#Y1-015 – Shenango - Hoytdale 345kV
Generation Interconnection

General

The Interconnection Customer is proposing a 1000MW (870MW Capacity) natural gas facility to be interconnected to the ATSI transmission system and located in Lawrence County, PA. ATSI is a FirstEnergy (FE) company. The proposed in-service date for this project is June 1, 2016.

This Generation Interconnection Feasibility Study provides analysis results to aid the Interconnection Customer in assessing the practicality and cost of incorporating the facility into the PJM system.

Facilities to Accommodate the Interconnection

Scope of Direct Connection Work

The Y1-015 project will tap the Shenango – Hoytdale 345kV line. To accommodate this interconnection, installation of a new three-breaker ring bus 345kV substation, ten disconnect switches, along with wave trap replacement, relaying, metering, RTU, SCADA and other miscellaneous supporting equipment will be required (See **Figure 1** below). The new 345kV three-breaker ring bus will be located approximately 14 miles from the Shenango substation. The direct connects are estimated to cost approximately **$8,070,500**, with an extra **$1,875,800** tax gross-up if applicable, to interconnect and take a minimum of **17 months** after the receipt of an executed Construction Service Agreement to complete this work (See **Table 1** below for cost breakdown and details). The cost estimate above does not include any of the upgrades listed in the Network Impacts section of the report.

The Interconnection Customer is responsible for meeting all criteria as specified in the applicable sections of the "FirstEnergy Requirements for Transmission Connected Facilities" document.

The Interconnection Customer is responsible for constructing all of the Interconnection Customer-owned facilities on the Interconnection Customer's side of the Point of Interconnection.

Direct Connect Cost Estimate

The total preliminary cost estimate for Direct Connection work performed by ATSI is listed in the following table:

Table 1. Direct Connect Cost Estimate

Description	Total Cost	Tax	Total with Tax
Install new 345kV three-breaker ring bus generation interconnection switching station	$6,790,200	$1,578,100	$8,368,300
At the Hoytdale substation, replace the wave trap, line tuner, and transfer trip receiver on the 345kV Y1-015 Interconnect (formerly Shenango) line exit	$173,700	$40,400	$214,100
At the Shenango substation, replace the wave trap, line tuner, and transfer trip receiver on the 345kV Y1-015 Interconnect (formerly Hoytdale) line exit	$173,700	$40,400	$214,100
Install a loop, approximately 0.1 mile in length, to the new 345kV three-breaker ring bus substation adjacent to the 345kV Shenango – Hoytdale line	$798,300	$185,600	$983,900
Engineering Oversight and Commissioning	$134,600	$31,300	$165,900
Total	**$8,070,500**	**$1,875,800**	**$9,946,300**

The following assumptions were made by ATSI when putting together the direct connection cost estimate listed in Table 1 above. If any of these assumptions prove not to be correct, this could cause time delays and changes in cost estimates:

- *The Interconnection Customer will acquire all easements, properties and permits relating to construction of both the new 345kV three-breaker ring bus substation and the associated attachment facilities.*
- *No environmental issue with any properties associated with this project.*
- *No delays acquiring necessary permits for implementing the defined direct connect and network upgrades.*
- *PJM will allow transmission system outages when requested.*

Revenue Metering and SCADA Requirements

For PJM: The Interconnection Customer will install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for Interconnection Customer's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Section 24.1 to 24.2.

For ATSI: The Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "FirstEnergy Requirements for Transmission Connected Facilities" document located at the following links: www.firstenergycorp.com/feconnect
www.pjm.com/planning/design-engineering/to-tech-standards.aspx

Network Impacts

The Y1-015 project was studied as a 1000MW (870MW Capacity) injection into the ATSI area as a tap of the 02SHNAGO – 02HOYTDL 345kV line. Project Y1-015 was evaluated for compliance with reliability criteria for summer peak conditions in 2015.

