2014 10-Year Assessment
www.atc10yearplan.com

Generation Interconnections

The size and location of new or expanded power plants can have significant impacts on the transmission system. These impacts can range from very positive (adding voltage support in a weak area of the system) to very negative (aggravating loading problems and/or causing generator instability). Information on the status, as of June 1, 2014, of ATC's portion of the MISO generation interconnection queue is provided in this section. There continues to be significant activity in ATC's portion of this queue, ranging from newly proposed generation projects to cancellation of previously proposed generation projects.

There are two key aspects in determining the total impacts a proposed new generator may have on the transmission system:

- ❑ impacts of interconnecting the new generator to the transmission system and
- ❑ impacts of using the transmission system to deliver power from the new generator.

Per MISO's Attachment X process, a generator interconnection study is usually performed in three stages: Interconnection Feasibility Study (Application Review Phase), Interconnection System Impact Study (System Planning and Analysis and/or Definitive Planning Phase), and an Interconnection Facilities Study (Definitive Planning Phase).

The *Interconnection Feasibility Study* includes a determination of thermal overload or voltage level impacts created by the new generator. This study process is performed by MISO approximately five to seven times per calendar year and provides a qualitative screen of the affected facilities, indicating if there is ample capacity on the system to support the new interconnection, and is a factor in determining the deposit required to enter the Definitive Planning Phase (DPP). The Interconnection Customer may then elect to enter into the DPP or the System Planning and Analysis Phase (SPA) to have a System Impact study performed.

The *Interconnection System Impact Study* includes a determination of whether the proposed generator and other nearby generators will remain connected to the system under various disturbance situations, such as line trips and equipment failures and includes a fault duty analysis to determine whether existing system equipment can accommodate the increased short circuit fault duty caused by the new generator. Finally, the System Impact Study will identify solutions for any thermal, stability or fault duty deficiencies.

Delivery impacts are assessed during the DPP portion of the interconnection study process using the MISO deliverability methodology, which determines whether a new generator is deliverable to the MISO energy market and to what percent if not wholly deliverable. Whatever portion of the new generator that is deliverable may then be used as a Network Resource by Network Customers through MISO's Module E Resource Adequacy procedures.

The *Interconnection Facilities Study* is conducted in the DPP process phase to specify and estimate the time and cost of the equipment, engineering, procurement and construction of the system upgrades identified in the earlier interconnection studies.

The results of the interconnection studies are needed to develop a comprehensive picture of the transmission facilities that will be required for a proposed generator. These necessary changes to the transmission system are why we include in our Assessment models those proposed generators for which interconnection studies have been completed.

The first portion of this section provides the status of the generation queue within our service territory. The second portion of this section describes the transmission system additions associated with various proposed generation projects for which final interconnection studies have been completed. The third portion of this section describes some of the implications associated with interconnecting generation at various locations within our service territory.

ATC Generation Queue
Since ATC's inception, 20 new generators have gone into service and four up rates to existing generators have been completed, totaling approximately 6,200 MW. The various Tables and Figures noted in the following paragraphs are available on ATC's website, www.atc10yearplan.com.

A list of the generators is given in Table PR-26. Table PR-27 lists the proposed generators in the generation queue for our service territory as of June 1, 2014. This table lists each proposed generation project and summarizes them by zone and MW amount. These proposed projects also are shown by approximate location in Figure PR-9. As shown, the total capacity of proposed generators in the queue is 4,886.7 MW. Of that proposed capacity, natural gas fired units reflect over 97 percent and wind units reflect 2.7 percent; less than 1 percent is comprised of hydro generation (see Figure PR-10). Of this generation, zero percent is in Zone 1, 26 percent in Zone 2, zero percent is proposed in Zone 3, 74 percent in Zone 4, and zero percent in Zone 5. Table PR-29 lists the required network upgrades associated with the generators shown in Table PR-27 with a signed Interconnection Agreement.

Link to publicly posted generation queue:
http://www.oasis.oati.com/woa/docs/ATC/ATCdocs/Cluster_8_Queue.mhtml

Implications of generation development
Availability of fuel, water and transmission interconnections are among the key aspects to be considered when sighting generation.

