



# Electric System Analysis and Study

Report SL-LEWES-2019-01 Revision 1 04/07/2020 Project No.: 13968.001

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### ISSUE SUMMARY AND APPROVAL PAGE

This is to certify that this document has been prepared, reviewed and approved in accordance with Sargent & Lundy's Standard Operating Procedure SOP-0405, which is based on ANSI/ISO/ASSQC Q9001 Quality Management Systems.

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## EXECUTIVE SUMMARY

Sargent & Lundy has performed an electric system analysis of the Lewes BPW distribution system to determine the current electric system strengths, weaknesses, and recommendations for future system planning. To perform this analysis, S&L developed a CYME software model of the Lewes BPW distribution system with cases representing the current system configuration and 5 year and 10 year projections. The following conclusions and recommendations were drawn based on the results of the system modeling.

- Considering projected future system loading and EV adoption, there is expected to be approximately 1.8% margin in the MVA rating of Schley Ave Substation Transformers T1 and T2, considering a single transformer supplying the entire distribution system. S&L recommends that the BPW consider replacing the transformers within the next ten years to provide additional margin and to increase system reliability, especially considering recent gassing in Transformer T1 (per September 29, 2017 Potomac testing report). Note that the T1 transformer was repaired by tightening loose connections and recent DGA tests show no additional gassing per December 6, 2019 Potomac testing report. Because of the recent gassing issues, S&L recommends annual DGA testing of the T1 transformer to ensure there are no further issues. If no further gassing is observed over the next several years, DGA testing could be performed on a bi-annual basis.
- S&L recommends the Lewes BPW update DER interconnection procedures to limit the total connected DERs to 5 MW (including existing installations). Once the 5 MW total limit is reached, potential DER owners may request, at their expense, to pay for upgrades that would allow them to install their system. Such upgrades may include a transfer trip scheme or co-located energy storage. The currently installed DER capacity on Lewes BPW's system is 2.84MW, leaving a margin of 2.16MW available DER capacity before system upgrades are required.
- The system grounding design for the University Wind Turbine is susceptible to potentially damaging overvoltage conditions if a line-to-ground fault occurs on the 12.47 kV distribution feeder resulting in a trip of the feeder circuit breaker. S&L recommends reviewing the system design, and if necessary, installing a grounding transformer at 12.47 kV to ensure the system remains effectively grounded with the feeder circuit breaker open. This is common practice for wind farm collection system circuits.
- The system protection setpoints and interrupting capacity of the overcurrent protective devices are sufficient considering the current system configuration and future buildout including distributed energy resources.
- There are no significant thermal, voltage drop or power factor issues under current and future system loading configurations. Placing the existing voltage regulators back in service may not provide significant benefits so long as the Schley Ave Substation transformer LTCs and feeder capacitor banks are functional. S&L recommends routine testing and maintenance for the feeder capacitor banks including external fusing, switching, and controller operation to keep this critical equipment working as intended. Other than the Schley Ave Substation transformers, there are no weak links in the distribution system that would require upgrade within the next ten years.
- The CYME model does not show overloading on distribution transformers. However, due to the available metering data, the CYME model only captures the aggregate load and does not have the level of granularity necessary to determine individual pole-top and pad-mounted distribution transformer loading. S&L recommends performing loading surveys (thermal imaging) of pole-top transformers during peak system loading to evaluate loading conditions. This is especially important in areas with high levels of electric vehicles penetration.
- Based on the results of the system analysis, battery energy storage could provide significant benefits to the Lewes Board of Public Works (BPW), such as peak shaving for reduction in demand charges, system islanding to increase reliability during transmission disturbances and defer a new 69kV line build, and mitigation of reverse power flows to enable increased penetration of renewables on the system.

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- Deployment of Advanced Metering Infrastructure (AMI) and Smart Meters could also provide significant benefits to the Lewes BPW, including the potential to provide "Time-of-Use" tariffs to incentivize customers to reduce summer peaks, install behind-the-meter battery energy storage and promote EV charging during off-peak hours. AMI and Smart Meters can also provide more insight into individual customer loading and system node voltages for further improvement of system modeling.
- At this time, the costs of investing in a large capital project to facilitate the installation of a redundant 69 kV transmission line outweigh the potential benefits for Lewes.



## 1. INTRODUCTION

#### 1.1. PURPOSE

Lewes BPW has requested Sargent & Lundy (S&L) to perform an electric system analysis to determine the current electric system strengths, weaknesses, and recommendations for future system planning. The purpose of this report is to document the inputs, assumptions, approach, recommendations, and conclusions of S&L's analysis of the Lewes BPW distribution system.

#### 1.2. SCOPE

The scope of the study and modeling begins at the 69kV DEMEC metering station and extends down through the ends of the four (4) 12.47kV distribution system circuits. The scope of work includes the following:

- Development of a CYME software model of Lewes' distribution network
- Power Flow and Short Circuit Analysis of the current system configuration and 5 year and 10 year projections
- High Level Review of System Protection Coordination Considering Future Buildout
- Evaluation of System Equipment Sizing, Voltage Drop and Thermal Capacity of the Distribution Network
- Potential Impact of Increased Penetration of Electric Vehicles (EVs) and Distributed Energy Resources (DERs)
- Develop Recommendation on Deployment of Smart Grid Technologies and Battery Energy Storage Systems
- Investigate the potential addition of a second 69kV line to improve reliability, including potential routing and Tie-in Points with Delmarva Power and Light's Transmission Network



## 2. INPUTS

#### 2.1. ELECTRICAL SYSTEM DATA

The following section document the input data used to develop Lewes' distribution system electrical model in CYME version 8.2 software.

#### 2.1.1. Schley Ave Substation Transformer Ratings

Schley Ave Substation transformers T1 and T2 nameplate data was obtained via site walkdown. This information is also contained in Reference 7.1.6. The transformer data is summarized in Table 2-1 below.

Table 2-1 — Schley Ave T1 and T2 Transformer Nameplate Data

Parameter	Value
Serial	302715-00-1 (T1)
	302715-00-1 (T2)
MVA at 55°C Rise	15.0/20.0/25.0 OA/FA/FA
MVA at 65°C Rise	16.8/22.4/28.0 OA/FA/FA
HV	67000 VOLTS (DELTA)
LV	13200 VOLTS (WYE-GROUNDED)
IMPEDANCE	8.63% at 15.0 MVA (T1)
	8.53% at 15.0 MVA (T2)
De-energized Tap Changer Position	A (70600 VOLTS)
On-Load Tap Changer	+/-10%, 33 Steps

#### 2.1.2. Schley Ave Substation Circuit Breaker Ratings

The Schley Ave Substation circuit breaker nameplate data was obtained via site walkdown. This information is also contained in Reference 7.1.6. The circuit breaker data is summarized in Table 2-2 below.

Table 2-2 — Schle	ev Ave Substation	<b>Circuit Breaker</b>	Nameplate Data
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Parameter	12.47 kV Breakers	69 kV Breakers
Туре	Siemens SDV4A	Siemens SPS2-72.5-20-2
Maximum Voltage	15.5 kV	72.5 kV
Interrupting Capacity	20kA @ 13.2kV	20kA @ 72.5kV
Ampacity	1200A	1200A
Interrupting Time	5 cycles	3 cycles

#### 2.1.3. Feeder Circuit Configurations

The circuit configurations for distribution circuits #1-#4 were developed based on a combination of available GIS data and feeder circuit maps. The GIS data provided precise GPS coordinates for distribution pole locations as well as the kVA rating of pole-top transformers. Feeder circuit maps were utilized to determine the circuit configurations for both overhead and underground sections as well as the normal position of the in-line disconnect switches.

Overhead lines were modeled based on typical 15kV class overhead distribution poles with cross arm construction. Spacing between adjacent phase conductors was assumed to be 3'6" based on typical data (Ref. 7.1.15). The conductor size for each section is based on the Lewes distribution circuit maps. Typical overhead lines sizes in the Lewes distribution network are 336 kcmil ACSR and 1/0 ACSR. Underground cables were modeled based on typical 15kV class underground residential distribution (URD) cables in the CYME library. Typical underground cable sizes on the Lewes distribution system are 750 kcmil Al and 1/0 AWG AI.

The kVA rating of the pad-mounted distribution transformers is based on the underground inventory spreadsheet provided by Lewes BPW. The spreadsheet contains the location, kVA rating, connected circuit, and transformer phasing of each pad-mounted transformer.

#### 2.1.4. Available Fault Current Data

The available fault current at the Lewes metering station was provided by Delmarva Power and Light (Ref. 7.1.16). The fault current values are listed in Table 2-3 below.

Туре	Magnitude (A)	X/R
Three Phase	8,285	8.89
Line to Ground	6,630	8.29
Line to Line	7,175	8.88
Line to Line to Ground	7,998	7.38

#### Table 2-3 — Fault Current at 69kV Lewes Metering Substation

#### 2.1.5. System Loading Data

Hourly kW and kVAR loading data captured at the Lewes 69kV demarcation point was provided by DEMEC (Ref. 7.1.5). The loading scenarios considered for the power flow analysis are listed in Table 2-4 below. Note that the hourly kVAR data provided by DEMEC shows negative values for all times. It was assumed that negative represents an inductive power factor (kVARs consumed). The 2018 load duration curve is shown in Figure 2-1.

Scenario	Date/Time	Total kW	Total kVAR
Summer Peak	July 20, 2019 18:00	21,630	-2,509
Winter Peak	January 7, 2018 8:00	22,294	-650



Spring/Fall Daytime Light Load	April 14, 2019 12:00	5,894	-3,005

#### Figure 2-1 — 2018 Load Duration Curve



#### 2.1.6. Large Individual Loads

Large spot loads were modeled based on the prior distribution study report (Ref. 7.1.2). Table 2-5 identifies the large spot loaded included in the model. The kW and kVAR demand from these loads are modeled



based on the projected 2013 case in Reference 7.1.2.

No.	СКТ	Name	Location	kW	kVAR
1	1	Cape Henlopen High School	Kings Highway & Gills Neck Road	360	223
2	1	Sussex Consortium	Savannah Road & School Ln	222	138
3	1	Beebe Medical Center	Savannah Road & Beebe Ave	940	582
4	4	Beebe Medical Center	Market St & W 4th St	1089	675
5	4	Beebe Medical Center	Near Mulberry St & St Paul St	317	197
6	4	Harbor Healthcare & Rehabilitation Center	Ocean View Blvd & Canary Dr	519	322
7	3	University of Delaware	Near Park Rd & Pilottown Rd	646	400
9	2	Cape May Lewes Ferry	Cape Henlopen Dr & Cape May Lewes Ferry Entrance	307	191
10	2	SPI Pharma	Near Cape Henlopen Dr & Engineer Rd	752	466

#### Table 2-5 — Large Individual Customer Loads

#### 2.1.7. 12.47kV Feeder Capacitor Banks

Distribution circuit capacitor bank kVAR sizes and locations were provided by the Lewes BPW. The following table lists the location and size of each capacitor bank included in the model. These capacitor banks are modeled as fixed. Additionally, it is assumed that the kVAR size is the individual pack size (i.e. kVAR per phase) based on initial power flow results and DEMEC metering data. The DEMEC metering data shows an average power factor of approximately 0.94, with a maximum kVAR demand of approximately 4,800 kVAR. Additionally, the DEMEC metering data shows the power factor is maintained above 0.975 when system loading is greater than 12,500kW. This demonstrates the capacitor banks are coming online when needed. Therefore, all capacitor banks are assumed to be operational for the CYME analysis.



No.	СКТ	Location	kVAR/phase
1	1	Schley Ave (outside substation)	200
2	1	Savannah Road & Jefferson Ave	200
3	1	Near Wellfield Site	200
4	2	Cedar St (Near Ferry Landing)	60
5	2	Cedar St (Near Barcroft Site)	200
6	3	Front St & Carpenter St	100
7	3	Cedar St & Camden Ave	50
8	3	Bay Ave & Connecticut Ave	100
9	3	Pilottown Rd (Near University)	200
10	3	Pilottown Rd (Near University)	50
11	3	Pilottown Rd (Near University)	50

#### Table 2-6 — Distribution Feeder Capacitor Banks

#### 2.1.8. Distributed Energy Resources (DERs)

Existing Distributed Energy Resources on the Lewes system include a 2.0 MW university wind installation, an approximately 163.2kW Library Solar PV installation and 78 home rooftop solar PV installations (total of approximately 844kW). The 2.0 MW wind turbine was modeled directly in the CYME model based on available drawings. The 78 home rooftop solar installations were assumed to be captured in the system-level metering data provided by DEMEC. Sensitivity studies are performed using the CYME model to determine impacts of potential future DER installations.

#### 2.2. LEWES, DELAWARE POPULATION DATA

The US Census Bureau estimates the 2018 population of Lewes, DE as 3,233 (Ref. 7.1.1). This data is used to approximate future scenarios for electric vehicles and rooftop solar PV installations. The total number of meters for Lewes BPW is approximately 3300 residential, 50 industrial, and 400 commercial.



## 3. ASSUMPTIONS

#### 3.1. ASSUMPTIONS NOT REQUIRING VERIFICATION

- 3.1.1. This analysis assumes feeder loading is balanced across the three phases. The historical loading data is given on a three-phase basis and no information was available regarding the connected phasing of the distribution transformers. Because the distribution circuits are relatively short, significant levels of voltage unbalance are not expected. S&L recommends that the BPW capture per-phase loading data at the feeder level and record connected phasing of distribution transformers to enhance the system model in the future.
- 3.1.2. The connected kVA method is applied for feeder load allocation. This method assumes the distribution transformers are loaded proportional to the ratio of the total feeder loading (as measured at the feeder breaker) to the connected kVA. This method accounts for voltage drop along the feeder, line losses, and feeder capacitor banks. During the load allocation process, the large loads discussed in Section 2.1.6 are locked and all capacitor banks are assumed to be online.
- 3.1.3. Average annual load growth is assumed to be 1%. The prior analysis conducted in 2005 considered average annual growth at 2.7% (Ref. 7.1.2). This resulted in a projected system peak load of 24.4 MW in 2014. However, Delmarva metering data for 2019 shows a peak load of approximately 22.3MW. Recent improvements in energy efficiency have caused load growth to remain relatively flat over the previous decade, but load growth is expected to resume at a rate of approximately 1% per year over the next 30 years (Ref. 7.1.3). Note these load growth projections do not include electric vehicle adoption as these are considered separately in this analysis (see Section 3.1.4).
- 3.1.4. Typical electric vehicle charging profiles (shown in Figure 3-1) are assumed based on recent study work performed by NREL for Columbus, Ohio. The profiles are generated based on typical driving patterns in Columbus, Ohio area for battery electric vehicles with a range of 100 and 250 miles (BEV100 and BEV250, respectively) and for a Sports Utility Vehicle (SUV) style BEV with a range of 250 miles (BEV250SUV). This data set is based on an average daily vehicle driving distance of approximately 20 miles, which is assumed to be conservative for the Lewes area. Charging is assumed to take place utilizing a mix of Level 1 (L1) 1.4kW and Level 2 (L2) 3.6kW chargers located in homes and public places. A small percentage of Direct Current Fast Chargers (DCFC)-150kW is also included. The estimated mix of electric vehicles in the Lewes area is assumed at 20% BEV100, 50% BEV250 and 30% BEV250SUV.



#### Figure 3-1 — Battery Electric Vehicle Aggregate Charging Load (Ref 7.1.4)

This document contains information that is confidential and proprietary to Sargent & Lundy, LLC, (S&L). It shall not be reproduced in whole or in part or released to any third party without the prior written consent of S&L. Copyright S&L 2020; all rights reserved. 3.1.5. Typical daily rooftop solar PV generation output profiles (shown in Figure 3-2) are assumed based on recent measurement data captured by S&L on a project in nearby New Jersey. Three typical seasonal profiles are utilized in this analysis –summer, spring/fall and winter. It is also assumed the typical rooftop PV array has an output AC power of 9kW based on existing installed residential solar.



Figure 3-2 — Rooftop Solar PV Output

3.1.6. The minimum interrupting rating of the distribution overcurrent protective devices is assumed to be 10kA. Based on Input 2.1.2, the 15.5kV Class circuit breakers at the Schley Ave Substation are rated 20kA. Based on Reference 7.1.14, the preferred interrupting rating of Class A expulsion fuses rated 7.8 kV to 8.3 kV (line-to-ground) is 10 kA.

#### 3.2. ASSUMPTIONS REQUIRING VERIFICATION

None





## 4. METHODOLOGY AND ACCEPTANCE CRITERIA

#### 4.1. SYSTEM MODELING AND ANALYSIS METHODOLOGY

CYME Power Engineering Software was used to model the Lewes 12.47 kV distribution system in detail. The model contains a representation of the following components:

- Thevenin equivalent sources to represent the 69kV transmission system at the DEMEC demarcation point
- Approximately 1.5 miles of 69 kV overhead line from the DEMEC demarcation point to the Schley Ave Substation
- Two-winding transformer models to represent the 67 kV/13.2 kV step-down transformers T1 and T2 at Schley Ave Substation. The models include the OLTC and associated controls.
- A model of the main 3-phase distribution feeder cables and overhead lines to capture the resistance, reactance, and capacitance of each line and cable section.
- Feeder circuit breakers
- Capacitor banks
- Spot loads to represent large customer loads
- Spot loads to represent individual distribution transformers
- Existing Distributed Energy Resources

The CYME software solver was used to compute the power flows and fault flows in the system for various system configurations.

