

# PECO Transformer Spare Power Transformer Strategy

## T&S Engineering

Tony Franchitti – Transformer SME

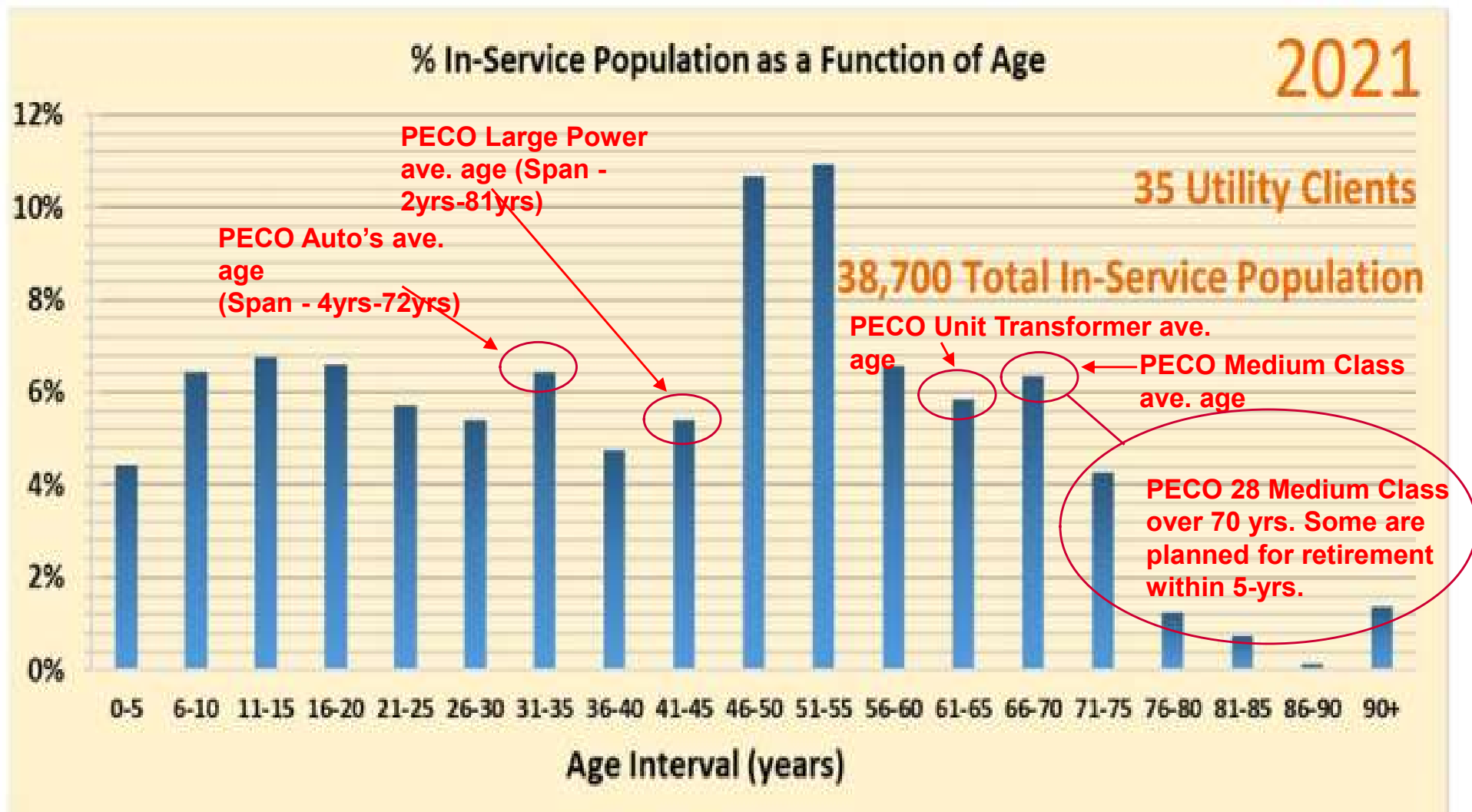
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# Overview of Defensive Layers

