

**#T148 – Caledonia Wind II Energy 138kV  
Generation Interconnection**

**Network Impacts**

The T148 project was studied as a 100 MW Energy (20 MW Capacity) injection at the TSS 890 Kelley Road substation (POI for Kinnikinnik Creek Wind Farm and T99) on the Wempletown to Belvidere 138 kV line #17105 in the ComEd area. Project T148 was evaluated for compliance with reliability criteria for summer peak conditions in 2012.

The results of this study and others performed for earlier queued projects indicate that the installation of all of these projects cannot be accommodated by the ComEd transmission system without the addition of major extra high voltage (EHV) reinforcements. The T148 project contributes to several of the same violations that were initially caused by earlier projects in the R and T queues. Upgrades required by these earlier queued projects included four new 345kV lines and the addition of a 765kV “backbone” transmission system with additional ties to the transmission system east of ComEd. These large upgrade projects may have costs in the billions of dollars and the T148 may have some cost allocation to them. Subsequent studies may indicate a different set of upgrades that this project may be assessed and will depend on whether earlier queued projects withdraw.

Potential network impacts were as follows:

**Generator Deliverability**

*(Single or N-1 contingencies for the Capacity portion only of the interconnection)*

No problems were identified.

**Multiple Facility Contingency**

*(Double Circuit Tower Line contingencies were studied for the full energy output. The contingencies of Line with Failed Breaker and Bus Fault will be performed for the Impact Study.)*

Table 1 - Multiple Facility Contingency Impacts								
Item	Project	Contribution MW	Overloaded Element	Overload %		Rating		Contingency
				From	To	Type	MVA	
1a	T148	22.6	Wayne to Silver Lake Red 345 kV line #14401	99.4%	100.8%	Applicable Load Dump	1572	Silver Lake to Libertyville Red 345 kV line #13821 & Tollway to Libertyville Blue 345 kV line #18502
1b	T148	11.8	Pleasant Valley 345/138 kV transformer #81	99.8%	101.8%	Applicable Load Dump	610	Cherry Valley to Silver Lake 345 kV line #15616 & Cherry Valley – W DeKalb – Glidden 138 kV line #15627

## **Short Circuit**

*(Summary of impacted circuit breakers)*

To be determined in the System Impact Study.

## **Contribution to Previously Identified Overloads**

*(T148 contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)*

Item	Project	Contribution MW	Overloaded Element	Overload %		Rating		Contingency
				From	To	Type	MVA	
2a	T148	22.2	Silver Lake to Libertyville Red 345kV line #13821	104.5%	105.6%	Applicable Load Dump	2024	Wayne to Silver Lake Red 345kV line #14401 & Tollway to Libertyville Blue 345kV line #18502
2b	T148	33.5	Byron to Lee County Blue 345 kV line #0627	169.1%	170.5%	Applicable Load Dump	2277	Cherry Valley to Silver Lake 345kV line #15616 & Cherry Valley – W DeKalb – Glidden 138kV line #15627
2c	T148	33.1	Nelson to Lee County 345kV line #15501	235.1%	236.8%	Applicable Load Dump	2024	Cherry Valley to Silver Lake 345kV line #15616 & Cherry Valley – W DeKalb – Glidden 138kV line #15627
2d	T148	14.2	Nelson to P20 345kV line #15502	189.2%	190.1%	Applicable Load Dump	1572	Cherry Valley to Silver Lake 345kV line #15616 & Cherry Valley – W DeKalb – Glidden 138kV line #15627
2e	T148	14.2	P20 to Electric Junction 345kV line #18402	194.1%	195.0%	Applicable Load Dump	1572	Cherry Valley to Silver Lake 345kV line #15616 & Cherry Valley – W DeKalb – Glidden 138kV line #15627
2f	T148	5.4	Libertyville 345/138kV transformer #81	136.2%	137.0%	Applicable Load Dump	610	Libertyville to Prospect Heights Red 345kV line #11723 & Libertyville to Prospect Heights Blue 345kV line #15424
2g	T148	17.2	Marengo Red Tap to Pleasant Valley portion of Belvidere – Marengo – Pleasant Valley Red 138kV line #12204	301.1%	305.5%	Applicable Load Dump	388	Cherry Valley to Silver Lake 345kV line #15616 & Cherry Valley – W DeKalb – Glidden 138kV line #15627
2h	T148	8.3	Pleasant Valley to Crystal Lake Red 138kV line #13809	133.6%	136.0%	Applicable Load Dump	345	Silver Lake to Pleasant Valley 345kV line #13817 & Cherry Valley to Silver Lake 345kV line #15616
2i	T148	29.6	Belvidere to Marengo Tap Blue portion of Belvidere – Marengo - Woodstock 138kV line #12205	223.1%	229.4%	Applicable Load Dump	473	Cherry Valley to Silver Lake 345kV line #15616 & Cherry Valley – W DeKalb – Glidden 138kV line #15627
2j	T148	13.7	Marengo Tap to Marengo Blue portion of Belvidere – Marengo - Woodstock 138kV line #12205	122.1%	126.1%	Applicable Load Dump	345	Cherry Valley – E Rockford – Alpine – Belvidere 138kV line #15623 & Cherry Valley - Alpine - E Rockford - Sand Park - Harlem - Roscoe Bert - Wempletown 138kV line #15625

