Regional System Plan

Transmission Projects and Asset Condition

March 2018 Update

Planning Advisory Committee Meeting

Brent Oberlin

DIRECTOR, TRANSMISSION PLANNING

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Highlights of the Project List Update

- **Major cost estimate changes that occurred between the October 2017 and March 2018 Project List**:

  (MA) - Central Western Massachusetts Upgrades – **Project 945** - Adams – install two new 115 kV breakers and replace two existing 115 kV breakers and associated line relocations. Project cost increased (cost increase $11.9M)
  Cost changes are due to an enhanced understanding of the multiple site condition impacts on the construction plan as outlined at the December 2017 PAC meeting.
  (MA) – Pittsfield/Greenfield – **Projects 1662, 1664, 1665, and 1663** cost decreased (cost reduction $12.3M). Cost changes are due to project cost alignments.

- **No New Projects**

- **22 Upgrades on the project list have been placed in-service since the October 2017 update**:

  (CT) SWCT- 1 project in-service
  (CT) GHCC- 4 projects in-service – includes new 115 kV (10.35 mile) line from Frost Bridge - Campville
  (MA) Central Western MA Upgrades – 1 project in-service
  (MA) Greater Boston - 6 projects in-service – includes new 345 kV line from Scobie – Tewksbury
  (MA) Pittsfield/Greenfield - 4 projects in-service
  (MA) C-181/D-182 Brayton Point – S. Wrentham line refurbishment
  (NH) Pelham Substation – install 115 kV tap and inline breaker
  (VT) Y25N Bennington – Harriman + Taps Refurbishment
  (VT) Connecticut River Valley - 1 project in-service
  (VT) Replace PV20 submarine cables
  (VT) Harriman Asset Condition

March 2018 Changes

No New Projects and Corresponding Need

Project ID #	Transmission System Upgrades	Cost (in millions $)	Improvement/Need

March 2018 Changes, *cont.*

22 Projects Placed In-Service and Corresponding Needs

Project ID #	Transmission System Upgrades	Cost (in millions $)	Improvement/Need
1563	Install 2 x 14.4 MVAR capacitor banks at West Brookfield Substation on 1618 line terminal (Connecticut) SWCT	7.1	Resolves low voltage issues in Housatonic area
1583	Add a new 10.35 mile, 115 kV line from Frost Bridge to Campville and associated terminal equipment (Connecticut) GHCC	45.5	Improve load serving capability in NW CT
1592	Reconfigure the Berlin 115 kV substation including the addition of two 115 kV breakers and the relocation of a capacitor bank (Connecticut) GHCC	4.2	Eliminate impact of breaker failure contingency
1595	Separation of 115 kV DCT corresponding to the Bloomfield to South Meadow (1779) line and the Bloomfield to North Bloomfield (1777) line and add a breaker at Bloomfield 115 kV substation (Connecticut) GHCC	7.1	Eliminate impact of breaker failure and DCT contingency
1597	Separation of 115 kV DCT corresponding to the Bloomfield to North Bloomfield (1777) line and the North Bloomfield – Rood Avenue – Northwest Hartford (1751) line and add a breaker at North Bloomfield 115 kV substation (Connecticut) GHCC	20.1	Eliminate impact of breaker failure and DCT contingency

March 2018 Changes, *cont.*
22 Projects Placed In-Service and Corresponding Needs

Project ID #	Transmission System Upgrades	Cost (in millions $)	Improvement/Need
937	Bear Swamp - install one 230/115 kV 333 MVA autotransformer, one 115 kV breaker, four 230 kV breaker replacements and upgrade various terminal equipment (Massachusetts) Central Western MA Upgrades	20.5	Increase load serving capability
1662	Install a 115 kV 20.6 MVAR capacitor at Doreen substation and operate the 115kV 13T breaker N.O (Massachusetts) Pittsfield/Greenfield Project	2.7	Resolves low voltage violations in the Pittsfield/Greenfield Area
1664	Install a 75-150 MVAR variable reactor at Northfield substation (Massachusetts) Pittsfield/Greenfield Project	10.9	Resolves high voltage violations in the Pittsfield/Greenfield Area
1665	Install a 75-150 MVAR variable reactor at Ludlow substation (Massachusetts) Pittsfield/Greenfield Project	7.5	Resolves high voltage violations in the Pittsfield/Greenfield Area
1213	Install new 345 kV (3124) circuit between NH/MA border and Tewksbury (this is the MA portion of NGRID's portion of the new Scobie-Tewksbury circuit) and associated substation work at Tewksbury (Massachusetts) Greater Boston – North	83.3	Address reliability concerns in Greater Boston Area

March 2018 Changes, *cont.*

22 Projects Placed In-Service and Corresponding Needs

Project ID #	Transmission System Upgrades	Cost (in millions $)	Improvement/Need
1199	Install a new 230/115 kV autotransformer at Sudbury Loop 230 kV line 282-602 in and out of a new 230 kV switchyard at Sudbury (Massachusetts) Greater Boston – Western Suburbs	34.0	Improve load serving capability in the Greater Boston Area
1337	Reconfigure Waltham Substation and one (1) 115 kV breaker. Includes relocating terminations for PARs and 282-507 line (Massachusetts) Greater Boston – Western Suburbs	17.5	Improve load serving capability in the Western Suburbs of Boston
1520	Equipment termination changes at North Cambridge Station to mitigate 115 kV stuck breaker 5 and 10 contingencies (Massachusetts) Greater Boston – Central	8.7	Eliminate critical breaker failure contingencies
1502	C-181/D-182 Brayton Point - S. Wrentham line refurbishment (Massachusetts)	24.9	Resolves asset condition issues
1220	Install a new 345 kV (3124) circuit between Scobie and Hudson NH (this is Eversource's portion of the new Scobie-Tewksbury circuit) (New Hampshire) Greater Boston – North	36.9	Address reliability concerns in Greater Boston Area

