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4 2 N D A N N U A L

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# Minnesota Power Systems Conference

**November 7-9, 2006**



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4 2 N D A N N U A L

# Minnesota Power Systems Conference



**November 7-9, 2006**

**Continuing Education and Conference Center**

**Sponsored by:**

**College of Continuing Education  
University of Minnesota**

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**IEEE, Twin Cities Section**

This conference provides electric utility engineers and consultants the opportunity to stay abreast of today's power system technology. The conference emphasizes the unique challenges faced by electric utilities in the Midwest. The conference also serves as a forum for power engineers to meet with their colleagues from other utilities to discuss mutual concerns. Newly created and redesigned concurrent sessions include substations, utility industry futures, delivery systems, project management, relaying, distribution automation, and distributed resources.

**[www.cce.umn.edu/mnpowersystems](http://www.cce.umn.edu/mnpowersystems)**

**UNIVERSITY OF MINNESOTA**

# Program Schedule

Tuesday, November 7, 2006

## GENERAL SESSION

8:15 a.m.-12:00 noon

Moderator: Dan Nordell

Co-Moderators: Ed Cannon, Steve Mohs, Roger Simundson, Gerry Steffens

7:15	Check-in Continental Breakfast	10:00	Break
8:15	Welcome <i>Dan Nordell</i> , Xcel Energy	10:30	South Dakota Ice Storm – November 28, 2005 <i>Michael Sydow</i> , Northwestern Energy
8:30	Minnesota Power's Centennial – History of Minnesota Power 1906-2006 <i>Steve Garvey</i> , Minnesota Power	11:15	Iraq Experience <i>Jon Wahlgren</i> , Ottertail Power Company; <i>Anthony Centore</i> , S/D Engineers, Inc.; <i>Terry Wolf</i> , Missouri River Energy Services
9:15	CapX 2020 Transmission Initiative – Power Through a Consortium Effort <i>Terry Grove</i> , Great River Energy; <i>Laura McCarten</i> , Xcel Energy	12:00	Lunch

## CONCURRENT SESSIONS

1:00 – 4:15 p.m.

### SUBSTATION

Moderator: **Chuck Healy**

Co-Moderators: **Denny Branca, Mark Harvey**

1:00	Case Study in Substation Monitoring <i>Mark Peterson</i> , Cannon Technologies, Inc.
1:45	Understanding and Dealing with Ferroresonance <i>Bruce Mork</i> , Michigan Technological University
2:30	Break
2:45	Digital Radiography for Inspection of High Voltage SF6 Power Circuit Breakers Increases Breaker Reliability and Performance <i>R. Todd Rittenhouse</i> , Siemens Power Transmission and Distribution, Inc.
3:30	Selection and Application of Group Operated Disconnect Switches <i>David Childress</i> , Southern States, LLC
4:15	Adjourn

### UTILITY INDUSTRY FUTURES

Moderator: **Nathan Germolus**

Co-Moderators: **Dave Peterson, Dave VanHouse**

1:00	The Nuclear Renaissance – How Real? How Soon? <i>John Lobre</i> , Westinghouse Electric
1:45	Tomorrow's Hybrids <i>Robert Graham</i> , EPRI
2:30	Break
2:45	Research and Improvements in Photovoltaic Devices <i>Michael Ropp</i> , South Dakota State University
3:30	C-BED Projects – How Will They be Financed, Who will Permit, Own, Operate, and Market Power? <i>Kevin Walli</i> , Fryberger, Buchanan, Smith & Frederick <i>Mike Kawlewski</i> , Ottertail Power Company
4:15	Adjourn

## EXHIBITOR RECEPTION

4:15-6:00 p.m.

**Wednesday, November 8, 2006**

**CONCURRENT SESSIONS**

**8:30 a.m.-12:00 noon**

**DISTRIBUTION AUTOMATION/COMMUNICATIONS**

**Moderator: Dan Nordell**

**Co-Moderators: Ed Cannon, Gerry Steffens**

- 7:30 Continental Breakfast
- 8:30 Update on BPL from the Radio User's Vantage Point  
*Gary Box, Aria Corporation*
- 9:15 IEC 61850: A Practical Application Primer for  
Protection Engineers  
*Mark Adamiak, GE Multilin*
- 10:00 Break
- 10:30 Through the Hacker's Looking Glass  
*Garrett Leischner, Schweitzer Engineering Laboratories,  
Inc.*
- 11:15 NERC Security Guidelines for the Electricity Sector  
*Frances Cleveland, Xanthus Consulting International*
- 12:00 Lunch

