Direct Testimony and Schedules
Richard Gonzalez

State of Minnesota
Before the Office of Administrative Hearings
For the Minnesota Public Utilities Commission

In the Matter of a Petition by Excelsior Energy Inc. for Approval of a Power Purchase Agreement Under Minn. Stat. § 216B.1694, Determination of Least Cost Technology, and Establishment of a Clean Energy Technology Minimum Under Minn. Stat. § 216B.1693

OAH Docket No. 12-2500-17260-2
PUC Docket No. E6472/M-05-1993

Transmission Costs and Timing

September 5, 2006

Table of Contents

I.	Introduction and Qualifications	1
II.	Purpose of Testimony	2
III.	Cost of Network Upgrades	3
IV.	Timing of Network Upgrades	8
V.	Conclusion	10

I. INTRODUCTION AND QUALIFICATIONS

Q. PLEASE STATE YOUR NAME.

A. My name is Richard Gonzalez.

Q. BY WHOM ARE YOU EMPLOYED AND WHAT IS YOUR POSITION?

A. I am employed by Excel Engineering, Inc. as Principal Engineer, Transmission Planning.

Q. FOR WHOM ARE YOU TESTIFYING?

A. I am providing testimony on behalf of Northern States Power Company doing business as Xcel Energy ("Xcel Energy").

Q. PLEASE SUMMARIZE YOUR QUALIFICATIONS AND EXPERIENCE.

A. I graduated from the University of Minnesota in 1982 with a Bachelor of Electrical Engineering degree. From 1983 to 1984 I was a Planning Engineer in the Division of System Engineering of the U. S. Department of Energy's Western Area Power Administration, Golden, Colorado. From 1984 to 2003 I was an engineer in the Delivery System Planning and Engineering Department at Northern States Power Company and subsequently Xcel Energy and was the principal planning engineer on the studies that resulted in the Public Utilities Commission March 2003 Order granting a Certificate of Need for Xcel Energy to construct four new high voltage transmission lines in western Minnesota. I am presently a Principal Engineer and Partner at Excel Engineering, Inc., an independent electrical engineering consulting firm. In these positions I have been responsible for electric transmission system technical and economic analyses. This includes load forecasting, power system modeling, development, and economic evaluation of options, and formulation of designs and specifications for new and upgraded transmission facilities. My resume is provided as Exhibit___(RG-1), Schedule 1. Exhibit___(RG-1), Schedule 2 provides further details regarding my experience in electric transmission studies.

II. PURPOSE OF TESTIMONY

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. I have been retained by Xcel Energy to evaluate the costs and timing of obtaining transmission access for delivery to Xcel Energy of the output from the 603-MW Mesaba Unit 1 project proposed by MEP-I LLC ("Mesaba 1 LLC"). To do so, I reviewed Mesaba 1 LLC's entire public filing, paying particular attention to the parts regarding transmission access. Specifically, I reviewed Section IV, Subsection I (Transmission Infrastructure Requirements) of the Petition, as well as the Testimony of Stephen D. Sherner. I also reviewed the MISO studies responding to Mesaba 1 LLC's interconnection request. I considered all of this information to provide a basis for describing likely scenarios and cost estimates for necessary transmission infrastructure improvements.

Q. WHAT ARE YOUR CONCLUSIONS REGARDING THE COST AND TIMING OF NEEDED TRANSMISSION IMPROVEMENTS TO DELIVER THE OUTPUT OF MESABA UNIT 1 TO XCEL ENERGY'S SYSTEM?

A. Based on my review and analysis, I conclude that:

- The costs of transmission system additions and upgrades necessary for "delivery" will be approximately $180 million, in addition to the approximately $70-73 million costs reported by Mesaba 1 LLC to interconnect the plant. Because I performed my study at a high level and only MISO can finally determine the upgrades that will ultimately be required, actual costs may exceed these numbers, perhaps by a significant amount. It is highly unlikely that costs would be less than I have identified.

- The transmission system improvements necessary for the delivery of Mesaba Unit 1's output to Xcel Energy's system will require a significant amount of time to properly plan, design, and construct. I estimate that the needed improvements would not be in service before 2014.

I describe the basis for these conclusions in the remainder of my testimony.

III. COST OF NETWORK UPGRADES

Q. MR. SCHERNER INDICATES THAT MESABA 1 LLC MAY SEEK LOCAL CAPACITY RESOURCE DESIGNATION FOR MESABA UNIT 1. IS THIS AN APPROPRIATE APPROACH?

A. I agree with Mr. Scherner that such designation is a more practical approach than attempting to secure Network Resource designation, given the significant number and scope of the system limitations identified in MISO's deliverability study. However, Mesaba 1 LLC indicates it does not know what network upgrades are necessary for Mesaba Unit 1 to secure this designation.

