BEFORE
THE PUBLIC UTILITIES COMMISSION OF OHIO

In the Matter of the Application of Ohio	**:**	**Case No. 09-1820-EL-ATA**
Edison Company, The Cleveland Electric	**:**	**Case No. 09-1821-EL-GRD**
Illuminating Company, and The Toledo	**:**	**Case No. 09-1822-EL-EEC**
Edison Company for Approval of Ohio	**:**	**Case No. 09-1823-EL-AAM**
Site Deployment of the Smart Grid	**:**	
Modernization Initiative and Timely	**:**	
Recovery of Associated Costs	**:**	

REPORT

On May 28, 2015, the Commission issued a Finding and Order ("Order") granting Ohio Edison Company, The Cleveland Electric Illuminating Company and The Toledo Edison Company's (collectively, the "Companies") Application to complete studies related to the Ohio Site Deployment of the Smart Grid Program ("Smart Grid Pilot"). In that Order, the Commission directed the Companies to file an interim report regarding the data obtained from the Volt Var Optimization and Distribution Automation studies annually. The Companies hereby submit their annual interim report for the 12-month period ending May 31, 2023.

Distribution Automation (DA)

As initially contemplated in the U.S. Department of Energy ("DOE") Smart Grid Investment Grant, the Smart Grid Pilot included 34 DA circuits. In the interim reports filed in 2015 through 2018 the Companies reported cumulative DA performance for the 34 circuits by comparing to those same circuits during a baseline period of 2005 to 2009 – prior to the installation of any DA equipment. Because the Companies' spend for DA work on the original 34 circuits was below the amount granted by the DOE, DA work was subsequently performed on two additional circuits. The two additional circuits were not part of the 2005-2009 baseline, and they were not included in the interim reports filed in 2015-2018.

Beginning with their 2019 interim report,[1] the Companies began reporting Smart Grid Pilot DA performance using a counterfactual approach.[2] From 2019 to 2022, the Companies' interim reports were intended to analyze DA performance using the counterfactual approach on the original 34 circuits. However, the Companies included customers interrupted (CI) and customer minutes interrupted (CMI) for all 36 circuits, while the customer counts continued to reflect only the customers on the original 34 circuits. To correct for this, in this report the Companies are including a revised table showing DA performance for the original 34 circuits from June 2014 – May 2023 excluding major storms and separately analyzing major storm performance. In addition, the Companies are adding a new table showing DA performance on all 36 circuits from June 2014 – May 2023, excluding major storms and separately analyzing major storm performance. Going forward, the Companies plan to report DA performance for all 36 Smart Grid Pilot DA circuits.

Non-Storm (DA) – 34 Circuits

Non-Storm Reliability Saved -- Smart Grid vs. Non Smart Grid (June 2014 thru May 2023)

					SG Circuit Savings	
	Customers Interrupted Savings	**% Savings**	**CMI Savings**	**% Savings**	**SAIFI**	**SAIDI**
Year One (Jun '14 thru May '15)	5,425	***11%***	783,922	***15%***	0.12	17.44
Year Two (June '15 thru May '16)	4,448	***6%***	883,757	***11%***	0.10	19.65
Year Three (June '16 thru May '17)	6,655	***9%***	1,346,560	***17%***	0.15	29.67
Year Four (June '17 thru May '18)	10,658	***14%***	1,788,477	***24%***	0.23	39.13
Year Five (June '18 thru May '19)	23,502	***22%***	3,216,606	***28%***	0.51	69.54
Year Six (June '19 thru May '20)	5,287	***8%***	1,627,374	***24%***	0.11	35.16
Year Seven (June '20 thru May '21)	11,648	***12%***	3,102,517	***27%***	0.25	67.56
Year Eight (June '21 thru May '22)	12,207	***14%***	2,491,315	***19%***	0.26	53.25
Year Nine (June '22 thru May '23)	8,213	***10%***	1,631,527	***14%***	0.18	35.15
Grand Total	**88,043**	***12%***	**16,872,055**	***20%***	**0.21**	**40.88**

Notes

1. Outages include, Distribution, Substation, and Transmission, excludes major storms
2. Includes tap outages that would not have been affected by Smart Grid facilities

[1] *See* Companies' Interim Report (8/15/2019).

