



# Dispersed Renewable Generation Transmission Study

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## Phase 1

Presented by:

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June 16, 2008



# DRG Study Phase I Overview

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- **Introduction**
- **DRG Study requirements**
- **DRG Study update & Findings**
- **Next Steps**
- **Q&A**



# DRG Study Requirements

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

## **Two phases**

- **Study Phase I: 600 MW**
  - Report by OES due June 2008
- **Study Phase II: 600 MW**
  - Report by OES due September 2009



# DRG Study Requirements

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- **MN Utilities performed the analytical work**
- **A DOC-appointed Technical Review Committee (TRC) reviewed methods and results**





# DRG Legislation

## (Next Generation Energy Act of 2007)

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### 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.



# DRG Legislation - Continued

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Subd. 3. **First phase study content; report.** In the first phase of the study, participants must analyze the impacts of the addition of a total of **600 megawatts** of new dispersed generation projects distributed among the following Minnesota electric transmission planning zones: the Northeast zone, the Northwest zone, the Southeast zone, the Southwest zone, and the West-Central zone.

Study participants must use a **generally accepted 2010 year transmission system model** including all transmission facilities expected to be operating in 2010.

The study must take into consideration regional projected load growth, planned changes in the bulk transmission network, and the long-range transmission conceptual plan being developed under Laws 2007, chapter 3, section 2.



# DRG Legislation - Continued

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In determining locations for the installation of dispersed generation projects that consist of [wind energy conversion systems](#), the study should consider, at a minimum, [wind resource availability](#), [existing and contracted wind projects](#), and [current dispersed generation projects](#) in the Midwest Independent System Operator interconnection queue.

The study must [analyze the impacts of individual projects and all projects in aggregate](#) on the transmission system, and [identify specific modifications to the transmission system](#) necessary to remedy any problems caused by the installation of dispersed generation projects, including [cost estimates for the modifications](#).

The study must analyze the additional dispersed generation projects [connected at the lowest voltage level](#) transmission that exists in the vicinity of the projected generation sites.

A preliminary analysis to identify transmission system problems must be conducted with the projects installed at initially selected locations.



# DRG Legislation - Continued

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The technical review committee may, after reviewing the locations selected for installation, recommend moving the installation sites once to new locations to reduce undesirable transmission system impacts.

The commissioner of commerce must submit a report containing the [findings](#) and [recommendations](#) of the first phase of the study to the commission no later than [June 15, 2008](#).





# DRG Legislation - Continued

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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;



# DRG Legislation - Continued

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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 Study

## Technical Review Committee

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- **TRC members:**
  - Individuals with experience & expertise in electric transmission system engineering, renewable energy generation technology, & dispersed generation
- **TRC duties:**
  - Oversee and guide the technical analyses
  - Make recommendations regarding proposed assumptions and analytical methods
  - Review preliminary results and draft report and make recommendations



# Technical Review Committee



- **Jared Alholinna** Great River Energy
- **Tami Anderson** Mid-Continent Area Power Pool
- **Dave Corbus** National Renewable Energy Laboratory
- **Tricia DeBleeckere** Minnesota Public Utilities Commission
- **Rick Gonzalez** Minnesota Utilities (Excel Engineering)
- **Grant Gunderson** Minnkota Power
- **Rick Hettwer** Southern Minnesota Municipal Power Agency
- **Michael Kaluzniak** Minnesota Public Utilities Commission
- **Dan Kline** Xcel Energy
- **Mike Klopp** Minnesota Power
- **Durgesh Manjure** Midwest Independent System Operator
- **Tom McDermott** Utility Wind Integration Group (EnerNex)
- **Natalie McIntire** Wind on the Wires
- **Mike Michaud** Community-Based Energy Development Initiative of the North American Water Office
- **Jarred Miland** Midwest Independent System Operator
- **Teresa Mogensen** Xcel Energy
- **Dale Osborn** Midwest Independent System Operator
- **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 Energy Security
- **Charlie Smith** Utility Wind Integration Group
- **Lise Trudeau** Minnesota Office of Energy Security
- **Dave Van House** Minnesota Power
- **John Weber** Missouri River Energy Services
- **Jason Weiers** Otter Tail Power
- **Marya White** Minnesota Office of Energy Security
- **Tom Wind** Windustry (Wind Utility Consulting)

