Appendix I

2021-2040 System & Resource Outlook (The Outlook)

A Report from the New York Independent System Operator

September 22, 2022

Table of Contents

Appendix I: Detailed Baseline and Contract Case Congestion Analysis

This appendix provides detailed analysis of the congestion identified in the baseline and contract cases.

In order to assess and identify the most congested elements of the grid, both positive and negative congestion on constrained elements are taken into consideration. Whether congestion is positive or negative depends on the choice of the reference point. All metrics are referenced to the Marcy 345 kV substation near Utica, New York. In the absence of losses, any location with a locational-based marginal price (LBMP) greater than the Marcy LBMP has positive congestion, and any location with an LBMP lower than the Marcy LBMP has negative congestion. The negative congestion typically happens due to transmission constraints that prevent lower cost resources from being delivered towards the Marcy bus.

I.1. Historic Congestion

Historic congestion assessments are based on actual market operation and have been conducted at the NYISO since 2005 with metrics and procedures developed in consultation with stakeholders. Four congestion metrics were developed to assess historic congestion: Bid-Production Cost as the primary metric, Load Payments metric, Generator Payments metric, and Congestion Payment metric. Starting in 2018, followed by Tariff changes in Appendix A of Attachment Y to the OATT, only the following historic Day-Ahead Market congestion-related data were reported: (i) LBMP load costs (energy, congestion and losses) by Load Zone; (ii) LBMP payments to generators (energy, congestion and losses) by Load Zone; (iii) congestion cost by constraint; and (iv) congestion cost of each constraint to load (commonly referred to in The Outlook as "demand$ congestion" by constraint). The results of the historic congestion analyses are posted on the NYISO website.[1]

Historic congestion costs by Zone, expressed as Demand$ Congestion, are presented in Figure 129, indicating that the highest congestion occurred in New York City and Long Island.

[1] For more information on the historical results below see: https://www.nyiso.com/ny-power-system-information-outlook

Figure 129: Historic Demand$ Congestion by Zone 2016-2020 (nominal $M)[2]

Zone	2016	2017	2018	2019	2020
West	$116	$63	$65	$88	$49
Genesee	$7	$12	$10	$2	$5
Central	$29	$40	$37	$24	$17
North	$7	$6	$15	$6	$10
Mohawk Valley	$7	$10	$7	$5	$3
Capital	$95	$90	$80	$70	$55
Hudson Valley	$64	$66	$50	$44	$33
Millwood	$19	$21	$16	$13	$11
Dunwoodie	$41	$44	$34	$30	$21
New York City	$378	$443	$405	$320	$200
Long Island	$339	$287	$303	$220	$242
NYCA Total	**$1,102**	**$1,082**	**$1,024**	**$823**	**$644**

Figure 130 below ranks historic congestion costs, expressed as Demand$ Congestion, for the top NYCA constraints from 2016 to 2020. The top congested paths are shown below.

Figure 130: Historic Demand$ Congestion by Constrained Paths 2016-2020 (nominal $M)

Demand Congestion (Nominal $M)	Historic					Total
	2016	2017	2018	2019	2020	
CENTRAL EAST	641	598	540	516	402	2,696
DUNWOODIE TO LONG ISLAND	164	88	133	82	98	565
EDIC MARCY	32	125	107	4	2	270
LEEDS PLEASANT VALLEY	63	101	9	20	1	195
GREENWOOD	31	18	62	25	22	159
PACKARD HUNTLEY	54	30	41	9	3	136
DUNWOODIE MOTTHAVEN	2	30	65	28	4	129
CHESTR-SHOEMAKR_138	-	-	-	19	10	30
UPNY-ConEd	-	4	-	0	3	8
VOLNEY SCRIBA	0	1	1	3	1	6

I.2. Projected Future Congestion

Future congestion for the Baseline Case study period was determined from a MAPS software simulation. As reported in the "Historic Congestion" section above, congestion is reported as Demand$ Congestion. MAPS software simulations are highly dependent upon many long-term assumptions, each of which affects the study results. The MAPS software utilizes the input

[2] Reported values do not deduct TCCs. NYCA totals represent the sum of absolute values. DAM data include Virtual Bidding and Planned Transmission Outages.

assumptions listed in Appendix C: Production Cost Assumptions Matrix.

When comparing historic congestion costs to projected congestion costs, it is important to note that there are significant assumptions not included in projected congestion costs using MAPS software including: (a) virtual bidding; (b) transmission outages; (c) price-capped load; (d) generation and demand bid price; (e) Bid Production Cost Guarantee payments; (f) co-optimization with ancillary services, and (g) real-time events and forecast uncertainty. As in prior Economic Planning Process cycles, the projected congestion is less severe than historical levels due to the factors cited.

Figure 131 presents the projected congestion from 2021 through 2040 by load zone. Year-to-year changes in congestion reflect changes in the model, which are discussed in the "Baseline System Assumptions" section above.

Figure 131: Projection of Future Demand$ Congestion 2021-2040 by Zone for Baseline Case (nominal $M)

Demand Congestion ($M)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
West	$33	$14	$6	$3	$3	$6	$6	$10	$13	$15
Genesee	$16	$8	$3	$2	$2	$3	$3	$5	$6	$6
Central	$51	$42	$26	$25	$32	$42	$40	$45	$48	$47
North	$3	$2	$0	$0	$1	$0	$1	$1	$1	$1
Mohawk Valley	$12	$6	$2	$0	$1	$1	$1	$1	$1	$0
Capital	$96	$45	$19	$13	$4	$2	$2	$3	$1	$1
Hudson Valley	$51	$22	$11	$0	$4	$7	$6	$7	$8	$9
Millwood	$16	$7	$3	$1	$1	$2	$2	$2	$2	$2
Dunwoodie	$30	$14	$7	$2	$2	$3	$3	$3	$4	$4
NY City	$266	$129	$66	$21	$9	$20	$19	$20	$25	$26
Long Island	$246	$153	$94	$58	$44	$37	$36	$34	$39	$45
NYCA Total	**$819**	**$442**	**$238**	**$125**	**$103**	**$122**	**$119**	**$130**	**$148**	**$157**

Demand Congestion ($M)	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
West	$17	$20	$21	$21	$24	$32	$32	$39	$39	$42
Genesee	$7	$8	$9	$9	$10	$13	$14	$16	$17	$19
Central	$49	$48	$51	$49	$51	$55	$62	$63	$69	$74
North	$0	$2	$2	$2	$2	$2	$2	$2	$2	$3
Mohawk Valley	$2	$3	$1	$1	$1	$2	$3	$3	$3	$3
Capital	$1	$0	$3	$6	$2	$1	$4	$2	$2	$1
Hudson Valley	$8	$10	$10	$9	$10	$13	$14	$15	$16	$19
Millwood	$2	$3	$3	$2	$2	$3	$3	$3	$3	$3
Dunwoodie	$4	$5	$5	$4	$5	$7	$5	$6	$7	$7
NY City	$22	$30	$32	$25	$26	$40	$24	$39	$42	$24
Long Island	$58	$58	$71	$82	$100	$89	$109	$119	$141	$150
NYCA Total	**$172**	**$188**	**$209**	**$209**	**$234**	**$256**	**$270**	**$308**	**$341**	**$345**

Note: Reported costs have not been reduced to reflect TCC hedges and represent absolute values.