From a transmission perspective, the ability of the transmission system to accommodate new generation is a function of stability, power flow and short circuit analyses. For certain generation technologies, harmonics and voltage fluctuations may need to be considered as well. In most instances, new generation will require certain transmission system reinforcements to interconnect and deliver the generation output. In a few specific instances, new generation can be beneficial to the transmission system, perhaps even deferring or eliminating the need for transmission reinforcements that would be necessary absent the new generation. The ability of generation to defer or eliminate the need for transmission reinforcements also can be a function of the generation location, number of generators and/or expected generator capacity factor.

In this section, a general zone-by-zone evaluation of the likelihood of needing or deferring transmission reinforcements for various generator locations is provided. The purpose of these evaluations is to provide a cursory indication to the generation market of the likely magnitude of the impact and the transmission reinforcements that would likely be needed by general location.

Zone 1
Within Zone 1, generation has been proposed in various locations, and most of the proposals have involved generation located in the vicinity of the 345-kV infrastructure. Based on studies that we have conducted for proposed generation interconnections to date, some transmission reinforcements are likely to be required for any significant (>100 MW) generation development. The extent and nature of the reinforcements largely would be a function of where the power from the generation is to be delivered.

The reliability of the northern portion of Zone 1, the Rhinelander Loop, has been significantly improved with the completion of the new Cranberry to Conover 115-kV line and the Conover to Plains 138 kV conversion. While no new generator requests have been studied for this area, the addition of the Rhinelander Loop improvement projects may be able to support small-sized (up to 50 MW, depending on location) generation development, provided generator stability can be maintained, and provided it can be located in the northern portion of the Loop. Whether this generation would be cost-effective as a transmission-deferral mechanism would depend on a number of factors. The need for additional stability and thermal reinforcements in and outside of the Loop would be a function of where the new generation is sited and where the power is to be delivered. These improvements will be required to ensure that NERC reliability standards are continuously being met and that the security of the Rhinelander loop is not compromised.

The transmission infrastructure in the central portion of Zone 1 includes three new 345-kV lines which make up the GCMW corridor (Gardner Park – Highway 22, Morgan – Highway 22, and Highway 22 – Werner West). These additional lines significantly strengthen the Weston area, bringing much needed support to the area for both stability and thermal

considerations for the new Weston 4 facility. A new generating facility was studied interconnecting 50 MW of biomass generation to the 115-kV transmission system located near the Weston substation. This study proved that properly sited generation of 50 MW or less can be accommodated to the transmission system in the area with minimal network upgrades. While the evaluation of new generation in this area is limited to this one study, it is possible that the GCMW corridor has the potential to support additional small to medium size generation development depending on actual physical location of the facility.

The infrastructure in the southern portion of Zone 1 consists of five 138-kV lines and several 69-kV lines. Only smaller generation projects (typically <25 MW) could be accommodated with minimal transmission reinforcements. The existing infrastructure in this portion of Zone 1 is not suitable for significant generation development.

The following table lists Zone 1 generator studies completed in the last five years.

Zone 1 completed generation studies:

Request	Size	Type	County, State	Status
G588/J142	55/60 MW	Combustion Turbine	Wood County, WI	In-Service
J040	50 MW	Biomass	Marathon County, WI	Out of Queue

Zone 2

ATC has seen substantial interest in siting wind turbine generators in the Upper Peninsula of Michigan. One of the major challenges wind farms proposed for the Upper Peninsula will face is the limited transmission infrastructure to interconnect and deliver the energy produced by these power plants. Since the Upper Peninsula transmission grid was primarily designed to serve local load, substantial transmission upgrades may be required to accommodate these proposed plants. The completion of the Northern Umbrella Plan, however, will result in a much more robust 138-kV network at Plains Substation that could accommodate medium sized generation in the future at or near Plains.

It is likely that given the scarcity of 138-kV infrastructure in the Upper Peninsula there are very few locations in Zone 2 that are ideal candidates for significant generation development. Generation studies have indicated substantial reinforcements are required to accommodate small to medium size generation development throughout the Upper Peninsula.

