On
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.
“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/
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

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