Q. TO ACHIEVE THE LOCAL CAPACITY RESOURCE DESIGNATION THAT MESABA 1 LLC DESCRIBES IN ITS PETITION, ARE THE NETWORK UPGRADES FOR THIS DESIGNATION LIKELY TO BE SIGNIFICANT?

A. Yes. Increased firm deliveries of power from Minnesota Power's system, where the interconnection would occur, to Xcel Energy's system would require significant transmission system upgrades to increase the firm rating of the Minnesota Power-Xcel Energy interface.

Q. PLEASE DESCRIBE THE UPGRADES THAT YOU BELIEVE WOULD BE NEEDED TO PROVIDE FIRM TRANSMISSION SERVICE FOR THE MESABA UNIT 1 OUTPUT.

A. Delivery of Mesaba Unit 1's output would require development of a new 345-kV circuit from northern Minnesota to the Twin Cities, and improvements at the existing Chisago Co 500/345 kV substation. Exhibit___(RG-1), Schedule 3 lists the system additions and upgrades required for firm delivery of the Mesaba Unit 1's output to Xcel Energy's system.

Q. HOW DID YOU DETERMINE THAT THESE UPGRADES WOULD BE REQUIRED?

A. Based on my experience and knowledge of the regional transmission system, I developed a study to analyze this part of the system. Powerflow modeling was performed to simulate a power delivery from the Mesaba West Range/Blackberry site to the Xcel Energy system. This analysis indicates significant issues arising on the existing transmission network, particularly the Forbes-Chisago Co 500 kV line, which is a defined "constrained interface" or "flowgate" whose loading is monitored and managed by MISO. This interface is not currently robust enough to accommodate the additional generation output from Mesaba Unit 1 that would flow over this line. The upgrades described in Exhibit___(RG-1), Schedule 3 are a logical way to alleviate these problems.

Q. WHAT WOULD SUCH TRANSMISSION SYSTEM INVESTMENTS COST?

A. I estimate the costs of transmission delivery upgrades for Mesaba Unit 1 would be approximately $180 million, or approximately $300/kW.

Q. HOW DID YOU DERIVE THIS COST ESTIMATE?

A. My study found seven transmission line upgrades or additions and 15 substation improvements that need to be implemented to overcome the identified constraints. The transmission elements primarily involve constructing 345-kV lines at various locations in Minnesota. The longest segment would be the 62-mile rebuild of the Riverton-Benton Co line, upgrading the line from 230 kV to include a second circuit operating at 345 kV. My analysis indicates that another 41 miles of new 345-kV line on new right of way would be required as part of this undertaking. All of the project elements and my estimates of the cost for them are itemized in my Schedule 3.

Q. IS YOUR ESTIMATE CONSISTENT WITH RECENT EXPERIENCE?

A. Yes. The $180 million estimate is consistent with other relatively recent projects. This estimate is consistent with the actual costs of the Manitoba - Minnesota Transmission Upgrade ("MMTU") project and the Harvey-Glenboro project. In the MMTU project, which was designed to support a 400-MW capacity increase, the overall costs were $260/kW. For the Harvey-Glenboro transmission line projects, which increased transfer capability by 200 MW, the cost was $280/kW.

I believe my $180 million estimate is conservative, given the more recent costs associated with the 345 kV Arrowhead – Weston transmission line and Xcel Energy's experience on the Buffalo Ridge. While the Arrowhead – Weston line is not yet completed, the available public information indicates that the cost of this project will be over $500/kW. Similarly, Xcel Energy's "825 MW" series of Buffalo Ridge transmission projects is expected to be constructed for approximately $400/kW. Given these more recent projects, my estimate of $300/kW appears conservative.

Q. DOES YOUR COST ESTIMATE INCLUDE ALL THE COSTS ASSOCIATED WITH THE DELIVERY OF MESABA UNIT 1'S OUTPUT TO XCEL ENERGY'S SYSTEM?

A. No. My estimate does not include the costs associated with interconnecting Mesaba Unit 1 to the transmission grid. Mesaba 1 LLC reports the estimated costs to be $70 million for the Blackberry ("West") site and $73 million for the Forbes ("East") site. To get a full picture of the costs of delivering output to Xcel Energy, both transmission "delivery" and "interconnection" costs must be considered.

Q. DO YOUR IDENTIFIED TRANSMISSION PATH AND COSTS APPLY TO BOTH OF MESABA 1 LLC'S POSSIBLE SITES, OR WOULD SEPARATE ESTIMATES NEED TO BE PREPARED?