[2] The counterfactual approach compares actual reliability with the smart grid investments to performance without the smart grid investments.

Non-Storm (DA) – 36 Circuits

Non-Storm Reliability Saved -- Smart Grid vs. Non Smart Grid (June 2014 thru May 2023)

					SG Circuit Savings	
	Customers Interrupted Savings	% Savings	CMI Savings	% Savings	SAIFI	SAIDI
Year One (Jun '14 thru May '15)	5,425	*10%*	783,922	*14%*	0.11	16.29
Year Two (June '15 thru May '16)	4,448	*5%*	883,757	*11%*	0.09	18.29
Year Three (June '16 thru May '17)	7,207	*10%*	1,384,650	*17%*	0.15	28.38
Year Four (June '17 thru May '18)	10,814	*13%*	1,841,098	*24%*	0.22	37.74
Year Five (June '18 thru May '19)	23,502	*22%*	3,315,636	*28%*	0.47	66.92
Year Six (June '19 thru May '20)	6,198	*9%*	1,689,989	*25%*	0.13	34.21
Year Seven (June '20 thru May '21)	12,634	*11%*	3,506,419	*29%*	0.26	71.33
Year Eight (June '21 thru May '22)	12,495	*14%*	2,584,275	*19%*	0.25	51.31
Year Nine (June '22 thru May '23)	8,213	*10%*	1,631,527	*14%*	0.17	32.81
Grand Total	**90,936**	***12%***	**17,621,273**	***21%***	**0.21**	**39.85**

Notes

1. Outages include, Distribution, Substation, and Transmission, excludes major storms
2. Includes tap outages that would not have been affected by Smart Grid facilities

Storm (DA) – 34 Circuits

Major Storm Reliability Saved -- Smart Grid vs. Non Smart Grid (June 2014 thru May 2023)

					SG Circuit Savings	
	Customers Interrupted Savings	% Savings	CMI Savings	% Savings	SAIFI	SAIDI
Year One (Jun '14 thru May '15)	3,469	*18%*	631,594	*11%*	0.08	14.06
Year Two (June '15 thru May '16)	0	*0%*	0	*0%*	0.00	0.00
Year Three (June '16 thru May '17)	1,930	*7%*	1,830,772	*19%*	0.04	40.33
Year Four (June '17 thru May '18)	1,066	*9%*	402,142	*5%*	0.02	8.80
Year Five (June '18 thru May '19)	4,002	*12%*	2,295,659	*24%*	0.09	49.63
Year Six (June '19 thru May '20)	4,138	*12%*	1,720,949	*14%*	0.09	37.18
Year Seven (June '20 thru May '21)	715	*1%*	499,863	*1%*	0.02	10.89
Year Eight (June '21 thru May '22)	3,147	*19%*	317,183	*6%*	0.07	6.78
Year Nine (June '22 thru May '23)	3,459	*11%*	1,018,886	*6%*	0.07	21.95
Grand Total	**21,926**	***12%***	**8,717,048**	***14%***	**0.05**	**21.12**

Notes

1. Outages include, Distribution, Substation, and Transmission, includes major storms only
2. Includes tap outages that would not have been affected by Smart Grid facilities
3. Catastrophic events on 11-15-2020 and 12-1-2020 are excluded. Basis for this exclusion explained in the paper titled "Analysis of Catastrophic Events Using Statistical Outlier Method" published by IEEE.
4. Customer outages for major storms capped at 24 hours.