Item	Project	Contribution MW	Overloaded Element	Overload %		Rating		Contingency
				From	To	Type	MVA	
2k	T148	14.6	Marengo Tap to Woodstock Blue portion of Belvidere – Marengo - Woodstock 138kV line #12205	257.3%	262.2%	Applicable Load Dump	300	Cherry Valley to Silver Lake 345kV line #15616 & Cherry Valley – W DeKalb – Glidden 138kV line #15627
2l	T148	14.6	Woodstock to Pleasant Valley Blue 138kV line #14106	196.8%	201.0%	Applicable Load Dump	345	Cherry Valley to Silver Lake 345kV line #15616 & Cherry Valley – W DeKalb – Glidden 138kV line #15627
2m	T148	8.2	Pleasant Valley to Crystal Lake Blue portion of the Pleasant Valley - Crystal Lake - Silver Lake 138kV line #13809	128.9%	131.3%	Applicable Load Dump	345	Silver Lake to Pleasant Valley 345kV line #13817 & Cherry Valley to Silver Lake 345kV line #15616
2n	T148	44.4	Kelley Rd (TSS 890) to Belvidere Blue 138kV line #12206	164.4%	183.2%	Applicable Load Dump	236	Cherry Valley - Stillman Valley - O68/R54 138kV line #15621 & Cherry Valley – Daimler Chrysler – Belvidere Blue 138kV line #15624

### **Steady-State Voltage Requirements**

*(Summary of the VAR requirements based upon the results of the steady-state voltage studies)*

To be determined in the System Impact Study.

### **Stability and Reactive Power Requirement for Low Voltage Ride Through**

*(Summary of the VAR requirements based upon the results of the dynamic studies)*

To be determined in the System Impact Study.

### **New System Reinforcements**

*(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)*

### **Multiple Facility Contingency**

Previous projects in the PJM Queue have established the need for 345kV reinforcements in the Byron area (See details in the Contribution to Previously Identified System Reinforcements below). These 345kV additions also address the 345 kV overloads listed in Table 1 (Items 1a and 1b).

### **Contribution to Previously Identified System Reinforcements**

*(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)*

Previous projects in the PJM Queue have established the need for two 345kV lines from Byron to Wayne and a second Byron to Nelson 345kV line to satisfy ComEd’s transient stability criteria.