A. My analysis focused on developing a transmission plan for the West site. However, the conclusions are applicable also to the East site because the fundamental transmission needs are similar: regardless of where the new generation is located on the Minnesota Power system, there will be a need to provide additional transmission capacity from Minnesota Power's system to the Twin Cities (in addition to the site-specific interconnection requirements).

Although there may be subtle differences in which substations may be involved or which lines or transformers may need to be upgraded or added, the total costs will not differ significantly between the two identified Mesaba generation sites for any given level of generation addition.

Q. DO YOU HAVE ANY QUALIFICATIONS REGARDING YOUR STUDY OR COST ESTIMATES?

A. Yes. First, given the time available, it was not possible to conduct an in-depth transmission system study as would ordinarily be undertaken for a generation addition of this size, as this would take several months and would require the participation of all affected parties. However, drawing on my experience in transmission planning, I was able to develop an adequate and reasonable transmission outlet plan for Mesaba Unit 1.

Second, only MISO, applying its tariffed study process, can finally determine the actual network upgrades and provide associated cost estimates for transmission that would be required to provide firm transmission service for Mesaba Unit 1. While I have provided these types of transmission cost estimates in the past for utilities, including Xcel Energy, Great River Energy, and others to assist their resource selection processes, the official study of required upgrades and estimated costs can only be provided by MISO.

Q. WHAT IS YOUR RESPONSE TO MESABA 1 LLC'S ASSERTION THAT ANY POWER PLANT WOULD REQUIRE SIGNIFICANT UPGRADES AND COMPARABLE COSTS?

A. The required upgrades and costs of providing firm transmission service for a new generator depend on the generator's location. Without studies and specific projects to compare, I cannot agree with this conclusion.

For example, in conjunction with its 2004 Resource Plan, Xcel Energy retained me to conduct transmission studies to assess the costs of deliverability from a number of possible sites for new baseload resources, including a hypothetical 750-MW coal unit ("Sherco 4") from Becker, Minnesota to Xcel Energy's load. I revisited that analysis in preparation for my testimony here. For illustration, I updated the analysis and have provided my summary spreadsheet as Exhibit___(RG-1), Schedule 4. My total estimate for that work is approximately $91 million, or $121/kW.

IV. TIMING OF NETWORK UPGRADES

Q. HAVE YOU CONSIDERED THE TIMING OF THE NECESSARY NETWORK UPGRADES?

A. Yes. I expect that a reasonable time frame to complete all of the identified upgrades would be at least 2014. Given the number of activities involved with implementing the identified upgrades, I believe this estimate is conservative.

Q. HOW DID YOU REACH THIS ESTIMATED TIME FRAME?

A. I reviewed 12 transmission construction projects to consider the time required to plan, permit, and construct, as well as the complexity of the project. I considered this information to estimate a reasonable time frame for the upgrades likely to be required for Mesaba Unit 1. I provide the relevant information from these projects in Table 1 below.

Table 1

Project	Planning	Permitting	Construction	Yrs	Notes
MMTU (500 kV upgrade)	1989-1993	1990-94	1991-1995	6	No new lines
Split Rock-Sioux Falls 230 kV	1989	1989-1998	1999	10	1 mile 230 kV
Chisago-Apple River 230 kV	1994-1996	1996-?	?	12+	inactive
Stone Lake-Bay Front 161 kV	1994-1996	1996-1998	2000-2001	7	55 mi 161 kV
Arrowhead-Weston 345 kV	1997-1998	1999-2005	2004-2008	11	220 mi 345 kV
Harvey-Glenboro 230 kV	1997-1998	1998-2000	2001-2002	5	160 mi 230 kV
Buffalo Ridge 425→825 MW	1999-2001	2002-2003	2003-2008	9	94 mi 345 kV
Buffalo Ridge (BRIGO)	2004-2005	2006-2007	2009-2010	6	~55 mi 115 kV
SW MN→Twin Cities EHV	2005	2006-2008	2009-2011	6	327 mi 345 kV
St Cloud-Fargo (CapX 2020)	2004-2005	2006-2008	2010-2012	8	250 mi 345 kV
Red Rock-Rogers Lk 115 kV	1997	1997-2001	2002-2005	8	6 mi double ckt
Willmar-Paynesville 115→230 kV	1999	2001	2002-2003	4	26 mi rebuild

Q. WHAT DO YOU CONCLUDE FROM THIS INFORMATION?

A. It is evident that projects involving new 230 or 345 kV lines should generally be expected to take at least six years from beginning of planning to completion of construction; eight years is a more typical duration.

