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September 20, 2019

**VIA ELECTRONIC FILING**

Kimberly A. Campbell, Chief Clerk  
North Carolina Utilities Commission  
4325 Mail Service Center  
Raleigh, North Carolina 27699-4300

**RE: Duke Energy Carolinas, LLC and Duke Energy Progress, LLC's  
Information on Integrated Volt-Var Control  
Docket No. E-100, Sub 157**

Dear Ms. Campbell:

Pursuant to the Commission's July 22, 2019 *Order Accepting Smart Grid Technology Plans and Requiring Additional Information*, I enclose Duke Energy Carolinas, LLC and Duke Energy Progress, LLC's (collectively, "Duke Energy") detailed information on Integrated Volt-Var Control ("IVVC"), as provided in a data request response to the Public Staff, for filing in connection with the referenced matter. Duke Energy's relevant Data Request Response and Attachments 1 through 4 directly supporting the IVVC analysis are enclosed. The file identified as "Attachment 5" in the Data Request Response pertains to a different program and is not relevant.

Because Attachments 1 through 4 to the Data Request Response do not conform easily to standard format (e.g., 8.5 by 11 inches), I will provide the Excel spreadsheets to Commission counsel.

Thank you for your attention to this matter. If you have any questions, please let me know.

Sincerely,

Lawrence B. Somers

Enclosures

cc: Parties of Record

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Sep 20 2019

**DUKE ENERGY CAROLINAS, LLC AND DUKE ENERGY PROGRESS, LLC**

**Request:**

Please provide a summary of the cost-benefit analysis relied upon by each Company for each project identified in Section 3 ("Current or Scheduled"); Section 4 (Under Consideration), and Section 5 (Pilots or Initiatives) of each SGTP. The responses should explain the type/nature and value of the benefits identified, who will benefit (Company, customer, or both), and an estimate of when these benefits will be realized. If any cost-benefit analysis includes more than one project, to the extent possible, please provide a project-specific analysis. The responses should also include the net book value of any equipment taken out of service and either replaced or maintained in inventory for future use. The Public Staff may follow up with additional requests for specific analyses.

**Response:**

As discussed in detail in the pre-read materials provided at the November 8 North Carolina Grid Improvement Stakeholder Workshop, cost-benefit analyses are not needed, and are thus not performed, for all of the work that the Company performs, but the Company does ensure that all of its work is done in a cost-effective manner. As of the date of the filing of the 2018 SGTP, projects that are supported by a cost-benefit analysis were AMI (CBA's provided in prior filings), IVVC in DEC, and CVR in DEP. The details of the IVVC cost-benefit analysis are provided in the following attached files:

- SGTP PS DR 1-4 Attachment 1 – DEC\_IVVC\_Improved VAR Management\_Benefit.xlsx
- SGTP PS DR 1-4 Attachment 2 – DEP\_DS DR to CVR\_Capital and O&M\_Costs.xlsx
- SGTP PS DR 1-4 Attachment 3 – DEC IVVC DEP CVR\_PVRR\_Benefits.xlsm
- SGTP PS DR 1-4 Attachment 4 – IVVC\_DEC\_Capital and O&M\_Costs.xlsx

After the October 1 SGTP filing, the Company completed the self-optimizing grid (SOG) cost benefit analysis. The summary analysis results were presented at the November 8 North Carolina Grid Improvement Plan Stakeholder Workshop. The details of the SOG cost-benefit analysis are provided in the following file:

- SGTP PS DR 1-4 Attachment 5 – Duke Energy\_NorthCarolina\_GIP\_SOG\_BCA

Additionally, and upon request of the participants at the aforementioned November 8 workshop, the Company has agreed to provide additional cost benefit analyses results for projects in the Company's developing Grid Improvement Plan for the Carolinas as they are completed, and that information will also be provided to Public Staff informally as well as a supplement to this response if requested.

