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# Strategic Midwest Area Renewable Transmission (SMART) Study

*November 12, 2009*

- **Wind Generation Models by State for 2029**
- **Non-Wind Generation Models by State for 2029**
- **Preliminary Thoughts on Transmission Alternatives**

# Wind Energy Generation by State for 2029

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- Process- 1
  - Energy Usage by US State (MWh) / 2007 EIA
  - Total energy (MWh) usage for 2029 extrapolated assuming constant growth (~1%)
  - RPS renewable (MWh) – (Federal 20% - State RPS - Utility RPS in %)
  - Energy (MWh) renewable from wind required to meet ~80% (varies with state) RPS

# Wind Energy required by State for 2029

STATE	IA	IL	IN	MI	MN	MO	ND	NE	OH	SD	WI
Federal 20% - State RPS - Utility RPS in %	20	25	20	20	27.5	20	20	20	25	20	25
% of energy renewable from wind	80	75	80	80	80	80	80	80	50	80	65
Average Capacity Factor (Supplied from MISO 3 Year Capacity Factor Statistics)	0.378	0.3	0.325	0.303	0.363	0.354	0.398	0.403	0.304	0.404	0.3
Energy Growth (average US)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.1%
Energy Usage by US State (MWh) / 2007 EIA	45,269,523	146,055,151	109,420,150	109,296,749	68,231,182	85,532,850	11,905,695	28,248,400	161,770,827	10,603,301	71,301,300
Total energy usage extrapolated assuming constant growth (MWh) (2029)	56,347,693	181,797,163	136,196,996	136,043,397	84,928,434	106,464,095	14,819,207	35,161,231	201,358,714	13,198,097	90,703,255
RPS renewable (MWh)	11,269,539	45,449,291	27,239,399	27,208,679	23,355,319	21,292,819	2,963,841	7,032,246	50,339,679	2,639,619	22,675,814
Energy renewable from wind (MWh)	9,015,631	34,086,968	21,791,519	21,766,944	18,684,256	17,034,255	2,371,073	5,625,797	25,169,839	2,111,696	14,739,279

# Wind Generation by State for 2029

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- Process- 2
  - Energy (MWh) renewable from wind required to meet ~80% (varies with state) RPS
  - Estimate Energy (MWh) produced by existing wind installations by state
  - Estimate incremental Energy required to meet RPS based on proration from NREL potential by state
  - Calculate Imports / Exports of Energy by State.
  - Calculate the % of Energy generated inside each state
  - Calculate the incremental wind nameplate capacity per state based on proration from NREL potential by state

