Permitting & Public Outreach

SENT VIA E-Mail and FedEX

May 23, 2017

Robert Stein
Chairman
Connecticut Siting Council
Ten Franklin Square
New Britain, CT 06051

Re: **LIFE-CYCLE 2017 –** Connecticut Siting Council Investigation into Life-Cycle Costs of Electric Transmission Lines.

Dear Chairman Stein:

Please find enclosed the original and twenty (20) copies of The United Illuminating Company's ("UI") responses to the Connecticut Siting Council's ("CSC") first set of interrogatories regarding the Investigation into Life-Cycle Costs of Electric Transmission Lines, dated April 10, 2017. Additionally, UI will electronically file all responses and attachments via siting.council@ct.gov.

Respectfully submitted,

THE UNITED ILLUMINATING COMPANY

By:

Amy Hicks
Analyst
The United Illuminating Company

Enclosures

The United Illuminating Company
Life-Cycle 2017

Witness: Ronald Rossetti
Page 1 of 1

Q-CSC-I-1: For new overhead transmission line installations in Connecticut, what transmission structure designs, including structure material and conductor arrangement (i.e. single-circuit vertical steel monopole), are mostly commonly used and for what reason(s)?

A-CSC-I-1: For new overhead transmission line installations in Connecticut, UI most commonly utilizes single-circuit delta configuration arrangements installed on tubular steel poles. The delta configuration allows for optimal height and width for the supporting structures subject to availability of land / easements. However, UI's recent transmission line construction has occurred only along the Metro North corridor and due to the right of way constraints inherent in work along the rail corridor, UI has primarily utilized a vertical conductor configuration. A single-circuit line is used as it provides better reliability as compared to a double-circuit line in the event of a structure failure.

Tubular steel poles are UI's preferred structure for the following reasons:

1) Their known mechanical strength
2) Durability over 40 years of life
3) Availability through numerous domestic vendors

Q-CSC-I-2: What structure designs, including structure material and conductor arrangements, are no longer used and for what reason(s)?

A-CSC-I-2: Lattice steel structures are no longer used on UI's transmission system for new construction. The main reasons lattice steel structures are no longer used include: appearance, the larger amount of real estate required for their installation; and being prone to climbing, trespassing and vandalism. Improvements in tubular pole design and manufacturing has contributed towards increased popularity of tubular poles at UI. However If the situation dictated using a lattice tower, due to cost or structural requirements, we would consider using such structure(s).

UI utilizes various conductor configurations (horizontal, vertical and delta) and the configuration selected is the one that provide the best solution for a specific application.

The United Illuminating Company — Witness: Ronald Rossetti & Chris Malone

Life-Cycle 2017 — Page 1 of 1

Q-CSC-I-3: Of the overhead configurations listed in response to Question 1, what configurations would UI consider prudent for life cycle analysis? Please complete the table provided with current first cost per circuit mile and losses for each of the noted configurations.

A-CSC-I-3: The following costs and losses are based on actual construction costs of single circuit vertical steel pole configuration using 1590 ACSS conductor along Metro North Railroad right of way

	First Costs per Circuit Mile		Losses
Poles & Foundations	$1,227,045	Conductor Size & Type	1590 ACSS
Conductor & Hardware	$183,304	Resistance	.0747 ohm/mile
Site Work	$2,022,246	Peak Line Current	2651 A (428 MVA)
Construction	$3,198,065	Load Growth	.83%
Engineering	$1,430,839	Loss Factor	.38
Sales Tax	$28,982	Energy Cost	29.98 $/MWh
Project Management	$569,124	Energy Cost Escalation	-4.29%
UI's Costs	$1,147,095		
Total Cost	**$9,806,700**		

Interrogatory CSC-I-4

The United Illuminating Company
Life-Cycle 2017

Witness: Ronald Rossetti
Page 1 of 1

Q-CSC-I-4: Complete the table provided with current first cost per circuit 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	
Site Work		Peak Line Current	
Construction		Load Growth	
Engineering		Loss Factor	
Sales Tax		Energy Cost	
Project Management		Energy Cost Escalation	

A-CSC-I-4:

a) UI has not constructed any 115 kV wood H-frame structures since our last response in 2011

b) UI has not constructed any 115 kV steel delta structures since our last response in 2011

c) UI has not constructed any wood 345 kV H-frame structures our last response in 2011

d) UI has not constructed any 345 kV delta structures since our last response in 2011