Based on the positive Demand$ Congestion costs, the future top congested paths are shown below Figure 132.

Figure 132: Projection of Future Demand$ Congestion 2021-2040 by Constrained Path for Baseline Case (nominal $M)[3]

Demand Congestion ($M)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
CENTRAL EAST	$609	$286	$122	$25	$4	$1	$1	$4	$1	$2
DUNWOODIE TO LONG ISLAND	$56	$40	$29	$26	$27	$27	$29	$27	$30	$32
N.WAV-E.SAYR_115	$25	$29	$18	$12	$15	$17	$18	$18	$20	$20
ELWOOD-PULASKI_69	$24	$24	$14	$8	$5	$4	$1	$1	$6	$8
VOLNEY SCRIBA	$6	$6	$7	$6	$7	$8	$6	$8	$9	$9
UPNY-ConEd	$0	$0	$0	$2	$2	$2	$1	$3	$6	$5
CHESTR-SHOEMAKR_138	$31	$27	$26	$2	$1	$1	$1	$2	$3	$2
NEW SCOTLAND KNCKRBOC	$0	$0	$0	$20	$8	$3	$5	$13	$7	$8
SGRLF-RAMAPO_138	$0	$0	$0	$8	$5	$4	$5	$5	$5	$4
NORTHPORT PILGRIM	$7	$8	$5	$4	$2	$2	$1	$1	$3	$4
GREENBSH-STEPHTWN_115	$0	$0	$0	$5	$5	$5	$4	$5	$5	$5
INGHAMS CD-INGHAMS E_115	$0	$0	$0	$11	$2	$2	$2	$4	$2	$1
ALCOA-NM - ALCOA N_115	$0	$1	$1	$2	$2	$3	$3	$4	$4	$4
DUNWOODIE MOTTHAVEN	$3	$3	$0	$1	$1	$3	$3	$1	$2	$2
OWENSCRN-SABICO_115	$0	$0	$0	$3	$3	$3	$3	$2	$3	$3
FERND-W.WDB_115	$13	$6	$8	$2	$2	$1	$0	$0	$2	$1

Demand Congestion ($M)	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
CENTRAL EAST	$1	$1	$2	$6	$3	$5	$6	$7	$2	$1
DUNWOODIE TO LONG ISLAND	$38	$39	$47	$46	$58	$53	$57	$62	$72	$75
N.WAV-E.SAYR_115	$21	$21	$23	$21	$23	$26	$29	$30	$34	$36
ELWOOD-PULASKI_69	$9	$12	$13	$15	$18	$21	$26	$27	$31	$37
VOLNEY SCRIBA	$10	$10	$12	$11	$15	$12	$15	$15	$17	$18
UPNY-ConEd	$5	$4	$4	$5	$4	$6	$19	$19	$27	$42
CHESTR-SHOEMAKR_138	$1	$1	$4	$2	$5	$4	$3	$4	$4	$6
NEW SCOTLAND KNCKRBOC	$9	$8	$7	$12	$11	$4	$4	$3	$3	$1
SGRLF-RAMAPO_138	$6	$7	$6	$7	$10	$7	$16	$14	$9	$7
NORTHPORT PILGRIM	$4	$4	$4	$4	$6	$7	$7	$8	$9	$11
GREENBSH-STEPHTWN_115	$5	$5	$6	$6	$7	$7	$8	$8	$9	$9
INGHAMS CD-INGHAMS E_115	$2	$3	$5	$10	$4	$7	$11	$9	$11	$10
ALCOA-NM - ALCOA N_115	$4	$5	$5	$5	$5	$6	$5	$6	$6	$7
DUNWOODIE MOTTHAVEN	$3	$5	$4	$2	$3	$5	$6	$5	$3	$19
OWENSCRN-SABICO_115	$3	$4	$4	$5	$5	$5	$5	$7	$7	$8
FERND-W.WDB_115	$2	$2	$2	$3	$1	$3	$4	$4	$3	$1

[3] North Waverly – East Sayre 115 kV tie line between First Energy East and NY may be opened in real-time operation in accordance with NYISO and PJM Operating Procedures provided that this action does not cause unacceptable impact on local reliability in either system. Congestion reported in this table is a result of securing the line for N-1 contingency in production cost simulations.