#### 4.1.1. Steady State Thermal Loading and Feeder Voltage Profile

A steady state power flow analysis is performed for both light loading and heavy feeder loading conditions, for existing system conditions and expected future conditions considering potential load growth and DER additions. The primary concerns are high voltage under light feeder loading when the Solar PV plant is at maximum output, and thermal overloads under heavy feeder loading conditions.

#### Acceptance Criteria:

- The feeder voltages should be maintained between 114V and 126V (0.95pu to 1.05pu) per Reference 7.1.8.
- Schley Ave Substation Transformers T1 and T2 should be loaded to less than or equal to their top 65°C rating of 28 MVA. Note that an outage of one transformer is also considered for transformer loading.



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- Distribution line and cable loading should be less than the conductor/cable ampacity rating. CYME software is set to automatically alert based on the following typical ampacity ratings (Ref. 7.1.15). Overhead line ampacities are based on a 40°C ambient temperature with 2 ft/sec cross wind. Underground cable ampacities consider direct buried cable in a triplex arrangement with 90°C conductor temperature, 25°C ambient earth temperature, and typical soil thermal resistivity of 90°C-cm/W.
  - o 336 kcmil ACSR Overhead Line 430 A
  - o 1/0 ACSR Overhead Line 199 A
  - o 1/0 Al Cable 193 A
  - o 750kcmil Al Cable 547 A

#### 4.1.2. Available Short-Circuit Duty

The CYME ANSI short-circuit module is used to evaluate the available fault duty throughout the system to ensure the interrupting capabilities of the distribution overcurrent protective devices (e.g. fuses, breakers, reclosers) are not exceeded.

Acceptance Criteria:

• The available fault duty should not exceed 90% of the equipment interrupting ratings. Per Assumption 3.1.6, the minimum interrupting rating of any distribution overcurrent protective device is 10kA. Therefore, an available fault current of 9kA or less is considered acceptable.

#### 4.2. DISTRIBUTED ENERGY RESOURCE IMPACT

The CYME system model is also used to evaluate the impact of existing and potential future DER installations on the distribution system. In addition to the above criteria for short-circuit, steady-state power flows and voltage regulation, the model is used to evaluate potential DER impacts on Voltage Flicker, Mechanical Controls, Reverse Power Flow, and System Protection. The methodology and criteria for each of these conditions is discussed in the following sections.

The DER impact evaluation considers the exiting University Wind Turbine, the existing Library Solar PV, a proposed 2 MW solar plus 1 MW storage located near the Wellfield site, a proposed 8 MW battery located adjacent to the Schley Ave Substation, and approximately home 80 rooftop PV installations (approximately 800kW total). The rooftop PV arrays are modeled as four lumped 200kW PV arrays, with one 200kW array connected to each of the four distribution circuits. Table 4-1 summarizes the individual distributed energy resources modeled in CYME for the evaluation.

No.	СКТ	Description	Total kW
1	1	University Wind Turbine	2000
2	1	Library Solar	163.2
3	1	Wellfield Solar + Storage	3000
4	*	Schley Ave Substation Battery	8000
5	1	Circuit #1 Aggregate Rooftop PV	200
6	2	Circuit #2 Aggregate Rooftop PV	200
7	3	Circuit #3 Aggregate Rooftop PV	200
8	4	Circuit #4 Aggregate Rooftop PV	200

#### Table 4-1 — Distributed Energy Resources

#### 4.2.1. Voltage Flicker

The distribution system power flow model is used to conduct a voltage flicker analysis for both light loading and heavy feeder loading conditions to determine the change in voltage associated with a change in real power output of the DER generation. In these simulations, the output of all DERs is adjusted from zero to maximum output and vice versa while the substation transformer OLTC is fixed. This represents a rapid change in DER generation output (e.g. due to intermittent cloud cover), which occurs faster than the feeder voltage regulating equipment can respond.

Acceptance Criteria:

 The change in voltage (ΔV) anywhere along the feeder due to a rapid change in PV generation output from zero to maximum generation (and vice versa) should be less than 3% (or 3.6V on a 120V basis) based on IEEE 1453 Table 3 planning limits for rapid voltage changes in medium voltage systems (Ref. 7.1.9).

#### 4.2.2. Impact to Mechanical Controls

The voltage flicker cases are also analyzed to determine the potential for mechanical operation of the substation transformer OLTC. The operation of mechanical controls is analyzed by monitoring the change in voltage at the controlled nodes (i.e. the substation 12.47kV bus) to determine if the magnitude of the voltage change may result in operation of the substation transformer OLTC.

Acceptance Criteria:

 The change in voltage (ΔV) at the substation 12.47kV bus due to a change in DER output from zero to maximum generation (and vice versa) should not result in more than 1 tap change on the main distribution transformer.



#### 4.2.3. Potential for Reverse Power Flow

The annual load duration curves are analyzed to determine the potential for reverse power flow back into the 69kV system under varying levels of DER penetration.

#### 4.2.4. Impact to System Protection

The CYME fault flow module is utilized to evaluate the impact of existing and potential future DER installations on the existing system protection. The module is used to observe the feeder breaker and currents for an end of line fault for cases with the DER generation on. The protective device currents are compared to the circuit breaker relay and recloser pickup setpoints.

Acceptance Criteria:

• The fault flows through the feeder overcurrent protective devices for an end of line fault with the DERs online should be greater than the feeder circuit breaker pickup settings such that all faults will be detected and cleared.



## 5. SOFTWARE

#### 5.1. SOFTWARE CODES

CYME Power Engineering Software version 8.2, rev 2 (S&L program number 03.7.070-8.2.2) was used to perform this analysis. The cases were executed on S&L Computer DEAW114 in Windows 10 Enterprise operating system.

#### 5.2. INPUT AND OUTPUT FILES

The CYME model case files are listed in Table 5-1 below

File Name	File Time	File Size (kb)	Date
4/7/2020	10:39 AM	7,832	LEWES_BPW.mdb
4/6/2020	8:34 AM	2,037	LEWES_CKT.xst
4/7/2020	10:31 AM	2,342	LEWES_SUMMER_2019.xst
4/6/2020	8:47 AM	2,645	LEWES_SUMMER_2024.xst
4/6/2020	8:55 AM	2,944	LEWES_SUMMER_2024_10EV.xst
4/6/2020	9:05 AM	3,243	LEWES_SUMMER_2024_30EV.xst
4/6/2020	8:50 AM	2,948	LEWES_SUMMER_2029.xst
4/6/2020	9:10 AM	3,252	LEWES_SUMMER_2029_30EV.xst
4/7/2020	9:57 AM	3,551	LEWES_SUMMER_2029_50EV.xst
4/7/2020	10:39 AM	2,052	LEWES_CKT_WINTER_2019.xst
4/6/2020	8:36 AM	2,341	LEWES_CKT_WINTER_2024.xst
4/6/2020	8:39 AM	2,644	LEWES_CKT_WINTER_2029.xst

#### Table 5-1 — CYME Model Files



## 6. RESULTS AND RECOMMENDATIONS

#### 6.1. SYSTEM MODELING RESULTS

#### 6.1.1. System Power Flow and Short Circuit Results

The CYME model single line diagrams and input data reports are shown in Appendix A. The model results are documented in Appendix B. The load flow and short circuit results are summarized as follows:

- There is sufficient margin in the interrupting capacity of the distribution overcurrent protective devices. The available three phase fault current at Schley Ave Substation's 12.47kV main bus is approximately 6kA and the available line to ground fault current is approximately 6.4kA. Sensitivity analysis with the CYME model indicates an additional 25MVA of inverter-based generation could be added to the system without exceeding the 9kA acceptance criteria for available fault current.
- No significant voltage drop or thermal overloads were identified in the CYME model under current system loading configurations. The voltage drop results indicate that placing the existing voltage regulators back in service may not provide significant benefits as the voltage regulation at downstream nodes is sufficient without the regulators in service.
- A review of the DEMEC metering data shows an average power factor of approximately 0.94, with a maximum kVAR demand of approximately 4,800 kVAR. Additionally, the DEMEC metering data shows the power factor is maintained above 0.975 when system loading is greater than 12,500kW. This demonstrates the feeder capacitor banks are coming online when needed. S&L recommends routine testing and maintenance for the feeder capacitor banks including external fusing, switching, and controller operation to keep this critical equipment working as intended. Additionally, the capacitor controller setpoints should be cataloged for future enhancement to the CYME model. Routine testing and maintenance of the feeder capacitor banks could provide the benefit of limiting power factor charges incurred.
- The 2019 peak load was approximately 22.3MW. Ten-year load growth projections show the peak load increasing to 27.5 MW considering 1% average annual load growth plus 50% household EV adoption (approximately 1600 EVs). The top 65°C rating of the two transformers is 28MVA, which gives approximately 1.8% margin considering a single transformer supplying the entire distribution system. S&L recommends that the BPW consider replacing the transformers within the next ten years to provide additional margin and to increase system reliability, especially considering recent gassing in Transformer T1 (per September 29, 2017 Potomac testing report). Note that the T1 transformer was repaired by tightening loose connections and recent DGA tests show no additional gassing per December 6, 2019 Potomac testing report. Because of the recent gassing issues, S&L recommends annual DGA testing of the T1 transformer to ensure there are no further issues. If no further gassing is observed over the next several years, DGA testing could be performed on a biannual basis.
- For future enhancement to the system model, S&L recommends capturing the phasing connectivity of individual pole top and pad-mounted transformers in the Lewes GIS database. This would allow future modeling efforts to quantify the impact of potential unbalance in system loading.

#### 6.1.2. Impact of Future Electric Vehicle (EV) and DER Penetration

Attachment C contains future projections of the daily peak winter and summer loading profiles considering increased penetration levels of EVs and rooftop PV. Table 6-1and Table 6-2 detail the scenarios considered



for different levels of electric vehicle and solar PV penetration.

#### Table 6-1 — Electric Vehicle Penetration Level Scenarios

EV Penetration Level	BEV100	BEV250	BEV250SUV	Total Number of EVs
10%	66	165	99	330
30%	198	495	297	990
50%	330	825	495	1,650
75%	495	1,237	743	2,475

Note: BEV100 is a 100-mile range EV, BEV250 is a 250-mile range EV and BEV250SUV is a 250-mile range SUV style EV.

PV Penetration Level	# of Homes	Total kW Solar PV
10%	330	2,970
30%	990	8,910
50%	1,650	14,850
75%	2,475	22,275

#### Table 6-2 — Solar PV Penetration Level Scenarios

From the results in Appendix C, it can be observed that Summer Peak loading is expected to increase significantly with increasing levels of EV penetration. The daily loading profile for the Summer Peak shows the peak occurs at approximately 6pm, which coincides with the peak time of day for electric vehicle charging. The existing summer peak load is approximately 21.4 MW. This is projected to increase to approximately 23.5MW with 30% EV penetration, and to 25.9 MW with 50% EV penetration. Considering an additional 1% average annual load growth (in addition to EVs) over the next 10 years, the summer peak is projected to be approximately 26.1MW with 30% EV penetration, and 27.5 MW with 50% EV penetration. The addition of solar PV generation does not provide significant reduction in the summer peak load due to the time of day at which the peak occurs. For a sunny day in the summer, the typical solar PV output is only approximately 30% of maximum output kW at 6PM and 10% of maximum output kW by 7pm.

The Winter Peak loading is not expected to increase significantly with increasing levels of EV penetration. Existing daily peak loading profiles for winter show the peak load occurs at 8am, whereas most electric vehicle charging is expected to occur in the evening. Based on the forecasts, it is expected that the winter peak loading will be eclipsed by Summer Peak loading with increased levels of EV penetration.

The Spring Light Load case shows that there is a potential for reverse power flow back into the 69kV system, based on total DER generation output levels of 6 MW. Considering the existing 2.0 MW University Wind Site and the 163.2kW Library Solar site, this leaves a margin of 3.8 MW of additional DERs on the Lewes

system. This would equate to approximately 425 rooftop PV installations (averaging 9kW each) or three to four additional large-scale commercial installations similar in size to the University Wind project. To ensure there is no reverse power flow into the DPL system, S&L recommends the Lewes BPW update interconnection procedures to limit the total connected DERs to 5 MW (including existing installations). Once the 5 MW total limit is reached, potential DER owners may request, at their expense, to pay for upgrades that would allow them to install their system. To mitigate reverse power flow, upgrades such as a transfer trip protection scheme or co-located energy storage.

The acceptance criteria for rapid voltage changes and operation of mechanical controls due to change in DER output is only violated in the extreme case considering a 100% coincident change in all existing and proposed DERs (wind, solar, and battery) on the 12.47kV system with all four circuits supplied by a single transformer in Schley Ave Substation. The results are within the acceptance criteria for all other cases including the normal system configuration with two Schley Ave Substation transformers in service. Therefore, the results for DER impact on voltage flicker and mechanical controls are considered acceptable.

Short-circuit simulations with distributed energy resources connected on the feeders show minimal impact to the distribution system protection. An extreme case was considered with an 8 MW DER located at the Wellfield Site. This case shows only an approximately 4% reduction in reach in the phase protection on Feeder 1 and approximately 7% reduction in reach in the ground protection on Feeder 1. The end of line fault current was still well above the pickup settings of the feeder overcurrent relay.

A review of the system single line drawings for the University Wind Turbine shows that the wind turbine is not connected as an effectively grounded source as viewed from the 12.47 kV distribution system. The wind turbine generator step-up transformer is delta-connected (ungrounded) at 34.5 kV. Additionally, the 12.47 kV/34.5 kV transformer is connected wye-grounded/wye-grounded with no delta-connected stabilizing winding to provide a reference to ground. The only ground reference on the distribution circuit is the Schley Ave Substation transformer, which would be lost if the distribution feeder breaker is opened. This configuration is susceptible to potentially damaging overvoltage conditions if a line-to-ground fault occurs on the 12.47 kV distribution feeder resulting in a trip of the feeder circuit breaker. Once the feeder breaker is opened, the ground reference provided by the Schley Ave Substation transformer is lost. The wind turbine will continue to supply the fault after the feeder breaker is opened until its own internal protection operates. During this time when the feeder breaker is open and the turbine is still operating, the system is ungrounded and the un-faulted phase voltages may rise to 173% of nominal, which could damage phase-to-ground connected equipment such as lightning arresters and single-phase transformers. Based on this concern, S&L recommends reviewing the University Wind turbine transformer connections and grounding to confirm the installed condition matches the single line diagram. If the system is not effectively grounded, consistent with the single line, it may be necessary to install a grounding transformer at 12.47 kV to ensure the system remains effectively grounded with the feeder circuit breaker open. It is common practice to utilize feeder grounding transformers within wind farm collection system circuits.

Effective grounding is not as significant a concern with inverter-based resources (e.g. solar PV, battery energy storage) as it is with rotating resource such as wind turbine generators. This is because inverterbased resources are current limited and can employ control schemes to provide fast detection and interruption upon sensing an overvoltage condition. However, S&L recommends reviewing the neutral grounding on potential future large DER installations to ensure it coordinates with the normal system neutral grounding design and ground fault protection for all modes of operation including grid-tied and islanded.

#### 6.2. BATTERY ENERGY STORAGE SYSTEM DISCUSSION

The application of utility grade Battery Energy Storage (BES) on the T&D system is a major development in the utility energy market which impacts the design and operation of the power grid. The energy market is transitioning to a distributed generation model with the rapid deployment of low carbon technologies such as

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wind, solar and battery storage. Energy storage is a major solution to meet the carbon reduction and renewable energy targets being set by states, government entities and utilities.

The deployment of battery energy storage as a distributed energy resources with intelligent control systems coordinated and internet enabled software provides the grid operator an opportunity to optimize the dispatching of generation and manage the demand on T&D assets.

Utility grade Battery Energy Storage provides the capability to store excess energy when available from the grid and release it when it is required into central, decentralized and off-grid systems. The managed deployment of battery energy storage can have the following significant benefits for the utility grid operator:

- Defer upgrade of T&D infrastructure driven by peak demand
- Relieve congestion in the delivery of power at periods of high demand
- Enhance voltage and frequency regulation
- Provide local energy reserve and energy solutions to remote locations and communities
- Improve reliability
- Source of backup power for blackout event recovery in areas subject to severe weather.
- · Storing energy produced from renewable sources that otherwise could not be injected into the grid
- Delivering substantial annual electricity cost savings (T&D losses, reduce rolling reserve capacity)
- Stabilizing the electric grid at the transmission and distribution levels improving its working conditions, extending its capabilities and making it more secure

Battery Energy Storage can be linked with the deployment of solar and wind energy sources when added to facilities, as a development of an energy park that is connected to the utility grid or as a standalone facility. FERC Order 841 directed regional grid operators to remove restrictions on market participation for battery energy storage in the wholesale market. Order 841 created a clear path and framework for storage resources to operate in all wholesale electric markets. There has been serious growth in the capacity, energy and ancillary services markets for participation by energy storage as well as a change in the owners and operators of those facilities.

#### 6.2.1. High Level BES Market Overview

**Ancillary Services** – Essential support services needed to keep the electric grid running efficiently. These include services such as spinning reserves, frequency regulation, and black start. Duration of operation of the battery system is typically seconds up to minutes.

**Ramping** – The action of rapidly increasing or decreasing power to align supply with demand. Duration of operation of the battery system is within 30 minutes.

**Smoothing** – The ability to smooth out intermittent power output especially in regard to the integration of intermittent renewable energy, such as wind and solar resources. Duration of operation of the battery system is anywhere from one to four hours.



**Peaking** – Supplying extra power to the grid during times of peak demand. Duration of operation of the battery system is two to four hours.

