IEEE CSC & ESAS SUPERCONDUCTIVITY NEWS FORUM (global edition), February 2020.
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Chicago Superconductor Cable Project and Vision for the Technology

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32nd International Symposium on Superconductivity – Kyoto, Japan

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Exelon Utilities

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Exelon Utilities serves ~10M customers, covering over 24,000 sq. miles, and with peak load over 53 GW

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Operating Statistics

Commonwealth Edison	
Customers:	4,000,000
Service Territory:	11,400 sq. miles
Peak Load:	23,753 MW

Potomac Electric Power	
Customers:	856,000
Service Territory:	640 sq. miles
Peak Load:	6,674 MW

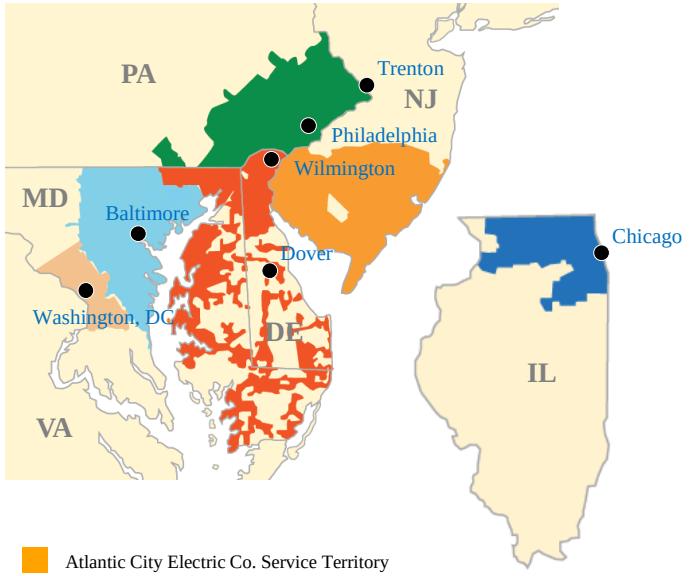
PECO Energy	
Customers:	2,100,000
Service Territory:	2,100 sq. miles
Peak Load:	8,983 MW

Atlantic City Electric Co.	
Customers:	550,000
Service Territory:	2,800 sq. miles
Peak Load:	2,797 MW

Baltimore Gas & Electric	
Customers:	1,970,000
Service Territory:	2,300 sq. miles
Peak Load:	7,236 MW

Delmarva Power & Light	
Customers:	631,000
Service Territory:	5,000 sq. miles
Peak Load:	4,121 MW

Combined Service Territory



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- ✓ 4 million electric customers in northern Illinois, including the City of Chicago
- ✓ ~6,400 Employees
- ✓ Service Territory: 11,429 square miles
- ✓ Peak Load: 23,753 MW (7/20/2011)
- ✓ 541,200 distribution transformers
- ✓ 113,100 circuit miles
  - 40,900 of low voltage
    - 15,400 (38%) overhead, 25,500 (62%) underground
  - 66,400 of primary distribution
    - 34,800 (52%) overhead, 31,600 (48%) underground
  - 5,800 circuit miles of transmission
    - 5,400 (93%) overhead, 400 (7%) underground
- ✓ 801 substations
  - 277 transmission-connected, 524 distribution-connected

AMSC's Resilient Power Solutions

From power generation to transmission and distribution using proprietary products based on core technologies: smart software/controls and smart materials

	What it is	What it does
Electrical Control System for wind turbines (wtECS™)	Components and controls that act as the "brain" and "nerves" of turbines	**Maximizes** power generation, ROI of wind power installations
Transmission Voltage Management (D-VAR®)	Voltage regulation solution, driven by power electronics components	**Connects** renewable energy to grid; provides reactive power compensation
Distribution Voltage Optimization (D-VAR VVO®)	Direct connect 15Kv class power quality system for distribution network	Optimally **controls** voltage, allowing utilities to build distribution networks using distributed generation (DG)
Resilient Electric Grid (REG) systems	System that increases electric grid resiliency, reliability, and load serving capacity	Increases **reliability** of urban grids and provides cost-effective, simplified solution for urban load growth
Ship Protection Systems (SPS)	Advanced HTS-based systems that enhance operational safety	Degaussing is a magnetic system that interferes with a mine's ability to **detect** and damage a ship

