From: Taylor, Helen M <helen.taylor@eversource.com>
Sent: Friday, July 29, 2022 11:59 AM
To: CSC-DL Siting Council <Siting.Council@ct.gov>
Cc: Shanley, Kathleen M <kathleen.shanley@eversource.com>
Subject: Eversource 2022 Life Cycle Cost

Dear Melanie Bachman:

Attached are the electronic versions of Eversource's response to the LIFE-CYCLE 2022 - Connecticut Siting Council Investigation into Life-Cycle Costs of Electric Transmission Lines. The hard copies will be mailed to Ten Franklin Square. Questions 3, 8, 13, 21, and 30 include attachments.

Please contact me with any questions or concerns.

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Letter Critter H
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Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 1

For new overhead transmission line installations in Connecticut, what transmission structure designs, including structure material and conductor arrangement (e.g. single-circuit vertical steel monopole), are mostly commonly used and for what reason(s)?

Response:

The Connecticut Light and Power Company d/b/a Eversource Energy's (Eversource) typical standard structure designs remain as they have been for many years. Its standard designs are H-frame design, with horizontal conductor configuration, and monopole design, with either vertical conductor configuration or "delta" conductor configuration. Standard voltages for its new transmission line construction remain at 115 kilovolts (kV) or 345 kV. Eversource has standardized on steel as the preferred material for transmission structures. Steel transmission structures can be either a weathering steel or galvanized steel finish. Eversource's use of "light-duty" or "wood pole equivalent" (WPE) steel has increased dramatically in recent years due to this material's resiliency, longevity and cost-efficient qualities. WPE steel poles have replaced the use of natural round wood in most Eversource applications. The selection of the particular configuration is determined by the specific needs of each project.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 2
What structure designs, including structure material and conductor arrangements, are no longer used and for what reason(s)

Response:

Eversource's use of wood materials has become less frequent than in the past because they are more susceptible to degradation from environmental factors, and steel poles are a superior alternative for the reasons stated in the response to question CSC-001. However, wood material does have certain benefits and is still used by Eversource in limited applications, such as emergency replacements or temporary configurations to support construction.

Laminated Wood structure material is being programmatically removed from the Eversource transmission system as it has been shown to be susceptible to degradation from environmental factors.

Steel lattice towers are not typically used for new construction, given the high labor cost to install and the overall larger structure footprint when compared to the footprint of tubular steel poles.

Eversource continues to use all conductor configurations discussed in previous life-cycle studies (horizontal, delta and vertical). The selection of the particular configuration to be used, is based on the specifics of each project.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 3

Of the overhead configurations listed in response to Question 1, what configurations would Eversource consider prudent for life cycle analysis? Please complete the table provided with current first cost per linear mile and losses for each of the noted configurations. Include information for both a single circuit and double circuit transmission line design.

First Costs		**Losses**	
Poles & Foundations		Conductor Size & Type	
Conductor & Hardware		Resistance (ohms/mile per conductor)	
Site Work		Number of Conductors Per Phase	
Construction		Peak Line Current (amps)	
Engineering		Annual Load Growth (%)	
Sales Tax		Loss Factor	
Project Management		Energy Cost ($/MWh)	
		Annual Energy Cost Escalation (%)	

Response:
Eversource considers all of the listed construction types as options for overhead transmission line construction. Estimates have been developed for the most common configurations, H Frame and Delta for 115-kV and 345-kV lines, in the categories requested in the attached table.
See attachment for summary of first costs. Double circuit transmission line costs are more variable due to various design considerations, location specific efficiencies, and as such are treated uniquely and priced on an individual basis as scopes are developed.

See table Attachment.

Eversource Energy - Typical OH Transmission Types

Life-Cycle Cost Components - Estimated Overhead Construction Costs/ Typical Mile

Cost Category	115-kV H Frame - Wood or WPE Steel	115-kV Delta - Steel Monopole	345-kV H Frame - Wood or WPE Steel	345-kV Delta - Steel Monopole
Poles & Foundations	$1,098,718	$1,025,312	$1,314,095	$1,789,171
Conductor & Hardware	$374,464	$343,670	$663,053	$627,077
Site Work	$855,333	$796,971	$974,944	$904,084
Construction	$1,954,208	$1,563,719	$2,365,318	$2,405,711
Engineering	353,586	$330,756	$499,710	$505,960
Sales Tax	$0	$0	$0	$0
Project Management	$304,191	$274,071	$364,681	$384,697
Totals	**$4,940,500**	**$4,334,499**	**$6,181,801**	**$6,616,700**

Typical Overhead - Electrical, Loss and Cost Assumptions				
Value	**115-kV H Frame - Wood or WPE Steel**	**115-kV Delta - Steel Monopole**	**345-kV H Frame - Wood or WPE Steel**	**345-kV Delta - Steel Monopole**
Conductor Size & Type - 1 conductor per phase for 115kV / 2 conductors per phase for 345kV	1272 kcmil ACSS 54/19 Pheasant	1272 kcmil ACSS 54/19 Pheasant	2 conductor x 1590 kcmil ACSS 54-19 Falcon	2 conductor x 1590 kcmil ACSS 54-19 Falcon
Resistance (ohms / mile)	0.0741	0.0741	0.0602	0.0602
Peak Line Current (first year)	1000	1000	1000	1000
Load Growth	-0.07%	-0.07%	-0.07%	-0.07%
Loss Factor	0.310	0.310	0.310	0.310
Energy Cost ($/MWH)	$100	$100	$100	$100
Energy Cost Escalation	-0%	-0%	-0%	-0%

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 4

Complete the table provided with current first cost per linear mile and losses for each of the following overhead electric transmission line configurations, if not already addressed in Question 3:

a) 115 kilovolt (kV) wood H-frame
b) 115 kV steel delta
c) 345 kV wood H-frame
d) 345 kV steel delta

First Costs		**Losses**	
Poles & Foundations		Conductor Size & Type	
Conductor & Hardware		Resistance (ohms/mile per conductor)	
Site Work		Number of Conductors Per Phase	
Construction		Peak Line Current (amps)	
Engineering		Annual Load Growth (%)	
Sales Tax		Loss Factor	
Project Management		Energy Cost ($/MWh)	
		Annual Energy Cost Escalation (%)	

Response:
The requested information is included in the table response to Question 3.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 5
What type of conductors does Eversource typically install for new overhead transmission lines? Why was this conductor type selected?