**DELIVERY SYSTEMS**

**Moderator: Denny Branca**

**Co-Moderators: Jim Hanson, Steve Mohs**

- 7:30 Continental Breakfast
- 8:30 Underground High Voltage and EHV Transmission  
*Roger Rosenqvist, ABB, Inc.*
- 9:15 Use of GIS in Transmission Line Routing and Permitting  
*Dan Schmidt and Michelle Bissonnette, HDR*
- 10:00 Break
- 10:30 Distribution Planning Criterion – Perspectives from  
Five Midwest Utilities  
*Philip Spaulding, Xcel Energy*  
*Tom Guttormson, Connexus*  
*Rick VanHatten, MidAmerican Energy*  
*Steve Cook, Rochester Public Utilities*  
*Reed Rosandich, Minnesota Power*
- 11:15 EHV Transmission Line and Substation Design  
Considerations  
*Steve LaCasse and Chad Nissen, Ulteig Engineers*
- 12:00 Lunch

**Wednesday, November 8, 2006**

**CONCURRENT SESSIONS**

**1:00 – 4:15 p.m.**

**RELAYING**

**Moderator: Al Haman**

**Co-Moderators: Nathan Germolus, Mark Harvey**

- 1:00 Relay Design Based on IEC 61850  
*Roger Hedding, ABB, Inc.*
- 1:45 Rebirth of the Phase Comparison Line Protection Principle  
*Bogdan Kasztenny, GE Multilin*
- 2:30 Break
- 2:45 Application Guidelines for Power Swing Detection on Transmission Systems  
*Joe Mooney, Schweitzer Engineering Laboratories, Inc.*
- 3:30 Selection of Pilot Relaying Communication Channels – A Case Study  
*Solveig Ward, RFL Electronics, Inc.*
- 4:15 Adjourn

**PROJECT MANAGEMENT**

**Moderator: Jim Hanson**

**Co-Moderators: Chuck Healy, Gerry Steffens**

- 1:00 Xcel Energy 345 kV Structure Replacement  
*Chad Pederson, Ulteig Engineers, Inc.*  
*Brad Hill, Xcel Energy*
- 1:45 Xcel Energy's 345kV Wind Outlet Transmission/Substation Project and the EPC Project Approach  
*Grant Stevenson, Xcel Energy*
- 2:30 Break
- 2:45 Parkwood-Willmar Transformer Exchange  
*Mark Peterson, Great River Energy*
- 3:30 Replacement of Winton Hydro's Original Wooden Penstocks  
*John Niemela, Minnesota Power*
- 4:15 Adjourn

**DISTRIBUTED RESOURCES**

**Moderator: Tom Guttormson**

**Co-Moderators: Pay Hayes, Roger Simundson**

- 1:00 New Developments in Utility Wind Generation Technology  
*Nicholas Miller, GE Energy*
- 1:45 Methods for Controlling Multiple Independent Generators in an International Island  
*Robert Lasseter, University of Wisconsin at Madison*
- 2:30 Break
- 2:45 Distributed Resources at End of Line  
*Terry Hopkins, Dairyland Power Cooperative*  
*Dean Robinson, Sebesta Blomberg*
- 3:30 MISO Interconnection Process  
*Cassie Polman, Great River Energy*
- 4:15 Adjourn

**Thursday, November 9, 2006**

**CONCURRENT SESSIONS**

**8:30 a.m.-12:00 noon**

**TUTORIAL 1**

7:30 Continental Breakfast  
8:30 The Making of a Transformer  
*H. Jin Sim, Waukesha Electric Systems*  
10:00 Break  
10:30 The Making of a Transformer (continued)  
*H. Jin Sim, Waukesha Electric Systems*  
12:00 Adjourn

**TUTORIAL II**

7:30 Continental Breakfast  
8:30 Power Systems 101  
*Rick Gonzalez, Excel Engineering, Inc.*  
10:00 Break  
10:30 Power Systems 101 (continued)  
*Rick Gonzalez, Excel Engineering, Inc.*  
12:00 Adjourn

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# Topic Descriptions

## GENERAL SESSION

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### Minnesota Power's Centennial – History of Minnesota Power 1906-2006

*Steve Garvey, Minnesota Power*

In 1906, MP was born through the acquisition of several hydroelectric companies. At that time, our forefathers also began constructing Thomson Station on the St. Louis River near Duluth, still the largest hydro facility in the state. Today we bring clean, reliable energy to over 137,000 residential, commercial, and industrial customers throughout northern and central Minnesota. We're equally committed to preserving our natural environment, helping create and preserve jobs in our region, and giving back to communities we serve. And we're continuously pursuing new and advanced energy technologies because we want our next century to be even better than our first.

### CapX 2020 Transmission Initiative – Power Through a Consortium Effort

*Terry Grove, Great River Energy  
Laura McCarten, Xcel Energy*

CapX is a consortium of investor-owned, cooperative and municipal transmission owning utilities in the Minnesota region that is developing large scale transmission infrastructure to maintain reliability as the demand for electricity in the region increases. Minnesota hasn't seen such large-scale transmission development since the late '70s and early '80s. The first group of CapX projects will add about 650 miles of new 345 and 230 kV lines, with a 2012 target in-service date and an estimated cost of over \$1 billion. The second and third groups of CapX projects, with in-service dates of approximately 2020, will add a new high voltage ring around the Twin Cities and provide connection to remote generation sources. The presenters will describe the unique opportunities available to the consortium from permitting and constructing the projects in a highly coordinated manner and the corresponding challenges.