The United Illuminating Company
Life-Cycle 2017

Witness: Ronald Rossetti
Page 1 of 1

Q-CSC-I-5: Complete the table provided with first cost per circuit mile and losses for each of the following underground electric transmission line configurations:

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

First Costs		**Losses**	
Ducts & Vaults		Cable Size & Type	
Cable & Hardware		Resistance	
Site Work		Peak Line Current	
Construction		Load Growth	
Engineering		Loss Factor	
Sales Tax (X %)		Energy Cost	
Project Management		Energy Cost Escalation	

A-CSC-I-5:

a) UI has not constructed any UG HPFF pipe type UG transmission line since our last response in 2011.

b) UI has not constructed any 345 kV HPFF UG cable transmission lines since our last response in 2011

c) UI has not constructed any 115 kV XLPE UG cable transmission lines since our last response in 2011

d) UI has not constructed any 345 kV XLPE UG cable transmission lines since our last response in 2011

Interrogatory CSC-I-6

The United Illuminating Company
Life-Cycle 2017

Witness: Chris Malone
Page 1 of 1

Q-CSC-I-6: For variables listed under Losses in Questions 3, 4 and 5, provide the origin of the value.

A-CSC-I-6: The origin of UI losses in question 3 are attached as Appendix 1 titled “UI Question3 – “Losses” Reference Material”

Interrogatory CSC-I-7

The United Illuminating Company
Life-Cycle 2017

Witness: Chris Malone
Page 1 of 1

Q-CSC-I-7: Provide the following variables for cost calculations including the origin of the value:

a) Capital recovery factor, ________________
b) Operation and maintenance cost escalation, and ________________
c) Discount rate. ________________

A-CSC-I-7:

a) The capital recovery factor is 12.66% per the Cost of Capital Rate calculated in the 2016 Regional Network Service Transmission Revenue Requirement.

b) The operation and maintenance cost escalation is 1.75% for general inflation and outside services per UIL's corporate accounting budgeting guidelines.

c) The discount rate is not applicable.

Q-CSC-I-8: 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.

A-CSC-I-8:

a) UI no longer uses lattice structures for new construction. As stated in the response to interrogatory Q-CSC-I-2, the reason they are no longer used for new construction: They require large amount of real estate which is hard to find in an urban environment like that of UI's territory. They are prone to climbing, trespassing and vandalism. Preference is being given to other structure types i.e. tubular steel pole as the technology has improved over the years due to extensive use of computerized designing and better manufacturing processes; however, lattice type may find their use at UHV i.e. 765 kV levels, in rural areas or under special design considerations.

b) UI does not use laminate structures for new construction. UI has only one wood pole line which utilizes traditional wood poles. The wood poles are direct buried and subject to rot, bird and insect damage. Wood poles (laminated or non-laminated) may be used in certain situations like temporary construction or at by-passes. Further, laminated structures are much more expensive than regular wood poles and are approaching the cost of steel poles.

c) UI will implement vertical conductor design at locations where real estate or right-of-way is limited or to minimize the amount of real estate acquisition. This design offers less conductor sway as one could chose a preferred conductor orientation i.e. away from the property / easement lines thus reducing land requirements. The drawback of this design is that it increases the required tower/structure heights. UI is presently using this design on its Metro North (MN) Railroad (RR) lines Projects.

Q-CSC-I-9: Discuss the applicability of life cycle cost analysis for double circuit configurations. Is there a multiplier that can be applied to account for a second circuit to the transmission line configurations?

A-CSC-I-9: Applicability of double circuit configuration is determined by thermal, reliability and stability needs of the transmission system. Those lines with heavy load flows are likely to be candidates for single circuit towers. Those with minimal loadings may lend themselves to double circuit configuration. No cost multipliers are currently used by UI for double circuit lines.

The United Illuminating Company
Life-Cycle 2017

Witness: Chris Malone

Q-CSC-I-10: Provide costs per circuit mile of the past five years for operation and maintenance of UI's existing overhead transmission lines in accordance with Federal Energy Regulatory Commission (FERC) Accounts 560, 563, 564, 568, 571, and 572.

