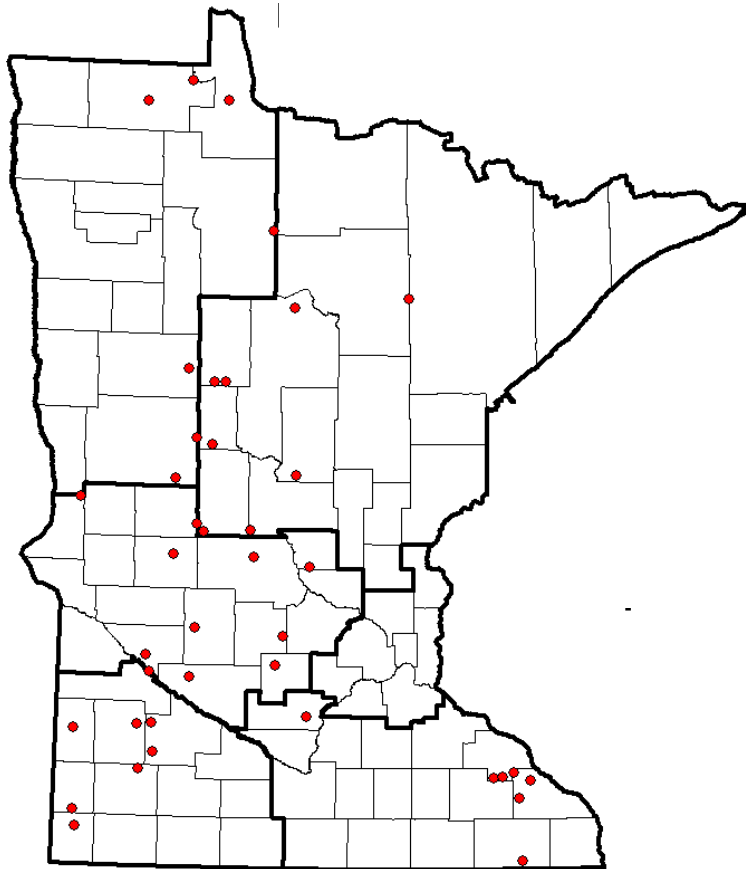


Dispersed Renewable Generation Transmission Study - Phase II

September 28, 2009



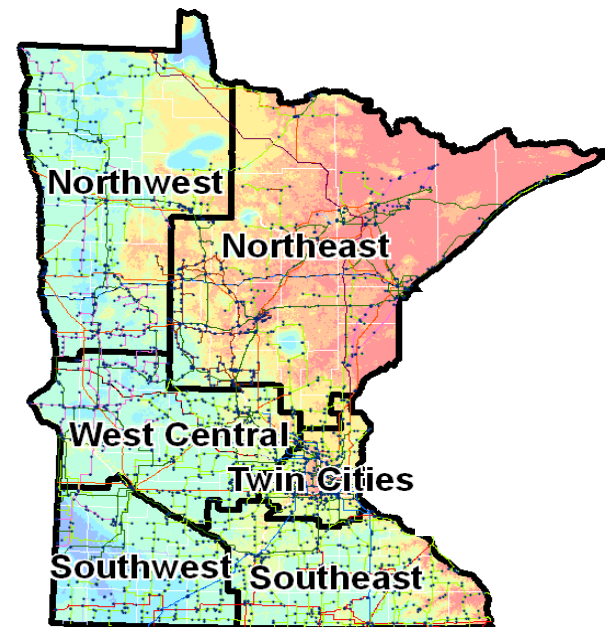
Presented by:

Jared Alholinna – Great River Energy



Webinar Overview

- Introduction
- DRG Phase II Study Requirements
- Model Building
- Study Results
- Conclusions
- Questions



DRG Study Requirements

Analyze transmission impacts of 1200 MW of new dispersed renewable generation located statewide

Two phases:

- Phase I: 600 MW
 - Report submitted June 16, 2008
- Phase II: 600 MW
 - Report due September 15, 2009



DRG Legislation

(Next Generation Energy Act of 2007)

Sec. 17. **STATEWIDE STUDY OF DISPERSED GENERATION POTENTIAL.**

Subdivision 1. **Definition.** "Dispersed generation" means an electric generation project with a generating capacity **between ten and 40 megawatts** that utilizes an "**eligible energy technology,**"

Subd. 2. **Study participants.** **Each electric utility subject to Minnesota Statutes, section 216B.1691, must participate** collaboratively in conducting a two-phase study of the potential for dispersed generation projects that can be developed in Minnesota.

Subd. 5. **Technical review committee.** Prior to the start of the first phase of the study, the **commissioner of commerce must appoint** a technical review committee consisting of between ten and 15 individuals with experience and expertise in electric **transmission system engineering, renewable energy generation** technology, and **dispersed generation** project development, including representatives from the federal **Department of Energy**, the **Midwest Independent System Operator**, and **stakeholder interests**.

The technical review committee **must oversee both phases** of the study, and must:

- (1) make recommendations to the utilities regarding the **proposed methods and assumptions** to be used in the technical study;
- (2) in conjunction with the appropriate utilities, **hold public meetings** on each phase of the study in each electricity transmission planning zone prior to the **beginning of each phase** of study, **after the impact analysis is completed**, and **when a draft final report** is available;

The **technical review committee** must oversee both phases of the study, and must:

(3) establish procedures for handling **commercially sensitive information**; and

(4) **review** the **initial** and **final drafts** of the study and **make recommendations** for improvement, including problems associated with the interconnections among utility systems that may be amenable to solution through cooperation between the utilities in each zone.

During each phase of the study, the technical review committee may recommend that the installation of dispersed generation projects be moved to new locations that cause fewer undesirable transmission system impacts.

DRG Legislation – Phase II

...participants must analyze the impacts of an **additional total of 600 megawatts** of dispersed generation projects installed among the five transmission planning zones, or a higher total capacity amount if agreed to by both the utilities and the technical review committee.

The utilities must **employ an analysis method similar to that used in the first phase** of the study, and must use the **most recent information available**, including information developed in the first phase.

The second phase of the study must use a **generally accepted 2013 year transmission system model** including all **transmission facilities** that are expected to be **in service at that time**.

The commissioner of commerce must submit a report containing the findings and recommendations of the second phase of the study to the commission no later than **September 15, 2009**.

Technical Review Committee – Phase II ⁸

- **Jared Alholinna - Great River Energy**
- **Tami Anderson - Mid-Continent Area Power Pool**
- **Dan Barr - ITC Midwest**
- **Lynn Coles - National Renewable Energy Laboratory**
- **Rick Gonzalez - Minnesota Utilities (Excel Engineering, Inc.)**
- **Rick Hettwer - Southern Minnesota Municipal Power Agency**
- **David Jacobson - Manitoba Hydro**
- **Michael Kaluzniak - Minnesota Public Utilities Commission**
- **Dan Kline - Xcel Energy**
- **Mike Klopp - Minnesota Power**
- **Durgesh Manjure - Midwest Independent Transmission System Operator**
- **Tom McDermott - Utility Wind Integration Group (MelTran)**
- **Natalie McIntire - Wind on the Wires**
- **Teresa Mogensen - Xcel Energy**
- **Gordon Pietsch - Great River Energy**
- **Tim Rogelstad - Otter Tail Power**
- **Larry Schedin - Minnesota Chamber of Commerce (LLS Resources)**
- **Matt Schuerger (TRC Chair) - Minnesota Office of the Reliability Administrator**
- **Charlie Smith - Utility Wind Integration Group**
- **Dale Sollom - Minnkota Power**
- **Dave Van House - Minnesota Power**
- **John Weber - Missouri River Energy Services**
- **Jason Weiers - Otter Tail Power**
- **Marya White - Minnesota Office of the Reliability Administrator**
- **Tom Wind - Windustry (Wind Utility Consulting)**

DRG Study Milestones

- TRC Appointed in July 2007
- Phase I was completed June 2008
- Phase II began Sept 2008
- Phase II was completed Sept 2009