There are areas in Zone 2, such as the western end of the Upper Peninsula, which are or will be in need of transmission reinforcements where smaller generation projects could be beneficial in terms of deferring transmission expenditures. The allowable capacity of such generation would depend on the location. However, other potential impacts (stability, fault duties) would need to be evaluated on a location-by-location basis.

The following table lists Zone 2 generator studies completed in the last five years.

Zone 2 completed generation studies:

Request	Size	Type	County, State	Status
G937	29 MW	Wind	Delta County, MI	Out of Queue
J039	50 MW	Biomass	Delta County, MI	Out of Queue
J060	29 MW	Wind	Delta County, MI	In Service
J061	70 MW	Wind	Delta County, MI	In Queue
J066	60 MW	Wind	Chippewa County, MI	Out of Queue
J078	26 MW	Biomass	Marquette County, MI	Out of Queue
J119	61.2 MW	Wind	Chippewa County, MI	Out of Queue
J147	60 MW	Wind	Chippewa County, MI	Out of Queue
J241	3.7 MW	Hydro	Florence County, WI	In Queue

We have completed studies of nine generation interconnection requests for the Zone 2 area in the last five years. Even though six of these requests are out of the MISO queue, they have helped us build a base of knowledge similar to what we have in other zones relating to likely generation interconnection impacts.

Zone 3

In Zone 3, generation has been proposed in various locations, but over half have been in the southern-most counties in Zone 3. Generation could be beneficial in a few areas depending on the capacity of such generation and the exact location.

Even with the on-going reinforcement plans for Dane County, smaller-scale generation (< 100 MW) in certain locations could be beneficial to improving the voltage profile in the area and potentially deferring transmission reinforcements. Stability analysis would need to be conducted to ensure stable operation of such generation.

Similarly, the southeast portion of Zone 3 is heavily loaded and will require transmission reinforcements in the future to ensure reliable operation. Small-scale generation in certain locations could be beneficial to changing power flow patterns and improving the voltage profile in the area. Generation studies completed in the southwest corner of the state have demonstrated that sighting large amounts of generation in rural areas may require substantial upgrades to the transmission system to ensure reliable operation.

The following table lists Zone 3 generator studies completed in the last five years.

Zone 3 completed generation studies:

Request	Size	Type	County, State	Status
G366	80 MW	Wind	Columbia County, WI	Out of Queue
G749	50 MW	Wind	Lafayette County, WI	Out of Queue

H012	150 MW	Wind	Columbia County, WI	In Service
H024	48 MW	Wind	Columbia County, WI	Out of Queue
J084	50 MW	Wind	Grant County, WI	Out of Queue
J134	150 MW	Wind	Dane County, WI	Out of Queue
J217	50 MW	Wind	Columbia County, WI	Out of Queue

Zone 4

Generation has been proposed in various locations in Zone 4. Generation could be beneficial in a few areas depending on the capacity of such generation and exact location. Given the nature of the issues in Zone 4, however, it is unlikely that new generation will significantly alter the need for the major transmission reinforcements contemplated in that zone.

One area where generation could defer the need for transmission reinforcements is in Door County, provided such generation is small-scale (< 50 MW) and appropriately located. Currently, the northern portion of the county is served radially, and electric service is subject to interruption for the loss of the single 69-kV line serving the area. The voltage profile in Door County is projected to precipitate the need for reinforcements in the future. Small-scale generation potentially could defer certain of these reinforcements.

One area in Zone 4 that cannot accommodate any additional generation without significant transmission reinforcements is the area around the Point Beach and Kewaunee nuclear plants. In this area, existing transmission lines have little excess capacity and the existing generation requests have demonstrated that large scale transmission projects are needed for even modest increases in existing generation capacity. As the system evolves, stability margins at those plants may become a concern even with the transmission improvements. Siting of additional generation in the area will require extensive studies to ensure that system reliability will continue to be met for the existing generators in the area.

The following table lists Zone 4 generator studies completed in the last five years.