**Capacity** – The ability of a system to store excess power to be called upon during critical grid demands. This system represents a commitment of resources to deliver when needed. Duration of operation of the battery system is four hours.

**Energy** – real-time (5 minute forward) and near-term (day ahead) markets which allows for the sale or purchase of energy in an ISOs market. Duration of operation of the battery system is one to four hours.

The deployment of BES technology as a meaningful asset for regulation of voltage and frequency at the T&D level. In addition, Energy Storage systems can be used for T&D deferral or T&D asset optimization, either as a centralized or distributed resource on the grid. Asset optimization deals with ensuring that transmission and/or distribution lines, substations and/or switchyards and other electrical equipment have the capacity to handle peak demand and maximize reliability. Installation of an energy storage system are often an alternative implemented to delay investing in new infrastructure such as feeder lines and substations or replacements or upgrades/relocation to underground to improve reliability. Energy Storage facility, when located at key nodal locations, can address load growth and rising peak demands, congestion of the grid and reliability issues. In addition to the ability to support the grid, energy storage projects when co-located with existing substations can minimize the challenges that come with constructing large scale projects, such as local community impacts/concerns, permitting and real estate challenges, schedule constrains with design and construction, rising costs to build new infrastructure in urban and remote areas, and uncertainty with future load growth and demand patterns.

Navigant Research indicates that the global installed energy storage power capacity for T&D deferral is expected to grow from 331.7MW in 2017 to over 14,000MW in 2026. The 2019 Lazard Unsubsidized Levelized Cost of Storage for Transmission and Distribution for In Front of the Meter applications ranges from \$353 - \$598 per kWh for 10MW/60MWh systems and for smaller behind the meter standalone systems the cost ranges from \$242 - \$521 per kWh for 1MW/2MWh systems.

#### 6.2.2. Potential Benefits of Battery Energy Storage at Lewes

Based on the results of the system analysis, utilizing battery energy storage to perform peak shifting would provide significant benefit to the Lewes Board of Public Works. The summer peak occurs between 5pm-7pm. From the figures in Appendix C, the summer peak is projected to get worse with increased adoption of EVs. The winter peak typically occurs at 8am. Solar PV will not help to reduce peak loading at these times. Energy storage could be dispatched to discharge at peak times to lower overall peak demand and reduce demand charges.

An additional benefit of battery energy storage is the potential to enable increased penetration of DERs on the Lewes Distribution System. Based on the DER impact study results, there is only margin for 3.8 MW of additional DERs on the Lewes system before potential reverse power flow issues are experienced. This would equate to approximately 425 rooftop PV installations (averaging 9kW each) or three to four additional large-scale commercial installations similar in size to the University Wind project. To provide additional capacity for renewable resources on the network, battery energy storage could be applied such that the battery is charged whenever there is high renewable output coincident with light loading. This could be accomplished by monitoring the power flow on the 69kV bus at Schley Ave Substation.

The optimal location for battery energy storage is near Schley Ave Substation. Locating storage near the substation minimizes overall system losses and impact on the distribution network. This location also provides the highest capacity for energy storage given that a dedicated circuit (or circuits) could be run directly to the battery site. The only drawback of locating energy storage near the substation is that it may

require the installation of additional controlled switches on the distribution network in order to island the system. For example, if the battery did not have enough capacity to supply the peak load, a load shedding scheme would need to be implemented to disconnect non-critical loads.

The Wellfield site is also well suited electrically for energy storage. The distribution circuit is double circuit 336kcmil ACSR to Schley Ave Substation so there is roughly 800A (17MVA) of capacity for discharging. In addition, Circuit #1, which runs by the Wellfield site, supplies several critical loads including the Beebe Medical Center, Cape Henlopen High School, Sussex Consortium, and Shields Elementary School. An additional benefit of energy storage on Circuit #1 would be the potential capability to island the circuit in the event of an outage to the 69kV line. Approximately 7-8MW of storage would be needed to serve the peak load of Circuit #1 with margin for future load growth. Alternatively, a smaller battery in combination with a load shedding scheme could be used to island critical portions of Circuit #1.

Figure 6-1 show an example islanding scheme for Circuit #1 considering a battery energy storage system connected to the spare 52-5 circuit breaker position, with the battery located near the Schley Ave Substation. Note for simplicity, the 15kV transfer bus is not shown. To island Circuit #1, circuit breakers 52-T1 and 52-2 are opened (green) and 52-1 and 52-5 are closed (red). To automatically island upon a loss of voltage at the 12.47kV bus, the following upgrades would be required at Schley Ave Substation:

- Installation of new circuit breaker in spare 52-5 position
- Upgrades to feeder breaker relay and 69kV transformer relay to devices capable of implementing custom logic high-speed communication (e.g. SEL-400 series)
- Installation of fiber communication loop between feeder breaker relays and transformer relays
- Installation of new 69kV VT to detect when 69kV system has been restored
- For capability to island feeder Circuits #3 and #4, replace existing GOAB bus-tie switch with motoroperated switch or circuit breaker.

Additional logic could be programmed into the system to provide the capability to supply multiple load feeders based on the pre-fault feeder loading and battery state of charge. Note that if the battery energy storage system was tied into existing spare feeder circuit breaker #5, the GOAB but-tie switch would need to be upgraded to a motor-operated switch to provide capability for remote operation.

Note that because Transformers T1 and T2 do not have secondary-side circuit breakers, the islanding scheme must consider energizing these transformers from the secondary side. This could be accomplished by using the battery energy storage system inverters to slowly ramp up the output voltage to limit the transformer inrush current.





#### Figure 6-1 — Example BESS Islanding Arrangement for Schley Ave Substation

#### 6.3. SMART METER DEPLOYMENT

Advanced Metering Infrastructure (AMI) and Smart Meters: AMI is the utility abbreviation for Advanced Metering Infrastructure. AMI is comprised of an entire information network (commonly referred to as the "Smart Grid") including Smart Meters on customer houses, communications to and from a utility, and even communication to devices within a customer's home. It provides customers with the ability to use electricity more efficiently and provides utilities with the ability to detect problems on their systems and operate them more effectively. This Smart Grid will facilitate incorporation of renewable energy, and it will be more decentralized than the traditional grid.

#### 6.3.1. The Overall Vision of the Smart Grid

The following excerpt was taken from the report "The Smart Grid: An Introduction" created by the Litos Strategic Communications for the Department of Energy:

**Intelligent** – capable of sensing system overloads and rerouting power to prevent or minimize a potential outage; of working autonomously when conditions require resolution faster than humans can respond, and cooperatively in aligning the goals of utilities, consumers and regulators

Efficient - capable of meeting increased consumer demand without adding infrastructure

**Accommodating** – accepting energy from virtually any fuel source including solar and wind as easily and transparently as coal and natural gas; capable of integrating anyand all better ideas andtechnologies–energy storagetechnologies, for example – as they are market-proven and ready to come online



**Motivating** – enabling real-time communication between the consumer and utility so consumers can tailor their energy consumptionbased on individual preferences, like price and/or environmental concerns

**Opportunistic** – creating new opportunities and markets by means of its ability to capitalize on plug-andplay innovation wherever and whenever appropriate

**Quality-focused** – capable of delivering the power quality necessary – free of sags, spikes, disturbances and interruptions – to power our increasingly digital economy and the data centers, computers and electronics necessary to make it run

**Resilient** – increasingly resistant to attack and natural disasters as it becomes more decentralized and reinforced with Smart Grid security protocols

"**Green**" – slowing the advance of global climatechange and offering a genuine path toward significant environmental improvement

Security of this data is paramount. The data transmitted over the Smart Grid's wireless network and through the associated systems must be secured by encryption techniques. Lewes BPW's internal applications, where various forms of customer related data are stored, must be password protected.

A Smart Meter is an electronic meter that is installed in place of current electro-mechanical meters at homes and businesses. It enables two-way communications between a customer and utility. Smart Meters can record and store information about electricity usage on specified intervals, for example, hourly or increments of 15 minutes, and transmit this information periodically back to the utility.

According to the US Energy Information Administration, in 2018, there were almost 87 million electric customers of the 150 million US electric customers (58% of the all US electric customers) that have Smart Meters. In Delaware, over 60% of the residential customers have Smart Meters.

Note: Delmarva Power & Light, the largest investor-owned electric and gas utility in Delaware, began implementing Smart Grid/Smart Meter technology across their entire customer base in 2009.

#### 6.3.2. Benefits of Implementing Smart Grid Technology

#### 6.3.2.1. Benefits to Customers with Smart Meters

- Faster response to customers, Turn-On/Turn-Off requests enabled by remote capability.
- Reduced need to enter a customers' home, meters can be read remotely.
- Improved accuracy of billing: Smart Meters will help prevent estimated bills and ensure more accurate billing.
- Information for customers: Smart Meters will provide customers with detailed information through their online account about their hourly, daily and peak energy usage. This will allow them to make more informed decisions in controlling their energy use and costs.
- Improved customer service: Smart Meters will assist the Lewes BPW to better serve customers because representatives will have more complete information about the customer and their electric use patterns.

• Improved ability to restore service during outages: Smart Meters will assist the Lewes BPW to immediately identify loss of power as opposed to waiting for the customer to call the company.

#### 6.3.2.2. Benefits to the Lewes BPW

- Potential to provide "Time-of-Use" tariffs capable of incentivizing customers to reduce summer peaks. This tariff may also increase the opportunity for customers to consider installing battery storage.
- Promote EV charging on "off-peak" hours with the established Time-of-Use tariff.
- Capable of capturing individual customer loading in order to improve system modeling and maximize/optimize distribution transformer loading. This becomes especially critical as EV's proliferate.
- Capable of capturing node voltages for better insights to load-side potential voltage losses or power quality issues.

## LEWES BPW - AMI METERING COSTS

#### 6.3.3. Cost Estimate DESIGN Inputs

Service territory of Lewes BPW – 4.72 sq. miles.

Number of meters in Lewes BPW's territory - 3750

Number of residential class meters - 3300

Number of commercial & industrial class meters - 450

#### 6.3.3.1. AMI METERING – PER UNIT COSTS

The following information was collected from a national AMI system integrator, who also presently provides electric system components to Lewes BPW. The information below are conservative estimates demonstrating the average per unit costs for a new AMI system of Lewes BPW's size.

This AMI system Integrator is on the approved list of NISC (see the attached NISC approved list of vendors included in Appendix D). Their AMI system can be integrated into all of Lewes BPW's customer/metering/operational data systems. This interface can be accomplished without significant additional cost from NISC. This is reflected in the costs below.



Туре	Cost
Cost for material/installation/integration of all network mesh equipment, and replacing all existing electric meters	\$200/meter
Cost for new AMI meters with the network card installed (residential class meters)	\$125/meter
Cost for new AMI meters with the network card installed (commercial & industrial class meters)	\$250/meter
Cost from NISC for software and integration support for Lewes BPW's new customer information system	\$50,000(one time)
Monthly recurring Vendor fee to backhaul data, maintenance of system, etc.	\$2/meter/month
Monthly recurring NISC fee for maintenance	\$1,000/month

#### 6.3.3.2. AMI METERING – TOTAL & RECURRING COSTS

Based on the above information, the following table summarizes the estimated fixed and recurring costs incurred by Lewes BPW for implementing an AMI infrastructure in their electric system.

Туре	Total Cost
Network Components and all Labor Costs - 3750 meters @ \$200/meter	\$750,000
AMI Meter Costs – 3300 residential meters @ \$125/meter	\$412,500
AMI Meter Costs – 450 commercial & industrial meters @ \$250/meter	\$112,500
NISC cost for software and support	\$50,000
Total Fixed Cost	\$1,325,000
Total Recurring Cost – 3750 meters @ \$2/meter/month + \$1000 x 12 months	\$19,500/month

Additional fixed costs may be applicable as the number of customers and service territory expands at projected growth rate.

Without being aware of actual charges paid to DEMEC by Lewes BPW, an exact cost savings/benefit plan is not included in the report and the above tables reflect a baseline cost as a starting point.

#### 6.3.3.3. AMI METERING - RECOMMENDED NEXT STEPS

The technology has seen significant improvements and cost reductions since 2006, when California first began installing smart meters across the state. There is now significant benefit in implementing this technology by every utility across the country.

The cost information provided above is a comprehensive base line on fixed initial costs and annual recurring

costs to implement a full AMI system for Lewes BPW. These initial costs will provide Lewes all the data (amperage, voltage, Kilowatts, Kilovars, kwhrs/kw demand every 15 minutes, meter status, etc.) needed to manage Lewes' system more efficiently and effectively. This data needs to be integrated with Lewes' SCADA and CIS billing platforms.

The following is Sargent and Lundy's recommended next steps.

Step 1.

Lewes and Lewes' system partner, NISC, will need to quantify the present expenses incurred to support Lewes' customer base. Examples are: transmission supply charges, distribution transformer replacements, meter reading, disconnecting/reconnecting customers, outage management costs, etc. Lewes will also want to decide which program should be implemented into Lewes' service territory. Examples are: Distributed Energy Resource Integration (integrating solar, wind, EV, battery and other renewables), Demand Response Integration (integrating an energy supply peak-shifting or peak-shaving model), Smart Communities applications (integrating smart street lights), etc.

Step 2.

Once the applicable interfaces have been identified and cost quantified, Lewes BPW can use those applicable interfaces to begin quantifying the savings to the utility and the customer.

Step 3.

A Cost/Benefits analysis can then be calculated to determine the projects payback period and/or net present value. This analysis may include the type of major benefit to Lewes BPW (such as reduction of congestion charges), opportunity cost to educate customers on incentives, customer behavior, rate of incentive adoptions by customers, time of use tariff structure etc.

Step 4.

Present analysis to Lewes BPW board members for a "Go/No-Go" decision.

Sargent and Lundy can be your trusted partner along this journey through these next steps. If an AMI program is approved by the board, S&L can act as Lewes' owner engineer/consultant to support from the Request for Proposal (RFP) process through to final implementation.

## 6.4. INVESTIGATION OF TRANSMISSION LINE RELIABILITY UPGRADES TO SERVE THE LEWES BOARD OF PUBLIC WORKS

#### 6.4.1. Scope and Present Conditions

As part of the electric system analysis and study being performed by Sargent & Lundy (S&L), Lewes Board of Public Works (Lewes) requested an investigation to establish a second, independent interconnection to their system from Delmarva Power & Light (DPL).

Presently, the entire electric system of Lewes is fed by one 69 kV tap off a transmission line between DPL's Five Points and Midway substations. The demarcation point between DPL and Lewes is a metering station on King's Highway.

Over the last few years, Lewes has experienced multiple outages on their 69 kV system; namely four 5-hour outages in 2018 due to electrical equipment upgrades at the metering station. This resulted in a total loss of power in Lewes' system, for the entire duration of each outage. Along with distributed energy resources, Lewes has demonstrated interest in strengthening their existing 69 kV transmission system by possibly adding a redundant 69 kV transmission line from an independent source and route.

Furthermore, Sussex County, DE has seen a recent increase in the number of approvals for new developments in the region. Lewes requested S&L to check with DPL on how they plan to serve these developments within their service territory (i.e., in the form of new substations, re-supply etc.)

#### 6.4.2. Discussions with Delmarva Power & Light

S&L reached out to various groups at DPL (Exelon), namely the Interconnection & Power System Studies group, Transmission Arrangements group, Transmission Planning group and Transmission Interconnections group.

S&L facilitated a meeting between DPL and Lewes on October 25<sup>th</sup>, 2019 (followed up through multiple correspondence) with the aforementioned teams to discuss Lewes' redundant 69 kV transmission line interconnection request. The following items were discussed:

- Allowable Configurations for New Interconnections
- Nearby DPL substations that could serve Lewes
- Re-configuration of Lewes' 69 kV transmission system
- Costs associated with new substation and transmission system upgrades

#### 6.4.3. Allowable Configurations for New Interconnections

DPL stated that barring requested or required change initiated by DPL, conversion of existing tapped interconnection configurations (like the existing 69 kV transmission line that currently serves Lewes) into dedicated line positions from a DPL substation are not required. However, DPL established that they no longer allow for new interconnections to be tapped. All new transmission lines must originate as a dedicated line position from a DPL substation.

#### 6.4.3.1. Options exploring nearby DPL substations that serve the territory

S&L and DPL explored various nearby substations in DPL's territory capable of providing Lewes' second transmission line:

1. Midway Substation

This substation is completely built out and there is no room for further bus/line expansions at the substation.

2. Five Points Substation

This substation cannot be expanded within the current property footprint. Furthermore, there isn't a feasible way to buy more property to expand the substation.

3. Cool Spring Substation



This substation is in a highly developed area, which is contentious when it comes to expansions. Furthermore, any new line position will have to be run underground for a certain distance before making a transition to an overhead line. The cost associated with designing and constructing an underground line section is almost ten times that of an overhead line.

4. Rehoboth Substation

There is no feasible way to expand this substation to add another line position.

5. Miscellaneous Substations to feed the nearby Overbrook development area

S&L believes the Overbrook area and similar regional developments may receive distribution class voltage supply (25kV and below) from DPL Five Points, DPL Harbeson or other nearby substations. Another option S&L believes for supplying the Overbrook development area could be via the Delaware Electric Coop (DEC) Lank substation (if this development is within DEC's territory). S&L does not expect DPL to build a 69kV network to serve this development and hence, this will not affect the nature of Lewes' 69 kV interconnection request.

At this time, DPL does not have a readily available substation line position that could be utilized to provide a redundant supply to Lewes.