# TRC Meetings

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- August 15, 2007 (Conf. call)
- October 2, 2007
- December 19, 2007
- February 20, 2008
- April 10, 2008 (Conf. Call)
- April 30, 2006
- May 16, 2008 (Conf. Call)
- May 30, 2008 (Conf. Call)



# Dispersed Renewable Generation Study Findings

Presented by  
Jared Alholinna  
Great River Energy



# DRG Study Study Team

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- **Jared Alholinna, Great River Energy – Team Lead**
- **Berhanu Bedada, Great River Energy**
- **Josh Lantto, Great River Energy**
- **Gordon Pietsch, Great River Energy**
- **Wayne Roelofs, Great River Energy**
- **William Quaintance, ABB on behalf of Xcel Energy**
- **Jerrod Nelson, Ulteig Engineers**
- **John Auel, United Services Group**
- **Andy Schmidt, United Services Group**
- **Ellen Lamb, Lamb Energy on behalf of Minnesota Utilities**



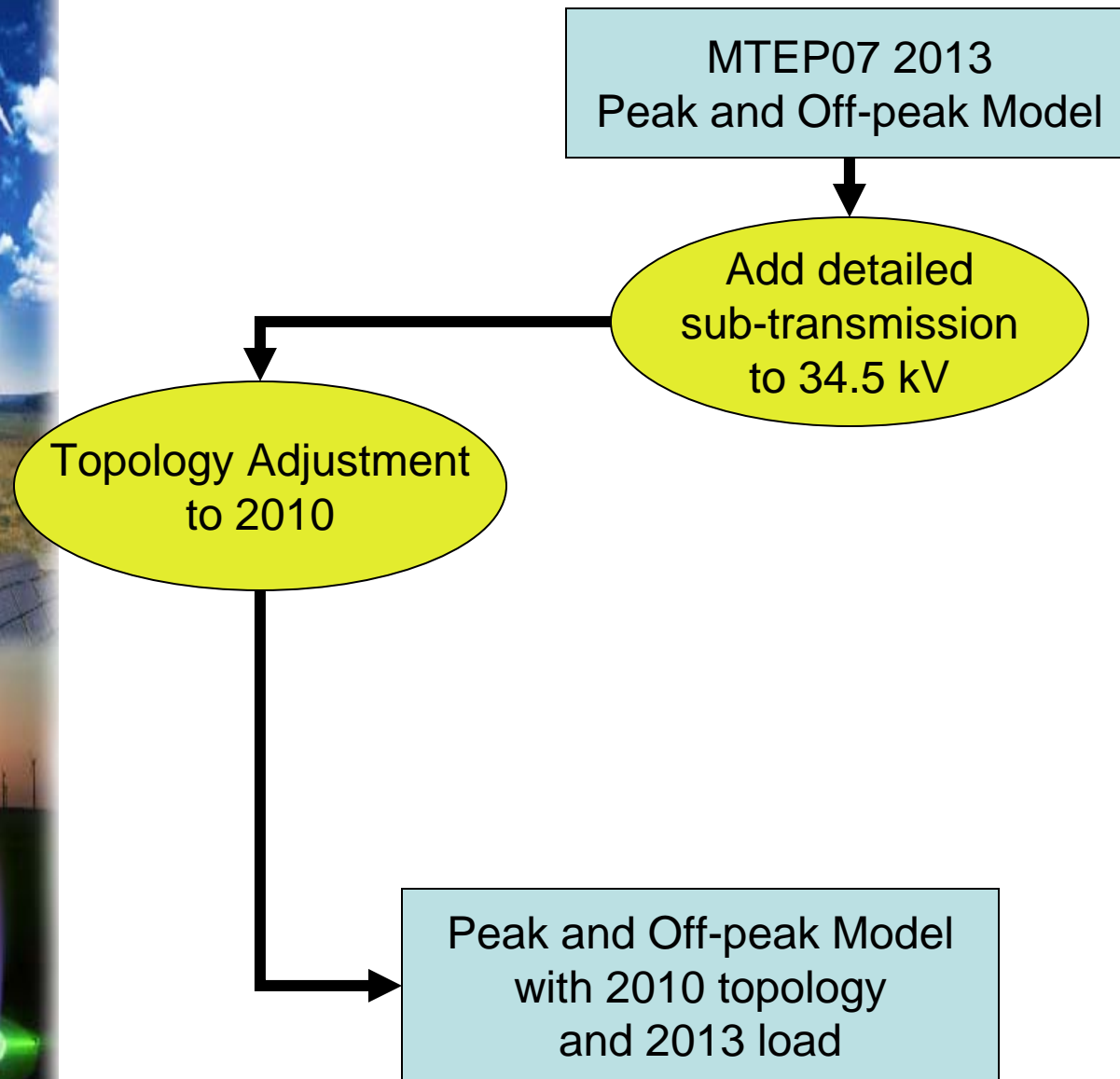
# Transmission Modeling

MTEP07, 2013 Summer Peak and Off-Peak models

- Removed Line/Facilities which will not be in-service before or during 2010.
- Integrated GRE-LRP transmission model detail
- Gather additional detail from Minnesota utilities
  - Added Lower Voltage Lines (34.5 kV, 41.6 kV, 46 kV)
  - Re-allocated loads from higher voltage to lower voltage buses
- Prior queued generation was not included in the study model.