A-CSC-I-10 Costs per circuit mile of the past five years for operation and maintenance (O&M) of UI's existing overhead transmission lines in accordance with FERC Accounts 560, 563, 564, 568, 571, and 572 is as follows:

	2016	2015	2014	2013	2012
Costs per circuit mile for O&M of UI's existing overhead transmission lines	$60,867	$77,259	$78,933	$39,648	$33,638

Q-CSC-I-11: Provide costs per circuit mile of the past five years for operation and maintenance of UI's existing underground transmission lines in accordance with FERC Accounts 560, 563, 564, 568, 571, and 572.

A-CSC-I-11 Costs per circuit mile of the past five years for operation and maintenance (O&M) of UI's existing underground transmission lines in accordance with FERC Accounts 560, 563, 564, 568, 571, and 572 is as follows:

	2016	2015	2014	2013	2012
Costs per circuit mile for O&M of UI's existing underground transmission lines	$49,401	$48,667	$41,895	$29,534	$26,636

Q-CSC-I-12: Provide costs per mile of the past five years for UI's vegetation management activities for transmission line rights-of-way.

A-CSC-I-12: UI Transmission Vegetation Management metrics track completed cycle maintenance miles only. Annual costs below also include UI's costs incurred by Metro North Railroad and Federal Rail Administration (Amtrak) personnel in support of UI's vegetation management work and non-cycle vegetation management work performed throughout the year for right-of-way (ROW) reclamation, LiDAR (Light Detection and Ranging) identified reliability work, off-ROW fall-in risk mitigation, etc.

Years	2012	2013	2014	2015	2016
Cycle Miles Completed	14.87	14.77	27.31	29.02	14.75
Total Annual Cost	$1,188,508	$1,858,039	$1,676,009	$1,145,677	$1,131,950
Cost per ROW mile (cost/completed miles)	$79,927	$125,798	$61,370	$39,479	$76,742
Cost per ROW mile (cost/territory miles)	$15,044.41	$23,519.48	$21,215.30	$14,502.24	$14,328.48

Interrogatory CSC-I-13

The United Illuminating Company — Witness: Chris Malone
Life-Cycle 2017 — Page 1 of 1

Q-CSC-I-13: Is UI's vegetative management cost part of the FERC Accounts 571 and/or 572?

A-CSC-I-13: UI's vegetation management costs are neither part of FERC Accounts 571 nor 572. The transmission portion of vegetation management costs primarily post to FERC account 560.

Q-CSC-I-14: Provide an updated breakdown of UI's existing transmission facilities by length, voltage, construction type, and single/double circuit.

A-CSC-I-14: The Company's transmission lines by voltage, construction type, single or double circuit (including circuit miles) are shown on Appendix 2, titled "UI Transmission Facilities – Breakdown".

The United Illuminating Company | Witness: Ronald Rossetti and Chris Malone

Life-Cycle 2017 | Page 1 of 1

Q-CSC-I-15: List all relevant standards applicable to transmission resources for the following categories (if standards differ between overhead and underground or 115kV and 345kV please so state):

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

A-CSC-I-15:

The following are all relevant standards applicable to transmission resources:

a) The following reliability criteria are followed: NERC TPL, NPCC Directory 1, ISO-NE PP3 and Avangrid Planning Criteria.

b) UI does not have any knowledge of transmission line security standards except the need for “Signage” on all structures per the National Electric Safety Code (“NESC”).

c) NERC FAC-003-4; and UI OP-T70, Transmission Vegetation Management Program procedure are the standards applicable to vegetation management. These are applicable to both 115kV and 345kV lines.

d) UI standards for storm hardening call for designing its overhead transmission facilities in accordance with current NESC and to the level of a category III hurricane and 1 ½ inch of radial ice. This is applicable to UI’s newer lines only. There is no difference between the 115 kV and 345 kV systems in terms of structural loading conditions.

Q-CSC-I-16: The National Electric Safety Code and the State of Connecticut Building Code have been updated. How may these updated codes impact life cycle costs and identify those relevant code changes.

A-CSC-I-16: The changes in the updated NESC (2017) revisions appear to be minor and are not expected to significantly impact the life cycle costs of UI's transmission lines. UI is still reviewing the updated version of the NESC 2017 code to understand its impact.