Storm (DA) – 36 Circuits

Major Storm Reliability Saved -- Smart Grid vs. Non Smart Grid (June 2014 thru May 2023)

	Customers Interrupted Savings	% Savings	CMI Savings	% Savings	SG Circuit Savings SAIFI	SG Circuit Savings SAIDI
Year One (Jun '14 thru May '15)	3,469	***18%***	631,594	***11%***	0.07	13.13
Year Two (June '15 thru May '16)	0	***0%***	13,520	***1%***	0.00	0.28
Year Three (June '16 thru May '17)	2,440	***9%***	2,070,046	***21%***	0.05	42.43
Year Four (June '17 thru May '18)	1,899	***15%***	614,638	***8%***	0.04	12.60
Year Five (June '18 thru May '19)	4,075	***12%***	2,374,258	***24%***	0.08	47.92
Year Six (June '19 thru May '20)	4,693	***14%***	1,876,616	***15%***	0.09	37.99
Year Seven (June '20 thru May '21)	715	***1%***	535,963	***1%***	0.01	10.90
Year Eight (June '21 thru May '22)	3,147	***19%***	317,183	***6%***	0.06	6.30
Year Nine (June '22 thru May '23)	3,459	***11%***	1,018,886	***6%***	0.07	20.49
Grand Total	**23,897**	***13%***	**9,452,704**	***15%***	**0.05**	**21.38**

Notes

1. Outages include, Distribution, Substation, and Transmission, includes major storms only
2. Includes tap outages that would not have been affected by Smart Grid facilities
3. Catastrophic events on 11-15-2020 and 12-1-2020 are excluded. Basis for this exclusion explained in the paper titled "Analysis of Catastrophic Events Using Statistical Outlier Method" published by IEEE.
4. Customer outages for major storms capped at 24 hours.

Integrated Volt Var Control (IVVC)

During this reporting period (June 1, 2022, through May 31, 2023), the Companies continued to operate and monitor the performance of the IVVC equipment in the Smart Grid Pilot area. The Companies analyzed seven core substations and 23 circuits deployed with IVVC during the 12-month period. During this reporting period, two primary operational modes for the IVVC were used:

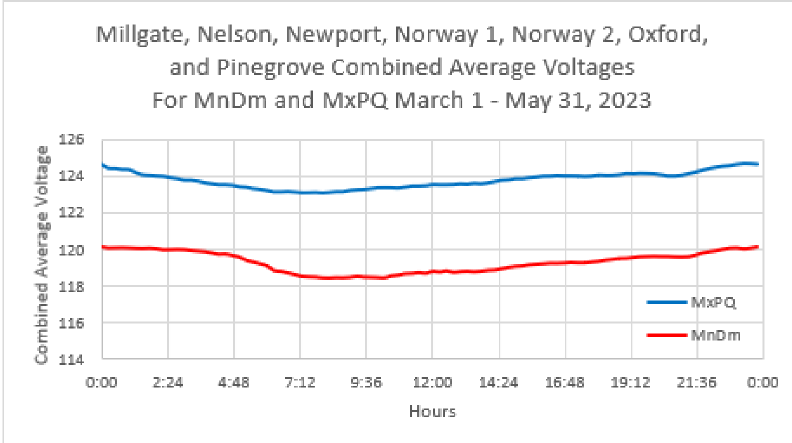
1. Minimize Demand (MnDm): This operational setting is used to reduce customer usage and to minimize peak demand, both on a circuit and substation level. This setting will lower circuit voltages to the lower end of the allowable range and could impact power quality. The target voltage range for MnDm is 117 to 120 volts.
2. Maximize Power Quality (MxPQ): This operational setting is used to mitigate power quality issues that may be created following operational switching to restore customers or by one customer that impacts other customers on the circuit. This setting typically causes voltage to increase. The target voltage range for MxPQ is 123 to 125 volts.

The Companies evaluated operation of the IVVC system in two key performance areas, voltage separation and Conservation Voltage Reduction (CVR). The results of these evaluations are summarized below.

Voltage Separation

Voltage separation represents the system's ability to respond to operational commands to lower voltage. The greater the ability to intentionally lower distribution voltage while still maintaining compliance within the ANSI range, the greater the potential performance in terms of demand and energy consumption (*i.e.,* CVR).