DRG Phase II Schedule

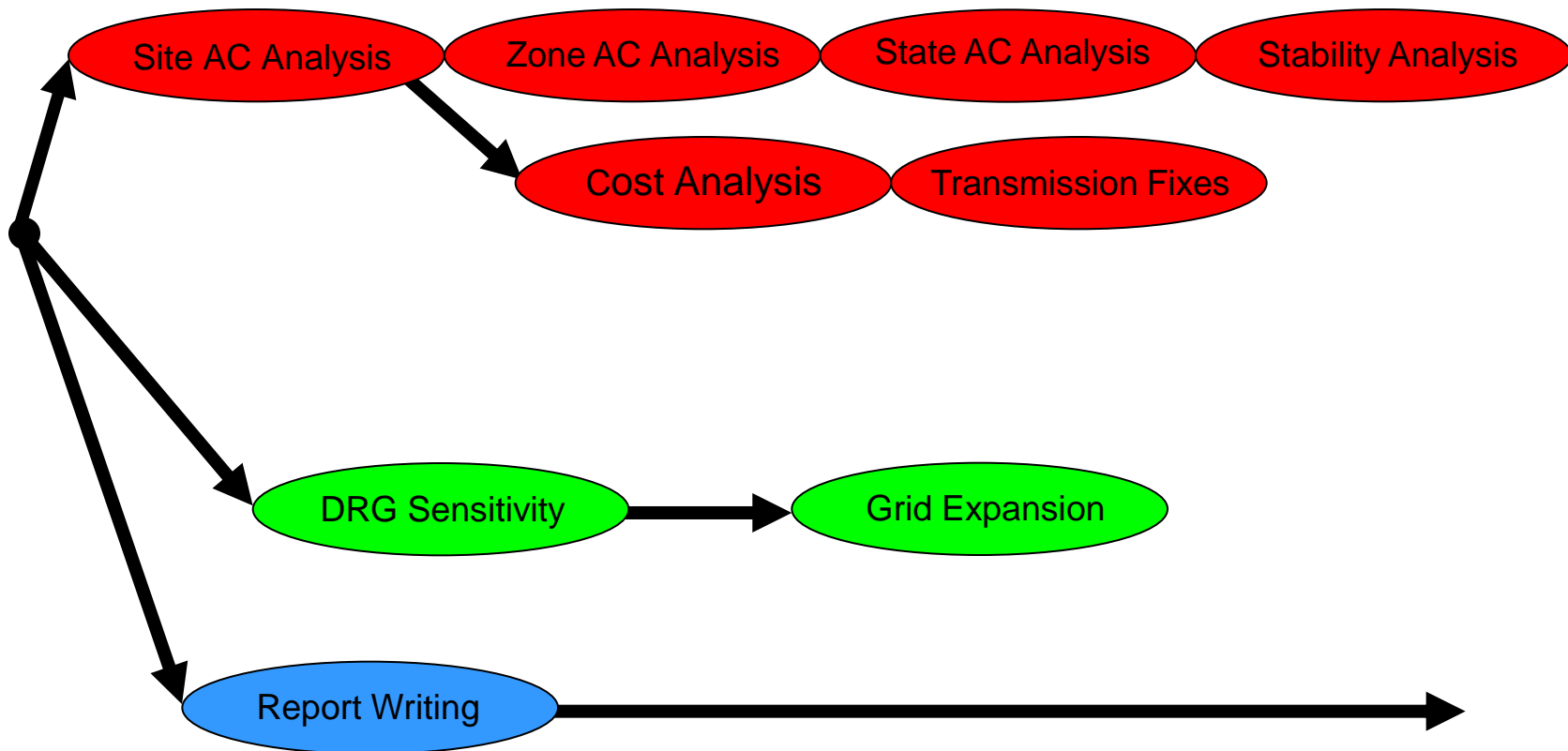
- TRC Meetings / Dates

- Sept 16, 2008, Web Conference (Initial Study Scoping)
- Oct 29, 2008, In-Person Meeting (Study Scope Discussions)
- Dec 4, 2008, Web Conference (Study Scope Refinements)
- Jan 22, 2009, Web Conference (Model Building Update)
- Feb 20, 2009, Web Conference (Model Building Update)
- Mar 26, 2009, Web Conference (Model Building Update)
- Apr 21, 2009, In-Person Meeting (Site Screening)
- May 20, 2009, Web Conference (Site Screening)
- July 21, 2009, In-Person Meeting (AC Analysis Review)
- Aug 7, 2009, Web Conference (Final Analysis Review)
- Sept 2, 2009, Web Conference (Report Review)

DRG Phase II Study Team

- Jared Alholinna - Great River Energy – Team Lead
- Berhanu Bedada - Great River Energy
- Josh Lantto - Great River Energy
- Ellen Lamb - Lamb Energy on behalf of Minnesota Utilities
- William Quaintance - Excel Engineering, Inc. on behalf of MN Utilities
- Andy Schmidt - United Services Group
- John Weber - Missouri River Energy Services

Study Process Path



DRG I vs DRG II

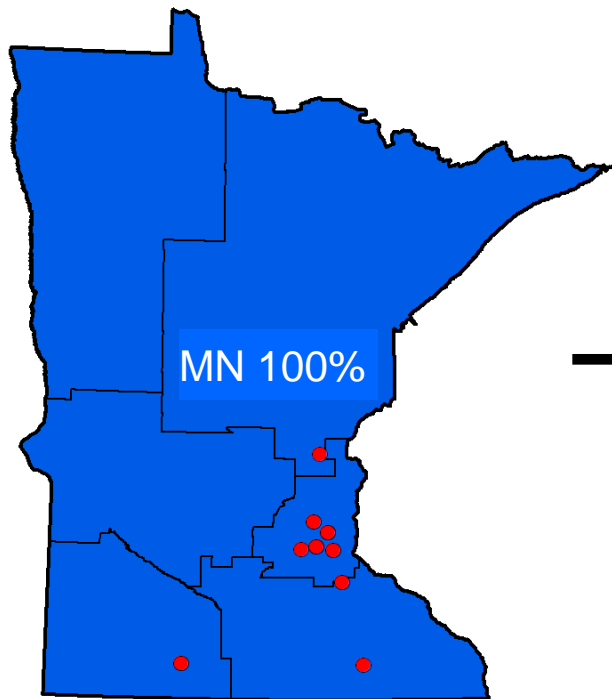
Scope & Study Improvements

	DRG I	DRG II
Time Frame	2010	2013
Queued Generation	Did not model	Modeled 7,000 of 50,000 in five-state region
Generation Sink	Wider Twin Cities Area	MISO Market
Bus Wind NCF	Right at Bus	2-mile radius around Bus
Wind Output Levels	100% - Summer Peak 100% - Summer Off-Peak	20% - Summer Peak 90% - Summer Off-Peak
Distribution Factor	3% - System Intact 5% - Contingency	5% - System Intact 5% - Contingency
Facility Ratings	Normal Rating	Emergency Rating
Monitored Areas	In and Around MN	Five-State Region

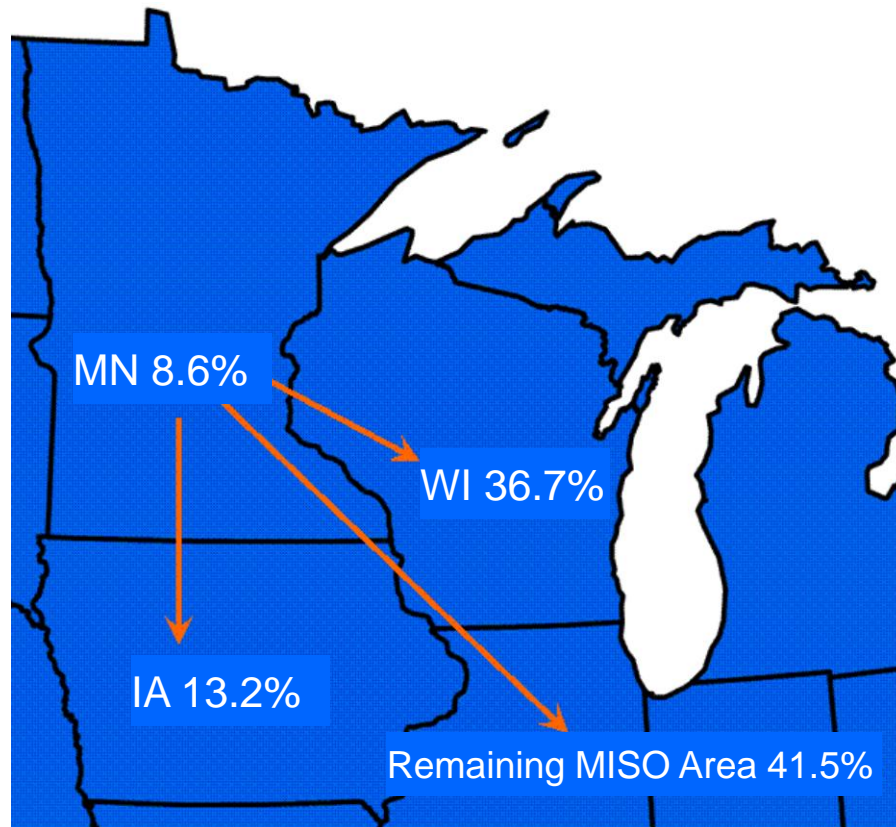
Sink Assumptions

Summer Off-Peak

DRG I



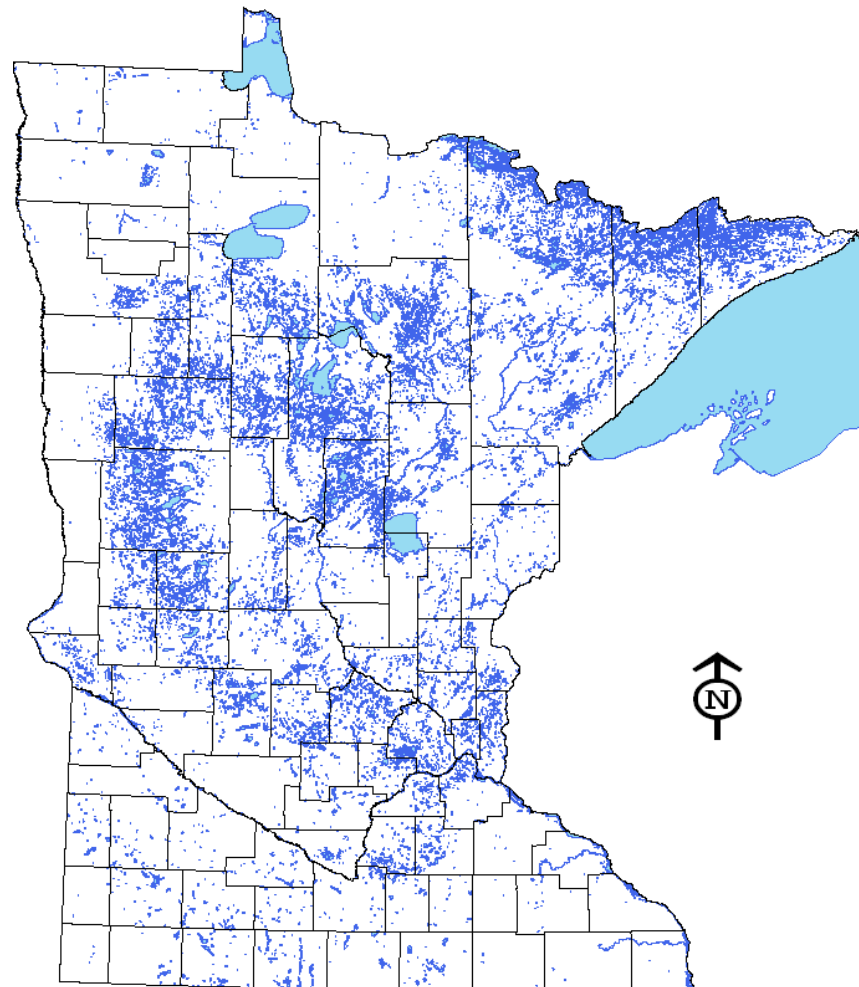
DRG II



Wind NCF (Net Capacity Factor)