#### 6.4.3.2. Transmission System Re-Configuration for Lewes

S&L and DPL explored the type, location and of a typical substation that could be constructed for the transmission line reconfiguration:

#### Type of Substation

If a transmission route is established, in order to provide transmission system redundancy, a greenfield 4breaker ring bus substation was recommended at the meeting (two incoming lines from DPL and two outgoing lines to Lewes).





#### Figure 6-2 — Example 4-breaker Ring Bus Substation

For a **<u>NEW</u>** 4-breaker ring bus design, DPL believes a minimum substation footprint of 6 acres (with a typical footprint of around 8 acres) will be required.

Per information provided by DPL, keeping in mind the smaller and nature of the substations (for e.g., only line buses), referencing these "historic" locations is problematic due to reasons such as:

- 1. These substations were built against standards dictated at their respective times of construction.
- 2. Revised codes related to storm-water management, setback, physical security, access/dedications etc. for new substations not existent at that time.
- 3. A lot of other variables are different today relative to when the above listed substations were constructed.

Detailed planning and physical arrangement of any proposed substation will drive the final area size needs.

#### Locations

The following locations were discussed as options for this 4-breaker ring bus substation:

- 1. Converting/expanding Lewes' Metering Station into a ring bus.
  - a. There is limited land around the Metering Station next to King's Highway.
- 2. Another option discussed was the installation of a new substation based on DelDOT's reconfiguration at the Five Points intersection.
  - a. This would result in the demolition of Lewes Metering station (as metering would be done at

the new location).

b. DPL notified S&L/Lewes that this intersection is highly crowded and contentious. Furthermore, acquisition of land for the substation and transmission line right-of-ways (ROW) near the intersection will be challenging.

#### 6.4.3.3.Typical Costs Associated with Forecasted Lewes Transmission System Upgrades

DPL provided the following cost estimates for any major transmission system upgrades in Lewes' system:

- 1. Transmission Line costs:
  - a. The approximate cost-per-mile for an overhead 69 kV transmission line is \$1.25 million. The cost is for a standard steel pole transmission line with typical conductors and associated materials. For a 3-4 mile transmission line section, this would cost upwards of ~\$3.75 million.
  - b. The approximate cost-per-mile for an underground 69kV transmission line is ~\$10-12 million (using standard conductors & materials, typical design and installation costs). For a 3-4 mile transmission line section, this would cost upwards of ~\$35 million.
  - c. The costs do not include right-of-way (ROW) acquisition across the length of the transmission line.

#### 2. New Substation costs:

The approximate cost for a greenfield 69 kV 4-breaker ring bus substation is \$6.5 million. The cost includes acquiring all major electrical equipment, engineering, design and construction of the substation. This cost does not include land acquisition.

#### 3. Existing DPL Substation costs:

Since the request for a new transmission line is for redundancy rather than large-scale load growth (which DPL has supporting data of), DPL expects Lewes to be responsible for the entire cost of capital expenditure associated with DPL's substation upgrades to support the new line position for Lewes.

#### 4. Forecasted costs:

For such a large-scale undertaking (barring ROW, land acquisition and DPL costs), capital costs would start at ~\$15 million and could go upwards of ~\$40 million.

#### 6.4.4. Transmission Line Evaluation Conclusions

At this time, the costs of investing in a large capital project to facilitate the installation of a redundant 69 kV transmission line outweighs the potential benefits for Lewes. Since load growth is not expected to rise significantly in the next ten years, Lewes is best served by adopting distributed energy resources (like solar and battery storage) to serve critical loads/critical circuits in the event of an outage.

However, if Lewes does choose to invest in a large capital project by adding a new redundant transmission line and associated substation, S&L would be happy to engage with Lewes and DPL to facilitate a more detailed strategy for engineering, design, construction and implementation of such services through an RFP process.
Furthermore, DPL's Planning teams are actively engaged in monitoring growth within Sussex County, DE, and shall continue to work closely with Delaware Electric Coop (DEC) and nearby public utilities to monitor growth and upgrades in the region.



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# 8. CONCLUSIONS

Sargent & Lundy has performed an electric system analysis of the Lewes BPW distribution system to determine the current electric system strengths, weaknesses, and recommendations for future system planning. To perform this analysis, S&L developed a CYME software model of the Lewes BPW distribution system with cases representing the current system configuration and 5 year and 10 year projections. The following conclusions and recommendations were drawn based on the results of the system modeling.

- The short-circuit analysis shows sufficient margin the in interrupting capacity of the overcurrent protective devices considering the current system configuration and future buildout including distributed energy resources. Additionally, there is enough margin in the system protection setpoints to ensure the system protection will remain reliable and secure considering future buildout.
- The power flow analysis shows no significant thermal or voltage drop issues under current system loading configurations. Placing the existing voltage regulators back in service may not provide significant benefits as the voltage regulation at downstream nodes is sufficient without the regulators in service so long as the Schley Ave Substation transformer LTCs are functional. Additionally, the CYME model and DEMEC metering data show the system power factor is maintained within an appropriate range. S&L recommends routine testing and maintenance for the feeder capacitor banks including external fusing, switching, and controller operation to keep this critical equipment working as intended. Additionally, the capacitor controller setpoints should be cataloged for future enhancement to the CYME model. Routine testing and maintenance of the feeder capacitor banks could provide the benefit of limiting power factor charges incurred.
- The 2019 peak load was approximately 22.3MW. Ten-year load growth projections show the peak load increasing to 26.1 MW considering 1% average annual load growth plus 30% household EV adoption (approximately 990 EVs). The peak load is estimated to be 27.5MW considering 50% household EV adoption (approximately 1,650 EVs). The top 65°C rating of the two transformers is 28MVA, which gives approximately 1.8% margin considering a single transformer supplying the entire distribution system. S&L recommends that the BPW consider replacing the transformers within the next three years to provide additional margin and to increase system reliability, especially considering recent gassing in Transformer T1 (per September 29, 2017 Potomac testing report). Note that the T1 transformer was repaired by tightening loose connections and recent DGA tests show no additional gassing per December 6, 2019 Potomac testing report. Because of the recent gassing issues, S&L recommends annual DGA testing of the T1 transformer to ensure there are no further issues. If no further gassing is observed over the next several years, DGA testing could be performed on a bi-annual basis.
- The CYME model does not show overloading on distribution transformers. However, due to the available metering data, the CYME model only captures the aggregate load and does not have the level of granularity necessary to determine individual pole-top and pad-mounted distribution transformer loading. S&L recommends performing loading surveys (thermal imaging) of pole-top transformers during peak system loading to evaluate loading conditions. This is especially important in areas with high levels of electric vehicles penetration.
- Other than of the Schley Ave Substation transformers, the results of the CYME modeling show that there is no weak link in the 12.47kV distribution system that would require upgrades within the next ten years.
- The Spring Light Load case shows that there is a potential for reverse power flow back into the 69kV system, based on total DER generation output levels of 6 MW. Considering the existing 2.0 MW University Wind Site and the 163.2kW Library Solar site, this leaves a margin of 3.8 MW of additional DERs on the Lewes system. This would equate to approximately 425 rooftop PV installations (averaging 9kW each) or three to four additional large-scale commercial installations

similar in size to the University Wind project. To ensure there is no reverse power flow into the DPL system, S&L recommends the Lewes BPW update DER interconnection procedures to limit the total connected DERs to 5 MW (including existing installations). Once the 5 MW total limit is reached, potential DER owners may request, at their expense, to pay for upgrades that would allow them to install their system. To mitigate reverse power flow, upgrades such as a transfer trip protection scheme or co-located energy storage may be required. The currently installed DER capacity on Lewes BPW's system is 2.84MW, leaving a margin of 2.16MW available DER capacity before system upgrades are required.

- Future load growth projections, including EV penetration, predict the system peak load may eventually occur in the summer. The daily loading profile for the Summer Peak shows the peak occurs at approximately 6pm, which coincides with the peak time of day for electric vehicle charging. At the time of day when the peak occurs, solar PV generation does not provide significant reduction in load. For a sunny day in the summer, the typical solar PV output is only approximately 30% of maximum output kW at 6PM and 10% of maximum output kW by 7pm.
- Based on the results of the system analysis, battery energy storage could provide significant benefits to the Lewes BPW, which are listed below. The potential site near the Schley Ave Substation and the Wellfield site are well-suited electrically to host battery energy storage systems.
  - o Peak shaving for reduction of demand charges.
  - System islanding during transmission system disturbances to increase reliability and defer construction of an alternate 69 kV transmission feed.
  - Mitigation of reverse power flow into the transmission system considering future buildout of rooftop PV and other commercial-scale renewable projects.
- Deployment of Advanced Metering Infrastructure and Smart Meters could also provide significant benefits to the BPW, which are listed below. S&L therefore recommends that the Lewes BPW consider performing cost/benefit analyses to evaluate the opportunities for integrating/deploying Smart Grid/Smart Meter technology to approximately 3,750 customers in the BPW's territory. Sargent & Lundy is ready and able to perform this cost/benefit analysis for the Lewes BPW.
  - Potential to provide "Time-of-Use" tariffs capable of incentivizing customers to reduce summer peaks. This tariff may also increase the opportunity for customers to consider installing battery storage.
  - o Promote EV charging on "off-peak" hours with the established Time-of-Use tariff.
  - Capable of capturing individual customer loading in order to improve system modeling and maximize/optimize distribution transformer loading. This becomes especially critical as EV's proliferate.
  - Capable of capturing node voltages for better insights to load-side potential voltage losses or power quality issues.
- At this time, the costs of investing in a large capital project to facilitate the installation of a redundant 69 kV transmission line outweigh the potential benefits for Lewes.
- For future enhancements to the system model, S&L recommends Lewes BPW capture and maintain following data:
  - Per-phase hourly loading at the feeder breaker level
  - Hourly bus voltage measurements at the two 12.47kV buses
  - o Capacitor bank control setpoints
  - Location, kVA size, voltage, and phase connections of all pole-top and pad-mounted transformers should be maintained in GIS

# APPENDIX A. CYME MODEL INPUT DATA AND SINGLE LINE



LEWES BPW Electric System Analysis and Study 13968.001

Appendix A - CYME Model Input Data and Single Line



S&L Report: SL-LEWES-2019-01 Rev. 001 04/07/2020 LEWES BPW Electric System Analysis and Study 13968.001

Appendix A - CYME Model Input Data and Single Line



S&L Report: SL-LEWES-2019-01 Rev. 001 04/07/2020

# APPENDIX B. CYME MODEL OUTPUT REPORTS

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# Load Flow - Summary Report By Network

Study Parameters	
Study Name	LEWES_CKT_WINTER_2019.xst
Date	Mon Apr 06 2020
Time	08h35m11s
Project Name	New
Calculation Method	Voltage Drop - Unbalanced
Tolerance	0.1 %
Load Factors	Global (P=100.00%, Q=100.00%)
Motor Factors	As defined
Generator Factors	As defined
Shunt Capacitors	On
Sensitivity Load Model	From Library

Feeder:

Source:

# 69KV\_DELMARVA

723

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	22293.21	653.00	22302.78	99.96
Generators	0.00	0.00	0.00	0.00
Total Generation	22293.21	653.00	22302.78	99.96
Load read (Non-adjusted)	0.00	0.00	0.00	0.00
Load used (Adjusted)	0.00	0.00	0.00	0.00
Shunt capacitors (Adjusted)	0.00	0.00	0.00	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	0.00	0.00	0.00	0.00
Cable Capacitance	0.00	0.00	0.00	0.00
Line Capacitance	0.00	-46.09	46.09	0.00
Total Shunt Capacitance	0.00	-46.09	46.09	0.00
Line Losses	43.80	103.86	112.72	38.86
Cable Losses	0.00	0.00	0.00	0.00
Transformer Load Losses	43.25	1513.67	1514.29	2.86
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	87.05	1617.53	1619.87	5.37

Abnormal Conditions	Phase	Count	Worst Condition	Value
	A	0	823	43.32 %
Overload	В	0	823	46.66 %
	С	0	823	43.10 %
	А	0	1705	99.80 %
Under-Voltage	В	0	1705	99.79 %
	С	0	1705	99.79 %
	А	0	760	100.66 %
Over-Voltage	В	0	760	100.64 %
	С	0	760	100.54 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	43.80	383.72	38.37
Cable Losses	0.00	0.00	0.00
Transformer Load Losses	43.25	378.85	37.88
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	87.05	762.57	76.26

Feeder:

#### FEEDER 1

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adjusted)	5810.31	1009.80	5897.41	98.52
Load used (Adjusted)	5810.34	1009.83	5897.44	98.52
Shunt capacitors (Adjusted)	0.00	-1816.87	1816.87	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	5810.34	-807.04	5866.12	-99.05
Cable Capacitance	0.00	-2.47	2.47	0.00
Line Capacitance	0.00	-10.03	10.03	0.00
Total Shunt Capacitance	0.00	-12.50	12.50	0.00
Line Losses	18.28	42.38	46.15	39.60
Cable Losses	0.20	0.18	0.27	73.35
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	18.48	42.56	46.40	39.82

Abnormal Conditions			Worst Condition	
Abhormai conditions	Phase	Count	Worst condition	Value
	А	3	1701	101.29 %
Overload	В	3	1701	101.24 %
	С	3	1701	101.01 %
	А	0	400	100.48 %
Under-Voltage	В	0	196	99.95 %
	С	0	196	99.70 %
	А	0	13	100.65 %
Over-Voltage	В	0	13	100.62 %
	с	0	13	100.51 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	18.28	160.12	16.01
Cable Losses	0.20	1.73	0.17
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	18.48	161.85	16.19

Feeder:

#### **FEEDER 2**

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adjusted)	6528.09	742.19	6570.14	99.36
Load used (Adjusted)	6528.28	742.52	6570.37	99.36
Shunt capacitors (Adjusted)	0.00	-777.53	777.53	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	6528.28	-35.02	6528.37	-100.00
Cable Capacitance	0.00	-26.46	26.46	0.00
Line Capacitance	0.00	-7.00	7.00	0.00
Total Shunt Capacitance	0.00	-33.46	33.46	0.00
Line Losses	37.34	87.77	95.38	39.14
Cable Losses	3.82	5.05	6.33	60.35
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	41.16	92.82	101.54	40.53

Abnormal Conditions	Phase	Count	Worst Condition	Value
	А	1	745	100.08 %
Overload	в	0	745	99.76 %
	С	1	745	100.02 %
	А	0	1154	99.69 %
Under-Voltage	В	0	1454	99.63 %
	С	0	1154	99.61 %
	А	0	648	100.65 %
Over-Voltage	В	0	648	100.63 %
	С	0	648	100.53 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	37.34	327.06	32.71
Cable Losses	3.82	33.48	3.35
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	41.16	360.53	36.05

Feeder:

#### **FEEDER 3**

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adiusted)	4610.88	461 76	4633.95	99 50
Load used (Adjusted)	4610.89	461.70	4633.95	99.50
Shunt capacitors (Adjusted)	0.00	-1959.17	1959.17	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	4610.89	-1497.40	4847.93	-95.11
Cable Capacitance	0.00	-24.07	24.07	0.00
Line Capacitance	0.00	-8.86	8.86	0.00
Total Shunt Capacitance	0.00	-32.93	32.93	0.00
Line Losses	39.47	92.06	100.17	39.41
Cable Losses	0.86	1.19	1.46	58.53
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	40.33	93.25	101.59	39.70

Abnormal Conditions	Phase	Count	Worst Condition	Value
	A	4	419	100.35 %
Overload	В	4	1129	100.59 %
	С	7	666	101.30 %
	А	0	1224-F	99.82 %
Under-Voltage	В	0	1224-F	99.77 %
	С	0	1115	100.39 %
	А	0	1197	100.44 %
Over-Voltage	В	0	1197	100.35 %
	С	0	1009	100.66 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	39.47	345.79	34.58
Cable Losses	0.86	7.50	0.75
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	40.33	353.28	35.33

Feeder:

#### FEEDER 4

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adjusted)	5124.27	1243.83	5273.07	97.18
Load used (Adjusted)	5124.31	1243.84	5273.11	97.18
Shunt capacitors (Adjusted)	0.00	0.00	0.00	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	5124.31	1243.84	5273.11	97.18
Cable Capacitance	0.00	-38.22	38.22	0.00
Line Capacitance	0.00	-4.57	4.57	0.00
Total Shunt Capacitance	0.00	-42.79	42.79	0.00
Line Losses	30.32	69.97	76.26	39.76
Cable Losses	2.20	0.66	2.29	95.73
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	32.52	70.64	77.76	41.81

Abnormal Conditions	Phase	Count	Worst Condition	Value
	А	0	1686	74.65 %
Overload	В	0	1686	74.65 %
	С	0	1686	74.65 %
	А	0	1190	99.43 %
Under-Voltage	В	0	1190	99.17 %
	С	0	1817	99.33 %
	А	0	867	100.42 %
Over-Voltage	В	0	867	100.33 %
	С	0	867	100.41 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	30.32	265.60	26.56
Cable Losses	2.20	19.24	1.92
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	32.52	284.84	28.48

# Load Flow - Summary Report By Network

Study Parameters	
Study Name	LEWES_CKT_WINTER_2024.xst
Date	Mon Apr 06 2020
Time	08h37m03s
Project Name	New
Calculation Method	Voltage Drop - Unbalanced
Tolerance	0.1 %
Load Factors	Global (P=100.00%, Q=100.00%)
Motor Factors	As defined
Generator Factors	As defined
Shunt Capacitors	On
Sensitivity Load Model	From Library

Feeder:

Source:

# 69KV\_DELMARVA

723

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	23319.99	1023.06	23342.42	99.90
Generators	0.00	0.00	0.00	0.00
Total Generation	23319.99	1023.06	23342.42	99.90
Load read (Non-adjusted)	0.00	0.00	0.00	0.00
Load used (Adjusted)	0.00	0.00	0.00	0.00
Shunt capacitors (Adjusted)	0.00	0.00	0.00	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	0.00	0.00	0.00	0.00
Cable Capacitance	0.00	0.00	0.00	0.00
Line Capacitance	0.00	-46.08	46.08	0.00
Total Shunt Capacitance	0.00	-46.08	46.08	0.00
Line Losses	47.98	113.77	123.47	38.86
Cable Losses	0.00	0.00	0.00	0.00
Transformer Load Losses	47.37	1657.78	1658.46	2.86
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	95.35	1771.55	1774.11	5.37

Abnormal Conditions	Dhasa	Count	Worst Condition	Volue
	Fliase	Count		value
	A	0	823	45.26 %
Overload	В	0	823	48.73 %
	С	0	823	45.02 %
	А	0	1705	99.78 %
Under-Voltage	В	0	1705	99.77 %
	С	0	1705	99.77 %
	А	0	760	100.54 %
Over-Voltage	В	0	760	100.53 %
	С	0	760	100.42 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	47.98	420.34	42.03
Cable Losses	0.00	0.00	0.00
Transformer Load Losses	47.37	414.92	41.49
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	95.35	835.26	83.53

Feeder:

#### FEEDER 1

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adjusted)	6078.95	1060.87	6170.82	98.51
Load used (Adjusted)	6078.98	1060.91	6170.87	98.51
Shunt capacitors (Adjusted)	0.00	-1812.02	1812.02	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	6078.98	-751.11	6125.21	-99.25
Cable Capacitance	0.00	-2.46	2.46	0.00
Line Capacitance	0.00	-10.00	10.00	0.00
Total Shunt Capacitance	0.00	-12.47	12.47	0.00
Line Losses	20.01	46.38	50.52	39.61
Cable Losses	0.21	0.20	0.29	73.35
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	20.22	46.58	50.78	39.82

Abnormal Conditions	Phase	Count	Worst Condition	Value
	A	3	1701	101.05 %
Overload	В	3	1701	101.00 %
	С	3	1701	100.75 %
	А	0	400	100.34 %
Under-Voltage	В	0	196	99.79 %
	С	0	196	99.53 %
	A	0	13	100.53 %
Over-Voltage	В	0	13	100.50 %
	с	0	13	100.38 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	20.01	175.28	17.53
Cable Losses	0.21	1.88	0.19
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	20.22	177.16	17.72

Feeder:

#### FEEDER 2

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adjusted)	6813.95	779.31	6858.37	99.35
Load used (Adjusted)	6814.17	779.67	6858.63	99.35
Shunt capacitors (Adjusted)	0.00	-774.80	774.80	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	6814.17	4.88	6814.17	100.00
Cable Capacitance	0.00	-26.36	26.36	0.00
Line Capacitance	0.00	-6.98	6.98	0.00
Total Shunt Capacitance	0.00	-33.34	33.34	0.00
Line Losses	40.80	95.92	104.24	39.14
Cable Losses	4.18	5.52	6.92	60.35
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	44.98	101.44	110.96	40.53

Abnormal Conditions	Phase	Count	Worst Condition	Value
	А	0	745	99.78 %
Overload	В	0	745	99.44 %
	С	0	745	99.70 %
	А	0	1154	99.50 %
Under-Voltage	В	0	1454	99.44 %
	С	0	1154	99.42 %
	A	0	648	100.53 %
Over-Voltage	В	0	648	100.51 %
	С	0	648	100.41 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	40.80	357.42	35.74
Cable Losses	4.18	36.58	3.66
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	44.98	394.00	39.40

Feeder:

#### FEEDER 3

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adjusted)	4821.49	484.93	4845.82	99.50
Load used (Adjusted)	4821.49	484.94	4845.82	99.50
Shunt capacitors (Adjusted)	0.00	-1953.08	1953.08	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	4821.49	-1468.14	5040.06	-95.66
Cable Capacitance	0.00	-23.99	23.99	0.00
Line Capacitance	0.00	-8.83	8.83	0.00
Total Shunt Capacitance	0.00	-32.83	32.83	0.00
Line Losses	42.77	99.75	108.54	39.41
Cable Losses	0.92	1.28	1.58	58.54
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	43.69	101.03	110.08	39.69

Abnormal Conditions	Phase	Count	Worst Condition	Value
	Α	1	419	100.06 %
Overload	В	4	1129	100.27 %
	С	7	654	101.02 %
	А	0	1224-F	99.64 %
Under-Voltage	В	0	1224-F	99.59 %
	С	0	1115	100.25 %
	А	0	1197	100.33 %
Over-Voltage	В	0	1197	100.24 %
	С	0	1009	100.52 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	42.77	374.67	37.47
Cable Losses	0.92	8.10	0.81
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	43.69	382.77	38.28

Feeder:

#### FEEDER 4

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adiusted)	5365.46	1306 97	5522 35	97 16
Load used (Adjusted)	5365.50	1306.98	5522.39	97.16
Shunt capacitors (Adjusted)	0.00	0.00	0.00	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	5365.50	1306.98	5522.39	97.16
Cable Capacitance	0.00	-38.10	38.10	0.00
Line Capacitance	0.00	-4.56	4.56	0.00
Total Shunt Capacitance	0.00	-42.66	42.66	0.00
Line Losses	33.34	76.94	83.85	39.76
Cable Losses	2.41	0.73	2.52	95.74
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	35.75	77.67	85.50	41.81

Abnormal Conditions	Phase	Count	Worst Condition	Value
	А	0	1686	78.45 %
Overload	В	0	1686	78.45 %
	С	0	1686	78.45 %
	А	0	1190	99.27 %
Under-Voltage	В	0	1190	99.00 %
	С	0	1817	99.17 %
	А	0	867	100.32 %
Over-Voltage	В	0	867	100.22 %
	С	0	867	100.31 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	33.34	292.04	29.20
Cable Losses	2.41	21.09	2.11
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	35.75	313.14	31.31

# Load Flow - Summary Report By Network

Study Parameters	
Study Name	LEWES_CKT_WINTER_2029.xst
Date	Mon Apr 06 2020
Time	08h38m45s
Project Name	New
Calculation Method	Voltage Drop - Unbalanced
Tolerance	0.1 %
Load Factors	Global (P=100.00%, Q=100.00%)
Motor Factors	As defined
Generator Factors	As defined
Shunt Capacitors	On
Sensitivity Load Model	From Library

Feeder:

Source:

# 69KV\_DELMARVA

723

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	24522.67	1448.94	24565.44	99.83
Generators	0.00	0.00	0.00	0.00
Total Generation	24522.67	1448.94	24565.44	99.83
Load read (Non-adjusted)	0.00	0.00	0.00	0.00
Load used (Adjusted)	0.00	0.00	0.00	0.00
Shunt capacitors (Adjusted)	0.00	0.00	0.00	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	0.00	0.00	0.00	0.00
Cable Capacitance	0.00	0.00	0.00	0.00
Line Capacitance	0.00	-46.07	46.07	0.00
Total Shunt Capacitance	0.00	-46.07	46.07	0.00
Line Losses	53.15	126.01	136.76	38.86
Cable Losses	0.00	0.00	0.00	0.00
Transformer Load Losses	52.46	1836.04	1836.78	2.86
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	105.60	1962.04	1964.88	5.37

Abnormal Conditions	Phase	Count	Worst Condition	Value
	А	0	823	47.56 %
Overload	В	0	823	51.21 %
	С	0	823	47.30 %
	A	0	1705	99.76 %
Under-Voltage	В	0	1705	99.75 %
	С	0	1705	99.75 %
	А	0	760	100.41 %
Over-Voltage	В	0	760	100.39 %
	С	0	760	100.27 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	53.15	465.56	46.56
Cable Losses	0.00	0.00	0.00
Transformer Load Losses	52.46	459.53	45.95
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	105.60	925.09	92.51

Feeder:

#### FEEDER 1

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adjusted)	6389.04	1114.99	6485.60	98.51
Load used (Adjusted)	6389.08	1115.03	6485.65	98.51
Shunt capacitors (Adjusted)	0.00	-1806.47	1806.47	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	6389.08	-691.44	6426.38	-99.42
Cable Capacitance	0.00	-2.46	2.46	0.00
Line Capacitance	0.00	-9.97	9.97	0.00
Total Shunt Capacitance	0.00	-12.43	12.43	0.00
Line Losses	22.13	51.31	55.88	39.61
Cable Losses	0.24	0.22	0.32	73.34
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	22.37	51.53	56.17	39.82

Abnormal Conditions	Phase	Count	Worst Condition	Value
	А	3	1701	100.78 %
Overload	В	3	1701	100.72 %
	С	1	1701	100.46 %
	А	0	400	100.19 %
Under-Voltage	В	0	196	99.62 %
	С	0	196	99.33 %
	А	0	13	100.39 %
Over-Voltage	В	0	13	100.37 %
	С	0	13	100.23 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	22.13	193.87	19.39
Cable Losses	0.24	2.09	0.21
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	22.37	195.96	19.60

Feeder:

# FEEDER 2

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adjusted)	7161.53	819.07	7208.22	99.35
Load used (Adjusted)	7161.79	819.47	7208.52	99.35
Shunt capacitors (Adjusted)	0.00	-771.64	771.64	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	7161.79	47.82	7161.95	100.00
Cable Capacitance	0.00	-26.25	26.25	0.00
Line Capacitance	0.00	-6.95	6.95	0.00
Total Shunt Capacitance	0.00	-33.21	33.21	0.00
Line Losses	45.23	106.33	115.55	39.14
Cable Losses	4.63	6.12	7.67	60.35
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	49.86	112.45	123.00	40.53

Abnormal Conditions	Phase	Count	Worst Condition	Value
	А	0	745	99.42 %
Overload	В	0	745	99.07 %
	С	0	745	99.33 %
	А	0	1154	99.29 %
Under-Voltage	В	0	1454	99.22 %
	С	0	1154	99.19 %
	А	0	648	100.40 %
Over-Voltage	В	0	648	100.38 %
	С	0	648	100.26 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	45.23	396.21	39.62
Cable Losses	4.63	40.55	4.06
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	49.86	436.76	43.68

Feeder:

#### **FEEDER 3**

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adjusted)	5067.44	509.67	5093.00	99.50
Load used (Adjusted)	5067.44	509.68	5093.01	99.50
Shunt capacitors (Adjusted)	0.00	-1946.19	1946.19	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	5067.44	-1436.51	5267.12	-96.21
Cable Capacitance	0.00	-23.91	23.91	0.00
Line Capacitance	0.00	-8.80	8.80	0.00
Total Shunt Capacitance	0.00	-32.71	32.71	0.00
Line Losses	46.86	109.30	118.93	39.40
Cable Losses	1.01	1.40	1.73	58.56
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	47.87	110.70	120.61	39.69

Abnormal Conditions	Phase	Count	Worst Condition	Value
	A	0	419	99.73 %
Overload	В	0	1129	99.91 %
	С	7	654	100.70 %
	А	0	1224-F	99.44 %
Under-Voltage	В	0	1224-F	99.37 %
	С	0	1115	100.08 %
	А	0	1197	100.21 %
Over-Voltage	В	0	1197	100.11 %
	С	0	1009	100.37 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	46.86	410.51	41.05
Cable Losses	1.01	8.87	0.89
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	47.87	419.38	41.94

Feeder:

#### FEEDER 4

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adjusted)	5639.15	1373.63	5804.04	97.16
Load used (Adjusted)	5639.20	1373.65	5804.09	97.16
Shunt capacitors (Adjusted)	0.00	0.00	0.00	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	5639.20	1373.65	5804.09	97.16
Cable Capacitance	0.00	-37.96	37.96	0.00
Line Capacitance	0.00	-4.54	4.54	0.00
Total Shunt Capacitance	0.00	-42.50	42.50	0.00
Line Losses	36.96	85.30	92.97	39.76
Cable Losses	2.67	0.81	2.79	95.74
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	39.63	86.11	94.79	41.81

Abnormal Conditions	Phase	Count	Worst Condition	Value
	А	0	1686	82.45 %
Overload	В	0	1686	82.45 %
	С	0	1686	82.45 %
	А	0	1190	99.10 %
Under-Voltage	В	0	1190	98.80 %
	С	0	1817	98.99 %
	А	0	867	100.20 %
Over-Voltage	В	0	867	100.09 %
	С	0	867	100.19 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	36.96	323.78	32.38
Cable Losses	2.67	23.39	2.34
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	39.63	347.17	34.72

# Load Flow - Summary Report By Network

Study Parameters	
Study Name	LEWES_CKT_WINTER_2024.xst
Date	Mon Apr 06 2020
Time	08h37m03s
Project Name	New
Calculation Method	Voltage Drop - Unbalanced
Tolerance	0.1 %
Load Factors	Global (P=100.00%, Q=100.00%)
Motor Factors	As defined
Generator Factors	As defined
Shunt Capacitors	On
Sensitivity Load Model	From Library

Feeder:

Source:

# 69KV\_DELMARVA

723

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	23319.99	1023.06	23342.42	99.90
Generators	0.00	0.00	0.00	0.00
Total Generation	23319.99	1023.06	23342.42	99.90
Load read (Non-adjusted)	0.00	0.00	0.00	0.00
Load used (Adjusted)	0.00	0.00	0.00	0.00
Shunt capacitors (Adjusted)	0.00	0.00	0.00	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	0.00	0.00	0.00	0.00
Cable Capacitance	0.00	0.00	0.00	0.00
Line Capacitance	0.00	-46.08	46.08	0.00
Total Shunt Capacitance	0.00	-46.08	46.08	0.00
Line Losses	47.98	113.77	123.47	38.86
Cable Losses	0.00	0.00	0.00	0.00
Transformer Load Losses	47.37	1657.78	1658.46	2.86
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	95.35	1771.55	1774.11	5.37

Abnormal Conditions	Phase	Count	Worst Condition	Value
	А	0	823	45.26 %
Overload	В	0	823	48.73 %
	С	0	823	45.02 %
	А	0	1705	99.78 %
Under-Voltage	В	0	1705	99.77 %
	С	0	1705	99.77 %
	А	0	760	100.54 %
Over-Voltage	В	0	760	100.53 %
	С	0	760	100.42 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	47.98	420.34	42.03
Cable Losses	0.00	0.00	0.00
Transformer Load Losses	47.37	414.92	41.49
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	95.35	835.26	83.53

Feeder:

#### FEEDER 1

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adjusted)	6078.95	1060.87	6170.82	98.51
Load used (Adjusted)	6078.98	1060.91	6170.87	98.51
Shunt capacitors (Adjusted)	0.00	-1812.02	1812.02	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	6078.98	-751.11	6125.21	-99.25
Cable Capacitance	0.00	-2.46	2.46	0.00
Line Capacitance	0.00	-10.00	10.00	0.00
Total Shunt Capacitance	0.00	-12.47	12.47	0.00
Line Losses	20.01	46.38	50.52	39.61
Cable Losses	0.21	0.20	0.29	73.35
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	20.22	46.58	50.78	39.82

Abnormal Conditions	Phase	Count	Worst Condition	Value
	А	3	1701	101.05 %
Overload	В	3	1701	101.00 %
	С	3	1701	100.75 %
	А	0	400	100.34 %
Under-Voltage	В	0	196	99.79 %
	С	0	196	99.53 %
	А	0	13	100.53 %
Over-Voltage	В	0	13	100.50 %
	С	0	13	100.38 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	20.01	175.28	17.53
Cable Losses	0.21	1.88	0.19
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	20.22	177.16	17.72

Feeder:

#### FEEDER 2

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adjusted)	6813.95	779.31	6858.37	99.35
Load used (Adjusted)	6814.17	779.67	6858.63	99.35
Shunt capacitors (Adjusted)	0.00	-774.80	774.80	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	6814.17	4.88	6814.17	100.00
Cable Capacitance	0.00	-26.36	26.36	0.00
Line Capacitance	0.00	-6.98	6.98	0.00
Total Shunt Capacitance	0.00	-33.34	33.34	0.00
Line Losses	40.80	95.92	104.24	39.14
Cable Losses	4.18	5.52	6.92	60.35
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	44.98	101.44	110.96	40.53

Abnormal Conditions	Phase	Count	Worst Condition	Value
	А	0	745	99.78 %
Overload	В	0	745	99.44 %
	С	0	745	99.70 %
	А	0	1154	99.50 %
Under-Voltage	В	0	1454	99.44 %
	С	0	1154	99.42 %
	А	0	648	100.53 %
Over-Voltage	В	0	648	100.51 %
	С	0	648	100.41 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	40.80	357.42	35.74
Cable Losses	4.18	36.58	3.66
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	44.98	394.00	39.40

Feeder:

# **FEEDER 3**

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adjusted)	4821.49	484.93	4845.82	99.50
Load used (Adjusted)	4821.49	484.94	4845.82	99.50
Shunt capacitors (Adjusted)	0.00	-1953.08	1953.08	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	4821.49	-1468.14	5040.06	-95.66
Cable Capacitance	0.00	-23.99	23.99	0.00
Line Capacitance	0.00	-8.83	8.83	0.00
Total Shunt Capacitance	0.00	-32.83	32.83	0.00
Line Losses	42.77	99.75	108.54	39.41
Cable Losses	0.92	1.28	1.58	58.54
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	43.69	101.03	110.08	39.69