### South Dakota Ice Storm – November 28, 2005

*Michael Sydow, Northwestern Energy*

November 28, 2005 started with light freezing drizzle and ended with up to 3" of clear ice, coating NorthWestern Energy's electrical system across eastern South Dakota. The freezing rain was followed by two days of winds up to 70 mph. The combination of ice and wind destroyed hundreds of miles of transmission and distribution lines across NorthWestern's system. This presentation will depict our efforts (human resources, materials, equipment, logistics, planning, engineering, and communication) to restore service.

## Iraq Experience

*Jon Wahlgren, Ottertail Power Company  
Anthony Centore, S/D Engineers, Inc.  
Terry Wolf, Missouri River Energy Services*

Every day is a new experience for a soldier in Iraq. No two are the same. Yet, the most common answer is 'Groundhog Day' when you ask a soldier what day it is. From an engineer's perspective, the days are full of challenges. There are many engineering and related needs of varying disciplines. Even if your military role is not an engineer, your civilian engineering skills are invaluable. This presentation discusses the Iraq deployment experiences from three electrical engineers who are in the reserve forces.

## SUBSTATION

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### Case Study in Substation Monitoring

*Mark Peterson, Cannon Technologies, Inc.*

Advances in the accurate real-time monitoring of electric substation apparatus are providing the capability for prompt high-quality assessments of equipment condition. This capability readily provides those responsible for maintaining substation equipment the information required to make intelligent preventative maintenance decisions based on actual performance data. This presentation will illustrate real world examples of online monitoring as applied to various equipment in transmission and distribution substations. It will include discussions on applied architectures, installation techniques, and operating examples.

### Understanding and Dealing with Ferroresonance

*Bruce Mork, Michigan Technological University*

The basic concept of ferroresonance is introduced and explained in engineering terms. A broad set of example problems in distribution, substation, and transmission systems is presented. Included are ferroresonance involving: a) 345-kV bus VTs and circuit breaker voltage grading capacitors, b) lightly loaded 12.47-kV padmount transformer fed by underground cable, c) failure of 72 VTs in temporarily ungrounded European system, and d) synch-check VT on ungrounded 13.8-kV delta winding of 30-MVA transformer in distribution substation. Simulation and analysis methods are outlined. Mitigation or fixes are discussed, as well as general guidance for design strategy and specification.

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## Digital Radiography for Inspection of High Voltage SF6 Power Circuit Breakers Increases Breaker Reliability and Performance

*R. Todd Rittenhouse*, Siemens Power Transmission and Distribution, Inc.

Digital radiography combined with regular “external” preventive maintenance will improve breaker reliability, ensure internal components are acceptable for continued use, and allow for tracking interrupter wear over the lifecycle of the breaker. Depending on breaker type and size, DR inspections could be as much as 50% less costly than traditional internal inspections. Digital radiography utilizes a field-applicable radiological source (X-ray, Cesium, Iridium, and/or Cobalt) to pass radiation through the breaker tank assembly onto the opposite side, where a phosphorous laden plate accepts the radiation. The choice of source type and strength as well as the type of materials and internal medium (SF6, air, oil, or vacuum) affect the required exposure time per image, amount of radiation penetration, size of the required safety zone during the exposure, and image quality. Radiation attenuation by the internal components (contacts, nozzles, shield, etc.) provides the image contrast due to the different material densities of the components.

## Selection and Application of Group Operated Disconnect Switches

*David Childress*, Southern States, LLC

This presentation covers the correct selection and proper application of all types of group operated disconnect switches commonly used in the United States and Canada today. Types to be covered include vertical break, double end break, double end break “Vee,” center break, center break “Vee,” and single end break. The relative merits of each type will be addressed with regard to all the various criteria which affect the selection of a specific type for a given application, taking into account such factors as overhead clearance, available phase spacing/substation space, desired mounting position, interrupting capability (if required for that specific installation), site available fault current, environmental conditions (particularly icing), required kV rating, required continuous current rating, economic considerations, etc. The standards which govern group operated disconnect switches will also be covered with particular attention to the key relevant differences between each standard and the impact these differences have on the end user’s selection of the correct product for their application need.

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## UTILITY INDUSTRY FUTURES

### The Nuclear Renaissance – How Real? How Soon?

*John Lobre*, Westinghouse Electric

Utility leaders around the world are examining their generation portfolio needed to meet the demands of the 21st century and many are looking at implementing new nuclear power plants as part of the mix in providing the solution. The presentation will focus on the recent developments in technology improvements, public awareness, political issues, and overall utility interest in nuclear power.