Response:

Eversource typically installs Aluminum Conductor Steel Supported (ACSS) conductor for new overhead transmission lines. ACSS is typically selected in preference over Aluminum Conductor Steel Reinforced (ACSR) because ACSS has a similar size but increased current carrying capability. In addition, ACSS has very similar structural loading impacts, but provides better conductor performance when compared to ACSR. While Eversource's use of ACSS conductor has increased, ACSR is still used by Eversource in limited applications to match existing conductor on a transmission line. In some instances, project specific requirements may necessitate the use of other conductor types on a limited basis, such as specialty core High Temperature Low Sag conductors for use in a long span like a river crossing.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 6
What is the expected design life of an overhead transmission line?

Response:

In the Siting Council's 2006 proceeding, Eversource stated that. for transmission line life cost analysis, the estimated life span for transmission lines is 40 years and Eversource affirmed this statement in the 2017 proceeding. Eversource continues to believe that an estimated life of 40 years is reasonable for life cycle analysis and asset depreciation ("book-life") purposes. In its previous responses to prior similar interrogatories, Eversource also noted that transmission lines have reliably and safely performed for longer periods if well maintained and with life extending component replacements (e.g., wood cross-arms, shield wires, conductor splices).

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 7
For variables listed under Losses in Questions 3 and 4, provide the origin of the value. Is the Loss Factor constant or does it vary over the life cycle period?

Response:

The Loss Factor is a dimensionless ratio between the average load loss and peak load loss. The Loss Factor value was determined using actual historic load data in one-hour increments over the 5-year period of 2017-2021 as found in published ISO NE SMD (Standard Market Data) Hourly load data for ISO NE Control Area. The Loss Factor was calculated for each year by summing all squared actual load over this period and dividing by the number of periods times the squared peak load. The average of all five years from 2017-2021 was determined to be 0.31.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 8
Provide costs per circuit mile of the past five years for operation and maintenance of Eversource's existing overhead transmission lines in accordance with Federal Energy Regulatory Commission (FERC) Accounts 560, 563, 564, 568, 571, and 572.

Response:
See Attachment for costs per circuit mile of the past five years.

Eversource Energy Operation & Maintenance Costs

CT Only - FERC Form 1, years 2017-2021

Line	Costs by FERC Account	2017	2018	2019	2020	2021
1	560 - Operation Sup & Eng	$4,788,839	$5,868,172	$6,479,692	$8,130,227	$5,878,109
2	563 - Overhead Line Expenses	$1,147,440	$1,817,992	$1,224,336	$225,839	$236,892
3	564 - Underground Line Expenses	$1,444,180	$1,371,404	$1,615,663	$2,179,216	$1,900,535
4	568 - Maintenance Sup & Eng	$1,126,830	$1,248,294	$1,047,438	$1,874,339	$609,140
5	571 - Maintenance of Overhead Lines	$17,173,730	$16,599,211	$32,392,260	$40,951,936	$34,400,769
6	572 - Maintenance of Underground Lines	$62,602	$63,150	$74,710	$80,634	$79,011
	Total O&M Costs	*$25,743,621*	*$26,968,223*	*$42,834,099*	*$53,442,191*	*$43,104,456*
7	Overhead Transmission Lines (Miles)	1247.9	1255.2	1255.7	1258.2	1259.3
8	Underground Transmission Lines (Miles)	117.2	117.2	117.2	123.5	123.5
	Total Transmission Lines (Miles)	1365.11	1372.4	1372.85	1381.76	1382.87
9	% of Overhead to total	91.4%	91.5%	91.5%	91.1%	91.1%
10	% of Underground to total	8.6%	8.5%	8.5%	8.9%	8.9%
	O&M Cost Per Circuit Mile - Overhead Transmission					
560 / 568	Supervision Costs (line 1+4)	5,915,669	7,116,466	7,527,130	10,004,566	6,487,249
	% of Overhead to Total (line 9)	91.42%	91.46%	91.46%	91.06%	91.07%
	Supervision % allocated to Overhead	5,407,829	6,508,787	6,884,595	9,110,153	5,907,751
563 / 571	Direct Overhead Costs (line 2+5)	18,300,560	17,847,505	33,439,698	42,826,275	35,009,909
	Total Overhead Costs	23,708,389	24,356,292	40,324,293	51,936,428	40,917,660
	Overhead Circuit Miles (line 7)	1247.92	1255.21	1255.66	1258.23	1259.34
	O&M Costs - Overhead Trans. Per Circuit Mile	$18,998	$19,404	$32,114	$41,277	$32,491
		34.95%	2.14%	65.50%	28.53%	-21.29%
				5 year O&M Cost Average - OH		$28,857
	O&M Cost Per Circuit Mile - Underground Transmission					
560 / 568	Supervision Costs (line 1+4)	5,915,669	7,116,466	7,527,130	10,004,566	6,487,249
	% of Underground to Total (line 10)	8.58%	8.54%	8.54%	8.94%	8.93%
	Supervision % allocated to Underground	507,840	607,679	642,535	894,413	579,498
564 / 572	Direct Underground Costs (line 3+6)	1,506,782	1,434,554	1,690,373	2,259,850	1,979,546
	Total Underground Costs	2,014,622	2,042,233	2,332,908	3,154,263	2,559,044
	Underground Circuit Miles (line 8)	117.19	117.19	117.19	123.53	123.53
	O&M Costs - Underground Trans.Per Circuit Mile	$17,191	$17,427	$19,907	$25,534	$20,716
		34.88%	1.37%	14.23%	28.27%	-18.87%
				5 year O&M Cost Average - UG		$20,155

