Generation Interconnection
Feasibility Study Report
Queue Position W1-008

The Interconnection Customer (IC), has proposed a 20 MWE (7.6 MWC) solar powered generating facility consisting of ground mounted fixed panel solar arrays to be located in Accomack County, Virginia. PJM studied W1-008 as a 20 MW injection into the Old Dominion Electric Cooperative (ODEC) system at the Tasley 69kV substation. The project was evaluated for compliance with reliability criteria for summer peak conditions in 2014. The planned in-service date, as stated in the Attachment N, is December 1, 2011.

Point of Interconnection

W1-008 will interconnect with the ODEC transmission system at a tap of the Tasley-Kellam 69kV circuit.

Direct Connection Requirements

Transmission Owner Scope of Direct Connection Work

The scope of work and estimated costs for the direct connection facilities is as follows:

$250,000.00	New 69kV structures
$ 80,000.00	New Conductor
$250,000.00	Installation Labor (Line construction only)
$ 30,000.00	New 69kV switches
$ 5,000.00	New 69kV lightning arrestors
$ 10,000.00	Power quality metering (Installed on Customer CT's and VT's)
$ 30,000.00	Additional conduit/junction boxes/control wiring
$ 75,000.00	Relaying modifications line #6721 (including transfer trip)
$ 40,000.00	Engineering
$770,000.00	Total Estimated Direct Connection Cost

The total estimated construction time for the Direct Connection facilities is **24 months**.

Connection cost estimates are based on the assumptions stated in the following Direct Connection Issues section. Network impacts and associated upgrade requirements are addressed at the end of the report.

These transmission costs exclude any applicable state or federal taxes. If at a future date Federal CIAC taxes are deemed necessary by the IRS for this project, PJM, ANEC, and ODEC shall be reimbursed by the Interconnection Customer for such taxes.

Costs for extraordinary Threatened and Endangered Species, Archaeological, Cultural, or other as yet unidentified mitigation strategies are not estimated nor included in the above estimate. No environmental, real estate, or permitting issues were reviewed for the W1-008 Impact Study.

Interconnection Customer Scope of Direct Connection Work

Queue W1-008 Interconnection Customer will be responsible for the construction of all generating station facilities on the W1-008 side of the POI (Point of Interconnection) as shown on the Figure 1 one line diagram of the previous page. W1-008 Interconnection Customer is required to design, construct, and own the 69 kV line from the POI to the Customer Facility. This line must be built in accordance RUS standards or an accepted national standard, be effectively grounded, and appropriately shielded from lightning. (Refer to RUS bulletins 1728f-810 and 1724E-200.) The customer's transformer shall be connected wye-ground on the 69 kV side and delta on the low-voltage side. ODEC requires that intertie protection relaying (including provision to receive transfer trip), and supervisory control and data acquisition (SCADA) be located at the customer's 69 kV interrupting device location (POI).

Protection equipment --

The Interconnection Customer is responsible for the design and implementation of all protection equipment on the W1-008 side of the Point of Interconnection and will do so in accordance with good utility practice.

ODEC will provide sensing and a transfer trip signal to the point of interconnection for all 69 kV faults on the line from Bayview to Kellam. W1-008 will provide a non-reclosing 69 kV interrupting device at the POI beyond which ODEC protection will no longer be a primary means of interrupting fault current. W1-008 is required to provide ODEC with any information necessary to set ODEC line relaying and coordinate with their protective device, and to trip the device upon receipt of the transfer trip signal.

Metering Equipment --

Installation of revenue grade Metering Equipment will be required at the Queue W1-008 Point of Interconnection (POI). At the customer's discretion, ODEC will design and supply the required metering equipment but all the installation cost would be borne by the customer. ODEC requires that power quality metering be installed to monitor compliance with industry standards for harmonics.

The interconnection Customer is also required to provide revenue metering and real-time telemetry data to PJM in compliance with the requirements listed in PJM Manuals M-01 and M-14. At the customer's discretion, ODEC will design and supply the required telemetering equipment but all the installation cost would be borne by the customer.

Distribution Service Requirements--

The Interconnection Customer must submit a request for electric service through ANEC if back up electric service at less than 69 kV is desired.

Direct Connection Issues

W1-008 Inverter and GSU modeling

The W1-008 Interconnection Customer must provide ODEC and PJM with the transformer test reports and a model of the inverters once they are available in order to perform more detailed analyses.

W1-008 Generator Harmonic Requirements

Harmonic Voltage Requirements:

On the 69 kV system, the total harmonic distortion to the fundamental voltage wave from a single customer is limited to 1.5% of nominal. In addition, no individual harmonic component can exceed 1.0% of the fundamental system voltage.

Maximum Allowable Harmonic Voltage Distortion Table (Tariff Rule 32)		
Voltage Level	**Distortion Factor (% System Voltage)**	**Individual Harmonic (% System Voltage)**
69 kV through 138 kV	1.5	1

Harmonic current limits must comply with IEEE standard 519 (see table 10.2 and 10.3 limits for power generation). Harmonic filtering sufficient to limit harmonic current to the limits proscribed by these tables may need to be installed. W1-008 will be responsible for installing such filtering and may be disconnected until remedies are taken if these standards are violated.

