



PPL Electric Utilities Spare Transmission Transformer Strategy

Andrew Funt
PPL Electric Utilities

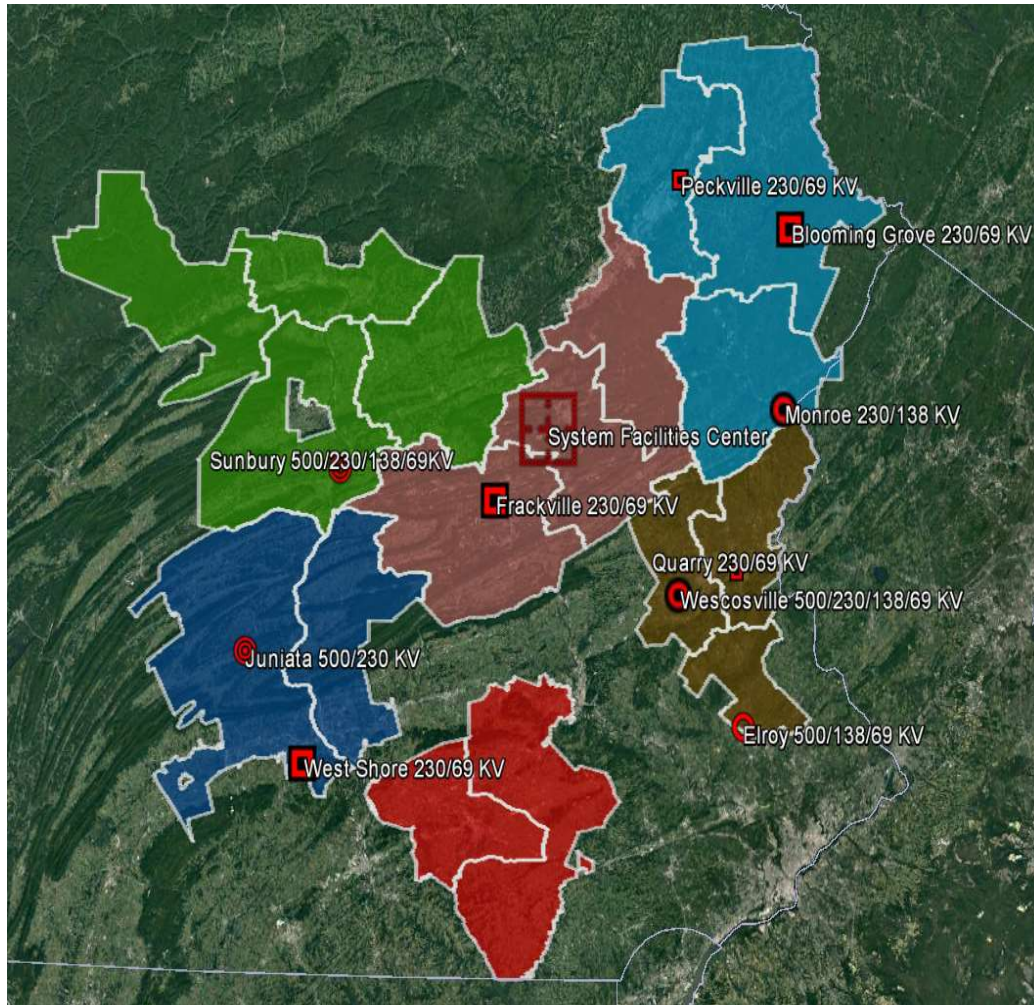
PPL Spare Transformer Program Overview

- Member of Spare Transformer Equipment Program (STEP)
 - Each Utility is obligated to commit a certain number of spares for each voltage class in which they are a member
 - PPL contributes to the 230/138kV and 230/69kV voltage classes
 - Each participating utility is committed to the Sharing Agreement required obligation based on the available spare units
 - The required obligation is a number of spare transformers that represents the MVA obligation value calculated for a participating utility based on its response to an S-5 contingency
- PPL is committed to being a good steward of the power system and supporting neighboring utilities as best possible during an emergency

