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November 12, 2009

Via Hand Delivery

Ms. Renee Jenkins
Administration/Docketing
Ohio Power Siting Board
180 East Broad Street, 11th Floor
Columbus, Ohio 43215-3793

Re: Hardin Wind Energy LLC, Case No. 09-479-EL-BGN

Dear Ms. Jenkins:

On September 18, 2009, Hardin Wind Energy LLC ("Hardin Wind") filed an Amended Application for a Certificate of Environmental Compatibility and Public Need under Ohio Administrative Code Chapter 4906-17. The purpose of this letter is to submit for filing a copy of the Impact Study prepared by PJM. As Staff is aware, Hard Wind has been waiting for this study, which has just been received.

If you have any questions, please call me at the number listed above.

Sincerely,

Sally W Bloomfield

Sally W. Bloomfield

Attachment

Cc: Parties of Record

PJM Generator Interconnection Request
Queue #U2-041
East Lima-Marysville (Hardin County) 345kV
Impact Study

567530

November 2008

U2-041 East Lima-Marysville (Hardin County) 345kV Feasibility Study Report

General

Invenergy Windpower Development, LLC (Invenergy) proposes to install PJM Project #U2-041, a 300 MW generating facility comprised of 200 - 1.5 MW General Electric wind turbine generators using option #1, described in the Feasibility Study, connecting to the American Electric Power (AEP) East Lima-Marysville 345kV circuit via a new 3-breaker ring bus. The proposed project will be located in Hardin County, Ohio. The projected in-service date is scheduled for November 1, 2010.

The intent of the Impact study is to determine system reinforcements and associated costs and construction time estimates required to facilitate the addition of the new generating plant to the transmission system. The reinforcements include the direct connection of the generator to the system and any network upgrades necessary to maintain the reliability of the transmission system.

Attachment Facilities

The attachment facilities will consist of a new in-line switching station located between AEP's East Lima and Marysville Stations or the Southwest Lima and Marysville Stations in Ohio. The new station would consist of three 345 kV circuit breakers configured in a ring-bus arrangement with 345 kV metering. AEP will retain ownership of the proposed in-line station facilities. A preliminary one-line diagram of these facilities is shown in Exhibit 2. It is understood that Invenergy will be responsible for all costs associated with this construction, as well as facilities associated with connecting the 300 MW of generation to the in-line facilities.

It is expected that a 400' x 400' (minimum) station site will be provided to AEP by Invenergy. Note that the Invenergy station facilities and any facilities outside the new station were not included in the cost estimate; these are assumed to be Invenergy's responsibility.

The AEP construction scope for the attachment facilities:

- Construction of a new switching station, including three 345 kV circuit breakers, relays, 345 kV metering, SCADA, and associated equipment.

  Estimated Cost (2008 dollars): **$8,000,000**

- Route the East Lima-Marysville 345kV circuit into and out of the new interconnection station and connect two terminals.

  Estimated Cost (2008 dollars): **$600,000**

- Modify line relaying with AEP standard package at East Lima station.

  Estimated Cost (2008 dollars): **$100,000**

- Modify line relaying with AEP standard package at Marysville station.

  Estimated Cost (2008 dollars): **$100,000**

Primary Attachment Facilities Cost[1]: **$8,800,000**

Final estimates will require an on-site review and coordination with Invenergy to determine final construction requirements. Estimates are based on 2009 dollars.

Invenergy is responsible for all costs associated with this connection. The costs above are reimbursable to AEP. Costs of the Invenergy collection station for 300 MW of generation and costs for line connection from the collection station to the AEP switching station are not included in this report.

Local AEP Impacts

The impact of the proposed generating facility on the AEP transmission system was assessed according to applicable reliability criteria and AEP planning criteria. The transmission system must meet single contingency performance in accordance with AEP FERC Form 715 criteria. The Invenergy project was studied as a 300 MW net energy injection. The results are summarized below.

Normal System (2012 Summer Conditions)

- No problems identified

Single Contingency (2012 Summer Conditions)

- No problems identified

Multiple Contingency (2012 Summer Conditions)

- No problems identified

Short Circuit Analysis

[1] The estimates are preliminary in nature, as they were determined without the benefit of detailed engineering studies. Final estimates will require an on-site review and coordination to determine final construction requirements. It will take approximately one year after obtaining the authorization to construct the facilities as outlined above.

- No problems identified.

Network Impacts

The Queue Project #U2-41 was studied as a(n) 300.0MW(Capacity=39.0MW) injection into the East Lima – Marysville 345 kV line in the AEP area. Project #U2-41 was evaluated for compliance with reliability criteria for summer peak conditions in 2013. Potential network impacts were as follows:

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

None

Multiple Facility Contingency
(Double Circuit Tower Line, Line with Failed Breaker and Bus Fault contingencies for the full energy output)

None

Short Circuit

No problems identified

Stability and Reactive Power Requirement
This study evaluates the stability and low voltage ride-through (LVRT) capability for PJM queue project U2-041. The U2-041 project consists of 200 GE 1.5 MW wind turbines for a total of 300 MW. This wind farm will interconnect to the AEP system by tapping on the East Lima – Marysville 345 kV line.

The stability and LVRT study for U2-041 was performed at 2013 summer peak conditions. The range of contingencies evaluated was limited to those necessary to assess compliance with the NERC criteria. Simulation time was 10 seconds for all faults.

Three main fault types were considered, namely:

1. Three-phase fault (3ph) with normal clearing.
2. Single-line-to-ground (slg) fault with delayed clearing as a result of breaker failure (stuck breaker).
3. SLG fault with delayed clearing as a result of communication failure.

Specific fault descriptions and breaker clearing times used for this study are provided in Appendix A. Generation equipment data is shown in Appendix B.

Results

The U2-041 project was tested using the following conditions:

	U2-041
Gross power output (MW)	300
Reactive power output (MVARS)	0
Auxiliary load (MW/MVARS)	0
Net real power injection	300

The wind farm was dispatched using power factor control and **unity** power factor at the generator bus.