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 9

Provide costs per mile of the past five years for Eversource's vegetation management activities for transmission line rights-of-way. What FERC Account is Eversource's vegetative management cost assigned to?

Response:

The cost per mile for vegetation management activities for transmission line rights-of-way for the last five years are:

Year	2017	2018	2019	2020	2021
Cost per mile	$8,370	$7,558	$16,104	$20,796	$17,483

The cost per mile is based on contractor costs and the total transmission line miles in Connecticut.

The FERC Account used for Vegetation Management is 571000.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 10

Provide the rationale of including or not including the following overhead transmission line configurations:

a) Lattice structures;
b) Laminate structures; and
c) Vertical conductor design.

Response:

Please see responses below:

a) Lattice structures have rarely been used for new transmission line construction in Connecticut in recent years. There have not been a sufficient number of new lattice installations to justify their inclusion in the life-cycle cost analysis.

b) Since laminated wood transmission line structures ("Laminated Structures") have shown to be more susceptible to degradation from environmental factors and component failure than light-duty steel structures, Eversource does not expect that it will use Laminated Structures in the future. Accordingly, inclusion of Laminated Structures in the life-cycle cost analysis is not warranted.

c) Vertical conductor designs are still used and have been considered in this life-cycle analysis. The vertical configuration uses the narrowest amount of space within a right-of-way and is sometimes the only option available when right-of-way width is limited.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 11

For new underground transmission line installations in Connecticut, what underground transmission designs, including cable type and arrangement (e.g. single-circuit horizontal XLPE), are most commonly used and for what reason(s)?

Response:

New underground transmission circuits are built primarily with solid dielectric cross-linked polyethylene (XLPE) insulation in a single-circuit or double-circuit arrangement, depending on the project design requirements. This is the current standard technology used in the industry, replacing older high-pressure fluid-filled (HPFF) systems to mitigate risk of leaks and avoid additional equipment required to maintain pressure in the line. Eversource's preferred installation methodology is trenching to install an underground duct bank with conduits, into which the cables are pulled. The typical duct bank is designed to minimize installation footprint while optimizing other technical factors (e.g. load balancing, communications system reliability).

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 12
Which underground transmission line designs, including cable type and arrangements, are no longer used and for what reason(s)?

Response:
Technology options for underground transmission on Eversource's system are high pressure fluid filled pipe type cable ("HPFF") or solid dielectric, such as cross-linked polyethylene ("XLPE") or ethylene propylene rubber ("EPR"). EPR is limited in applicability, as it cannot be used for lines operating at voltages above 138-kV and it is typically only used by Eversource in short substation runs. A significant portion of Eversource's current underground transmission system is the older HPFF technology, which the company is planning to phase out and replace with the newer solid dielectric technology. Phasing out the HPFF technology will increase system reliability and sustainability. There are multiple procurement options for XLPE cable, while there is only one remaining manufacturer of HPFF in the world. Eliminating Eversource's use of HPFF also will reduce the risk of leaks and allow for retirement of existing oil pressurization equipment required to maintain pressure in HPFF lines.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 13

Of the underground configurations listed in response to Question 11, what configurations would Eversource consider prudent for life cycle analysis? Please complete the table provided with current first cost per linear mile and losses for each of the noted configurations. Include information for both a single circuit and double circuit transmission line design.

First Costs		**Losses**	
Ducts & Vaults		Cable Size & Type	
Cable & Hardware		Resistance (ohms/mile per conductor)	
Site Work		Number of Conductors Per Phase	
Construction		Peak Line Current (amps)	
Engineering		Annual Load Growth (%)	
Sales Tax		Loss Factor	
Project Management		Energy Cost ($/MWh)	
		Annual Energy Cost Escalation (%)	

Response:

See attached table summary for current first cost per linear mile and losses.

Eversource Energy - Typical UG Transmission Types

Life-Cycle Cost Components - Estimated Underground Construction Costs/ Typical Mile

First Costs	XLPE 115-kV	HPFF 115-kV	XLPE 345-kV	HPFF 345-kV
	Single Circuit	Single Circuit	Single Circuit	Single Circuit
Ducts & Vaults	$6,325,268	$5,831,008	$6,564,081	$5,813,944
Cable & Hardware	$4,907,153	$5,231,053	$6,298,925	$6,573,099
Site Work	$2,322,881	$2,327,613	$2,296,640	$2,320,,802
Construction	$4,414,236	$3,677,883	$4,691,790	$3,735,001
Engineering	$1,750,256	$1,666,245	$1,939,625	$1,800,084
Sales Tax (X %)	$0	$0	$0	$0
Project Management	$1,120,706	$1,006,499	$1,232,438	$1,075,170
Totals	**$20,840,500**	**$19,740,301**	**$23,023,499**	**$21,318,100**