The graph below shows the combined average circuit phase voltage for the IVVC system core substations, Millgate, Nelson, Newport, Norway 1, Norway 2, Oxford, and Pinegrove during the Spring 2023 evaluation period (March 1 through May 31, 2023). The blue lines represent the average circuit phase voltage when the operating mode was set to Maximize Power Quality (MxPQ). The red lines represent the average circuit phase voltage when the operating mode was set to Minimize Demand (MnDm). Overall, for all hours of operation during the study period, the average voltage separation between MxPQ and MnDm operating modes across these core substations was 4.48 volts, a difference of 3.6%. The tables below the following graph show a comparison of voltage separation from Spring 2023 versus Spring 2022 and Spring 2021. Results were consistent year over year.



Average Voltage March 1 - May 31, 2023[1]	
Average Voltage	
MxPQ	123.79
MnDm	119.31
Voltage Δ	4.48
%	3.62%

Average Voltage April 1 - May 31, 2022	
Average Voltage	
MxPQ	123.65
MnDm	119.23
Voltage Δ	4.43
%	3.58%

Average Voltage March 14 - May 31, 2021[2]	
Average Voltage	
MxPQ	123.70
MnDm	119.41
Voltage Δ	4.29
%	3.47%

Notes:
1. There is 1% differrence in voltage separation between this graph which is 4.48 volts and the table below that has 4.44 volts. The table below uses historical CVR factors in order to produce the voltage separation, whereas, this table uses realized values from this time period.
2 The Newport Substation was excluded from the 2021 data due to the installation of mobile substation. See Companies' Interim Report (9/3/2021) at 4.

Conservation Voltage Reduction (CVR)

Conservation Voltage Reduction (CVR) is the long-term practice of controlling distribution voltage levels within the lower range of ANSI standard acceptable service entrance voltage levels in order to reduce demand and energy consumption.

A combination of the calculated Spring 2022 and Spring 2021 CVR factors[3] (using the historic Weighted Average Real Load to Voltage Ratio (CVRf) and CVR Off Average Voltage) was used to compute CVR results for 2023 for six of the seven substations (Millgate, Nelson, Newport, Norway 2, Oxford, and Pinegrove). The Companies selected the CVR factor based on the year during which each circuit had the greatest number of operating days in normal circuit configuration. For Norway 1, the Companies selected the CVR factors from the ENGO device

[3] *See* Companies Interim Report (9/3/2021) at 6 and Companies' Interim Report (9/14/2022) at 6.

testing performed in Spring 2023. The following tables show the Millgate, Nelson, Newport, Norway 1, Norway 2, Oxford, and Pinegrove core substation CVR analysis results by circuit, by substation and combined for all seven substations for the period March 1 through May 31, 2023. Overall, the calculated average voltage reduction was 4.44 volts and led to kWh savings of approximately 2.7%, while maintaining voltage well within the expected range.

Core Substation Circuit CVR Estimates: March 1 - May 31, 2023 Using Spring 2021 & 2022 Historic CVR Factors