Potential network impacts were as follows:

Generator Deliverability

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

Table 2 below provides a summary of the impacts caused by Y1-015 on the ATSI transmission system and other TO areas for generator deliverability:

Table 2: Generator Deliverability Impact

Item #	Project	Contribution MVA	Overloaded Element	Overload %		Rating		Contingent Element
				From	To	Type	MVA	
1a	Y1-015	47.7	02EU TAP-02CDR ST 138 kV line	75.09%	89.20%	Emergency	338	'930_B2_B'
1b	Y1-015	57.94	02SENECA-01KRENDL 138 kV line	83.27%	96.52%	Emergency	339	'01CABOT_02CRNBRY_071'
1c	Y1-015	62.97	02CRSLND-02MASURY 138 kV line	57.70%	85.20%	Emergency	229	'982_B2'
1d	Y1-015	57.94	02MAPLE-02SENECA 138 kV line	84.77%	97.60%	Emergency	350	'01CABOT_02CRNBRY_071'
1e	Y1-015	47.7	02NCASTL-02EU TAP 138 kV line	89.00%	103.11%	Emergency	338	'930_B2_B'

Item 1a. The 02EU TAP-02CDR ST 138 kV line (from bus 238706 to bus 238610 ckt 1) loads from 75.09% to 89.2% (**DC power flow**) of its rating (338 MVA) for the single line contingency ('930_B2_B'). This project contributes approximately 47.7 MW to the thermal violation.

CONTINGENCY '930_B2_B'
OPEN BRANCH FROM BUS 913100 TO BUS 239106 CKT 1 / 238812 02HOYTDL 345 239106 02SHNAGO 345 1
END

Item 1b. The 02SENECA-01KRENDL 138 kV line (from bus 239099 to bus 235205 ckt 1) loads from 83.27% to 96.52% (**DC power flow**) of its rating (339 MVA) for the single line contingency ('01CABOT _02CRNBRY _071'). This project contributes approximately 57.94 MW to the thermal violation.

CONTINGENCY '01CABOT _02CRNBRY _071'
DISCONNECT BRANCH FROM BUS 235104 TO BUS 239280 CKT 1 /* 500/500KV, AREA 201/202.
END

Item 1c. The 02CRSLND-02MASURY 138 kV line (from bus 238642 to bus 238944 ckt 1) loads from 57.7% to 85.2% (**DC power flow**) of its rating (229 MVA) for the single line contingency ('928_B2'). This project contributes approximately 62.97 MW to the thermal violation.

CONTINGENCY '928_B2'
OPEN BRANCH FROM BUS 238796 TO BUS 239106 CKT 1 / 238796 02HGHLND 345 239106 02SHNAGO 345 1
END

Item 1d. The 02MAPLE-02SENECA 138 kV line (from bus 238942 to bus 239099 ckt 1) loads from 84.77% to 97.6% (**DC power flow**) of its rating (350 MVA) for the single line contingency ('01CABOT _02CRNBRY _071'). This project contributes approximately 57.94 MW to the thermal violation.

CONTINGENCY '01CABOT _02CRNBRY _071'
DISCONNECT BRANCH FROM BUS 235104 TO BUS 239280 CKT 1 /* 500/500KV, AREA 201/202.
END

Item 1e. The 02NCASTL-02EU TAP 138 kV line (from bus 238991 to bus 238706 ckt 1) loads from 89% to 103.11% (**DC power flow**) of its rating (338 MVA) for the single line contingency ('930_B2_B'). This project contributes approximately 47.7 MW to the thermal violation.

CONTINGENCY '930_B2_B'
OPEN BRANCH FROM BUS 913100 TO BUS 239106 CKT 1 / 238812 02HOYTDL 345 239106 02SHNAGO 345 1
END

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.)

Item 2a. The 02SHNAGO-02MASURY 138 kV line (from bus 239107 to bus 238944 ckt 1) loads from 96.86% to 99.15% (**DC power flow**) of its rating (188.800003051758 MVA) for the tower line contingency ('C5-TWL-ER018'). This project contributes approximately 26.76 MW to the thermal violation.

```
CONTINGENCY 'C5-TWL-ER018'                                  /* CROSSLAND -
SHENANGO #1 & #2 138KV
DISCONNECT BRANCH FROM BUS 238642 TO BUS 239107 CKT 1       /*
02CRSLND 138.00 02SHNAGO 138.00
DISCONNECT BRANCH FROM BUS 238642 TO BUS 239107 CKT 2       /*
02CRSLND 138.00 02SHNAGO 138.00
END
```

Short Circuit

(Summary of impacted circuit breakers)

PJM has completed the short circuit analysis of the Y1-015 queue project **Shenango-Hoytdale 345kV**. One option was considered during this study: the option was a tap of the 02SHNAGO and 02HOYTDL 345 kV line. PJM analysis found **3 new breakers** to be over-duty in the ATSI transmission area. The new over-duty breakers are listed below:

Bus_NO	BUS	BREAKER	Duty % with Y1-015_ATSI	Duty % without Y1-015_ATSI	Duty % Difference	Notes
9710	HOYTDL N 138 138.kV	83-B-26	107.20%	98.00%	9.20%	New Overduty
9104	EVERGREEN138 138.kV	802-B-93	101.20%	99.60%	1.60%	New Overduty
9518	WICKLIFFE138 138.kV	144-B-103	100.50%	99.80%	0.70%	New Overduty

In addition, the analysis also showed a significant fault contribution (i.e. above 3%) to 1 breaker, which was already identified as over-duty. The breaker is listed below:

Bus_NO	BUS	BREAKER	Duty % with Y1-015_ATSI	Duty % without Y1-015_ATSI	Duty % Difference	Notes
9712	CROSSLND 138 138.kV	85-B-8	118.40%	115.30%	3.10%	Over 100%, > 3% contribution

The following upgrades in **Table 3** below will mitigate the overduty breakers listed above:

Table 3. Breaker Replacement Cost Estimate			
Description	**Total Cost**	**Tax**	**Total with Tax**
Replace overdutied 138kV circuit breaker 26 at Hoytdale.	$318,800	$74,100	$392,900
Replace overdutied 138kV circuit breaker 93 at Evergreen.	$318,800	$74,100	$392,900
Replace overdutied 138kV circuit breaker 103 at Wickliffe.	$318,800	$74,100	$392,900
Replace overdutied 138kV circuit breaker 8 at Crossland. This project contributes to this prior overloaded breaker. Cost allocations will be provided in the System Impact Study Report.	$318,800	$74,100	$392,900
Total	**$1,275,200**	**$296,400**	**$1,571,600**

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)

No violations were found.

New System Reinforcements

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

For Items 1a and 1e, the overloads of the 02EU TAP-02CDR ST 138 kV line and 02NCASTL-02EU TAP 138 kV line can be relieved by reconductoring the Cedar Street – New Castle (Z-100) 138kV line, replacing existing 3.18 miles of the existing 795 kcmil ACSR conductor with new 795 kcmil ACSS conductor. The total estimated cost to perform this work is **$848,800**. Apply 34.55% tax gross up if applicable. Later projects cause these overloads. Therefore, Y1-015 will have a cost allocation to these overloads and cost allocations will be given during the System Impact Study phase.

For Item 1b, the overload of the 02SENECA-01KRENDL 138 kV line can be relieved by replacing a circuit breaker and replacing 1000MCM Cu conductor on the 138kV Seneca line teriminal at Krendale substation. The total estimated cost to perform this work is **$272,400**. Apply 25% tax gross up if applicable. Later projects cause these overloads. Therefore, Y1-015 will have a cost allocation to these overloads and cost allocations will be given during the System Impact Study phase.

For Item 1c, the overload of the 02CRSLND-02MASURY 138 kV line can be relieved by replacing the limiting Masury substation conductor on the 138kV Crossland line terminal and reconductoring approximately 0.9 miles of the Crossland – Masury 138kV line with 477 kcmil ACSS conductor and replacing the existing 477 kcmil ACSR conductor. The total estimated cost to perform this work is **$554,500**. Apply 24.96% tax gross up if applicable. The cost breakdown by upgrade is shown below in **Table 1a**. Later projects cause these overloads. Therefore, Y1-015 will have a cost allocation to these overloads and cost allocations will be given during the System Impact Study phase.

Table 1a. Reinforcements for Crossland – Masury 138kV Line Overload	
Reinforcement Description	**Upgrade Cost**
Reconductoring approximately 0.9 miles of the Crossland – Masury 138kV line with 477 kcmil ACSS conductor and replacing the existing 477 kcmil ACSR conductor	$537,500
Replacing the limiting Masury substation conductor on the 138kV Crossland line terminal	$17,000
Total estimated cost:	**$554,500**

For Item 1d, the overload of the 02MAPLE-02SENECA 138 kV line can be relieved by replacing limiting Seneca substation conductor on the 138kV Maple line terminal and reconductoring 7.1 miles of the Maple – Seneca section of the Krendale – Maple 138kV line with 954 kcmil ACSS conductor, replacing the existing 954 kcmil ACSR conductor. The total estimated cost to perform this work is **$3,254,300**. Apply 24.99% tax gross up if applicable. The cost breakdown by upgrade is shown below in **Table 1b**. Later projects cause these overloads. Therefore, Y1-015 will have a cost allocation to these overloads and cost allocations will be given during the System Impact Study phase.