### *Summary of Required Upgrades to Satisfy Stability Criteria*

1. First 345kV transmission line between Byron and Wayne (56 miles). This line is required to mitigate transient stability criteria violations initially caused by the R16 project. The T148 project may have a cost allocation to this upgrade. The cost estimate for this upgrade is **\$250,000,000**. (PJM Network Upgrade# **N1606**).
2. Second 345kV transmission line between Byron and Wayne (56 miles). This line is required to mitigate transient stability criteria violations initially caused by the R33 project. The T148 project may have a cost allocation to this upgrade. The cost estimate for this upgrade is **\$50,000,000** (PJM Network Upgrade# **N1638**).
3. A new 345kV transmission line between Byron and Nelson (33 miles). This line is required to mitigate transient stability criteria violations initially caused by the R33 project. The T148 project may have a cost allocation to this upgrade. The cost estimate for this upgrade is **\$125,000,000** (PJM Network Upgrade# **N1639**).

In addition, a new 31-mile 345kV Cherry Valley to Pleasant Valley line is proposed. One 345kV breaker at Cherry Valley substation and a three-breaker 345kV ring bus at Pleasant Valley will be required to terminate the proposed line. This line will provide a second 345kV path between Cherry Valley and Silver Lake. The estimated costs for these facilities are **\$97,000,000**. The T148 project may have a cost allocation to this upgrade.

These projects mitigate the thermal violations described below:

These 345 kV additions address the 345kV overloads resulting from T32 and prior PJM queue projects listed in Table 2 (Items 2a, 2b, 2c, 2d, and 2e.) The 345kV additions also reduce the base flows on the 138kV facilities in the Belvidere – Marengo – Woodstock – Pleasant Valley – Crystal Lake corridor. A preliminary investigation shows that these reductions in flows appear to eliminate the 138kV overloads listed in Table 2 (Items 2g, 2h, 2i, 2j, 2k, 2l, 2m and 2n.)

T148 also contributes to the overload of the Libertyville 345/138kV transformer #81 (Item 2f). To address this overload, a 345kV line breaker and associated facilities on the 345kV Red bus at Prospect Heights is required.

Other projects in the T-Queue prior to T148 demonstrate the need for long-lead time facilities including a 765kV “backbone” transmission system tying the Byron area to the transmission system east of ComEd. While project T148 may have some contributions to the need for this 765kV “backbone”, it may be possible to place T148 in service prior to construction of the 765kV “backbone”. With the addition of the four 345kV lines listed above and the Libertyville transformer relief sufficient 138 kV capacity may be available to add project T148.

The cost of all of the upgrades mentioned above can be in the range of billions of dollars.

Additional studies will be performed during the System Impact and Facilities Studies to determine the ability to add project T148 after the four 345kV lines are installed and prior to the installation of the 765kV “backbone”. These studies will also develop the optimum plan to

address these issues. Studies will also be performed regarding cost allocation among the various projects.

### **Potential Issues**

With the addition of the T148 project, the full output of all three wind farm projects connected to TSS 890 Kelley Road will overload the transmission line conductor on each side of the Kelley Road substation for the single contingency of the opposite-side line. The reliability requirements for operating the transmission system require the curtailment of generation to be completed prior to such a single contingency. The potential for curtailment would be a year-round issue. For an outage of the transmission line on either side of the Kelley Road substation, the output of all three wind farms flows radially towards the remaining outlet line. Upgrading the various sections of 138kV lines #12206 and #17105 would be required to deliver the full nameplate output of all three projects to the transmission grid.

Up through the T99 project, the chance for curtailment at this location would be limited to the summer rating period (usually May through September) because the summer emergency rating for lines #12206 and #17105 on both sides of Kelley Road is 178 MVA. With the addition of the T148 project and the potential to inject 300 MW, the curtailment would take place year-round because the winter rating is 199 MVA.

The restrictions discussed above are detailed in Table 3 for the summer peak conditions using summer ratings.

