APPENDIX H

PUC’s Response to OEB

Order #6

The following is the methodology and targets outlined for each category in OEB Order number 6 from the decision and order for EB-2018-0219/2020-0249. This response forms part of the Distribution System Plan, Section 5.3.6.2.3 (Pg 94).

5.3.6.2.3 PUC's Response to OEB Order #6

The SSG project performance metrics being developed are summarized in the following table and referenced appendices. There are three metric categories in Table 1: SSG Project Performance Metrics; (1) Green House Gas ("GHG") emissions reduction, (2) Improved asset utilization and increased (energy) efficiency, and (3) Increased reliability and resiliency. The main direct measurable metrics are "Energy Savings", which is also an input to GHG emissions reduction, and reliability improvement, that will be developed for measurement purposes with the SSG project and used to derive other metric calculations. As noted, certain measures are intended more as trending performance indicators than targets which will require development and data analysis over a longer-term period.

Table 1: SSG Project Performance Metrics

Area	Metric	Description	Target
GHG emissions reductions	Reduction in GHG Emissions	GHG emissions reduction from provincial generation sources achieved through the SSG VVO reduction in kWh energy use/purchase.	2860 (tCO_2e)
	Reduced energy losses from GHG emitting supply (kWh) (but not calculated directly)	Energy reduction of lower power purchase/supply by PUC applied to average provincial transmission grid loss factor means less energy production from provincial generation sources and additional GHG reduction.	Is Included in above GHG calculation
Improved Asset Utilization and increased energy efficiency	Reduction in peak demand on utility assets (kW)	Demand reduction (kW on station assets) will be measured as part of the VVO performance measurements.	Trending KPI's (kW and %)
	Reduction in energy losses (% of PP kWh)	The energy reduction achieved with the SSG VVO solution will reduce system losses in relation to the reduced energy delivery.	2.7% of system losses
	$ savings from deferred system upgrades	This measure requires further research on methodology and data collection and will be part of future asset management programs. The measure and associated target will be evaluated with asset management planning systems over the 2023-2027 DSP period.	Trending KPI TBD
	$ energy savings to customers (& kWh)	The VVO energy savings (kWh) and a total system average energy price (P_{AVG}) calculation.	2.7% kWh and $'s (calc)
Increased reliability and resiliency	# events Fault Location, Isolation and Restoration (FLISR) responded to	Utilize data captured in the Outage Management System (OMS) combined with data from SCADA report an event count and trending KPI.	FLISR Event Trending KPI

Area	Metric	Description	Target
	# Customer calls/ complaints avoided due to fewer outages	After review, PUC decided this metric would not be used as a satisfactory measurement method could not be determined.	N/A
	$ revenue loss avoided from outages avoided	Calculation/estimate from the customer minute reliability improvement metric multiplied by an average customer revenue value.	Calculated $'s
	NEW Reduced customer minutes of interruption (CMI)	Utilize the new OMS and SCADA system to calculate the difference in customer minutes of interruption (CMI) on feeders with DA deployed and an estimate of CMI that would have occurred without DA.	10% CMI

Energy Savings

The energy savings performance metric target is 2.7%. This metric applies to customers supplied from PUC's 12.5kV distribution system with VVO deployed and includes savings on annual kWh energy purchases of reduced customer consumption and energy losses. Guidance on development of the Measurement and Verification (M&V) methodology was drawn from the EPC design team and the IEEE 1885-2022[1] Standard. The VVO M&V methodology summary is provided in Appendix A.

An example of the annual calculation of the overall 2.7% target calculation is provided in Figure 1 below.

Figure 1: 2.7% Target Calculation

[Energy Savings (1)] / [Purchased Energy (2) + Energy Savings (1)]	e.g.	[17,456,712] / [617,414,778 + 17,456,712]	x 100% =	2.7%
(1) Annual kwh saved on 12.5 kV circuits deployed				
(2) Total System Purchased Energy less direct 34.5 kV customers				
The kWh values used in the example calculation are from the SSG ICM application Appendix AA14				

Calculations of savings to specific customer classes will utilize a proportional allocation initially and may evolve over time with future data analysis. It is unknown if statistically supported alternative allocation approaches or conclusions can be derived at this time. New data collected over future years of VVO operation may inform alternative methods for customer class specific benefit measurement. The methodology developed for the ICM energy savings financial benefit estimate (ICM Appendix AA14), attached as appendix C, will be applied with new annual actual data each year.

The kWh energy savings will also be used as an input value in calculation of GHG emission reductions.

- Reduction in GHG Emissions (tCO2e), and
- Reduced energy losses from GHG emitting supply (kWh)

[1] IEEE 1885-2022 Guide for Assessing, Measuring and Verifying Volt-Var Control Optimization on Distribution Systems.