All facilities in service:

1. Low Voltage Ride Through: For the cases studied, the U2-041 queue project rides through the faults shown in Appendix A thus meeting the LVRT test specified in FERC order 661 and 661A.

2. Voltage Recovery: For all cases studied, the U2-041 queue project recovers to an acceptable steady state voltage within 10 seconds.

3. Transient Stability: For all cases studied, transient stability is maintained with all oscillations stabilized in less than 10 seconds. Also, the voltage levels returned to normal for all cases following the fault clearance.

Maintenance outage: Maintenance outage conditions were not studied during the impact study phase since the project equipment data provided by the project developer is preliminary in nature. The stability and LVRT study including the maintenance outage test will be re-evaluated during the facility study phase (or at later stage), when more accurate dynamic data becomes available. Note that any and all changes to the generation equipment's dynamic data, including the GSU data, must be submitted to PJM for evaluation.

Note: While the stability analysis has been performed at extreme system conditions, there is a potential that evaluation at a different level of generator MW and/or MVAR output at different system load levels and operating conditions may disclose unforeseen stability problems. The regional reliability analysis routinely performed to test all system changes will include one such evaluation. Any problems uncovered in that or other operating or planning studies will need to be resolved.

Moreover, when the proposed generating station is designed and plant specific dynamic data for the plant and its controls are available, it must be forwarded to PJM. If it is different than the data provided for this study, a transient stability analysis at a variety of expected operating conditions using the more accurate data shall be performed to verify impact on the dynamic performance of the system. Note that any and all changes to the generation equipment's dynamic data, including the GSU data, must be submitted to PJM for evaluation.

Contribution to Previously Identified Overloads

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

1. This project contributes 22.24 MW to the overload on the Sammis – Wylie Ridge 345 kV line (from bus 239092 to bus 20709 ckt 1) of its emergency rating (1483 MVA) for the breaker contingency outage ('01WR S-01WR TID-01WR T7-05TIDD-345-13N2).

2. This project contributes 37.70 MW to the overload of the Belmont 765/500 kV transformer of its emergency rating (2094 MVA) for the outage of Kammer – South Canton 765 kV line, Kammer 765/500 kV transformer, South Canton 765/345 kV transformer#3, Kammer – 502 Junction 500 kV line, and South Canton 345/138 kV transformer#4 for the breaker failure at Kammer 765 kV station ('05KAMMER-05SCANTO-01KAMMER-01 5-765-5N2').

New System Reinforcements

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

None

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)

1. **Sammis – Wylie Ridge 345 kV Upgrade:**
   Upgrade#1
   APS Upgrade:
   The reinforcement for this overload is to reconductor the Sammis-Wylie Ridge No. 240 345kV line (6.9miles) with 1622 ACSS conductor to exceed 3000A capacity. Assume no structure replacement is required, only minor steel reinforcement. Upgrade the line trap on the Sammis terminal at Wylie Ridge with a 4000A rated trap and replace risers and connectors for 1622 ACSS. A System Impact level estimate for this work is **$3,226,000 (Network Upgrade# n1432)**. The estimated project duration is **24 months** after the receipt of an executed Interconnection Service Agreement and Construction Service Agreement. Increase in Rating = **1790 MVA.**

   FE Upgrade:
   Sammis Sub: Replace backup line relaying and metering
   on the 345 kV Wylie Ridge line (ISD 12/1/2010) 173,100
   (Network Upgrade# n1574)

   Sammis -Wylie Ridge 345 kV, Reconductor 4.39 Miles:

Re-conductor the Sammis-Wylie Ridge 345 kV line (4.39 mile)
with 954 Kcmil ACSS wire (ISD 12/1/2011) 2,159,500
(Network Upgrade# n1575)
Increase in Rating = **1792 MVA**
TOTAL **2,332,600**
Note: Reconductor assumes that FE begins work 7/2010

Queue	MW contribution	Percentage of cost	**$ cost (K) = $5,558.600 K**
T32	59.61	6.5%	359.544
T33	80.85	8.8%	487.656
T34	80.85	8.8%	487.656
T35	80.85	8.8%	487.656
T92	77.94	8.5%	470.104
T93	77.94	8.5%	470.104
T94	65.97	7.2%	397.911
T105	18.49	2.0%	111.549
T120	13.47	1.5%	81.216
T124	10.34	1.1%	62.391
T125	10.31	1.1%	62.198
T126	10.52	1.1%	63.465
T127	10.52	1.1%	63.465
T130	20.75	2.3%	125.144
T139	162.18	17.6%	978.207
T142	18.74	2.0%	113.002
T143	31.27	3.4%	188.584
T183	10.52	1.1%	63.465
T184	10.52	1.1%	63.465
U1-37	13.42	1.5%	80.929
U1-49	5.39	0.6%	32.486
U1-60	15.92	1.7%	96.018
U1-87	7.78	0.8%	46.938
U1-88	5.19	0.6%	31.292
U2-41	22.24	2.4%	**134.155**

At the T126 position the original upgrade is insufficient and the following work is also required.

Upgrade#2

APS Upgrade:

Reinforcement: Reconductor the AP portion (approximately 2.94 miles) of the existing Sammis-Wylie Ridge 345kV line with twin bundle 795 Drake ACSS-AW HT conductor for emergency ½ hour rating of 3760A and 4 hour rating of 3647A at 225C. Assume only minor steel reinforcement is required. At Wylie Ridge SS, replace the Sammis 345kV line trap with a 4000A rated line trap. (Network Upgrade#n1580)

$1,901,682

The estimated project duration for the line reconductor is 18 months after the receipt of an executed Interconnection Service Agreement and Construction Service Agreement. Increase in rating = 2179 MVA

FE Upgrade:

Sammis Sub: Replace backup line relaying and metering on the 345 kV Wylie Ridge line (ISD 12/1/2010) **$68,200**

Ridge line Replace GCX51 backup line relayes with an SEL 421. Replace existing meeting with digital multimeter. Replace 3000 A wave trap. (Network Upgrade# n1576). Increase in rating = 2166 MVA