1. In Item #3v, the overload of the Sand Park Tap to Kelley Rd TSS 890 portion of the Wempletown to TSS 890 138kV line #17105 is caused by the outage of the Kelley Rd TSS 890 to Belvidere Blue 138kV line #12206. (See Table 3 below). Reconductoring of approximately 5 miles of 138kV line 17105 will achieve a summer emergency rating greater than 300 MVA. Replacing, reinforcing and/or adding new structures to some of the existing single circuit H-frame structures also may be required. An order-of-magnitude cost estimate for the reconductor is **\$5,000,000**. This is not a required upgrade for this project at this time, but will be reevaluated in the System Impact Study. To correct this issue, the customer would have to put in a Merchant Transmission project and follow the appropriate process.
2. In Item #3w, the overload of the Kelley Rd TSS 890 to Belvidere Blue 138kV line #12206 is caused by the outage of the Wempletown - Roscoe Bert - Harlem - Sand Park - Kelley Rd TSS 890 138kV line #17105. (See Table 3 below). Reconductoring of approximately 7.5 miles of 138kV line 12206 will achieve a summer emergency rating greater than 300 MVA. Replacing, reinforcing and/or adding new structures to some of the existing single circuit H-frame structures also may be required. An order-of-magnitude cost estimate for the reconductor is **\$7,500,000**. This is not a required upgrade for this project at this time, but will be reevaluated in the System Impact Study. To correct this issue, the customer would have to put in a Merchant Transmission project and follow the appropriate process.

3. In Item #3x, the overload of the Harlem to Sand Park Tap portion of 138kV line #17105 is caused by the outage of the Kelley Rd TSS 890 to Belvidere Blue 138kV line #12206. (See Table 3 below). Reconductoring of approximately 5 miles of 138kV line 17105 will achieve a summer emergency rating greater than 270 MVA. Replacing, reinforcing and/or adding new structures to some of the existing single circuit H-frame structures also may be required. An order-of-magnitude cost estimate for the reconductor is **\$1,700,000**. This is not a required upgrade for this project at this time, but will be reevaluated in the System Impact Study. To correct this issue, the customer would have to put in a Merchant Transmission project and follow the appropriate process.

The impacts on the AEP system due to the expansion of the 765kV system in ComEd and the new 765kV tie lines to AEP have not been studied. Additional system reinforcements may be required due to Project T148 and these line additions.

**Impacts on the MISO member transmission systems are not included in this analysis, but they will be included in the Impact Study, which may reveal upgrades needed in the MISO system not identified in this Feasibility Study.**

#### **Delivery of Energy Portion of Interconnection Request**

*PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.*

*Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.*

*As a result of the aggregate energy resources in the area, the following violations were identified:*

