K42 Asset Condition Project

Franklin County Line Upgrade

vermont electric power company

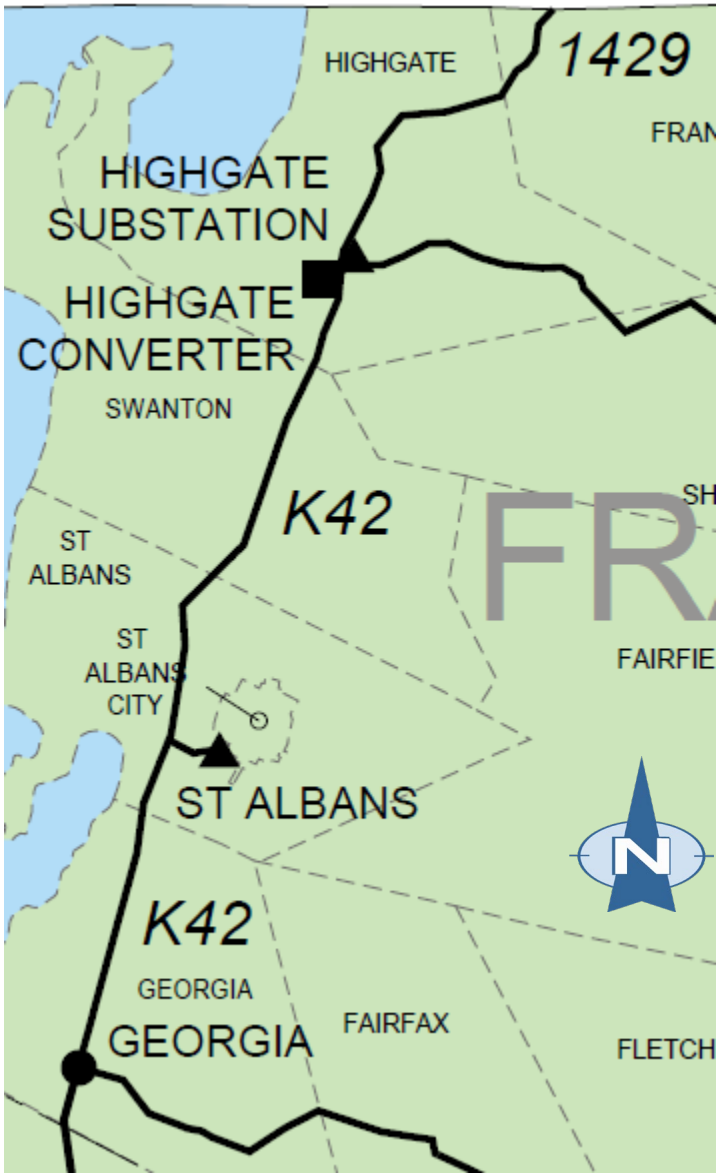
VELCO

May 19, 2022

VELCO Operating Committee

K42 Line Overview

- Constructed in 1958; majority of 212 structures are original build
- 115 kV wood H-frame line from Highgate to Highgate Converter Tap to St Albans Tap to Georgia (16.6 miles)
- Main transmission path for HVDC Converter and wind generation toward load center (Burlington)
- Significant wetlands, crop farming, and long access routes drive need for substantial matting



Identified K42 Deficiencies

- 146 (~70%) out of 212 structures to be replaced in the near term
  - Pole and cross arm damage:
    - Woodpecker holes
    - Cracks, splitting, rotting wood
    - Leaning poles
    - Target practice
  - Reaching end of asset life

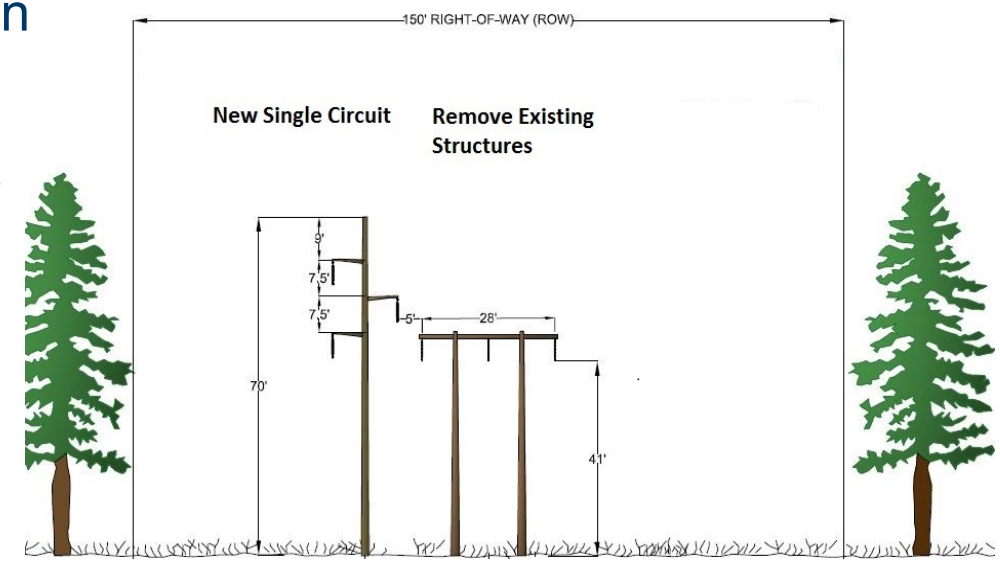
- Additional future structure replacements as needed
  - Reevaluation every 8 years