Queue	MW contribution	Percentage of cost	**$ cost (K) = $1,969.882 K**
T126	2.96	0.9%	17.282
T127	10.52	3.1%	61.434
T130	20.75	6.1%	121.139
T139	162.18	48.1%	946.903
T142	18.74	5.6%	109.386
T143	31.27	9.3%	182.550
T183	10.52	3.1%	61.434
T184	10.52	3.1%	61.434
U1-37	13.42	4.0%	78.339
U1-49	5.39	1.6%	31.447
U1-60	15.92	4.7%	92.946
U1-87	7.78	2.3%	45.436
U1-88	5.19	1.5%	30.291
U2-41	**22.24**	**6.6%**	**129.862**

2. **Belmont 765/500 kV Transformer Upgrade:** The reinforcement for this overload is to install a second 765/500kV transformer at Belmont substation. The scope of this work is as follows: At Belmont substation, expand the yard, fence, and ground grid on the

existing property approximately an additional 600' x 200' and construct a new 765 kV cross bus. Install 4-3000A 765kV breakers in a ring bus configuration for the existing Mountaineer and Kammer 765kV lines. Install three single phase, 600 MVA, 765/500kV non-LTC transformers, one spare unit, and oil containment. Install 7-3000A 765kV disconnect switches, and 2-3000A 500kV disconnect switches. Install the BL-8 500kV breaker. Install all required structures, foundations, bus tubing, connectors, grounding, control cables, control panels, and associated equipment. A System Impact level estimate for this work is **$37,611,000 (Network Upgrade# n1433)**. The estimated project duration is **36 months** after the receipt of an executed Interconnection Service Agreement and Construction Service Agreement.

Queue	MW contribution	Percentage of cost	$ cost (K) = $37,611 K
T92	42.5	7.10%	2671.843
T93	152.27	25.45%	9572.426
T99	10.18	1.70%	639.922
T105	36.07	6.03%	2267.451
T106	14.17	2.37%	891.0501
T120	25.51	4.26%	1603.577
T124	20.43	3.41%	1284.245
T125	20.41	3.41%	1282.862
T126	20.46	3.42%	1286.131
T127	20.46	3.42%	1286.131
T142	34.27	5.73%	2154.197
T143	61.22	10.23%	3848.962
T183	20.46	3.42%	1286.131
T184	20.46	3.42%	1286.131
U1-37	25.85	4.32%	1625.109
U1-49	10.31	1.72%	648.2833
U1-87	15.33	2.56%	963.8436
U1-88	10.22	1.71%	642.5624
U2-41	**37.70**	**6.30%**	**2370.144**

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.

Only the most severely overloaded conditions are listed. 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 will study all overload conditions associated with the overloaded element(s) identified.

1. The Convoy – Robison Park 345 kV line (from bus 22605 to bus 22670 ckt 1) loads from 115.96% to 117.2% (AC power flow) of its normal rating (878 MVA) for non-contingency condition. This project contributes approximately 24.14 MW to cause the thermal violation.

2. The Convoy – Robison Park 345 kV line (from bus 22605 to bus 22670 ckt 1) loads from 109.48% to 110.53% (AC power flow) of its emergency rating (1022 MVA) for the single line contingency outage of the Greentown-Jefferson 765kV circuit ('05GRNTWN 765 - 05JEFRSO 765 - 1'). This project contributes approximately 23.83 MW to cause the thermal violation.

MISO Impacts

Iimpacts on facilities in the MISO transmission system will be identified in the Facilities Study.