Current Distortion Limits in % of 60~ Current (from IEEE 519 tables 10.2 and 10.3)						
Voltage Level	<11	11<h<17	17<h<23	23<h<35	35<h	TDD
69 kV	2.0	1.0	0.75	0.3	0.15	2.5
25 kV	4.0	2.0	1.5	0.6	0.3	5.0

W1-008 Generator Flicker Requirements

W1-008 must limit the severity of voltage variation to within a level which will not cause objectionable flicker to other customers. A voltage drop greater than 5% at the point of interconnection is not acceptable. The interconnection customer's facilities are required to be able to receive the necessary VARS during normal operation to assure that voltage does not drop below guidelines during intermittent cloud cover.

ODEC uses the General Electric flicker-irritation curve as a guideline to determine if the system is operating within acceptable limits. ODEC will require corrective actions by the W1-008 customer if their operation causes flicker that exceeds this guideline. One such correction could be the installation of static var compensators (SVC) to hold a constant voltage.

W1-008 Inverter Regulation or Reactive Support Requirements

As specified in Interconnection Service Agreement, Appendix 2, Section 4.7.1.1 of the PJM OATT (Open Access Transmission Tariff), the W1-008 generator may need to design its Facility to meet the following power factor requirement, depending on the outcome of an impact study:

"For all new wind-powered and other non-synchronous generation facilities, if determined in the system impact study to be required for the safety or reliability of the Transmission System, the Generation Interconnection Customer shall design its Customer Facility with the ability to maintain a composite power delivery at continuous rated power output at a power factor of at least 0.95 leading to 0.95 lagging."

Preliminary Schedule and Notes / Assumptions
ODEC will begin the project only after the Interconnection Service Agreement (ISA) and Interconnection Construction Service Agreement (ICSA) are fully executed and ODEC receives a written authorization by PJM to commence activities. The estimated time to complete the direct connection work is approximately 24 months after the execution of an ICSA. The 2011 requested in-service date will not be attainable. The schedule for the 69 kV transmission and substation work to accommodate W1-008 would depend on the project start date. The work to accommodate W1-008 will require transmission line outages. ODEC's outage windows for construction are typically available in the spring and fall of the year. Missing an outage window could result in project delays.

Notes / Assumptions:
During construction, if extreme weather conditions or other system safety concerns arise, field construction may need to be rescheduled, which could possibly impact the schedule plan.

Excepting any operational, governmental and/or environmental regulatory delays, the use of additional resources, such as overtime, premiums for expedited material, and/or contractor labor, may enable ODEC to decrease this construction period. It is also assumed that all right-of-way and easements are secured without impact on anticipated construction start dates.

Network Impacts

Potential transmission network impacts are 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

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)

None

Short Circuit

None

Stability Analysis

Not required due to project size.

New System Reinforcements

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

None

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project.

None

Potential Congestion due to Local Energy Deliverability

(PJM also studied the delivery of the energy portion of the surrounding generation. Any potential 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 Transmission Interconnection Request. Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full deliverability for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which analyzes all overload conditions associated with the identified overloaded element(s). As a result of the aggregate energy resources in the area, the following violations were identified:

These are not required reliability upgrades.

1. The TASLEY-PARKSLEY 69 kV line (from bus 232284 to bus 232845 ckt 1) loads from 51.9% to 77.21% (DC power flow) of its emergency rating (79 MVA) for the single line contingency ('CKT 6778'). This project contributes approximately 19.99 MW to cause the thermal violation.

2. The N_CHURCH-PINEY138 138 kV line (from bus 232131 to bus 232128 ckt 1) loads from 94.1% to 98.96% (DC power flow) of its normal rating (172 MVA) for non-contingency condition. This project contributes approximately 8.35 MW to cause the thermal violation.

3. The OAK HALL-POCOMOKE 138 kV line (from bus 232132 to bus 232130 ckt 1) loads from 101.15% to 106.76% (DC power flow) of its emergency rating (289 MVA) for the single line contingency ('CKT 13764'). This project contributes approximately 16.21 MW to cause the thermal violation.

4. The PINEY_69-M HERMON 69 kV line (from bus 232274 to bus 232272 ckt 1) loads from 105.22% to 109.4% (DC power flow) of its emergency rating (143 MVA) for the single line contingency ('CKT 23002'). This project contributes approximately 5.98 MW to cause the thermal violation.

5. The POCOMOKE-T-144 TAP 138 kV line (from bus 232130 to bus 292497 ckt 1) loads from 111.38% to 117.95% (DC power flow) of its emergency rating (247 MVA) for the single line contingency ('CKT 13764'). This project contributes approximately 16.21 MW to cause the thermal violation.

6. The T-144 TAP-COSTEN 138 kV line (from bus 292497 to bus 232807 ckt 1) loads from 115.33% to 121.89% (DC power flow) of its emergency rating (247 MVA) for the single line contingency ('CKT 13764'). This project contributes approximately 16.21 MW to cause the thermal violation.

7. The N_CHURCH-PINEY138 138 kV line (from bus 232131 to bus 232128 ckt 1) loads from 131.77% to 139.04% (DC power flow) of its emergency rating (226 MVA) for the single line contingency ('CKT 13787'). This project contributes approximately 16.42 MW to cause the thermal violation.