March 2018 Changes, *cont.*

22 Projects Placed In-Service and Corresponding Needs

Project ID #	Transmission System Upgrades	Cost (in millions $)	Improvement/Need
1365	Install new 345 kV (3124) circuit between Eversource border and NH/MA border (NH portion of National Grid's portion of new Scobie - Tewksbury line) (New Hampshire) Greater Boston – North	Part of project ID# 1213 83.3	Address reliability concerns in Greater Boston Area
1625	Pelham Substation - Install 115 kV Tap and inline breaker (Associated with the 2nd 115/13.2 kV transformer addition) (New Hampshire)	2.0	Address reliability concerns in the Pelham area
1529	Y25N Bennington - Harriman + Taps (Knox Insulator refurbishment) (Vermont)	5.8	Resolves asset condition issues
1210	Harriman Station - Installation of 115 kV tie breaker with associated buswork and reconductor of buswork and new control house (Vermont) Pittsfield/Greenfield Project	4.7	Resolve low voltage violations by preventing simultaneous loss of two 115 kV lines
1488	Harriman Station - Breaker replacement and terminal equipment upgrades (Vermont) Harriman Asset Condition	8.0	Resolves asset condition issues

March 2018 Changes, *cont.*

22 Projects Placed In-Service and Corresponding Needs

Project ID #	Transmission System Upgrades	Cost (in millions $)	Improvement/Need
1613	Replace the PV20 submarine cables (Vermont)	46.0	Resolves asset condition issues
1617	Rebuild Chelsea Station to a three-breaker ring bus (Vermont) Connecticut River Valley	14.0	Reconfigure substation to resolve low voltage violations at Chelsea

March 2018 Changes, *cont.*

Cost Estimate Comparisons of Reliability Projects
October 2017 vs. March 2018 Update [1]

	As of Oct 2017 Plan Update (in millions $)	As of Mar 2018 Plan Update (in millions $)	Change in Plan Estimate (in millions $)
MAJOR PROJECTS			
Maine Power Reliability Program (MPRP)	1466	1466	0
Greater Hartford & Central Connecticut (GHCC)	337	337	0
New England East - West Solution (NEEWS)	1581	1581	0
NEEWS (Greater Springfield Reliability Project) $676.0			
NEEWS (Rhode Island Reliability Project) $362.3			
NEEWS (Interstate Reliability Project) $482.3			
NEEWS $59.6			
Southeast Massachusetts/Rhode Island Reliability Project	309	309	0
Pittsfield/Greenfield Project	191	179	-12
Greater Boston - North, South, Central, Western Suburbs	827	827	0
New Hampshire Solution - Southern, Central, Seacoast, Northern	328	328	0
Vermont Solution - Southeastern, Connecticut River	86	86	0
Southwest Connecticut (SWCT)	419	419	0
SUBTOTAL [2]	**5544**	**5532**	**-12**
OTHER PROJECTS	6781	6793	12
NEW PROJECTS		0	0
PROJECTS WHOSE COST ESTIMATES WERE PREVIOUSLY REPORTED AS TO BE DETERMINED (TBD)			
TOTAL [2]	**12325**	**12325**	**0**
Minus 'in-service'	-10002	-10413	
Aggregate estimate of active projects in the Plan [2]	**2324**	**1913**	

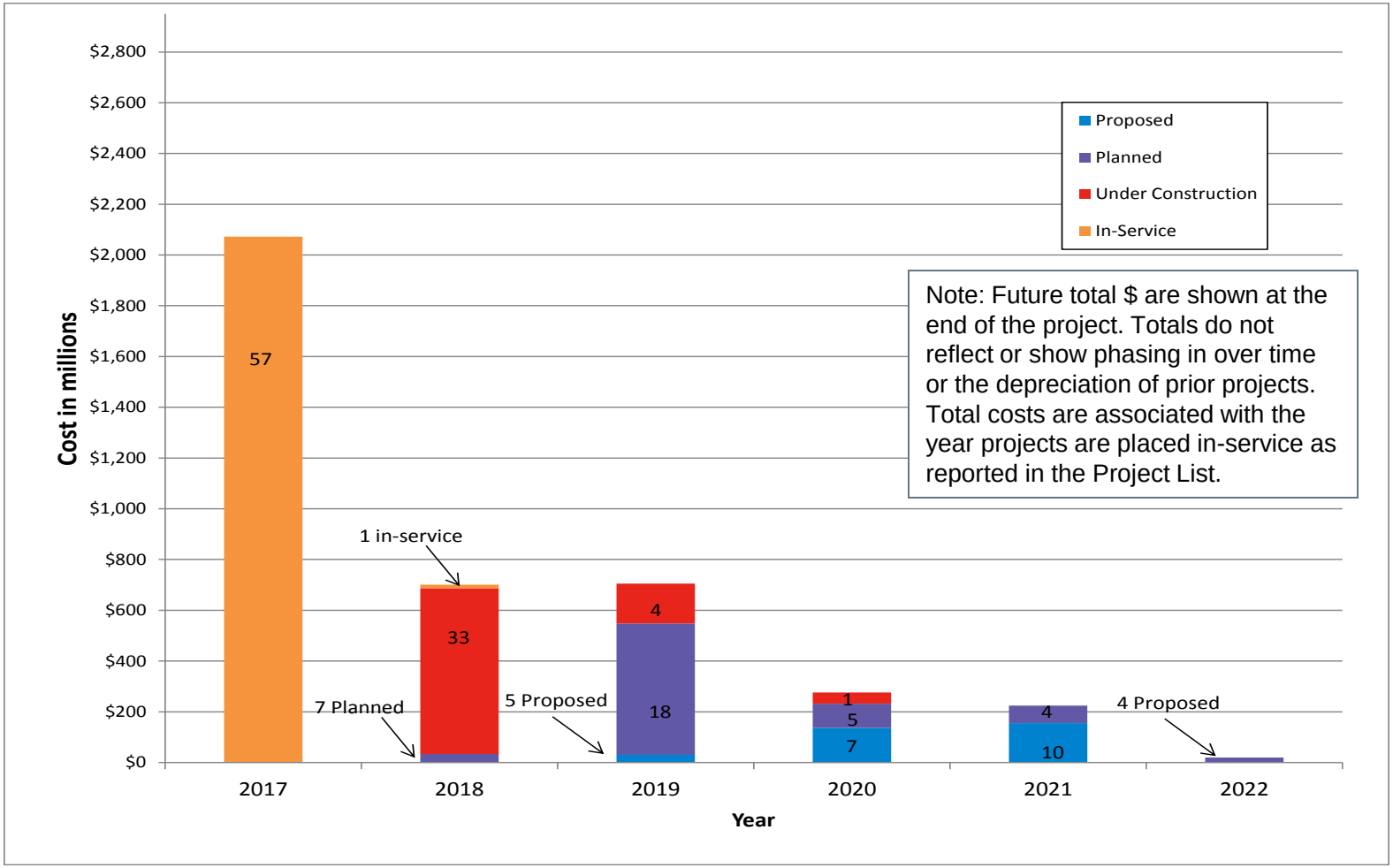
[1] Transmission Owners provided all estimated costs, which may not meet the guidelines described in Planning Procedure 4, Attachment D