The State of Connecticut Building Code does not apply to overhead or underground transmission lines.

Interrogatory CSC-I-17

The United Illuminating Company
Life-Cycle 2017

Witness: Ronald Rossetti

Q-CSC-I-17: Where are the costs associated with applicable standards and environmental permits found in first costs?

A-CSC-I-17: All costs associated with revised or prevailing standards and environmental permits are incorporated in the Engineering costs.

Interrogatory CSC-I-18

The United Illuminating Company
Life-Cycle 2017

Witness: Shawn Crosbie
Page 1 of 1

Q-CSC-I-18: Does UI agree with the list of environmental permits/certificate approvals in Table 8-2 in the Life Cycle 2012 final report dated November 12, 2012? If not, list other permitting authorities.

A-CSC-I-18: Due to the fact that many of environmental permits or registrations have changed since 2012, UI would like to provide its revised table of environmental permits / certificates attached as Appendix 3 titled "Environmental Permits / Certificates".

Q-CSC-I-19: Describe the effects on life cycle costs applicable for underground/overhead transmission lines as it pertains to those entities referenced in Question 18.

A-CSC-I-19: The projected life cycle costs for obtaining all permits, registrations or regulatory approvals and the conditions associated with those approvals through the permitting authorities outlined in Q-CSC-I-18 are typically included in the initial budget planning sessions for the construction and life of the underground/overhead transmission line. As a result, effects on life cycle costs are allowed to be captured upfront and not incurred unnecessarily to the transmission line after the fact.

Interrogatory CSC-I-20

The United Illuminating Company	Witness:	Ronald Rossetti and Chris Malone
Life-Cycle 2017	Page 1 of 1	

Q-CSC-I-20: Does UI agree that approximately 40 years is a reasonable value to assign to an overhead or underground transmission line's useful life? If not, what typical life expectancies would UI use for each of the transmission line configurations identified in Questions 1 and 2?

A-CSC-I-20: Yes. UI agrees that 40 years is a reasonable value to assign to an overhead or underground transmission line's useful life

Q-CSC-I-21: Would UI consider constructing new 69-kV transmission lines in Connecticut?

A-CSC-I-21: No, UI does not consider 69-kV construction to be appropriate for new construction in Connecticut due to the dense load characteristics and proximity to the stronger 115 kV and 345 kV transmission networks.

Q-CSC-I-22: Are polymer insulators the preferred type of insulators? Have they largely replaced porcelain or glass insulators?

A-CSC-I-22: No, UI's preferred choice of insulators is porcelain. UI does not use glass insulators. UI does have a short line section insulated with polymers. Polymer insulators are also being used for special applications i.e. temporary lines or horizontal V insulator assemblies only. Porcelain is a proven technology with over one century of its use and has not been replaced at UI with glass or polymers. Furthermore, polymer insulators are more costly than porcelain.

Q-CSC-I-23: Describe how leak prevention and containment measures used on HPFF cable systems could impact life-cycle costs.

A-CSC-I-23: Presently UI monitors fluid pressures, fluid flows and pump-run characteristics continuously. Leaks are detected by rapid pressure variations and excessive pump operation. The system is monitored continuously by Supervisory Control and Data Acquisition (SCADA). This type of monitoring obviates the need for repeated patrols and manual data review by Operation's personnel, thereby reducing O&M costs. The costs for this system were incorporated in the overall cost of the pumping plants.

The United Illuminating Company | Witness: Ronald Rossetti
Life-Cycle 2017 | Page 1 of 1

Q-CSC-I-24: Has UI researched or evaluated the use of composite conductors for transmission lines to increase line capacity? If so, what is estimated life cycle cost impact? Please break into first cost and ongoing cost elements.

A-CSC-I-24: Yes, UI did investigate the use of composite conductors on two of its line re-conductoring projects. One of the projects was cancelled while UI found that the conductor was incompatible for use on the second project due to wind and ice loading. UI will consider the use of composite conductors for future projects; however UI has never used such conductors on its OH transmission lines.

Q-CSC-I-25: Does UI anticipate utilizing ACSS conductors as a common practice or would ACSR or other conductor types be used for overhead lines?