- Maximum NCF from 2-mile radius around buses
- Greatly increased number of sites for screening process
- Filtered out water areas

WIND NCF SUMMARY TABLE			
PLANNING ZONE	AVG. NCF @ BUS	AVG. NCF 2 MILE RADIUS	NEW SITES > 35%
NW	37.3	38.2	35
NE	30.5	32	46
WC	36.5	37.4	59
SW	38.8	39.5	2
SE	34.9	36.3	61
TOTALS	35.6	36.7	203



Wind Output Modeling

DRG Phase I

100% Summer Peak (SUPK) & 100% Summer Off-Peak (SUOP)
(% of nameplate)

Midwest Reliability Organization (MRO)

20% SUPK & 35% SUOP

Midwest ISO Generation Interconnections

20% SUPK & 100% SUOP

DRG Phase II

20% SUPK & 90% SUOP

DRG II Model – New Generation

Signed IA's Summary Table		
STATE	MW	IN-SERVICE DATE RANGE
Minnesota	5,628	4/2/02 - 5/30/12
North Dakota	430	10/1/03 - 6/1/08
South Dakota	305	5/1/05 - 11/1/07
Wisconsin	3,837	6/1/01 - 6/1/11
Iowa	1,088	4/1/01 - 12/31/07
TOTAL	11,288	4/1/01 - 5/30/12

Generator Additions to Model		
	SUOP (MW)	SUPK (MW)
SIGNED IA PROJECTS	5,207	7,026
DRG PHASE I PROJECTS	541	120
GRANDFATHERED PROJECTS	691	154
MINNKOTA WIND PROJECTS	322	72
MN POWER PROJECTS	336	75
TOTALS	7,097	7,446

DRG II Model

MISO Queue Generation Not Included in Model						
WIND	IA	MN	ND	SD	WI	Totals
DPP	241	831	150	0	527	1,748
SPA	5,756	20,922	7,436	11,418	0	45,532
Grandfathered	760	335	0	216	749	2,060
Complete SIS; conform to new process starting with M3 milestone	0	0	150	0	99	249
Totals	6,757	22,088	7,736	11,634	1,374	49,590

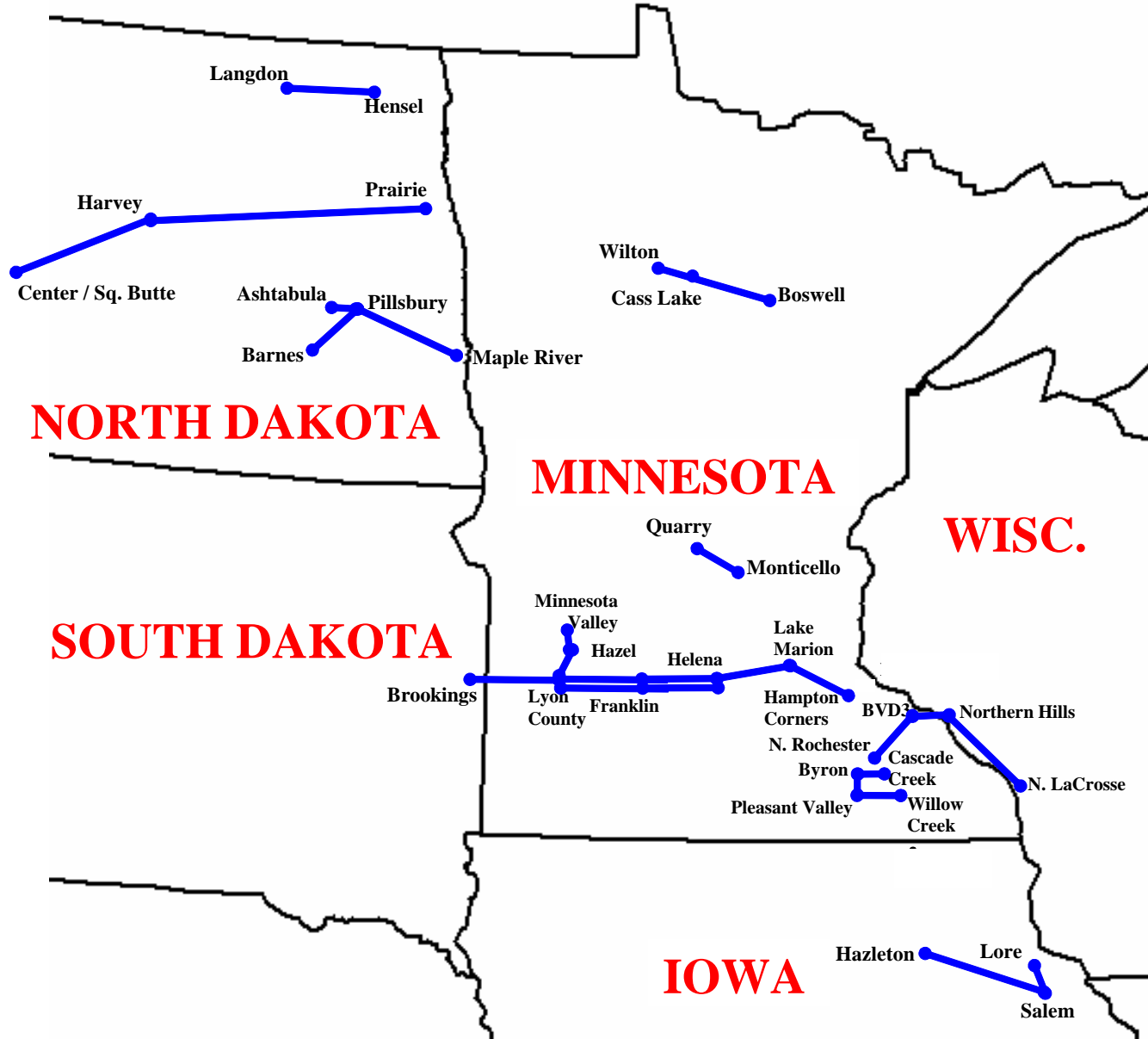
DPP – Definitive Planning Phase

SPA – System Planning and Analysis phase

SIS – System Impact Study

DRG II Model Development

Additional 2013 Transmission



Bus Screening Process

Planning Zone	Number of Buses				
	All Buses	2. After Eliminating Combined FCITC < 0	3. After Eliminating Buses Less than 23 kV and Greater than 230 kV	4. After Eliminating Buses w/ NCF < 35%	5. Buses After Eliminating Counties w/ MISO Queue Generation > 500 MW
NW	424	40	29	28	28
NE	676	424	368	108	106
WC	477	347	323	318	271
SW	267	74	74	74	74
SE	400	21	21	20	16
TOTALS	2244	906	815	548	495

Bus Screening Process

NW Planning Zone

Substation Name	kV	County	NCF	FCITC
Compton	34.5	Otter Tail	37	24
Osage	34.5	Becker	35	26
Nashua Tintah	41.6	Wilkin	38	18
Parkers Prairie	41.6	Otter Tail	39	21
Moranville	69	Roseau	39	28
Shooks	69	Beltrami	37	31
Stafford	69	Roseau	39	28
Williams	69	Lk of Woods	37	16

WC Planning Zone

Substation Name	kV	County	NCF	FCITC
Albany	69	Stearns	38	89
Benton County	69	Benton	35	112
Big Swan	69	Meeker	39	58
Crooks	69	Renville	44	42
Douglas County	69	Douglas	39	59
Fiesta	69	Chippewa	37	52
Glenwood	69	Pope	40	49
Hutchinson Plant1 Tap	69	McLeod	37	68
Willmar Municipal	69	Kandiyohi	38	93

SW Planning Zone

Substation Name	kV	County	NCF	FCITC
Granite Falls	69	Ylw Medicine	38	57
Hardwick	69	Rock	41	60
Ivanhoe	69	Lincoln	43	56
Lake Sarah Tap	69	Murray	43	35
Lyon County	115	Lyon	38	107
Milroy	69	Redwood	37	30
Holland	69	Pipestone	41	42
Walnut Grove	69	Redwood	39	41