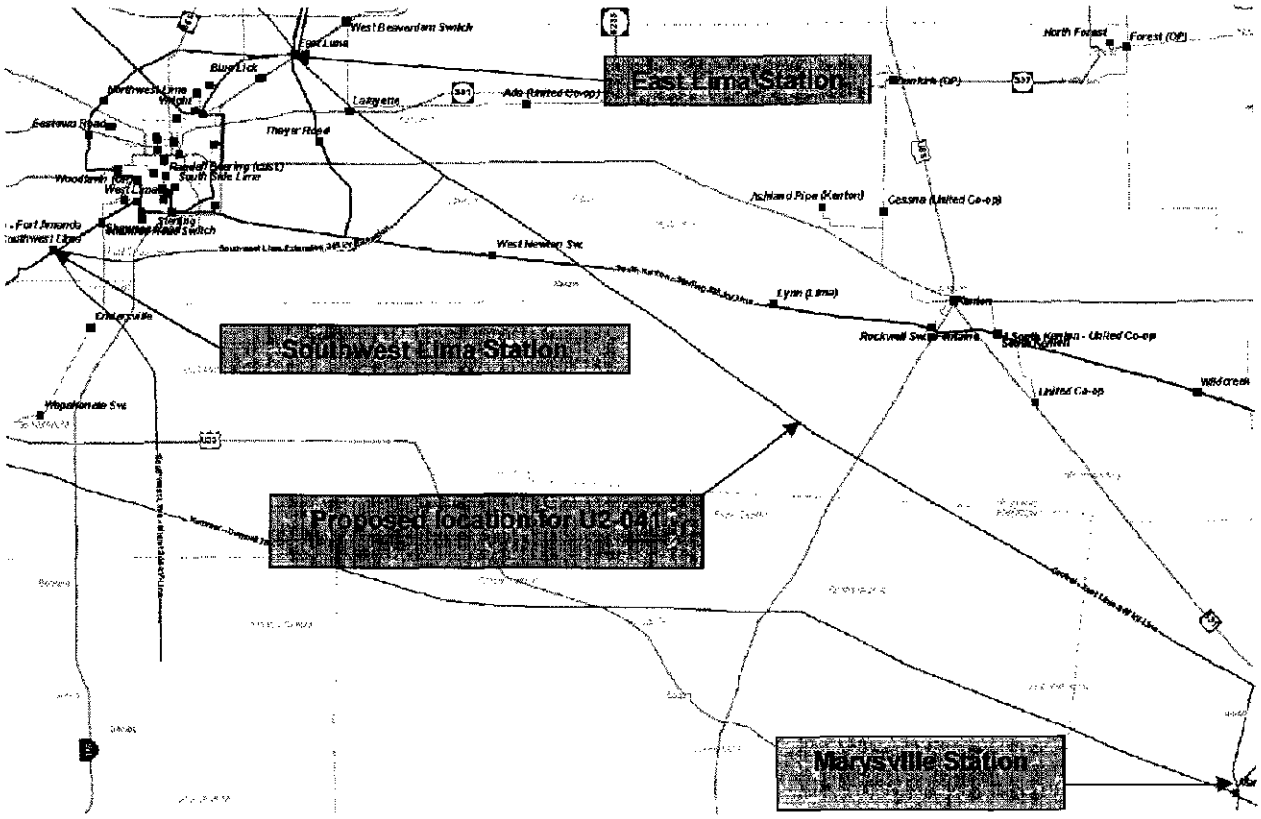

Exhibit 1: Approximate interconnection location of the proposed facilities

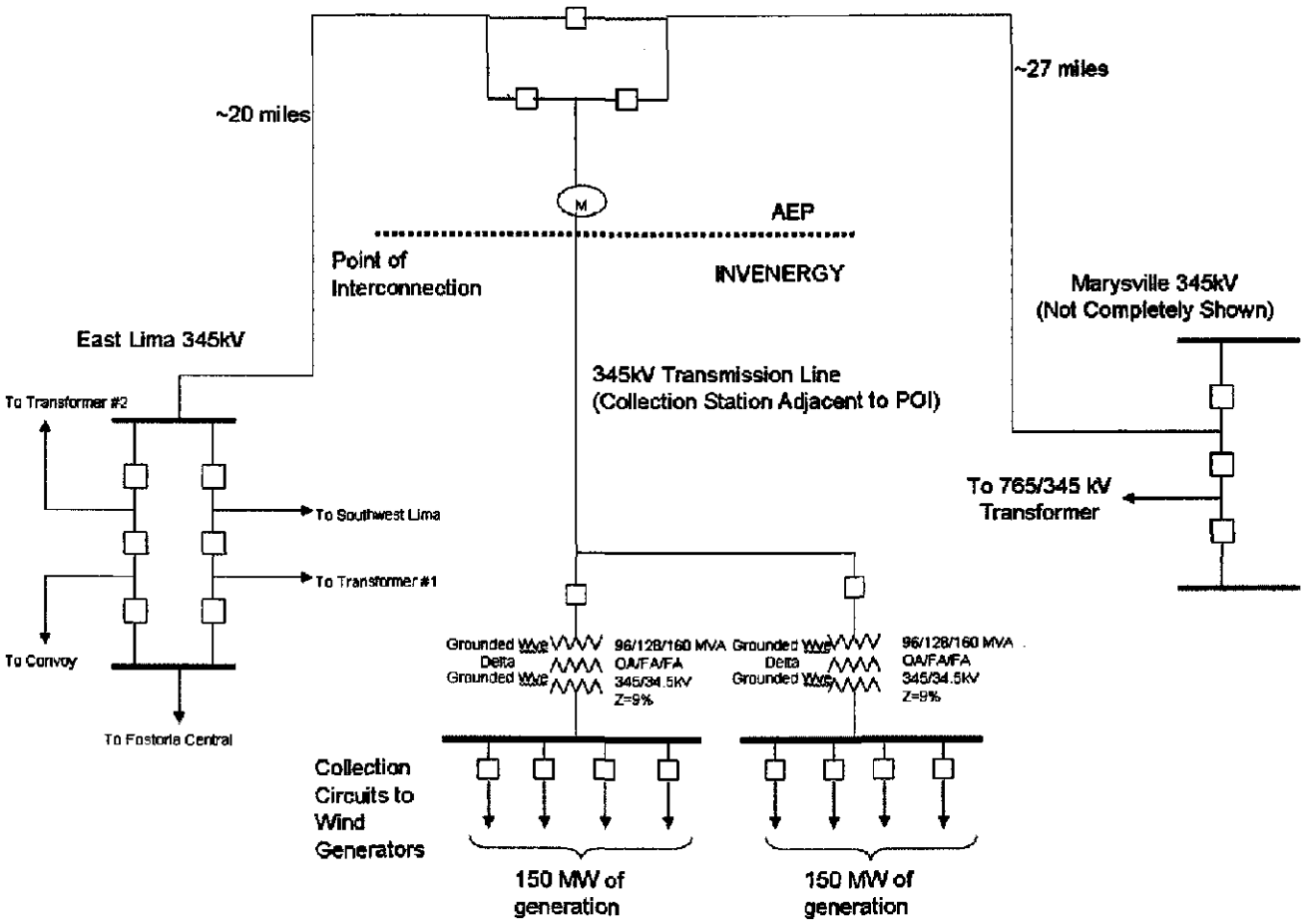

Exhibit 2: Simplified diagram of proposed 345 kV interconnection

APPENDIX A
U2-041

A.1) POWER FLOW CONDITIONS

2013 Summer Peak Base Case

A.2) BREAKER CLEARING TIMES (CYCLES)

Table A.1. AEP Clearing Times (Cycles)

Station	Primary (3ph/slg)	Stuck Breaker (Total)	Zone 2 (Total)	Re-closing
345 kV	4	15	4	N/A
115 & 138 kV	5	18	63	N/A

A.3) FAULTS CONSIDERED (All facilities in service)

Note: For simplicity of fault type identification, PJM *has adopted the following notation:*

A faults: *three-phase faults with normal clearing time*
B faults: *slg faults due to stuck breaker with delayed clearing time*
C faults: *slg faults with delayed clearing time due to protection system failure*

This notation is for internal purposes only, and does not necessarily correspond with the NERC category definition stated in TPL-001.

