LG&E-KU EPRT After Action Review

December 23, 2022

Event: Winter Storm Elliott	**Event Date:** Dec 23, 2022

On Thursday December 22, LG&E/KU experienced rain across the service territory for most of the day which transitioned over to snow early to late evening – with flash freeze conditions. When the transition from rain to snow started it brought in brutally cold temperatures and sustained winds. During the early morning hours on December 23, the winds were sustained around 25 to 30 mph with gusts up to 40 to 50 mph moving across the service territory. Temperatures were below zero with the wind chills between -20 to -28 degrees.

During the morning hours, LG&E/KU had a few transmission-related contingency events (N-1) occur within the TOP Area and surrounding areas that LG&E/KU addressed with the RC and neighboring entities. For the most part, these contingencies were primarily a result of high system load and heavy transfers in the North to South direction.

Generation Dispatch began the December 23 with 7,368mw of available net capacity. This number included 75% of Trimble County 2 (TC1 was unavailable as of December 22 because of issues with the ash handling system) and our share of OVEC (as a firm import of 67mw). The cold weather began to impact available capacity early in the morning when fuel valves froze at the Brown generating station froze, tripping Brown 5 and 8 and making Brown 9, and 11 unavailable. At 06:26, TVA issued an EEA3 and pulled their reserves from the Contingency Reserve Sharing Group (CRSG), which increased the LG&E/KU contingency reserve requirement from 243mw to 710mw. By 10:33, our available capacity was down to 7,120mw and load was running approximately 550mw above forecast (6,400mw in real time).

During the afternoon of December 23, the LG&E/KU BA Area saw additional, more material impacts to available capacity. At 13:08, Texas Gas Transmission pipeline pressure fell below 500 psi which caused derates at Trimble County and Cane Run. The contracted minimum pressure at each plant is 530 and 550 psi, respectively. The gas pressure issues on the Texas Gas Transmission pipeline resulted in a combined derate of 871 mw on our Trimble County CT's and Cane Run 7 which took our total available capacity down to approximately 6,200mw and caused us to request an EEA3 at 13:36.

In response to the decrease in available internal capacity, LG&E/KU began to purchase power from the real time market to meet load and maintain our share of contingency reserves within the CRSG. TVA restored its share of contingency reserves to the group at 14:05, dropping the CRSG obligation back down to 243mw, but at 16:29 PJM cut the non-firm purchases imported by LG&E/KU, requiring the LG&E/KU BA to call for 400mw from the CRSG. At 16:45, LG&E/KU BA went to an EEA3 as outages and derates of generating units occurred causing our available capacity to dip to a low point of 5,871mw at around 17:00.

At 17:18, TVA went into an EEA 3 and again pulled its contingency reserves from the Contingency Reserve Sharing Group as of 18:00. The gas heaters at Brown became available allowing all available units at the Brown CT site to come online at 17:22. However, as of 18:00 power purchases could not be scheduled into the LG&E/KU BAA and LG&E/KU was not able to ramp up any other internal generation, causing the BA to be deficient. At 17:58 as the ACE started to decrease, the LG&E/KU BA and TOP initiated load shed to maintain ACE as close to zero as possible, using rotating load shed practices to

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limit the amount of time any particular load was interrupted. Max firm load shed was approximately 317 mw and load was completely restored at 22:10.

Damages to LG&E and KU Transmission facilities included:

- None

Operations and Outages:

- Actual out: 12/23/2022 01:09:45 Actual In: 12/23/2022 01:09:46. Line/Equipment: Delvinta to Lake Reba Tap 161kV line and West Irvine 161/69 Transformer. Weather: 38 degrees, 31 mph winds (W), 49 mph gusts, Conditions- Light Rain. Customer Impact: None
- Actual out: 12/23/2022 01:14:35 Actual In: 12/23/2022 11:40:00. Line/Equipment: Delvinta to Lake Reba Tap 161kV line and West Irvine 161/69 Transformer. Weather: 38 degrees, 31 mph winds (W), 49 mph gusts, Conditions- Light Rain. Split section between Delvinta 139 to West Irvine 193 everything checked ok. Then tested to Lake Reba Tap 162 and everything held. Transmission Lines was going to send crews out but Line tested good. Substation crews Checked Lake Reba Tap 804 for low Air pressure/ Breaker Air system froze up and maintenance resolved issue. Customer Impact: None.
- Actual out: 12/23/2022 07:39:17 Actual In: 12/23/2022 10:16:00 2h 36m 43s. Line/Equipment: Brown Plant 728 to West Cliff 712 138 kV LINE and West Cliff T02 138/69 KV Trans. Weather: -6 degrees, 20 mph winds (WSW) , 29 mph gusts, Conditions- Foggy. Cause: Gas Pressure switch froze. Customer Impact: None.
- Actual out: 12/23/2022 14:14:57 Actual In: 12/23/2022 15:37:00 1h 22m 3s. Line/Equipment: Paynes Mill to Tyrone 69kV line, Paynes Mill to Pisgah 69kV line. Weather: -1 degrees, 17 mph winds (W) , 30 mph gusts, Conditions- Light Snow. Cause: Over Current settings set wrong on the low side. Customer Impact: Paynes Mill 1298, 1 hr 32 min.