[2] May not sum exactly due to rounding

[3] The cost estimates for projects in the "Major Projects" category are moved to the "Other Projects" category once they are fully completed.

March 2018 Changes, *cont.*

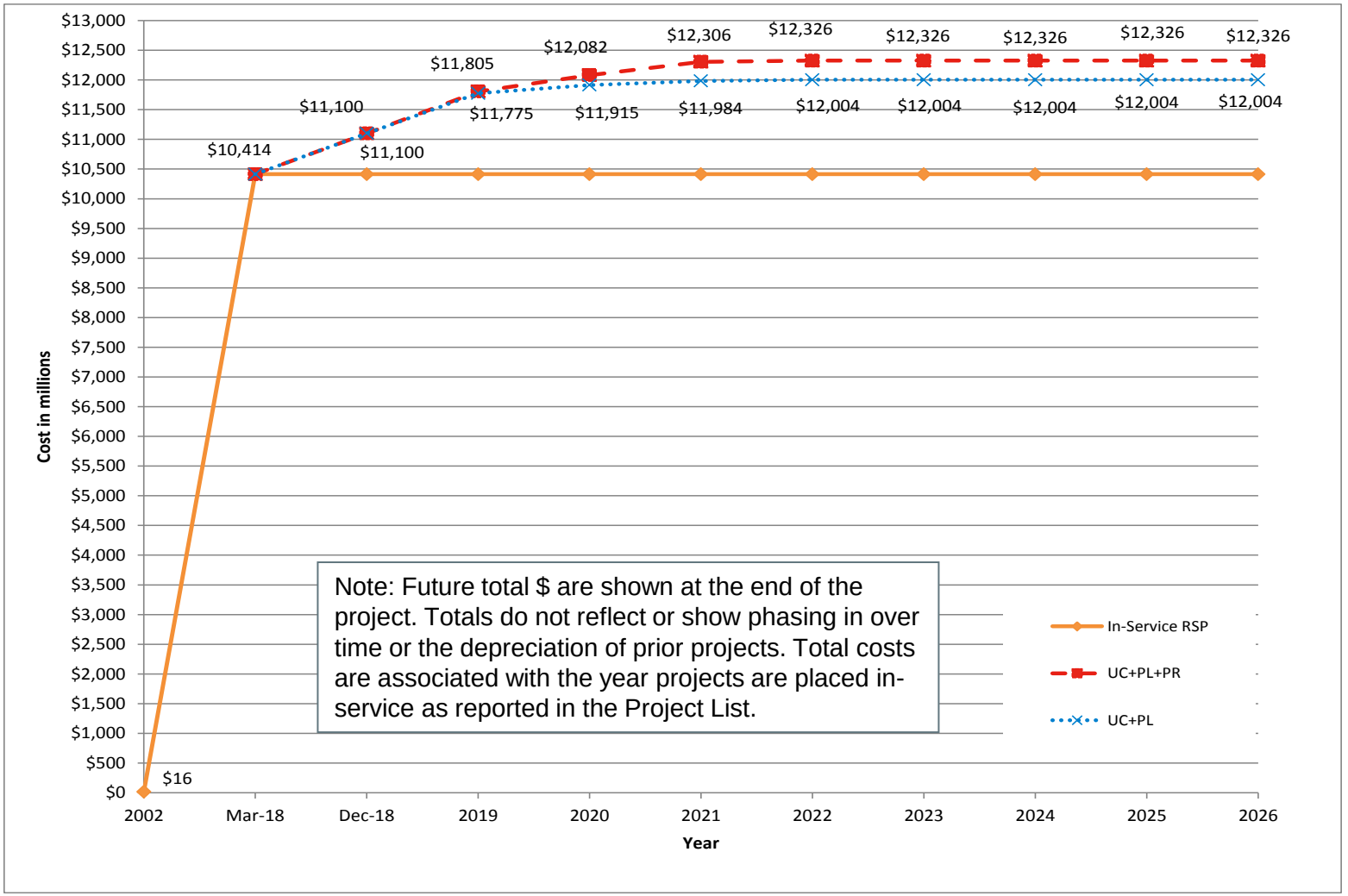
Investment of New England Transmission Reliability Projects by Status through 2022