# Wind Generation by State for 2029

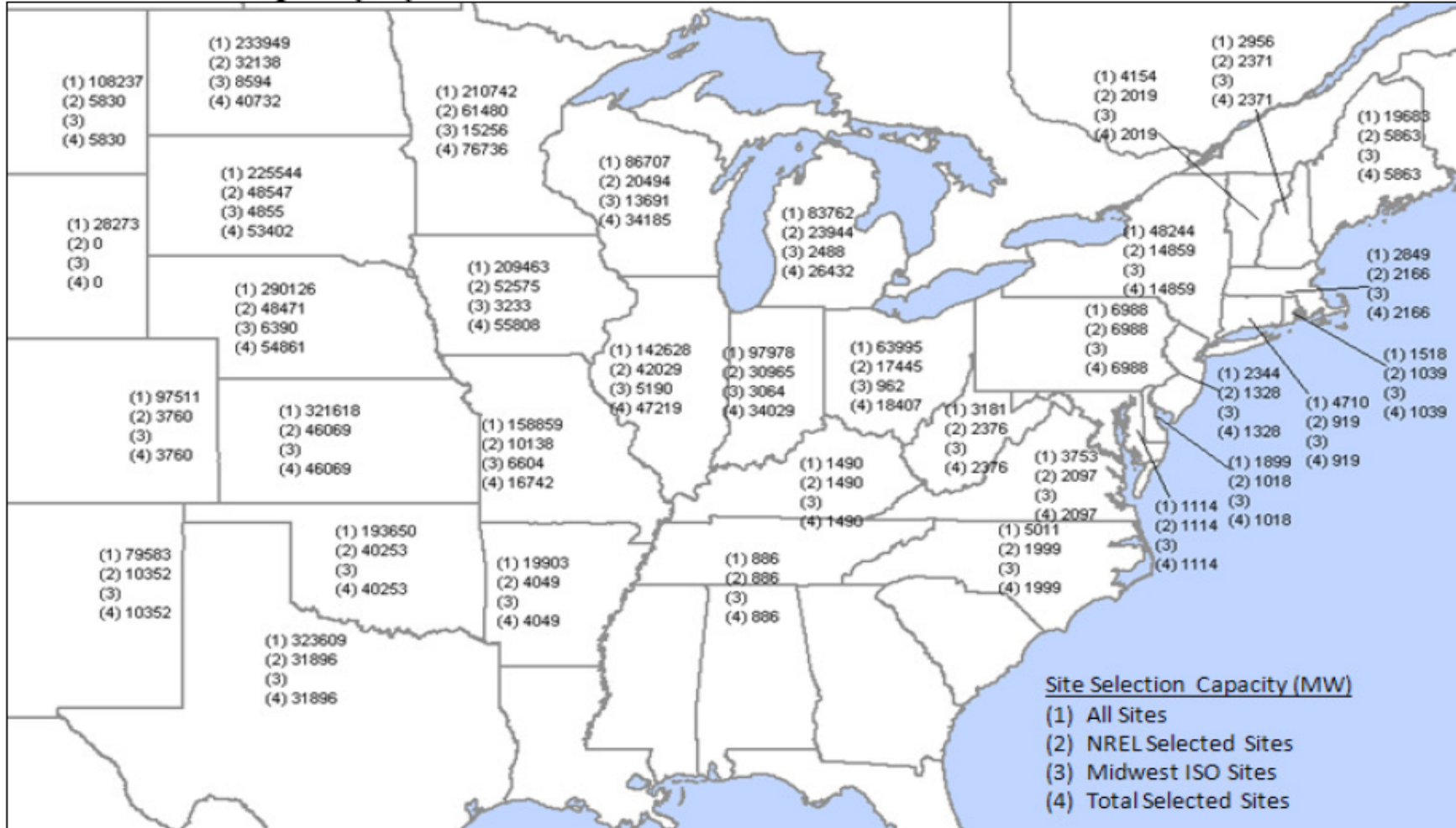
A	B	C	D	E	F	G	H
State	Energy to meet ~80% RPS Requirement MWh	Existing & Under Construction Wind MWh	Incremental wind to meet ~80% RPS (B-C) MWh	Incremental Wind Prorate of NREL by State* MWh	Energy Import/Export by State (E-D) MWh	% RPS Wind Generated In State %	Incremental Wind Prorate of NREL by State* MW
IA	9,015,631	10,109,338	-1,093,707	17,425,420	18,519,127	100%	5,262
IL	34,086,968	2,932,848	31,154,120	9,416,948	-21,737,172	36%	3,583
IN	21,791,519	1,511,757	20,279,762	7,160,026	-13,119,737	40%	2,515
MI	21,766,944	342,402	21,424,541	21,424,541	0	100%	8,072
MN	18,684,256	5,739,683	12,944,572	16,836,114	3,891,542	100%	5,295
MO	17,034,255	958,221	16,076,034	12,376,539	-3,699,495	78%	3,991
ND	2,371,073	2,707,725	-336,652	20,749,631	21,086,282	100%	5,878
NE	5,625,797	533,431	5,092,366	25,412,878	20,320,513	100%	7,289
OH	25,169,839	18,641	25,151,198	4,281,577	-20,869,621	17%	1,608
SD	2,111,696	1,019,244	1,092,452	20,053,804	18,961,352	100%	5,666
WI	14,739,279	1,500,588	13,238,691	5,724,790	-7,513,901	49%	2,178
	172,397,256	27,373,879	145,023,378	160,862,268	15,838,890		51,337

\* Michigan - 100% of RPS will be come from with in state



# NREL Site Selection – 2030 MISO Developed from NREL Data

## Site Selection Capacity by State



# NREL All Site Selection - 2030

State	NREL All Sites MWh	%
IA	693,590,643	12%
IL	374,826,384	6%
IN	284,993,241	5%
MI	222,327,801	4%
MN	670,134,271	12%
MO	492,628,113	9%
ND	825,905,476	14%
NE	1,011,518,496	18%
OH	170,421,245	3%
SD	798,209,238	14%
WI	227,865,996	4%
	5,772,420,904	100%



# Wind Generation by State for 2029

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- Base Case - ~60 GW in 2029 - Based on the requirements of each state to meet ~80% of the RPS standards
  - Purpose
    - Middle level of development, 1% yearly energy growth for most states
    - 20% Federal RPS Standard
    - Typical high end range for lower forecasts and mid/low end for high end forecasts

# Wind Generation by State for 2029

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- **High Wind Future – ~74 GW in 2029**