A-CSC-I-25: Yes, UI anticipates utilizing ACSS conductors as a common practice, because of its low sag and high temperature characteristics. UI is using ACSS conductors on its projects currently under construction and plan to use them on its future overhead lines.

Interrogatory CSC-I-26

The United Illuminating Company
Life-Cycle 2017

Witness: Shawn Crosbie
Page 1 of 1

Q-CSC-I-26: Has UI experienced, in the last five years, issues with construction or maintenance of transmission lines in locations that required special processes or procedures due to environmental sensitivity? If so, please describe the situations and the cost impacts.

A-CSC-I-26: Yes. During UI's Housatonic River Crossing Project the Company was required to perform unique and special compliance processes due to the property owner's need to comply with CT's Property Transfer Act. Such processes where based on existing or tentatively approved site specific Soil & Groundwater Management Plans or proposed "Environmental Land Use Restrictions." While performing construction and in order to comply with property owner conditions, UI implemented a fully enclosed containment area to manage soil and groundwater, testing of the vegetation for contamination, and site specific training. The cost impacts for these additional special processes and procedures ranged from approximately $125,000 to $150,000.

Q-CSC-I-27: 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 UI expect the standards to impact transmission line life-cycle costs, and if so, to what extent?

A-CSC-I-27: No, UI does not anticipate the ISO-NE planning and operating standards for design and operation of transmission facilities to impact transmission line life-cycle costs.

Interrogatory CSC-I-28

The United Illuminating Company — Witness: Chris Malone
Life-Cycle 2017 — Page 1 of 1

Q-CSC-I-28: Has UI 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?

A-CSC-I-28: No, UI has not identified other ISO-NE policies or operating procedures that are anticipated to impact transmission life cycle costs.

The United Illuminating Company
Life-Cycle 2017

Witness: Chris Malone
Page 1 of 1

Q-CSC-I-29: Under what conditions would UI 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?

A-CSC-I-29: HVDC systems are appropriate when there's a need to transmit power over long distances or when interconnecting two systems that require isolation to preserve system reliability. The cost of HVDC becomes competitive to HVAC only when applied for very long distance lines due to the additional cost of the AC-DC converter stations.

Q-CSC-I-30: Does UI believe that its transmission line capital and construction costs are higher, on par, or lower than other Northeast Power Coordinating Council region utilities? If higher or lower, by what percentage and perceived reason?

A-CSC-I-30: In general, UI believes that its transmission line capital and construction costs are on par with other Northeast Power Coordinating Council region utilities except along the congested and densely populated Metro North Railroad Corridor. Work along the railroad corridor tends to be more complex and costly per mile when compared to similar work in a rural area for reasons that include the following:

1) Narrow and congested ROW
2) Limited construction outage availability (i.e. commuter train schedule restrictions)
3) Railroad resources required for all construction (i.e. flagmen, groundmen)

Q-CSC-I-31: Does UI believe that its transmission line operation and maintenance costs are higher, on par, or lower than other Northeast Power Coordinating Council region utilities? If higher or lower, by what percentage and perceived reason?

A-CSC-I-31: UI believes its transmission line operation and maintenance costs are higher than other Northeast Power Coordination Council region utilities. Two major factors are Metro-North Rail, and Reclamation.

48 miles, or nearly half, of UI's Transmission lines run along Metro-North Rail catenaries. In order to perform vegetation management along the rail corridor, UI is required by the Federal Rail Administration to secure a 5-year permit ($5,500) and a daily Metro-North safety flagger ($1,100/day). Also, for any vegetation within 10 feet of an energized Metro-North conductor, an outage must be scheduled, requiring two Metro North groundmen at a cost of $1,100/day each.

Right-of-way reclamation is an ongoing project following implementation of NERC regulations. The goal of reclamation is to fully clear the right-of-way to its full width for maintenance and reliability purposes and to increase the area maintainable by selective foliar herbicide treatment. While crews are on site for routine cycle maintenance, ROWs such as Metro North, which have difficult access, are also being reclaimed each time through. Approximately 3 trees are being removed for every 1 tree that could be pruned during cycle maintenance in a fully reclaimed ROW. Reclamation and LiDAR-based reliability work are also performed outside of cycle maintenance, particularly on NERC-designated critical lines, for risk mitigation, compliance, and increased maintenance efficiency.