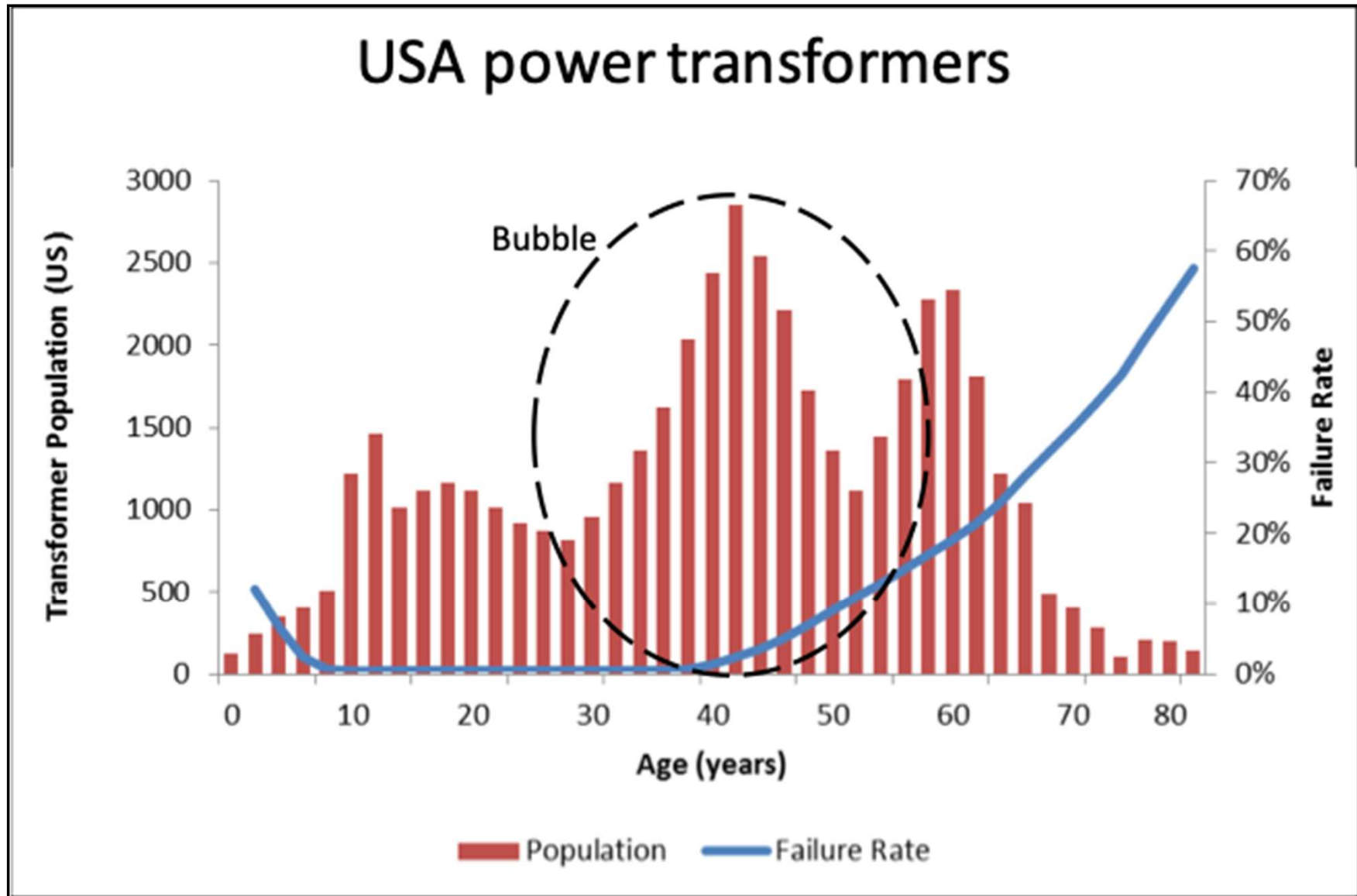
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- Planning Criteria
  - Transmission Planning
  - Distribution Capacity Planning
  
- Spare Transformer Stocking
  - Methodology
  - Spare Inventory
  - Locations
  
- STEP & RESTORE
  - Utility Transformer Sharing Agreements
  
- Facility Enhancement Program (FEP)
  - Physical Defense

# Industry Population Data (Source Doble) Compared to PECO Transformer Classes (2021 industry data; 2022 PECO data)



## Appendix D - Industry Population and Failure Rates – Source Aurtra Solutions (2020 population data; failure rate data over many years)