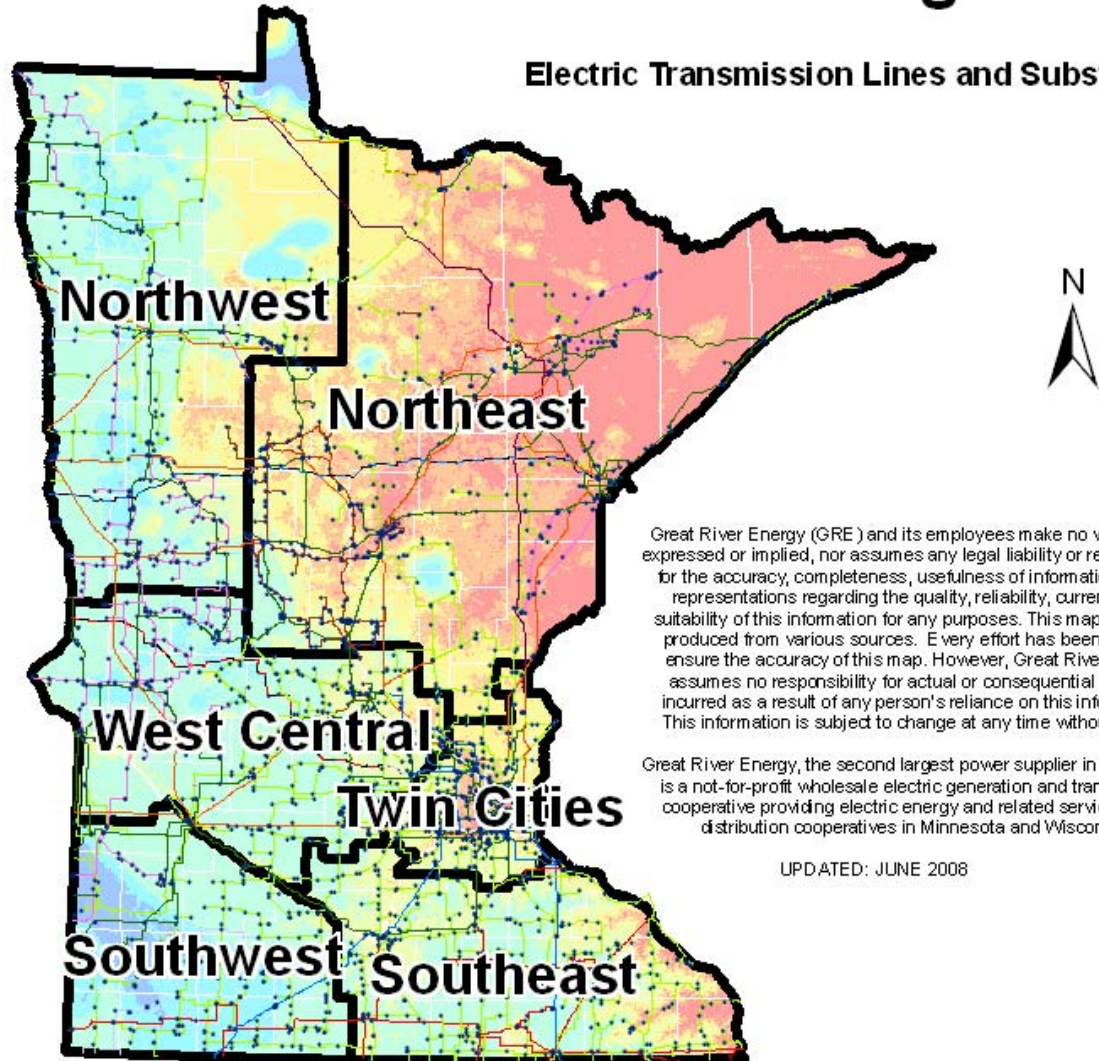


# Model Development



# Minnesota Electric Transmission Planning Zones

Electric Transmission Lines and Substations



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Great River Energy, the second largest power supplier in Minnesota, is a not-for-profit wholesale electric generation and transmission cooperative providing electric energy and related services to 27 distribution cooperatives in Minnesota and Wisconsin.

UPDATED: JUNE 2008

- Sources:
- Center for Urban and Regional Affairs (CURA)
  - Federal Aviation Administration Digital Obstacle Data, acquired from Minnesota Department of Commerce. Xcel file dated 2/12/07.
  - Wind Logics 80m Wind Data & Reader, Minnesota Department of Commerce, 11/2005.
  - MISO Generation Interconnection Queue, 3/17/2008.



# Substation Information

- Wind Profile Information
  - Started with existing high level transmission map
  - Added sub-transmission detail to map
  - Located sub-transmission substations based on known GIS map data and utility one-line diagrams
- Distribution Transformer Information
  - Requested data from Minnesota utilities



# Summary of Substation Information

Summary of Substation Information					
Planning Zone	Number of Substation Buses	Summer Peak Load (MW)	Summer Off-Peak Load (MW)	MISO Queued (11/26/07) Generation (MW)	MISO Queued (11/26/07) Dispersed Generation (MW) (# of projects)