- Purpose

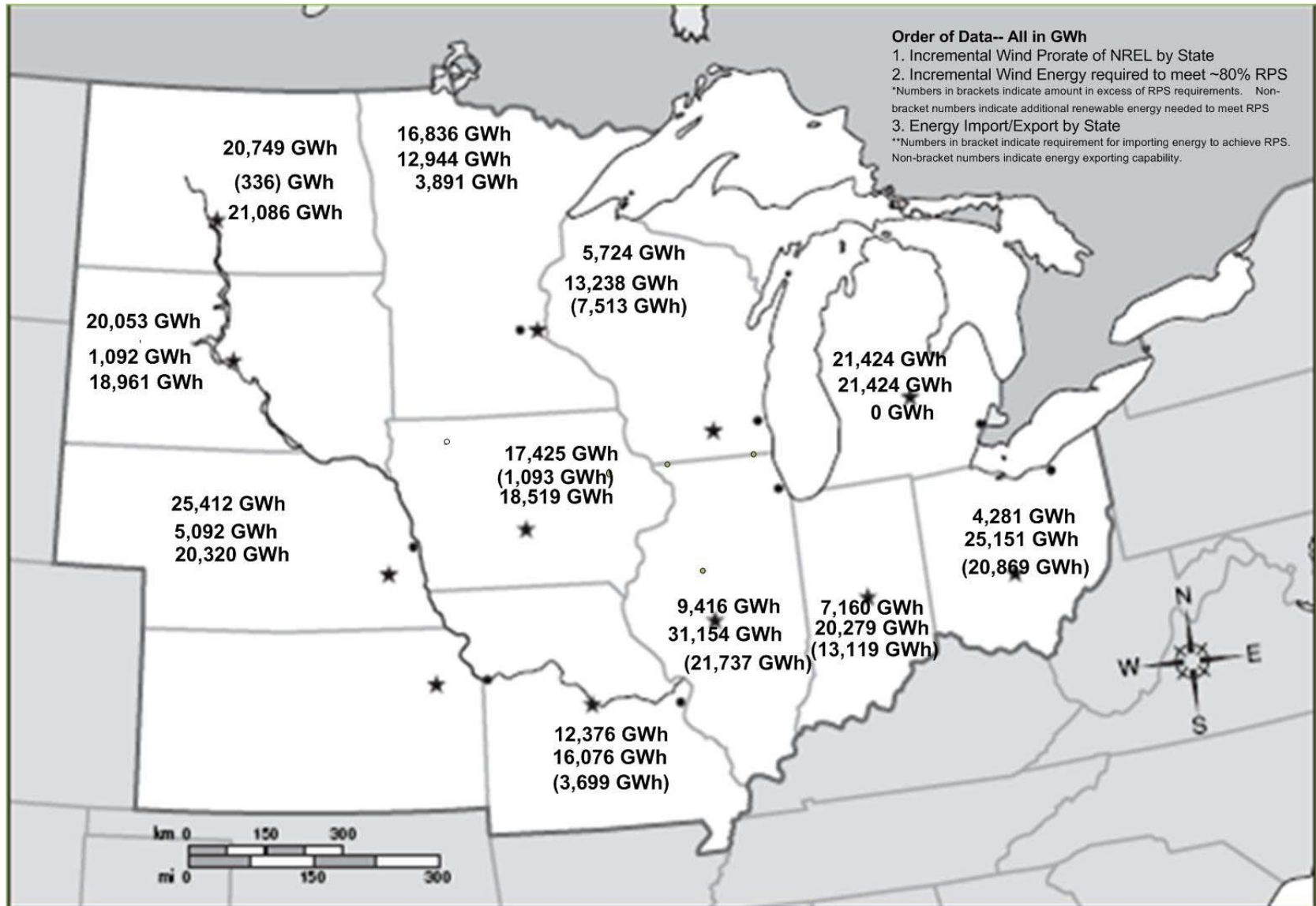
- High level of development - 2% yearly energy growth
- 20% Federal RPS Standard
- Geographic area is a supplier of renewable energy for additional portions of the USA – primarily the east, but also potentially to the south