Note: Numbers shown represent project quantities

March 2018 Changes, *cont.*

Cumulative Investment of New England Transmission Reliability Projects through 2026



Note: UC – Under Construction, PL – Planned, PR – Proposed

March 2018 Changes, *cont.*

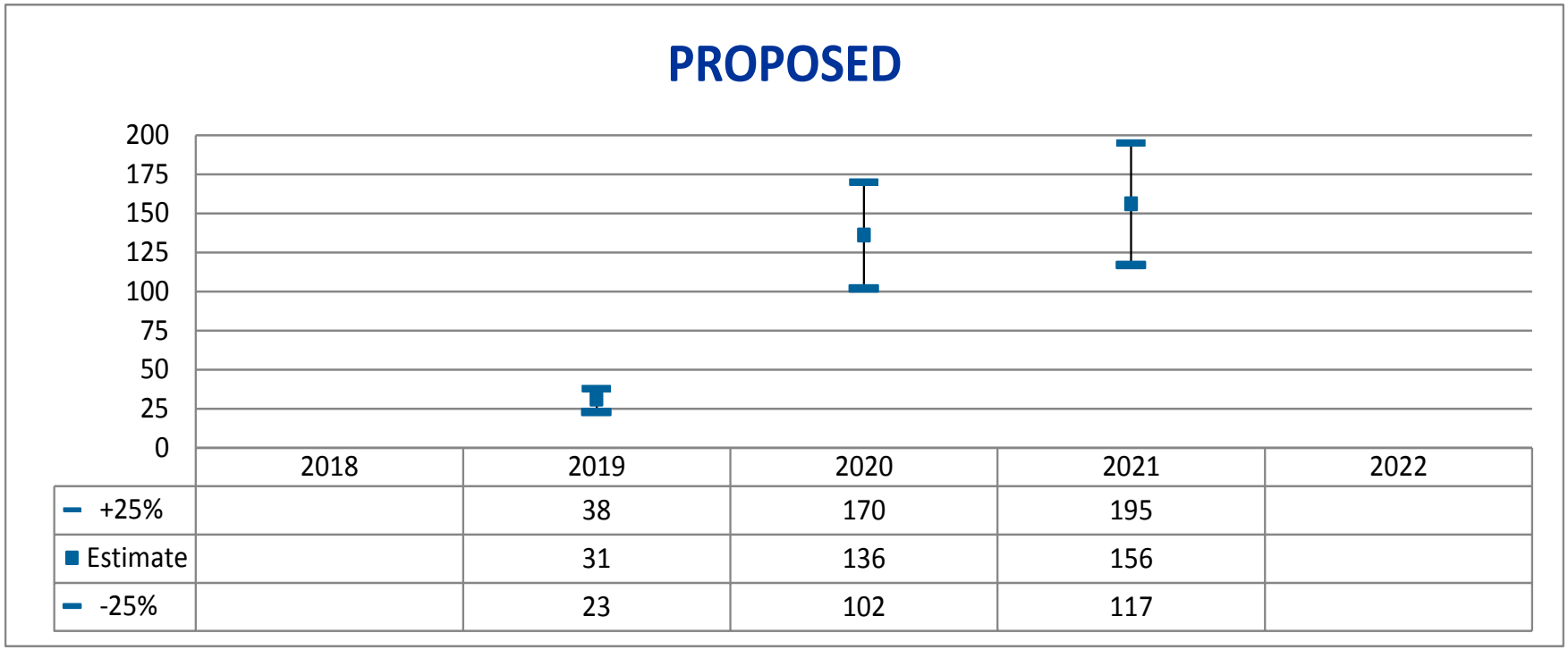
Reliability Project Counts and Aggregated Cost Estimates by Project Stage with Applied Accuracy Ranges (1)

Project Stage (Status)	Component / Project / Plan Count (2)	Estimate Range Minimum	Estimate Range Maximum	Estimated Costs ($millions)	Range Minimum ($millions)	Range Maximum ($millions)
Proposed	22	-25%	25% (3)	322	242	403
Planned	38	-25%	25%	735	551	919
Under Construction	38	-10%	10%	855	769	940
Total Plan (excluding Concept)	**98**			(5) **1912**	**1562**	**2262**
Concept	0			(4) 0		
In-Service	22	-10%	10%	411	370	452
Cancelled	0			75		

(1) All costs provided by Transmission Owners. The costs in the table reflect all projected in-service dates
(2) Efforts need to be made to describe projects on a more consistent basis
(3) All estimates may not yet be at this level of accuracy; many estimates may be -25%/+50%
(4) Not included here are the costs of reliability projects for which no estimates have been provided. **Estimates for these projects are noted as TBD in the Project Listing and are only Concept Projects.**
(5) May not add up due to rounding.