### Tomorrow’s Hybrids

*Robert Graham*, EPRI

Plug-in hybrid vehicles are receiving significant attention in Federal, State, and Local governments. Consumer interest is rising. The need to achieve energy independence while improving the environment is critical to our countries long-term sustainability. The issue before us is how to meet the challenges facing plug-in hybrid vehicle path to commercialization. The plug-in hybrid presentation identifies the technical, environmental, and infrastructure challenges that are impacting successful market penetration of plug-in hybrid vehicles.

### Research and Improvements in Photovoltaic Devices

*Michael Ropp*, South Dakota State University

Photovoltaics has long promised to sustainably produce electric power, but large-scale deployment has been inhibited by high costs. However, PV technology is improving rapidly, and this coupled with an expanding production capacity have led to declining PV energy costs. This presentation will explore some of the technological advancements that have occurred, and some that appear poised to occur. The presentation will conclude with a brief discussion of the future relevance of PV to the electric power sector (basically, a “why should I care?” section for conference participants).

### C-BED Projects – How Will They be Financed, Who will Permit, Own, Operate, and Market Power?

*Kevin Walli*, Fryberger, Buchanan, Smith & Frederick

*Mike Kawlewski*, Ottertail Power Company

This session will focus on business structures formed to develop C-BED projects – including the accommodation of an “equity investor” to help finance projects. The evolution of a business entity as it proceeds through the development process will be reviewed. Financial arrangements for the equity investment and debt financing will be reviewed with attention to satisfaction of federal production tax credit requirements and maintaining eligibility as a Minnesota C-BED project. The Interconnection Study process will be reviewed with attention to transmission system constraints, curtailment provisions, and future transmission system upgrades. Required permits and jurisdictional questions with respect to permitting will also be examined.



### **Update on BPL from the Radio User's Vantage Point**

*Gary Box, Aria Corporation*

It has now been over 18 months since the FCC released its Report and Order on BPL. This presentation will explore the EMI successes and failures of pilot programs and deployments from across the country as well as exploring the pros and cons of the various technologies employed and the lessons learned.

### **IEC 61850: A Practical Application Primer for Protection Engineers**

*Mark Adamiak, GE Multilin*

The world utility community is in the process of adopting a new international communication standard called "Communication Networks and Systems in Substations" or more commonly IEC 61850. This protocol is unlike any other to date in that it not only standardizes the names of the data items being communicated but it also defines the behavior of the modeled objects. This presentation will provide a basic overview of the standard and will address items that will have to be addressed as 61850 moves into mainstream communications.

### **Through the Hacker's Looking Glass**

*Garrett Leischner, Schweitzer Engineering Laboratories, Inc.*

Have you ever wondered what hackers are trying to do to penetrate your system, or how they may be trying to gain access to your assets? In this paper we will walk you through some possible scenarios that you may be faced with, and the security practices you can apply to help prevent hackers from being successful.

### **NERC Security Guidelines for the Electricity Sector**

*Frances Cleveland, Xanthus Consulting International*

Presidential Decision Directive 63 (PDD-63), "Protecting America's Critical Infrastructures," officially identifies "electricity" as a critical infrastructure. The North American Electric Reliability Council (NERC) has been identified as the Sector Coordinator responsible for assessing the vulnerabilities of the nation's electric system and developing a plan to reduce those vulnerabilities. This presentation will discuss the guidelines which NERC has issued in response to this Presidential Directive and the ways in which utilities and their control centers can apply these guidelines to reduce their vulnerability to physical and cyber security risks.

### **Underground High Voltage and EHV Transmission**

*Roger Rosenqvist, ABB, Inc.*

This presentation will review history, applications, and performance of solid dielectric cables for underground and submarine transmission circuits, including brief overviews of major existing and upcoming solid dielectric cable projects at 230-kV, 345-kV and 400-kV in North-America and Europe. The presentation will also discuss the use of solid dielectric DC cables as a feasible alternative to overhead lines in long and medium distance transmission circuits, and the installation of submarine and underground cable circuits within existing right-of-ways as a means to shorten the permitting process for new transmission circuits in densely populated and/or environmentally sensitive areas.

### **Use of GIS in Transmission Line Routing and Permitting**

*Dan Schmidt and Michelle Bissonnette, HDR*

Transmission line routing and permitting is largely an exercise in identifying constraints and opportunities. Geographic Information Systems (GIS) can be a helpful tool in collecting and analyzing spatial data that is required to identify those constraints and opportunities. GIS allows for large amounts of data to be analyzed quickly and provides a graphic way of presenting the constraints and opportunities to agencies and the public.

### **Distribution Planning Criterion – Perspectives from Five Midwest Utilities**

*Philip Spaulding, Xcel Energy*

*Tom Guttormson, Connexus*

*Rick VanHatten, MidAmerican Energy*

*Steve Cook, Rochester Public Utilities*

*Reed Rosandich, Minnesota Power*

Distribution planning criterion is foundational as to how a utility invests, manages risks, and operates its electric system. This presentation will be conducted in a panel format, with a facilitator and panelists representing five Midwest utilities: MidAmerican Energy, Rochester Public Utilities, Connexus Energy, Minnesota Power and Xcel Energy. The audience will be able to compare and contrast the philosophies of these companies, based on the following posed questions:

- Describe your company's prioritization model for projects. Also, how do you draw the line on which projects get funded or deferred?
- Describe how your company determines its peak load. Also, what are your load forecasting scenarios?
- Describe your company's contingency planning philosophy.
- How does your company validate the accuracy of its planning model?
- What is your company's greatest single challenge when it comes to distribution planning?