Fault list

1a. 3ph @ U2-041 – Marysville 345KV Line
1c. slg @ U2-041 – Marysville 345KV Line, 80% from U2-041 Zone 2 clearing time

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2a. 3ph @ U2-041 – East Lima 345KV Line
2c. slg @ U2-041 – East Lima 345KV Line, 80% from U2-041 Zone 2 clearing time

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3a. 3ph @ Marysville 765/345KV Xformer
3b1. slg @ Marysville 765/345KV Xformer, BF (J) @ Marysville
Loss of: Marysville – U2-041 345KV Line
3b2. slg @ Marysville 765/345KV Xformer, BF (J1) @ Marysville
Loss of: Marysville – Tangy 345KV Line

4a. 3ph @ Marysville – Tangy 345KV Line

4b$_1$. slg @ Marysville – Tangy 345KV Line, BF (L1) @ Marysville
Loss of: Marysville – 765/345KV Xformer
4b$_2$. slg @ Marysville – Tangy 345KV Line, BF (L) @ Marysville
Loss of: Marysville – 765/345KV Xformer
4c. slg @ Marysville – Tangy 345KV Line, 80% from Marysville Zone 2 clearing time

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5a. 3ph @ Marysville – Hyatt 345KV Line
5b1. slg @ Marysville – Hyatt 345KV Line, BF (L) @ Marysville
Loss of: East Lima – Southwest Lima 345KV Line
5b2. slg @ Marysville – Hyatt 345KV Line, BF (L2) @ Marysville
5c. slg @ Marysville – Hyatt 345KV Line, 80% from Marysville Zone 2 clearing time

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6a. 3ph @ East Lima - Fostoria Central 345KV Line
6b. slg @ East Lima – Fostoria Central 345KV Line, BF (P2) @ East Lima
Loss of: East Lima 345/138 KV Xformer 1
6c. slg @ East Lima – Fostoria Central 345KV Line, 80% from East Lima Zone 2 clearing time

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7a. 3ph @ East Lima – Southwest Lima 345KV Line
7b. slg @ East Lima – Southwest Lima 345KV Line, BF (P) @ East Lima
Loss of: East Lima 345/138 KV Xformer 1
7b2 slg @ East Lima – Southwest Lima 345KV Line, BF (P1) @ East Lima
Loss of: East Lima to U2-041 345 KV Line
7c. slg @ East Lima – Southwest Lima 345KV Line, 80% from East Lima Zone 2 clearing time

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8a. 3ph @ East Lima 345/138 KV Xformer 1
8b$_1$. slg @ East Lima 345/138 KV Xformer 1, BF (P) @ East Lima
Loss of: East Lima - Southwest Lima 345KV Line
8b2. slg @ East Lima 345/138 KV Xformer 1, BF (P2) @ East Lima
Loss of: East Lima – Fostoria Central 345KV Line

9a. 3ph @ East Lima 345/138 KV Xformer 2
9b. slg @ East Lima 345/138 KV Xformer 2, BF (M1) @ East Lima
Loss of: East Lima – Marysville 345KV Line

10a. 3ph @ East Lima to Rockhill 138 KV line
10b$_1$. slg @ East Lima to Rockhill 138 KV line, BF (D2) @ East Lima
Loss of: East Lima to Sterling 138 KV
Loss of: East Lima to East Leipsic 138 KV
10b$_2$. slg @ East Lima to Rockhill 138 KV line, BF (D) @ East Lima
Loss of: East Lima to New Liberty 138 KV
10c. slg @ East Lima to Rockhill 138 KV line, 80% from East Lima Zone 2 clearing time

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11a. 3ph @ East Lima to Ford Lima 138 KV line
11b$_1$. slg @ East Lima to Ford Lima 138 KV line, BF (C2) @ East Lima
Loss of: East Lima to Sterling 138 KV

Loss of: East Lima to East Leipsic 138 KV
11b$_2$. slg @ East Lima to Ford Lima 138 KV line, BF (C) @ East Lima
Loss of: East Lima 345/138 Xformer 1
11c. slg @ East Lima to Ford Lima 138 KV line, 80% from East Lima Zone 2 clearing time

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12a. 3ph @ East Lima to West Lima 138 KV Line, through Northwest Lima and Woodlawn
12b$_1$. slg @ East Lima to West Lima 138 KV Line, BF (B2) @ East Lima
Loss of: East Lima to Sterling 138 KV
12b$_2$. slg @ East Lima to West Lima 138 KV Line, BF (B) @ East Lima
Loss of: East Lima 345/138 Xformer 2
12c. slg @ East Lima to West Lima 138 KV Line, 80% from East Lima Zone 2 clearing time

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13a. 3ph @ East Lima to Haviland 138 KV line
13b$_1$. slg @ East Lima to Haviland 138 KV line, BF (A2) @ East Lima
Loss of: East Lima to Sterling 138 KV
13b$_2$. slg @ East Lima to Haviland 138 KV line, BF (A) @ East Lima
Loss of: East Lima to Fostoria Central 138 KV Line, through N Findlay & NE Findlay
13c. slg @ East Lima to Haviland 138 KV line, 80% from East Lima Zone 2 clearing time

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14a. 3ph @ East Lima to Sterling 138 KV Line, through Thayer Road and Hanthorn Road
14b. slg @ East Lima to Sterling 138 KV Line, BF (E2) @ East Lima
Loss of: East Lima to East Leipsic 138 KV
14c. slg @ East Lima to Sterling 138 KV Line, 80% from East Lima Zone 2 clearing time

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15a. 3ph @ East Lima to New Liberty 138 KV Line
15b$_1$. slg @ East Lima to New Liberty 138 KV Line, BF (D1) @ East Lima
Loss of: East Lima to U1-060 Tap 138 KV Line
15b$_2$. slg @ East Lima to New Liberty 138 KV Line, BF (D) @ East Lima
Loss of: East Lima to Rockhill 138 KV Line
15c. slg @ East Lima to New Liberty 138 KV Line, 80% from East Lima Zone 2 clearing time