Q. GIVEN THIS INFORMATION, WHAT DO YOU BELIEVE IS A REASONABLE TIME LINE FOR DEVELOPING OUTLET TRANSMISSION FOR MESABA UNIT 1?

A. If transmission planning studies were initiated immediately, they could possibly be completed sometime in 2008. Permitting and routing could occur in 2009-2010, with design, land acquisition, and construction beginning in 2011 and completing in 2014. This represents an eight-year implementation schedule

This scenario assumes relatively favorable conditions regarding permitting, and assumes no delays in arranging and implementing financing and cost-sharing arrangements among the requestor, MISO, and the affected transmission owners. This schedule also assumes no unusual difficulty in securing line and substation construction contractors, materials, and construction outages. Considering the number and magnitude of planned major transmission projects in the region and throughout North America, it is uncertain that such assumptions would be satisfied. Completion could thus take longer than this estimate, since there is little opportunity for significantly accelerating any of the required activities.

Q. DO YOU HAVE AN OPINION AS TO HOW LONG IT WOULD TAKE TO BUILD THE TRANSMISSION ASSOCIATED WITH THE SHERCO 4 COMPARABLE THAT YOU IDENTIFIED IN YOUR TESTIMONY?

A. It would take a similar amount of time as my estimates for the relevant utilities to permit and construct the transmission necessary for delivery from Mesaba Unit 1.

V. CONCLUSION

Q. PLEASE SUMMARIZE YOUR CONCLUSIONS.

A. I estimate that the upgrades required to deliver the output of Mesaba Unit 1 to Xcel Energy's system would require the following:

- A new 345-kV transmission line between the Minnesota Power and Xcel Energy systems and substation expansions.
- Approximately $180 million or more to construct, over and above the $70-73 million in interconnection costs.
- Approximately eight years (until at least 2014) to complete.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?
A. Yes, it does.

RICHARD GONZALEZ, PE
Excel Engineering, Inc.
Minneapolis, Minnesota

Experience

2003-Present	Principal Engineer Transmission Planning Excel Engineering, Inc., Minneapolis, MN
1984-2003	Engineer I/Engineer II/Planning Engineer/Superintendent/Principal Engineer Transmission Planning/Delivery System Planning & Engineering Northern States Power Company/Xcel Energy, Minneapolis, MN
1983-1984	Engineer Division of System Engineering; System Studies Branch Western Area Power Administration, Golden, CO
1980-1982	Engineering Intern Student Power Supply Planning Northern States Power Company, Minneapolis, MN

Education

Bachelor of Electrical Engineering, University of Minnesota Institute of Technology, 1982

Additional technical/business coursework at University of Minnesota and University of Colorado:

- Statistics
- Business Law
- Engineering Economics/Accounting
- Semiconductor power electronic circuits
- Quality control and reliability
- Fluid mechanics
- Heat transfer
- Surveying
- Measurement techniques and data acquisition

Licenses

Licensed Professional Engineer, State of Minnesota (18938)
Class A Master Electrician, State of Minnesota (AM01282)
Electrical Contractor, State of Minnesota (CA02012)
Commercial Radiotelephone Operator (with radar endorsement),
Federal Communications Commission (PG-16-19197)
Amateur Radio Operator (Extra Class), Federal Communications Commission

Supervision of Technical Studies

Manitoba-Minnesota Transmission Upgrade (MMTU) Project Technical Studies (1989-1993, multiple utilities). Included specification of 500 kV series compensation and world's largest Static VAR Compensator (SVC).

EPRI Research Project RP3012-18 (Evaluation of Thyristor-Controlled Series Compensation). Definition of project scope, review of contractor (Ontario Hydro) study results.

Measurement of Sherburne County Generating units' subsynchronous frequency response (February, 1992): selection, scheduling, supervision, review of contractor (Power Math Associates, San Diego, CA) measurements and technical analysis.

Subsynchronous Resonance Analysis of the MMTU Project: selection, supervision, review of contractor (General Electric Company, Schenectady, NY) technical analysis.

Exciter Instability Study of Angus C Anson generating Plant: coordination of on-line testing; selection, supervision, review of contractor (EUMAC Inc, Phoenix, AZ) technical analysis.

Statistical Analysis of Wisconsin Northern Area Winter peak load sensitivity to temperature: selection, supervision of statistical consultant (Prof. S Weisberg, University of Minnesota).

Central North Dakota-Manitoba Interconnection Study (1997-98): Organized & led technical study group; performed technical and economic analysis of transmission options. Study resulted in construction of new 160-mile 230 kV Manitoba-U.S. interconnection.

Southwest Minnesota/Southeast South Dakota Electric Transmission Study (1999-2001): Organized & led technical study group; performed technical and economic analysis of transmission options. Study culminated in successful permitting of $160 million transmission improvement plan, including 90-mile interstate 345 kV line.