NE	677	2455	1790	1614	30 (1)
NW	457	1093	712	1443	20 (1)
W-C	470	2033	1376	8825	337 (16)
SW	265	660	497	5399	367 (15)
SE	400	2003	1564	9617	58 (3)



# Site Screening Approaches

- Analytical
- Engineering Judgment
- Public Input
- TRC Input



# Screening Methodology/Criteria

- The Screening Methodology and the Criteria have been changed several times in response to TRC comments.
  - Utilized DC Analysis to select DRG Short List sites
  - Selected lower-voltage generation study sites
  - Screen promising sites further by wind profile
  - Divided sites equally among planning zones
  - Added Biomass site to Short List



# Potential Short List of DRG Sites after Screening Process



Northwest Transmission Planning Zone				
Substation Name	kV	County	FCITC	Wind Net Capacity Factor
Viking	115	Marshall	94	39.8
Cormorant	115	Becker	110	39.4
Halma	115	Kittson	88	38.8
Plummer	115	Red Lake	69	38.8
Audubon	41.6	Becker	74	38.7
Crookston Sugar	41.6	Polk	37	37.4
Osage	41.6	Otter Tail	34	37.6
Airport	41.6	Beltrami	25	35.0

Northeast Transmission Planning Zone				
Substation Name	kV	County	FCITC	Wind Net Capacity Factor
Little Sauk	115	Todd	109	37.6
RDO	115	Hubbard	122	35.5
Aldrich (Verndale)	115	Wadena	110	37.1
Bertran	34.5	Morrison	35	35.2
Walker	34.5	Cass	24	35.1
Hewitt	34.5	Wadena	37	37.9
Aldrich	34.5	Todd	35	36.4
Flensburg	34.5	Morrison	18	35.8
Cloquet	115	Carlton	>35	Biomass