Substation / Circuit	Temp Avg (Degrees F)		Operating Mode Days		Average Voltage (Volts)		Weighted Average Real LtVR (CVRf) Historic	Voltage Reduction (Volts) Based on Spring Historic CVR Off vs	Voltage Reduction (Per Unit)	Average kWh/Day Reduction	Average kWh/Day Savings %
	CVR On	CVR Off	CVR On	CVR Off	CVR On	Historic Spring					
Millgate L01	58.8	53.2	9.9	20.4	119.2	123.3	0.55	4.07	0.0339	604	1.9%
Millgate L02	-		-		-			-		-	0.0%
Millgate L03	59.1	53.5	10.1	22.9	118.7	123.1	0.72	4.40	0.0367	1,035	2.6%
Millgate L04	59.1	45.5	10.1	11.7	118.4	123.0	1.12	4.58	0.0382	642	4.3%
MG Roll-Up	**59.0**	**51.7**	**10.0**	**18.3**	**118.7**	**123.1**	**0.72**	**4.37**	**0.0364**	**2,281**	**2.6%**
Nelson L01	52.9	51.2	34.7	20.1	118.9	123.1	0.61	4.14	0.0345	1,370	2.1%
Nelson L02	52.9	51.5	34.8	21.1	120.1	125.5	0.52	5.37	0.0447	1,038	2.3%
Nelson L03	52.9	52.6	34.8	22.3	118.8	123.1	0.66	4.29	0.0358	1,015	2.4%
Nelson L04	53.3	52.6	33.8	22.3	119.2	123.9	0.42	4.71	0.0393	825	1.7%
NL Roll-Up	**53.0**	**52.0**	**34.5**	**21.4**	**119.3**	**123.9**	**0.55**	**4.63**	**0.0385**	**4,248**	**2.1%**
Newport L01	54.2	53.0	41.5	19.4	120.3	122.6	0.37	2.27	0.0189	88	0.7%
Newport L02	54.3	52.6	41.4	18.4	118.4	123.8	0.63	5.36	0.0447	512	2.8%
Newport L03	54.3	53.0	41.5	19.2	119.9	123.7	0.74	3.77	0.0314	968	2.3%
Newport L04	54.3	53.0	41.4	19.4	119.1	122.6	0.37	3.43	0.0286	505	1.1%
Newport L05	54.2	52.9	41.5	16.6	118.6	123.1	1.17	4.46	0.0372	1,042	4.4%
NP Roll-Up	**54.3**	**52.9**	**41.4**	**18.6**	**119.1**	**123.2**	**0.70**	**4.12**	**0.0344**	**3,115**	**2.2%**
Norway L01	51.9	50.9	11.8	12.8	118.5	123.1	0.94	4.51	0.0376	2,478	3.5%
Norway L02	51.5	51.2	12.8	14.0	120.2	125.5	0.78	5.26	0.0438	2,033	3.4%
NW 71 Roll-Up	**51.7**	**51.1**	**12.3**	**13.4**	**119.4**	**124.3**	**0.87**	**4.85**	**0.0404**	**4,510**	**3.5%**
Norway L03								-	0.0000	-	0.0%
Norway L04	53.0	55.1	34.5	16.8	118.3	122.7	0.59	4.45	0.0371	1,712	2.2%
NW 72 Roll-Up	**53.0**	**55.1**	**34.5**	**16.8**	**118.3**	**122.7**	**0.59**	**4.45**	**0.0371**	**1,712**	**2.2%**
Oxford L01	69.2	53.1	5.0	22.5	121.0	123.8	1.34	2.77	0.0231	1,307	3.1%
Oxford L02	69.2	53.1	5.0	22.5	118.4	124.2	1.47	5.78	0.0482	800	7.1%
OX Roll-Up	**69.2**	**53.1**	**5.0**	**22.5**	**119.7**	**124.0**	**1.37**	**4.28**	**0.0356**	**2,107**	**4.9%**
Pinegrove L01	57.1	53.8	16.9	20.2	119.2	123.5	0.25	4.33	0.0361	544	0.9%
Pinegrove L02	57.1	53.8	16.9	20.2	120.1	124.0	0.52	3.91	0.0326	1,500	1.7%
Pinegrove L03	57.1	53.8	16.9	20.2	120.1	124.0	0.52	3.91	0.0326	1,500	1.7%
Pinegrove L04	60.6	53.8	10.4	20.2	120.7	124.3	0.67	3.51	0.0292	1,011	2.0%
PG Roll-Up	**57.7**	**53.8**	**15.3**	**20.2**	**120.0**	**123.9**	**0.49**	**3.99**	**0.0333**	**4,554**	**1.6%**
Project Roll-Up	**54.6**	**52.8**	**21.9**	**18.7**	**119.4**	**123.80**	**0.76**	4.44	0.0370	22,528	**2.7%**