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## **EHV Transmission Line and Substation Design Considerations**

*Steve LaCasse and Chad Nissen, Ulteig Engineers*

The Extra High Voltage (EHV) Transmission System consists of transmission lines and substations operating at 345 kV and above. The design of EHV transmission lines and substations involves selection of conductors and hardware based on mechanical and electrical ratings. The design of EHV transmission lines and substations differs from the design of lower voltage lines and substations in that greater consideration must be given to electric and magnetic fields, and to the selection of conductors and hardware to reduce the level of corona generation. The presentation will discuss the factors that affect the levels of electric fields and corona generation, which can result in audible noise, radio interference, and damage to insulators. Examples of designs that reduce the likelihood of corona, audible noise and radio interference will be provided.

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## **RELAYING**

### **Relay Design Based on IEC 61850**

*Roger Hedding, ABB, Inc.*

The IEC 61850 architecture for substation communication has been in development for several years. It's the outgrowth of the UCA 2.0 Utility Interoperability initiative in this country. This paper discusses the concepts in IEC 61850 with specific emphasis on how modern relays can be designed to take advantage of this architecture and how IEC 61850 can be integrated into the relay design.

### **Rebirth of the Phase Comparison Line Protection Principle**

*Bogdan Kasztenny, GE Multilin*

This paper presents Phase Comparison (PC) protection from the following angles:

- How popular PC schemes work, in logic block diagrams.
- Channel requirements and limitations, including impact of typical channel misbehaviors on protection.
- Application rules, benefits, and limitations including handling of multi-terminal and weak feed situations.
- Relay designs in use to date – early and late analog solid-state relays, and microprocessor implementations. Drawbacks of schemes available until now.
- Capabilities of latest-generation multi-microprocessor platforms, and resulting solutions for drawbacks of existing schemes.
- Why PC is the ideal standard scheme for many or most utilities (and when other choices make sense). Pros and cons of PC versus directional comparison (DC) pilot relaying.

## **Application Guidelines for Power Swing Detection on Transmission Systems**

*Joe Mooney, Schweitzer Engineering Laboratories, Inc.*

Traditionally, setting relays for power swing blocking (PSB) or power swing tripping applications has been very complex and time consuming. In some cases, the settings are not correct, which is discovered when the relay operates incorrectly. This paper provides the reader with practical setting and application guidelines for traditional impedance-based PSB schemes. It shows how to set a PSB scheme without stability studies. Highlighted are some problem areas when setting and applying power swing detection elements. Application of these setting guidelines will be demonstrated using a power system modeled on a real-time digital simulator.

### **Selection of Pilot Relaying Communication Channels – A Case Study**

*Solveig Ward, RFL Electronics, Inc.*

This paper looks at how a power utility evaluated their options for Pilot Relaying Communications channels. It covers the selection criteria and the qualities required for relaying. It addresses reliability concerns such as substation environment and delay characteristics of communications equipment. The paper is designed to enlighten the Protective Relay Engineer in the area of communications as applied to protective relaying.

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## **PROJECT MANAGEMENT**

### **Xcel Energy 345 kV Structure Replacement**

*Chad Pederson, Ulteig Engineers, Inc.; Brad Hill, Xcel Energy*

Xcel Energy has begun four projects to increase the reliability of four 345 kV transmission lines across Minnesota and Wisconsin. A total of 528 of 1,332 structures will be replaced using hot-line construction techniques. This presentation discusses the effort that was put into planning, estimating, engineering, and constructing these projects. Also discussed are some of the problems and lessons that were learned from a project management perspective.

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## **Xcel Energy's 345kV Wind Outlet Transmission/ Substation Project and the EPC Project Approach**

*Grant Stevenson, Xcel Energy*

In 1999, Xcel Energy proposed transmission system upgrades to accommodate 825 MW of wind-generated power in Southwestern Minnesota and Eastern South Dakota. This project involves 520 miles of transmission lines and work at 29 substations over a broad geographic area bounded by Sioux Falls, Brookings, Alexandria, Burnsville, Faribault, and Fairmont. The project is in the home stretch, with construction under way of the final components of the plan, including a new 86 mile 345 kV line, 66 miles of new 115 kV lines, and many substations. This presentation reviews the project history, permitting requirements and Xcel Energy's project approach. Of key interest is the Engineering, Procurement, and Construction (EPC) method that Xcel Energy elected to utilize for a significant portion of this work. Multiple members of the project team will be on hand to answer questions (and likely debate) the use of the EPC approach.