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16a. 3ph @ East Lima to North Findlay 138 KV Line, through N Woodcock
16b$_1$. slg @ East Lima to North Findlay 138 KV Line, BF (A1) @ East Lima
Loss of: East Lima to U1-060 Tap 138 KV Line
16b$_2$. slg @ East Lima to North Findlay 138 KV Line, BF (A) @ East Lima
Loss of: East Lima to Haviland 138 KV line
16c. slg @ East Lima to North Findlay 138 KV Line, 80% from East Lima Zone 2 clearing time

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17a. 3ph @ East Lima to East Leipsic 138 KV Line, through Campbell Rd Switch & Riley Creek Switch
17b. slg @ East Lima to East Leipsic 138 KV Line, BF (AA2) @ East Lima
Loss of: East Lima to Sterling 138 KV Line, through Thayer Road and Hanthorn Road
17c. slg @ East Lima to East Leipsic 138 KV Line, 80% from East Lima Zone 2 clearing time

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18a. 3ph @ Marysville to Dumont 765KV Line

18b_1. slg @ Marysville to Dumont 765KV Line, BF (B2) @ Marysville
Loss of: Marysville to Maliszewski 765 KV Line
18b_2. slg @ Marysville to Dumont 765KV Line, BF (B) @ Marysville
Loss of: Marysville to Flat Lick 765 KV Line
18c. slg @ Marysville to Dumont 765KV Line, 80% from Marysville Zone 2 clearing time

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19a. 3ph @ Marysville to Flat Lick 765 KV Line
19b_1. slg @ Marysville to Flat Lick 765 KV Line, BF (B) @ Marysville
Loss of: Marysville to Dumont 765KV Line
19b_2. slg @ Marysville to Flat Lick 765 KV Line, BF (B1) @ Marysville
Loss of: Marysville to Maliszewski 765 KV Line
19c. slg @ Marysville to Flat Lick 765 KV Line, 80% from Marysville Zone 2 clearing time

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20a. 3ph @ Marysville to Maliszewski 765 KV Line
20b_1. slg @ Marysville to Maliszewski 765 KV Line, BF (A1) @ Marysville
Loss of: Marysville to Flat Lick 765 KV Line
20b_2. slg @ Marysville to Maliszewski 765 KV Line, BF (B2) @ Marysville
Loss of: Marysville to Dumont 765KV Line
20c. slg @ Marysville to Maliszewski 765 KV Line, 80% from Marysville Zone 2 clearing time

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21a. 3ph @ East Lima to U1-060 138 KV Line
21b_1. slg @ East Lima to U1-060 138 KV Line, BF (E1) @ East Lima
21c. slg @ East Lima to U1-060 138 KV Line, 80% from East Lima Zone 2 clearing time

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APPENDIX B
Project Data

B.1) Wind farm and wind turbine data for U2-041

Queue Letter/Position/Unit ID: _____ U2-041

Wind farm data

Primary Fuel Type: _____ Wind

Maximum Net MW Output: _____ 300

Maximum Gross MW Output: _____ 300

Station Service Load in MW/MVAR: _____ 0

Wind turbine data

Wind Turbine Type: _____ GE 1.5

MW Size: _____ 1.5

MVA Base: _____ 1.67

Nominal Power Factor: _____ N/A

Terminal Voltage (kV): _____ 0.69

Control Mode: _____ Power Factor

Number of Turbines (total): _____ 200

Wind farm capacitors

Queue Letter/Position/Unit ID: _____ U2-041

Additional Capacitor: _____ N/A

Location of Additional Capacitor: _____ N/A

Type of Additional Capacitor: _____ N/A

Steps of Switching Shunt: _____ N/A

Unit GSU data

Queue Letter/Position/Unit ID: U2-041

Generator Step-up Transformer MVA Base: 1.75

Generator Step-up Transformer Impedance (R+jX, on MVA Base): 5.75%

Generator Step-up Transformer Reactance-to-Resistance Ratio (X/R): N/A

Generator Step-up Transformer Rating (MVA): 1.75

Generator Step-up Transformer Low-side Voltage (kV): 0.69

Generator Step-up Transformer High-side Voltage (kV): 34.5

Generator Step-up Transformer Off-nominal Turns Ratio: N/A

Generator Step-up Transformer Number of Taps and Step Size: N/A

Main transformer data

Queue Letter/Position/Unit ID: U2-041

Generator Step-up Transformer MVA Base: 96

Generator Step-up Transformer Impedance (R+jX, in p.u, on Xfmr MVA Base): 9%

Generator Step-up Transformer Reactance-to-Resistance Ration (X/R): N/A

Generator Step-up Transformer Rating (MVA): OA/FA/FA Rating: 96/128/160

Generator Step-up Transformer Low-side Voltage (kV): 34.5

Generator Step-up Transformer High-side Voltage (kV): 345

Generator Step-up Transformer Off-nominal Turns Ratio: N/A

Transmission line data:

Queue Letter/ ID: U2-041

Transmission Line MVA Base: N/A

Transmission Line kV Base: N/A

Transmission Line length (mi): N/A

Conductor Type: N/A

Transmission Line Positive Seq. Impedance (R+jX, p.u. on MVA Base): N/A

Transmission Line Positive Seq. Charging Admittance (B, p.u. on MVA Base): N/A

APPENDIX C
PSSE MODEL

C.1) Load flow model:

```
ltap
22603 22614
929592
U2-041   TAP 345
0.35

rdch
1
929593,'U2-041 COL ', 34.5000,1,    0.000,    0.000, 205, 251,1.00115,  -1.7209,  1
929594,'U2-041 COL ', 34.5000,1,    0.000,    0.000, 205, 251,1.00115,  -1.7209,  1
929595,'U2-041 GEN ',  0.7000,2,    0.000,    0.000, 205, 251,1.00648,  1.0830,  1
929596,'U2-041 GEN ',  0.7000,2,    0.000,    0.000, 205, 251,1.00648,  1.0830,  1
0 / END OF BUS DATA, BEGIN LOAD DATA
0 / END OF LOAD DATA, BEGIN GENERATOR DATA
929595,'1 ',  150.000,    0.000,    0.000,    0.000,1.00000,    0,  167.000,  0.00000,  0.80000,  0.00000,  0.00000,1.00000,1,  100.0,  150.000,    0.000,  1,1.0000
929596,'1 ',  150.000,    0.000,    0.000,    0.000,1.00000,    0,  167.000,  0.00000,  0.80000,  0.00000,  0.00000,1.00000,1,  100.0,  150.000,    0.000,  1,1.0000
0 / END OF GENERATOR DATA, BEGIN BRANCH DATA
0 / END OF BRANCH DATA, BEGIN TRANSFORMER DATA
929592,929593,    0,'1 ',1,1,1,  0.00000,  0.00000,2,'          ',1,  1,1.0000
  0.00234,  0.09375,  100.00
1.00000,  0.000,  0.000,  96.00,  128.00,  160.00, 0,    0, 1.10000, 0.90000, 1.10000, 0.90000,  33, 0, 0.00000, 0.00000
1.00000,  0.000
929592,929594,    0,'1 ',1,1,1,  0.00000,  0.00000,2,'          ',1,  1,1.0000
  0.00234,  0.09375,  100.00
1.00000,  0.000,  0.000,  96.00,  128.00,  160.00, 0,    0, 1.10000, 0.90000, 1.10000, 0.90000,  33, 0, 0.00000, 0.00000
1.00000,  0.000
929595,929593,    0,'1 ',1,1,1,  0.00000,  0.00000,2,'          ',1,  1,1.0000
  0.00438,  0.03286,  100.00
1.00000,  0.000,  0.000,  175.00,   0.00,   0.00, 0,    0, 1.10000, 0.90000, 1.10000, 0.90000,  33, 0, 0.00000, 0.00000
1.00000,  0.000
929596,929594,    0,'1 ',1,1,1,  0.00000,  0.00000,2,'          ',1,  1,1.0000
  0.00438,  0.03286,  100.00
1.00000,  0.000,  0.000,  175.00,   0.00,   0.00, 0,    0, 1.10000, 0.90000, 1.10000, 0.90000,  33, 0, 0.00000, 0.00000
1.00000,  0.000
0 / END OF TRANSFORMER DATA, BEGIN AREA DATA
 205, 22987,  5711.000,    5.000,'AEP         '
0 / END OF AREA DATA, BEGIN TWO-TERMINAL DC DATA
0 / END OF TWO-TERMINAL DC DATA, BEGIN VSC DC LINE DATA
0 / END OF VSC DC LINE DATA, BEGIN SWITCHED SHUNT DATA
0 / END OF SWITCHED SHUNT DATA, BEGIN IMPEDANCE CORRECTION DATA
0 / END OF IMPEDANCE CORRECTION DATA, BEGIN MULTI-TERMINAL DC DATA
0 / END OF MULTI-TERMINAL DC DATA, BEGIN MULTI-SECTION LINE DATA
0 / END OF MULTI-SECTION LINE DATA, BEGIN ZONE DATA
 251,'AEP-OP    '
0 / END OF ZONE DATA, BEGIN INTER-AREA TRANSFER DATA
0 / END OF INTER-AREA TRANSFER DATA, BEGIN OWNER DATA
  1,'CENT HUD   '
0 / END OF OWNER DATA, BEGIN FACTS DEVICE DATA
0 / END OF FACTS DEVICE DATA
```