Typical Underground - Electrical, Loss and Cost Assumptions				
Value	**XLPE 115-kV**	**HPFF 115-kV**	**XLPE 345-kV**	**HPFF 345-kV**
Cable Size & Type - 1 conductor per phase	3000 kcmil XLPE	2500 kcmil HPFF	3000 kcmil XLPE	2500 kcmil HPFF
Resistance	0.0268	0.0317	0.0268	0.0317
Peak Line Current	1000	1000	1000	1000
Load Growth	-0.70%	-0.70%	-0.70%	-0.70%
Loss Factor	0.3100	0.3100	0.3100	0.3100
Energy Cost	$100	$100	$100	$100
Energy Cost Escalation	-0%	-0%	-0%	-0%

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 14

Complete the table provided with first cost per linear mile and losses for each of the following underground electric transmission line configurations if not already addressed in Question 13:

a) 115 kV high pressure fluid filled (HPFF) pipe
b) 345 kV HPFF
c) 115 kV cross-linked polyethelene (XLPE)
d) 345 kV XLPE

First Costs		**Losses**	
Ducts & Vaults		Cable Size & Type	
Cable & Hardware		Resistance (ohms/mile per conductor)	
Site Work		Number of Conductors Per Phase	
Construction		Peak Line Current (amps)	
Engineering		Annual Load Growth (%)	
Sales Tax		Loss Factor	
Project Management		Energy Cost ($/MWh)	
		Annual Energy Cost Escalation (%)	

Response:
Please see the attachment to Question 13.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 15
Do First Costs for HPFF transmission include fluid pumping and cooling equipment?

Response:
The first costs for HPFF facilities, as provided in Eversource's response to Question 13 do not include the costs of fluid pumping and cooling equipment.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 16
For variables listed under Losses in Questions 13 and 14, provide the origin of the value. Is the Loss Factor constant or does it vary over the life cycle period?

Response:

The loss factor is assumed to be constant over the life cycle period.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 17
What is the expected design life of an underground transmission line?

Response:
The expected design life for an underground transmission line is at least 40 years, based on qualification testing done by the cable manufacturers.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 18
Provide costs per circuit mile of the past five years for operation and maintenance of Eversource's existing underground transmission lines in accordance with FERC Accounts 560, 563, 564, 568, 571, and 572.

Response:
Please see the attachment to Eversource's response to question #8.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 19
What type of conductors does Eversource typically install for new underground transmission lines? Why was this conductor type selected?

Response:

Eversource typically uses either 5000 kcmil segmented aluminum or 5000 kcmil segmented enameled copper conductors for new underground transmission lines. Because of its lower cost, Eversource typically uses 5000 kcmil segmented aluminum conductor. However, if the required capacity for a line would require that another cable per phase be added for 5000 kcmil segmented aluminum conductor, and 5000 kcmil segmented enameled copper conductor (which has higher ampacity ratings), would avoid the need for another cable per phase, then Eversource will use 5000 kcmil segmented enameled copper conductor.

Eversource typically installs one size underground conductor (5000 kcmil) in order to move toward dimensionally consistent designs and thereby optimize spare inventory needs and increase system reliability.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 20

Provide the following variables for cost calculations including the origin of the value:

a) Capital recovery factor;
b) Annual Operation and maintenance cost escalation rate as a percent; and
c) Discount rate.

Response:

The Capital recovery factor used was 11.21%. The Annual Operation and Maintenance cost escalation rate per year used was 2%. The discount rate used was 8%. The Capital recovery rate was updated based on the 2022 Annual Update posted on ISO-NE's website on June 15, 2022.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 21
Provide information regarding existing transmission facilities by length, voltage, construction type, and single/double circuit installation.

Response:

The attached table provides the information on Eversource's transmission line facilities as reported in FERC Form 1. The information on construction type is difficult to summarize due to the mixed use of various construction types on lines in the Eversource transmission system.

Eversource Transmission Summary 2021				
Connecticut Transmission Lengths		**Length (in Structure miles)**		**Total Ckt Miles**
	# Circuits	**On Pri Str**	**On Str of Another Line**	
Total Transmission Miles	**222**	**1468.1**	**352.4**	**1820.5**
345-kV Total	**34**	**527.4**	**11.8**	**539.2**
345-kV OH	29	480.1	11.8	491.9
345-kV UG	5*	47.3		47.3
138-kV Total	**3**	**16.8**	**0**	**16.8**
138-kV OH	0	0		0
138-kV UG	3	16.8		16.8
115-kV Total	**173**	**855.4**	**309.2**	**1164.6**
115-kV OH	142	779.2	309.2	1088.4
115-kV UG	31**	76.2		76.2
69-kV Total	**12**	**68.5**	**31.4**	**99.9**
69-kV OH	11	65.7	31.4	97.1
69-kV UG	1	2.8		2.8

Source: The Connecticut Light & Power Company; FERC Form 1
*Notes: *One line that has been included in UG circuit total also has OH sections*
***Sixteen lines that have been included in UG circuit total also have OH sections*

Definitions:
"OH" = Overhead
"UG" = Underground
"On Pri Str" = On Primary Structure.
"On Str of Another Line" = On Structure of Another Line
"Total Ckt Miles" = Total Circuit Miles
Additional Note: In multi-circuit construction only one circuit can own the structure. Structure miles are counted in Column "On Pri Str". Multi-circuit construction is counted on "On Str of Another Line" where another circuit owns the structure. The addition of both those columns equals the Total Circuit Miles listed in the "Total Ckt Miles" column.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 22

List all relevant standards applicable to 115kV and/or 345kV transmission resources for the following categories:

a. Reliability;
b. Security;
c. Vegetation Management, and
d. Storm hardening.