## **Parkwood-Willmar Transformer Exchange**

*Mark Peterson, Great River Energy*

A transformer exchange was performed between Parkwood, Willmar, and Wilson Lake Substations. The transformer exchanges were needed in order to fulfill contract obligations and future capacity upgrade needs. These exchanges meant buying only one new transformer instead of three, saving Great River Energy (GRE) and Willmar Municipal Utilities (WMU) over one million dollars. The 115/69kV autotransformer swaps included buying a new 140MVA transformer for GRE's Parkwood Substation, moving the existing 112 MVA transformer from Parkwood to WMU's Willmar Substation, and moving the existing 84 MVA transformer from Willmar to storage in Elk River for future use at GRE's Wilson Lake Substation. These transformer exchanges were required to be done prior to January 1, 2006, creating an extremely tight schedule. The additional transformation capacity installed at Parkwood necessitated that the 69kV bus, switches, and circuit breakers had to be replaced. This additional work at Parkwood also had to be done in a compressed time frame due to the load serving importance of this metro substation and schedule impacts to other time sensitive projects in the area.

## **Replacement of Winton Hydro's Original Wooden Penstocks**

*John Niemela, Minnesota Power*

When the historic 4 mW Winton Hydroelectric Development was built in 1923, two 9-ft. diameter penstocks (pipes) were constructed to provide the generating turbines with the water from the dam. The penstocks, built of fir planks banded by steel rods, functioned well for over 80 years. Design for end-of-life replacement evaluated various materials, cost, and replacement timing to minimize station down-time. Construction was completed on-time and on-budget during one of the driest August's on record.

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## **DISTRIBUTED RESOURCES**

### **New Developments in Utility Wind Generation Technology**

*Nicholas Miller, GE Energy*

The development of new wind generation technologies are increasing the economy and performance of wind generation. Successful grid integration is critical to the acceptance and continued growth of wind generation as major energy resource. The latest technology advancements are facilitating the development of wind generation that exhibits characteristics similar to, and in many regards superior to, conventional thermal and hydro generation. The presentation will identify trends and the latest capabilities of wind generation equipment for Grid Friendly integration, with application examples, experience and discussion of emerging grid code requirements.

### **Methods for Controlling Multiple Independent Generators in an International Island**

*Robert Lasseter, University of Wisconsin at Madison*

Application of multiple individual distributed generators can cause as many problems as it may solve. A better way to realize the emerging potential of distributed generation is to take a system approach which views generation and associated loads as a subsystem or a "microgrid." It is important to have local controls that allow multiple generators to work together as a system without relying on communications. This approach allows generations to operate in parallel to the grid or as an island. The microgrid can disconnect from the utility during large events (i.e. faults, voltage collapses), but may also intentionally disconnect when the quality of power from the grid falls below certain standards. When the utility power returns to "normal," the microgrid can reconnect using local information.

### **Distributed Resources at End of Line**

*Terry Hopkins, Dairyland Power Cooperative  
Dean Robinson, Sebesta Blomberg*

Renewable "Green Power" Distributed Generation (DG) installations are becoming more prevalent, with legislators enacting requirements for generation companies to maintain an increasing percentage of their generation portfolios with renewable resources. This has resulted in the placement of many of these DGs on distribution lines. DPC currently has a goal of installing 25 renewable generating units utilizing cow manure as part of the feedstock. Most of these sites are and will be out in the rural distribution electrical grid, often at the end of a multi-feeder circuit. DPC has recently added three landfill gas to electricity projects to their renewable resource, which are also located on a rural distribution grid. DPC has experienced operating problems with these types of installations that result from unbalances in the distribution electrical feeder loads. High neutral currents and negative sequence currents result and must be considered in the interconnection design. This presentation will examine DPC's experience with these problems and provide DPC's recommended solution.

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## MISO Interconnection Process

*Cassie Polman, Great River Energy*

In the past few years, FERC has mandated open access to the transmission grid. This allows any customer (generator) that desires the right to connect to the transmission grid. As a result, the Midwest Independent System Operator, Inc. (MISO) was established. MISO's primary objectives are to regulate the interconnections and to "direct traffic" on the transmission grid. To accomplish this, MISO has established a process for interconnections. This presentation describes the Large Generator (LG) and Small Generator (SG) interconnection procedures along with the difference between being considered a Network Resource (NR) or an Energy Resource (ER). While implementing numerous interconnections, Great River Energy has encountered several common issues which will be addressed during this presentation.

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## TUTORIALS

### The Making of a Transformer

*H. Jin Sim, Waukesha Electric Systems*

A very in-depth, step-by-step look at the construction of a transformer, from raw materials to finished product. A large number of photos and illustrations are used to graphically display each step in the process. Design principles and calculations are also presented, including mechanical, electrical, and material design considerations.