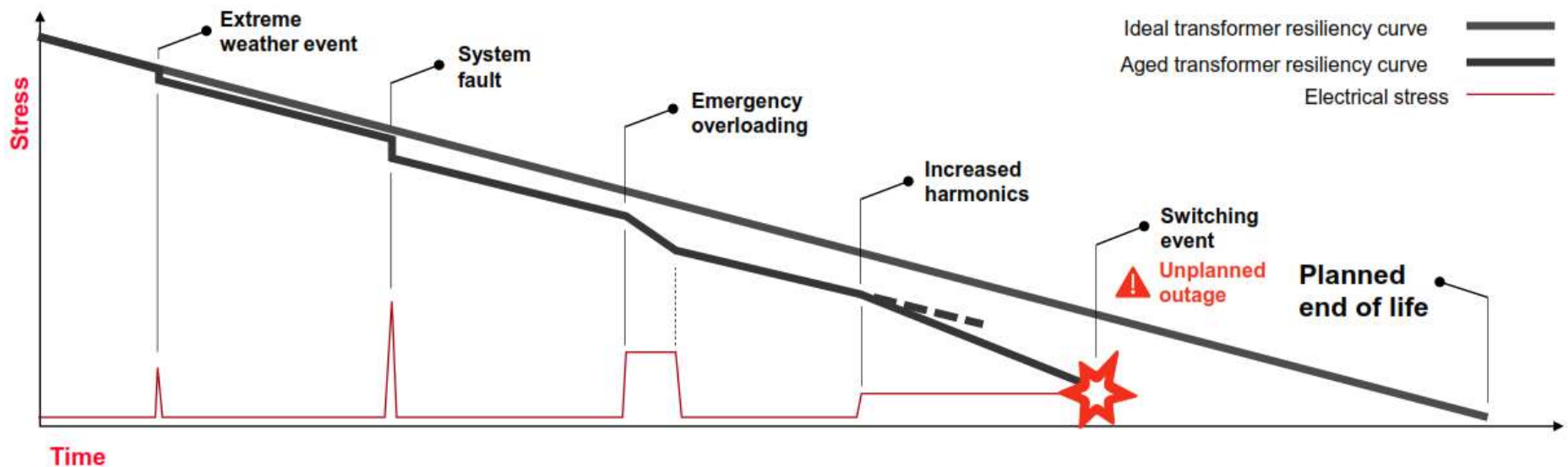


# Appendix C - Transformer Life Cycle – Source ABB

## External stresses may affect transformer life expectancies

HITACHI ABB

Realistic transformer life curve



Unplanned outages are costly and result in significant downtime. With proper monitoring, they can be avoided.

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# Transformer Spare Stocking Strategy

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- Historical Failure Rate Approach
  - Involves a statistical analysis of multiple variables to determine required spares
    - each transformer class to have at least one spare
      - class defined as HV/LV/TV, MVA rating, physical configuration
    - transformer class population
    - historic failure rate for each class
    - current spare inventory and need for multiple spares for a class
- 2015 Resiliency Initiative
  - Enhanced spare strategy to cover replacement of all autotransformers at any one *transmission* station in the chance of a catastrophic event
  - Sufficient *distribution* transformer capacity will be required to serve summer peak load at the substation but not account for further distribution transformer contingency
- Spare transformers are stored strategically
  - Strive to store spare transformers at different substations rather than at the location they will be used
  - Due to transportation infrastructure limitations, critical transformers are stored in both the north and south of territory.

# Overview of Distribution Planning Criteria

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- Distribution Capacity Planning plans and designs the system for N-1 contingency scenarios
  - Normal capacity with all transformers in service
  - The short-term rating of the remaining transformers with the largest transformer out of service, prior to load transfers
  - The long-term emergency rating of the remaining transformers with the largest transformer out of service, plus planned load transfers to other sources, for the replacement period
  - Other planning scenarios exist as documented in Electric Distribution Capacity Planning Guidelines

# EU Resiliency Spare Storage Strategy - 2015

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## Assumptions:

- Future spare transformers cannot be stored at the substation where they are intended to be used
- Existing operational spares will not be relocated as part of this project
- If the existing spares are stored at a tier 1 or 2 location, they were considered to be adequately protected at the time of original analysis

## Definition of Strategic Transformer – meets one or both of the following criteria:

- Non-standard design that can be used at a single-specific site (unique)
- Supplies or is a part of the Bulk Electric System path
- This applies to substations containing 500kV-230kV auto's

## Strategy for Storage of Incoming Spares:

- De-centralized outdoor storage
  - Distribute spare transformers throughout existing substations with no more than four strategic transformers at any one location (no additional security beyond current FEP level required)
  - Store spare transformers at tier 0, 1 or tier 2 sites
  - Many logistical challenges including access to rail sidings, transportability from spare location to in-service location (bridges, tunnels, etc.), available space in substations for new pads, security tiering requirements of substations



**Slide 8**

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**FAJO**

**Tier 1 or 2**

Franchitti, Anthony J.(PECO), 2023-02-20T17:33:08.499

# Strategy (cont'd) and Challenges

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## Long-term Strategy:

- As existing operational spares (stored at the site for which they are to be used) are utilized and replacements are ordered, the replacements will be evaluated to be delivered to a different site for storage, further distributing the spare fleet.
- Opportunities are being evaluated to pour new pads for future spares when projects are being designed
- Because of long lead-times and an aging spare inventory, PECO has begun to rotate spares into in-service positions as part of expansion and replacement projects. New spares are then ordered to replace the spare inventory

## Challenges:

- Many project delays causing challenges to delivery schedules and logistics
  - Some manufacturers offer no-cost storage options for a limited time which is a big help
- Project budgets are typically approved on an annual basis, however, transformer lead-times require orders to be placed up to three (3) years in advance making the budgeting process a challenge
- Production slots are being negotiated with manufacturers without an approved budget, but sometimes the slots need to be re-adjusted or cancelled due to changes in project timeframes or changes in project scopes
- Finding locations for new spare transformers with enough space to house them and meet the Resiliency requirements discussed above

# Mobile Transformer Strategy

- PECO has (8) mobile transformers capable of restoring load at multiple voltages
- Mobile transformers can typically be deployed within 24 hours of required need
- Annual PM for the 230/138kV high-side mobiles is performed to deploy and connect one mobile per year as practice and reliability check (4-yr cycle for each)

Mobile Unit	Voltage (kV)	MVA
86-006 (Unit Mobile #1)	33.0-4.3GY	2.5
	13.2-4.3GY	2.0
	33.0x4.3-0.46	1.0
86-206 (Unit Mobile #2)	33.0-4.3GY	2.5
	13.2-4.3	2.5
86-306 (Unit Mobile #3)	33.0-4.3GY	3.0
86-209 (Unit Mobile #4)	33.0-4.3GY	3.0
86-100*	225-35GY	60.0
86-200**	230x138-13.8GY	40.0
86-300*	230-35GY	60.0
86-400**	230x135.8-13.8GY	40.0

\*Can only be installed at 16 “mobile-ready substations”

\*\*Can only be installed at 10 “mobile-ready substations”

# Spare Transformer Equipment Program (STEP)

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- In addition to Resiliency Strategy and is not considered a supplement to Resiliency Strategy
- STEP is a mature, industry-led program designed to help participating companies restore their system following an act of terrorism.
- The STEP program:
  - Imposes a binding contractual obligation to share spare transformers following a triggering event (act of terrorism)—pursuant to a mutual Sharing Agreement
  - Provides a flexible framework and ready mechanism to also share assets in response to other (non-terrorism-related) emergencies
  - Fosters a trusted community of industry peers to share leading practices and participate in preparedness efforts.

# What is a STEP Triggering Event?

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- "Triggering Event" means an act or coordinated acts of deliberate, documented terrorism, as defined in the Homeland Security Act of 2002, 6 U.S.C. §101(15), ... , resulting in
  - (1) the destruction or long-term disabling of one or more electric transmission substations, and
  - (2) either
    - the declaration of a state of emergency by the President of the United States pursuant to the National Emergencies Act, 50 U.S.C. §1601 et seq., ... , or
    - the declaration of a grid security emergency by the President of the United States pursuant to the Federal Power Act, 16 U.S.C. §824 et seq., ... .

