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, 2018, of generation requests in 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.

As described in MISO's Attachment X process, a generator interconnection study is usually performed in three phases which are all within the Definitive Planning Phase (DPP): an Interconnection System Impact Study (Phase 1, 2, and 3), and an Interconnection Customer Interconnection Facilities Facilities Study (Phase 2 and 3). The Network Upgrade Facilities Study begins after the System Impact Study is completed in Phase 3.

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 the output of 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 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. Only transmission facilities that result from generators with a signed Interconnection Agreement are included in the 10-Year Assessment Models.

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 Portion of MISO Generation Queue
Over the last ten years, 9 new generators have gone into service and five uprates to existing generators have been completed, totaling approximately 2,600 MW. These generators are shown in Table PR-26.

Table PR-27 lists the proposed generators in the generation queue for our service territory as of June 1, 2018. 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 this portion of the queue is 6,632 MW. Of this proposed capacity, natural gas fired units reflect 6 percent, wind units reflect 14.3 percent, solar 74.1 percent and storage is 2.6 percent; (see Figure PR-10). Of the proposed capacity, 22 percent is in Zone 1, 4.2 percent is in Zone 2, 44 percent is proposed in Zone 3, 6.3 percent in Zone 4, and 23 percent in Zone 5. Table PR-29 lists the required network upgrades associated with the generators with a signed Interconnection Agreement.

Link to publicly posted generation queue:
https://www.misoenergy.org/planning/generator-interconnection/GI_Queue/
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, fast control interactions, 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 near 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 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 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 (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 includes three 345-kV lines (Gardner Park – Highway 22, Morgan – Highway 22, and Highway 22 – Werner West). These lines significantly strengthen the Weston area, bringing much needed support to the area for both stability and thermal considerations.

The infrastructure in the southern portion of Zone 1 consists of five 138-kV lines and several 69-kV lines. 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

None	None	None	None	None

Zone 2
ATC has seen substantial interest in siting wind turbine and natural gas fired generators in the Upper Peninsula of Michigan. One of the major challenges generation 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, transmission upgrades may be required to accommodate these proposed plants. Completion of the Northern Umbrella Plan and the ATC Energy Collaborative-Michigan projects have started to improve this infrastructure. ATC is also working with MISO and particularly our Michigan stakeholders to identify appropriate solutions to potential generation retirements.

There are areas in Zone 2, which are or will need 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. Please see the Generator Siting tab, under selected planning initiatives for more information.

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
J394	327 MW	Gas	Marquette County, MI	Out of Queue
J557	0.9 MW	Solar	Delta County, MI	In Service
J703	128.1 MW	Gas	Marquette County, MI	Under Construction
J704	54.9 MW	Gas	Baraga County, MI	Under Construction
J711	130 MW	Wind	Baraga County, MI	Waiting construction

We have completed studies of five generation interconnection requests for the Zone 2 area in the last five years. They have helped us build a base of knowledge similar to what we have in other zones related 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 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
J384	21 MW	Gas	Dane County, WI	In Service
J390	702 MW	Gas	Rock County, WI	In Queue
J395	98 MW	Wind	Lafayette County, WI	In 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 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.

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
J293	475 MW	Natural Gas	Outagamie County, WI	Out of Queue
J505	99 MW	Solar	Manitowoc County, WI	waiting construction

Zone 5

Two major generation additions have been completed within the last ten years for Zone 5. The first addition is at Port Washington Power Plant, which was completed in June of 2008. 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.

The other site of generation is the Oak Creek Power Plant. The first unit achieved 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.