March 2018 Changes, *cont.*

Project Cost Estimate Tolerances by Status and Year in Millions $

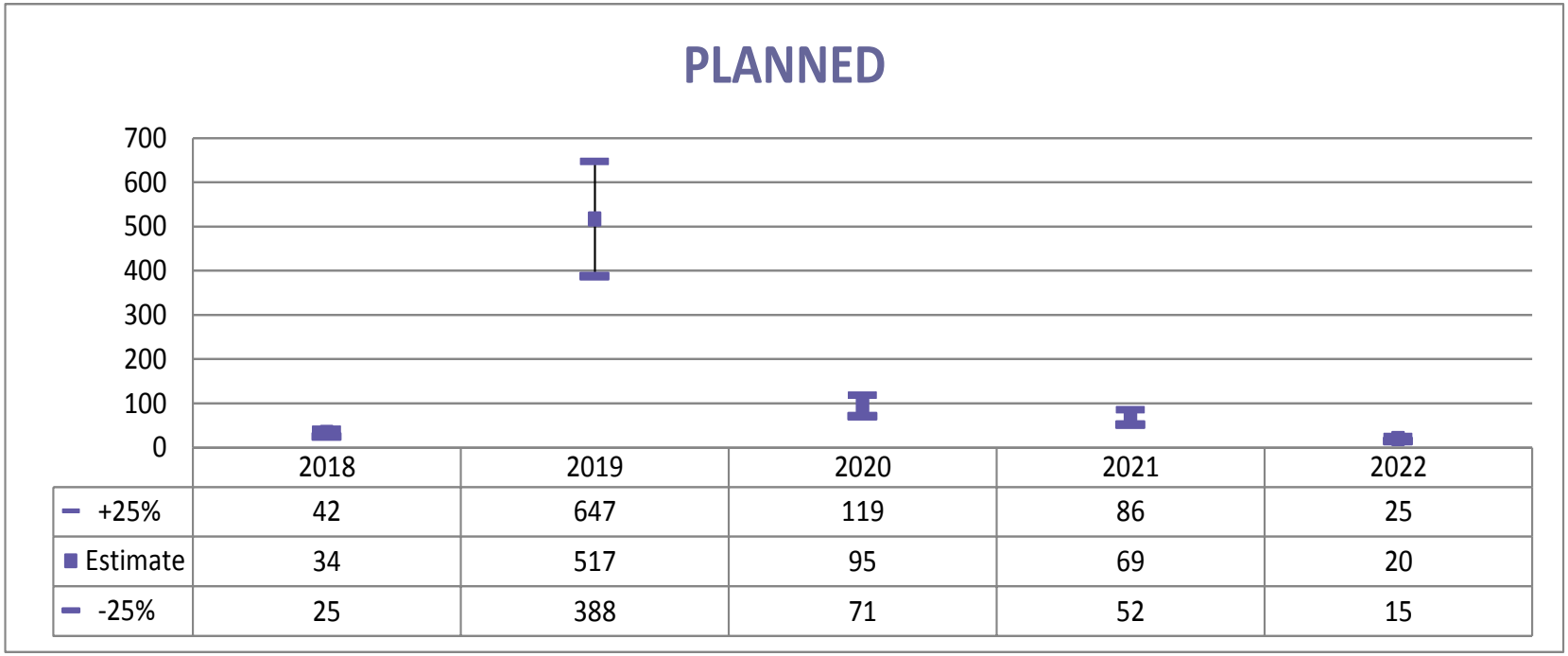


	2018	2019	2020	2021	2022
+25%		38	170	195	
Estimate		31	136	156	
-25%		23	102	117	

Note: Future total $ are shown at the end of the project. Totals do not reflect or show phasing in over time or the depreciation of prior projects. Total costs are associated with the year projects are placed in-service as reported in the Project List.

March 2018 Changes, *cont.*

Project Cost Estimate Tolerances by Status and Year in Millions $



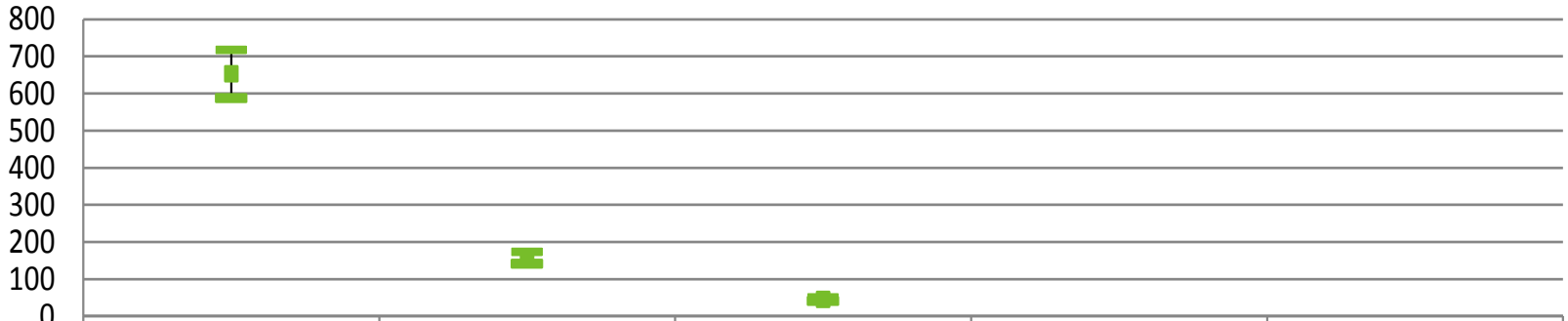
	2018	2019	2020	2021	2022
+25%	42	647	119	86	25
Estimate	34	517	95	69	20
-25%	25	388	71	52	15

Note: Future total $ are shown at the end of the project. Totals do not reflect or show phasing in over time or the depreciation of prior projects. Total costs are associated with the year projects are placed in-service as reported in the Project List.

March 2018 Changes, *cont.*

Project Cost Estimate Tolerances by Status and Year in Millions $

UNDER CONSTRUCTION



	2018	2019	2020	2021	2022
+10%	718	173	50		
Estimate	653	157	45		
-10%	588	141	41		

Note: Future total $ are shown at the end of the project. Totals do not reflect or show phasing in over time or the depreciation of prior projects. Total costs are associated with the year projects are placed in-service as reported in the Project List.