Abnormal Conditions	Phase	Count	Worst Condition	Value
	А	1	419	100.06 %
Overload	В	4	1129	100.27 %
	С	7	654	101.02 %
	А	0	1224-F	99.64 %
Under-Voltage	В	0	1224-F	99.59 %
	С	0	1115	100.25 %
	A	0	1197	100.33 %
Over-Voltage	В	0	1197	100.24 %
	С	0	1009	100.52 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	42.77	374.67	37.47
Cable Losses	0.92	8.10	0.81
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	43.69	382.77	38.28

Feeder:

# FEEDER 4

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adjusted)	5365 46	1306 97	5522 35	97 16
Load used (Adjusted)	5365.50	1306.98	5522.39	97.16
Shunt capacitors (Adjusted)	0.00	0.00	0.00	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	5365.50	1306.98	5522.39	97.16
Cable Capacitance	0.00	-38.10	38.10	0.00
Line Capacitance	0.00	-4.56	4.56	0.00
Total Shunt Capacitance	0.00	-42.66	42.66	0.00
Line Losses	33.34	76.94	83.85	39.76
Cable Losses	2.41	0.73	2.52	95.74
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	35.75	77.67	85.50	41.81

Abnormal Conditions	Phase	Count	Worst Condition	Value
	А	0	1686	78.45 %
Overload	В	0	1686	78.45 %
	С	0	1686	78.45 %
	А	0	1190	99.27 %
Under-Voltage	В	0	1190	99.00 %
	С	0	1817	99.17 %
	А	0	867	100.32 %
Over-Voltage	В	0	867	100.22 %
	С	0	867	100.31 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	33.34	292.04	29.20
Cable Losses	2.41	21.09	2.11
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	35.75	313.14	31.31

# Load Flow - Summary Report By Network

Study Parameters	
Study Name	LEWES_SUMMER_2024_30EV.xst
Date	Mon Apr 06 2020
Time	09h01m10s
Project Name	New
Calculation Method	Voltage Drop - Unbalanced
Tolerance	0.1 %
Load Factors	Global (P=100.00%, Q=100.00%)
Motor Factors	As defined
Generator Factors	As defined
Shunt Capacitors	On
Sensitivity Load Model	From Library

Feeder:

Source:

# 69KV\_DELMARVA

723

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	24074.83	3449.02	24320.63	98.99
Generators	0.00	0.00	0.00	0.00
Total Generation	24074.83	3449.02	24320.63	98.99
Load read (Non-adjusted)	0.00	0.00	0.00	0.00
Load used (Adjusted)	0.00	0.00	0.00	0.00
Shunt capacitors (Adjusted)	0.00	0.00	0.00	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	0.00	0.00	0.00	0.00
Cable Capacitance	0.00	0.00	0.00	0.00
Line Capacitance	0.00	-46.05	46.05	0.00
Total Shunt Capacitance	0.00	-46.05	46.05	0.00
Line Losses	52.10	123.53	134.07	38.86
Cable Losses	0.00	0.00	0.00	0.00
Transformer Load Losses	51.44	1800.54	1801.27	2.86
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	103.54	1924.06	1926.85	5.37

Abnormal Conditions	Phase	Count	Worst Condition	Value
	А	0	823	46.74 %
Overload	В	0	823	50.41 %
	С	0	823	46.48 %
	А	0	1705	99.73 %
Under-Voltage	В	0	1705	99.71 %
	С	0	1705	99.71 %
	А	0	1189	100.35 %
Over-Voltage	В	0	760	100.30 %
	С	0	1189	100.33 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	52.10	456.40	45.64
Cable Losses	0.00	0.00	0.00
Transformer Load Losses	51.44	450.65	45.06
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	103.54	907.05	90.71

Feeder:

#### FEEDER 1

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adjusted)	6265.79	1624.49	6472.95	96.80
Load used (Adjusted)	6265.84	1624.53	6473.01	96.80
Shunt capacitors (Adjusted)	0.00	-1800.97	1800.97	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	6265.84	-176.44	6268.32	-99.96
Cable Capacitance	0.00	-2.45	2.45	0.00
Line Capacitance	0.00	-9.93	9.93	0.00
Total Shunt Capacitance	0.00	-12.38	12.38	0.00
Line Losses	21.50	49.86	54.30	39.60
Cable Losses	0.24	0.22	0.33	73.32
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	21.74	50.08	54.60	39.82

Abnormal Conditions	Phase	Count	Worst Condition	Value
	А	3	1701	100.59 %
Overload	В	3	1701	100.52 %
	С	1	1701	100.09 %
	A	0	400	100.04 %
Under-Voltage	В	0	196	99.45 %
	С	0	196	98.93 %
	А	0	13	100.30 %
Over-Voltage	В	0	13	100.27 %
	С	0	13	100.05 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	21.50	188.38	18.84
Cable Losses	0.24	2.10	0.21
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	21.74	190.48	19.05

Feeder:

#### **FEEDER 2**

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adjusted)	7051.75	1496.64	7208.83	97.82
Load used (Adjusted)	7052.03	1497.08	7209.19	97.82
Shunt capacitors (Adjusted)	0.00	-767.38	767.38	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	7052.03	729.71	7089.68	99.47
Cable Capacitance	0.00	-26.11	26.11	0.00
Line Capacitance	0.00	-6.92	6.92	0.00
Total Shunt Capacitance	0.00	-33.03	33.03	0.00
Line Losses	44.22	103.95	112.96	39.15
Cable Losses	4.56	6.02	7.56	60.37
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	48.79	109.97	120.31	40.55

Abnormal Conditions	Phase	Count	Worst Condition	Value
	А	0	745	99.02 %
Overload	В	0	745	98.55 %
	С	0	745	98.68 %
	А	0	1154	99.05 %
Under-Voltage	В	0	1454	98.95 %
	С	0	1154	98.84 %
Over-Voltage	А	0	648	100.31 %
	В	0	648	100.28 %
	С	0	648	100.08 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	44.22	387.41	38.74
Cable Losses	4.56	39.96	4.00
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	48.79	427.37	42.74

Feeder:

#### FEEDER 3

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adjusted)	4994.29	1006.17	5094.63	98.03
Load used (Adjusted)	4994.29	1006.18	5094.64	98.03
Shunt capacitors (Adjusted)	0.00	-1943.42	1943.42	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	4994.29	-937.24	5081.47	-98.28
Cable Capacitance	0.00	-23.86	23.86	0.00
Line Capacitance	0.00	-8.79	8.79	0.00
Total Shunt Capacitance	0.00	-32.66	32.66	0.00
Line Losses	43.80	102.21	111.20	39.39
Cable Losses	0.96	1.33	1.64	58.53
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	44.76	103.53	112.79	39.68
Abnormal Conditions	Phase	Count	Worst Condition	Value
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	A	0	419	99.77 %
Overload	В	0	1129	99.57 %
	С	7	654	100.67 %
	А	0	1224-F	99.44 %
Under-Voltage	В	0	1224-F	99.16 %
	С	0	1115	100.08 %
	А	0	1197	100.33 %
Over-Voltage	в	0	1197	100.16 %
	С	0	1009	100 35 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	43.80	383.69	38.37
Cable Losses	0.96	8.39	0.84
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	44.76	392.08	39.21

Feeder:

#### FEEDER 4

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adjusted)	5504.87	1727.51	5769.57	95.41
Load used (Adjusted)	5504.92	1727.53	5769.62	95.41
Shunt capacitors (Adjusted)	0.00	0.00	0.00	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	5504.92	1727.53	5769.62	95.41
Cable Capacitance	0.00	-37.96	37.96	0.00
Line Capacitance	0.00	-4.54	4.54	0.00
Total Shunt Capacitance	0.00	-42.50	42.50	0.00
Line Losses	36.45	84.14	91.69	39.75
Cable Losses	2.64	0.80	2.75	95.72
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	39.09	84.93	93.50	41.81

Abnormal Conditions	Phase	Count	Worst Condition	Value
	А	0	1686	78.45 %
Overload	В	0	1686	78.45 %
	С	0	1686	78.45 %
	А	0	1186	99.13 %
Under-Voltage	В	0	1190	98.74 %
	С	0	1817	98.98 %
	А	0	867	100.32 %
Over-Voltage	В	0	867	100.14 %
	С	0	867	100.30 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	36.45	319.32	31.93
Cable Losses	2.64	23.10	2.31
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	39.09	342.42	34.24

## Load Flow - Summary Report By Network

Study Parameters	
Study Name	LEWES_SUMMER_2029_50EV.xst
Date	Mon Apr 06 2020
Time	09h14m29s
Project Name	New
Calculation Method	Voltage Drop - Unbalanced
Tolerance	0.1 %
Load Factors	Global (P=100.00%, Q=100.00%)
Motor Factors	As defined
Generator Factors	As defined
Shunt Capacitors	On
Sensitivity Load Model	From Library

Feeder:

Source:

# 69KV\_DELMARVA

723

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	27505.21	4972.95	27951.15	98.40
Generators	0.00	0.00	0.00	0.00
Total Generation	27505.21	4972.95	27951.15	98.40
Load read (Non-adjusted)	0.00	0.00	0.00	0.00
Load used (Adjusted)	0.00	0.00	0.00	0.00
Shunt capacitors (Adjusted)	0.00	0.00	0.00	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	0.00	0.00	0.00	0.00
Cable Capacitance	0.00	0.00	0.00	0.00
Line Capacitance	0.00	-46.03	46.03	0.00
Total Shunt Capacitance	0.00	-46.03	46.03	0.00
Line Losses	68.82	163.17	177.09	38.86
Cable Losses	0.00	0.00	0.00	0.00
Transformer Load Losses	67.95	2378.39	2379.36	2.86
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	136.77	2541.55	2545.23	5.37

Abnormal Conditions	Dhara	Ormat	Worst Condition	Mahua
	Phase	Count		value
	А	0	823	53.45 %
Overload	В	0	823	57.66 %
	С	0	823	53.14 %
	А	0	1705	99.66 %
Under-Voltage	В	0	1705	99.65 %
	С	0	1705	99.65 %
	А	0	1189	100.58 %
Over-Voltage	В	0	760	100.44 %
	С	0	1189	100 56 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	68.82	602.85	60.29
Cable Losses	0.00	0.00	0.00
Transformer Load Losses	67.95	595.28	59.53
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	136.77	1198.13	119.81

Feeder:

#### FEEDER 1

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adiusted)	7145 99	1847 79	7381.03	96.82
Load used (Adjusted)	7146.06	1847.86	7381.11	96.82
Shunt capacitors (Adjusted)	0.00	-1803.89	1803.89	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	7146.06	43.97	7146.20	100.00
Cable Capacitance	0.00	-2.45	2.45	0.00
Line Capacitance	0.00	-9.95	9.95	0.00
Total Shunt Capacitance	0.00	-12.40	12.40	0.00
Line Losses	27.96	64.82	70.60	39.60
Cable Losses	0.31	0.29	0.43	73.32
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	28.27	65.11	70.99	39.82

Abnormal Conditions	Phase	Count	Worst Condition	Value
	А	4	1308	100.96 %
Overload	В	4	1308	100.96 %
	С	2	1308	100.96 %
	А	0	400	100.13 %
Under-Voltage	В	0	196	99.46 %
	С	0	196	98.84 %
	А	0	13	100.44 %
Over-Voltage	В	0	13	100.40 %
	С	0	13	100.14 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	27.96	244.90	24.49
Cable Losses	0.31	2.74	0.27
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	28.27	247.63	24.76

Feeder:

## FEEDER 2

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adjusted)	8048.21	1704.26	8226.67	97.83
Load used (Adjusted)	8048.62	1704.86	8227.20	97.83
Shunt capacitors (Adjusted)	0.00	-766.26	766.26	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	8048.62	938.60	8103.16	99.33
Cable Capacitance	0.00	-26.07	26.07	0.00
Line Capacitance	0.00	-6.92	6.92	0.00
Total Shunt Capacitance	0.00	-32.99	32.99	0.00
Line Losses	57.77	135.79	147.57	39.15
Cable Losses	5.97	7.88	9.88	60.38
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	63.74	143.66	157.17	40.55

Abnormal Conditions	Phase	Count	Worst Condition	Value
	А	0	745	99.04 %
Overload	В	0	745	98.50 %
	С	0	745	98.61 %
	А	0	1154	98.96 %
Under-Voltage	В	0	1454	98.84 %
	С	0	1154	98.70 %
	А	0	648	100.45 %
Over-Voltage	В	0	648	100.42 %
	С	0	648	100 18 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	57.77	506.10	50.61
Cable Losses	5.97	52.26	5.23
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	63.74	558.35	55.84

Feeder:

## FEEDER 3

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adjusted)	5700.94	1146.12	5815.01	98.04
Load used (Adjusted)	5700.95	1146.14	5815.02	98.04
Shunt capacitors (Adjusted)	0.00	-1944.94	1944.94	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	5700.95	-798.80	5756.64	-99.03
Cable Capacitance	0.00	-23.88	23.88	0.00
Line Capacitance	0.00	-8.80	8.80	0.00
Total Shunt Capacitance	0.00	-32.68	32.68	0.00
Line Losses	56.10	130.93	142.44	39.39
Cable Losses	1.22	1.69	2.09	58.58
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	57.33	132.62	144.48	39.68

Abnormal Conditions	Phase	Count	Worst Condition	Value
	А	0	419	99.95 %
Overload	В	0	1092	99.60 %
	С	7	654	100.89 %
	А	0	1224-F	99.42 %
Under-Voltage	В	0	1224-F	99.07 %
	С	0	1115	100.17 %
	А	0	1197	100.56 %
Over-Voltage	В	0	1197	100.34 %
	С	0	1197	100 56 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	56.10	491.46	49.15
Cable Losses	1.22	10.73	1.07
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	57.33	502.19	50.22

Feeder:

#### FEEDER 4

Source:

69KV\_DELMARVA

Total Summary	kW	kvar	kVA	PF(%)
Sources (Swing)	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00
Total Generation	0.00	0.00	0.00	0.00
Load read (Non-adjusted)	6272 93	1963 27	6572 98	95 44
Load used (Adjusted)	6273.00	1963.29	6573.05	95.44
Shunt capacitors (Adjusted)	0.00	0.00	0.00	0.00
Shunt reactors (Adjusted)	0.00	0.00	0.00	0.00
Motors	0.00	0.00	0.00	0.00
Total Loads	6273.00	1963.29	6573.05	95.44
Cable Capacitance	0.00	-37.99	37.99	0.00
Line Capacitance	0.00	-4.55	4.55	0.00
Total Shunt Capacitance	0.00	-42.54	42.54	0.00
Line Losses	47.31	109.19	119.00	39.75
Cable Losses	3.43	1.04	3.58	95.72
Transformer Load Losses	0.00	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00	0.00
Total Losses	50.73	110.23	121.34	41.81

Abnormal Conditions	Phase	Count	Worst Condition	Value
	А	0	1686	88.98 %
Overload	В	0	1686	88.98 %
	С	0	1686	88.98 %
	A	0	1186	99.19 %
Under-Voltage	В	0	1190	98.73 %
	С	0	1817	99.02 %
	А	0	867	100.55 %
Over-Voltage	В	0	867	100.32 %
	С	0	867	100.53 %

Annual Cost of System Losses	kW	MW-h/year	k\$/year
Line Losses	47.31	414.40	41.44
Cable Losses	3.43	30.00	3.00
Transformer Load Losses	0.00	0.00	0.00
Transformer No-Load Losses	0.00	0.00	0.00
Total Losses	50.73	444.40	44.44

#### **DER Impact Evaluation - Summary Report**

Study Parameters	
Study Name	LEWES_SPRING_2019.xst
Date	Tue Apr 07 2020
Time	10h21m37s
Project Name	New
Verifications	Steady State Voltage
	Voltage Variation
	Thermal Loading
	Protection Reduction of Reach
	Minimum Fault Clearance
	Sympathetic Tripping
	Reverse Flow
Minimum DER Contribution	0.0%
Maximum DER Contribution	100.0%
Reference Power	Rated Power

Study Cases	Load Model	Load Scaling Factors
Case #1	DEFAULT	P = 100.0%, Q = 100.0%

			Minimum	Maximum
Installation Devices		PCC	Generation	Generation
WECS	Rated Power: 1999.0 kW	n/a	0.0 %	100.0 %
1220	Inverter Rating: 2197.0 kW		0.0 kW	1999.0 kW
Electronically Coupled Generator	Rated Power: 163.2 kW	n/a	0.0 %	100.0 %
1715	Inverter Rating: 200.0 kW		0.0 kW	163.2 kW
Electronically Coupled Generator	Rated Power: 3000.0 kW	n/a	0.0 %	100.0 %
1717	Inverter Rating: 3000.0 kW		0.0 kW	3000.0 kW
Electronically Coupled Generator	Rated Power: 8000.0 kW	n/a	0.0 %	100.0 %
1719	Inverter Rating: 8000.0 kW		0.0 kW	8000.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1723	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1720	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1721	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1722	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW

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#### DER Impact Evaluation - Spring Light Load

	Phase	Case #1
DER Off		
	A	119.8
Minimum Voltage	В	119.8
	С	119.8
	А	120.5
Maximum Voltage	В	120.5
	С	120.5
DER @ 100.0%		
	А	120.0
Minimum Voltage	В	120.0
	С	120.0
	A	121.5
Maximum Voltage	В	121.5
	С	121.5

Voltage Variation (DER Max	to Min)	
		Case #1
Network: 69KV_DELMA	RVA	
	Voltage with DER @ 100.0%	120.0 V
High Voltage	Voltage with DER Off	119.9 V
	Voltage Variation	0.16 V
	Voltage with DER @ 100.0%	120.6 V
Medium Voltage	Voltage with DER Off	119.8 V
	Voltage Variation	0.81 V
Network: FEEDER 1		
	Voltage with DER @ 100.0%	121.0 V
Medium Voltage	Voltage with DER Off	120.2 V
	Voltage Variation	0.80 V
Network: FEEDER 2	·	
	Voltage with DER @ 100.0%	120.1 V
Medium Voltage	Voltage with DER Off	119.8 V
	Voltage Variation	0.33 V
Network: FEEDER 3		
	Voltage with DER @ 100.0%	121.5 V
Medium Voltage	Voltage with DER Off	119.1 V
	Voltage Variation	2.36 V
Network: FEEDER 4		
	Voltage with DER @ 100.0%	120.0 V
Medium Voltage	Voltage with DER Off	119.1 V
	Voltage Variation	0.88 V

Voltage Variation (DER Min	to Max)	
		Case #1
Network: 69KV_DELM	ARVA	
	Voltage with DER Off	119.9 \
High Voltage	Voltage with DER @ 100.0%	120.0 \
	Voltage Variation	0.16 \
	Voltage with DER Off	120.5 \
Medium Voltage	Voltage with DER @ 100.0%	121.3 V
	Voltage Variation	0.81 \
Network: FEEDER 1		
	Voltage with DER Off	120.2 V
Medium Voltage	Voltage with DER @ 100.0%	121.0 \
	Voltage Variation	0.81 \
Network: FEEDER 2		
	Voltage with DER Off	119.8 V
Medium Voltage	Voltage with DER @ 100.0%	120.1 V
	Voltage Variation	0.32 V
Network: FEEDER 3		
	Voltage with DER Off	119.9 V
Medium Voltage	Voltage with DER @ 100.0%	122.2 V
	Voltage Variation	2.36 V
Network: FEEDER 4		
	Voltage with DER Off	119.9 V
Medium Voltage	Voltage with DER @ 100.0%	120.8 V
-	Voltage Variation	0.88 V

The worst voltage variation occurs for: (DER Min to Max)

Reverse Flow				
Device Type	Device Number	Phase	Case #1	
DER Off				
		А	1956.6 kW	
Source	723	В	1964.7 kW	
		С	1959.4 kW	
DER @ 100.0%				
		A	-2691.1 kW	
Source	723	В	-2682.8 kW	
		С	-2687.8 kW	

Thermal Loading			
Device Type	Device Number	Case #1	
		Flow	Loading (%)

No thermal loading conditions were identified.