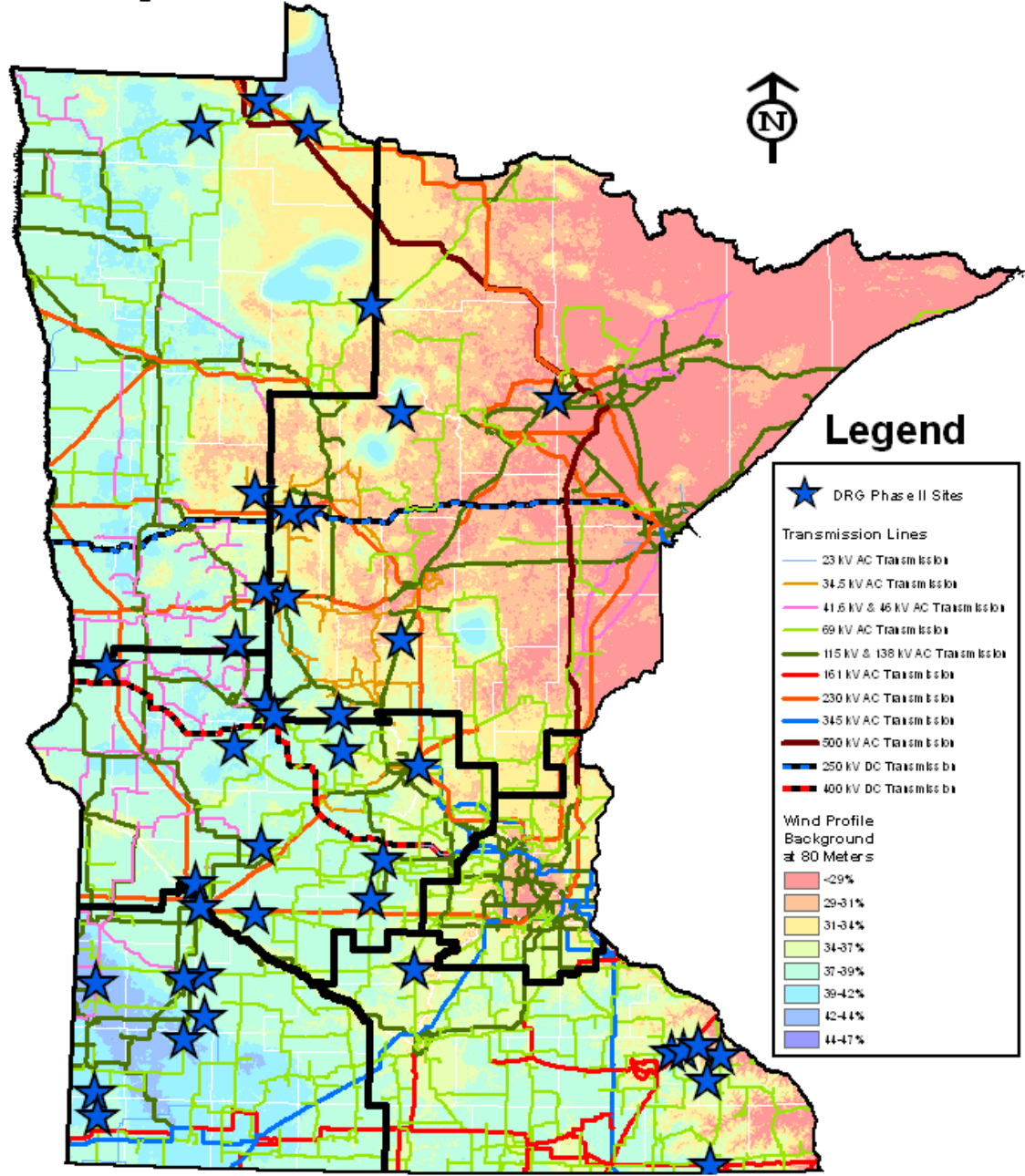
NE Planning Zone

Substation Name	kV	County	NCF	FCITC
Pine Lake	34.5	Morrison	38	34
Hubbard	34.5	Hubbard	36	45
Verndale	34.5	Wadena	38	59
Bena	69	Cass	37	29
West Union	69	Todd	39	42
Dewing	115	Crow Wing	36	35
National Taconite	115	St. Louis	35	191
Palmer Lake	115	Hubbard	35	110

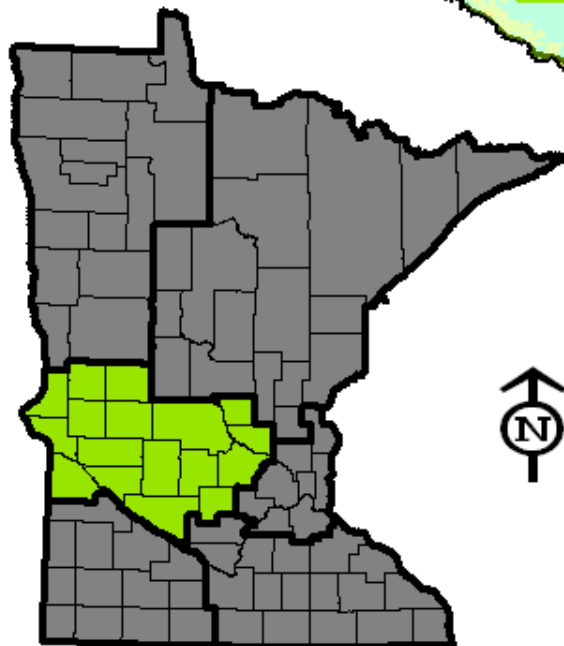
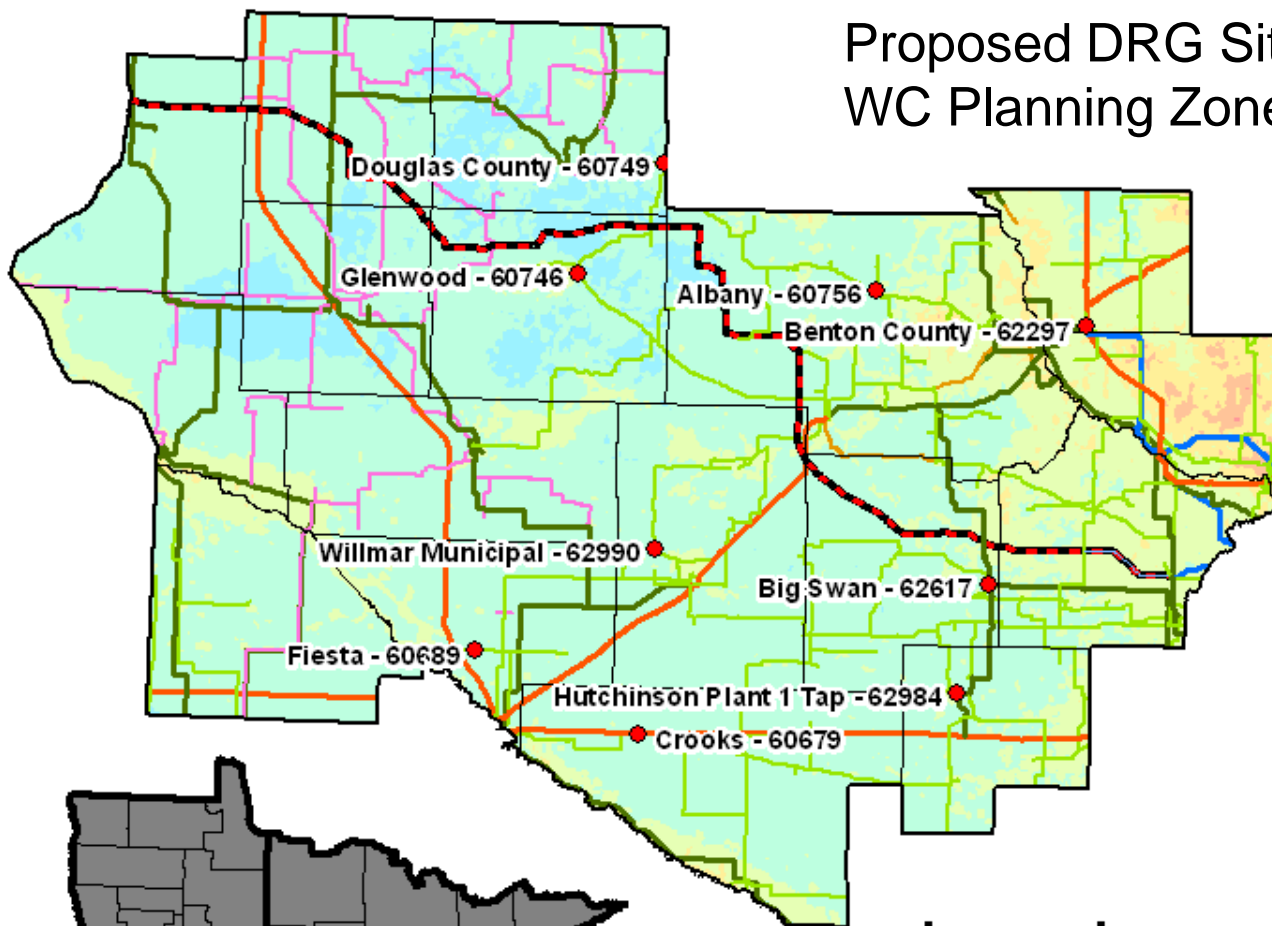
SE Planning Zone

Substation Name	kV	County	NCF	FCITC
Altura	69	Winona	36	89
Elgin	69	Wabasha	37	40
Harmony	69	Fillmore	44	73
Henderson	69	Sibley	43	26
St. Charles Tap	69	Winona	37	49
Whitewater	69	Winona	36	19
Wabaco	161	Wabasha	35	190

Proposed DRG Phase II Sites



Proposed DRG Sites in the WC Planning Zone



Legend

Proposed DRG Sites	
Wind Profile at 80 Meters	Transmission Lines
<29%	34.5 kV AC Transmission
29-31%	41.6 kV AC Transmission
31-34%	69 kV AC Transmission
34-37%	115 kV AC Transmission
37-39%	230 kV AC Transmission
39-42%	345 kV AC Transmission
42-44%	400 kV DC Transmission
44-47%	