amsc smarter, cleaner ...better energy

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REG NETWORKS: ACHIEVING ENHANCED RESILIENCY IN TODAY'S GRID

Resilient Electric Grid (REG) Networks

Achieve Major Increases in Reliability

AND

- ✓ Avoid land acquisition for new or expanded substations
- ✓ Avoid construction of new transmission circuits
- ✓ Minimize public disruption during construction
- ✓ Enable new options for installation in congested ROW
- ✓ Avoid the delay and risk of transmission siting and permitting
- ✓ Avoid public debate of new sources of EMF
- ✓ Avoid oil and SF6

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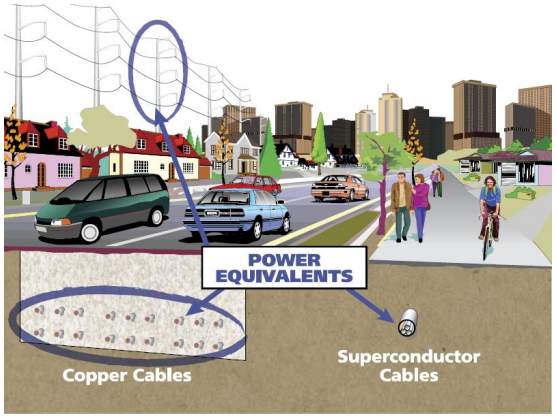
REG Networks' Unique Value

- ✓ Allows for much simpler permitting, siting, and installation in smaller Rights-of-Way, due to near zero thermal and EMF signature
- ✓ Provides an option to improve resiliency that is effective even in areas served by multiple Transmission Voltage levels
- ✓ Expected lower total project costs due to lower voltage equipment and smaller footprints and Rights-of-Way requirements and eliminating the need for costly land acquisition



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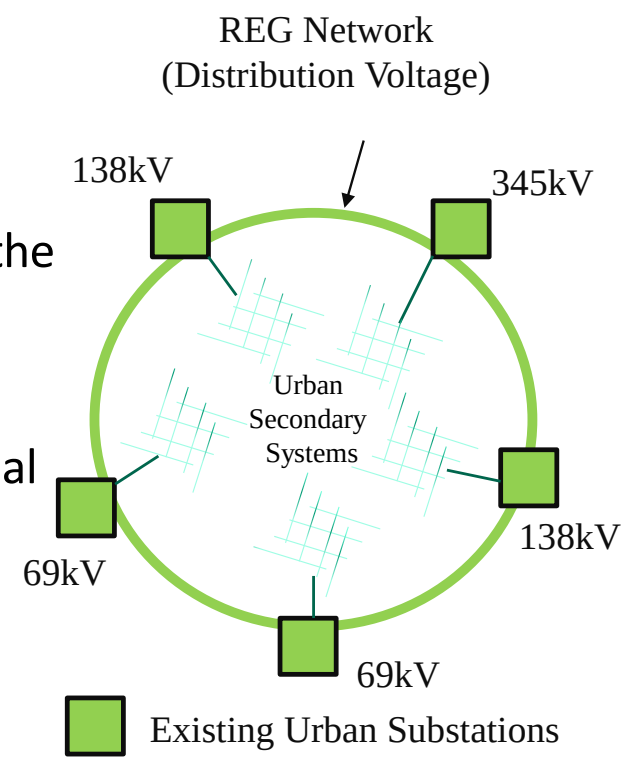
REG Networks Utilize High Temperature Superconductor (HTS) Cables

Creating a higher level network above the existing Urban Secondary System

- ✓REG Networks provide **resiliency** by creating grid **redundancy**
- ✓REG Networks c**onnect** urban substations on the d**istribution side**, effectively **reinforcing** the transmission system
- ✓REG Networks provide **high capacity, distribution voltage connections** with minimal footprint, civil work and permitting
- ✓Approach is independent of **transmission voltage levels,** but compliments the existing transmission system



COMED PROPOSED PROJECTS

Focus on Resiliency

- ✓ There are many variations of what resiliency means, but fundamentally they all encompass the following three areas:

- ✓ Withstand
  - Eliminating or Preventing the event or resulting damage
- ✓ Recover
  - System and plans to provide rapid damage assessment and **restoration**
- ✓ Survive
  - The ability to **maintain** some basic level of **electrical functionality**

Superconductor Cable

REG Benefits from Possible Second Project in Chicago's Central Business District

Intended to Provide Greater Resilience with Lower Cost and Less Disruption

- ✓ **Expected to increase reliability in the heart of the Chicago central business district:**
  - Dearborn, Plymouth Court and State substations
- ✓ **Dearborn** and **Plymouth Court** are radial substations, served from 69kV sources. State is looped at 138kV.
- ✓ Project intended to loop together all three substations into a network, increasing reliability and resiliency for all to N-3.
- ✓ **Expected to be far less disruptive** to the downtown core area than conventional transmission upgrades and not to:
  - Require **additional high voltage transformation**
  - Require **significant infrastructure construction**
  - Require **land acquisition for substation expansion**

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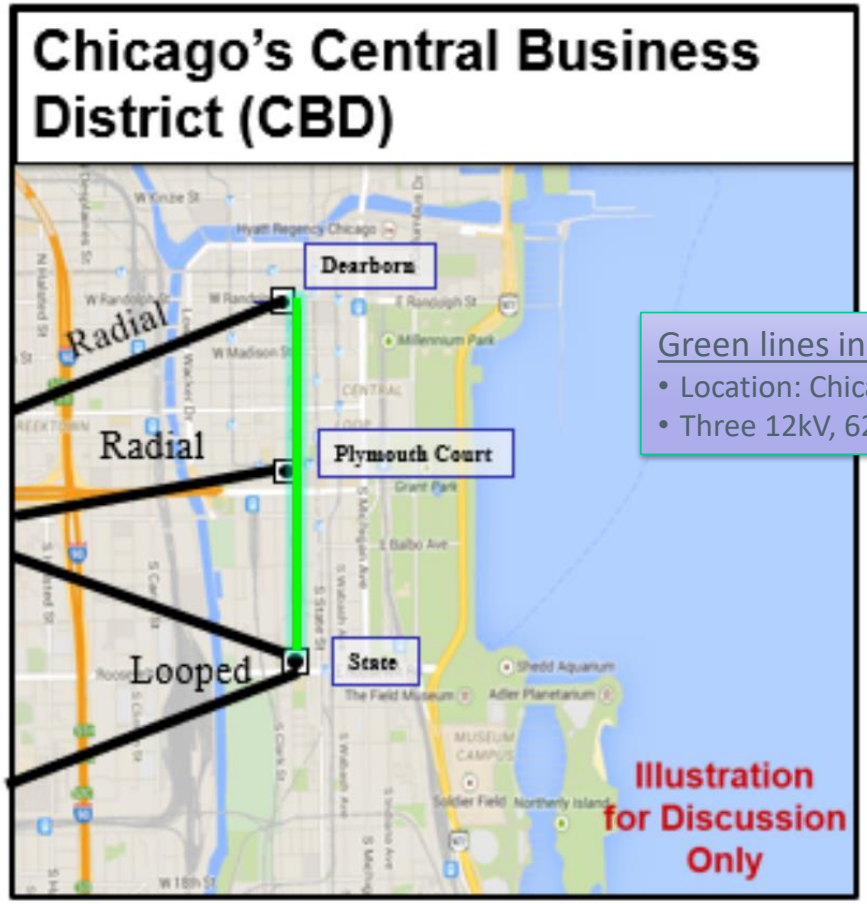
Possible Second REG Project in Chicago's Central Business District



Green lines indicate superconducting cables:

- Location: Chicago's Central Business District (CBD)
- Three 12kV, 62MVA superconductor cables

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Initial Project - Northwest

Smaller scale initial phase with similar benefits

- ✓ As a prelude to the possible CBD project, ComEd will implement a REG Network at different Chicago substation to increase the reliability level from N-1 to N-2
- ✓ Project will serve to increase the reliability within the substation by providing a high-capacity link between two terminals in the substation
- ✓ Effort will provide experience and lessons learned to be incorporated into the possible CBD project