#### **DER Impact Evaluation - Voltage Variation Report**

Study Parameters	
Study Name	LEWES_SPRING_2019.xst
Date	Tue Apr 07 2020
Time	10h21m37s
Project Name	New
Verifications	Steady State Voltage
	Voltage Variation
	Thermal Loading
	Protection Reduction of Reach
	Minimum Fault Clearance
	Sympathetic Tripping
	Reverse Flow
Minimum DER Contribution	0.0%
Maximum DER Contribution	100.0%
Reference Power	Rated Power

Study Cases	Load Model	Load Scaling Factors
Case #1	DEFAULT	P = 100.0%, Q = 100.0%

Installation Devices		PCC	Minimum	Maximum
Installation Devices		FCC	Generation	Generation
WECS	Rated Power: 1999.0 kW	n/a	0.0 %	100.0 %
1220	Inverter Rating: 2197.0 kW		0.0 kW	1999.0 kW
Electronically Coupled Generator	Rated Power: 163.2 kW	n/a	0.0 %	100.0 % 163.2 kW
Electronically Coupled Generator	Rated Power: 3000.0 kW	n/a	0.0 %	100.0 %
1717	Inverter Rating: 3000.0 kW		0.0 kW	3000.0 kW
Electronically Coupled Generator	Rated Power: 8000.0 kW	n/a	0.0 %	100.0 %
1719	Inverter Rating: 8000.0 kW		0.0 kW	8000.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1723	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1720	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1721	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1722	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW

			Location
Case #1			
High Voltage - Netwo	ork: 69KV_DELMARVA		
	Voltage with DER @ 100.0%	120.0 V	
DER Max to Min	Voltage with DER Off	119.9 V	1705
	Voltage Variation	0.16 V	
	Voltage with DER Off	119.9 V	
DER Min to Max	Voltage with DER @ 100.0%	120.0 V	1705
	Voltage Variation	0.16 V	
Medium Voltage - Ne	etwork: 69KV_DELMARVA		
	Voltage with DER @ 100.0%	120.6 V	
DER Max to Min	Voltage with DER Off	119.8 V	794
	Voltage Variation	0.81 V	
	Voltage with DER Off	120.5 V	
DER Min to Max	Voltage with DER @ 100.0%	121.3 V	794
	Voltage Variation	0.81 V	
Medium Voltage - Ne	etwork: FEEDER 1		
	Voltage with DER @ 100.0%	121.0 V	
DER Max to Min	Voltage with DER Off	120.2 V	103
	Voltage Variation	0.80 V	
	Voltage with DER Off	120.2 V	
DER Min to Max	Voltage with DER @ 100.0%	121.0 V	103
	Voltage Variation	0.81 V	
Medium Voltage - Ne	etwork: FEEDER 2		•
	Voltage with DER @ 100.0%	120.1 V	
DER Max to Min	Voltage with DER Off	119.8 V	1154
	Voltage Variation	0.33 V	
	Voltage with DER Off	119.8 V	
DER Min to Max	Voltage with DER @ 100.0%	120.1 V	1154
	Voltage Variation	0.32 V	
Medium Voltage - Ne	etwork: FEEDER 3		•
	Voltage with DER @ 100.0%	121.5 V	
DER Max to Min	Voltage with DER Off	119.1 V	1224-F
	Voltage Variation	2.36 V	
	Voltage with DER Off	119.9 V	
DER Min to Max	Voltage with DER @ 100.0%	122.2 V	1224-F
	Voltage Variation	2.36 V	
Medium Voltage - Ne	etwork: FEEDER 4		
-	Voltage with DER @ 100.0%	120.0 V	
DER Max to Min	Voltage with DER Off	119.1 V	1178
	Voltage Variation	0.88 V	1
	Voltage with DER Off	119.9 V	
DER Min to Max	Voltage with DER @ 100.0%	120.8 V	1178

The worst voltage variation occurs for: (DER Min to Max)

#### **DER Impact Evaluation - Summary Report**

Study Parameters	
Study Name	LEWES_SUMMER_2019.xst
Date	Tue Apr 07 2020
Time	10h28m29s
Project Name	New
Verifications	Steady State Voltage
	Voltage Variation
	Thermal Loading
	Protection Reduction of Reach
	Minimum Fault Clearance
	Sympathetic Tripping
	Reverse Flow
Minimum DER Contribution	0.0%
Maximum DER Contribution	100.0%
Reference Power	Rated Power

Study Cases	Load Model	Load Scaling Factors
Case #1	DEFAULT	P = 100.0%, Q = 100.0%

Installation Devices		PCC	Minimum	Maximum
WECS 1220	Rated Power: 1999.0 kW Inverter Rating: 2197.0 kW	n/a	0.0 %	100.0 % 1999.0 kW
Electronically Coupled Generator	Rated Power: 163.2 kW	n/a	0.0 %	100.0 %
1715	Inverter Rating: 200.0 kW		0.0 kW	163.2 kW
Electronically Coupled Generator	Rated Power: 3000.0 kW	n/a	0.0 %	100.0 %
1717	Inverter Rating: 3000.0 kW		0.0 kW	3000.0 kW
Electronically Coupled Generator	Rated Power: 8000.0 kW	n/a	0.0 %	100.0 %
1719	Inverter Rating: 8000.0 kW		0.0 kW	8000.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1723	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1720	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1721	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1722	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW

Steady State Voltage		
	Phase	Case #1
DER Off		
	А	119.4 V
Minimum Voltage	В	119.0 V
	С	119.2 V
	А	120.8 V
Maximum Voltage	В	120.7 V
	С	120.8 V
DER @ 100.0%		
	А	119.1 V
Minimum Voltage	В	118.7 V
	С	118.9 V
	А	121.1 V
Maximum Voltage	В	120.8 V
	С	121.8 V

Voltage Variation (DER Max	to Min)	
		Case #1
Network: 69KV_DELMA	RVA	
	Voltage with DER @ 100.0%	119.9 V
High Voltage	Voltage with DER Off	119.7 V
	Voltage Variation	0.20 V
	Voltage with DER @ 100.0%	120.2 V
Medium Voltage	Voltage with DER Off	119.0 V
	Voltage Variation	1.24 V
Network: FEEDER 1		
	Voltage with DER @ 100.0%	120.7 V
Medium Voltage	Voltage with DER Off	119.7 V
	Voltage Variation	1.05 V
Network: FEEDER 2		
	Voltage with DER @ 100.0%	119.0 V
Medium Voltage	Voltage with DER Off	118.4 V
	Voltage Variation	0.58 V
Network: FEEDER 3		
	Voltage with DER @ 100.0%	120.8 V
Medium Voltage	Voltage with DER Off	117.9 V
	Voltage Variation	2.86 V
Network: FEEDER 4		
	Voltage with DER @ 100.0%	118.7 V
Medium Voltage	Voltage with DER Off	117.4 V
	Voltage Variation	1.33 V

Voltage Variation (DER Min	to Max)	
		Case #1
Network: 69KV_DELM	ARVA	
	Voltage with DER Off	119.7 V
High Voltage	Voltage with DER @ 100.0%	119.9 V
	Voltage Variation	0.20 V
	Voltage with DER Off	120.5 V
Medium Voltage	Voltage with DER @ 100.0%	121.8 V
	Voltage Variation	1.26 V
Network: FEEDER 1		
	Voltage with DER Off	120.6 V
Medium Voltage	Voltage with DER @ 100.0%	121.6 V
	Voltage Variation	1.05 V
Network: FEEDER 2		
	Voltage with DER Off	119.2 V
Medium Voltage	Voltage with DER @ 100.0%	119.8 V
	Voltage Variation	0.57 V
Network: FEEDER 3		
	Voltage with DER Off	119.6 V
Medium Voltage	Voltage with DER @ 100.0%	122.4 V
	Voltage Variation	2.85 V
Network: FEEDER 4		•
	Voltage with DER Off	119.0 V
Medium Voltage	Voltage with DER @ 100.0%	120.3 V
	Voltage Variation	1.33 V

The worst voltage variation occurs for: (DER Min to Max)

Reverse Flow				
Device Type	Device Number	Phase	Case #1	
DER Off				
		A	7174.8 kW	
Source	723	В	7319.8 kW	
		С	7134.6 kW	
DER @ 100.0%				
		А	2481.7 kW	
Source	723	В	2637.6 kW	
		С	2451.4 kW	

Thermal Loading			
Device Type	Device Number	Case #1	
		Flow	Loading (%)

No thermal loading conditions were identified.

#### **DER Impact Evaluation - Voltage Variation Report**

Study Parameters	
Study Name	LEWES_SUMMER_2019.xst
Date	Tue Apr 07 2020
Time	10h16m19s
Project Name	New
Verifications	Steady State Voltage
	Voltage Variation
	Thermal Loading
	Protection Reduction of Reach
	Minimum Fault Clearance
	Sympathetic Tripping
	Reverse Flow
Minimum DER Contribution	0.0%
Maximum DER Contribution	100.0%
Reference Power	Rated Power

Study Cases	Load Model	Load Scaling Factors
Case #1	DEFAULT	P = 100.0%, Q = 100.0%

			Minimum	Maximum
Installation Devices	I	PCC	Generation	Generation
WECS	Rated Power: 1999.0 kW	n/a	0.0 %	100.0 %
1220	Inverter Rating: 2197.0 kW		0.0 kW	1999.0 kW
Electronically Coupled Generator	Rated Power: 163.2 kW	n/a	0.0 %	100.0 %
1715	Inverter Rating: 200.0 kW		0.0 kW	163.2 kW
Electronically Coupled Generator	Rated Power: 3000.0 kW	n/a	0.0 %	100.0 %
1717	Inverter Rating: 3000.0 kW		0.0 kW	3000.0 kW
Electronically Coupled Generator	Rated Power: 8000.0 kW	n/a	0.0 %	100.0 %
1719	Inverter Rating: 8000.0 kW		0.0 kW	8000.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1723	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1720	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1721	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1722	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW

Voltage Variation			
			Location
Case #1			
High Voltage - Netw	ork: 69KV_DELMARVA		
	Voltage with DER @ 100.0%	119.9 V	
DER Max to Min	Voltage with DER Off	119.7 V	1705
	Voltage Variation	0.20 V	
	Voltage with DER Off	119.7 V	
DER Min to Max	Voltage with DER @ 100.0%	119.9 V	1705
	Voltage Variation	0.20 V	
Medium Voltage - N	etwork: 69KV_DELMARVA	1	l .
	Voltage with DER @ 100.0%	120.2 V	
DER Max to Min	Voltage with DER Off	119.0 V	794
	Voltage Variation	1.24 V	
	Voltage with DER Off	120.5 V	70.1
DER MIN to Max	Voltage with DER @ 100.0%	121.8 V	794
Madium Valtara N	voltage variation	1.26 V	
wedium voltage - N		100 71	
DEB May ta Min	Voltage with DER @ 100.0%	120.7 V	103
DER Max to Min	Voltage Variation	119.7 V	103
	Voltage with DER Off	1.05 V	
DER Min to Max	Voltage with DER @ 100.0%	120.6 V	103
	Voltage Variation	121.0 V	
Medium Voltage - N	etwork: FEEDER 2	1.00 0	
	Voltage with DER @ 100.0%	119.0 V	
DER Max to Min	Voltage with DER Off	118.4 V	1154
	Voltage Variation	0.58 V	
	Voltage with DER Off	119.2 V	
DER Min to Max	Voltage with DER @ 100.0%	119.8 V	1154
	Voltage Variation	0.57 V	
Medium Voltage - N	etwork: FEEDER 3		·
	Voltage with DER @ 100.0%	120.8 V	
DER Max to Min	Voltage with DER Off	117.9 V	1224-F
	Voltage Variation	2.86 V	
	Voltage with DER Off	119.6 V	
DER Min to Max	Voltage with DER @ 100.0%	122.4 V	1224-F
	Voltage Variation	2.85 V	
Medium Voltage - N	etwork: FEEDER 4	n	1
	Voltage with DER @ 100.0%	118.7 V	
DER Max to Min	Voltage with DER Off	117.4 V	1178
	Voltage Variation	1.33 V	
	Voltage with DER Off	119.0 V	1170
DER Min to Max	Voltage with DER @ 100.0%	120.3 V	1178
	Voltage Variation	1.33 V	

The worst voltage variation occurs for: (DER Min to Max)

#### **DER Impact Evaluation - Summary Report**

Study Parameters	
Study Name	LEWES_CKT_WINTER_2019.xst
Date	Tue Apr 07 2020
Time	10h34m34s
Project Name	New
Verifications	Steady State Voltage
	Voltage Variation
	Thermal Loading
	Protection Reduction of Reach
	Minimum Fault Clearance
	Sympathetic Tripping
	Reverse Flow
Minimum DER Contribution	0.0%
Maximum DER Contribution	100.0%
Reference Power	Rated Power

Study Cases	Load Model	Load Scaling Factors
Case #1	DEFAULT	P = 100.0%, Q = 100.0%

Installation Devices		PCC	Minimum	Maximum
WECS 1220	Rated Power: 1999.0 kW Inverter Rating: 2197.0 kW	n/a	0.0 %	100.0 % 1999.0 kW
Electronically Coupled Generator	Rated Power: 163.2 kW	n/a	0.0 %	100.0 %
1715	Inverter Rating: 200.0 kW		0.0 kW	163.2 kW
Electronically Coupled Generator	Rated Power: 3000.0 kW	n/a	0.0 %	100.0 %
1717	Inverter Rating: 3000.0 kW		0.0 kW	3000.0 kW
Electronically Coupled Generator	Rated Power: 8000.0 kW	n/a	0.0 %	100.0 %
1719	Inverter Rating: 8000.0 kW		0.0 kW	8000.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1723	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1720	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW Inverter Rating: 200.0 kW	n/a	0.0 % 0.0 kW	100.0 % 200.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1722	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW

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#### DER Impact Evaluation - Winter Heavy Load

	Phase	Case #1
DER Off	Thate	
	A	119.3
Minimum Voltage	В	119.0
	С	119.2
	A	120.8
Maximum Voltage	В	120.8
	С	120.8
DER @ 100.0%		
	A	119.4
Minimum Voltage	В	119.3
	С	119.3
	A	121.8
Maximum Voltage	В	121.8
	С	122.6

Voltage Variation (DER Max	to Min)	
		Case #1
Network: 69KV_DELM	ARVA	
	Voltage with DER @ 100.0%	119.9 V
High Voltage	Voltage with DER Off	119.7 V
	Voltage Variation	0.20 V
	Voltage with DER @ 100.0%	120.9 V
Medium Voltage	Voltage with DER Off	119.6 V
	Voltage Variation	1.24 V
Network: FEEDER 1		
	Voltage with DER @ 100.0%	120.8 V
Medium Voltage	Voltage with DER Off	119.8 V
	Voltage Variation	1.05 V
Network: FEEDER 2	·	
	Voltage with DER @ 100.0%	119.3 V
Medium Voltage	Voltage with DER Off	118.7 V
	Voltage Variation	0.57 V
Network: FEEDER 3	·	
	Voltage with DER @ 100.0%	121.8 V
Medium Voltage	Voltage with DER Off	119.0 V
	Voltage Variation	2.84 V
Network: FEEDER 4		•
	Voltage with DER @ 100.0%	119.5 V
Medium Voltage	Voltage with DER Off	118.2 V
	Voltage Variation	1.33 V

Voltage Variation (DER Min	to Max)	
		Case #1
Network: 69KV_DELM	ARVA	
	Voltage with DER Off	119.7 V
High Voltage	Voltage with DER @ 100.0%	119.9 V
	Voltage Variation	0.20 V
	Voltage with DER Off	120.4 V
Medium Voltage	Voltage with DER @ 100.0%	121.7 V
	Voltage Variation	1.25 V
Network: FEEDER 1		
	Voltage with DER Off	120.7 V
Medium Voltage	Voltage with DER @ 100.0%	121.8 V
	Voltage Variation	1.05 V
Network: FEEDER 2		
	Voltage with DER Off	119.5 V
Medium Voltage	Voltage with DER @ 100.0%	120.1 V
	Voltage Variation	0.57 V
Network: FEEDER 3		•
	Voltage with DER Off	119.8 V
Medium Voltage	Voltage with DER @ 100.0%	122.6 V
-	Voltage Variation	2.84 V
Network: FEEDER 4		•
	Voltage with DER Off	119.0 V
Medium Voltage	Voltage with DER @ 100.0%	120.3 V
-	Voltage Variation	1.33 V

The worst voltage variation occurs for: (DER Min to Max)

Reverse Flow				
Device Type	Device Number	Phase	Case #1	
DER Off				
		А	7384.1 kW	
Source	723	В	7543.4 kW	
		С	7365.7 kW	
DER @ 100.0%				
		A	2689.9 kW	
Source	723	В	2859.5 kW	
		С	2682.2 kW	

Thermal Loading			
	Device Number	Case #1	
Device Type	Device Number	Flow	Loading (%)

No thermal loading conditions were identified.