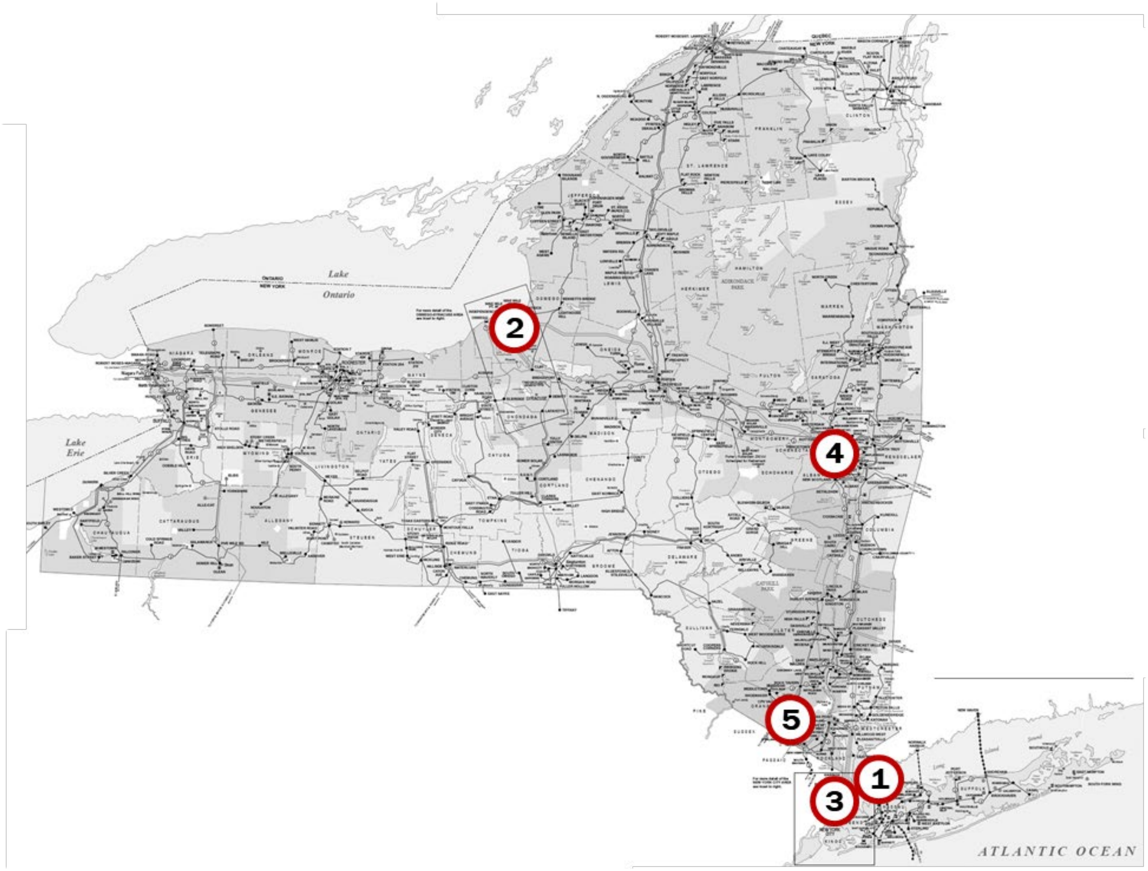
I.3. Baseline Case Congestion Analysis

Prior CARIS cycles examined the top three congested elements in the system and impacts of various solutions to alleviate congestion on those paths. In the System and Resource Outlook, we focus on congestion on lines which are projected to have congestion in the future system. These lines may or may not have been studied in prior cycles.

Five congested paths are selected for congestion analysis in the Baseline Case as shown in Figure 133.

1. Dunwoodie – Long Island 345 kV
2. Volney – Scriba 345 kV
3. Dunwoodie – Motthaven 345 kV
4. New Scotland – Knickerbocker 345 kV
5. Sugarloaf – Ramapo 138 kV

Figure 133: Locations of Constraints on New York State Map

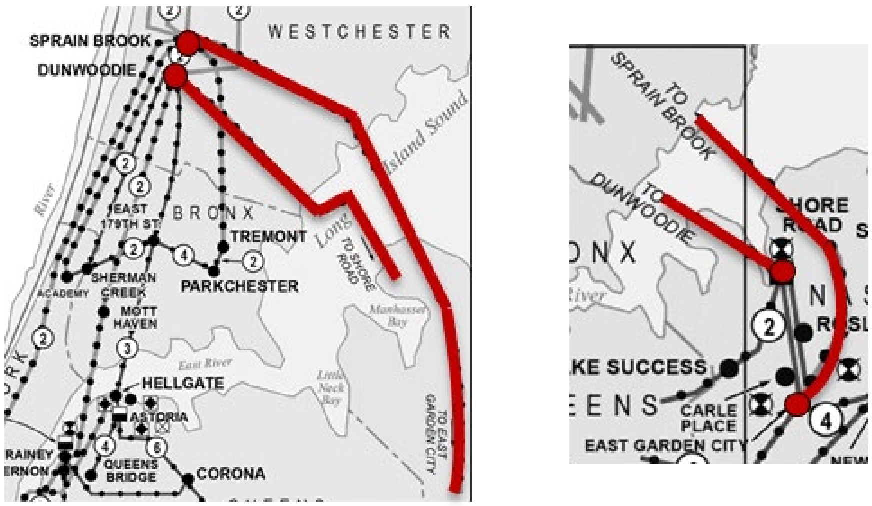


Each constrained path is separately evaluated by 'relaxing' the limits on the line or contingency that is binding in the Baseline Case. Results from the 'relaxed' cases compared to the Baseline Case estimate the impact of relieving congestion on each individual constraint. Individual constrained path congestion and relaxation results are discussed below.

Dunwoodie- Long Island 345 kV

The Dunwoodie-Long Island interface consists for two single circuit lines – Sprainbrook-East Garden City 345 kV (Y49) and Dunwoodie-Shore Road 345 kV (Y50). This interface transfers power from Dunwoodie (Zone I) to Long Island (Zone K). Line parameters for each line is listed below and their location in the NYCA system are shown in Figure 134.

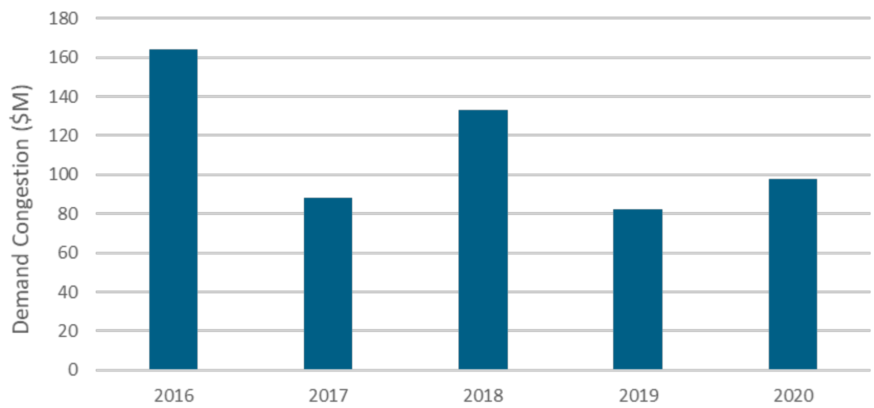
Figure 134: Dunwoodie to Long Island Location and Line Parameters



	Y49	Y50
Type	Single Circuit 345kV	
Normal Op. Rating	637/693 MW	656/741 MW
Contingency Op. Rating	900/940 MW	916/977 MW
Length	~26 Miles	>10 Miles
Owner	NYPA	Con Edison/LIPA

Historically, this path is congested due to transmission outage of one of the lines while the other one is still in service. The demand congestion (nominal $M) for the past five years is presented below in Figure 135.

Figure 135: Dunwoodie to Long Island Demand Congestion (nominal $M)



In the Baseline case, changes in series reactor status causes increased flow on the parallel circuit, thereby increasing congestion on the line. For 2021-2022, the series reactor on Y49 is in service all year round, which causes heavy congestion on Y50. Starting 2023, the series reactor on Y49 is bypassed during summer, which reduces congestion on this path. Congestion is observed on both Y49 and Y50 instead of being concentrated on Y50 as in the first two years.