PPL Spare Transformer Program Overview

- Member of Regional Equipment Sharing for Transmission Outage Restoration (RESTORE)
- Organization developed from a team of regional utilities; goal is to mitigate the increased risk of coordinated physical attack on the grid
 - Develops capabilities and the perceived need to be able to recover from a catastrophic event
 - RESTORE defines a triggering event as a catastrophic event creating an urgent grid need which the utility loses ability to serve significant load or cannot maintain grid stability
 - PPL participates in annual mock casualty drills
- PPL contributes to the 500/230kV and 230/138kV classes

PPL EU Spare Transformer Map & Inventory



Requirement to maintain at least 1 spare unit for every classification of transformer on the system

Spare Inventory by Class:

- 138/69kV 170MVA – 1
- 230/69kV 75MVA – 2
- 230/138kV 340MVA – 2
- 230/69kV 170MVA – 3
- 500/138kV 340MVA – 1
- 500/230kV 217MVA 1PH unit – 1
- 500/230kV 250MVA 1PH unit – 1
- 500/230kV 650MVA 3PH unit – 1

Spare Transformer Fleet Management

- Units spread across the system
 - Typically staged for future project or became a spare unit after a yard reconfiguration
- Staging is important to eliminate the O&M expense for relocation
- New units will be fully assembled and tested by the factory at time of deliver
 - Vaisala/Dynamic Ratings/SEL ETM health monitoring equipment connected
- Legacy units completely refurbished and tested before returning to service
- Fleet management is handled through frequent coordination with T&S Standards and Asset Management teams

Spare Transformer Fleet Management

- Storage:
 - Spare transmission units stored outside; smaller distribution voltage class units stored indoors at the PPL Systems Facility Center in Hazleton, Pa
 - Spare units are fully assembled and tested; low-oil alarm connected to station Alarm Management System and station SCADA
 - Typically, no maintenance testing performed; units visually inspected during substation inspection
- PowerBI dashboard provides organizational-level visibility to status and location of the fleet
 - PowerBI dashboard data fed directly from Cascade record inventory

Spare Transformer Fleet Management PowerBI Dashboard



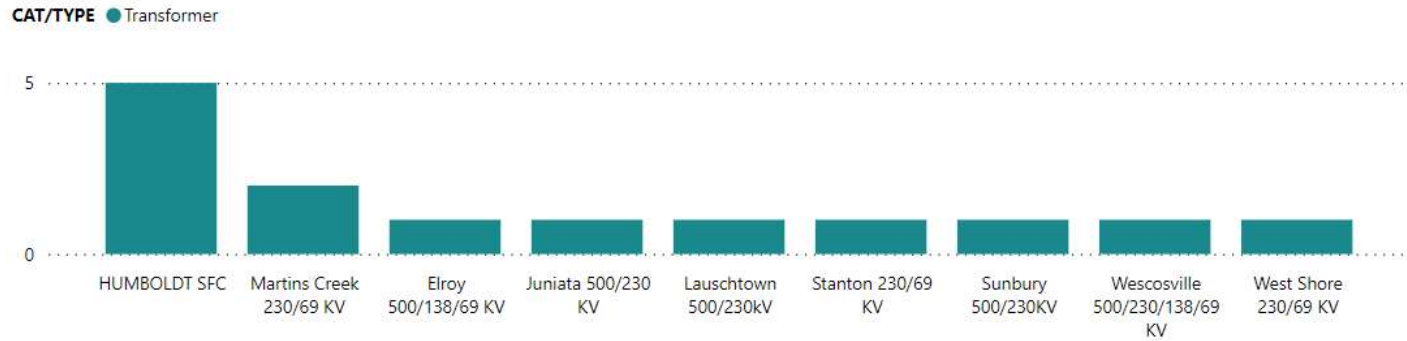
Spare Equipment Dashboard

Equip Category
Transformer

Voltage
All

EEl Step Committed
All

Transformer Count
14
Breaker Count
(Blank)
CCVT/PT Count
(Blank)