Response:

Please see the responses below:

a. The following standards apply to reliability:

1. North American Electric Reliability Corporation (NERC) TPL-001-4 Transmission System Planning Performance Requirements
2. Northeast Power Coordinating Council (NPCC) Regional Reliability Reference Directory # 1 Design and Operation of the Bulk Power System
3. Independent System Operator- New England (ISO-NE) PP 03 Reliability Standards for the New England Area Pool Transmission Facilities

b. There are no applicable standards for transmission line security.

c. Vegetation Management Standards

1. National Electric Safety Code (NESC) Rule 218
2. North American Regulatory Corporation (NERC) FAC-003-4
3. American National Standards Institute (ANSI) A300
4. American National Standards Institute (ANSI) Z133

d. There are no applicable standards for storm hardening for transmission lines. Overhead Transmission facilities are designed in accordance with the current National Electric Safety Code (NESC). The NESC dictates design criteria for wind and ice loading that may occur on a line. Most notably Rule 250B Grade B Heavy loading (combined ice and wind), Rule 250C Extreme Wind Loading (100-120mph based on wind region), and Rule 250D Extreme Ice with Concurrent Wind loading.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 23
Have the National Electric Safety Code and/or the State of Connecticut Building Code been updated within the last five years? If yes, would the updated codes impact life cycle costs? Identify code changes that significantly increase life cycle costs.

Response:

No, the 2017 version of the National Electrical Safety Code (NESC) is still the current version. The Connecticut Building Code does not apply to transmission line construction, so any changes to the Building Code will not affect transmission line life cycle costs.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 24
List federal and state permits and registrations that may be required to a construct a transmission line in Connecticut. How are such permits/registrations accounted for in first costs and life cycle costs?

Response:

FEDERAL AGENCIES	Permits
U.S. Army Corps of Engineers	Section 404 Permit for dredge and fill activities in waters of the United States (Programmatic General Permits)
	Section 10 Permit for work in navigable waterways
	Section 408 permit for altering federal land public works projects (dams and levees)
Federal Aviation Administration	Notification of presence of overhead lines and structures
U.S. Fish and Wildlife Service	Endangered Species Act Review
CONNECTICUT AGENCIES	Permits
Connecticut Siting Council	Certificate of Public Need and Environmental Compatibility ("Certificate") or a Declaratory Ruling that a Certificate is Not Required.
Department of Energy and Environmental Protection	Section 401 Water Quality Certification
	Storm Water Pollution Prevention (General Permit)
	Land Water Resource Division LWRD - Certificate of Permission (COP)
	Land Water Resource Division LWRD - Structures dredge and fill; tidal wetlands Section 401 tidal wetlands
	Natural Diversity Database Review for Connecticut endangered, threatened, or special concern species
State Historic Preservation Office	Review of archaeological resources and finding of consistency with the National Historic Preservation Act
Department of Transportation	Encroachment Permits for activities within or over state highway rights-of-way
Public Utilities Regulatory Authority	Approval of Method and Manner of Construction and Permission to Energize.
RAILROADS (Various)	Permits

	Encroachment Permits for activities within or over railroad right-of-way

The costs to obtain the permits are accounted for in the engineering costs of the line construction project. These engineering costs are included in the first costs for the transmission line.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 25
Does Eversource anticipate constructing new transmission lines that operate only at 69-kV or 138-kV within the next 5 years. If yes, in what locations and for what reasons?

Response:
No. Eversource does not plan to construct new 69-kV or 138-kV transmission lines within the next 5 years.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 26
Describe how leak prevention and containment measures used for HPFF cable systems could impact life-cycle costs.

Response:
While leak prevention measures have not been reflected in prior life-cycle study estimates and are not included in the estimates provided in response to Question #13, their costs are relatively small as compared to the initial capital cost of HPFF systems. Leak prevention starts with a high-quality corrosion coating of the pipe, careful testing of the coating several times during the construction and placing a high-quality backfill around the pipes. A cathodic protection system is provided to protect the pipe in the event of unknown or unreported damage to the pipe's corrosion coating. The pipe coating and the cathodic protection system are included in periodic maintenance procedures for the line to maintain the quality of the leak prevention systems. Measures to reduce fluid loss consist of containment volumes designed into foundations under the pump plant/fluid expansion tank enclosures. Also included are a variety of pressure gauges and alarms to detect low fluid pressure or frequently operating pumps that might indicate a leak in the system, and valves to isolate appropriate portions of the system. Eversource has recently been adding enhanced technology to limit leaks during an event, as such events (e.g., dig-ins) can be outside company control. The program includes installation of motor-operated valves (MOVs) and stop-joints that can be used to hydraulically isolate the lines or segments thereof.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 27
Has Eversource experienced, in the last five years, issues with construction or maintenance of overhead or underground transmission lines in locations that required special processes or procedures due to environmental sensitivity? If so, please describe the situations and the cost impacts.

Response:
During the last five years Eversource has not experienced any issues with construction of overhead or underground transmission lines in locations that required special processes or procedures due to environmental sensitivity.

Eversource routinely constructs and maintains transmission lines in locations that require the application of best management practices for work in environmental resource areas. Eversource has developed and utilizes its Construction and Maintenance Environmental Requirements, Best Management Practices Manual for Massachusetts and Connecticut ("C&M BMPs") when working in wetland areas and for stormwater management – – erosion and sediment control. For example, construction mats are used when vehicles require access to wetland areas to minimize damage to these resources consistent with applicable local, state and federal regulations. In addition to following the C&M BMPs, Eversource also protects endangered species by hiring biologists to monitor construction activities, providing contractor training for all construction crews and installing protective fencing to ensure that rare, threatened, or endangered species are not adversely affected by construction. Where feasible, the Company will also work during different times of the year to help prevent adverse effects to the environment.