**Duke Energy Carolinas, LLC  
and  
Duke Energy Progress, LLC**

**Attachment 1**

**Docket No. E-100, Sub 157**

Benefits (\$000)	PVRR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Improved VAR Management	(89,233)	-	(1,585)	(3,065)	(4,660)	(6,321)	(6,508)	(7,305)	(7,607)	(7,884)	(8,271)	(8,577)	(9,227)	(9,784)	(10,281)	(11,023)	(11,737)	(8,691)	(8,926)	(9,259)	(9,539)	(10,005)	(10,430)	(10,799)	(11,142)	(11,278)	(11,416)

Benefit phase-in	0.0%	25.0%	50.0%	75.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
------------------	------	-------	-------	-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

Load	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043
Peak Load (MW)	13,168	13,279	13,390	13,503	13,617	13,731	13,847	13,963	14,080	14,199	14,318	14,439	14,560	14,683	14,806	14,931	15,020	15,110	15,201	15,292	15,384	15,476	15,569	15,662	15,756	15,851
Load Growth (MW)		111	112	113	114	115	115	116	117	118	119	120	121	122	123	125	90	90	91	91	92	92	93	93	94	95
Load Growth (%)		0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%

Plant Carrying Cost (\$/kW/Yr)
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CC - F Class 2X2X1	\$	58.43	\$	56.56	\$	54.21	\$	54.49	\$	54.98	\$	56.13	\$	62.47	\$	64.51	\$	66.31	\$	68.99	\$	70.94	\$	75.68	\$	79.58	\$	82.92	\$	88.17	\$	93.09	\$	96.05	\$	98.05	\$	101.11	\$	103.55	\$	107.96	\$	111.87	\$	115.13	\$	118.09	\$	118.82	\$	119.55
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VAR Factor	0.60	[VAR Factor = (Avg VARS) / (Peak VARS) Based on emperical data this is typically about 0.6]
% Capacitors OFF-LINE	15%	[Based on Imperical Data]
Unit Conversion	1,000	[Conversion of KW to MW]
Deployment Schedule	4.0	[ Years (Using a conservative approach, the Improved VAR Management Benefits were not accounted for until after the Completion of the 4-Year Deployment) ]

Improved VAR Management = 
$$\sqrt{((\text{Distribution Peak Load} * \text{Expected Annual Load Growth} * \text{VAR Factor} * \% \text{ of Capacitors Offline})^2 + ((\text{Distribution Peak Load} * \text{Expected Annual Load Growth})^2) * \text{Carrying Cost of a Plant} * 1000 \text{ for unit conversion} * \text{Deployment Schedule})}$$

= Square Root ((Distribution Peak Load \* Expected Annual Growth of Load \* VAR Factor \* % of Capacitors Offline) ^ 2 + (Distribution Peak Load \* Expected Annual Growth of Load) ^ 2) \* Carrying Cost of a Plant \* 1000 for unit conversion \* Deployment Schedule