Sentient Energy[4] Performance Evaluation

During this reporting period, the Companies further tested and evaluated the performance of the Sentient Energy ENGO® (Edge Network Grid Optimization) devices.[5] Assessment and analysis of the test data using accepted CVR Protocol #1 CVR computation and forecasting procedures, plus Sentient Energy engineering evaluation, shows measurable incremental improvements based upon the ENGO® device operation. In this test the overall percent energy savings improvements provided by ENGO® were 9.6% on Norway circuit 1 (L_01) and 9.4% on Norway circuit 2 (L0_2). This equates to an overall improvement of 9.5% on the Norway number 71 transformer (TR 71). The energy savings with and without ENGO are also shown in the tables below. The energy savings without the ENGO® static var compensator (SVC) in operation would have been 3.2% rather than the 3.5% that was obtained with ENGO SVC working in a coordinated fashion with the IVVC CVR software.

Table 1: CVR On, ENGO Off

Norway 71 L_01 & L_02 ENGO Test Phase 1 April 11 to May 11 CVR Analysis

Substation	Average Temperature (Degrees F)		Problem Formulation Days		Average Voltage (Volts)		Weighted Average Real LtVR (CVRf)	Voltage Reduction (Volts)	Voltage Reduction (Per Unit)	Average kWh/day Reduction	Average kWh Savings %
	CvrOn	CvrOff	CvrOn	CvrOff	CvrOn	CvrOff					
Norway 71 L_01	51.9	50.9	11.8	12.8	119.0	123.1	0.94	4.08	0.0340	2,551	3.2%
Norway 71 L_02	51.5	51.2	12.8	14.0	120.5	125.5	0.78	4.92	0.0410	2,063	3.1%
Norway TR 71 L0_1 and L_02	51.7	51.1	12.3	13.4	119.8	124.3	0.87	4.47	0.0373	4,614	3.2%

Table 2: CVR On, ENGO On

Norway 71 L_01 & L_02 ENGO Test Phase 1 CVRf Applied to Phase 3 CVR On Voltage

Substation	Average Temperature (Degrees F)		Problem Formulation Days		Average Voltage (Volts)		Weighted Average Real LtVR (CVRf)	Voltage Reduction (Volts)	Voltage Reduction (Per Unit)	Average kWh/day Reduction	Average kWh Savings %	ENGO Improvement kWh Savings %
	CvrOn	CvrOff	CvrOn	CvrOff	CvrOn	CvrOff						
Norway 71 L_01	51.9	50.9	11.8	12.8	118.5	123.1	0.94	4.51	0.0376	2,797	3.5%	9.6%
Norway 71 L_02	51.5	51.2	12.8	14.0	120.2	125.5	0.78	5.26	0.0438	2,256	3.4%	9.4%
Norway TR 71 L0_1 and L_02	51.7	51.1	12.3	13.4	119.4	124.3	0.87	4.85	0.0404	5,054	3.5%	9.5%

[4] Formerly Varentec.

[5] *See also*, the Companies' Interim Report for 12-Month Period Ending May 31, 2021, on Volt Var Optimization and Distribution Automation Studies (9/3/2021) at 6-7 for discussion of a prior Sentient Energy performance evaluation.

Summary

The investments in the Smart Grid Pilot area have produced solid results and benefits for customers. The Companies continue to explore ways to improve reliability and reduce energy consumption through these investments. The Companies will continue to seek out ways to improve the customer experience and will work with their DA/IVVC vendor to enhance system performance of the DA and IVVC circuits.

In nine years of operation in the Smart Grid Pilot area, the Companies have gained significant knowledge and lessons learned on how DA and IVVC can be deployed to benefit customers. The Companies have identified improvements to construction practices and analytics which include, but are not limited to, grounding improvements with smart devices, device control settings, conducting real time analysis of circuits to gain better CVR, and implementing DA and IVVC along with associated software systems together in an integrated fashion to drive benefits for customers.

The Companies will continue analyzing the performance of the DA and IVVC investments in the Smart Grid Pilot area.