Figure 136: Projected Baseline Case Demand Congestion and Congested Hours

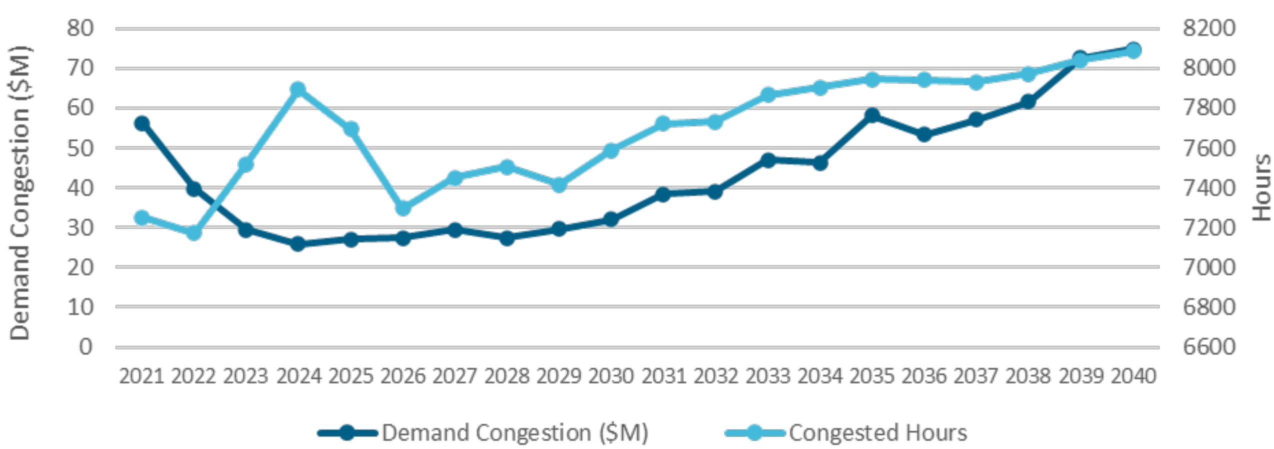


Figure 137 below shows the line utilization on the Dunwoodie to Long Island interface in forms of violin charts. A violin plot is a hybrid of a box plot and a kernel density plot, which shows peaks in the data. It is used to visualize the distribution of numerical data. Unlike a box plot that can only show summary statistics, violin plots depict summary statistics and the density of each variable. Wider sections of the violin plot represent a higher probability that members of the population will take on the given value; the skinnier sections represent a lower probability. Shaded area of the violin plot represents all the points in the population.

Freed energy in GWh is presented below the annual violin plots which shows the increased flow on the line when limits are removed relative to the total Contract Case flows The Freed energy metric is defined as the sum of the hourly delta between the relaxed case compared to the Contract Case flows.

$$\text{Freed Energy} = \sum_{h=1}^{8760}[Max(Relax\ Case\ Flow)_h - Max(Contract\ Case\ Flow)_h]$$

Figure 137: Dunwoodie to Long Island Baseline Case Hourly Line Utilization

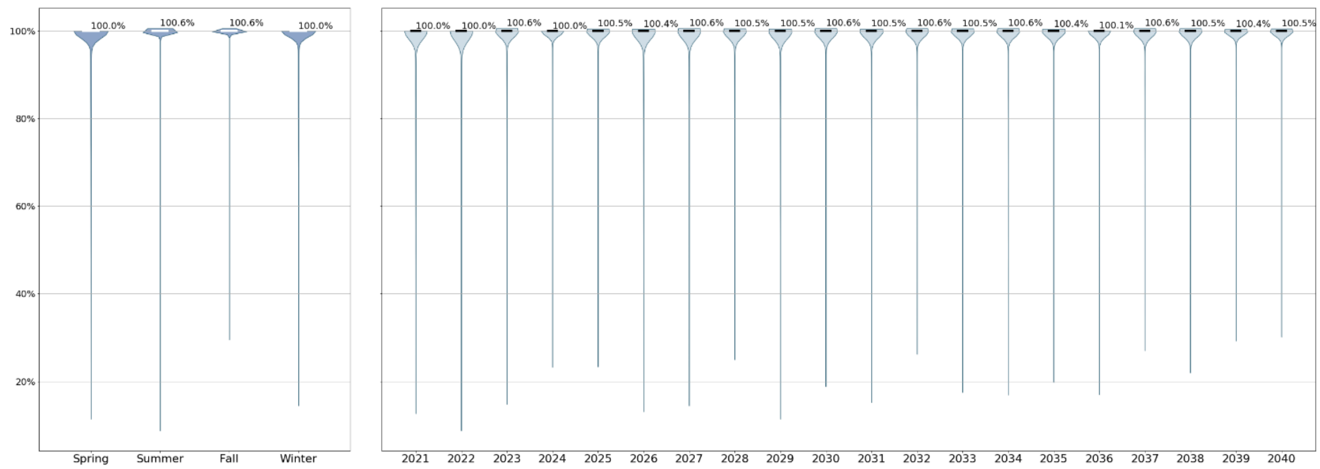


Figure 137 is divided into two parts. The seasonal plot on the left side depicts the line utilization for four seasons[4] using data from all 20 years in the study period. It bulges in the summer and fall seasons show that the line is highly utilized during these seasons and the flow on the line is lower in the winter and spring seasons. The yearly plot on the right shows that the line is highly utilized (flow on the line is near the limit) during most hours of the year. The 'Black' lines in the body of the plots represent the median value of hourly line utilization. Since this median is close to 100% in most years, the line is projected to be operating at or close to its limit in most hours of the year. Price differentials across the zones is the main driver behind high flows across this interface.

A 'relaxed' case was run where the limits on the lines were removed to examine the impact of eliminating any congestion on the interface. The flow duration curve in Figure 138 below shows the

[4] Seasons included in the analysis are Spring: February-April, Summer: May-July, Fall: August-October, and Winter: November-January. For comparison, the NYISO Summer Capability Period is May – October and the Winter Capability Period is from November – April.

delta flows on the interface in the *relaxed* case relative to the flows in the Baseline case. A positive value means that the flow increases in the same hour when the limits are removed in the relaxed case. Some sample years are presented as colored lines and the grey shaded area represents the entire range of values for the whole twenty-year period.