#### **DER Impact Evaluation - Steady State Report**

Study Parameters	
Study Name	LEWES_CKT_WINTER_2019.xst
Date	Tue Apr 07 2020
Time	10h03m20s
Project Name	New
Verifications	Steady State Voltage
	Voltage Variation
	Thermal Loading
	Protection Reduction of Reach
	Minimum Fault Clearance
	Sympathetic Tripping
	Reverse Flow
Minimum DER Contribution	0.0%
Maximum DER Contribution	100.0%
Reference Power	Rated Power

Study Cases	Load Model	Load Scaling Factors
Case #1	DEFAULT	P = 100.0%, Q = 100.0%

Installation Devices		PCC	Minimum	Maximum
WECS 1220	Rated Power: 1999.0 kW Inverter Rating: 2197.0 kW	n/a	0.0 %	100.0 % 1999.0 kW
Electronically Coupled Generator	Rated Power: 163.2 kW	n/a	0.0 %	100.0 %
1715	Inverter Rating: 200.0 kW		0.0 kW	163.2 kW
Electronically Coupled Generator	Rated Power: 3000.0 kW	n/a	0.0 %	100.0 %
1717	Inverter Rating: 3000.0 kW		0.0 kW	3000.0 kW
Electronically Coupled Generator	Rated Power: 8000.0 kW	n/a	0.0 %	100.0 %
1719	Inverter Rating: 8000.0 kW		0.0 kW	8000.0 kW
Electronically Coupled Generator	Rated Power: 100.0 kW	n/a	0.0 %	100.0 %
1723	Inverter Rating: 100.0 kW		0.0 kW	100.0 kW
Electronically Coupled Generator	Rated Power: 100.0 kW	n/a	0.0 %	100.0 %
1720	Inverter Rating: 100.0 kW		0.0 kW	100.0 kW
Electronically Coupled Generator	Rated Power: 100.0 kW	n/a	0.0 %	100.0 %
1721	Inverter Rating: 100.0 kW		0.0 kW	100.0 kW
Electronically Coupled Generator	Rated Power: 100.0 kW	n/a	0.0 %	100.0 %
1722	Inverter Rating: 100.0 kW		0.0 kW	100.0 kW

Minimum Voltages			
	Phase	Worst Condition	Voltage
Case #1			
	A	1190	119.3 V
DER Off	В	1190	119.0 V
	С	1817	119.2 V
	A	1154	119.3 V
DER @ 100.0%	В	1163	119.2 V
	С	1154	119.2 V

Maximum Voltages			
	Phase	Worst Condition	Voltage
Case #1			
	A	760	120.8 V
DER Off	В	760	120.8 V
	С	1009	120.8 V
	A	1224-F	121.8 V
DER @ 100.0%	В	1224-F	121.7 V
	С	1224-F	122.6 V

Load Tap Changers		
	Device Number	Case #1
Device Type	Device Number	Тар
DER Off		
Two-Winding Transformer	823	-4
DER @ 100.0%		
Two-Winding Transformer	823	-5

#### **DER Impact Evaluation - Voltage Variation Report**

Study Parameters	
Study Name	LEWES_CKT_WINTER_2019.xst
Date	Tue Apr 07 2020
Time	10h12m29s
Project Name	New
Verifications	Steady State Voltage
	Voltage Variation
	Thermal Loading
	Protection Reduction of Reach
	Minimum Fault Clearance
	Sympathetic Tripping
	Reverse Flow
Minimum DER Contribution	0.0%
Maximum DER Contribution	100.0%
Reference Power	Rated Power

Study Cases	Load Model	Load Scaling Factors
Case #1	DEFAULT	P = 100.0%, Q = 100.0%

			Minimum	Maximum
Installation Devices	1	PCC	Generation	Generation
WECS	Rated Power: 1999.0 kW	n/a	0.0 %	100.0 %
1220	Inverter Rating: 2197.0 kW		0.0 kW	1999.0 kW
Electronically Coupled Generator	Rated Power: 163.2 kW	n/a	0.0 %	100.0 %
1715	Inverter Rating: 200.0 kW		0.0 kW	163.2 kW
Electronically Coupled Generator	Rated Power: 3000.0 kW	n/a	0.0 %	100.0 %
1717	Inverter Rating: 3000.0 kW		0.0 kW	3000.0 kW
Electronically Coupled Generator	Rated Power: 8000.0 kW	n/a	0.0 %	100.0 %
1719	Inverter Rating: 8000.0 kW		0.0 kW	8000.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1720	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1721	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1722	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW
Electronically Coupled Generator	Rated Power: 200.0 kW	n/a	0.0 %	100.0 %
1723	Inverter Rating: 200.0 kW		0.0 kW	200.0 kW

Voltage Variation			
			Location
Case #1			
High Voltage - Netwo	ork: 69KV_DELMARVA		
	Voltage with DER @ 100.0%	119.9 V	
DER Max to Min	Voltage with DER Off	119.7 V	1705
	Voltage Variation	0.20 V	
	Voltage with DER Off	119.7 V	
DER Min to Max	Voltage with DER @ 100.0%	119.9 V	1705
	Voltage Variation	0.20 V	
Medium Voltage - Ne	twork: 69KV_DELMARVA		t
	Voltage with DER @ 100.0%	120.9 V	
DER Max to Min	Voltage with DER Off	119.6 V	794
	Voltage Variation	1.24 V	
	Voltage with DER Off	120.4 V	
DER Min to Max	Voltage with DER @ 100.0%	121.7 V	794
	Voltage Variation	1.25 V	
Medium Voltage - Ne	twork: FEEDER 1	1	
	Voltage with DER @ 100.0%	120.8 V	
DER Max to Min	Voltage with DER Off	119.8 V	103
		1.05 V	
	Voltage with DER Off	120.7 V	100
DER MIN to Max	Voltage with DER @ 100.0%	121.8 V	103
Madium Valtaria Na		1.05 V	
Medium voltage - Ne		440.034	
DER Max to Min	Voltage with DER @ 100.0%	119.3 V	1154
DER Max to Mill	Voltage Variation	118.7 V	1154
	Voltage with DER Off	0.57 V	
DER Min to Max	Voltage with DER @ 100.0%	119.5 V	1154
	Voltage Variation	120.1 V	
Medium Voltage - Ne	twork: FEEDER 3	0.57 V	
inculation restage inc	Voltage with DER @ 100.0%	121 8 V	
DER Max to Min	Voltage with DER Off	119.0 V	1224-F
	Voltage Variation	2.84 V	
	Voltage with DER Off	119.8 V	
DER Min to Max	Voltage with DER @ 100.0%	122.6 V	1224-F
	Voltage Variation	2.84 V	
Medium Voltage - Ne	twork: FEEDER 4	•	
	Voltage with DER @ 100.0%	119.5 V	
DER Max to Min	Voltage with DER Off	118.2 V	1178
	Voltage Variation	1.33 V	
	Voltage with DER Off	119.0 V	
DER Min to Max	Voltage with DER @ 100.0%	120.3 V	1178
	Voltage Variation	1.33 V	

The worst voltage variation occurs for: (DER Min to Max)

					Without DER		With DER		Reduction in Reach		
					Phase	Ground	Phase	Ground	Phase	Ground	
		Fault	Phase Relay	Ground	Current	Current	Current	Current	Current	Current	
Case	Fault Location	Туре	Pickup	Relay Pickup	(A)	(3*I0, A)	(A)	(3*I0, A)	(%)	(%)	Acceptable
	Circuit #3 -Fault at Node 869 (End of Pilottown Rd)	LLLG	540A	120A	2854	0	2840	0	0.5%	*	Y
1	Effect of Univerity Wind Turbine	LG	540A	120A	2209	2210	2185	2150	1.1%	2.7%	Y
	Circuit #3 -Fault at Node 1115 (End of Cedar St)	LLLG	540A	120A	2790	0	2751	0	1.4%	*	Y
2	Effect of Univerity Wind Turbine	LG	540A	120A	2030	2028	1990	1985	2.0%	2.1%	Y
	Circuit #1 - Fault at Node 196 (Kings Dr & Salty Dog Ln)										
3	Effect of 8MW DER at Wellfield Site	LG	540A	120A	1556	1549	1495	1445	4.0%	6.8%	Y

## **Overcurrent Protection Reduction in Reach**

# APPENDIX C. FUTURE LOADING PROJECTIONS

















Sargent & Lundy













# APPENDIX D. NISC APPROVED VENDOR LIST



## Electric System Analysis and Study 13968.001 Vendor Overview List for Members

LEWES Board of Public Works

Appendix D





	Vendor	Technology	Electric Support	Water Support	Gas Support	Requires Custom	Supported Reading Format	Supports MultiSpeak 3.0	Supports MultiSpeak 4.1
1	Aclara Badger HOP	RF					MDMS (NISC FORMAT) MDMS (EV_BINNING) MDMS Event Codes (HEX)	No	No
2	Aclara Metrum	Cellular	✓				MDMS (CMEP 01/02)	No	No
3	Aclara Star	RF		<ul><li>✓</li></ul>	<ul> <li>Image: A set of the set of the</li></ul>		CIS (NISC FORMAT) MDMS (CMEP) MDMS (NISC FORMAT)	No	Yes
4	Aclara TWACS/TNS without AclaraOne	PLC					CIS (NISC FORMAT) MDMS (NISC FORMAT) MDMS (EV_BINNING) MDMS Event Codes (Quality Codes) ProaSYS	Yes	No
5	Aclara AclaraOne	PLC RF	<b>~</b>				CIS (NISC FORMAT) MDMS (NISC FORMAT) MDMS (EV_BINNING) MDMS Event Codes (Quality Codes)	No	Yes
6	Aclara IHUB	Cellular PLC RF	<ul><li>✓</li></ul>	<ul><li>✓</li></ul>				PENDING	PENDING
7	Advanced Control Systems							No	Yes
8	Badger	Cellular Drive-by Hand-Held Probe	✓	✓	✓		CIS (Flat File) - MONTHLY	No	No
9	C3-ilex								
10	Chapman								
11	Clevest								
12	Eaton/Cooper Cannon	PLC RF	✓	~	<b>~</b>		CIS (NISC FORMAT) MDMS (CMEP) MDMS (NISC FORMAT) MDMS Event Codes (Eaton Prorieratry)	Yes	No
13	Honeywell (Elster) NetSense	Cellular RF	<	<ul><li>✓</li></ul>	<ul><li>✓</li></ul>		CIS (NISC FORMAT) MDMS (CMEP) MDMS (NISC FORMAT) MDMS (XML)	Yes	Yes
14	Honeywell (Elster) Route Manager	Drive-by Hand-Held Probe				<ul><li>✓</li></ul>	CIS (Flat File) - MONTHLY	No	No
15	GE	RF	<ul><li>✓</li></ul>				MDMS (CMEP 01/02) MDMS (MLA)	Yes	Yes
16	GE								
17	HD Supply								
18	Itron								
19	Itron Fixed Network	Fixed Network	<ul><li>✓</li></ul>	<ul><li>✓</li></ul>			CIS (XML)	No	No
20	Itron Gen5 (AMM)	RF	✓				MDMS (NISC FORMAT)	No	Yes
21	Itron Open Way (Classic)	Cellular	✓				MDMS (XML)	Yes	No
22	Itron Open Way Operations Center								
23	Itron MV90	Cellular Drive-by Hand-Held	<ul><li>✓</li></ul>				MDMS (CMEP)	No	No
24	Itron MVRS/FCS	Drive-by Hand-Held Probe	<	<ul><li>✓</li></ul>	<ul><li>✓</li></ul>		CIS (Flat File) - MONTHLY	No	No
25	Itron SmartSync	Cellular	✓				MDMS (CMEP)	Yes	No
26	Landis & Gyr TS1/TS2	PLC	✓	✓	<ul><li>✓</li></ul>		CIS (NISC FORMAT) MDMS (CMEP) MDMS (NISC FORMAT) WS API - Events	Yes	No
27	Landis & Gyr Load Management		<ul><li>✓</li></ul>				N/A	No	Yes
28	Landis & Gyr Gridstream	PLC RF	<ul><li>✓</li></ul>				CIS (NISC FORMAT) MDMS (CMEP) MDMS (NISC FORMAT) MDMS Events (WS API)	Yes	No
29	Leidos	RF	✓				CIS (NISC FORMAT)	Yes	No
30	Luthan Electric Meter Testing								
31	Master Meter 3g Mobile	Drive-by Hand-Held Probe					CIS (Flat File) - MONTHLY	No	No
SL Report No.: SL-LEWES-2019-01 Rev. No. 001 04/07/2020

LEWES Board of Public Works							
Electric System Analysis and Study							
13968.001							

	/endor	Technology	Electric Support	Water Support	Gas Support	Requires Custom	Supported Reading Format	Supports MultiSpeak 3.0	Supports MultiSpeak 4.1
32	Master Meter Allegro	RF		<ul> <li>Image: A start of the start of</li></ul>				No	No
33	MSFDS Fusion	Cellular	✓				MDMS (CMEP)	No	Yes
34	Mueller Mega-Net	Drive-by Hand-Held Probe		<b>~</b>		?	CIS (Flat File) - MONTHLY	No	No
35	MyMeter		✓					Yes	No
36	Neptune EZRoute/N_Sight	Drive-by Hand-Held Probe		<ul> <li>✓</li> </ul>		<	CIS (Flat File) - MONTHLY	No	No
37	Neptune360	Cellular Drive-by Hand-Held Probe Fixed Network		<ul> <li>✓</li> </ul>		<	CIS (Flat File) - MONTHLY	No	No
38	NexGrid	RF	✓				MDMS (CMEP)	Yes	No
39	Nighthawk Adaptiv	Cellular	✓				CIS (NISC FORMAT) MDMS (CMEP) MDMS (NISC FORMAT)	Yes	No
40	Northrop Grumman VersaTerm	Drive-by Hand-Held Probe	✓	<ul> <li>Image: A start of the start of</li></ul>		<	CIS (Flat File) - MONTHLY	No	No
41	OnRamp								
42	Open Systems International		✓				MDMS (SCADA FORMAT) MultiSpeak	No	No
43	RG3 Tesla	Drive-by Hand-Held Probe				<b>V</b>	CIS (Flat File) - MONTHLY	No	No
44	Sensus AutoRead	Drive-by Hand-Held Probe	<			<	CIS (Flat File) - MONTHLY	No	No
45	Sensus RNI	RF	✓	<b>~</b>	<		CIS (NISC FORMAT) MDMS (CMEP) MLA - Events	Yes	Yes
46	Sensus Logic (Harris)	MDMS	✓	<ul> <li>Image: A start of the start of</li></ul>		<	CIS (NISC FORMAT) MDMS (CMEP)	No	No
47	Sensus Analytics	MDMS	✓	<ul> <li>Image: A start of the start of</li></ul>		<	CIS (NISC FORMAT) MDMS (CMEP)	No	No
48	Survalent	SCADA	✓				MDMS (SCADA FORMAT)	No	No
49	Siemens								
50	STS								
51	Tantalus TuNET	RF ERT	✓	✓	<	<	CIS (NISC FORMAT) MDMS (CMEP) MDMS (MLA)	Yes	No
52	Trilliant OTV (OnRamp)	RF	<			<		Y/N	No
53	Trilliant SerViewCom	RF	<b>~</b>			<		Y/N	No
54	UtiliSmart	RF						Yes	No
55	Verizon Grid Wide	Cellular	<ul> <li>Image: A set of the set of the</li></ul>				CIS (NISC FORMAT) MDMS (CMEP 01/02)	No	Yes
56	Vision Metering		Image: A start of the start			<	CIS (MultiSpeak) CIS (MTU FORMAT)	No	Yes
57	WECO		✓			<	CIS (MultiSpeak) CIS (MTU FORMAT)	No	Yes