A summary of the general issues and associated cost impacts follow:

Wetland Area Protection –

- Construction matting for access roads: $90/linear foot installed for two months;
- Construction matting for work pads: approximately, $54,000 per typical work pad (100 feet x 100 feet) installed and removed (assuming two months of mat rentals);
- Stormwater Management features (Silt fences and hay bales): $8/linear foot installed;
- Culverts: $8,400/pipe installed (steel corrugated, 18-inch diameter pipe, 20 feet in length);
- Site restoration (grading, mulch, seeding, etc.): $30,000/mile.

State regulations and requirements require special handling and disposal of contaminated and/or polluted soil and water encountered during excavation activities for overhead and underground facilities.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 28
ISO-New England (ISO-NE) has issued planning and operating standards for design and operation of transmission facilities. One standard prescribes transmission line ratings for normal conditions, short-term emergency and long-term emergency conditions. Does Eversource expect the standards to impact transmission line life-cycle costs, and if so, to what extent?

Response:

Additional impacts to life-cycle costs are not expected since the ISO-NE rating criteria from Planning Procedure 7 has been in effect for many years and is accounted for in Eversource design standards and estimated costs.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 29
Has Eversource identified other ISO-NE policies or operating procedures that are anticipated to impact transmission line life-cycle costs? If so, what are they and what is the anticipated impact?

Response:
Eversource is not aware of any other ISO-NE policies or operating procedures that impact transmission line life cycle costs.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 30
Under what conditions would Eversource consider using high voltage direct current (HVDC) lines for long-distance power transfers? How would the life cycle costs of HVDC lines compare to high voltage alternating current (HVAC) transmission lines?

Response:

Eversource would consider using high voltage direct current (HVDC) lines for long-distance power transfers when doing so is the most cost-effective means for transferring the necessary amount of power, necessary to accomplish market objectives, or required to tie areas operating at different frequencies (example Quebec vs. Eastern Interconnect).

Based on industry experience with HVDC lines and associated converters, the overhead conductors and structures are very similar in life cycle costs to HVAC conductors and structures. While HVAC circuits do not require any converter (rectifier or inverter) stations in order to operate, HVDC circuits need a converter station installed at each end of the circuit. These converter stations are expensive to install, require on-going maintenance, incur power losses, and require refurbishment or complete overhaul approximately every 20-25 years.

Highgate Converter Station

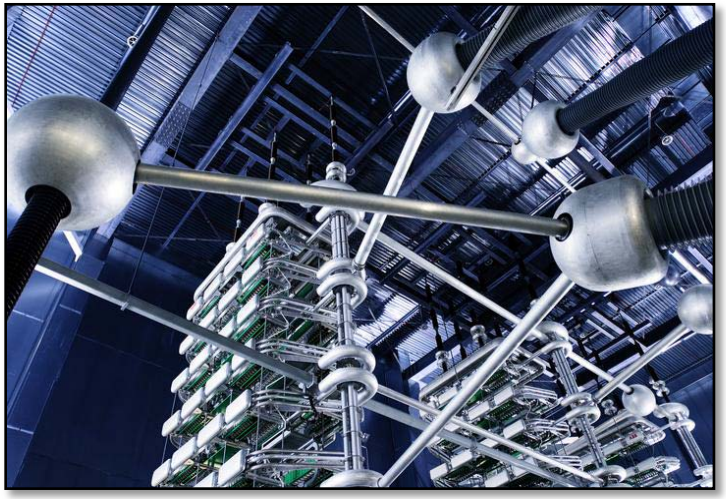
Cooling & Control System Refurbishment

February, 2011

Highgate Converter Station
Outline

- Converter Configuration & Present State
  - The converter and the transmission network
  - Recent critical equipment maintenance
- System Protection and Controls Replacement
  - AC/DC system protection
  - Valve controls system
- Cooling System & Valve Hall Equipment Replacement
  - Valve Cooling System
  - Cooling Controls Integration
  - Valve equipment replacement
- Project Status
  - Project Timeline
  - Conceptual Cost Estimate
- Benefits of the project
  - Asset Life extension
  - Maintain nominal rating of 225MW

Note: Aerial view of the Back to Back converter station



Note: Valve Hall Testing Facility

Converter Station Configuration

Facility Overview

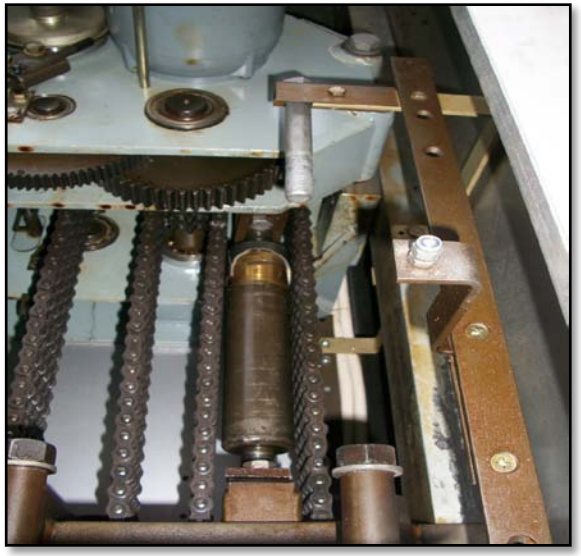
Converter Configuration:

- Back to Back Converter Station tying VELCO and Hydro Québec transmission networks.
- The converter station was built in 1985.
- Import of 218+ MW on average daily into New England.
- The converter supports load and has provided reliable power delivery to Northwest Vermont.
- Source to the VELCO Transmission System.