Zone 4 completed generation studies:

Request	Size	Type	County, State	Status
G427	98 MW	Wind	Fond du Lac County, WI	Out of Queue
G833/J023	59 MW	Nuclear	Manitowoc County, WI	In Service
G834/J022	59 MW	Nuclear	Manitowoc County, WI	In Service
J094	200 MW	Wind	Manitowoc County, WI	Out of Queue

Zone 5

Two major generation additions have been completed for Zone 5. The first addition is at Port Washington Power Plant, which was completed in June of 2008. In order to accommodate the two blocks of generation at Port Washington, the two Port Washington–Rangeline 138-kV lines and the three Port Washington–Saukville 138-kV lines were rebuilt in 2005 and the Saukville–Pleasant Valley–Arthur Road–St. Lawrence 138-kV line was rebuilt in 2007 at a cost of approximately $10 million.

The other site for new generation is the Oak Creek Power Plant. The PSCW approved two new units at the Oak Creek Power Plant with the first unit achieving Commercial Operation in December of 2009 and the second unit achieved Commercial Operation in January of 2011.

Studies of other proposed generation projects that are no longer in the generation queue indicate that additional generation in certain areas of Zone 5 would pose stability problems. In particular, larger-scale generation interconnecting to the 345-kV network could pose stability issues.

Smaller-scale generation in certain locations in Washington and Waukesha counties potentially could be accommodated without the need for transmission reinforcements if located appropriately.

No Zone 5 generator studies have been completed in the last five years.