EEI



STEP<sup>TM</sup>  
SPARE TRANSFORMER EQUIPMENT PROGRAM


# Regional Equipment Sharing for Transmission Outage Restoration (RESTORE) Program

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- Current under the North American Transmission Forum (NATF). An optional, self-funding program available to all NATF members.
  - Designed to enhance the resiliency and reliability of the energy grid by providing additional sources for obtaining critical equipment following disastrous events.
  - Establishes a voluntary-but-formal agreement between transmission owners to commit to share (own, maintain and sell to one another) available spare equipment (e.g., spare transformers and other transmission equipment) for an event that results in major damage to the transmission grid.
- Exelon has committed 4 transformers in 2 distinct voltage classes to RESTORE including 2 in the 500/230kV class

# Facility Enhancement Program (FEP) Development

**April 16, 2013 PGE's Metcalf Substation Attack**



**Shots in the Dark**  
A look at the April 16 attack on PGE's Metcalf Transmission Substation

1 12:59 a.m. 2:07 a.m. Attackers cut telephone cables	2 1:25 a.m. Attackers open fire on substation	3 1:48 a.m. First 911 call from power plant operator	4 1:45 a.m. Transformers all over the substation start cordfiring	5 1:50 a.m. Attack ends and gunmen leave	6 1:51 a.m. Police arrive but can't enter the locked substation	7 2:15 a.m. Utility electricians arrive
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Sources: PGE, Santa Clara County Sheriff's Dept., California Independent System Operator, California Public Utilities Commission, Google (Images), The Wall Street Journal

- No intrusion into substation
- Law enforcement found over 150 shell casings from AK-47
- 50 bullet holes in 19 pieces of PGE equipment
- 10 of 11 500-230KV transformers were struck in their radiations
- 1 transformer not struck was out of service
- Additional 230KV-115KV transformers struck
- 6 Control breakers short and 2 extensively damaged
- Transformers leaked 52,000 gallons of oil
- To date, the total cost for Metcalf (recovery ?) is \$30M and counting

**As a result of the Metcalf incident, Exelon Sr. Leadership, requested Exelon/OPCO Security Teams, T&S and Gas SMEs to:**

- Conduct a technical analysis of electric and gas assets.
- Align on Critical Asset Tiering methodology across the utilities.
- Protect Exelon assets, employees and customers through Prevention (facility design hardening), Distribution (perimeter systems monitoring) and Recovery (spare transformers and associated equipment).
- Develop a set of physical security standards/requirements, based upon tier level and a timeline for completion.
- Develop a resiliency strategy that supports defense in depth approach.
- Develop a life cycle planning program for security equipment.
- Complete a Ballistic Protection evaluation with recommendations for Resiliency.

# Electric Asset Tiering

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- Exelon Security, OPCO Security and OPCO T&S SMEs review Exelon's scoring criteria at a minimum of every 36 months, as well conduct a tiering re-assessment. Next scheduled for 2023.
- Results are shared with T&S and OPCO Sr. Leadership and approved by the COO's at OPCO Security Council Meetings.

## Overview:

Tiering is a rank/tiered category assigned to an Exelon facility following an assessment of the operational criticality of the facility.

- **Tier 0** - Electrical assets deemed critical to the integrity of the national grid so that if rendered inoperable or damaged, as a result of a physical attack, could result in instability, uncontrolled separation, or cascading within an Interconnection.
- **Tier 1** - Electrical assets most critical to the integrity of the bulk electric system and/or conservation of critical load areas or customers. Tier I Security level is generally reserved for Transmission Substations which, if severely damaged or destroyed, would have a significant impact on the ability to serve large quantities of customers for an extended period of time, would have a detrimental impact to the reliability or operability of the power grid or would cause significant risk to public health and safety.
- **Tier 2** - Electrical assets moderately critical to the bulk electric system and /or conservation of critical load areas or customers.
- **Tier 3** - Electrical assets important to the bulk electric system and/or conservation of critical load areas or customers.
- **Tier 4** - All electrical assets not determined to be Tier 0, Tier 1, Tier 2, or Tier 3.

***NOTE: The PECO FEP funding is planned for Tiers 0 through 3. Tier 4 physical security upgrades should be completed opportunistically.***