GHG Emission Calculations

National Resources Canada ("NRCan") has developed a Smart Grid Program GHG Project Accounting Template for use in reporting by program participants. The on-line reporting template was issued earlier in 2022 to begin implementation. PUC submitted our initial data in July 2022 in the template and is currently in the validation phase with the program administrators.

The following figure is from the NRCan reporting template and has the GHG estimates developed by PUC and submitted to NRCan for the project.

Figure 2: NRCan Reporting Template

CALCULATIONS FOR SSR ELEMENT P1			
Parameter/Variable	Value	Unit	Source documents and notes
PUCD energy savings	17456712	kWh/year	PUCD ICM rate application records - VVM Energy Savings Estimate
Electricity Sector GHG Emissions	5500000	tCO2e/year	IESO Annual Planning Outlook Report (2020) - Figure 37
IESO Annual Energy Demand	1.446E+11	kWh/year	IESO Annual Planning Outlook Report (2020) - Figure 2
Ratio Annual/Marginal Emission Factor	4.32		PUCD ICM rate application records - SSG GHG Emission Estimate with MEF
x Emission factor	0.000164315	tCO2e/kWh	Marginal emission factor (MEF)
Emissions from P1 (annual)	**2868.405789**	**tCO2e/year**	

[Estimated Energy Savings (1)] * [Ontario Energy/Ontario GHG) (2)] * [[AEF/MEF]		[17,456,712] * [5500MtCo2e/1.446TWh] *[4.32]	=	2868
(1) on 12.5 kV circuits with VVO deployed				
(2) From IESO Annual Outlook Report				
(3) Ratio of Marginal Emission to Average Emission factors - TAF Report				

PUC's understanding of IESO data suggests GHG savings from the provincial transmission grid would be included in IESO reporting so it is not directly calculated.

PUC has proposed to NRCan the same methodology for GHG savings calculations utilized in the SSG ICM (EB-2020-0249/EB-2018-0219) interrogatory responses to ED-1 filed on January 25, 2021 .

The proposed calculation of subsequent year savings would be updated with new input factors from PUC calculated energy savings and new IESO and industry data on provincial source emission factors. A ten-year forecast using current IESO data is in table 2 below.

Table 2: Ten Year Forecast of Project GHG Savings

YEAR	Project emissions (tCO2e/year)
2023	2,151
2024	2,861
2025	2,861
2026	2,861
2027	2,861
2028	2,861
2029	2,861
2030	2,861
2031	2,861
2032	2,861
2033	2,861

Reliability Improvement

Reliability performance metrics are focused on positive trending over time of customer minutes of improved reliability on an event-based calculation. Each outage event with Distribution Automation FLISR and DA action will be tracked, and calculations of improved customer minutes of interruption performed. An added row to the table has been included for Reduced Customer Minutes of Interruption (CMI). Calculations for normal scorecard metrics of SAIDA and SAIFI will also be completed. The Reliability Improvement Methodology Summary is provided in Appendix B.

Development of Metric Detailed Procedures

The previously referenced 'A' and 'B' appendices for the energy savings and reliability metrics provide a summary level description of the methodology being used. Ensuring efficient and sustainable metric measurement requires documented detailed methodology with standard operating procedures, data and security management, report development, etc. which will be developed and integrated into the new SCADA and OMS systems as part of the scope of work of the EPC contractor engaged for the project.

Other future Metrics and KPI's

Determination of additional and new Key Performance Indicators and metrics are expected to evolve over time with new data collection based on the primary metrics outlined above. Data captured in the new Outage Management System and SCADA data historian along with potentially other data sources will with future analysis support ongoing efficiency efforts in operations, maintenance, and asset management areas.

With substantial completion of the new systems and assets in-service and operating by the end of 2022 the initial VVO testing, measurement, and fine tuning is expected to occur early in 2023. The first set of metric reporting of energy savings, GHG emissions and reliability improvements for the initial 2023 operation year will align with the annual RRR reporting period for 2023 in April 2024.

Appendix A

VVO M&V Methodology Summary

Appendix A. VVO M&V Methodology Summary

IEEE 1885-2022 identifies several measurement and verification methods that could be used after implementing Volt-VAr Optimization (VVO) or Conservation Voltage Reduction (CVR) to confirm whether the expected energy savings benefit is being achieved using Equation 1:

$$CVR_F = \frac{\frac{\Delta E}{E_0}}{\frac{\Delta V}{V_0}} = \frac{\%\ Change\ in\ Energy}{\%\ Change\ in\ Voltage} \quad \text{Equation 1}$$

Where solving for "*% Change in Energy*" provides the expected energy savings benefit as follows:

$$\%\ Change\ in\ Energy = CVR_F * (\%\ Change\ in\ Voltage)$$

For the change needed in *"% Change in Voltage*", a normal operating voltage is needed in order to determine the percentage of change. For example, a PUC average system voltage is approximately 126 Volts on a 120 Volt basis. So, a new average system voltage of 122 Volts results in a 3.2% change in voltage.