Location	Equip Cat	Equip ID	Manufacturer	Model	Position	Voltage	Status	Manu Date	Install Date	EEl Step Committed
Wescosville 500/230/138/69 KV	Transformer	316390	GE-Protec		SYSTEM SPARE	138KV-69KV	Spare On Site	02/01/2009		
HUMBOLDT SFC	Transformer	2784384	HICO		340MVA-10165862_0001	230KV-138KV	Equipment Tested Not Yet In Service	02/14/2022		
HUMBOLDT SFC	Transformer	2784385	Delta Star		170MVA-E5227	230KV-69KV	Equipment Tested Not Yet In Service	03/14/2022		
Martins Creek 230/69 KV	Transformer	4762	Pauwel		TRANSFORMER 21 230-69 KV	230KV-69KV	Spare Available - Unit Complete	01/01/2007	01/01/2008	
Stanton 230/69 KV	Transformer	316431	ABB		85MVA 1134091	230KV-69KV	Spare Available - Unit Complete	01/24/2014	09/08/2022	
West Shore 230/69 KV	Transformer	313831	Waukesha		WSHO TRANSFORMER #2	230KV-69KV	Spare Available - Unit Complete	02/01/2013	05/31/2013	
Elroy 500/138/69 KV	Transformer	320852	Hyundai		SPARE	500KV-138KV	Spare On Site	12/01/2012	02/13/2015	
HUMBOLDT SFC	Transformer	2784425	Smit		250MVA_3231636	500KV-230KV	Equipment Tested Not Yet In Service	01/05/2022		
HUMBOLDT SFC	Transformer	2784426	Smit		250MVA_3231637	500KV-230KV	Equipment Tested Not Yet In Service	01/05/2022		
HUMBOLDT SFC	Transformer	2784427	Smit		250MVA_3231638	500KV-230KV	Equipment Tested	01/05/2022		



PPL Electric Utilities Spare Distribution Transformer Strategy

Becca Hetrick
PPL Electric Utilities

Distribution Power Transformer Spare Strategy Overview

- Using the conservative failure rate of 0.48% (2-3 transformers annually), it is required that our distribution spare transformer inventory be maintained at or above 1% for each class
- The following are PPL EU's current policies pertaining to the Distribution Substation transformer design standards which affect which spares are acquired:
 1. All spare transformers to be purchased and used on the Distribution system shall be Load Tap Changer (LTC) transformers.
 2. The following transformer capacities are being purchased
 - a) 14, 28, & 35 MVA transformers (69-12kV)
 - b) 35 MVA transformers (138-12kV)
 - c) 10 MVA transformers are no longer being purchased.

Distribution Power Transformer Spare Strategy Overview

Nominal Primary Voltage (kV)	Nominal Secondary Voltage (kV)	Rating(s) (MVA)	No. In-Service	Min. No. Spares Req'd	Rating of Spare
69	12	<10, 10, 11.2,12,14	199	2	14 MVA
69	12	15,16,16.8,20,25,26,28	329	3	28 MVA
69	12	28.8,33.3, 34, 35	31	2	35 MVA
69	23	5,20	2	-	-
138	12	20,21	6	-	-
138	12	33.3, 34, 35	57	1	35 MVA

- For reactive replacements, the oldest spare is preferred to be used, if feasible, to rotate the stock of spare equipment.
 - If a spare transformer is not used for greater than 4 years, transformer testing may be warranted as to not void the 5-year warranty.
- In the event of depletion of the transformer spare quantities, the following hierarchy should be followed:
 1. Spare Transformer Pool
 2. On-Site Spare Transformer (if appropriate)
 3. Planned Work Transformer Pool

Questions, Comments & Suggestions?