Legend

Proposed DRG Sites

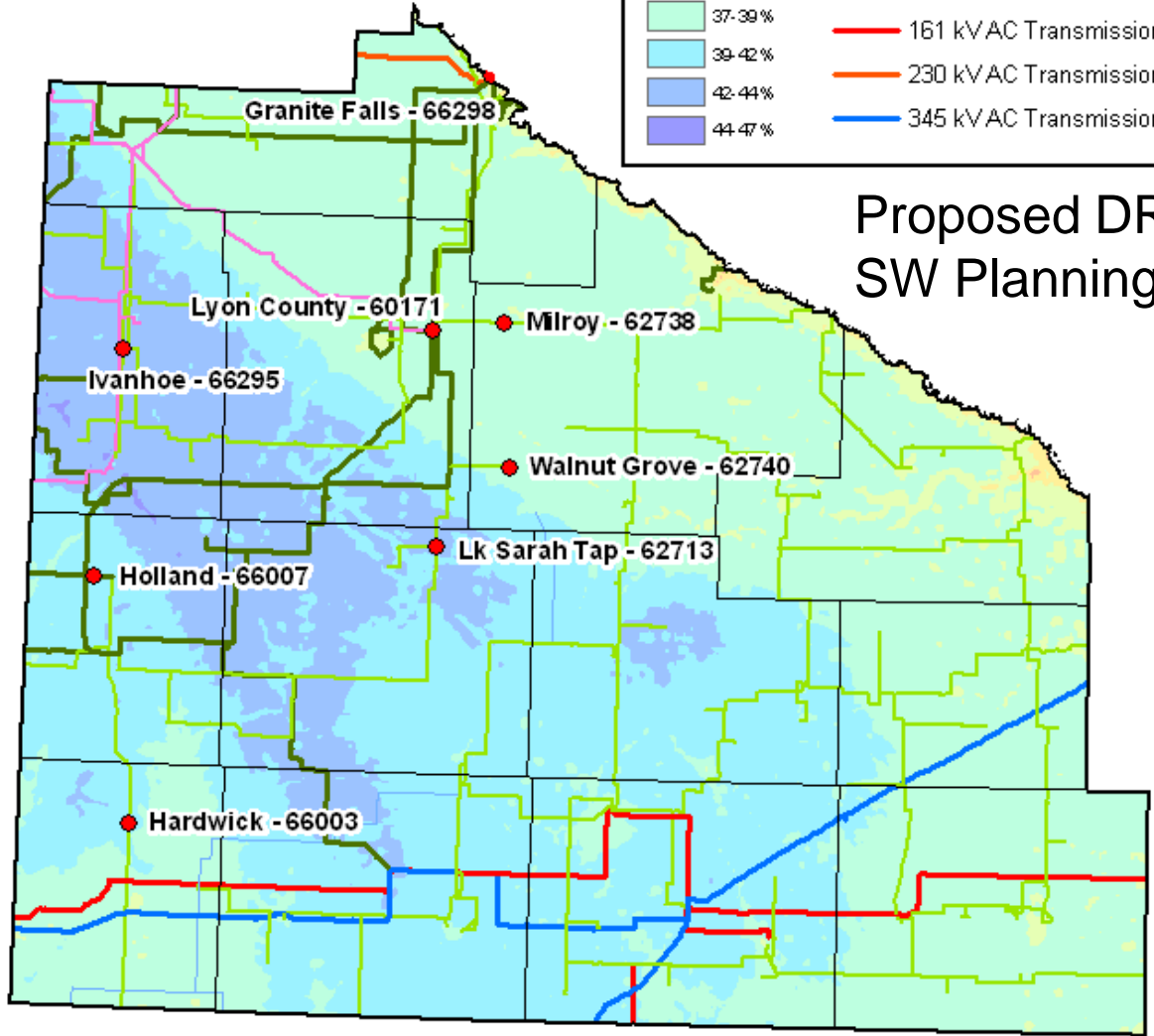
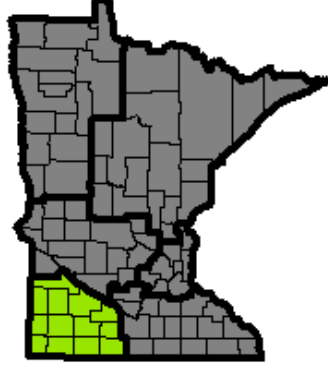
- Proposed DRG Sites

Wind Profile at 80 Meters

- <29%
- 29-31%
- 31-34%
- 34-37%
- 37-39%
- 39-42%
- 42-44%
- 44-47%

Transmission Lines

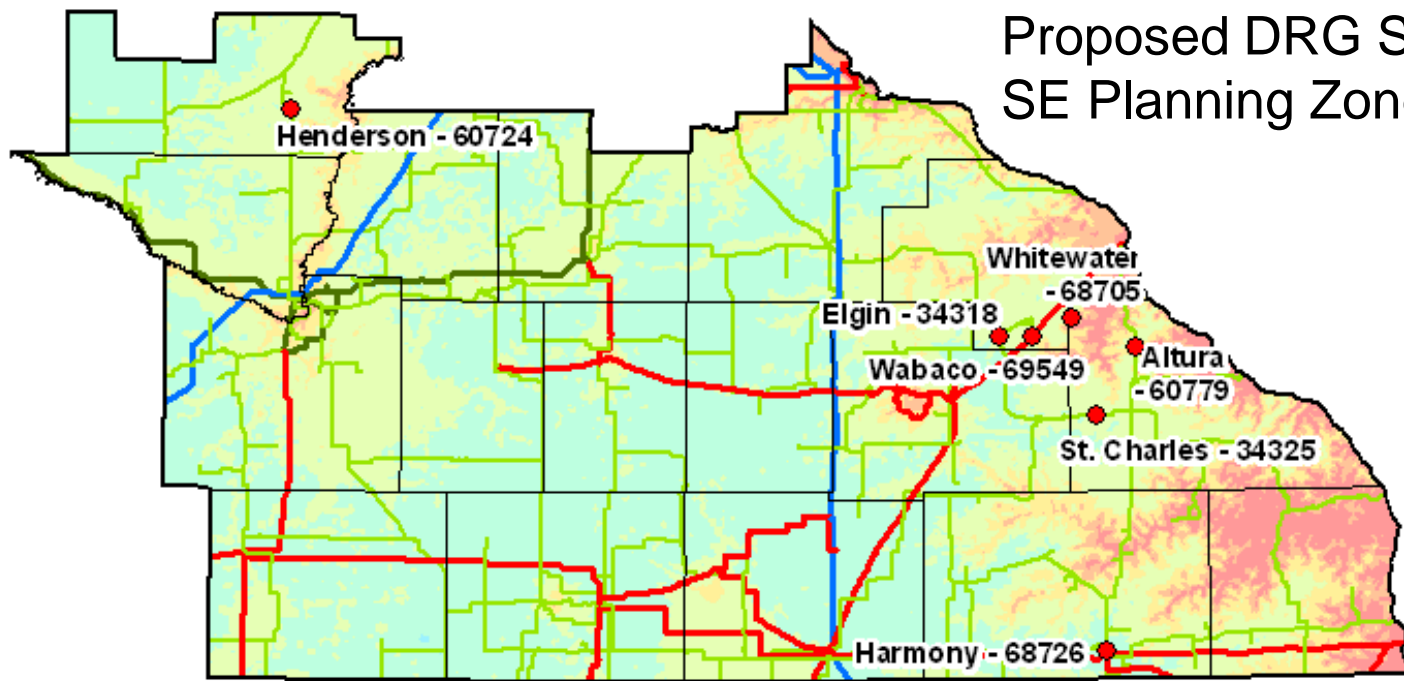
- 23 kV AC Transmission
- 41.6 kV AC Transmission
- 69 kV AC Transmission
- 115 kV AC Transmission
- 161 kV AC Transmission
- 230 kV AC Transmission
- 345 kV AC Transmission



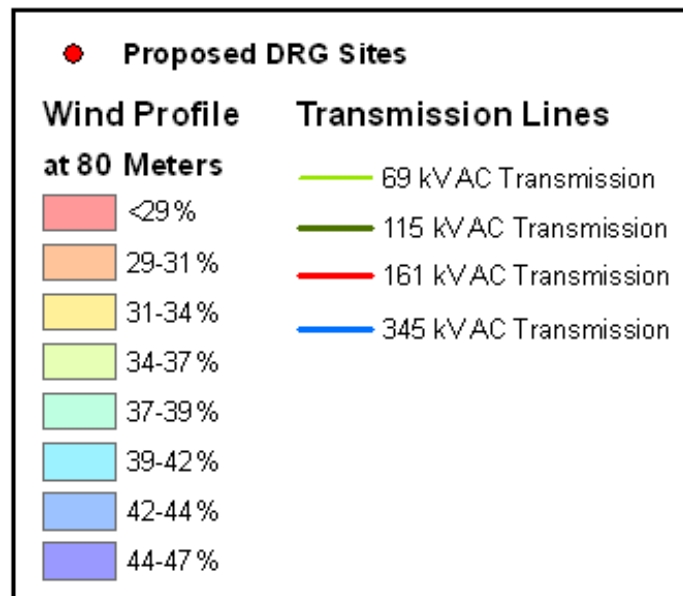
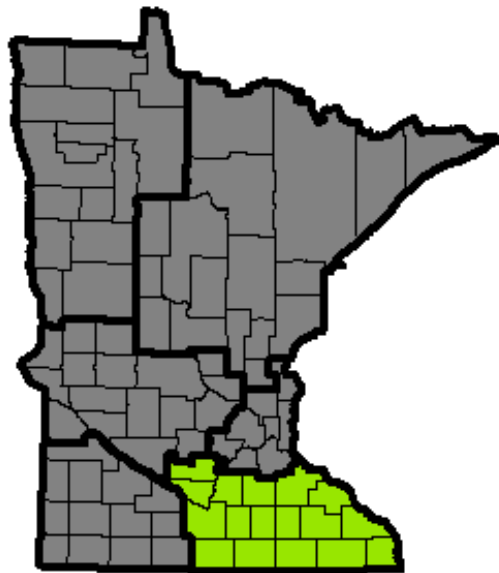
Proposed DRG Sites in the SW Planning Zone