2018 Duke Energy Carolinas Integrated Resource Plan page 16,17 load growth projection through year 2033.

RES	0.013000	26%	0.260	0.00338
GEN SVC	0.007000	59%	0.590	0.00413
IND	0.006000	15%	0.150	0.0009
				0.841%

**Duke Energy Carolinas, LLC  
and  
Duke Energy Progress, LLC**

**Attachment 2**

**Docket No. E-100, Sub 157**

				ESCALATION RATE:		2.5%																														
				TOTAL PROJECT COST 5 YEARS (Nominal):		\$ 9,242,437																														
								PROJECT																												
				TOTAL COST 26 Year Investment Period (Nominal):		\$9,242,437																														
LIFE (YRS)	TRANSMISSION	Cost Estimate Uncertainty Contingency:	5.00%	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	27	28	29	30	31	32		
	Transmission - Substation Relays			97,641	100,082	102,584	104,635	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
10	Sub Capacitor Bank Controls - Retail Station Capacitor Equipment Replacement			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
15	Sub LTC Control Panel Replacement (Load Tap Changer)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
10	Sub LTC Position for IVC			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
15	Sub Voltage Regulator (VR), VR Control Panel & Comms			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
15	Mobile Substations			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	Spartan Replacements			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	Add or change control settings for CVR operation on substation devices.			97,641	100,082	102,584	104,635	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	Transmission: Contingency			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	TELECOM	Cost Estimate Uncertainty Contingency:	5.00%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
7	Subst Comms: Cellular Connected Subs			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	On-Going Capital: Cellular Connected Subs			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
20	Subst Comms: Fiber Connected Subs			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
20	Subst Comms: Leased T1/MPLS Connected Sites			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	Subst Comms: Intra-sub Communications - SDM to Regulator, Cap Bank, LTC Controls			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	Subst Comms: Leased T1/MPLS Connected Subs			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	Subst Comms: Material Freight			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
7	Dist Line Communications Materials			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	On-Going Capital: Dist Line Communications Materials			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	Dist Network Connectivity - Firewall, Testing, Support			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
7	Dist Modern Procure, Config, Activate, Support			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	On-Going Capital: Dist Modern Procure, Config, Activate, Support			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
7	Dist Modern Configuration & Activation - USAT			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	On-Going Capital: Dist Modern Configuration & Activation - USAT			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	Dist Material Freight			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	Dist Mesh/Travel/Lodging			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	Telecom: Contingency			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	IT	Cost Estimate Uncertainty Contingency:	5.00%	1,008,246	1,033,451	1,059,287	1,085,770	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
10	IT Materials & Mat Burdens/Contract Labor: (assume servers/hardware covered under DMS upgrade)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	IT: CVR operation mode Configuration for Substation & Distribution Line Devices			302,474	310,035	317,786	325,731	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
10	IT: DMS Model Updates / Testing CVR operation mode			604,948	620,071	635,573	651,462	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
10	IT: Infrastructure Labor			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
15	IT: EMAX / Aspen / Asset Management Settings Modifications			100,824	103,345	105,928	108,577	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	IT: Contingency			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	DISTRIBUTION	Cost Estimate Uncertainty Contingency:	5.00%	878,167	896,136	913,895	932,894	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
15	Line Regulator Control Panels Replace / Upgrade (Existing)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
15	Line Capacitor Bank Controls Replace / Upgrade (Existing)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	Circuit Conditioning: Load Balancing			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	Circuit Conditioning: Reconductoring (wire size)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	Circuit Conditioning: Transformer/Service Issues			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	Circuit Conditioning New Line Capacitor Bank & Controls			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
30	Line Regulators Replace / Upgrade (Existing)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
10	Medium Voltage Sensors (3 phase Sensors)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	GIS Field Verification			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	GIS Update from Verification			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	Circuit Conditioning: Feeder Analysis			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	Circuit Conditioning: Work Order Design			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	Circuit Conditioning: QA/QC			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	Add or change control settings for CVR operation on distribution line IVC devices.			878,167	896,136	913,895	932,894	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
	Distribution: Contingency			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
	STAFFING PLAN			247,594	257,462																															

ESCALATION RATE:				2.5%																																	
TOTAL PROJECT O&M COST 5 YEARS (Nominal):				\$ 82,128		PROJECT																															
TOTAL O&M COST 32 Year Investment Period (Nominal):				\$82,128		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	28	29	30	31	32	
TRANSMISSION				976	1,001	1,026	1,046	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Transmission - Substation Relays				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Assume 1% of Capital Cost for Transmission O&M				976	1,001	1,026	1,046	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
On Going Substation Costs				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
TELECOM				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Subst Comms On Going O&M				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Dist Line Communications (Operations Support / Cellular)				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Project O&M				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
IT				10,082	10,335	10,593	10,858	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Assume 1% of Capital Cost for IT O&M				10,082	10,335	10,593	10,858	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DISTRIBUTION				8,782	8,961	9,139	9,329	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Assume 1% of Capital Cost for Distribution O&M				8,782	8,961	9,139	9,329	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On Going Distribution Costs				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Staff Support				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grid Management: Transition GMgmt Deployment personnel to On-Going Support (Post-Project)				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total - All Cash Flow Categories				\$82,128	19,841	20,297	20,758	21,233	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

The substation, distribution, telecommunications, and IT infrastructure are already in place because DSDR already exists in DEP. As such, it is expected that few new devices will be installed. The current DEP DMS will transition to the enterprise DMS platform in the future. This evaluation assumes the future version of the DMS platform will have already been deployed.