Interrogatory CSC-I-32

The United Illuminating Company — Witness: Chris Malone
Life-Cycle 2017 — Page 1 of 1

Q-CSC-I-32: Are there any updates or changes to the coordination of transmission and distribution planning activities within UI or in conjunction with the ISO New England Regional System Planning process? If so, please discuss the changes and the impacts they have on transmission line life-cycle costs.

A-CSC-I-32: No, there are no process changes regarding the coordination of transmission and distribution planning activities within UI or in conjunction with the ISO-NE Regional System Planning Process that will have an impact on transmission line life-cycle costs.

Q-CSC-I-33: Provide any comments and/or suggestions regarding how the Council's Life Cycle 2012 report could be improved.

A-CSC-I-33: UI does not have any comments or suggestions at this time.

APPENDIX 1

Appendix 1
UI Question 3 - "Losses" Reference Material

Resistance	Reference Value	Resistance (Ohms)	Mileage	Per/Mile Resistance	Comments
	88005A-2 (Milvon - Devon Tie) 1590 ACSS	0.1023	1.3700	***0.0747***	UI P&C Transmission Line Parameters - 2016-08-15

Peak Line Current	Reference Value	Peak Line Current *(Normal Rating)*		Comments
		MVA	Amps	
	88005A-2 (Milvon - Devon Tie) 1590 ACSS	428	2654	ISO-NE NX-9 - (88005A-2 Line) Assumes summer normal thermal rating

Load Growth (CAGR)	Reference Value	Peak Load Forecast[1] *(50/50 w/ BTM PV & PDR reduction)*		CAGR	Comments
		2017	2026		
	ISO-NE 2017 CELT Forecast (May 1, 2017)	26,482	26,310	***-0.07%***	*CAGR = (Ending Load/Beginning Load)* $^{(1/\#yrs.)-1}$

Loss Factor = (0.3 x Load Factor) + (0.7)*(Load Factor)^2 -- [2]
Load Factor = Average Load/Peak Load

Loss Factor	Reference Value	2016 Average Load[4] *(Actual)*	2016 Peak Load[5] *(Actual)*	Load Factor	Loss Factor	Comments
	ISO-NE 2017 CELT Forecast & "2016 SMD Hourly Data"[3]	14,159	25,596	***0.55***	***0.38***	--

Energy Cost	Reference Value	2016 avg. Real-Time Energy Costs *(CT Load Zone)* ***$/MWh***		Comments
		Energy (EC) Component (LMP)	Loss (MLC) Component (LMP)	
	"2016 SMD Hourly Data"[6]	$28.98	$0.10	--

Energy Cost Escalation	Reference Value	2016 avg. Real-Time Energy Costs *(CT Load Zone)* ***$/MWh***			Average CT LMP Cost Escalation *(2010 - 16)*	Comments
		Year	Energy (EC) Component (LMP)	% Change		
	SMD Hourly Data[6]	2010	$49.49	--	***-4.29%***	These data represent the energy cost component of CT LMP zonal pricing over a 6 year period (2010 - 2016)
		2011	$46.79	***-5.46%***		
		2012	$36.33	***-22.36%***		
		2013	$55.74	***53.43%***		
		2014	$62.77	***12.61%***		
		2015	$40.77	***-35.05%***		
		2016	$28.98	***-28.92%***		

Note(s):	
1)	ISO-NE 2017 CELT Forecast - Load value represents 50/50 NE peak load net of Behind the meter PV *(https://www.iso-ne.com/system-planning/system-plans-studies/celt)* - Reference Tab 1.6 Forecast Distributions
2)	Depazo et al "An optimization technique for real and reactive power allocation, Proc. IEEE. Nov, 1967. *http://www.arpapress.com/Volumes/Vol12Issue2/IJRRAS_12_2_20.pdf*
3)	"2016 SMD Hourly Data" lists hour ending ISO-NE load data for 2016 *(https://www.iso-ne.com/isoexpress/web/reports/load-and-demand/-/tree/zone-info)*
4)	Average "System_Load" located in the "ISO-NE CA" Tab
5)	Reference Tab 1.5.1 "Peak Loads" August 2016 *(Reduced for BTM PV and PDR)*
6)	"2016 SMD Hourly Data" lists hour ending ISO-NE/CT LMP data for 2016 *(https://iso-ne.com/isoexpress/web/reports/pricing/-/tree/zone-info)*