Proposed DRG Sites in the SE Planning Zone 25



Legend



AC Analysis

- Steady-state contingency analysis
- Was conducted:
 - Without DRG II
 - With DRG II

} - Differences were Recorded
- Overloads were Filtered
- Limiters were Established
- Performed on:
 - Individual Site Basis
 - For each Planning Zone
 - Statewide Aggregation

Single Site Analysis Results



DRG II - Single Site Contingency Results					
Zone	Site Name	Outlet MW	Zone	Site Name	Outlet MW
	NW	Compton		20	NE
Moranville		10	Pine Lake	15	
Nashua Tintah		15	Dewing	15	
Osage		20	Hubbard	40	
Parkers Prairie		20	National Taconite	15	
Shooks		35	Palmer Lake	40	
Stafford		10	Verndale	15	
Williams		5	West Union	15	
WC	Albany	40			
	Benton	40			
	Big Swan	40			
	Crooks	35			
	Douglas County	40			
	Fiesta	40			
	Glenwood	40			
	Hutchinson Plant 1 Tap	40			
Willmar Municipal	30				
SW	Granite Falls	40	SE	Altura	40
	Hardwick	40		Elgin	40
	Holland	30		Harmony	40
	Ivanhoe	40		Henderson	10
	Lake Sarah Tap	5		St. Charles Tap	40
	Lyon County	5		Wabaco	35
	Milroy	0		Whitewater	15
	Walnut Grove	5			

Zonal Analysis Results



Zonal Contingency Analysis Summary Table							
Bus	Site Name	FCITC	Distribution of Zonal Generation				Zonal Outlet Capacity
			200 MW	150 MW	100 MW	50 MW	
WC Planning Zone							
60756	Albany	89	22	17	11	6	50
62297	Benton	112	22	17	11	6	
62617	Big Swan	58	22	17	11	6	
60679	Crooks	42	22	17	11	6	
60749	Douglas County	59	22	17	11	6	
60689	Fiesta	52	22	17	11	6	
60746	Glenwood	49	22	17	11	6	
62984	Hutchinson Plant1 Tap	68	22	17	11	6	
62990	Willmar Municipal	93	22	17	11	6	
SW Planning Zone							
66298	Granite Falls	57	26	19	13	6	40
66003	Hardwick	60	26	19	13	6	
66008	Holland	42	19	15	10	5	
66295	Ivanhoe	56	26	19	13	6	
62713	Lake Sarah Tap	35	26	19	13	6	
60171	Lyon County	107	26	19	13	6	
62738	Milroy	30	26	19	13	6	
62740	Walnut Grove	41	26	19	13	6	
SE Planning Zone							
60779	Altura	89	31	24	16	8	40
34318	Elgin	40	31	24	16	8	
68726	Harmony	73	31	24	16	8	
60724	Henderson	26	31	24	16	8	
34325	St. Charles Tap	49	31	24	16	8	
69549	Wabaco	190	31	24	16	8	
68705	Whitewater	19	12	9	6	3	

Statewide Analysis Results



Statewide Contingency Analysis Summary Table					
Bus	Site Name	FCITC	Generation Level for Statewide analysis	Statewide Outlet Capacity	
WC Planning Zone					
60756	Albany	89	13	50	
62297	Benton	112	13		
62617	Big Swan	58	13		
60679	Crooks	42	13		
60749	Douglas County	59	13		
60689	Fiesta	52	14		
60746	Glenwood	49	14		
62984	Hutchinson Plant 1 Tap	68	14		
62990	Willmar Municipal	93	13		
SW Planning Zone					
66298	Granite Falls	57	16		
66003	Hardwick	60	16		
66008	Holland	42	12		
66295	Ivanhoe	56	16		
62713	Lake Sarah Tap	35	15		
60171	Lyon County	107	15		
62738	Milroy	30	15		
62740	Walnut Grove	41	15		
SE Planning Zone					
60779	Altura	89	19		
34318	Elgin	40	19		
68726	Harmony	73	18		
60724	Henderson	26	19		
34325	St. Charles Tap	49	19		
69549	Wabac	190	19		
68705	Whitewater	19	7		

Limiter Summary

Limiter Summary - Number of limiters							
Zone		Single Site- to achieve 40 MW	Zonal- to achieve 200 MW	Zone		Single Site- to achieve 40 MW	Zonal- to achieve 200 MW
	Site Name				Site Name		
NW	Compton	3	5	NE	Bena	2	7
	Moranville	3			Pine Lake	3	
	Nashua Tintah	16			Dewing	1	
	Osage	4			Hubbard	0	
	Parkers Prairie	5			National Taconite	3	
	Shooks	1			Palmer Lake	1	
	Stafford	5			Verndale	1	
	Williams	9			West Union	2	
WC	Albany	0	1	<div style="border: 1px solid black; padding: 5px; text-align: center;"> Statewide- to achieve 600 MW 34 </div>			
	Benton	0					
	Big Swan	0					
	Crooks	4					
	Douglas County	0					
	Fiesta	0					
	Glenwood	0					
	Hutchinson Plant1	0					
	Willmar Municipal	1					
SW	Granite Falls	0	12	SE	Altura	0	9
	Hardwick	0			Elgin	0	
	Holland	2			Harmony	0	
	Ivanhoe	0			Henderson	4	
	Lake Sarah Tap	9			St. Charles Tap	0	
	Lyon County	3			Wabaco	1	
	Milroy	4			Whitewater	4	
	Walnut Grove	5					



Cost Analysis - Single Site

- Projects & associated costs to achieve 40 MW on a single site basis
- Projects listed are only indicative of the actual corrections that may be required after detailed engineering study

West Central

Facility Name	Owner	Length	Voltage	Existing Cond Size	Rate B (MVA)	System Upgrade	Upgrade Size	Estimated Cost
ALBANY								
								\$ -
BENTON								
								\$ -
BIG SWAN								
								\$ -
CROOKS								
60679 CROOKS 8 60680 EMMET R8 1	XCEL	2.0	69	2/0 ACSR	40.7	Line Rebuild	477 ACSR	\$ 552,000
60680 EMMET R8 60694 RENVILL8 1	XCEL	0.8	69	2/0 ACSR	40.7	Line Rebuild	477 ACSR	\$ 221,000
60679 CROOKS 8 60695 DANUBE 8 1	XCEL	4.8	69	2/0 & 4/0 ACSR	40.7	Line Rebuild	477 ACSR	\$ 1,380,000
60680 EMMET R8 60694 RENVILL8 1	XCEL	2.3	69	2/0 ACSR	40.7	Line Rebuild	477 ACSR	\$ 661,000
								\$ 2,814,000
DOUGLAS COUNTY								
								\$ -
FIESTA								
								\$ -
GLENWOOD								
								\$ -
HUTCHINSON								
								\$ -
WILLMAR								
60767 WLMSTAP8 62009 LKJOHNA8 1	GRE	4.5	69	4/0 ACSR	38.6	Line Rebuild	266 ACSR	\$ 1,849,000
								\$ 1,849,000

Cost Analysis - Single Site

- Projects & associated costs to achieve 40 MW on a single site basis
- Projects listed are only indicative of the actual corrections that may be required after detailed engineering study