**Duke Energy Carolinas, LLC  
and  
Duke Energy Progress, LLC**

**Attachment 3**

**Docket No. E-100, Sub 157**

BENEFITS with CO2		DEC IVVC Only	DEC IVVC Only
\$K - PVRR Thru 2043		Change:	Delta: Change - Base
<b>System Costs (PROSYM)</b>			
Variable Costs			
VOM	\$4,021,580	\$3,997,696	(\$23,884)
Fuel Cost	\$36,184,040	\$35,814,819	(\$369,220)
Reagent Cost	\$37,137	\$36,855	(\$282)
Start Cost	\$946,252	\$934,289	(\$11,963)
SO2 Cost	\$536	\$529	(\$7)
NOx Cost	\$23,380	\$23,039	(\$341)
Subtotal	\$41,212,925	\$40,807,228	(\$405,698)
Fixed O&M	\$3,274,219	\$3,269,647	(\$4,572)
Fuel Demand Cost	\$8,477,838	\$8,477,838	\$0
CO2 Cost	\$6,885,131	\$6,770,123	(\$115,007)
Avoided Capacity of 217MW F-frame	\$0	-\$112,201	(\$112,201)
<b>Total System Costs Saving of Performing upgrade now</b>	<b>\$59,850,113</b>	<b>\$59,324,836</b>	<b>(\$637,478)</b>
<b>IVVC Capital</b>			
Charged Capital	\$0	\$563,979	\$563,979
Improved VAR Management	\$0	-\$89,233	(\$89,233)
	\$0	\$474,746	\$474,746
<b>IVVC O&amp;M</b>			
O&M (non-levelized)	\$0	\$67,586	\$67,586
Empty	\$0	\$0	\$0
	\$0	\$67,586	\$67,586
<b>DEP CVR</b>			
Capital (non-levelized)	\$0	\$0	\$0
O&M (non-levelized)	\$0	\$0	\$0
	\$0	\$0	\$0
<b>Total Benefit for Outage Now</b>	<b>\$59,850,113</b>	<b>\$59,867,167</b>	<b>(\$95,147)</b>

BENEFITS without CO2	Base	DEC IVVC Only	DEC IVVC Only
\$K - PVRR Thru 2043	Base	Change:	Delta: Change - Base
<b>System Costs (PROSYM)</b>			
Variable Costs			
VOM	\$3,945,581	\$3,923,630	(\$21,951)
Fuel Cost	\$37,230,698	\$36,844,636	(\$386,062)
Reagent Cost	\$38,622	\$38,423	(\$200)
Start Cost	\$1,125,076	\$1,105,349	(\$19,727)
SO2 Cost	\$732	\$721	(\$11)
NOx Cost	\$25,314	\$24,929	(\$385)
Subtotal	\$42,366,023	\$41,937,688	(\$428,335)
Fixed O&M	\$3,106,008	\$3,099,999	(\$6,008)
Fuel Demand Cost	\$7,641,414	\$7,641,414	\$0
CO2 Cost	\$0	\$0	\$0
Avoided Capacity of 217MW F-frame	\$0	-\$112,201	(\$112,201)
<b>Total System Costs Saving of Performing upgrade now</b>	<b>\$53,113,445</b>	<b>\$52,679,101</b>	<b>(\$546,545)</b>

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1		Year	Total cost	E_N_S_cost	Dump revenue	Dump Energy	VOM Cost	Fuel Cost	Reagent Cost	Start Cost	SO2 Cost	NOx Cost	Total FOM	Fuel Demand	CO2 Cost
1	1	3,243,582	0	0	0	4								192,090	
2	2	3,129,078	0	0	0	28								280,781	
3	3	3,203,182	0	0	0	38								578,564	
4	4	3,078,733	0	0	0	37								574,707	
5	5	3,075,623	0	0	0	6								574,106	
6	6	3,062,031	0	0	0	12								563,788	
7	7	3,111,548	0	0	0	5								563,612	
8	8	3,332,283	0	0	0	2								563,423	
9	9	3,569,301	1,004	0	0	2								567,901	
10	10	3,725,003	17	0	0	5								630,528	
11	11	3,990,042	0	0	0	5								714,518	
12	12	4,271,040	0	0	0	0								714,518	
13	13	4,842,518	0	0	0	0								714,240	
14	14	5,271,474	0	0	0	2								721,545	
15	15	5,965,882	1	0	0	0								814,947	
16	16	6,430,636	0	0	0	6								777,361	
17	17	6,709,912	14	0	0	13								787,082	
18	18	6,993,786	217	0	0	0								903,970	
19	19	7,318,382	0	0	0	0								1,013,567	
20	20	7,816,694	944	0	0	1								1,013,567	
21	21	8,347,209	1,777	0	0	0								1,024,297	
22	22	8,840,873	0	0	0	0								1,142,322	
23	23	9,446,328	118	0	0	12								1,142,321	
24	24	9,761,535	0	0	0	0								1,165,430	
25	25	10,198,041	0	0	0	0								1,419,630	
26	26	10,784,698	0	0	0	0								1,419,630	
Total		149,519,409	4,092	0	0	178	0	0	0	0	0	0	0	20,578,445	0