Legend
Calculated Values

APPENDIX 2

Appendix 2

UI Transmission Facilities - Breakdown

	UI Transmission Facilities - Breakdown						
Desegnation		Voltage (kV)	Structure Type *(Overhead-OH)* *(Underground-UG)*	Circuit Type	Length (Circuit Miles) *ISO-NE NX-9 Data, 12/02/2016*		
Line Number	Terminals (From - To)				UI Circuit (Total)	UI OH	UI UG
1130	Pequonnock -> Compo (ES Owned)	115	OH - Metal Tower	Single	6.8	6.8	0.0
1430	Ash Creek -> Sasco Creek	115	OH - CAT Tower	Single	4.0	4.0	0.0
1460	East Shore -> Branford RR (ES Owned)	115	OH - Steel Pole	Double	3.0	3.0	0.0
1537	Branford RR (ES Owned) -> Branford (ES Owned)	115	OH - Steel Pole	Double	2.9	2.9	0.0
1560	Pootatuck -> Stevenson (ES Owned) -> Ansonia	115	OH - Metal Towe	Double	3.9	3.9	0.0
1570	Devon (ES Owned) -> Indian Well -> Beacon Falls	115	OH - Metal Tower	Double	1.4	1.4	0.0
1594	Ansonia -> Indian Well	115	OH - Metal Tower	Double	2.5	2.5	0.0
1610	June St -> Mix Ave -> Southington (Glen Lake - Mix)	115	OH - H Frame (Wood)/Steel Pole	Single/Double	3.6	3.6	0.0
1630	North Haven -> Walrec Tap	115	OH - Steel Pole	Double	1.7	1.7	0.0
1655	North Haven -> Branford (ES Owned)	115	OH - Steel Pole	Double	1.7	1.7	0.0
1685	June St -> Devon (ES Owned)	115	OH - Steel Pole	Double	0.8	0.8	0.0
1714	Trumbull -> Weston (ES Owned)	115	OH	Double	0.0	0.0	0.0
1730	Trumbull -> Devon (ES Owned)	115	OH	Double	0.0	0.0	0.0
1780	Devon Tie -> Devon (ES Owned)	115	OH - Metal Tower	Double	0.1	0.1	0.0
1790	Devon Tie -> Devon (ES Owned)	115	OH - Metal Tower	Double	0.1	0.1	0.0
8100	East Shore -> Grand Ave	115	OH - Steel Pole	Double	1.6	1.6	0.0
8200	East Shore -> Grand Ave	115	OH - Steel Pole	Double	1.6	1.6	0.0
8300	Grand Ave -> Quinnipiac	115	OH - Steel Pole	Double	2.3	2.3	0.0
8301	Grand Ave -> Mill River	115	OH - Steel Pole	Single	0.0	0.0	0.0
8400	Grand Ave -> Sackett	115	OH - Steel Pole	Double	4.3	4.3	0.0
8600	North Haven -> Quinnipiac	115	OH - Steel Pole	Double/Single	8.1	8.1	0.0
91001	Pequonnock -> Ash Creek -> Bridgeport Resco	115	OH - CAT Tower	Single	3.6	3.6	0.0
88005A	Devon Tie -> Milvon -> Woodmont	115	OH-CAT Tower/Steel Pole	Double/Single	5.4	5.4	0.0
88006A	Baird -> Barnum -> Devon Tie (ES Owned)	115	OH-CAT Tower	Double	2.5	2.5	0.0
8804A	Allings Crossing -> Woodmont	115	OH-CAT Tower	Double	2.8	2.8	0.0
8809A	Baird -> Congress -> Pequonnock	115	OH-CAT Tower	Double	3.0	3.0	0.0
89005B	Devon Tie -> Milvon -> Woodmont	115	OH-CAT Tower/Steel Pole	Double/Single	5.4	5.4	0.0
89006B	Baird -> Barnum -> Devon Tie	115	OH-CAT Tower	Double	2.5	2.5	0.0
8904B	Allings Crossing -> Woodmont	115	OH-CAT Tower	Double	2.8	2.8	0.0
8909B	Baird -> Congress -> Pequonnock	115	OH-CAT Tower	Double	3.0	3.0	0.0
1697	Pequonnock -> Trumbull	115	OH-Metal Tower/UG	Double	5.2	3.8	1.4
1710	Pequonnock -> Devon (ES Owned) -> Old Town	115	OH-Metal Tower/UG	Double	5.2	3.8	1.4
88003A	Grand Ave -> West River -> Elmwest -> Allings Crossing	115	OH-CAT Tower/UG	Double	5.2	2.4	2.8
89003B	Grand Ave -> West River -> Elmwest -> Allings Crossing	115	OH-CAT Tower/UG	Double	5.2	2.4	2.8
1943	Singer -> Bridgeport Energy	115	UG	Single	0.2	0.0	0.2
1955	Pequonnock -> Singer	115	UG	Single	0.4	0.0	0.4
8500	Grand Ave -> Water Street	115	UG	Single	1.5	0.0	1.5
8700	Water Street -> Union Ave	115	UG	Single	0.2	0.0	0.2
8702	Union Ave -> West River	115	UG	Single	1.3	0.0	1.3
9500	Broadway -> Water Street	115	UG	Single	1.6	0.0	1.6
9502	Broadway -> Mill River	115	UG	Single	1.7	0.0	1.7
9550	Grand Ave -> Mill River	115	UG - GIL	Single	0.1	0.0	0.1
84004	Mix Ave -> Sackett	115	UG	Single	2.3	0.0	2.3
387	East Shore -> Halvarsson -> Scovill Rock	345	OH-Steel Pole/Metal Tower	Double/Single	6.3	6.3	0.0
3216	North Bloomfield -> Agawam	345	OH - Steel Pole	Single	3.8	3.8	0.0
3271	Card -> Lake Road	345	OH - Steel Pole	Single	4.5	4.5	0.0
3642	Manchester -> Meekville Jct	345	OH - Steel Pole	Single	1.1	1.1	0.0
3165	Singer -> East Devon (ES Owned)	345	UG	Double	5.6	0.0	5.6
3619	Singer -> East Devon (ES Owned)	345	UG	Double	5.6	0.0	5.6
				Totals-->	*138.1*	*109.2*	*28.9*