Safety:

- Transmission did not have any close calls or near misses.

What went well:

- Coordination and teamwork between TCC, Generation Dispatch, DCC, and field personnel
- Coordination with LSEs (OMU, KMPA, and KYMEA)
- Coordination with Reliability Coordinator (RC-TVA)

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- ESCs were well prepared and able to successfully implement established operating plans to address system emergencies throughout the event
- ESCs and Engineers worked well together to manage multiple N-1 issues occurring simultaneously
- NERC Reporting (Initial report 1 hour and final report 72 hours later).
- No staffing issues; management, additional ESCs and support staff present in the control center during the event and engineers provided additional support remotely.
- Load shed tool provided energy relief needed
- Load shed implementation was well coordinated and communicated among GD and TOP/BA allowing for ACE to remain around zero

What did NOT go well:

- Communication with Key Accounts
- TCC did not have an understanding prior to shedding load that DCC was going to open Distribution feeder breakers after Transmission breakers were opened
- Public appeal occurred after the load shed rollouts were implemented
- Ability to purchase power in an emergency situation. MISO said we could not buy from them since we did not have a BA/BA agreement. (Will followup with Policy and Tariffs) (Owner: Jackson, Ramos)

Comments/Suggestions to Improve:

- EMS – A single operator command to shed loads in blocks determined by operator. (What are the CIP implications if any) (Owner: Jackson, Ramos, Bradley)
- EMS– Ability to take snap shot of load shed screens right before load shedding action takes place. (Owner: Jackson, Ramos, Bradley)
- EMS – Single action to disable all ARS schemes associated with Load Shed breakers. (Owner: Jackson, Ramos, Bradley)
- EMS – Timer on each load shed breaker set to time of rotating feeders. (Owner: Jackson, Ramos, Bradley)
- Training with transmission and distribution on capacity load shedding (Owner: Jackson, Isbell)
- Training on Purhcasing emergency power BA/BA and tagging. BA/TOP/GD (Owner: Jackson, Isbell)
- Blast call to Customer Commitment and Key Accounts when we go to an (EEA1, EEA2 or EEA3) to be determined. Need specifics of who gets the blast, what does the blast say and when do they get it. (Owner: Steinmetz, Jackson)

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- Educate the organization on EEA levels (definitions, protocols and procedures) (Owner: Steinmetz)

Next steps:

- Address all follow-up items that may result from the Distribution After Action Review, creating subteams as needed. (Owner: Steinmetz/Jackson/Meacham)
- Operational debrief with Generation Dispatch on January 12th. (Owner: Jackson)
- Complete a compliance review with legal and compliance. Kick Off meeting scheduled for January 23rd. Have started Compliance Inquiry form. (Owner: Hall/Colvin)
- Review and update Transmission Capacity Load Shed Standard. (Owner: Steinmetz)
- Work with Distribution and review criticality scores, groups, and expand audience to major accounts etc... Kick off meeting scheduled for January 19th. (Owner: Jackson)
- Review and update as necessary the LG&E/Capacity and Energy Emergency Operating Plan. (Owner: Jackson)
- Work on BA/BA agreements with MISO on being able to purchase emergency power. (Owner: Jackson)
- Review Conservative Operations protocols with Generation Dispatch and make changes as needed. (Owner: Jackson)
- Discuss whether BA/TOP need to be involved in the review of CRSG protocols with Generation Dispatch. (Owner: Jackson)
- Develop and execute the necessary Corp Awareness Training for any New or Updated Transmission Operating Plans/Programs. (Owner: Steinmetz)
- Incorporate any New or Updated Operating Plans/Programs (Transmission & Other) into the 2023 GRID EX where they will be exercised. (Owner: Steinmetz)
- Consider a defined LG&E/KU Power Conservation Alert Process/Program. (Owner: McFarland)
- Schedule a meeting with major accounts corporate communications, customer service and committment to discuss options for canned responses and internal blast calls. (Owner Jackson/ Steinmetz)
- Gather CA data from PostgreSQL for Ops Eng relating to the Winter Storm Event (Owner: Meacham)

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