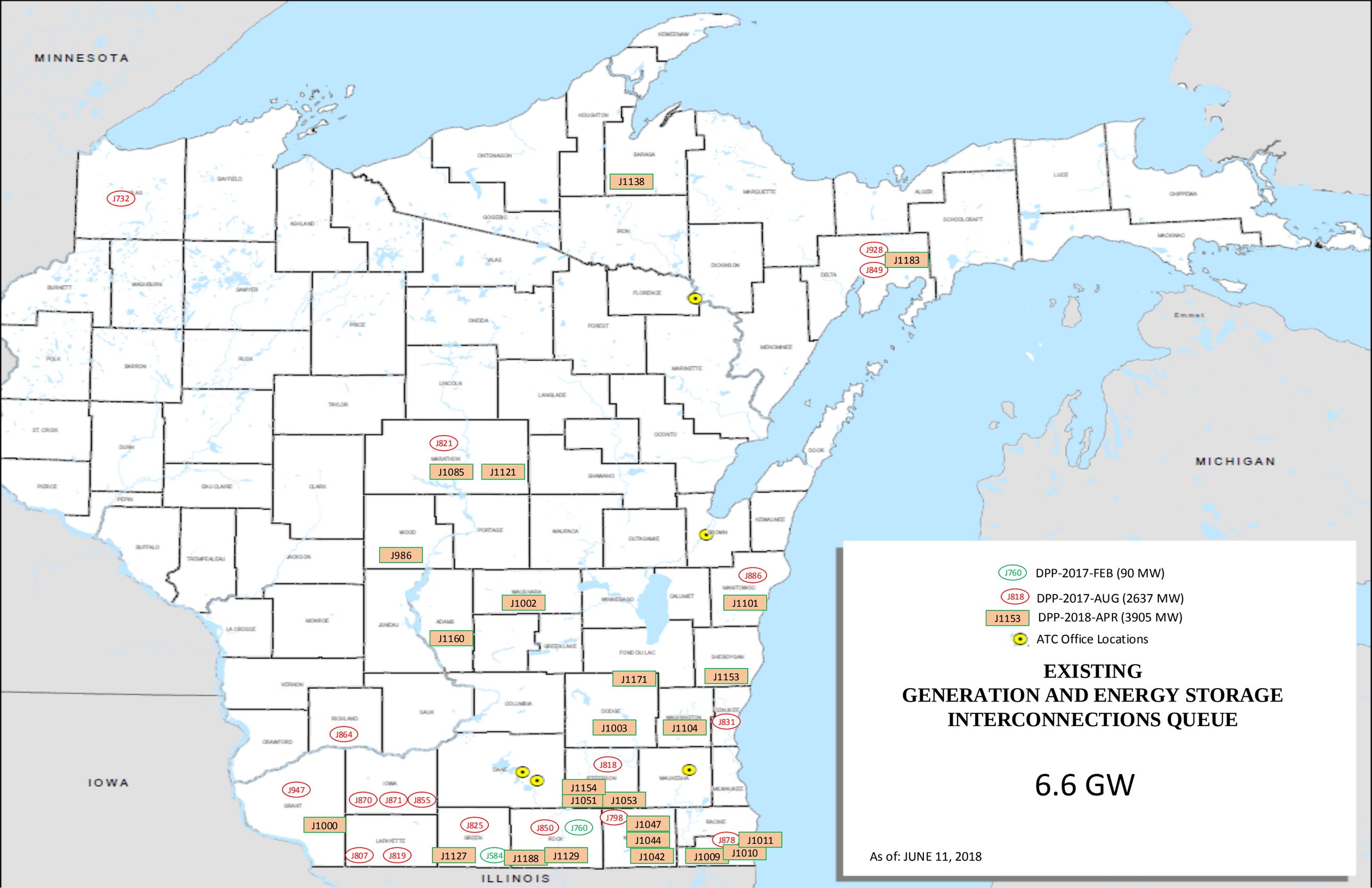
MINNESOTA
IOWA
ILLINOIS
MICHIGAN
J732
J1138
J928
J849
J1183
J821
J1085
J1121
J986
J1002
J1160
J886
J1101
J1153
J1171
J1003
J1104
J831
J818
J1154
J1051
J1053
J798
J1047
J1044
J1042
J1009
J878
J1011
J1010
J1000
J947
J870
J871
J855
J825
J850
J760
J807
J819
J1127
J584
J1188
J1129
J864
KEWEENAW
HOUGHTON
ONTONAGON
BARAGA
MARQUETTE
ALGER
LUCE
CHIPPEWA
MACKINAC
SCHOOLCRAFT
GOGEBIC
IRON
DICKINSON
DELTA
FLORENCE
MENOMINEE
BAYFIELD
ASHLAND
VILAS
ONEIDA
FOREST
MARINETTE
BURNETT
WASHBURN
SAWYER
PRICE
RUSK
BARRON
POLK
ST CROIX
DUNN
PIERCE
PEPIN
EAU CLAIRE
CLARK
TAYLOR
LINCOLN
LANGLADE
OCONTO
SHAWANO
DOOR
KEWAUNEE
BROWN
WOOD
PORTAGE
WAUPACA
OUTAGAMIE
BUFFALO
TREMPEALEAU
JACKSON
LA CROSSE
MONROE
JUNEAU
ADAMS
WAUSHARA
WINNEBAGO
CALUMET
MANITOWOC
GREEN LAKE
FOND DU LAC
SHEBOYGAN
VERNON
RICHLAND
SAUK
COLUMBIA
DODGE
WASHINGTON
OZAUKEE
CRAWFORD
GRANT
IOWA
DANE
JEFFERSON
WAUKESHA
MILWAUKEE
LAFAYETTE
GREEN
ROCK
RACINE
J760 DPP-2017-FEB (90 MW)
J818 DPP-2017-AUG (2637 MW)
J1153 DPP-2018-APR (3905 MW)
ATC Office Locations
EXISTING
GENERATION AND ENERGY STORAGE
INTERCONNECTIONS QUEUE
6.6 GW
As of: JUNE 11, 2018