MISO transmission service studies (multiple).

Generation outlet capacity evaluations (multiple): Performed single- and multi-site transmission outlet evaluations for Independent Power Producers, investor-owned utilities, and G & T Cooperatives for plant sizes of 20 – 1500 MW for sites in Minnesota, Dakotas, Iowa, Wisconsin, Illinois, Kansas.

Wilmarth-Lakefield 345 kV Series Compensation Study (August, 2004): Determined optimal amount and location of series compensation to alleviate constrained interface ("flowgate") concerns. Determined recommended ratings for capacitor bank and protective equipment.

Buffalo Ridge Incremental Generation Outlet ("BRIGO") Electric Transmission Study (June, 2005): Organized & led technical study group; performed technical and economic analysis of "incremental" transmission options involving only 115 kV and lower-voltage improvements.

Southwest Minnesota→Twin Cities EHV Development Electric Transmission Study (November, 2005): Organized & led technical study group; formulated transmission options, performed technical and economic analyses. Recommended Plan includes 327 circuit-miles of new 345 kV transmission and 1300 MVAR of reactive compensation.

MAPP Reactive Adequacy Study (2005). Identify regional load centers within MAPP territory for detailed analysis; direct technical staff's voltage stability analyses (Q-V, P-V, power factor sensitivity); interpret results; provide recommendations.

Red River Valley/Northwest Minnesota Load-Serving Transmission Study (2006): Identify upcoming load-serving deficiencies; formulate & evaluate short- and long-range transmission options to address overloads and voltage stability issues. Recommended Plan includes new 230 and 345 kV lines and reactive compensation.

Publications

"Manitoba-Minnesota Transmission Upgrade Project", *Transmission & Distribution*, May 1992.
"Evaluation of FACTS Technologies' Application to the Manitoba-Minnesota Transmission Interface", (IEEE Special Publication: *Current Activities in FACTS Technologies*), 1992.
"Recommended Practice for Modelling of Static VAR Compensators", (Contributor) IEEE publication.
"500 kV Series Compensation Project", (Co-Author) EEI Electrical Systems and Equipment Committee, October, 1992.
"Application of Fast-Switched Shunt Capacitors to Improve Power System Dynamic and Steady-State Performance", (Co-Author), American Power Conference (Chicago, IL 1995).
"Transmission Outlet Cost Minimization Strategies for Wind-Electric Generating Facilities", American Wind Energy Association (Austin, TX 1997)
"Probabilistic Planning of Shunt Reactive Installations: Application of Binomial Probability Distribution Function to Prediction of Aggregate Shunt Reactive Compensation Availability and Determination of Spares Requirement", American Power Conference (Chicago, IL 1997)
"Solid Dielectric 115 kV Direct-Buried Cable Applied Within Substation Enables Conversion to Ring Bus Configuration to Meet Enhanced Reliability Needs", American Power Conference (Chicago, IL 1997)
"Statistical and Engineering Analysis of Transmission System Topology's Influence on Large Autotransformer Failure Rates", (Lead Author), American Power Conference (Chicago, IL 1997)
"Developing a Long-Range Bulk Transmission System Plan for Northern States Power" (Co-Author), American Power Conference (Chicago, IL 1997)
"Why FACTS Devices May Not Achieve Widespread Use", Minnesota Power Systems Conference, October, 1997.
"Recent NSP Experience with Application of Mechanically-Switched Shunt Capacitors to Improve Power System Dynamic and Steady-State Performance", IEEE "FACTS Applications" IEEE Special Publication, 1996.
"Stepped Capacitor Applications: Design of Multi-Stage 115 kV Shunt Capacitor Bank", Minnesota Power Systems Conference, October, 1996.
"Approach to Modeling Utility Network for Harmonic Impedance Analysis", (Co-author),Minnesota Power Systems Conference, October, 1996.
"Voltage Stability Issues and Analysis Methods as Applied to Reactive Compensation Requirements of Red River Valley Electric Transmission System", Minnesota Power Systems Conference, October, 1995.
"Application of Fast-Switched Shunt Capacitors to Enhance Power System Dynamic and Steady-State Performance", (Co-Author), North American Power Symposium (Massachusetts Institute of Technology, November, 1996).
"An Exploration of Utility Concerns Due to Wind Electric Generation" (Co-Author) University of Minnesota, June, 1996.
"Semiconductor-Based Power Control is Exciting, but Evolutionary Enhancements to Conventional Devices Render them More Practical", The Future of Power Delivery in the 21st Century, (EPRI Conference; La Jolla, CA, November, 1997).