Figure PR-9
Generation Interconnection Requests
as of 6/1/14

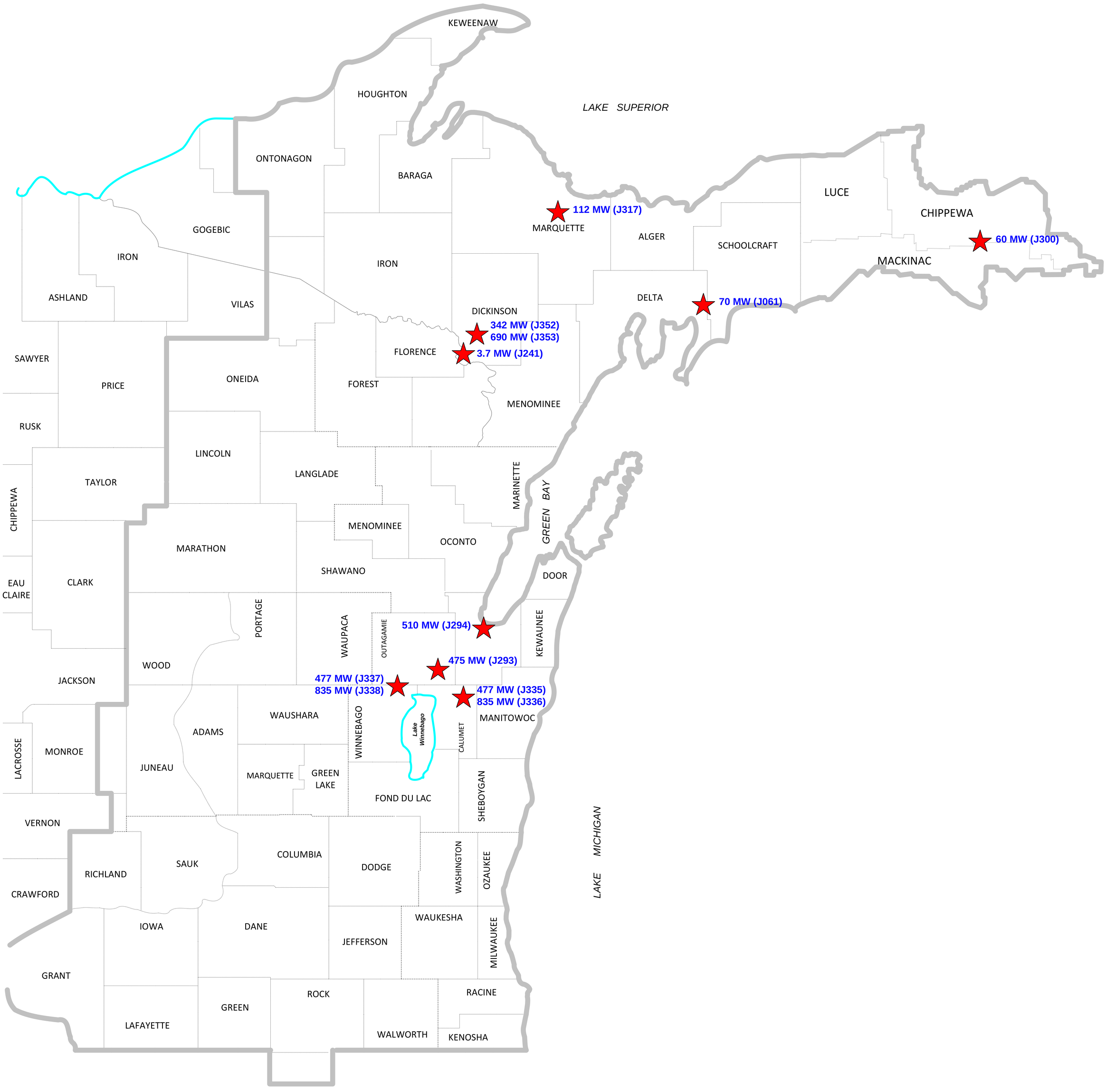

Figure PR-10
ATC Generation in Queue by Type

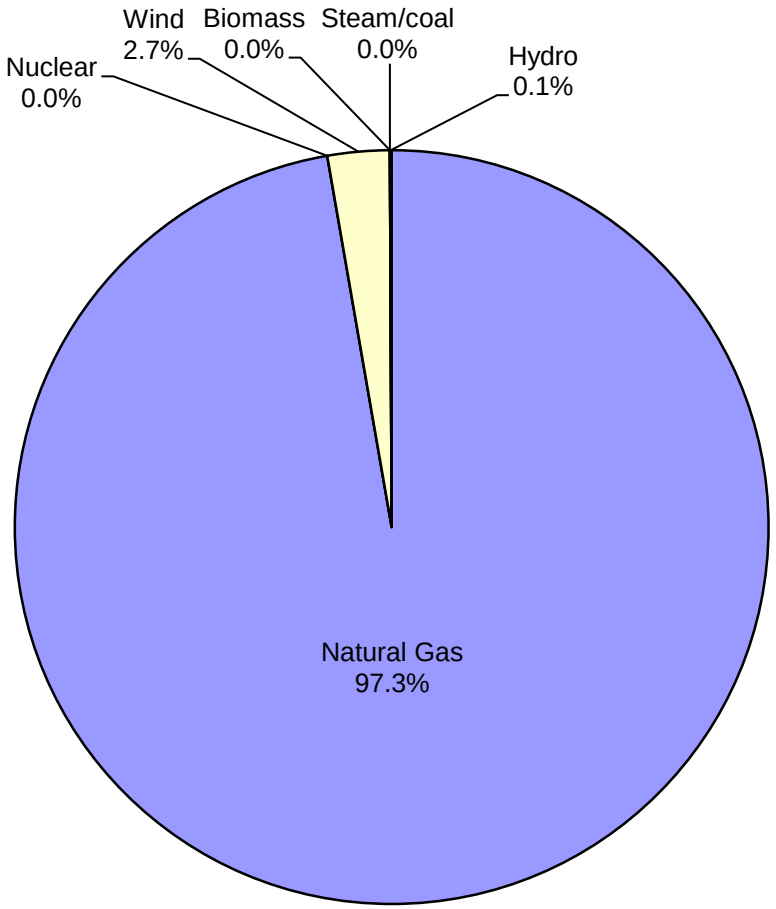

Table PR-26
Former Generator Requests Now In-Service

Date	Requests on-line	Megawatts
6/14/01	IC006 (Eden/Little Badger)	31
2001	G074 (Combined Locks)	53
6/1/03	G111 (Pulliam CT)	85
6/1/03	G148 (Petenwell/Big Pond)	19.5
3/19/04	G165 & G383 (Kewaunee uprate)	43
6/1/04	G225 (Kaukauna CT)	60
6/15/04	G035 & G072 (Riverside)	655
5/1/05	G096 & G160 (West Campus)	150
6/1/05	G044 (Fox Energy)	602
6/2/05	G103 (Sheboygan)	370
7/16/05, 9/1/06, 6/1/08,	G014 & G093 (Port Washington) G510 (Port Washington increase)	1200
4/1/07	G240 (Manitowoc)	54
5/07, 6/09	G550 (Concord uprate)	24
4/30/08	G353 & G354 (Blue Sky Green Field)	145
3/31/08	G368 (Forward)	129
6/26/08	G144 (Weston Unit 4)	550
12/11/08	G507 & G507B (Cedar Ridge)	68
3/16/09	G338 (Butler Ridge)	54
12/29/09, 1/12/11	G051 (Oak Creek Units 1 and 2)	1300
6/1/11	G588 (Marshfield CT)	59.7
6/22/11	G833 & J023 (Point Beach Unit 2 uprate)	59
12/31/11	G706 & H012 (Glacier Hills)	249
12/31/11	G834/J022 (Point Beach Unit 1 uprate)	59
3/30/12	J060 (Garden Wind)	29

Table PR-27

Proposed Projects Active in the Generation Queue as of June 1, 2014

Zone	Queue #	County	Project capacity	Interconnection voltage	Generator technology and fuel	Developer projected in-service date
1	None					
1	Total		0 MW			
2	J061	Delta	70 MW	138 kV	wind turbine	10/2015
2	J241	Dickinson	3.7 MW	69 kV	hydro	6/2016
2	J300	Mackinac	60 MW	69 kV	wind turbine	12/2015[1]
2	J317	Marquette	112 MW	138 kV	natural gas	6/2016[1]
2	J352	Dickinson	342 MW	TBD	natural gas	12/2017