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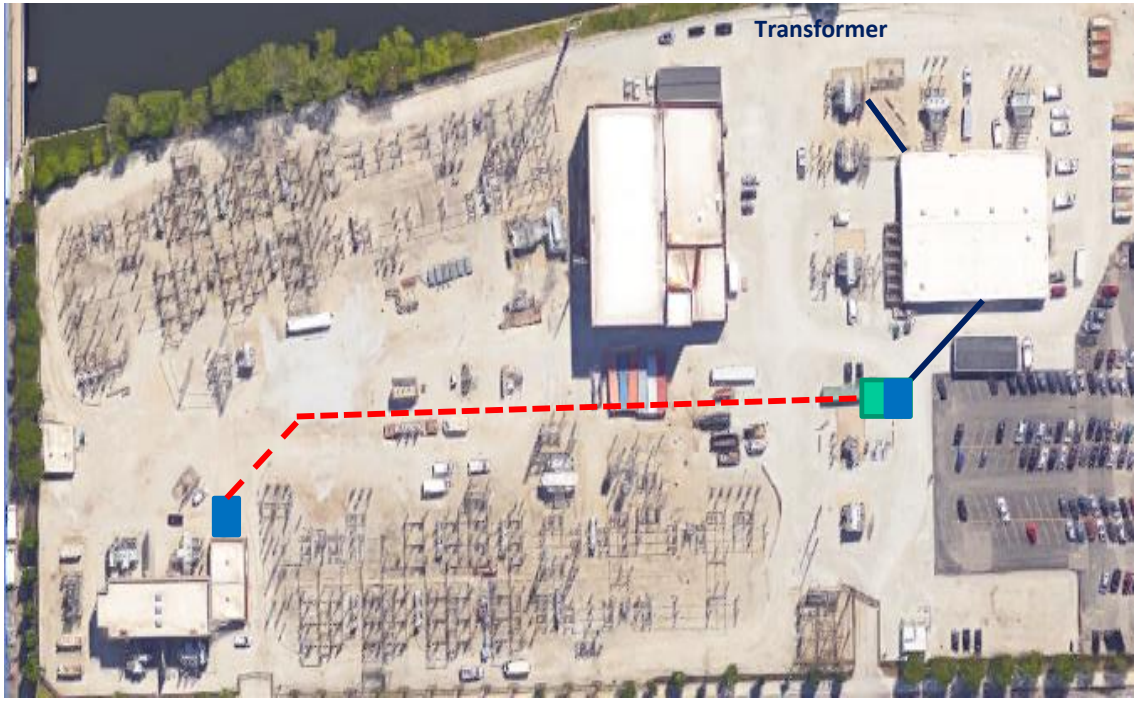
Superconductor Cable – Initial Project



Legend
- Superconductor Cable
- Refrigeration Building
- Underground Cable
- Terminations

← North

FERC Ruling
Approval Received on May 28th 2019

- ✓ FERC Approved all aspects of ComEd's March 29th, 2019 filing:
  - FERC, which allows utilities to recover their investments in transmission systems, recently granted ComEd's request to recover its portion of the cost to construct, operate and maintain both phases of the project through its transmission rates
  - Approved request to classify both phases of the project as a "transmission plant" even though the equipment is operated at distribution voltage
    - Agreed project serves a transmission function per 7 factor test.
  - Approved "Abandonment Incentive" allowing recovery in the event of project cancellation or abandonment due to factors beyond ComEd's control

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Superconductivity Cable Applications

Potentially economically viable solutions today

- New Suburban Station that brings capacity into a City station, avoiding the expensive property expansion

Potentially economically viable solutions in the future?

- Replacing an existing LPFF or HPFF cable, leveraging the existing pipe for conduit and pumping plant location for new cryogenic plants
- Directly competing against an installation of XLPE cable
  - Directly competing against a new overhead installation

Risks and Challenges to Utilizing Superconductivity Cable

Total cost of ownership

- Initial capitalization costs
  - Cable
  - Cryogenics
  - Civil work
- Ongoing maintenance costs over a 40 year life
- Competition is XLPE and pipe type cable, both of which have pros and cons

Operations risks and challenges

- Level of Cryogenic system redundancy to be installed
- New technology hurdle needs to be overcome
  - Worker safety associated with liquid nitrogen
  - Community acceptance of a system with liquid nitrogen
  - Uncertainty of operational life

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