"Recent Storm-Induced Transmission Facility Outages in Minnesota Imposing Operating Challenges on Bulk System Reliability and Performance" (Co-Author) American Power Conference (Chicago, IL 1998)

"Transmission System Shunt Capacitor Banks: Recent Advances in Control Concepts and Switching Equipment Yield Improved Application Flexibility and Performance", Minnesota Power Systems Conference, October, 1998.

"Southwest Minnesota Wind Generation Transmission Outlet: SVC Installation at Lake Yankton Substation", Minnesota Power Systems Conference, November, 2004.

Industry Groups/Seminar Participation

Panelist, IEEE Transmission & Distribution Conference, Dallas, TX (2003)
Presenter, IEEE Winter Power Meeting, New York (1992, 1995)
Presenter, MAPP Engineering Conference (1992)
Presenter, Minnesota Power Systems Conference (1991, 95, 96, 97, 98, 2000, 2003, 2004)
Presenter, Tutorial Session, Minnesota Power Systems Conference (2006)
Presenter, Iowa State University Power System Operators' Short Course (1999, 2003)
Presenter, EEI System Planning Committee (1992)
Presenter, EPRI Flexible AC Transmission Systems (FACTS) Workshop (1990)
Presenter, North Central Electric Association, 1997
Participant, EPRI/NERC Voltage Stability Forum (1992)
Participant, "Probabilistic Methods Applied to Power Systems" Symposium
Participant, EPRI "Power System Planning & Operations Voltage/VAR Projects" Symposium
Participant, EPRI "Non-Linear Dynamics" Seminar (1993)
Coordinator, Power System Voltage Stability Seminar (1994)
Member, Mid-Continent Area Power Pool Design Review Subcommittee (1997-2001)
Member, Electrical Section, National Fire Protection Association (National Electrical Code Sponsor)
Member, Institute of Electrical and Electronics Engineers (IEEE), Power Engineering Society
Past Member, Mid-Continent Area Power Pool, Transmission Studies Task Force
Past Member, EPRI Industry Advisory Panel RP1208 (Extended Transient/Mid-Term Stability Program)
Past Chair, Mid-Continent Area Power Pool Red River Valley Sub-regional Planning Group

Other Presentations

MAPP Design Review Subcommittee (Multiple)
MAPP Sub-Regional Planning Groups (Multiple)
EPRI Industry Advisors' Meeting (project RP3022: Evaluation of Thyristor-Controlled Series Compensation) (multiple)
IEEE Power Engineering Society (Twin Cities)
Minnesota Legislative Electric Energy Task Force (2004)
NSP Engineers' Association (multiple)
Manitoba-U.S. Tie Line Coordinating Committee (1994)
American Power Dispatchers Association (1994)
National Wind Coordinating Committee: Midwest Wind Conference (2005)
Missouri Basin Systems Group Planning Committee (1994)
EPRI "FACTS" System Studies Project Review (1993)
Excel Engineering Industrial/Utility Seminar (2006)

Testimony in Legal & Regulatory Proceedings

Certificate of Need/Route Certification for transmission lines and substations (States of MN & WI)
Local transmission permitting proceedings (various municipalities)
Certificate of Need for generation facilities (State of MN)
Corporate Merger (FERC)
Presidential Permit (DOE) for U.S.-Canada new and upgraded interconnections
Right-of-way condemnations
Electric shock/burn litigation

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Summary of Experience in Electric Transmission Studies for Generation Outlet or Regional Transfer Capability Enhancement