2		Year	Total cost	E_N_S_cost	Dump revenue	Dump Energy	VOM	Fuel Cost	Reagent Cost	Start Cost	SO2 Cost	NOx Cost	Total FOM	Fuel Demand	CO2 Cost
1	1	3,243,582	0	0	0	4								192,090	
2	2	3,129,078	0	0	0	28								280,781	
3	3	3,203,182	0	0	0	38								578,564	
4	4	3,072,265	0	0	0	39								574,707	
5	5	3,063,365	0	0	0	7								574,106	
6	6	3,047,447	0	0	0	14								563,788	
7	7	3,086,608	0	0	0	5								563,612	
8	8	3,300,696	0	0	0	5								563,423	
9	9	3,524,783	995	0	0	8								567,901	
10	10	3,683,478	17	0	0	13								630,528	
11	11	3,946,788	0	0	0	6								714,518	
12	12	4,226,247	0	0	0	3								714,518	
13	13	4,785,878	0	0	0	0								714,240	
14	14	5,207,284	0	0	0	1								721,545	
15	15	5,899,506	0	0	0	3								814,947	
16	16	6,358,256	0	0	0	6								777,361	
17	17	6,622,539	16	0	0	11								787,082	
18	18	6,923,692	96	0	0	3								903,970	
19	19	7,239,818	0	0	0	3								1,013,567	
20	20	7,733,210	841	0	0	0								1,013,567	
21	21	8,239,687	1,780	0	0	0								1,024,297	
22	22	8,712,800	0	0	0	1								1,142,322	
23	23	9,339,788	118	0	0	11								1,142,321	
24	24	9,632,876	0	0	0	0								1,165,430	
25	25	10,082,223	0	0	0	0								1,419,630	
26	26	10,656,764	0	0	0	0								1,419,630	
Total		147,961,937	3,863	0	0	210	0	0	0	0	0	0	0	20,578,445	0

3		Year	Total cost	E_N_S_cost	Dump revenue	Dump Energy	VOM	Fuel Cost	Reagent Cost	Start Cost	SO2 Cost	NOx Cost	Total FOM	Fuel Demand	CO2 Cost
1	1	3,243,582	0	0	0	4								192,090	
2	2	3,129,078	0	0	0	28								280,781	
3	3	3,203,182	0	0	0	38								578,564	
4	4	3,075,456	0	0	0	37								574,707	
5	5	3,066,870	0	0	0	6								574,106	
6	6	3,052,207	0	0	0	11								563,788	
7	7	3,093,367	0	0	0	4								563,612	
8	8	3,312,373	0	0	0	2								563,423	
9	9	3,548,244	897	0	0	3								567,901	
10	10	3,704,519	0	0	0	4								630,528	
11	11	3,969,937	0	0	0	5								714,518	
12	12	4,244,478	0	0	0	0								714,518	
13	13	4,816,004	0	0	0	0								714,240	
14	14	5,238,089	0	0	0	0								721,545	
15	15	5,927,489	0	0	0	3								814,947	
16	16	6,392,759	0	0	0	7								777,361	
17	17	6,670,874	0	0	0	12								787,082	
18	18	6,951,590	137	0	0	1								903,970	
19	19	7,278,447	0	0	0	0								1,013,567	
20	20	7,772,704	795	0	0	0								1,013,567	
21	21	8,301,681	1,627	0	0	0								1,024,297	
22	22	8,781,260	0	0	0	0								1,142,322	
23	23	9,408,521	106	0	0	14								1,142,321	
24	24	9,704,990	7	0	0	0								1,165,430	
25	25	10,145,767	0	0	0	0								1,419,630	
26	26	10,725,918	0	0	0	0								1,419,630	
Total		148,759,383	3,569	0	0	180	0	0	0	0	0	0	0	20,578,445	0