C.2) Dynamic model:

```
/ Feeder 1

929595 'USRMDL' 1  'GEWTG1'  1 1 2 11 3 5
     0  100
      1.5000     0.80000     0.50000     0.90000     1.1100
      1.2000     2.0000     0.40000     0.80000     5.0000     0.20000E-01/
929595 'USRMDL' 1  'GEWTE1'  4 0 10 62 18 7
       929595       0           0           1           0           0
          1         0           0           0
     0.15000     18.000     5.0000     0.0000     0.0000     0.50000E-01   3.0000
     0.60000     1.1200     0.40000E-01 0.43660    -0.43600     1.1000     0.20000E-01
     0.45000       -0.45000          5.0000          0.10000          0.90000          1.1000          40.000
     0.50000          1.4500          0.50000E-01          0.50000E-01          1.0000          0.15000          0.96000
     0.99600          1.0040          1.0400          1.0000          0.95000          0.95000          0.40000
      1.0000          0.20000          1.0000          0.25000          -1.0000          11.000          25.000
      3.0000          -0.90000          8.0000          0.25000          10.000          1.0000          1.7000
      1.1100          1.2500          5.0000          0.0000          0.0000          10.000          0.25000E-02
      1.0000          5.5000          0.10000          -1.0000          0.10000          0.0000
/
929595 'USRMDL' 1  'GEWTT'       5   0   1   5   4   3   0
       4.9400       0.0000       0.0000       1.8800       2.3000   /
0 'USRMDL'  0 'WGUSTC' 8   0   3   6   0   4
       929595       '1 ' 0
       9999.0       5.0000       30.000       9999.0       9999.0
       30.000   /
0 'USRMDL'  0 'GEWTA'       8   0   3   9   1   4
       929595       '1 '  0
       20.000       0.0000       27.000       -4.0000       0.0000       1.2250
       35.250       72.000       1200.0   /
0 'USRMDL'  0 'GEWTP'       8   0   3   10   3   3
       929595       '1 '  0
       0.30000       150.00       25.000       3.0000       30.000
       -4.0000       27.000       -10.000       10.000       1.0000   /
0 'USRMDL'  0 'GEWTPT' 8   0   2   0   0   17        929595       '1 '   /

0 'USRMDL' 0 'VTGTPA' 0 2 6 4 0 1  929595  929595 '1' 0 0 0 0.15 5.0 0.200 0.08 /
0 'USRMDL' 0 'VTGTPA' 0 2 6 4 0 1  929595  929595 '1' 0 0 0 0.3 5.0 0.7 0.08 /
0 'USRMDL' 0 'VTGTPA' 0 2 6 4 0 1  929595  929595 '1' 0 0 0 0.5 5.0 1.2 0.08 /
0 'USRMDL' 0 'VTGTPA' 0 2 6 4 0 1  929595  929595 '1' 0 0 0 0.75 5.0 1.9 0.08 /
0 'USRMDL' 0 'VTGTPA' 0 2 6 4 0 1  929595  929595 '1' 0 0 0 0.0 1.1 1.0 0.08 /
0 'USRMDL' 0 'VTGTPA' 0 2 6 4 0 1  929595  929595 '1' 0 0 0 0.0 1.15 0.1 0.08 /

/ Feeder 2

929596 'USRMDL' 1  'GEWTG1'  1 1 2 11 3 5
     0  100
      1.5000     0.80000     0.50000     0.90000     1.1100
      1.2000     2.0000     0.40000     0.80000     5.0000     0.20000E-01/
929596 'USRMDL' 1  'GEWTE1'  4 0 10 62 18 7
       929596       0           0           1           0           0
          1         0           0           0
     0.15000     18.000     5.0000     0.0000     0.0000     0.50000E-01   3.0000
     0.60000     1.1200     0.40000E-01 0.43660    -0.43600     1.1000     0.20000E-01
     0.45000       -0.45000          5.0000          0.10000          0.90000          1.1000          40.000
     0.50000          1.4500          0.50000E-01          0.50000E-01          1.0000          0.15000          0.96000
     0.99600          1.0040          1.0400          1.0000          0.95000          0.95000          0.40000
      1.0000          0.20000          1.0000          0.25000          -1.0000          11.000          25.000
      3.0000          -0.90000          8.0000          0.25000          10.000          1.0000          1.7000
      1.1100          1.2500          5.0000          0.0000          0.0000          10.000          0.25000E-02
      1.0000          5.5000          0.10000          -1.0000          0.10000          0.0000
/
929596 'USRMDL' 1  'GEWTT'       5   0   1   5   4   3   0
       4.9400       0.0000       0.0000       1.8800       2.3000   /
0 'USRMDL'  0 'WGUSTC' 8   0   3   6   0   4
       929596       '1 ' 0
```

```
      9999.0     5.0000     30.000     9999.0     9999.0
      30.000  /
0 'USRMDL' 0 'GEWTA'    8  0  3  9  1  4
      929596    '1 '  0
      20.000     0.0000     27.000    -4.0000     0.0000     1.2250
      35.250     72.000     1200.0  /
0 'USRMDL' 0 'GEWTP'    8  0  3  10  3  3
      929596    '1 '  0
      0.30000     150.00     25.000     3.0000     30.000
      -4.0000     27.000    -10.000     10.000     1.0000  /
0 'USRMDL' 0 'GEWTPT' 8  0  2  0  0  17     929596    '1 '  /

0 'USRMDL' 0 'VTGTPA' 0 2 6 4 0 1  929596  929596 '1' 0 0 0 0.15 5.0 0.200 0.08 /
0 'USRMDL' 0 'VTGTPA' 0 2 6 4 0 1  929596  929596 '1' 0 0 0 0.3 5.0 0.7 0.08 /
0 'USRMDL' 0 'VTGTPA' 0 2 6 4 0 1  929596  929596 '1' 0 0 0 0.5 5.0 1.2 0.08 /
0 'USRMDL' 0 'VTGTPA' 0 2 6 4 0 1  929596  929596 '1' 0 0 0 0.75 5.0 1.9 0.08 /
0 'USRMDL' 0 'VTGTPA' 0 2 6 4 0 1  929596  929596 '1' 0 0 0 0.0 1.1 1.0 0.08 /
0 'USRMDL' 0 'VTGTPA' 0 2 6 4 0 1  929596  929596 '1' 0 0 0 0.0 1.15 0.1 0.08 /
```

Notes:

1. The dynamic data provided above corresponds with the **gewt_p303cvf_w51.lib** user model.

C.3) Single-line diagram:

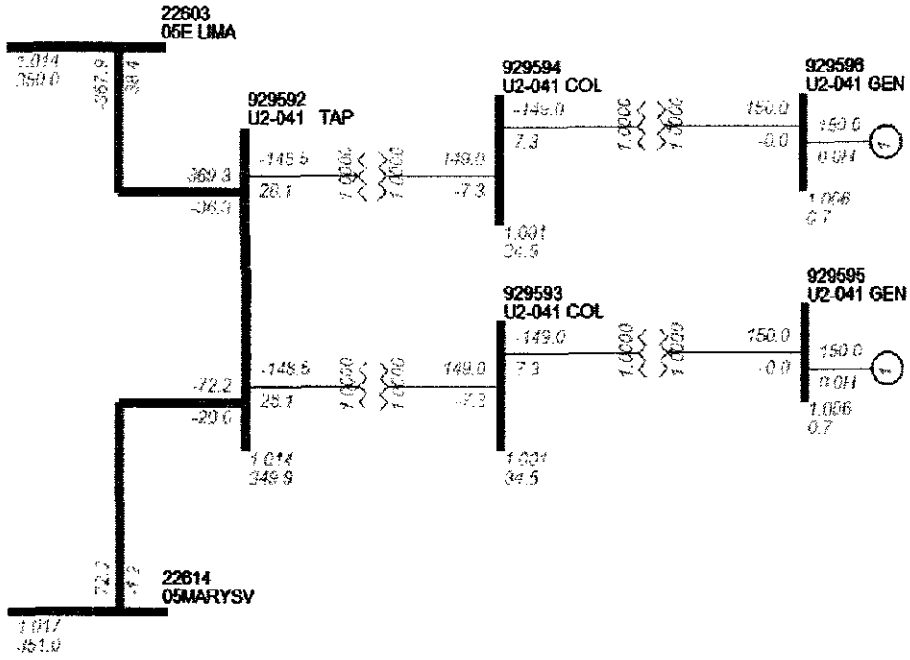

Figure C.1. Single-line diagram for U2-041. Breaker information not shown.

C.4) Base Case Reinforcements:

None