### Power Systems 101

*Rick Gonzalez, Excel Engineering, Inc.*

Electric power systems consist of Generation, Transmission, and Distribution facilities, all of which must be properly planned, designed, constructed, maintained, and operated in order to provide reliable and economical service to the end-use customers. In addition, tariffs, billing, and other administrative matters must also be properly handled. This session provides an overview of the Generation, Transmission, and Distribution systems, with respect to the technical, economic, and strategic considerations involved in their proper development and management.

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# Registration Information

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## LOCATION AND ACCOMMODATIONS

The conference will be held at the Continuing Education and Conference Center, 1890 Buford Avenue, on the St. Paul campus of the University of Minnesota. Parking is available adjacent to the Center in lot S104 for \$5.25 per day and in the Fairground lot S108 for \$3.50 per day. Please see map for details.

Convenient lodging for out-of-town participants is available at the Four Points Sheraton Hotel Minneapolis, 1330 Industrial Boulevard, Minneapolis, 612-331-1900 or 1-888-627-8129. The rate is \$89, plus tax, for a single or double room. Participants are responsible for making their own lodging reservations. To receive the special conference rate, please identify yourself as a participant of the **Minnesota Power Systems Conference**. Reservations must be made by October 15. After this date reservations will be accepted on a space and rate available basis.

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## REGISTRATION AND FEES

The fee for the conference is \$225 if received by October 23; if received after October 23 the fee is \$250. The conference fee includes all sessions, two luncheons, refreshments breaks, the exhibitor reception, and the conference proceedings. You are encouraged to register early to take advantage of the lower fee. If you cancel your registration in writing by October 31, a refund, minus \$30, will be issued. If you cancel after this date you will not be eligible for a refund. A full refund will be issued if the conference is cancelled by the University of Minnesota.

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## EXHIBITOR RECEPTION

The exhibitor reception will be held on Tuesday, November 7, from 4:15-6:00 p.m. at the Continuing Education and Conference Center (the same location as the conference sessions). Exhibitors will display brochures and small equipment. All conference attendees are invited to attend this reception to view the exhibits, meet the exhibitors, and enjoy some hors d'oeuvres and beverages.

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## CONTINUING EDUCATION UNITS (CEUs)

Participants who attend the entire conference will receive 1.5 CEUs. Participants who attend only Tuesday and Wednesday will receive 1.2 CEUs. One CEU is defined as 10 contact hours of participation in an organized continuing education experience under responsible sponsorship, capable directions, and qualified instruction. A CEU certificate will be sent to each participant after the conference. A permanent record of CEUs earned will be maintained by the University of Minnesota Office of Admissions and Record Transcript Unit.

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## FOR FURTHER INFORMATION

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Kay Syme  
College of Continuing Education  
University of Minnesota  
352 Classroom Office Building  
1994 Buford Avenue  
St. Paul, Minnesota 55108  
Phone: 612-624-4938  
Fax: 612-624-6225  
E-mail: [conferences4@cce.umn.edu](mailto:conferences4@cce.umn.edu)

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## CALL FOR PAPERS FOR 2007 CONFERENCE

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Deadline for title and abstract submission for MIPSYCON 2007 is January 15, 2007. Notification of acceptance will be mailed by June 2007. The deadline for final paper submission for accepted speakers is August 31, 2007. If you would like to be considered for the 2007 program, please submit an abstract of approximately 300 words to: Kay Syme, College of Continuing Education, University of Minnesota, 352 Classroom Office Building, 1994 Buford Avenue, St. Paul, Minnesota 55108, E-mail: [conferences4@cce.umn.edu](mailto:conferences4@cce.umn.edu)

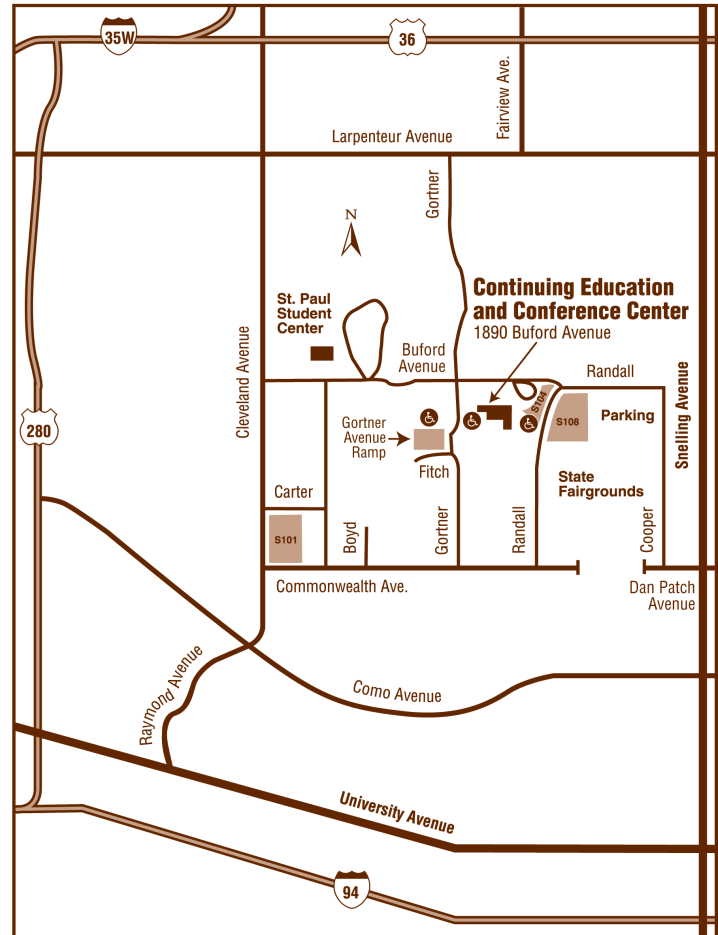
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Disability accommodations will be provided upon request. This publication is available in alternative formats upon request. Call 612-624-4938. The University of Minnesota is committed to the policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, color, creed, religion, national origin, sex, age, marital status, disability, public assistance status, veteran status, or sexual orientation.