Southwest									
Facility Name	Owner	Length	Voltage	Existing Cond Size	Rate B (MVA)	System Upgrade	Upgrade Size	Estimated Cost	
GRANITE FALLS									\$ -
HARDWICK									\$ -
HOLLAND									
66006 H TAP 66008 HOLLAND 1	L & O	7.5	69		45.4	Line Rebuild	336 ACSR	\$	2,070,000
66007 HOLLAND 66008 HOLLAND 1	L & O	XFMR	115/69	N/A	52.0	Transformer Upgrade	65 MVA	\$	1,368,000
									\$ 3,438,000
IVANHOE									
LAKE SARAH									
60392 WRIDGE 8 60859 ROCKTAP8 1	XCEL	2.7	69	2/0 CU	51.7	Line Rebuild	336 ACSR	\$	745,000
60392 WRIDGE 8 66005 PIPETAP 1	XCEL	7.5	69	2/0 CU & 4/0 ACSR	51.7	Line Rebuild	336 ACSR	\$	2,070,000
60395 ERIDGE 8 60835 CHNDLRT8 1	GRE	3.3	69	2/0 ACSR	34.8	Line Rebuild	266 ACSR	\$	916,000
60395 ERIDGE 8 62710 CHANDLR8 1	GRE	4.6	69	2/0 ACSR	34.8	Line Rebuild	266 ACSR	\$	1,270,000
60683 MINNVAL8 60684 YELWMED8 1	XCEL	15.9	69	4/0 ACSR & 2/0 CU	34.0	Line Rebuild	477 ACSR	\$	4,571,000
60728 FRANKLN8 60771 RDWDFLTG 1	XCEL	16.0	69	2/0 ACSR	24.0	Line Rebuild	477 ACSR	\$	4,600,000
60855 TRACYSW8 62713 LKS RHTP8 1	XCEL	6.0	69	2/0 CU	51.7	Line Rebuild	336 ACSR	\$	1,656,000
60855 TRACYSW8 62741 WLNTGTP8 1	XCEL	1.0	69	4/0 ACSR	51.7	Line Rebuild	795 ACSS	\$	150,000
62713 LKS RHTP8 62714 CURRIE 8 1	GRE/ XCEL	8.5	69	2/0 CU & 4/0 ACSR	47.0	Line Rebuild	266 ACSR	\$	2,346,000
									\$ 18,324,000
LYON COUNTY									
60171 LYON 60903 LYON CO8 1	XCEL	XFMR	115/69	N/A	80.5	Transformer Upgrade	95 MVA	\$	1,573,000
60683 MINNVAL8 60684 YELWMED8 1	XCEL	15.9	69	4/0 ACSR & 2/0 CU	34.0	Line Rebuild	477 ACSR	\$	4,571,000
60728 FRANKLN8 60771 RDWDFLTG 1	XCEL	16.0	69	2/0 ACSR	24.0	Line Rebuild	477 ACSR	\$	4,600,000
									\$ 10,744,000
MILROY									
60683 MINNVAL8 60684 YELWMED8 1	XCEL	15.9	69	4/0 ACSR & 2/0 CU	34.0	Line Rebuild	477 ACSR	\$	4,571,000
60728 FRANKLN8 60771 RDWDFLTG 1	XCEL	16.0	69	2/0 ACSR	24.0	Line Rebuild	477 ACSR	\$	4,600,000
60771 RDWDFLTG 62735 REDWOOD8 1	GRE	1.1	69	2/0 ACSR	34.8	Line Rebuild	266 ACSR	\$	295,000
62735 REDWOOD8 62737 SHRDNTP8 1	GRE	8.0	69	1/0 ACSR	31.6	Line Rebuild	266 ACSR	\$	2,214,000
									\$ 11,680,000
WALNUT GROVE									
60392 WRIDGE 8 66005 PIPETAP 1	XCEL	7.5	69	2/0 CU & 4/0 ACSR	51.7	Line Rebuild	336 ACSR	\$	2,070,000
60395 ERIDGE 8 60835 CHNDLRT8 1	GRE	4.8	69	2/0 ACSR	34.8	Line Rebuild	266 ACSR	\$	1,325,000
60395 ERIDGE 8 62710 CHANDLR8 1	GRE	4.6	69	2/0 ACSR	34.8	Line Rebuild	266 ACSR	\$	1,270,000
60683 MINNVAL8 60684 YELWMED8 1	XCEL	15.9	69	4/0 ACSR & 2/0 CU	34.0	Line Rebuild	477 ACSR	\$	4,571,000
60728 FRANKLN8 60771 RDWDFLTG 1	XCEL	16.0	69	2/0 ACSR	24.0	Temperature Upgrade	477 ACSR	\$	4,600,000
									\$ 13,836,000



Cost Analysis - Single Site

- Projects & associated costs to achieve 40 MW on a single site basis
- Projects listed are only indicative of the actual corrections that may be required after detailed engineering study

Southeast

Facility Name	Owner	Length	Voltage	Existing Cond Size	Rate B (MVA)	System Upgrade	Upgrade Size	Estimated Cost
ALTURA								
								\$ -
ELGIN								
								\$ -
HARMONY								
								\$ -
HENDERSON								
34008 FOX LK 5 34012 FOXLAKE8 1	ALTW	XFMR	161/69	N/A	74.7	Transformer Upgrade	85 MVA	\$ 1,938,000
60724 HENDRSN8 62674 JSNLDTP8 1	XCEL	3.0	69	2/0 CU	34.0	Line Rebuild	336 ACSR	\$ 828,000
60730 ARLNGTN8 60731 GRENISL8 1	XCEL	5.8	69	2/0 CU	34.0	Line Rebuild	336 ACSR	\$ 1,601,000
60730 ARLNGTN8 62674 JSNLDTP8 1	XCEL	2.5	69	2/0 CU	34.0	Line Rebuild	477 ACSR	\$ 719,000
								\$ 5,086,000
ST. CHARLES								
								\$ -
WABACO								
34000 NIW 5 34015 LIME CK5 1	ITC	16.3	161	477 - 26/7 ACSR	202	Line Rebuild	795 ACSR	\$ 5,443,000
								\$ 5,443,000
WHITEWATER								
68703 PLAINVIE 68705 WHITEWAT 1	Peoples	3.8	69	1/0 ACSR	19.0	Line Rebuild	266 ACSR	\$ 1,035,000
68703 PLAINVIE 69158 T PLV 8 1	DPC/ Peoples	3.2	69	1/0 ACSR	19.0	Line Rebuild	266 ACSR	\$ 883,000
68706 T WHWATR 69158 T PLV 8 1	DPC/ Peoples	8.0	69	1/0 ACSR	19.0	Line Rebuild	266 ACSR	\$ 2,208,000
68707 T ZUM 68711 WEST ALB 1	Peoples	8.5	69	1/0 ACSR	19.0	Line Rebuild	266 ACSR	\$ 2,346,000
								\$ 6,472,000

Cost Analysis - Zonal

– Projects & associated costs to achieve 200 MW on a Zonal basis

Zonal Cost Analysis										
Facility Name	Owner	Length	Voltage	Existing Cond Size	Rate B (MVA)	System Upgrade	Upgrade Size	Est. Cost		
WC										
34137 TRIBOJ15 66563 SPENCER5 1	ITC	18.8	161	636 ACSR	195	Temperature Upgrade	636 ACSR	\$ 376,000		
								TOTAL	\$ 376,000	
SW										
60392 WRIDGE 8 60859 ROCKTAP8 1	XCEL	2.7	69	2/0 CU	51.7	Line Rebuild	266 ACSR	\$ 745,000		
34000 NIW 5 34015 LIME CK5 1	ITC	16.3	161	477 - ACSR	202	Line Rebuild	795 ACSR	\$ 5,443,000		
34008 FOX LK 5 34012 FOXLAKE8 1	ALTW	XFMR	161/69	N/A	74.7	Transformer Upgrade	85 MVA	\$ 1,938,000		
34137 TRIBOJ15 66563 SPENCER5 1	ITC	18.8	161	636 ACSR	195	Temperature Upgrade	636 ACSR	\$ 376,000		
60392 WRIDGE 8 66005 PIPETAP 1	XCEL	7.5	69	2/0 CU & 4/0 ACSR	51.7	Line Rebuild	266 ACSR	\$ 2,070,000		
60395 ERIDGE 8 60835 CHNDLRT8 1	GRE	3.3	69	2/0 ACSR	34.8	Line Rebuild	477 ACSR	\$ 1,380,000		
60395 ERIDGE 8 62710 CHANDLR8 1	GRE	4.6	69	2/0 ACSR	34.8	Line Rebuild	477 ACSR	\$ 1,323,000		
60683 MINNVAL8 60684 YELWMED8 1	XCEL	15.9	69	4/0 ACSR & 2/0 ACSR	34.0	Temperature Upgrade	4/0 ACSR	\$ 318,000		
60684 YELWMED8 62739 MLRY TP8 1	XCEL	11.4	69	2/0 CU	51.7	Line Rebuild	336 ACSR	\$ 4,116,000		
60728 FRANKLN8 60771 RDWDFLTG 1	XCEL	16.0	69	2/0 ACSR	24.0	Line Rebuild	477 ACSR	\$ 4,600,000		
60771 RDWDFLTG 62735 REDWOOD8 1	GRE	1.1	69	2/0 ACSR	34.8	Line Rebuild	266 ACSR	\$ 295,000		
62735 REDWOOD8 62737 SHRDNTP8 1	GRE	8.0	69	1/0 ACSR	31.6	Line Rebuild	266 ACSR	\$ 2,214,000		
								TOTAL	\$ 24,818,000	
SE										
34000 NIW 5 34015 LIME CK5 1	ITC	16.3	161	477 - ACSR	202	Line Rebuild	795 ACSR	\$ 5,443,000		
34008 FOX LK 5 34012 FOXLAKE8 1	ALTW	XFMR	161/69	N/A	74.7	Transformer Upgrade	85 MVA	\$ 1,938,000		
34137 TRIBOJ15 66563 SPENCER5 1	ITC	18.8	161	636 ACSR	195	Temperature Upgrade	636 ACSR	\$ 376,000		
34325 ST.CHRT8 68713 ST CHARL 1	DPC	1.0	69	4/0 ACSR	47	Line Rebuild	336 ACSR	\$ 361,000		
68713 ST CHARL 68774 UTICA 1	ITC	5.09	69	4/0 ACSR	47	Line Rebuild	336 ACSR	\$ 1,837,000		
39033 DAR 138 39036 NOM 138 1	ATC	25.6	138	266.8 ACSR 26/7	105	Line Rebuild	477 ACSR	\$ 10,599,000		
60184 APACHET7 60185 ARDNHLS7 1	XCEL	5.4	115	477 ACSR & 2312 AL	210	4.1M of 477 to 2312	2312 ACSR	\$ 2,279,000		
60730 ARLNGTN8 60731 GRENISL8 1	XCEL	5.8	69	2/0 CU	34.0	Line Rebuild	336 ACSR	\$ 1,601,000		
60730 ARLNGTN8 62674 JSNLDTP8 1	XCEL	2.5	69	2/0 CU	34.0	Line Rebuild	477 ACSR	\$ 719,000		
								TOTAL	\$ 25,153,000	

