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Energy Security  
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# **„Focus on Electrical Grids - Transformers“**

Green Book on Critical Energy Infrastructure – final meeting  
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Heiki Jakson  
SME, NATO ENSEC COE



# Electrical Grids

- Criticality of HV substations
- **Targeting (physical attacks!)**
- Security measures
- Conclusion
  
- Approx 15 min
- **Question during the Q/A session!**

# Base material



## Physical Security of the U.S. Power Grid: High-Voltage Transformer Substations

Paul W. Parfomak  
Specialist in Energy and Infrastructure Policy

June 17, 2014

Congressional Research Service  
7-5700  
www.crs.gov  
R43604

CRS REPORT  
Prepared for Members and  
Committees of Congress



Infrastructure Security and Energy Restoration  
Office of Electricity Delivery and Energy Reliability  
U.S. Department of Energy



April 2014 Update

<http://fas.org/sgp/crs/homesec/R43604.pdf>

[http://energy.gov/sites/prod/files/Large%20Power%20Transformer%20Study%20-%20June%202012\\_0.pdf](http://energy.gov/sites/prod/files/Large%20Power%20Transformer%20Study%20-%20June%202012_0.pdf)



# Criticality of HV substations



# HV Transformers

- Custom buildt and expensive
- Wery few in reserve
- Production time up to 20 months
- Complicated transportation process



# Experience so far (in US):

- Physical attacks have occasionally caused limited black-outs but no widespread or long-lasting outage.
- **No experience of simultaneous failure of several substations!**
- Thus, energy companies prepare for a maximum loss of **one** transformer substation at a time



# Experts evaluate that:

- 2-3 transformer substations lost in a region:
    - local short-term black-out
  - more than 3 transformer substation lost:
    - long-term blackout for many areas in the US
  - 9 out of 30 most critical substations lost:
    - „coast-to-coast black-out“
- \*Alltogether some 2100 huge transformers operating in US



# Transformer resilience

- Designed to withstand lightning strikes, hurricanes and other natural and technical disasters and accidents, **but not resistant to physical attack.**
- Can be:
  - Draining of oil and arsony
  - Short circuiting
  - Explosives or Fireing upon
- Easier to access than power plants, control centers or other critical facilities





# Targeting of HV Transformers



# History of attacks

1996 - IRA was prevented from conducting a coordinated attack against six (6) HV transmission substations in UK.

- Electrical engineer
- US Marine corps diversion specialist – specialized on attacks on energy infrastructure behind enemy lines

Material for attacks was obtained from **library**



# 2013 - Metcalf shooting

Several individuals used rifles to destroy 17 HV transformers in transmission substation in California, U.S.

- Communications were cut for the area
- Experts found traces of expert level sniper conduct
- Attackers had good knowledge of energy system functioning
- It took a month to restore the substation



# Pakistan 2015 January

- Lack of investment to transmission system
- Overburdened transmission system
- Rebel attack that damaged several power towers
- Country-wide Black-Out.





# Security measures for transformers



# Physical security measures

- **Protecting information**
- Surveillance and monitoring
- Restricting physical Access
- **Visual shielding the assets**
- Modifying substation design



# Initiatives

- Transformer equipment Programs
  - DHS Recovery Transformer programm
  - EEI Spare Transformer Equipment Program
  - **NERC Spare Equipment database**
- **Public-Private Partnership!!!**
  - **Coordination and Information Exchange**
  - Standards and Best Practices
  - Education and Exercises



# Conclusions

- Making the electrical infrastructure resilient against deliberate attack is extremely **expensive**, therefore PPP must be implemented, in order to use rare resources for best possible result.
- Energy companies do not have knowledge to plan defence against attacks, thus government must take a **coordinating** initiative.





Heiki Jakson

[heiki.jakson@enseccoe.org](mailto:heiki.jakson@enseccoe.org)

Phone: office +370 5 203 23 89

mobile +370 616 82 431

*... Thank you!*

NATO ENSEC COE

Šilo str. 5a,

Vilnius

Lithuania

<http://enseccoe.org>