Figure 138: Dunwoodie-Long Island Flow Duration Curve (Relax-Baseline)

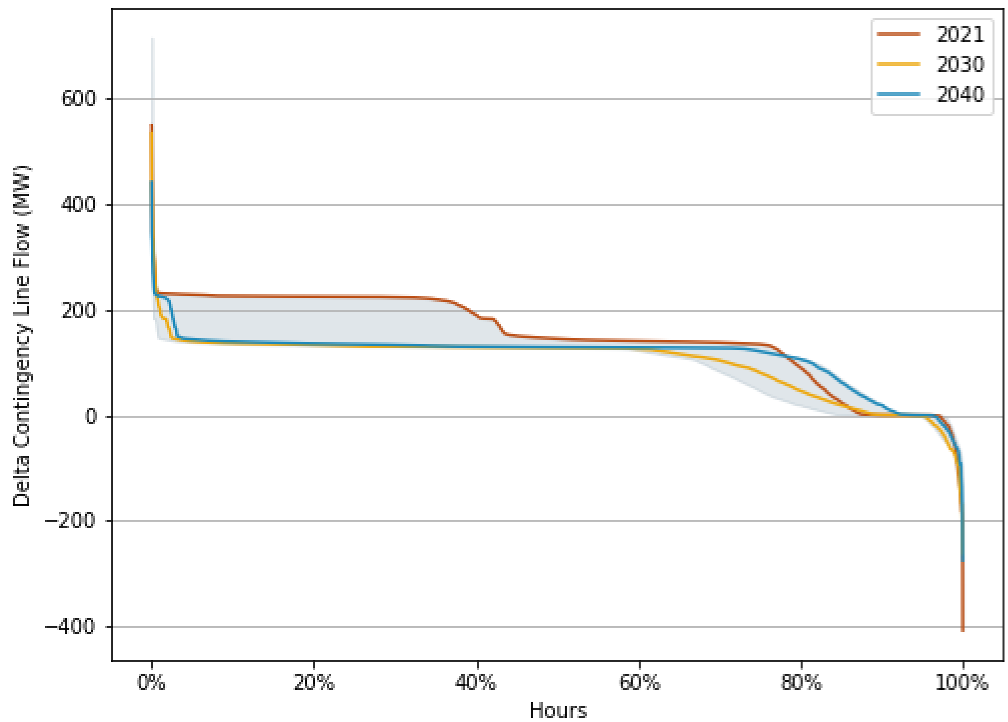


Figure 139: Dunwoodie-Long Island Average Delta Flow (MW)

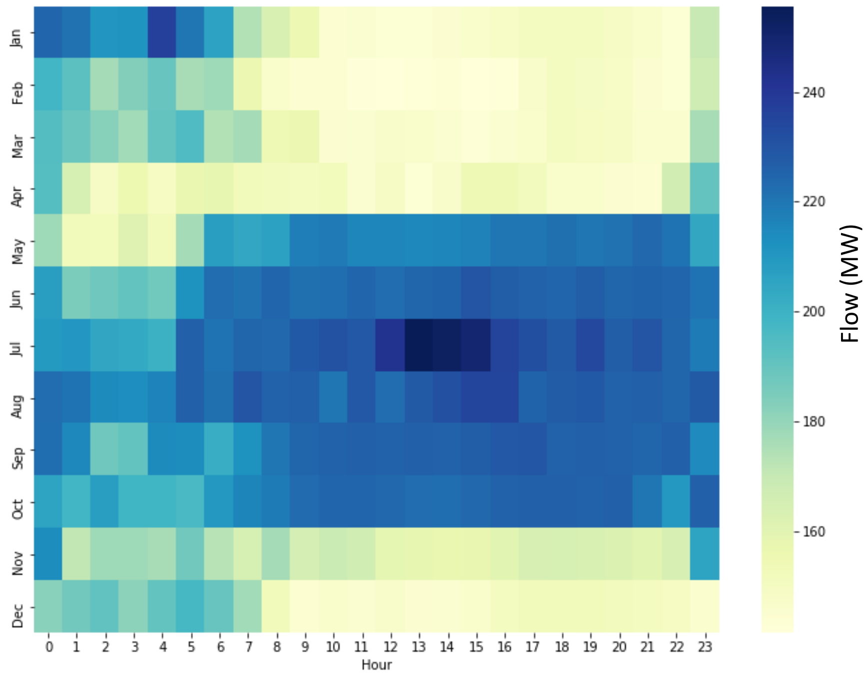
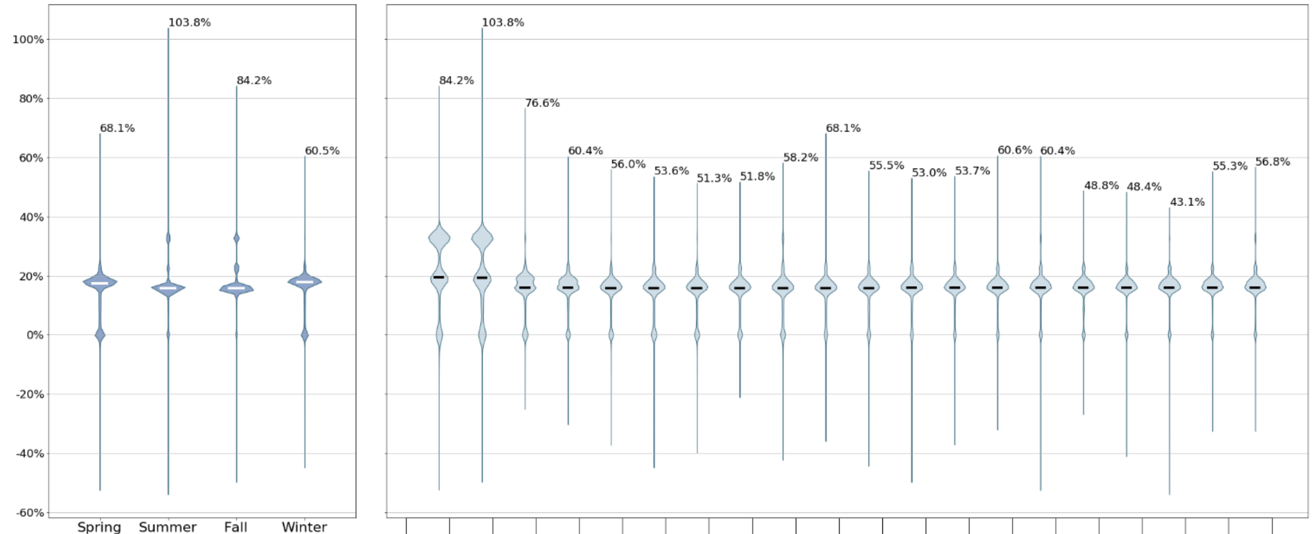


Figure 139 depicts a heat map that represents the average delta flows in each hour for each month in the whole study period. It shows that the largest increase in flows in the relaxed case occurs during the summer peak hours. This can also be seen in the delta violin plots in Figure 140 below which show the largest spikes during the summer and fall seasons. Overall, the line utilization on the relaxed interface increases by approximately 18-20% on average. Freed energy in GWh is presented below the annual violin plots and shows the increased flow on the line when limits are removed relative to the total Baseline flows.