Status of Major Transmission Projects

	PPA	TCA	Construction
Pittsfield/Greenfield Project	Approved 12/12, 01/16, 05/16	Partial 2/11/16, 7/17/17	Project completion 2014-2019
Maine Power Reliability Program (MPRP)	Approved 7/08, 2/09, 11/10	Approved 1/29/10	Project completion 2014-2018
Vermont Solution – Connecticut River Valley	Approved 4/15	TCA Submitted	Project completion 2016-2018
Southwest Connecticut (SWCT)	Approved 4/15	Partial 7/16/15, 4/15/16, 5/13/16, 1/3/17	Project completion 2013-2020
Southeast MA/RI Reliability	Partially Approved 5/17	Not Submitted	Project completion 2017-2021

Status of Major Transmission Projects, *cont.*

	PPA	TCA	Construction
Central/Western MA Reinforcements	Approved 12/07, 3/11	Group 1 2/29/2012	Project completion 2009-2019
Greater Boston – North, South, Central and Suburbs	Approved 4/15, 5/15, 6/16	TCA Submitted	Project completion 2013-2019
New Hampshire Solution – Western, Central, Southern and Seacoast	3/13	Seacoast 11/5/15 Southern 1/7/16 Western 12/17/15 Central 11/25/15	Project completion 2013-2020
Greater Hartford & Central Connecticut (GHCC)	4/15	TCA Submitted	Project completion 2015-2018

March 2018 Asset Condition
36 New Projects

Project ID #	Transmission System Upgrades	Cost (in millions $)
53	NPCC Directory #1 Protection Modifications - Phase 2 (Massachusetts)	12.4
54	NPCC Directory #1 Protection Modifications - Phase 1 (Rhode Island)	0.4
55	Eversource 345 kV Structure Replacement Project - Line 307 (New Hampshire)	12.9
56	Eversource 345 kV Structure Replacement Project - Line 326 (New Hampshire)	12.3

March 2018 Asset Condition
36 New Projects

Project ID #	Transmission System Upgrades	Cost (in millions $)
57	Eversource 345 kV Structure Replacement Project - Line 367 (New Hampshire)	15.8
58	Eversource 345 kV Structure Replacement Project - Line 379 (New Hampshire)	14.8
59	Eversource 345 kV Structure Replacement Project - Line 381 (New Hampshire)	13.6
60	Eversource 345 kV Structure Replacement Project - Line 391 (New Hampshire)	19.6
61	1231/1242 Structure Replacement Project (Massachusetts)	8.0

March 2018 Asset Condition
36 New Projects

Project ID #	Transmission System Upgrades	Cost (in millions $)
62	Oil Circuit Breaker Replacement Project at the Agawam Substation (Massachusetts)	5.4
63	Lexington Station #320 Asset Condition Upgrade Project (Massachusetts)	14.3
64	Eversource 345 kV Structure Replacement Project - Line 393 (Massachusetts)	10.0
65	Eversource Laminated Structure Replacement Project - Line 1512 (Massachusetts)	14.5
66	Eversource Laminated Structure Replacement Project - Line 1211/1161 (Massachusetts)	12.5

March 2018 Asset Condition
36 New Projects

Project ID #	Transmission System Upgrades	Cost (in millions $)
67	Manchester Control House Expansion (Connecticut)	21.4
68	Card-Montville-Tunnel Corridor Asset Condition and OPGW Installation Project (Connecticut)	55.0
69	Oil Circuit Breaker Replacement Project at the Frost Bridge Substation (Connecticut)	7.3
70	Oil Circuit Breaker Replacement Project at the Plumtree Substation (Connecticut)	6.9
71	Eversource 345 kV Structure Replacement Project - Line 310 (Connecticut)	16.5

March 2018 Asset Condition
36 New Projects

Project ID #	Transmission System Upgrades	Cost (in millions $)
72	Eversource 345 kV Structure Replacement Project - Line 321 (Connecticut)	6.0
73	Eversource 345 kV Structure Replacement Project - Line 330 (Connecticut)	13.5
74	Eversource 345 kV Structure Replacement Project - Line 348 (Connecticut)	16.0
75	Eversource 345 kV Structure Replacement Project - Line 364 (Connecticut)	14.3
76	Eversource 345 kV Structure Replacement Project - Line 371 (Connecticut)	10.6

March 2018 Asset Condition
36 New Projects

Project ID #	Transmission System Upgrades	Cost (in millions $)
77	Eversource 345 kV Structure Replacement Project - Line 383 (Connecticut)	15.5
78	Eversource 345 kV Structure Replacement Project - Line 387 (Connecticut)	13.1
79	Eversource 345 kV Structure Replacement Project - Line 398 (Connecticut)	7.8
80	Eversource 345 kV Structure Replacement Project - Line 3041 (Connecticut)	9.7
81	Eversource 345 kV Structure Replacement Project - Line 3642 (Connecticut)	9.9

March 2018 Asset Condition
36 New Projects

Project ID #	Transmission System Upgrades	Cost (in millions $)
82	Eversource Laminated Structure Replacement Project - Line 1505/1607 (Connecticut)	52.5
83	Eversource Laminated Structure Replacement Project - Line 1675/1080 (Connecticut)	17.8
84	Eversource Laminated Structure Replacement Project - Line 1921 (Connecticut)	10.8
85	Phase 1 of multi-phase project involving like for like equipment replacement. Phase 1 includes replacing three approximately 1,000 ft. long horizontal gas-insulated lines (GIL) comprising the three phases of the 345kV Seabrook-to-Timber Swamp 369 line. Post-top insulators for the 369 line located in the open-air to GIS transition yard will also be replaced. A bridge covering the GILs where they surface from below grade upon entering the GIS Switchyard will also be replaced during this phase (New Hampshire) Seabrook 345 kV GIS Switchyard Like-for Like Equipment Replacement	77.0