- **Low Wind Future - ~35 GW in 2029**

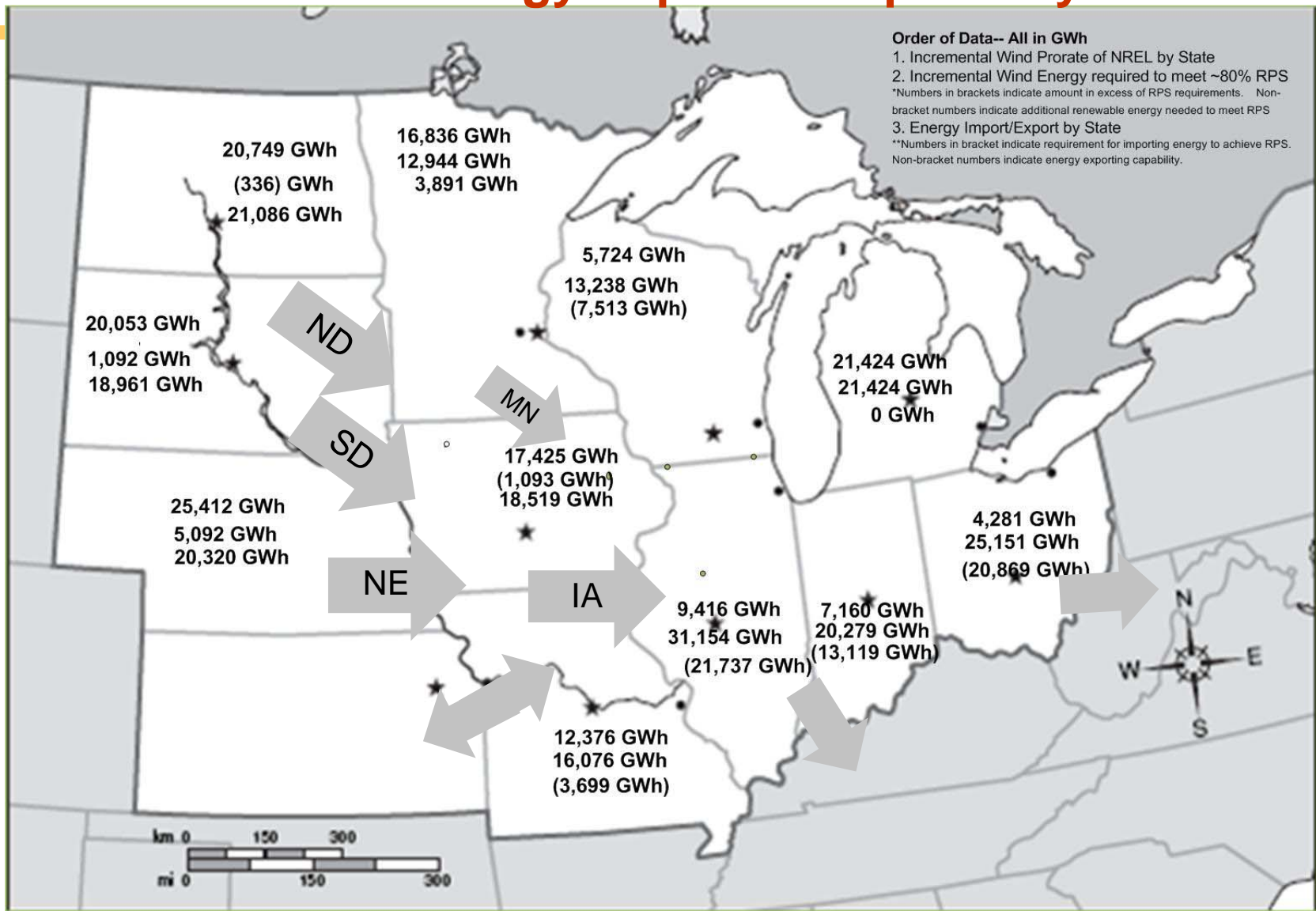
- Purpose

- Low End Development - .3% yearly energy growth
- State oriented\_RPS standards
- Slowed economy