PUC will use an "on-off" methodology from IEEE 1885-2022 to perform verification. The "on" part of the methodology will have PUC lowering the voltage by at least 3%[2] and measuring the energy used. The "off" portion of the methodology will have PUC returning the voltage to what has been the normal operating practice that results in an average system voltage of approximately 126 Volts. The resulting percentage change in energy used and voltage during each period is calculated in Equation 2 and Equation 3:

$$\%\ Change\ in\ Energy = \frac{\Delta E}{E_0} = \frac{E_{ON} - E_{OFF}}{E_{OFF}} \quad \text{Equation 2}$$

Where:

E_{ON} Energy used during the "on period"
E_{OFF} Energy used during the "off period"

$$\%\ Change\ in\ Voltage = \frac{\Delta V}{V_0} = \frac{V_{ON} - V_{OFF}}{V_{ON}} \quad \text{Equation 3}$$

Where:

V_{ON} Average Voltage during the "on period"
V_{OFF} Average Voltage during the "off period"

The changes in voltage and energy are direct measurements and result in the ability to calculate CVR_f. Reporting of CVR_f, "% Change in Energy", and "% Change in Voltage" provides standard industry metrics that can then be compared with other published results from other utilities.

[2] IEEE 1885-2022 Guide for Assessing, Measuring and Verifying Volt-Var Control Optimization on Distribution Systems. - recommends a minimum of 3% voltage reduction for an on-off methodology.

Appendix B

Reliability Improvement Methodology Summary

Appendix B. Reliability Improvement Methodology Summary

The measurement of reliability improvement through implementation of Distribution Automation (DA) technologies recognizes two main benefit elements but only the first will be used in the calculation. The first is a data driven calculation of customer outage minutes captured in SCADA and the Outage Management System (OMS) that will calculate a percentage reliability improvement. The second is more subjective and recognizes the improved ability to isolate and determine the fault location on a reduced feeder section as well as a much broader situational awareness in the more wide-spread storm related system outages to improve direct field crew response time and improve customer communications.

The data calculation methodology is described below.

The SCADA/OMS will have integration to GIS/AMI meter and customer data. This provides the feeder location and number of initial customers "C_I" for an initial outage event.

DA action will provide a automated partial restoration to some customers "C_M" who only experience a momentary outage while remaining customers "C_S" experience a sustained outage.

$$C_I - C_M = C_S$$

Upon restoration the customer minutes of interruption "CMI" can be determined for each of the customer groups above utilizing the start and finish timestamp *"TS"* data from the SCADA/OMS.

$C_I \times TS = CMI_I$ *(customer minutes of interruption of initial outage - no DA operation)*

$C_S \times TS = CMI_S$ *(customer minutes of interruption of sustained customers)*

Summation of above CMI calculations for all outage events can then be used to allow calculation of annual percent reliability improvement in relation to customer minutes of interruption as well as for the Scorecard SCADI and CAIDI reliability metrics.

As example, annual calculation of SAIDI and CAIDI reliability metrics are completed in normal manner for both factors above across all outage events to generate initial $SAIDI_I$ and $CAIDI_I$ and sustained $SAIDI_S$ and $CAIDI_S$ values all referred to as "METRIC" below. Calculation as illustrated below will provide the improved reliability performance from DA.

$$\%\ Improved\ Reliability = \frac{METRIC_I - METRIC_S}{METRIC_I}\ X\ 100\%$$

Appendix C

ICM (EB-2018-0219/EB-2020-0249)
Amended Application Appendix AA14
VVM Energy Savings Estimate

Appendix AA14
VVM Energy Savings Estimate Spreadsheet
(Live Excel model filed with Amended Application)

Energy Savings Estimated from VVM System

1. Table below is from 2018 CoS application with normalized load forecast.

2018 CoS Rate Application Data						Loss Factor	1.0481	
	Total Base Revenue Requirement	Class %	Number of Customers	2018 Test Year Weather Normal kWh (Load Forecast)	Class %	kW	2018 Test Year Weather Normal (kWh w/LF)	Class %
Res	$ 11,226,807	58.50%	29,816	288,323,799	45.85%		302,192,174	45.85%
GS<50kW	$ 3,149,458	16.41%	3431	92,411,463	14.69%		96,856,454	14.69%
GS>50kW	$ 4,544,464	23.68%	357	244,620,598	38.90%	614,743	256,386,849	38.90%
Sentinel lights	$ 34,742	0.18%	354	209,800	0.03%	593	219,891	0.03%
Street lights	$ 195,345	1.02%	8070	2,398,221	0.38%	7,030	2,513,575	0.38%
USL	$ 39,551	0.21%	22	944,731	0.15%		990,173	0.15%
	$ 19,190,367	100.00%		628,908,612	100%		659,159,116	100%