Figure 140: Dunwoodie-Long Island Delta Hourly Line Utilization

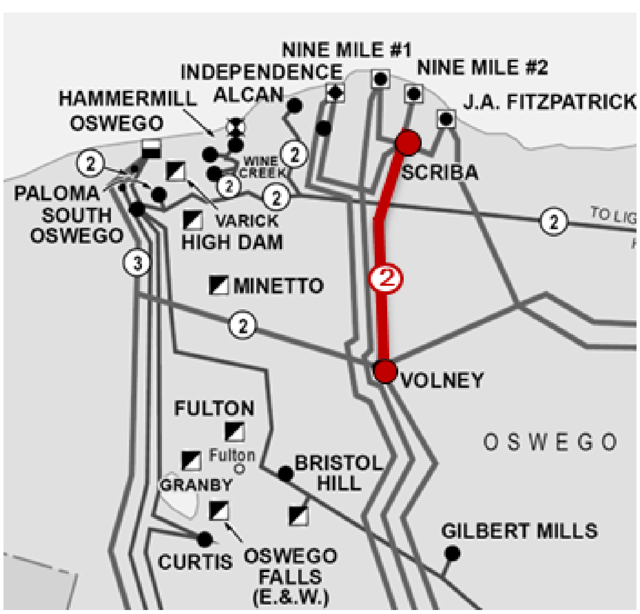


	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Freed Energy (GWh)	1291	1205	920	941	868	811	843	860	846	871	871	899	935	928	942	929	959	951	971	981

Volney-Scriba 345 kV

The Volney-Scriba constraint consists of two parallel lines from Scriba 345 kV to Volney 345 kV substation. These two lines have unequal ratings so the flow on one of the lines is larger than the other. The limiting contingency for this constraint is the loss of the line with higher rating while monitoring the one with lower rating.

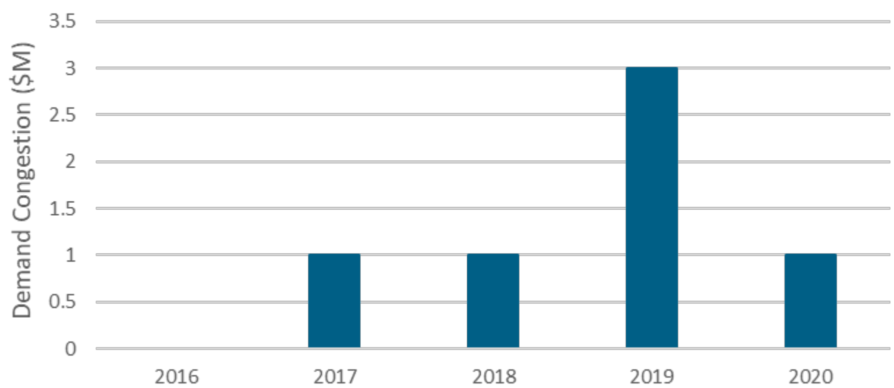
Figure 141: Volney-Scriba 345 kV Line Location and Parameters



Type	Single Circuit 345kV
Normal Op. Rating	1200/1474 MVA
Contingency Op. Rating	1396/1626 MVA
Length	~9 Miles
Owner	National Grid

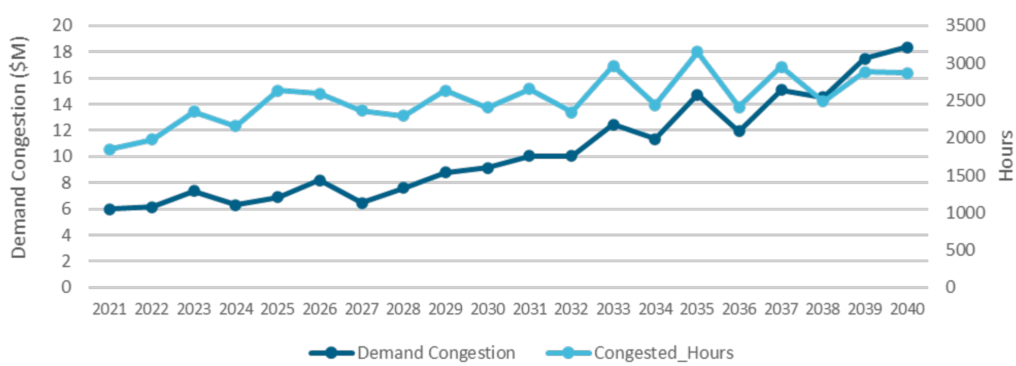
Historical congestion on this path for the past five years is shown

below. **Figure 142: Volney-Scriba Demand Congestion (nominal $M)**



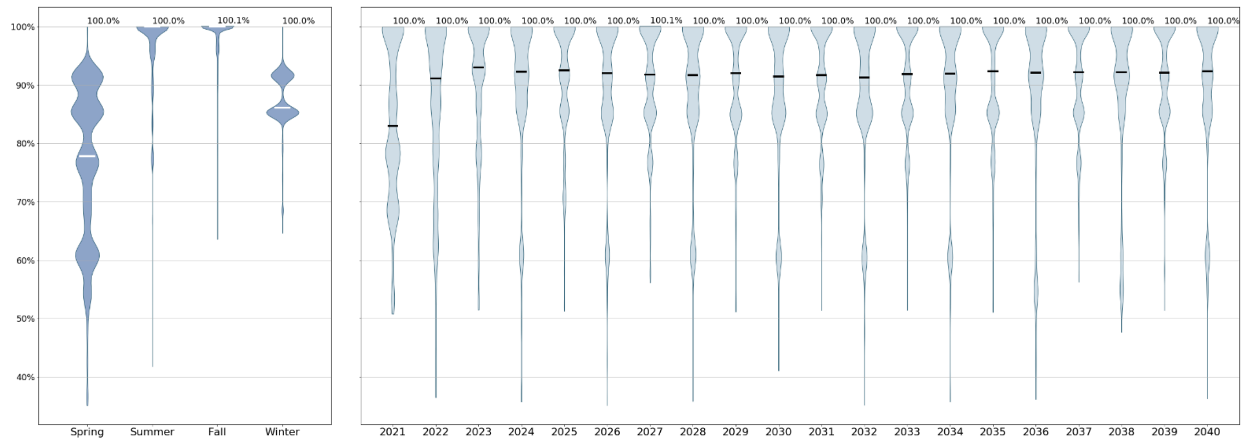
This path is located directly downstream of major generators in the New York System in and around the Oswego complex. Projected congestion on this path is directly related to generators operating upstream of the constraint and the contingency securing the flow on the line with lower limits.

Figure 143: Volney-Scriba Baseline Projected Demand Congestion and Congested Hours



The violin plots below show line utilization for this path broken down by seasons and by year for the entire study period. The seasonal plot shows that the line is mostly congested during the summer period. The summer seasonal rating is lower than the winter rating for these lines. Increased output from Sithe Independence during the peak summer period causes increase in flow along this path. The average line utilization for both lines is above 90% for most years in the study period.