Table 3 - Delivery of Energy Portion of Interconnection Request								
Item	Project	Contribution MW	Overloaded Element	Overload %		Rating		Contingency
				From	To	Type	MVA	
3a	T148	29.9	Cherry Valley to Silver Lake 345kV line #15616	288.6%	290.6%	Emergency	1530	Nelson to Lee County 345kV line #15501
3b	T148	30.8	Byron to Lee County Blue 345kV line #0627	205.1%	206.9%	Emergency	1739	Cherry Valley to Silver Lake 345kV line #15616
3c	T148	18.4	Silver Lake to Libertyville Red 345kV line #13821	137.1%	138.3%	Emergency	1530	Nelson to Lee County 345kV line #15501
3d	T148	16.0	Wempletown to T92T93 Blue 345kV line #17101	161.3%	162.3%	Emergency	1214	Wempletown to T92T93 Red 345kV line #17102
3e	T148	13.5	T92T93 to Rockdale Blue 345kV line #17101	168.9%	170.0%	Emergency	1214	T92T93 to Paddock Red 345kV line #17102
3f	T148	15.9	Wempletown to T92T93 Red 345kV line #17102	183.7%	184.9%	Emergency	1341	Wempletown to T92T93 Blue 345kV line #17101
3g	T148	15.6	T92T93 to Paddock Red 345kV line #17102	179.2%	180.3%	Emergency	1341	T92T93 to Rockdale Blue 345kV line #17101
3h	T148	30.4	Nelson to Lee County 345kV line #15501	292.7%	294.7%	Emergency	1530	Cherry Valley to Silver Lake 345kV line #15616
3i	T148	13.2	Nelson to P20 345kV line #15502	231.7%	232.8%	Emergency	1234	Cherry Valley to Silver Lake 345kV line #15616
3j	T148	13.2	P20 to Electric Junction 345kV line #18402	237.9%	239.0%	Emergency	1234	Cherry Valley to Silver Lake 345kV line #15616
3k	T148	8.3	Zion to Pleasant Prairie Red 345kV line #2221	136.8%	137.6%	Emergency	1096	Cherry Valley to Silver Lake 345kV line #15616
3l	T148	44.4	Kelley Rd (TSS 890) to Belvidere Blue 138kV line #12206	217.6%	242.6%	Emergency	178	Cherry Valley – Daimler Chrysler – Belvidere Blue 138kV line #15624
3m	T148	29.1	Belvidere to Marengo Tap Blue portion of Belvidere – Marengo - Woodstock 138kV line #12205	227.3%	234.0%	Emergency	430	Cherry Valley to Silver Lake 345kV line #15616
3n	T148	23.0	Marengo Tap to Marengo portion of the Belvidere-Marengo-Woodstock Blue 138kV line #12205	147.1%	155.9%	Emergency	261	Woodstock to Pleasant Valley Blue 138kV line #14106
3o	T148	13.9	Marengo Tap to Woodstock Blue portion of Belvidere to Woodstock 138kV line #12205	267.4%	272.7%	Emergency	261	Cherry Valley to Silver Lake 345kV line #15616
3p	T148	13.9	Woodstock to Pleasant Valley Blue 138kV line #14106	231.7%	237.1%	Emergency	261	Cherry Valley to Silver Lake 345kV line #15616

**Table 3 - Delivery of Energy Portion of Interconnection Request (Continued)**

Item	Project	Contribution MW	Overloaded Element	Overload %		Rating		Contingency
				From	To	Type	MVA	
3q	T148	23.0	Marengo Blue to Marengo Red 138kV Bus Tie	161.9%	174.3%	Emergency	185	Woodstock to Pleasant Valley Blue 138kV line #14106
3r	T148	16.3	Marengo Red Tap to Pleasant Valley portion of Belvidere – Marengo – Pleasant Valley Red 138kV line #12204	322.8%	328.3%	Emergency	293	Cherry Valley to Silver Lake 345kV line #15616
3s	T148	5.3	Pleasant Valley to Crystal Lake Blue portion of the Pleasant Valley - Crystal Lake - Silver Lake 138kV line #13809	116.4%	118.4%	Emergency	261	Cherry Valley to Silver Lake 345kV line #15616
3t	T148	5.8	Cherry Valley to W DeKalb tap portion of Cherry Valley – W DeKalb – Glidden 138kV line #15627	182.7%	184.4%	Emergency	338	Nelson to Lee County 345kV line #15501
3u	T148	5.8	W DeKalb tap to Glidden portion of Cherry Valley – W DeKalb – Glidden 138kV line #15627	245.8%	248.2%	Emergency	235	Nelson to Lee County 345kV line #15501
3v	T148	100.0	Sand Park Tap to Kelley Rd (TSS 890) portion of Wempletown - Roscoe Bert - Harlem - Sand Park - TSS 890 138kV line #17105	112.4%	168.5%	Emergency	178	Kelley Rd (TSS 890) to Belvidere Blue 138kV line #12206
3w	T148	100.0	Kelley Rd (TSS 890) to Belvidere Blue 138kV line #12206	112.4%	168.5%	Emergency	178	Wempletown - Roscoe Bert - Harlem - Sand Park - Kelley Rd (TSS 890) 138kV line #17105
3x	T148	100.0	Harlem to Sand Park Tap portion of Wempletown - Roscoe Bert - Harlem - Sand Park - TSS 890 138kV line #17105	94.0%	150.2%	Emergency	178	Kelley Rd (TSS 890) to Belvidere Blue 138kV line #12206