Transfer Capability

1) Manitoba-Minnesota Transmission Upgrade (MMTU) Project (1989-93): *Lead engineer* in major transmission study efforts relating to increasing north-south transfer capability between Manitoba and the U.S.
   - *Transmission planning studies,* formulating and evaluating options, technical and economic performance, identifying the performance characteristics and ratings of upgrades required; and
   - *MAPP Design Review Subcommittee* (MAPP DRS) *studies*, to demonstrate the proposed additions adequate to satisfy the MAPP System Design Standards under proposed power transfer conditions.
   - The MMTU Project achieved 400 MW increase in Manitoba-U.S. (southward) and 500 MW (northward) power transfer capability primarily by extensive installations of reactive power supply facilities.
   - Completed in May, 1995 at a cost of $100,300,000. Roughly 75% allocated to 400 MW southward transfer capability. Therefore, the cost of the incremental southward transfer capability was approximately $188/kW in 1995 dollars. Adjusting to today's dollars (at 3.0%/yr), this is approximately $260/kW.
2) Central North Dakota-Manitoba ("Harvey-Glenboro 230 kV") 1997-00
   - The Harvey-Glenboro project increased Manitoba-U.S. (southward) power transfer capability by 200 MW (from 1975) to 2175 MW, and also established a 700 MW northward transfer capability. This was achieved primarily by the addition of a 160-mile 230 kV line from central North Dakota (Harvey) to southwestern Manitoba (Glenboro).
   - Less noticeable, but crucial to achieving satisfactory performance, was the addition of large shunt capacitor banks in North Dakota (Balta Switching Station) and the Twin Cities (Chisago County Substation).
   - The Harvey-Glenboro project was completed in October, 2002 at a cost of approximately $50 million. The cost of the incremental transfer capability can be reckoned to be $250/kW. Adjusting to today's dollars (at 3.0%/yr), this is approximately $280/kW.
3) Wisconsin Interface Reliability Enhancement Study (WIRES) 1997-98
   - The WIRES Study formulated and evaluated 47 transmission options for increasing bulk power import capability into eastern Wisconsin, as required to satisfy provisions of Wisconsin Act 204.
   - Transmission options were evaluated with respect to steady-state, dynamic stability, and voltage stability performance. As the lead NSP transmission planning engineer in

this effort, I performed some of the transfer capability evaluations, interpreted results of the technical analyses, and participated in development of the study report.

- Utility managements subsequently elected to implement the 220-mile Arrowhead-Weston 345 kV line.
- Arrowhead-Weston under construction. Public information indicates that the cost of this project will be over $500/kW.

Generator Interconnection and Outlet

4) Sherco/Monticello Generation Increase Study
5) Chemolite Generation (265 MW)
6) Buffalo Ridge wind outlet (425 MW)
7) Lakefield Generating Station (550 MW). These studies were performed to demonstrate the proposed generation interconnection and outlet facilities are adequate to satisfy the MAPP System Design Standards for these baseload, intermediate, wind, and peaking facilities. This demonstration is necessary to achieve generating capacity accreditation in the MAPP generation reserve sharing pool. I was the lead engineer on all four studies, and secured MAPP Design Review Subcommittee acceptance of the studies. Study (5) showed no need for off-site improvements due to the generation being located within the Minneapolis/St. Paul load center, while all others confirmed need for off-site transmission system upgrades to accommodate firm delivery of the new generation's output.
8) Buffalo Ridge 825 MW (Split Rk-Lakefield Jct 345 kV and 3 115 & 161 kV lines), Xcel Energy's "825 MW" series of Buffalo Ridge transmission projects is expected to be constructed for approximately $400/kW. This project includes 94 miles of new 345 kV line, and 3 lower-voltage lines.
9) Buffalo Ridge Incremental Generation Outlet (BRIGO) (825→1200 MW). Ongoing project just commencing regulatory permitting; includes two new 115 kV lines.
10) Buffalo Ridge EHV (1200→1800 MW). Like (8) and (9), this study was performed for the purpose of identifying the preferred transmission option for achieving increased levels of southwest Minnesota/southeast South Dakota Buffalo Ridge generation outlet capacity. Activities for all three studies included organization and coordination of inter-utility study group, performance of technical and economic analyses, and report compilation. This project, which includes over 300 circuit miles of new 345 kV, is in initial stages of permitting.
11) Xcel Energy (baseload, multi-site) (750 & 1500 MW) (2005).
12) Great River Energy (baseload, multi-site) (2005). These two studies were screening-level studies to support baseload generation siting efforts. Transmission outlet improvement plans were developed for each site to accommodate one or more generating units, subject to MAPP and MISO reliability and constrained interface loading criteria. In the Xcel Energy study it was concluded that sites remote from the Twin Cities would typically require one 345 kV line addition from the site to the Twin Cities for each 750 MW generator addition.

Transmission Facilities for Delivery of Mesaba Unit 1Output to Xcel Energy Twin Cities Load Center
(Blackberry site)