March 2018 Asset Condition
36 New Projects

Project ID #	Transmission System Upgrades	Cost (in millions $)
86	Phase 2 of multi-phase project involving like for like equipment replacement. Phase 2 includes replacing three approximately 1,000 ft. long horizontal gas-insulated lines (GIL) comprising the three phases of the 345kV Seabrook-to-Ward Hill 394 line, and replacing two GIS 345kV Circuit Breakers and related switches that are the 394 line termination equipment. Post-top insulators for the 394 line located in the open-air to GIS transition yard will also be replaced. Phase 2 also includes replacing Breaker Failure Relay Protection Systems for the 394 line. (New Hampshire) Seabrook 345 GIS Switchyard - Phase 2	Part of Asset Condition #85 77.0
87	Phase 3 of multi-phase project involving like for like equipment replacement. Phase 3 includes replacing three approximately 1,000 ft. long horizontal gas-insulated lines (GIL) comprising the three phases of the 345kV Seabrook-to-Scobie Pond 363 line, and replacing two GIS 345kV Circuit Breakers and related switches that are the 363 line termination equipment. Post-top insulators located in the open-air to GIS transition yard will also be replaced. Phase 3 also includes replacing Breaker Failure Relay Protection Systems for the 363 line (New Hampshire) Seabrook 345 GIS Switchyard - Phase 3	Part of Asset Condition #85 77.0
88	NPCC Directory #1 Protection Modifications - Phase 1 (Massachusetts)	1.4

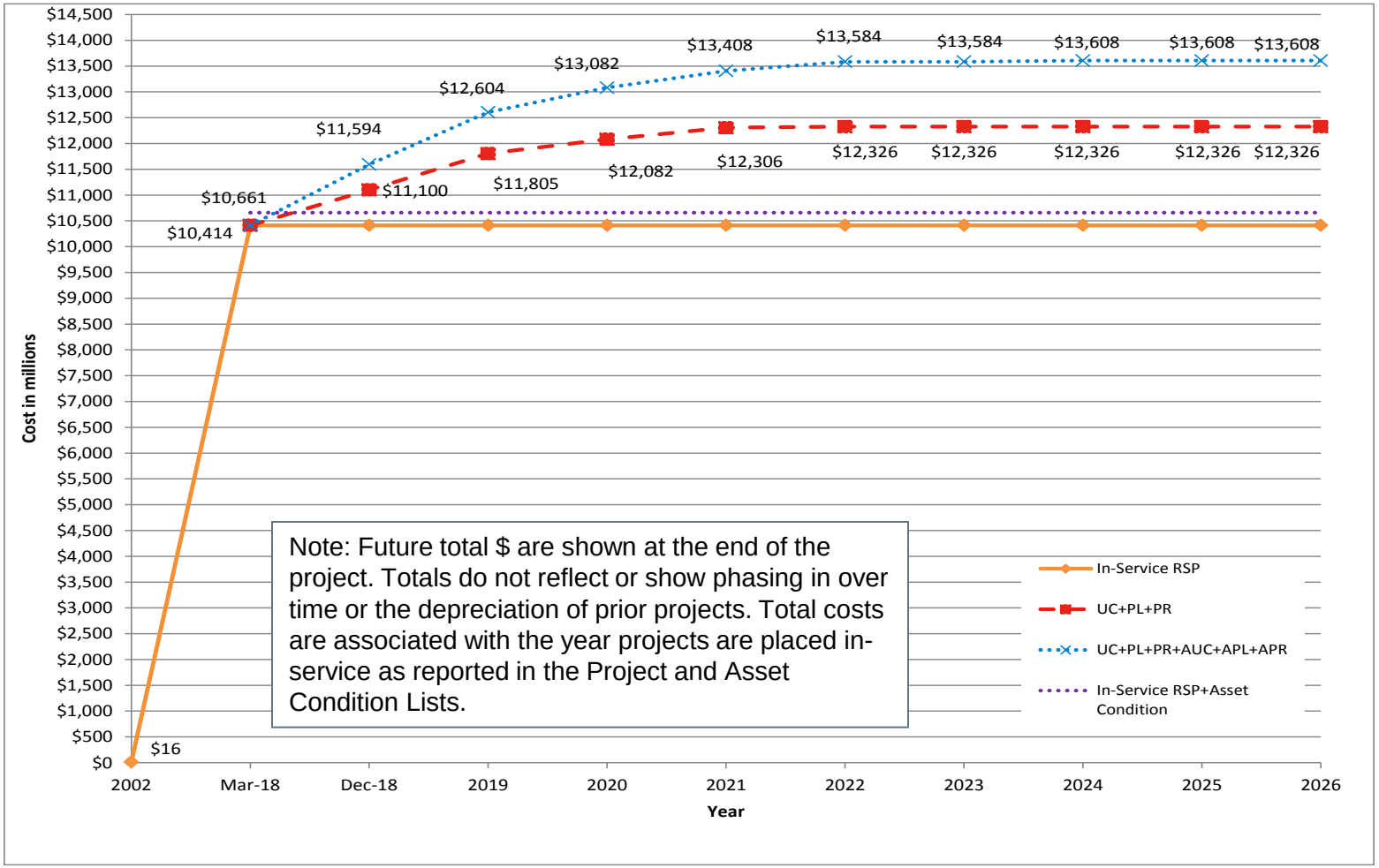
March 2018 Asset Condition, *cont.*

5 Projects Placed In-Service

Project ID #	Transmission System Upgrades	Cost (in millions $)
5	Phase 2 - Remove Breaker 11 and upgrade sections of Bus 1 (New Hampshire) Seabrook 345 kV GIS Breaker Removal and Bus Upgrade	12.0
46	Southern CT Loop Line Structure Replacements - 1261/1598 115 kV (Connecticut)	7.6
33	1410 and 100 Line Structure Replacements (Connecticut)	6.5
39	3419 line (portion in Connecticut) asset condition and OPGW project (Connecticut)	Part of project ID #38 13.4
38	3419 line (portion in Massachusetts) asset condition and OPGW project (Massachusetts)	13.4