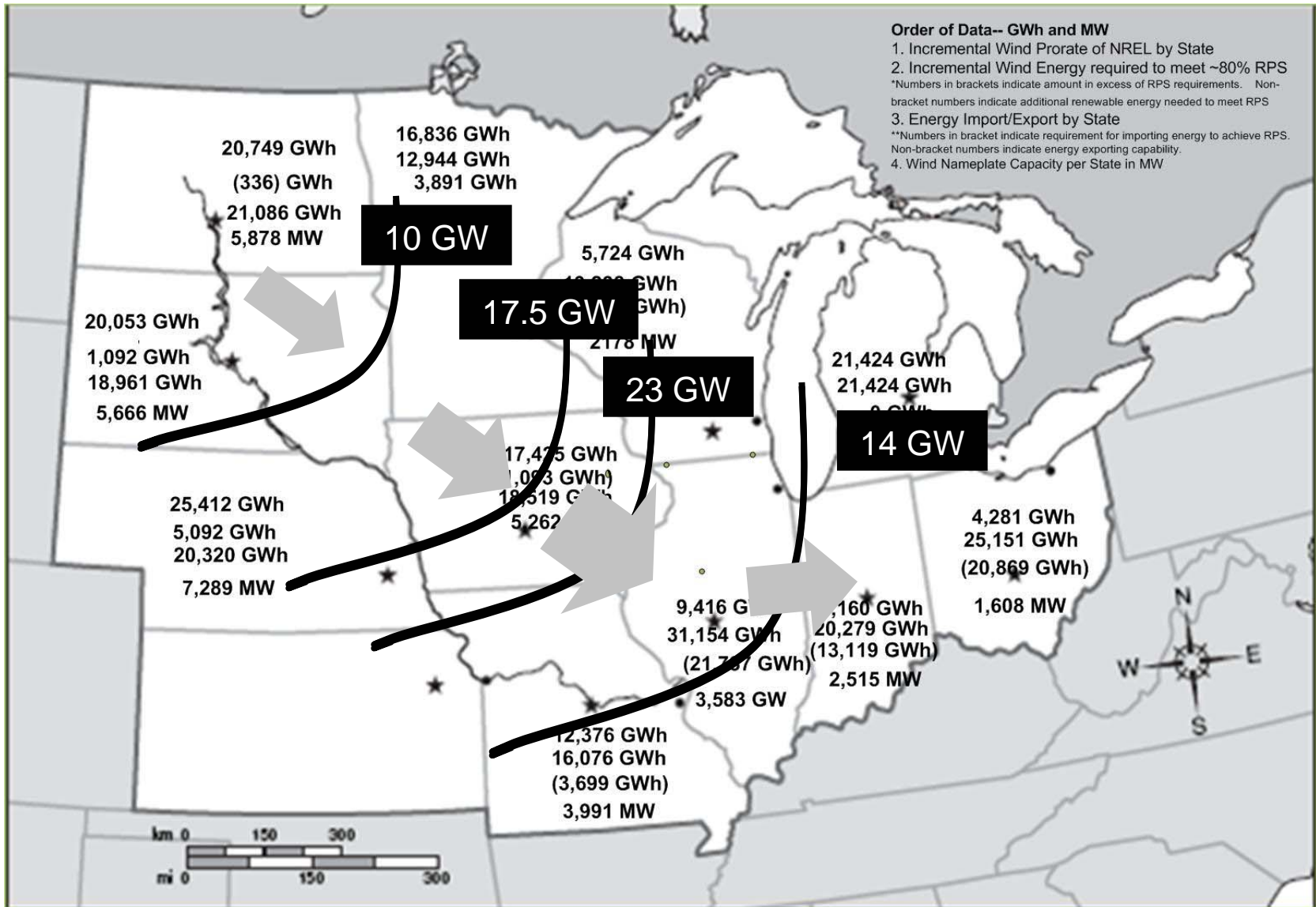
# Wind Energy, RPS requirements & Import/Export by state



# Individual Wind Energy Exports / Imports by State



# Theoretical Interfaces of Power Corridors by State



# Preliminary Transmission Alternatives

## ■ Assumptions

- Only single circuits 765 kV are considered.
- For 345 and 500 kV, at the most, two double circuits are considered on the same right of way. Three double circuits on the same ROW do not seem practical.
- Approximate power carrying in MW based on the table below

Nominal Voltage		345 kV	345 kV *	500 kV	765 kV
Number and Size of Conductors per phase		2x954	2x954	3x954	6x795
Surge Impedance Loading (MW)		390	780	910	2380
Line Length (miles)	Line Loading in SIL	Loadability in MW (No Compensation)			
50	3.0	1170	2340	2730	7140
100	2.0	780	1560	1820	4760
150	1.6	630	1250	1460	3810
200	1.3	510	1010	1180	3090
250	1.1	430	860	1000	2620
300	1.0	390	780	910	2380

\* Double Circuit

# Non-Wind Generation by State for 2029

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- Approximately 20 GW for 2029 Peak Load
- Capture Input from supporters for Non Wind generation as proxy units.
- Non-wind used by MISO 2009
- Non-wind from JCSP
- Relaxing the AGC for gas only units.
- Add combined cycle units to near gas lines and EHV



# Next Steps

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- Collect input from Stakeholders - [info@smartstudy.biz](mailto:info@smartstudy.biz)
- Web conference to present transmission alternatives to be studied, by Dec 3<sup>rd</sup>
- Preliminary Alternatives will be posted when completed [www.smartstudy.biz](http://www.smartstudy.biz)

# SMARTransmission Study

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## QUESTIONS?

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