West Central Transmission Planning Zone				
Substation Name	kV	County	FCITC	Wind Net Capacity Factor
Alexandria SW	115	Douglas	136	38.4
Bird Island	69	Renville	83	37.0
Swan Lake	115	Meeker	142	36.4
Glencoe Muni	115	McLeod	239	36.0
Erdahl	41.6	Grant	29	39.4
Westport	69	Pope	36	37.8
Paynesville	34.5	Stearns	28	38.8
Hoffman	41.6	Grant	25	36.5
Atwater	69	Kandiyohi	50	37.7 - Biomass

Southeast Transmission Planning Zone				
Substation Name	kV	County	FCITC	Wind Net Capacity Factor
Waseca	69	Waseca	72	35.6
Airtech Park	115	Rice	79	35.0
New Prague	69	Le Sueur	60	36.6
Crystal Foods	69	Sibley	57	36.1
Vasa	69	Goodhue	47	36.1
Lafayette	69	Nicollet	39	36.1
French Lake	69	Rice	29	36.6
Goodhue	69	Goodhue	47	37.3

Southwest Transmission Planning Zone				
Substation Name	kV	County	FCITC	Wind Net Capacity Factor
Mountain Lake	69	Cottonwood	63	39.6
New Ulm	69	Brown	92	35.8
Lakeside Ethanol	69	Cottonwood	55	40.2 - Biomass
Morgan	69	Redwood	42	37.6
Magnolia	69	Rock	20	38.2
Sveadahl	69	Watonwan	40	38.2
Steen	69	Rock	30	37.5
Brookville	69	Redwood	35	37.0



# Analysis

- **Steady-state contingency analysis**
  - Individual site
  - Planning zone
  - State wide
- **Loss analysis**
- **Stability analysis**
  - Aggregate
  - Utilize existing regional stability model
  - Need to model new generation on high side buses



# Key Results Included:

- Per scenario
  - Limiting element (transmission facility)
  - Proposed system improvement
  - Estimated cost
    - Previously identified in a Construction Work Plan
    - New project
- Identify common system upgrades for various combinations of sites
- Qualitative discussion of distribution system issues