Figure PR-10
ATC Generation in Queue by Type

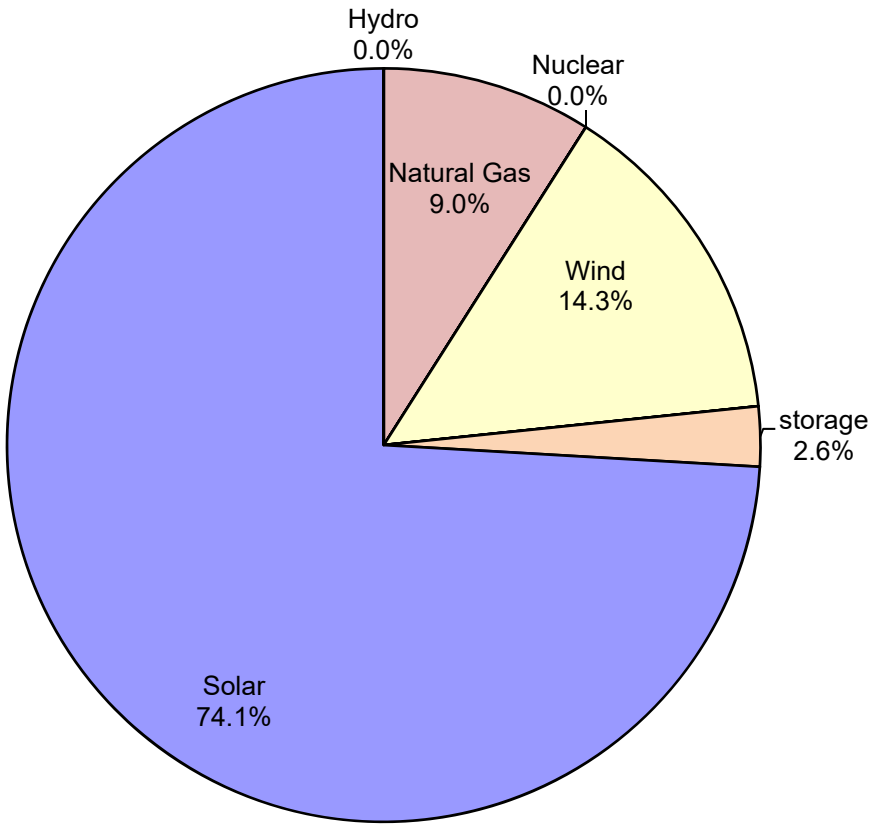

Table PR-26
Former Generator Requests Now In-Service

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
3/4/2016	J382 (RockGen Increase)	48.3
4/27/2016	J241 (Twin Falls Hydro uprate)	3.7
5/1/2017	J384 (Christiana uprate)	21
5/8/2017	J557 (Garden Corners solar)	0.9
11/4/2017	J395 (Quilt Block Wind Farm)	98