603 MW Excelsior--> Twin Cities

Transmission Lines	miles	cost/mi	Installed cost ($1,000's)	
Riverton-Benton Co 230 kV: rebuild to double ckt 345/230 kV	62	800	49,600	
Benton Co-Monticello 230 kV: rebuild to double ckt 345/230 kV	22	800	17,600	
Monticello-(Dickinson)-W Waconia: new 345 kV single ckt	41	525	21,525	
Monticello-(Dickinson)-W Waconia: acquire right-of-way	41	100	4,100	
W Waconia-Blue Lk: rebuild to double ckt 345/230 kV	24	800	19,200	
Chisago Co-Kohlman Lk: reconductor low-capacity section	6.1	180	1,098	
Chisago Co-King 345 kV: reconductor low-capacity section	6.7	180	1,206	
Total Lines			114,329	
Substations				
Riverton Sub: add 345/230 kV transformation (2 x 400 MVA)			8,000	
Riverton Sub: add 4 230 & 3 345 kV breakers, establish 3-position 345 kV ring bus			6,000	
Riverton Sub: add ±150 MVAR Static VAR Compensator @ 230 kV			13,500	
Benton Co Sub: add 5 345 kV breakers to develop 5-position ring bus			5,000	
Benton Co Sub: install series compensation for Riverton 345 kV line			8,500	
Benton Co Sub: add 50 MVAR shunt reactor			1,000	
Monticello Sub: add 4 345 kV breakers (2 line terminations)			4,000	
Blue Lk Sub: add 3 345 kV breakers (8M29, 30, 31; new row for new Monti line & PI line)			4,000	
Blue Lk Sub: add 50 MVAR shunt reactor			1,000	
Chisago Co Sub: upgrade 500 kV series capacitors to 2500 amps			3,000	
Chisago Co Sub: add 3 x 80 MVAR 115 kV caps			3,000	
Riverton Sub: add 3 x 60 MVAR 230 kV shunt capacitors			3,000	
Benton Co Sub: add 1 x 80 MVAR 115 kV shunt capacitors			1,000	
Blue Lk Sub: add 1 x 80 MVAR 115 kV shunt capacitors			1,000	
A S King Sub: add 2 345 kV breakers (establish 3rd row)			4,000	
Total Substations			66,000	$/kW
Grand Total Lines & Substations			**180,329**	299

Notes:

1. Line costs:

	$1,000/mi
single ckt 345	525
double ckt 345	800
removal of existing	50

2. Costs do not include recovery of undepreciated value of existing facilities to be removed.
3. Assumes Boswell-Riverton 230 kV line already provided as part of interconnection facilities.

Transmission Facilities for Delivery of Sherco Unit 4 Output to Xcel Energy Twin Cities Load Center

	unit cost	units	total element cost	total project cost	total project cost	total plan cost	$/KW
Sherco – Chisago Co 345 kV					$26,625,000	**$90,825,000**	$121
345 kV line							
Sherco – Chisago Co	$525 000	45	$23 625 000				
345 kV breakers							
Sherco	$1 000 000	2	$2 000 000				
Chisago Co	$1 000 000	1	$1 000 000				
				$26 625 000			
Red Rock-Chisago 345kV dbl ckt					$42,250,000		
345 kV dbl ckt							
Red Rock-Chisago	$850 000	45	$38 250 000				
345 kV breakers							
Red Rock	$1 000.000	1	$1 000 000				
Chisago	$1 000 000	3	$3 000 000				
				$42 250 000			
Chisago-Rush City 230kV					$3,000,000		
230 kV line							
Chisago-Chisago tap	$350 000	2	$700 000				
move 345-230 kV tx							
to Chisago from Red Rock	$300 000	1	$300 000				
345 kV breakers							
Chisago	$1 000 000	2	$2 000 000				
				$3 000 000			
add an additional 48 Mvars at Eau Claire					$100,000		
48 Mvar Cap							
Eau Claire	$100 000	1	$100 000				
				$100 000			
Second Monticello 345-230 kV transformer					$7,000,000		
345-230 kV 336 Mva tx							
Monticello	$3 000 000	1	$3 000 000				
345 kV breakers							
Monticello	$1 000 000	2	$2 000 000				
230 kV breakers							
Monticello	$1 000 000	2	$2 000 000				
				$7 000 000			
Add two South Faribault 161-115 kV 336 MVA transformers					$7,000,000		
161-115 kV 336 Mva tx							
South Faribault	$2 000 000	2	$4 000 000				
161 kV breakers							
South Faribault	$800 000	2	$1 600 000				
115 kV breakers							
South Faribault	$700 000	2	$1 400 000				
				$7 000 000			
Reconductor Cannon Falls Transmission - Pine Island 69 kV to					$2,850,000		
69 kV 477 ACSR reconductor							
Cannon Falls Tr - Cannon Falls	$100 000	1 3	$130 000				
Cannon Falls - South CF	$100 000	2 4	$240 000				
South Cannon Falls - Hader	$100 000	9 4	$940 000				
Hader - Zumbrota	$100 000	8 0	$800 000				
Zumbrota - Lena TP	$100 000	1.0	$100 000				
Lena TP - Pine Island	$100 000	6 4	$640 000				
		28 5		$2 850 000			
Add shunt reactors for new 345 kV lines (2 x 50 MVAR)	$1 000 000	2	$2 000 000	$2 000 000	$2 000 000		
						$90,825,000	$121