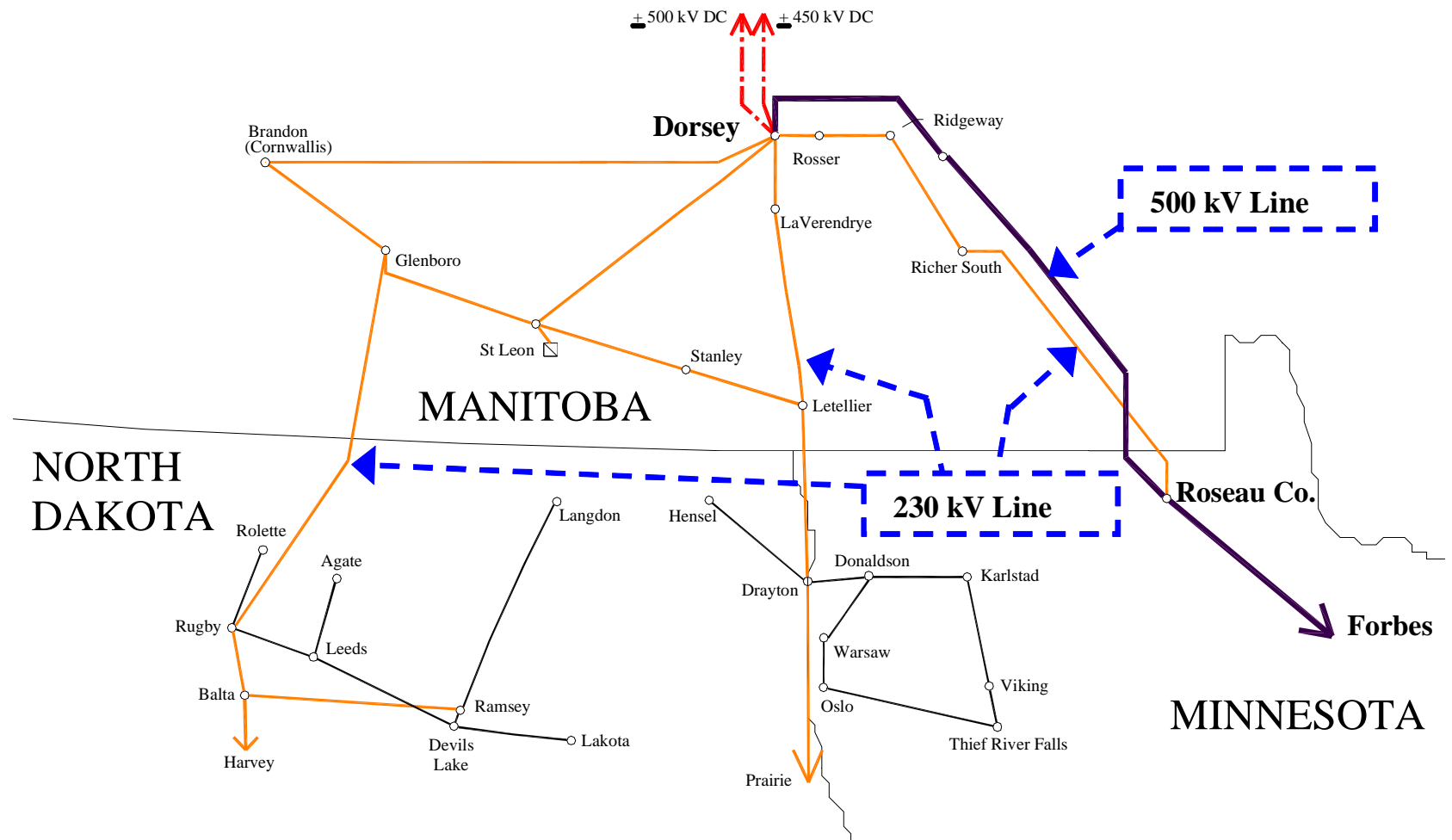
# AC Analysis Single Site



Planning Zone	Bus Name	Generation Outlet Capability (MW)	Planning Zone	Bus Name	Generation Outlet Capability (MW)
		Single Site			Single Site
NW	Viking	<10*	NE	Little Sauk	35*
	Silver Lake	20*		RDO	25*
	Plummer	<10*		Aldrich (Verndale)	35*
	Halma	<10*		Bertram	30*
	Cormorant	15*		Walker	20*
	Crookston	<10*		Hewitt	35*
	Audubon	15*		Aldrich	20*
	Bemidji Airport	10*		Flensburg	15*
W-C	West Port	25*		Cloquet	40*
	Swan Lake	15*		SE	Waseca
	Paynesville	35*	Vasa		40
	Hoffman	25*	New Prague		40
	Glencoe	25	Lafayette		30
	Erdahl	20*	Goodhue		40
	Birds Island	40	French Lake		40
	Atwater	40	Crystal Foods		40
	Alexandria	25*	Airtech		40
SW	Sveadah	35	* Denotes a limitation due to the Dorsey Transformer Overloads		
	Steen	25			
	New Ulm	40			
	Mountain Lake	40			
	Morgan	35			
	Magnolia	25			
	Lakeside Ethanol	40			
Brookville	35				

# Dorsey Transformer Issues

- Behavior of Transmission System
- Additional Generation effects on Dorsey



# Cost Analysis - Single Site

- Improvements needed beyond Dorsey issues
- 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