Table PR-27

Proposed Projects Active in the Generation Queue as of June 1, 2018

Zone	Queue #	County	Project Capacity (MW)	Interconnection Voltage	Generator Technology and Fuel	Developer Projected Commercial Operation Date
1	J732	Douglas	527.8	345 kV	Natural gas – combined cycle	6/8/2021
1	J821	Marathon	99.9	115 kV	Wind	9/15/2020
1	J986	Wood	150	138 kV	Solar	12/1/2020
1	J1002	Waushara	99	138 kV	Solar	12/1/2021
1	J1085	Marathon	300	345 kV	Wind	12/1/2020
1	J1121	Marathon	200	345 kV	Solar	12/1/2020
1	J1160	Adam	100	138 kV	Solar	12/31/2021
1 Total			1476.7			
2	J849	Delta	125	138 kV	Solar	9/30/2021
2	J928	Delta	79.96	138 kV	Wind	9/1/2019
2	J1138	Baraga	70	138 kV	Wind	12/31/2020
2	J1183	Delta	1.35	138 kV	Solar	1/31/2019
2 Total			276.31			
3	J584	Green	60	69 kV	Wind	9/15/2019
3	J760	Rock	30	138 kV	Natural gas – simple cycle	4/1/2019
3	J798	Walworth	124	138 kV	Solar	9/1/2019
3	J807	Lafayette	41.4	138 kV	Wind	9/15/2020
3	J818	Jefferson	149	138 kV	Solar	9/1/2019
3	J819	Lafayette	99.9	138 kV	Wind	9/15/2020
3	J825	Green	99.9	138 kV	Wind	9/25/2020
3	J850	Rock	250	138 kV	Solar	9/3/2021
3	J855	Iowa	100	138 kV	Wind	8/1/2019
3	J864	Richland	49.98	69 kV	Solar	9/15/2020
3	J870	Iowa	200	138 kV	Solar	9/10/2021
3	J871	Iowa	100	138 kV	Solar	9/10/2021
3	J947	Grant	200	138 kV	Solar	12/1/2020
3	J1000	Grant	50	138 kV	Solar	12/1/2020
3	J1003	Dodge	50	69 kV	Solar	12/1/2021
3	J1042	Walworth	200	138 kV	Solar	12/1/2020
3	J1044	Walworth	200	138 kV	Solar	12/1/2020
3	J1047	Walworth	200	138 kV	Solar	12/1/2020
3	J1051	Jefferson	50	138 kV	Storage	12/1/2020
3	J1053	Jefferson	300	138 kV	Solar	12/1/2020
3	J1127	Green	50	138 kV	Solar	6/1/2021
3	J1129	Rock	65	138 kV	Solar	6/1/2021
3	J1154	Jefferson	200	138 kV	Solar	6/30/2021
3	J1188	Rock	50	69 kV	Solar	11/30/2020
3 Total			2919.18			

4	J886	Manitowoc	150	138 kV	Solar	9/15/2019
4	J1101	Manitowoc	20	138 kV	Storage	12/1/2020
4	J1153	Sheboygan	150	138 kV	Solar	6/30/2021
4	J1171	Dodge	100	138 kV	Solar	12/1/2020
4 Total			420			
5	J831	Ozaukee	40	138 kV	Natural Gas – Combined Cycle	6/3/2018
5	J878	Kenosha	200	138 kV	Solar	9/10/2021
5	J1009	Kenosha	400	345 kV	Solar	12/1/2020
5	J1010	Kenosha	400	345 kV	Solar	12/1/2020
5	J1011	Kenosha	400	345 kV	Solar	12/1/2020
5	J1104	Washington	100	138 kV	Storage	12/1/2020
5 Total			1540			
Grand Total			6632.19			

Table PR-28
Requests Previously in the Generation Queue
Which Have been Withdrawn/Removed between June 1, 2017 and June 1, 2018

Zone	Queue #	County	Project Capacity (MW)	Interconnection Voltage	Generator Technology and Fuel	Developer Projected Commercial Operation Date	Date Withdrawn
1	None						
1 Total			0				
2	J861	Marquette	99.96	345 kV	Solar	Dec - 2019	May 2018
2	J879	Baraga	74.97	138 kV	Wind	Dec - 2020	May 2018
2 Total			174.93				
3	J712	Iowa	200	138 kV	Wind	Dec - 2020	March 2018
3 Total			200				
4	J657	Manitowoc	100.8	138 kV	Wind	Dec – 2019	March 2018
4 Total			100.8				
5	J892	Walworth	74.97	138 kV	Solar	Dec - 2019	March 2018
5 Total			74.97				
Grand Total			550.7				

Table PR-29
Required Upgrades for Active Projects in the Generator Queue with a Signed Interconnection Agreement as of June 1, 2018

Zone	Queue #	County	Project Capacity	Upgrades
1	None			
2	J703	Marquette	128.1	• New 138 kV “Huron” Substation
2	J704	Baraga	54.9	• New 138 kV “Silver River” Substation
2	J711	Baraga	130	• Uprate NLKG31, Silver River – North Lake • Uprate M38, Silver River – Perch Lake
3	J390	Rock	702	• New 345 kV “Kitty Hawk” Substation
4	J505	Manitowoc	99	• New 138 kV “Apollo” Substation
5	None			