Note: OLTC Filter Maintenance

Recent equipment investments & current condition:

- Main converter transformers (3) were rewound in 1997 and have performed well since.
- Most of the thyristors were replaced in 1998.
- Original filter and capacitor banks.
- Maintenance cycle twice a year (spring and fall) with short outages.
- Breaker operators and other yard equipment have been rebuilt and replaced over the years following routine maintenance cycles.



Note: Breaker inspection & repairs

System Protection and Controls Replacement
Controls System Replacement

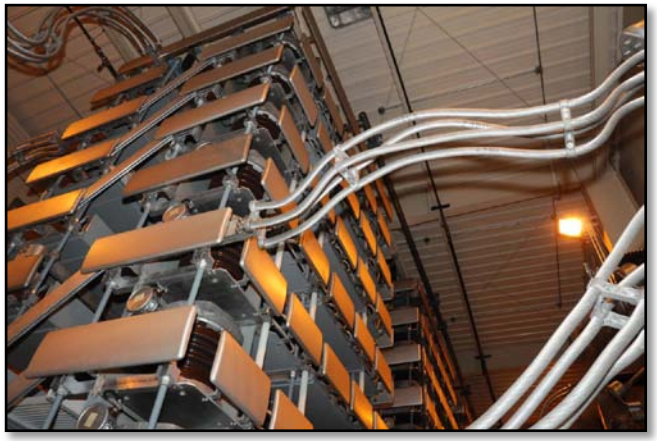
Need for Control System Replacement:

- Aging equipment (25+ years) with very limited industry knowledge of the control system.
- Increased failures of the control system resulting in deteriorated reliability and greater exposure to extended forced outages.
- Improves availability of the Highgate facility.
- The need to extend the life of the facility for 25 to 30 years.

Note: HVDC Control System where internal Faults generally lead to failed equipment and permanent failures

Control Systems most recent failure events:

- Control System A experienced three (3) complete stalls one (1) internal fault over the last year
- Control System B experienced nine (9) stalls and three (3) internal faults over the last year
- One event on the Control System led to both systems to fail resulting in a forced outage over this last year.



Note: Valve Unit block

System Protection and Controls Replacement
Control System Replacement

Local Alarm System Failures:

- 3 failures of the local alarm system in the last 4 months. When local system alarms fail, the control center loses alarm indicators and technicians need to be dispatched to the facility.
- Occasionally, resetting the system does not work and the fault requires the alarms to be reloaded into the system.

Note: Computer used to reset local alarms. The display is not operational anymore and resetting takes several tries

Control System life expectancy :

- The original control system already exceeded the life expectancy of 25 years. The table below indicates similar controls and cooling system upgrades of similar HVDC converter station.

	Highgate (US)	Blackwater (US)	Square Butte (US)	CU Project (US) x3	Cahora Bassa (S. Africa)	Skagerrak 1&2 (Norway)
	200MW	200MW	500MW	1000MW	500MW	500MW
Original Construction	1985	1985	1977	1978	1977	1977
Upgrade (Actual/Planned)	2012	2009	2004	2001-2004	2007	1991
Years of Service	**27**	**24**	**27**	**23-26**	**30**	**14**

Note: Recent similar upgrades performed on HVDC converter stations. Blackwater (NM) has a very similar design to Highgate

Cooling System Equipment Replacement

Valve Cooling System Replacement:

- Cooling System is critical to the proper and reliable operation of the valves.
- The efficiency of the cooling system heat exchanger's has decayed over the years. This will result in degraded performance and ultimately an increase of thyristor failures due to the higher operating temperatures.
- The cooling system pumps and motors have been exposed to wear and tear over the years, which results in an increased amount of preventative maintenance. Each time the pumps are out for maintenance, the redundancy is lost to the cooling system, which will increase the odds of a forced outage.
- The existing configuration has no redundancy for the raw water system cooling towers. If failures occur in the cooling towers, this would result in a reduction in power transfer through the converter.
- The new cooling system controls will integrate with the converter protection control for optimal utilization of the facility and greater equipment protection.

Note: Liquid to liquid heat exchangers

Note: Raw water heat exchangers

Valve Hall Equipment Replacement

Valve Equipment Replacement:

- Replacement of leaking snubber capacitors with oil free capacitors eliminating exposure to oil leaks and reducing risk of fire in the valve hall.
- Replacement of the existing thyristor control units with modern thyristor control units that will protect the valve more efficiently.
- Purchase of spare thyristors to cover normal failure rate over the extended life of the converter.