Figure 144: Volney-Scriba Baseline Case Hourly Line Utilization



The relaxed case when compared to the Baseline case flows show that the flows on the lines increase when the limits on the lines are removed. The flow duration curve below shows that the flows increase in the relaxed case for 40% of the year compared to the Baseline Case flows. The heatmap chart shows that the flow increase is mostly during the high peak load periods in the summer season. The relaxed case has higher flows overall in all years in the study period. The flow increases mostly in the summer peak periods. Since the line was binding during the summer period in the Baseline Case, relaxing the limit on the line causes higher flows during this period.

Figure 145: Volney-Scriba Delta Flow Duration Curve (Relax-Baseline)

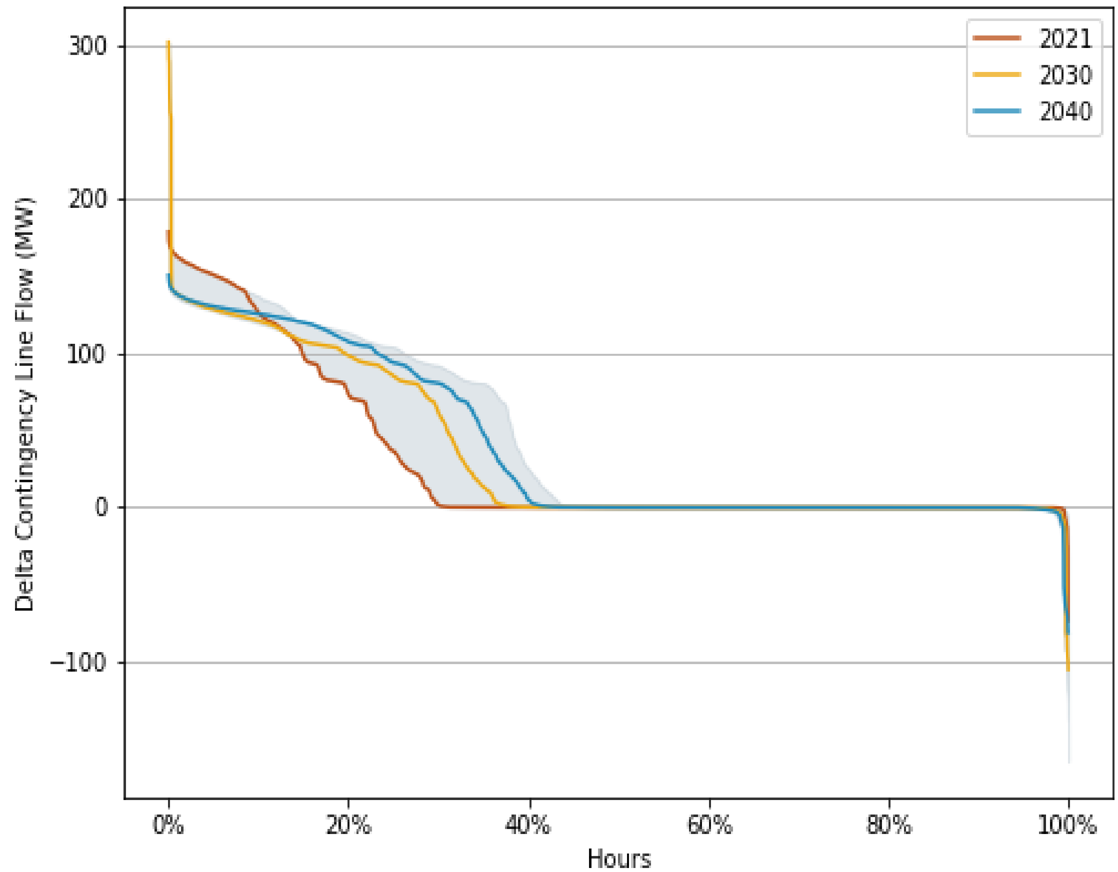
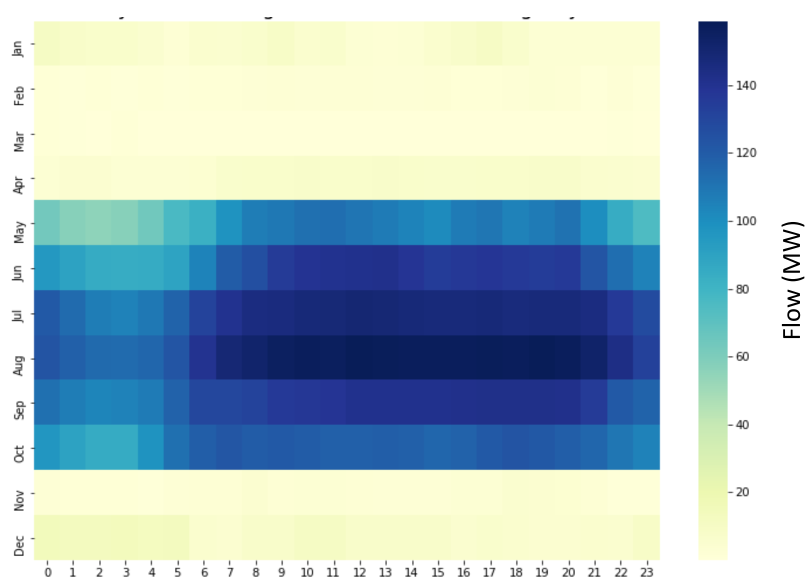
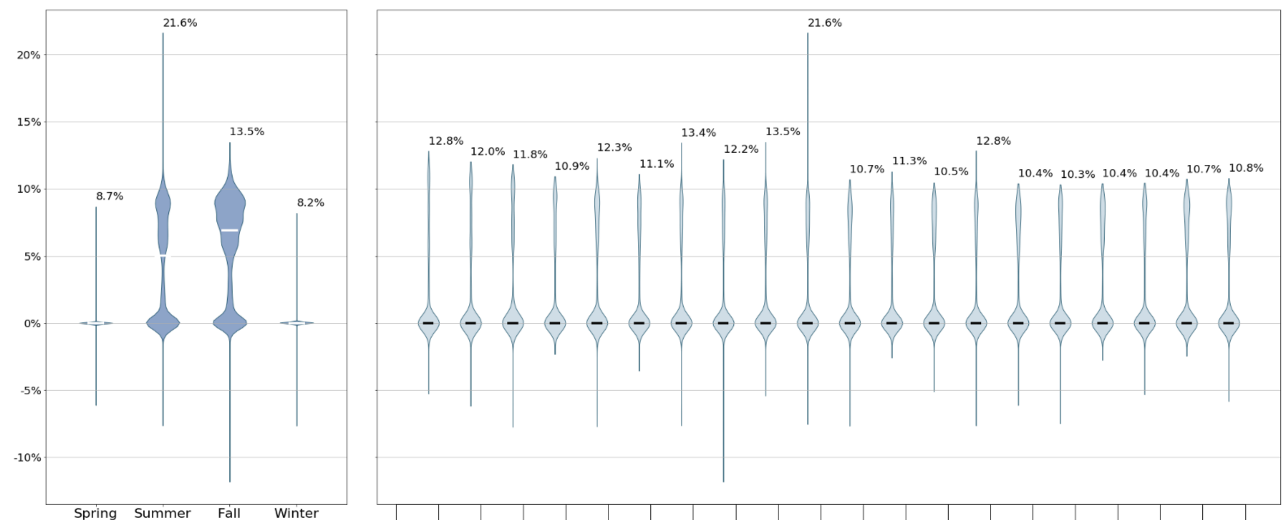