Northwest Zone								
Facility Name	Owner	Length	Voltage	Existing Cond Size	Rate A (MVA)	System Upgrade	Upgrade Size	Estimated Cost
<b>BEMIDJII AIRPORT</b>								
7909 AIRPORT JCT - 7910 AIRPORT	OTP	0.3	41.6	1/0 ACSR	19.1	Line Rebuild	336 ACSR	\$ 52,000
<b>Total</b>								<b>\$ 52,000</b>
<b>CROOKSTON</b>								
7972 CROOKSTON - 7974 SIMPLOT	OTP	2.9	41.6	266&1/0&3/0 ACSR	26.8	Line Rebuild	336 ACSR	\$ 580,000
7972 CROOKSTON - 7982 CROOKSTON SUGAR	OTP	1.3	41.6	266 ACSR	39.6	Line Rebuild	336 ACSR	\$ 273,000
7980 CROOKSTON - 7982 CROOKSTON SUGAR	OTP	0.6	41.6	266 ACSR	40.2	Line Rebuild	336 ACSR	\$ 144,000
7975 CROOKSTON PLANT - 7980 CROOKSTON JCT	OTP	0.3	41.6	266 ACSR	40.2	Line Rebuild	336 ACSR	\$ 69,000
66776 WILTON TAP - 66968 WILTON	MPC	XFMR	115/69	N/A	88.4	Xfmr Upgrade	112 MVA	\$ 1,703,000
<b>Total</b>								<b>\$ 2,769,000</b>
<b>PLUMMER</b>								
7966 BROOKS - 7967 PLUMMER SW	OTP	6.2	41.6	3/0 ACSR	17.4	Line Rebuild	336 ACSR	\$ 1,240,000
7967 PLUMMER SW - 63252 PLUMMER	OTP	XFMR	115/41.6	N/A	33.6	Xfmr Upgrade	48 MVA	\$ 1,264,000
<b>Total</b>								<b>\$ 2,504,000</b>
<b>SILVER LAKE</b>								
63166 SILVER LAKE - 63366 SILVER LAKE	OTP/GRE	XFMR	230/41.6	N/A	27.0	Xfmr Upgrade	48 MVA	\$ 1,897,000
<b>Total</b>								<b>\$ 1,897,000</b>



# AC Analysis

## Zonal Aggregation

Planning Zone	Generation Outlet Capability (MW)
	Zonal Aggregation
NW	20*
NE	35*
W-C	40*
SW	50
SE	300