2	J353	Dickinson	690 MW	TBD	natural gas	12/2017
2	Total		1277.7 MW			
3	None					
3	Total		0 MW			
4	J293	Outagamie	475 MW	345 kV	natural gas	12/2018
4	J294	Brown	510 MW	138 kV	natural gas	12/2018[1]
4	J335	Calumet	477 MW	345 kV	natural gas	6/2019
4	J336	Calumet	835 MW	345 kV	natural gas	6/2019
4	J337	Winnebago	477 MW	345 kV	natural gas	6/2019
4	J338	Winnebago	835 MW	345 kV	natural gas	6/2019
4	Total		3609 MW			
5	None					
5	Total		0 MW			

Notes:

1. Project was moved into the MISO System Planning and Analysis phase and will require certain milestones to be met by the Interconnection Customer

Table PR-28
Requests Previously in the Generation Queue
Which Have been Withdrawn/Removed between July 1, 2013 and July 1, 2014

Zone	Queue no.	County	Size	Voltage	Type	In-Service Date
1	None					
2	J119	Chippewa	61.2 MW	69 kV	wind turbine	10/2012
2	J147	Chippewa	60 MW	69 kV	wind turbine	12/2013
3	J084	Grant	50 MW	69 kV	wind turbine	12/2012
3	J109	Lafayette	99 MW	138 kV	wind turbine	10/2015
3	J217	Columbia	50 MW	138 kV	wind turbine	12/2012
3	J314	Columbia or Dane	101 MW	345 kV or 138 kV	wind turbine	12/2017
3	J315	Rock	101 MW	138 kV	wind turbine	12/2017
4	J094	Manitowoc and Kewaunee	200 MW	345 kV or 138 kV	wind turbine	12/2012 and 12/2013
5	None					

Table PR-29
Required Upgrades for Active Projects in the Generator Queue with a Signed Interconnection Agreement as of June 1, 2014

Zone	Queue #	County	Project Capacity	Upgrades
1	None			
2	J061	Delta	70 MW	▪ Indian Lake-Hiawatha 138 kV line energization. ▪ Mackinac HVDC Converter Station.
2	J241	Dickinson	3.7 MW	▪ Bus work and jumpers at Twin Falls Substation
3	None			
4	None			
5	None			