2. VVM Energy Savings estimate is only applicable to customers on the 12.5 kV distribution network with intended design & application.
3. A reduction of the energy consumption above in the GS>50kW customers connected to the 34.5kV subtransmission network is thus needed .
4. The 7 customers for above annual energy consumption was totaled across two years and an average of 41,744,343.60 kWh used.
5. Note: as actual consumption in period was above Normalized this creates a more conservative estimate on total energy saved by VVM.
6. The Table below shows where the reduction applied results in 617,414,773 kWh energy for VVM targeted customers on the LV customers.

2018 CoS Rate Application Data - adjusting 34.5kV load						Loss Factor	1.0481			
	Total Base Revenue Requirement	Class %	Number of Customers	2018 Test Year Weather Normal kWh (Load Forecast)	Class %	kW	2018 Test Year Weather Normal (kWh w/LF)	Class %	Reduce GS>50kW 34.5kV (no VVM)	LV Feeder Energy Consumption Base for VVM
Res	$ 11,226,807	58.50%	29,816	288,323,799	45.85%		302,192,174	45.85%		302,192,174
GS<50kW	$ 3,149,458	16.41%	3431	92,411,463	14.69%		96,856,454	14.69%		96,856,454
GS>50kW	$ 4,544,464	23.68%	357	244,620,598	38.90%	614,743	256,386,849	38.90%	41,744,344	214,642,505
Sentinel lights	$ 34,742	0.18%	354	209,800	0.03%	593	219,891	0.03%		219,891
Street lights	$ 195,345	1.02%	8070	2,398,221	0.38%	7,030	2,513,575	0.38%		2,513,575
USL	$ 39,551	0.21%	22	944,731	0.15%		990,173	0.15%		990,173
	$ 19,190,367	100.00%		628,908,612	100%		659,159,116	100%	16.3%	617,414,773

7. The Cost of Power forecast from the 2018 CoS rate Applcation was used in original application for estimating energy $ savings.

2018 CoS Cost of Power (CoS Application)

	Total	Residential	GS <50	GS>50-Regular	GS> 50-TOU		GS >50-Intermediate	Large Use >5MW	Street Light	Sentinel	Unmetered Scattered Load
Cost of Power (COP*)	$77,725,426	$35,945,091	$11,467,389	$29,880,767	$0		$0	$0	$288,889	$25,865	$117,425
(*) gross w/loss factor											
REDUCE GS>50kW by 16.3%				$ 4,865,121							
Revised COP	$72,860,305	$35,945,091	$11,467,389	$25,015,646	$0		$0	$0	$288,889	$25,865	$117,425
Estimate for VVM customers											

8. Table below uses the current Cost of Power forecast with updated IESO rates as provided below and the 16.3% reduction in energy from the GS>50kW class kWh used to get balance for VVM customers.

2020 CoS Cost of Power (uses 2019 IESO rates)

	Total	Residential	GS <50	GS>50-Regular	GS> 50-TOU		GS >50-Intermediate	Large Use >5MW	Street Light	Sentinel	Unmetered Scattered Load
Cost of Power (COP*)	$88,047,743	$40,624,176	$12,936,129	$33,995,412	$0		$0	$0	$330,827	$29,119	$132,080
(*) gross w/loss factor	*$ 0.1336*	*Avg rate*									
REDUCE GS>50kW by 16.3%				$ 5,535,058							
Revised COP	$82,512,685	$40,624,176	$12,936,129	$28,460,354	$0	$0	$0	$0	$330,827	$29,119	$132,080
Estimate for VVM customers											

9. Next table describes the VVM energy and $ savings estimated to be achieved by the VVM system.

ENTER VALUES	***CVR factor***	0.9			System Energy Loss Savings Estimate kWh			2.60%	786,513		
	Voltage Savings	3.0	volts		Using avg $/kWh from COP			$ 0.1336	$ 105,111		
	Energy Savings	2.7	%								
Total $'s saved with VVM	$2,227,842	$1,096,853	$349,275	$768,430	$0	$0	$0	$0	$8,932	$786	$3,566
Total VVM w/Syst losses included	***$2,332,954***										
Total kWh saved with VVM	16,670,199	8,159,189	2,615,124	5,795,348	-	-	-	-	67,867	5,937	26,735
Total kWh saved with losses incl.	***17,456,712***										