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## Continuing Education and Conference Center

1890 Buford Avenue, St. Paul, MN 55108 • 612-624-3275



■ = Parking facilities  
♿ = Handicapped access and parking

## Directions

From I-694: Take 35W south to the Cleveland Avenue exit (Note: exit to the left). Follow Cleveland Avenue to Larparenteur Avenue. Go east (left) on Larparenteur to Gortner, turn south (right) on Gortner and go to Buford Avenue. Turn east (left) on Buford Avenue.

From I-35W: Take the Highway 36 exit and turn south on Cleveland Avenue to Larparenteur Avenue. Go east (left) on Larparenteur to Gortner, turn south (right) on Gortner and go to Buford Avenue. Turn east (left) on Buford Avenue.

From downtown St. Paul: Go west on I-94 to Snelling Avenue. Go north on Snelling Avenue to Larparenteur Avenue. Go west (left) on Larparenteur to Gortner, turn south (left) on Gortner and go to Buford Avenue. Turn east (left) on Buford Avenue.

From downtown Minneapolis: Go east on I-94 to MN-280, exit number 236. (Note: exit to the left). Merge onto MN-280 north. Exit at Larparenteur Avenue. Take Larparenteur east (right) to Gortner (3rd traffic light). Turn south (right) on Gortner and go to Buford Avenue. Turn east (left) on Buford Avenue to the parking area.



## 2006 MIPSYCON PLANNING COMMITTEE

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Cannon Technologies  
Golden Valley, Minnesota

**Larry Brusseau**

Midwest Reliability Organization  
Saint Paul, Minnesota

**Ed Cannon**

Cannon Technologies  
Golden Valley, Minnesota

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**Jon Wahlgren**

Otter Tail Power Company  
Fergus Falls, Minnesota

**Bruce Wollenberg**

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Minneapolis, Minnesota

*\*Planning Committee Chair*

## 42nd Annual Minnesota Power Systems Conference

**November 7-9, 2006**

Name \_\_\_\_\_

(Last)

(First)

(M.I.)

Social Security Number (last four digits for CEUs) XXX-XX-\_\_\_\_\_

Business Address (Street/P.O. Box) \_\_\_\_\_

City

State

Zip Code

E-mail \_\_\_\_\_

Fax \_\_\_\_\_

Company/Institution \_\_\_\_\_

Title/Position \_\_\_\_\_

Daytime phone \_\_\_\_\_

Home Telephone \_\_\_\_\_

**I do not want to be listed on the participant list.**

### Conference Fee

Enclosed is \$225 in full payment of the conference registration fee (received by October 23).

Enclosed is \$250 in full payment of the conference registration fee (received after October 23).

### Method of Payment

Enclosed is a check or money order payable to the University of Minnesota.

The fee will be paid by my employer. Enclosed is a purchase order.

Payment should be charged to my credit card (check one).

Type of Credit Card: \_\_\_\_\_ Visa \_\_\_\_\_ MasterCard \_\_\_\_\_ Discover/Novus \_\_\_\_\_ American Express

Credit Card Number \_\_\_\_\_ Expiration Date \_\_\_\_\_

Name as printed on card (please print) \_\_\_\_\_

Signature of cardholder \_\_\_\_\_

If your check is returned because of insufficient funds or closed account, or because you have made a stop payment request, you will be charged a check handling fee of \$20.

The information on this form is private data, used to identify and locate you, obtain payment, and enable instructors to better know their audience. Name, address, and payment method are mandatory. Information on this form may be shared with instructors and program cosponsors.

### Mail to (with credit card information):

Information Center 179408  
University of Minnesota  
20 Coffey Hall  
1420 Eckles Avenue  
St. Paul, MN 55108-6069

### Register Online:

[www.cce.umn.edu/mnpowersystems](http://www.cce.umn.edu/mnpowersystems)

### Fax to (with credit card information):

612-624-5359