YEAR																											
Thousands of Dollars	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	
Total cost	3,243,582	3,129,078	3,203,182	3,078,733	3,075,623	3,062,031	3,111,548	3,332,283	3,569,301	3,725,003	3,990,042	4,271,040	4,842,518	5,271,474	5,965,882	6,430,636	6,709,912	6,993,786	7,318,382	7,816,694	8,347,209	8,840,873	9,446,328	9,761,535	10,198,041	10,784,698	
E_N_S_cost	0	0	0	0	0	0	0	0	1,004	17	0	0	0	0	0	1	0	14	217	0	944	1,777	0	118	0	0	
Dump revenue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Dump Energy	4	28	38	37	6	12	5	2	2	5	5	0	0	0	2	0	6	13	0	1	0	0	12	0	0	0	
VOM	309,045	325,288	326,972	254,699	248,313	250,283	270,646	262,369	273,251	290,575	297,591	283,924	298,466	300,749	322,619	335,773	341,746	352,409	375,476	387,442	400,594	407,077	423,387	442,935	489,784	506,744	
Fuel Cost	2,509,315	2,280,622	2,054,205	2,013,694	2,029,949	2,005,699	2,028,087	2,063,907	2,149,187	2,117,108	2,168,805	2,343,005	2,743,420	3,019,222	3,450,779	3,783,898	3,906,888	4,006,201	4,071,694	4,383,264	4,725,983	4,954,882	5,332,321	5,485,522	5,565,452	5,904,762	
Reagent Cost	3,020	2,624	3,117	3,189	3,178	2,936	3,145	3,158	3,152	2,949	2,955	2,906	2,951	2,896	2,629	2,640	2,606	2,540	2,523	2,547	2,558	2,476	2,551	2,557	2,240	2,337	
Start Cost	44,869	44,792	41,686	37,521	41,512	47,811	51,035	51,889	57,785	54,339	51,508	66,433	69,425	74,927	76,394	92,724	121,968	133,675	135,164	149,115	161,695	185,103	193,354	180,964	143,109	172,361	
SO2 Cost	103	83	60	49	41	39	37	38	41	34	32	23	29	33	37	47	33	15	5	7	8	2	4	3	1	1	
NOx Cost	2,076	1,809	1,681	1,738	1,694	1,675	1,658	1,647	1,810	1,703	1,695	1,713	1,774	1,924	1,911	2,070	2,165	1,898	1,906	2,009	2,113	1,773	1,888	1,917	1,847	2,045	
Total FOM	183,065	193,079	196,898	193,136	176,829	189,798	193,326	199,766	207,989	222,699	243,099	264,628	282,393	300,634	326,725	305,831	320,998	342,487	368,228	379,024	394,457	419,923	437,296	451,309	480,206	495,007	
Fuel Demand	192,090	280,781	578,564	574,707	574,106	563,788	563,612	563,423	567,901	630,528	714,518	714,518	714,518	721,545	816,947	777,361	787,082	903,970	1,013,567	1,103,562	1,024,297	1,142,322	1,142,321	1,165,430	1,410,630	1,415,630	
CO2 Cost	0	0	0	0	0	0	0	186,086	307,183	405,009	509,839	593,889	728,521	849,544	969,888	1,130,291	1,226,411	1,293,376	1,349,818	1,498,773	1,633,686	1,777,316	1,913,087	2,030,898	2,095,775	2,281,809	
3,243,582	3,129,078	3,203,182	3,078,733	3,075,623	3,062,031	3,111,548	3,332,282	3,569,301	3,725,003	3,990,042	4,271,039	4,842,518	5,271,474	5,965,882	6,430,636	6,709,912	6,993,786	7,318,381	7,816,693	8,347,209	8,840,874	9,446,328	9,761,536	10,198,040	10,784,697		



1		Year	Total cost	E_N_S_cost	Dump revenue	Dump Energy	VOM Cost	Fuel Cost	Reagent Cost	Start Cost	SO2 Cost	NOx Cost	Total FOM	Fuel Demand	CO2 Cost
1	1	3,243,582	0	0	0	4								192,090	
2	2	3,129,078	0	0	0	28								280,781	
3	3	3,203,677	0	0	0	41								578,564	
4	4	3,076,565	0	0	0	26								574,707	
5	5	3,073,582	0	0	0	5								574,106	
6	6	3,069,598	0	0	0	13								563,788	
7	7	3,109,328	0	0	0	4								563,612	
8	8	3,154,426	0	0	0	1								563,423	
9	9	3,263,476	0	0	0	3								567,901	
10	10	3,222,022	17	0	0	4								622,350	
11	11	3,470,858	0	0	0	6								616,389	
12	12	3,681,766	0	0	0	2								616,389	
13	13	4,124,921	0	0	0	0								616,110	
14	14	4,442,289	0	0	0	2								614,390	
15	15	4,946,917	0	0	0	5								608,501	
16	16	5,268,292	14	0	0	5								570,916	
17	17	5,455,529	0	0	0	18								580,636	
18	18	5,767,576	22	0	0	0								697,524	
19	19	6,016,936	19	0	0	41								807,122	
20	20	6,355,597	0	0	0	1								807,122	
21	21	6,760,557	315	0	0	3								817,851	
22	22	7,303,058	0	0	0	3								946,874	
23	23	7,657,267	0	0	0	9								1,067,849	
24	24	7,845,777	39	0	0	3								1,079,403	
25	25	8,126,551	469	0	0	0								1,206,503	
26	26	8,584,578	14	0	0	0								1,218,642	
Total			127,453,800	908	0	187	0	0	0	0	0	0	0	17,953,542	0