APPENDIX 3

Appendix 3
Environmental Permits /
Certificates

Name of Permit	***Name of Permit - Applicability/Overview***
	FEDERAL
Army Corp of Engineers	*Self-Verification Form* ("*SVF*")- Impacts to resource areas outlined under impact specific General Permit(s) within Connecticut Programmatic General Permit
	Pre-Construction Notification ("*PCN*")- Impacts to resource areas outlined under impact specific General Permit(s) within Connecticut Programmatic General Permit ("*CT PGP*")
	Individual Permit – Large scale impacts not covered under SVF or PCN General Permits in CT PGP
	Section 106 Review – Based on potential impacts to Historical Properties under State Historic Preservation Office, Tribal Historical Preservation Office or National Register of Historic Places
US Fish and Wildlife	*Northern Long-Eared Bat Review Form* – Based on Federal nexus and potential impacts to hibernacula and roosting trees
	Federal Listed Species Consultation
	STATE
Connecticut Department of Energy and Environmental Protection	
Land and Water Resources Division (Inland)	*Section 401 Water Quality Certification* – Related to inland impacts, filters up to ACOE SVF or PCN
Land and Water Resources Division (Tidal)	*Structure Dredge and Fill: Certificate of Permission* – Impacts to Tidal resources
	Structure Dredge and Fill: Individual Permit – Type or quantity of impacts to tidal impacts
Wildlife Division	*NDDB Project Review Form* – Projects with impacts within polygon
Stormwater Division	*Stormwater Pollution Control Plan & Registration Under CT DEEP General Permit (DEEP-WPED-GP-015)* – Projects with >1 acre of temporary construction footprint will need to register and generate SWPCP
Water Bureau	*Groundwater Remediation Directly to Surface Water* – Groundwater management based on characterization of groundwater and municipal acceptance. More appropriate for Urban/Industrial-Commercial settings
	Groundwater Remediation Directly to a Sanitary Sewer – Groundwater management based on characterization of groundwater. More appropriate for Urban/Industrial-Commercial settings
State Historic Preservation Office	*Project Review Form*