March 2018 Changes, *cont.*

Cumulative Investment of New England Transmission Reliability Projects and Asset Condition through 2026



Note: RSP - UC – Under Construction, PL – Planned, PR – Proposed,
Asset Condition - AUC – Under Construction, APL – Planned, APR - Proposed

Appendix

Summary: Project Listing Definitions

- **ISO New England Inc. Transmission, Markets and Services Tariff Section II**
  - **Attachment K, Regional System Planning Process**
    - Definition of Needs Assessment
    - Definition of Solution Studies
  - **Project Listing Subcategories**
    - **Concept:** shall include a transmission project that is being considered by its proponent as a potential solution to meet a need identified by the ISO in a Needs Assessment or the RSP, but for which there is little or no analysis available to support the transmission project. (Project not well-defined, costs not well-defined, solution implementation not supportable).
    - **Proposed:** The project will include a regulated transmission solution that has been proposed in response to a specific Needs Assessment on the RSP and has been evaluated or further defined and developed in a Solutions Study and communicated to PAC. (Project well-defined, cost estimate quality sufficient for comparison of alternatives).
    - **Planned:** The project will include a Transmission upgrade that has been approved by the ISO, pursuant to Section I.3.9 (presumes Needs Assessment and Solutions Study have been completed). (Still subject to Schedule 12C review for Transmission Cost Allocation)

Project Listing

Project Listing Column Definitions for:

- Reliability Projects
- Interconnection Projects
- Market Efficiency Upgrades
- Elective Projects
- Projects In-Service
- Cancelled Projects

Project Listing – Column Definitions

Part Number (Part #)

The Part #'s designate the 'need' category of the project. Original categories are not changed when a project is placed 'In-Service' or 'Cancelled'.

Part 1 – These projects are Reliability Upgrades.

- 1a: Planned or Under Construction
- 1b: Concept or Proposed

Part 2 – These projects are Generator Interconnection Upgrades.

- 2a: Planned (I.3.9 approval with Generator Interconnection Agreement including FCM related transmission upgrades to meet the Capacity Capability Interconnection Standard), or Under Construction
- 2b: Concept or Proposed (at a minimum, a completed System Impact Study and I.3.9 approval but no Generator Interconnection Agreement)

Part 3 – These projects are Market Efficiency Upgrades.

- 3a: Planned or Under Construction
- 3b: Concept or Proposed

Part 4 – These projects may be promoted by any entity electing to support the cost of transmission changes. The entity sponsoring the changes will have their own justification for their actions.

- 4a: Planned or Under Construction
- 4b: Concept or Proposed

Project Listing – Column Definitions, *cont.*

Project ID

This number is generated from ISO-NE System Planning Information Tracking System. It may change in the future as the tracking system evolves.

Primary Equipment Owner

The company listed here is the responsible equipment owner / provider designated to design and implement the project.

Other Equipment Owner

For projects that involve multiple Transmission Owners, the company listed here is also a responsible equipment owner / provider designated to design and implement the project.

Projected Month/Year of In-Service

The month/year entered is the date the project is expected to be placed in service.

Major Project

Name given to a project that consists of smaller subprojects.

Project / Project Component

A brief, high-level description of the project is entered here. It will either include major pieces of substation equipment and/or types of line work to be performed.

Project Listing – Column Definitions, *cont.*

Status

In Service: The project has been placed in operation.

Under Construction: The project has received necessary approvals and a significant level of engineering or construction is underway.

Planned: The project will include a Transmission upgrade that has been approved by the ISO.

Proposed: The project will include a regulated transmission solution that has been proposed in response to a specific Needs Assessment on the RSP and has been evaluated or further defined and developed in a Solutions Study and communicated to PAC.

Concept: Shall include a transmission project that is being considered by its proponent as a potential solution to meet a need identified by the ISO in a Needs Assessment or the RSP, but for which there is little or no analysis available to support the transmission project.

Cancelled: Project has been cancelled.

Project Listing – Column Definitions, *cont.*

PPA Approval (Review of Market Participant's Proposed Plans)

A date in this column signifies when the project received approval pursuant to Section I.3.9 of the ISO-New England Tariff. This approval indicates that the project will have no adverse impact on the stability, reliability, or operating characteristics of the system. A 'no' indicates that an approval is required, but has not been received yet. An 'NR' indicates that an I.3.9 approval is not required.

TCA Approval (Transmission Cost Allocation)

A date in this column signifies when the project PTF costs were reviewed and approved. This approval indicates that it has been agreed whether, and by how much, the scope of the project and associated costs exceed regional needs. An 'NR' indicates that a TCA approval is not applicable either because the project has been cancelled or no/very minimal PTF costs are involved.

Estimated Costs

The pool-supported project cost estimate presented here should be the best estimate available. It is understood that the estimate accuracy may vary dependent on the maturity of the project.

Accuracy tolerances for these estimates are targeted as follows:

Concept Project

Proposed Project that has been reviewed and approved to proceed by ISO-NE (+50%/-25%),

I.3.9-Approved Project (+/-25%), and

TCA-Approved Project (+/-10%)