2		P:\B\Wright\I\VC ProSym Runs\I\VC Study Files_Version 3_09_25_2018\ProSym Runs\I\VC_noCO2_Scenario1.xlsx													
1		Year	Total cost	E_N_S_cost	Dump revenue	Dump Energy	VOM	Fuel Cost	Reagent Cost	Start Cost	SO2 Cost	NOx Cost	Total FOM	Fuel Demand	CO2 Cost
1	1	3,243,582	0	0	0	4								192,090	
2	2	3,129,078	0	0	0	28								280,781	
3	3	3,203,677	0	0	0	41								578,564	
4	4	3,069,619	0	0	0	38								574,707	
5	5	3,060,715	0	0	0	5								574,106	
6	6	3,053,100	0	0	0	9								563,788	
7	7	3,083,369	0	0	0	5								563,612	
8	8	3,120,974	0	0	0	4								563,423	
9	9	3,226,829	0	0	0	4								567,901	
10	10	3,287,605	17	0	0	13								622,350	
11	11	3,431,277	0	0	0	2								616,389	
12	12	3,642,143	0	0	0	4								616,389	
13	13	4,077,160	1	0	0	1								616,110	
14	14	4,392,243	0	0	0	1								614,390	
15	15	4,887,803	0	0	0	2								608,501	
16	16	5,204,387	6	0	0	4								570,916	
17	17	5,400,969	34	0	0	10								580,636	
18	18	5,702,399	27	0	0	0								697,524	
19	19	5,950,211	91	0	0	6								807,122	
20	20	6,282,852	0	0	0	1								807,122	
21	21	6,676,000	269	0	0	7								817,851	
22	22	7,220,456	0	0	0	3								946,874	
23	23	7,576,557	0	0	0	9								1,067,849	
24	24	7,755,727	39	0	0	0								1,079,403	
25	25	8,041,736	460	0	0	0								1,206,503	
26	26	8,497,617	14	0	0	0								1,218,642	
Total			126,218,080	957	0	201	0	0	0	0	0	0	0	17,953,542	0

3		Year	Total cost	E_N_S_cost	Dump revenue	Dump Energy	VOM	Fuel Cost	Reagent Cost	Start Cost	SO2 Cost	NOx Cost	Total FOM	Fuel Demand	CO2 Cost
1	1	3,243,582	0	0	0	4								192,090	
2	2	3,129,078	0	0	0	28								280,781	
3	3	3,203,677	0	0	0	41								578,564	
4	4	3,071,224	0	0	0	34								574,707	
5	5	3,066,363	0	0	0	5								574,106	
6	6	3,059,084	0	0	0	12								563,788	
7	7	3,091,133	0	0	0	6								563,612	
8	8	3,136,402	0	0	0	1								563,423	
9	9	3,248,129	0	0	0	4								567,901	
10	10	3,303,041	0	0	0	4								622,350	
11	11	3,451,169	0	0	0	6								616,389	
12	12	3,661,623	0	0	0	3								616,389	
13	13	4,101,929	0	0	0	0								616,110	
14	14	4,417,581	0	0	0	4								614,390	
15	15	4,918,400	0	0	0	3								608,501	
16	16	5,235,822	3	0	0	6								570,916	
17	17	5,423,802	0	0	0	14								580,636	
18	18	5,737,197	17	0	0	1								697,524	
19	19	5,981,962	15	0	0	0								807,122	
20	20	6,319,705	0	0	0	1								807,122	
21	21	6,721,513	272	0	0	4								817,851	
22	22	7,262,278	0	0	0	3								946,874	
23	23	7,615,220	0	0	0	13								1,067,849	
24	24	7,801,416	28	0	0	0								1,079,403	
25	25	8,079,990	407	0	0	0								1,206,503	
26	26	8,535,463	0	0	0	0								1,218,642	
Total			126,816,779	741	0	197	0	0	0	0	0	0	0	17,953,542	0