Note: Valve Module

Note: Leaking capacitor in a valve module (center of the picture)

Converter Station Refurbishment
Project Draft Timeline

Preliminary System Design & Construction Activities:

- The project scope definition is still being refined based on the final facility assessment and recommendation from the engineering team. Detailed design will be conducted by the vendor retained to replace the controls and system protection equipment.
- Partial valve hall equipment replacement (snubber capacitors) is planned for the 2011 Fall Outage
- Controls & system protection replacement as well as the cooling system refurbishment will take place during an extended outage in fall 2012

Converter Station Refurbishment
Project Cost Estimate & Project Financing

Conceptual Cost Estimate

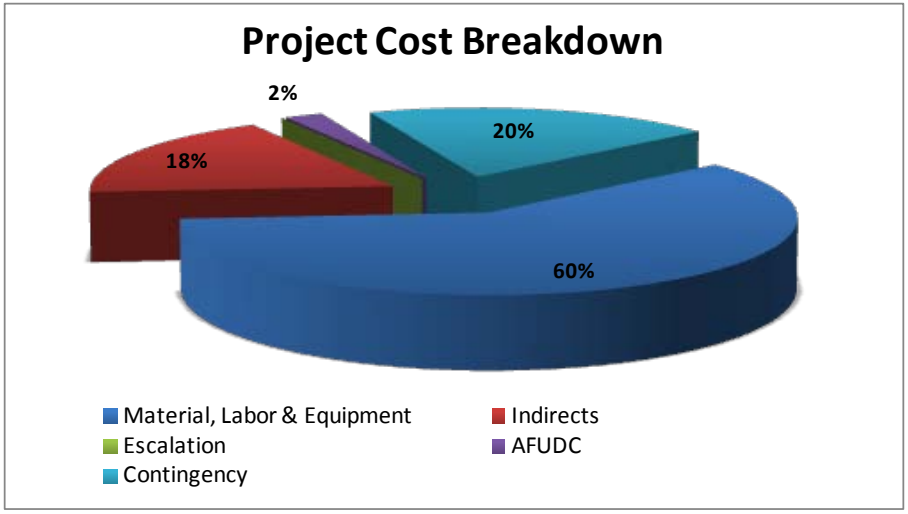
- A conceptual cost estimate was assembled based on the preliminary scope of work and projected project costs. At this stage of the project scope definition, a 25% contingency was applied based on the ISO-NE project cost estimating guideline (PP4).
- The estimate will be refined based on the final scope of work. A design level estimate will be developed for the Transmission Cost Allocation application in March 2011.

Preliminary Project Cost Breakdown

Project Cost Summary		
Material, Labor & Equipment	$	23,000,000
Indirects	$	6,900,000
Escalation		*Included*
AFUDC	$	831,000
Contingency	$	7,683,000
Total Project Cost	**$**	**38,414,000**

Note 1: *This facility is anticipated to be 100% regionally funded*

Note 2: *25% Contingency has been applied*



Benefit of the Project

Extend the life of the Facility while insuring optimal usage:

- Extend the life of the facility for 25 to 30 years.
- Replacing the existing controls with the MACH2 control system, which has been installed in over 82 HVDC and HVDC light applications and 1,400 total applications world wide.
- The cooling system will insure proper cooling of the valve hall based on the extended facility utilization rate and levels of import (218 MW average over the past year).

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 31
Are Eversource's transmission line capital and construction costs higher, on par, or lower than other Northeast Power Coordinating Council region utilities? If higher or lower, by what percentage and perceived reason?

Response:

It is very difficult to compare transmission line construction costs between utilities and projects in the Northeast because costs often vary widely depending upon project-specific features and locations. These factors include line routing, terrain and topographical features, sub-soil obstructions, wetland impact avoidance and mitigation, mitigation to address electric and magnetic fields, circuit outage availability, seasonal impacts, work hour/day restrictions, and special permit conditions.

In general, transmission projects in areas of higher population densities and greater density of existing infrastructure tend to face more challenges in siting and permitting, engineering and construction. Connecticut is a predominantly urban and suburban state, with a high density of existing infrastructure. This can result in line designs that have substantially more angles, require acquisition of additional land rights and/or involve several highway and railroad crossings, all of which add to the cost and complexity of a line project.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 32
Are Eversource's transmission line operation and maintenance costs higher, on par, or lower than other Northeast Power Coordinating Council region utilities? If higher or lower, by what percentage and perceived reason?

Response:
Eversource has not performed an analysis of its operation and maintenance costs in comparison with other Northeast Power Coordinating Council region utilities.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 33
What policies and/or methods could be implemented to reduce or offset life-cycle costs of transmission lines?

Response:

Eversource has implemented effective methods and policies to reduce initial capital costs such as by minimizing acquisitions and associated costs of additional rights-of-way by maximizing use of existing utility corridors and other linear corridors (e.g., public road rights-of-way) and optimizing line designs considering capital costs and use of right-of-way space.

Eversource has policies governed by the Procurement organization in regard to competitive bidding. Equipment and materials used in the construction of transmission projects are contracted through a competitive bid process, with the only exception being equipment that is only available through one documented source. Eversource uses our aggregated spend volume across our service territories to leverage negotiations and lower acquisition costs of materials and equipment. Where applicable, index-based pricing is a common contract structure that eliminates the practice of suppliers building unknown commodity risk into their bid pricing. Long-term contracts are established with selected vendors.

In addition, Eversource uses a common practice of pre-approving qualified line contractors for use in our capital transmission program. All projects are competitively bid using the prequalified vendors and bids are evaluated on both a commercial and technical basis to ensure fair and equal competition. Where applicable, Eversource will also aggregate multiple projects into a single bid to take advantage of economies of scale – and to make transition from project to project more efficient.

Consequently, Eversource does not currently have suggestions for additional policies or methods to reduce or offset transmission line life-cycle costs.

Date Filed: July 29, 2022

Request from: Connecticut Siting Council

Question: 34
Does Eversource have a telecommunications antenna attachment policy for overhead transmission line structures? If so, what is the policy?

Response:
No. Eversource has a colocation process that adheres to the state's tower sharing guidance. Requests to collocate Personal Communication Service (PCS) equipment on Eversource transmission line structures undergo engineering evaluation by an independent third party to ensure conformance with applicable standards and that they do not pose a risk to the transmission system operation or maintenance.