\* Denotes a limitation due to the Dorsey Transformer Overloads

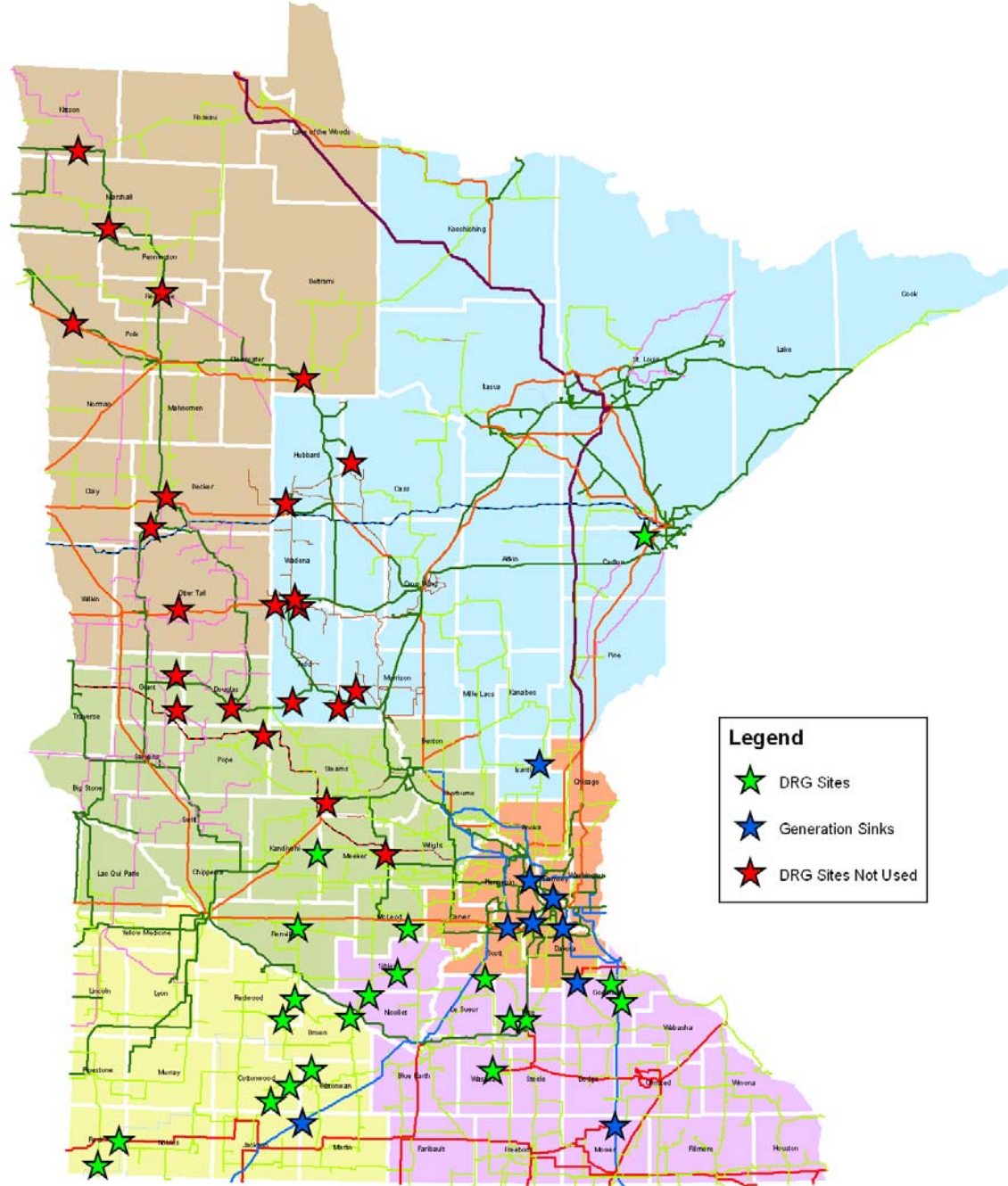


# AC Analysis Statewide Aggregation



Zone	Name	Single Site (MW)	Zone (MW)	Zone	Name	Single Site (MW)	Zone (MW)		
<b>NW</b>	Viking	0	0	<b>NE</b>	Little Sauk	0	40		
	Silver Lake	0			RDO	0			
	Plummer	0			Aldrich (Verndale)	0			
	Halma	0			Bertram	0			
	Cormorant	0			Walker	0			
	Crookston	0			Hewitt	0			
	Audubon	0			Aldrich	0			
	Bemidji Airport	0			Flensburg	0			
						Cloquet		40	
<b>W-C</b>	West Port	0	100		<b>Statewide Total</b>			<b>600 MW</b>	
	Swan Lake	0							
	Paynesville	0							
	Hoffman	0							
	Glencoe Municipal	40							
	Erdahl	0							
	Birds Island	40							
	Atwater	20							
	Alexandria	0							
<b>SW</b>	Sveadah	19		160	<b>SE</b>	Waseca	39	300	
	Steen	21	Vasa			39			
	New Ulm	21	New Prague			39			
	Mountain Lake	21	Lafayette			29			
	Morgan	21	Goodhue			39			
	Magnolia	16	French Lake			39			
	Lakeside Ethanol	21	Crystal Food			39			
	Brookville	19	Airtech			39			

# Map of Final DRG Sites



# Summary

- The analysis successfully demonstrated a DRG scenario where 600 MW could be sited without significantly affecting any transmission infrastructure.
- Extensive study and analysis showed that even dispersed generation can have substantial impacts on the electric grid.
- This study report represents a snapshot in time and is only a representative of the results which may be discovered during more extensive analysis.
- DRG developers need to contact the local utility to examine opportunities for DRG site selection and foster coordination for further study work and/or interconnection requirements.
- There may be existing interconnection requests in a utility queue or MISO queue that might occupy these potential DRG sites.



## Next Steps

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- OES plans to convene and facilitate a technical working group in the second half of 2008 to look into actions necessary, in coordination with the Midwest ISO and with the Minnesota utilities, to interconnect potential DRG projects with a focus on lower voltage interconnections.
- Phase II of the DRG Study will begin in the fall of 2008, with a report due by September 2009



# DRG Study Phase 1 Study

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The full report will be posted at:

[http://www.puc.state.mn.us/news\\_events/index.htm#electric](http://www.puc.state.mn.us/news_events/index.htm#electric)

Please send additional comments & feedback  
to: [DGStudy.Commerce@state.mn.us](mailto:DGStudy.Commerce@state.mn.us)

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Thank you!