Table 1b. Reinforcements for Maple – Seneca 138kV Line Overload	
Reinforcement Description	**Upgrade Cost**
Reconductoring approximately 7.1 miles of the Maple – Seneca section of the Krendale – Maple 138kV line with 954 kcmil ACSS conductor and replacing the existing 954 kcmil ACSR conductor	$3,237,400
Replacing the limiting Seneca substation conductor on the 138kV Crossland line terminal	$16,900
Total estimated cost:	**$3,254,300**

For Item 1f, the overload of the 02HOYTDL-02MAPLE 138 kV line can be relieved by replacing limiting Hoytdale substation conductor on the 138kV Maple line terminal, replacing limiting Maple substation conductor on the 138kV Hoytdale line terminal, and reconductoring approximately 11.7 miles of the Hoytdale – Maple 138kV line with 795 kcmil ACSS conductor, replacing the existing 795 kcmil ACSR conductor. The total estimated cost to perform this work is **$5,286,900**. Apply 24.99% tax gross up if applicable. The cost breakdown by upgrade is shown below in **Table 1c**. Later projects cause these overloads. Therefore, Y1-015 will have a cost allocation to these overloads and cost allocations will be given during the System Impact Study phase.

Table 1c. Reinforcements for Hoytdale – Maple 138kV Line Overload	
Reinforcement Description	**Upgrade Cost**
Reconductoring approximately 11.7 miles of the Hoytdale – Maple 138kV line with 795 kcmil ACSS conductor and replacing the existing 795 kcmil ACSR conductor	$5,155,300
Replacing the limiting Hoytdale substation conductor on the 138kV Maple line terminal	$65,800
Replacing the limiting Maple substation conductor on the 138kV Hoytdale line terminal	$65,800
Total estimated cost:	**$5,286,900**

For Item 2a, the overload of the 02SHNAGO-02MASURY 138 kV line can be relieved by replacing limiting Masury substation conductor on the 138kV Shenango line terminal and reconductoring 0.3 miles of the Masury – Shenango 138kV line with 477 kcmil ACSR conductor, replacing the existing 300 kcmil copper conductor. The total estimated cost to perform this work is **$134,500**. Apply 24.99% tax gross up if applicable. The cost breakdown by upgrade is shown below in **Table 1d**. Later projects cause these overloads. Therefore, Y1-015 will have a cost allocation to these overloads and cost allocations will be given during the System Impact Study phase.

Table 1d. Reinforcements for Shenango – Masury 138kV Line Overload	
Reinforcement Description	**Upgrade Cost**
Reconductoring approximately 0.3 miles of the Masury – Shenango 138kV line with 477 kcmil ACSR conductor and replacing the existing 300 kcmil copper conductor	$114,800
Replacing the limiting Masury substation conductor on the 138kV Shenango line terminal	$19,700
Total estimated cost:	**$3,254,300**

Contribution to Previously Identified System Reinforcements

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

Not required.

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:

Item 3a. The Y1-015 TAP-02HOYTDL 345 kV line (from bus 913100 to bus 238812 ckt 1) loads from 0.11% to 58.16% (**DC power flow**) of its rating (1719 MVA) for the single line contingency ('930_B2_B'). This project contributes approximately 1000 MW to the thermal violation.

CONTINGENCY '930_B2_B'
OPEN BRANCH FROM BUS 913100 TO BUS 239106 CKT 1 / 238812 02HOYTDL 345 239106 02SHNAGO 345 1
END

Item 3b. The Y1-015 TAP-02SHNAGO 345 kV line (from bus 913100 to bus 239106 ckt 1) loads from 0.11% to 58.16% (**DC power flow**) of its rating (1719 MVA) for the single line contingency ('930_B2_A'). This project contributes approximately 1000 MW to the thermal violation.

CONTINGENCY '930_B2_A'
OPEN BRANCH FROM BUS 238812 TO BUS 913100 CKT 1 / 238812 02HOYTDL 345 239106 02SHNAGO 345 1
END