Thousands of Dollars	YEAR																									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Total cost	3,243,582	3,129,078	3,203,677	3,076,565	3,073,582	3,069,598	3,109,328	3,154,426	3,263,476	3,322,022	3,470,858	3,681,766	4,124,921	4,442,289	4,946,917	5,268,292	5,455,529	5,767,576	6,016,936	6,355,597	6,760,557	7,303,058	7,657,267	7,845,777	8,126,551	8,584,578
E_N_S_cost	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	14	0	22	19	0	315	0	0	39	469	14
Dump revenue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dump Energy	4	28	41	26	5	13	4	1	3	4	6	2	0	2	5	5	18	0	4	1	3	9	0	0	0	0
VOM	309,045	325,288	326,785	252,593	244,090	247,111	267,961	261,439	272,589	291,012	286,818	274,840	297,728	302,527	320,529	331,313	332,164	336,313	356,540	366,087	376,393	377,902	409,776	426,248	459,202	472,699
Fuel Cost	2,509,315	2,280,622	2,054,661	2,010,027	2,021,776	2,006,489	2,021,200	2,067,129	2,151,549	2,128,436	2,271,613	2,457,286	2,869,688	3,166,183	3,634,281	3,983,564	4,109,420	4,267,982	4,345,602	4,643,086	4,989,632	5,335,813	5,533,968	5,687,879	5,801,388	6,185,033
Reagent Cost	3,020	2,624	3,117	3,194	3,189	2,942	3,143	3,143	3,131	2,935	3,157	3,134	3,158	3,143	3,036	2,980	3,040	2,928	2,789	2,762	2,721	2,747	2,716	2,784	2,738	2,781
Start Cost	44,869	44,792	41,844	40,317	50,371	56,190	56,748	56,232	57,686	53,273	56,259	76,395	74,961	83,524	95,604	116,675	153,091	164,025	183,763	200,809	218,540	254,301	231,036	221,850	206,927	243,538
SO2 Cost	103	83	59	47	37	36	35	37	40	37	42	40	58	78	116	118	101	71	60	63	61	12	12	13	13	13
NOx Cost	2,076	1,809	1,681	1,674	1,547	1,566	1,578	1,570	1,749	1,696	1,897	1,960	2,121	2,362	2,626	2,754	2,882	2,354	2,349	2,481	2,586	2,254	2,194	2,232	2,213	2,467
Total FOM	183,065	193,079	196,966	194,007	178,466	191,476	195,050	201,453	208,830	222,265	234,683	251,722	261,095	270,082	282,224	259,959	274,194	296,356	318,695	333,187	352,459	383,156	425,330	447,099	459,390	495,390
Fuel Demand	192,090	280,781	578,564	574,707	574,106	563,788	563,612	563,423	567,901	622,350	616,389	616,389	616,110	614,390	608,501	580,216	580,636	697,524	807,122	807,122	817,851	946,874	1,067,849	1,079,403	1,206,503	1,218,642
CO2 Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3,243,582	3,129,078	3,203,676	3,076,565	3,073,583	3,069,598	3,109,328	3,154,426	3,263,476	3,322,021	3,470,858	3,681,766	4,124,920	4,442,289	4,946,917	5,268,292	5,455,529	5,767,575	6,016,937	6,355,597	6,760,558	7,303,057	7,657,268	7,845,778	8,126,552	8,584,578



After-Tax Discount Rate	6.81%
Escalation Rate	2.50%

**Duke Energy Carolinas, LLC  
and  
Duke Energy Progress, LLC**

**Attachment 4**

**Docket No. E-100, Sub 157**

[illegible]

[illegible]

## CERTIFICATE OF SERVICE

I certify that a copy of Duke Energy Progress, LLC and Duke Energy Carolinas, LLC's Information on Integrated Volt-Var Control, in Docket No. E-100, Sub 157, has been served by electronic mail, hand delivery or by depositing a copy in the United States mail, postage prepaid to the following parties of record:

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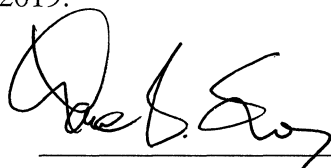
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This is the 20<sup>th</sup> day of September, 2019.

A handwritten signature in black ink, appearing to read 'Lawrence B. Somers', written over a horizontal line.

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