K42 line very difficult to take out of service

- System topology and load/gen balance are problematic
  - Outages result in radial supply almost 100 miles long
    - Loss of Northern Loop load post-contingency (15% of VT peak, nearly all of Vermont Electric Coop's service territory)
  - Portions of structure work disconnect St. Albans Tap
    - Exposure to low voltage post-contingency
  - Several resources switched off during outages
    - Highgate converter – 97% capacity factor
    - Wind plants – High generation except in the summer
  - K42 outages potentially can restrict planned outages in Vermont, Southern NH, and Central MA

Proposed solution: Rebuild K42 as single-pole line

- More efficient construction – minimizes mobilizations
- Maintains the existing line in service during construction
  - Avoids approximately 30 daily outages and their consequences
- Steel structures lower ongoing maintenance costs and future replacements
- Meets current VELCO line design standard
- Creates space in key ROW for a future line if needed by region
- What conductor size?



Line rebuild options

Options	Line electrical characteristics	System strength	Cost (+/- 25%)	Decision
Single 1351 ACSS	Standard conductor	Almost no change	$ 42.59M	Base
Single 2515 ACSR	Resistance 45% lower Reactance 12% lower Charging 13% higher	Minor change	$ 48.98M	Reject
Double 1272 ACSR	Resistance 50% lower Reactance 33% lower Charging 45% higher	Noticeably better	$ 48.99M	Investigate further

- Loss reduction from double-bundle 1272 ACSR design
  - 50% reduction of annual historical losses is 11,762 MWh (SCADA info)
  - Reduction in system losses is higher at 14,068 MWh (PSSE simulations)

Cost-effectiveness test: Utilized Energy Efficiency evaluation approach

- EE total-cost evaluation approach is well-established

Load reduction method	Location	Valuation rates	Performance timing	Measure life
Energy efficiency	Distribution	Retail	When the appliance is on	Average 10 years
K42 Loss reduction	Pool Transm Facility (PTF)	Wholesale	When the line is in service	Many decades

- Conductor incremental cost of $6.39M
- Annual revenue requirement of $922K
- Benefit-to-cost ratio needs to be greater than 1
- Benefit valuation rates based on AESC* report used in state total resource cost evaluations

* Avoided Energy Supply Component
https://www.synapse-energy.com/sites/default/files/AESC%202021_20-068.pdf

Project Value/Cost Summary

- Addresses asset condition need with minimal disruptions
- New single-pole line
  - More efficient construction
  - Avoids outages and associated generation lost revenue and reliability impacts
  - No interference with other planned outages
  - Lowers maintenance cost and structure replacement frequency
  - Optimizes utilization of the ROW
- Bundle conductors
  - Reduce PTF losses by 50% and LMP impacts
  - Improves system strength
  - Improves reactive margin
  - Addresses current export constraints
  - Facilitates renewable energy growth by about 20 MW
  - Avoids Vermont lost opportunity cost for SHEI improvement

Recommendation

- Rebuild as single-pole double-bundle 1272 ACSR
  - Benefit-to-cost ratio is greater than 1.0 for larger conductor
- Should consider cost-effective modest transmission incremental efficiency spending in support of a cleaner electric grid
- Consistent with FERC ANOPR holistic planning
  - Reliability, economic, public policy, interconnection, renewables
- Not all the benefits are quantified or quantifiable
  - Ensure equitable access to renewables
  - Enable future renewable growth
  - Minimize regret

Project milestones

- Received ISO-NE support on costs (January 2022)
- Discussions with VDUs & DPS (March-April 2022)
  - Studying cost/benefit analysis for single pole and double conductor investments
- Commenced draft line design (April 2022)
- Began environmental and aesthetic assessments (May 2022)
- Public outreach/ stakeholder engagement (April & August 2022)
- VSPC update (April 2022)
  - NTA screening to follow
- Construction cost quotes (August 2022)
- Permitting process (2023)
- Construction and removal of old line (2024-2025)