Cost Analysis - Statewide

Statewide Cost Analysis

Facility Name	Owner	Length	Voltage	Existing Cond Size	Rate B (MVA)	System Upgrade	Upgrade Size	Est. Cost
34008 FOX LK 5 34012 FOXLAKE8 1	ALTW	XFMR	161/69	N/A	74.7	Transformer Upgrade	85 MVA	\$ 1,938,000
60771 REDWOODFLTG 62735 REDWOOD8	GRE	1.1	69	2/0 ACSR	34.8	Line Rebuild	266 ACSR	\$ 295,000
34000 NIW 5 34015 LIME CREEK5 1	ITC	16.3	161	477 - 26/7 ACSR	202	Line Rebuild	795 ACSR	\$ 5,443,000
61625 BLACKBERRY4 61626 BOSWELL4 2	MP	18.4	230	1431 ACSR	438.0	Temperature Upgrade	1431 ACSR	\$ 368,000
9269 BIRCHDAL 6 66801 LUND 8 1	MPC	20.9	69	1/0 ACSR &4/0 ACSR	40.0	Line Rebuild	266 ACSR	\$ 5,757,000
9269 BIRCHDAL 6 9270 LOMAN 6 1	MPC	23.6	69	1/0 ACSR	40.0	Line Rebuild	266 ACSR	\$ 6,508,000
9270 LOMAN 6 67017 RUNNING8 1	MPC	9.8	69	1/0 ACSR &4/0 ACSR	40.0	Line Rebuild	266 ACSR	\$ 2,699,000
60683 MINNVAL8 60684 YELLOWMED8 1	XCEL	15.9	69	4/0 ACSR & 2/0 CU	34.0	Line Rebuild	266 ACSR	\$ 4,388,000
60728 FRANKLN8 60771 REDWOODFLTG 1	XCEL	16.0	69	2/0 ACSR	24.0	Temperature Upgrade	2/0 ACSR	\$ 320,000
60730 ARLINGTON8 60731 GREENISLE8 1	XCEL	5.8	69	2/0 CU	34.0	Line Rebuild	336 ACSR	\$ 1,601,000
60751 SAUKCMU8 62820 WEST UNION8 1	XCEL	9.9	69	3/6CU 2/0ACSR 4/0ACSR	39.6	Line Rebuild	266 ACSR	\$ 4,042,000
34137 TRIBOJI5 66563 SPENCER5 1	ITC	18.8	161	636 ACSR	195	Temperature Upgrade	636 ACSR	\$ 376,000
34423 MONONA_8 68748 POST 1	ITC	5.77	69	4/0 ACSR	28	Temperature Upgrade	4/0 ACSR	\$ 115,000
34671 KLEMM8 63727 HANCOCK8 1	ITC	6.3	69	266 ACSR	36	Line Rebuild	336 ACSR	\$ 2,274,000
36242 SHEFFLD8 63731 HAMPTON8 2	ITC	14.14	69	3/0 ACSR	41	Line Rebuild	336 ACSR	\$ 3,903,000
36242 SHEFFLD8 63774 SHEFFLD5 1	ITC	XFMR	161/69	N/A	84	Transformer Upgrade	90 MVA	\$ 1,984,000
36421 ZION ; R 38849 PLEASANT PRAIR2 1	ATC		345	N/A	2000	New Bain-Zion 345 kV (6 miles)	2-954 ACSS	\$ 18,000,000
37384 ZION ; 39362 LAKEVIEW 1	"	"	"	"	"	"	"	"
38141 NST 69 38142 STM 69 1	"	"	"	"	"	"	"	"
38364 SGL 69 39242 SGL 138 1	ATC	XFMR	138/69	N/A	70	Transformer Upgrade	75 MVA	\$ 1,665,000
38590 SHOTO 39641 SHOTO 1	ATC	XFMR	138/69	N/A	72	Transformer Upgrade	75 MVA	\$ 1,665,000
39033 DAR 138 39036 NOM 138 1	ATC	25.6	138	266.8 ACSR 26/7	105	Line Rebuild	477 ACSR	\$ 10,599,000
39328 GRANVL 6 91318 GRANVL3 1	ATC	XFMR	345/138	N/A	478	2nd 478 MVA Transformer	478 MVA	\$ 23,236,000
39345 KENOSH45 39362 LAKEVIEW 1	ATC	5.0	138	477 ACSR	288	Line Reconductor	477 ACSS	\$ 860,000
39901 COC DPC 68843 T TC 1	DPC	3.79	69	795ACSR &4/0ACSR	47	Line Rebuild	795 ACSR	\$ 802,000
58190 HOPE MD8 63719 HOPE 5 1	ITC	XFMR	161/69	N/A	84	Transformer Upgrade	90MVA	\$ 1,984,000
58190 HOPE MD8 63720 HOPE 8 1	"	"	"	"	"	"	"	"
60104 CANNONFLS7 60801 CANFLSTR8 1	XCEL	XFMR	115/69	N/A	112	Transformer Upgrade	115 MVA	\$ 1,727,000
60104 CANNONFLS7 60801 CNFLSTR8 2	XCEL	XFMR	115/69	N/A	112	Transformer Upgrade	115 MVA	\$ 1,727,000
60184 APACHET7 60185 ARDENHILLS7 1	XCEL	5.4	115	477 ACSR &2312 AL	210	4.1M of 477 to 2312	2312 AL	\$ 3,001,000
60190 BLACK DOG7 60258 WILSON 7 1	XCEL	4.5	115	795 ACSR	239	Line Rebuild	795 ACSS	\$ 2,403,000
60307 JACKSON5 60966 JACKCO 8 1	XCEL	XFMR	161/69	N/A	47	Transformer Upgrade	50 MVA	\$ 1,275,000
60321 HYDROLN7 61006 WISSOTAG 1	XCEL	XFMR	115/69	N/A	48	Transformer Upgrade	50 MVA	\$ 1,275,000
60823 REDWING8 62387 SPRINGCREEK8 2	XCEL	4.6	69	477 ACSR &1250 AL	92.4	Line Rebuild	795 ACSR	\$ 1,845,000
STONE LAKE, 60 MVAr Fast Swi Capacitor	XCEL	N/A	345	N/A	N/A	Capacitor Addition	N/A	\$ 5,000,000
A.S. KING - Two 345 kV Breakers	XCEL	N/A	345	N/A	N/A	Breaker Addition	N/A	\$ 2,000,000
								\$ 121,075,000

Cost Analysis - Summary

DRG II - Cost Analysis Summary

Zone		Single Site- Cost to achieve 40 MW	Zonal- Cost to achieve 200 MW	Zone		Single Site- Cost to achieve 40 MW	Zonal- Cost to achieve 200 MW				
	Site Name				Site Name						
NW	Compton	\$ 3,739,000	\$ 15,089,000	NE	Bena	\$ 22,112,000	\$ 31,378,000				
	Moranville	\$ 14,964,000			Pine Lake	\$ 19,539,000					
	Nashua Tintah	\$ 23,028,000			Dewing	\$ 18,000,000					
	Osage	\$ 5,713,000			Hubbard	\$ -					
	Parkers Prairie	\$ 5,505,000			National	\$ 19,354,000					
	Shooks	\$ 4,684,000			Palmer Lake	\$ -					
	Stafford	\$ 15,795,000			Verndale	\$ 18,000,000					
	Williams	\$ 26,583,000			West Union	\$ 20,588,000					
WC	Albany	\$ -	\$ 376,000	<table border="1"> <tr> <td colspan="2" style="text-align: center;">Statewide- Cost to achieve 600 MW</td> </tr> <tr> <td colspan="2" style="text-align: center;">\$ 121,075,000</td> </tr> </table>				Statewide- Cost to achieve 600 MW		\$ 121,075,000	
	Statewide- Cost to achieve 600 MW										
	\$ 121,075,000										
	Benton	\$ -									
	Big Swan	\$ -									
	Crooks	\$ 2,814,000									
	Douglas County	\$ -									
	Fiesta	\$ -									
Glenwood	\$ -										
Hutchinson Plant1	\$ -										
Willmar Muni	\$ 1,849,000										
SW	Granite Falls	\$ -	\$ 24,818,000	SE	Altura	\$ -	\$ 25,153,000				
	Hardwick	\$ -			Elgin	\$ -					
	Holland	\$ 3,438,000			Harmony	\$ -					
	Ivanhoe	\$ -			Henderson	\$ 5,086,000					
	Lake Sarah Tap	\$ 18,324,000			St. Charles Tap	\$ -					
	Lyon County	\$ 10,744,000			Wabaco	\$ 5,443,000					
	Milroy	\$ 11,680,000			Whitewater	\$ 6,472,000					
	Walnut Grove	\$ 13,836,000									

Report Topics not covered in this Presentation

- Electric Grid Overview
- Midwest ISO Queue Analysis after DRG Phase I Report Release
- Loss Analysis
- Grid Expansion
- Stability Analysis
- DRG Sensitivity Exercise
- DRG Integration Issues
- Midwest ISO Interconnection Process
- Enhanced details and much more

Summary

- The MISO Queue is flush with requests
- The 2013 transmission system is at its design capacity
- There are numerous local injection related limiters
- There are widespread regional limiters
- “Small” DRG projects, in aggregate, do affect the regional system
- 600 MW of Statewide DRG II is only possible with additional transmission upgrades
- Very limited “free” DRG opportunities



Summary - continued

- There may be existing interconnection requests in a utility queue or MISO queue that might occupy these potential DRG sites.
- This study report is only representative of the results which may be discovered during more extensive analysis.
- This study makes no attempt to address the allocation of or responsibility of such costs. These costs may or may not be allocated to generation developers.



DRG Study Phase II Study

**The full report will be posted at
the MN PUC Website:**

<http://www.puc.state.mn.us/PUC/electricity/documents/reports-studies/index.html>

or

www.energy.mn.gov

**Energy Home > Data > Next Generation Energy
> Dispersed Renewable Generation**

Docket Number: E999/DI-08-649

DRG Study Phase II Study

**Please send additional comments &
feedback to:**

DGStudy.Commerce@state.mn.us

Minnesota Office of Energy Security

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Thank you!