Figure 146: Volney-Scriba Average Delta Flow



The impacts of removing line limits can also be seen in the violin plots below for delta line utilization in the relaxed case compared to the Baseline Case. The seasonal plot shows that the line utilization increases in the summer and fall months with average increases of about 5-7%. Line utilization does not change significantly in the winter period as the Baseline Case had lower utilization and lower congestion during this period as well. The freed energy by relaxing the constraint amounts to a range between approximately 250 to 370 GWh.

Figure 147: Volney-Scriba Delta Hourly Line Utilization (Relax-Baseline)

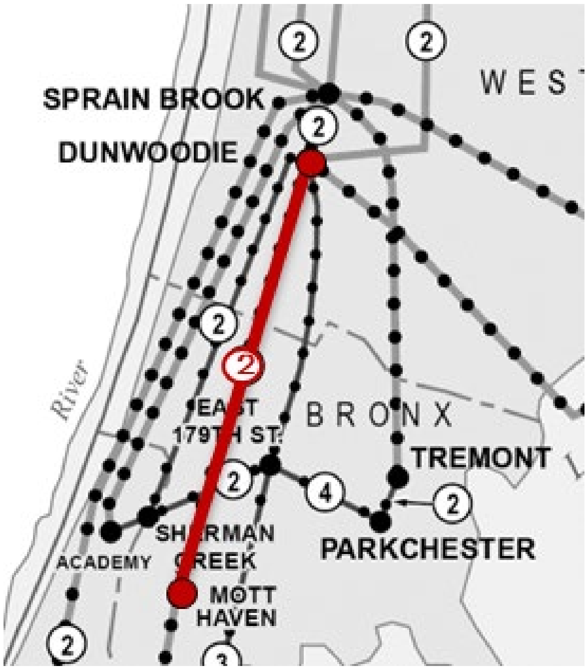


	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Freed Energy (GWh)	252	287	312	301	350	304	273	263	285	300	323	278	326	277	359	293	350	300	373	339

Dunwoodie – Motthaven 345 kV

The Dunwoodie-Motthaven 345 kV path consists of two parallel 345 kV lines 71 and 72. This is one of the main paths through which power flows from the lower Hudson Valley to New York City. The line location and parameters are presented below in Figure 148.

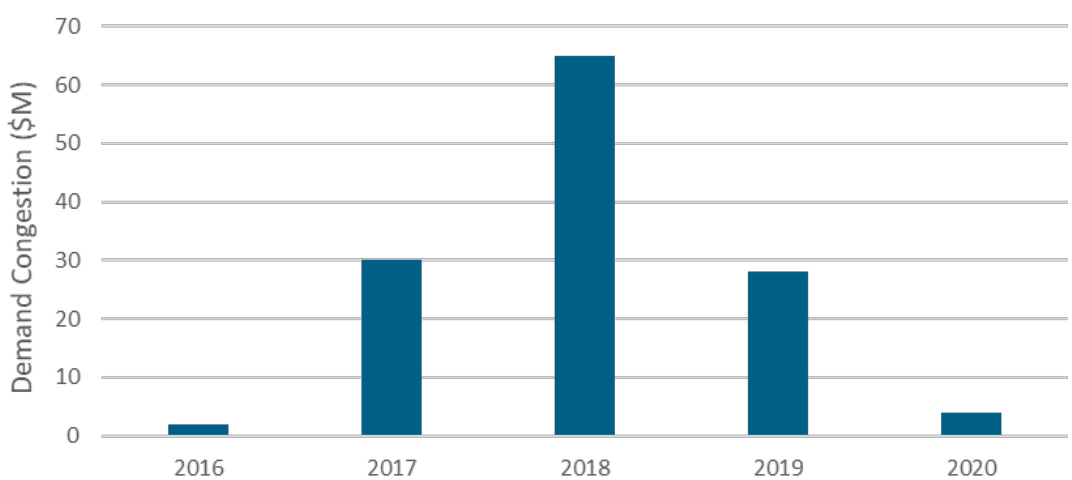
Figure 148: Dunwoodie-Motthaven 345 kV Line Location and Parameters



Type	Double Circuit 345kV
Normal Op. Rating	707/741 MVA
Contingency Op. Rating	1066/1083 MVA
Length	~12 Miles
Owner	Con Edison

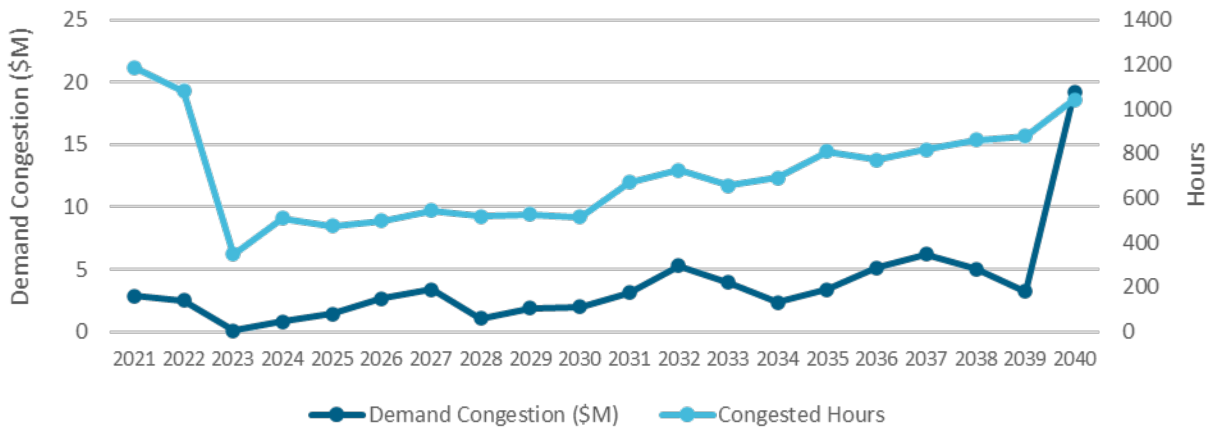
Figure 149 provides a look at historical congestion shows an increase after 2017. After the ConEd/PSEG wheeling agreement expired in 2017, the flow on this path into New York City increases, contributing to increased congestion. Outages in parallel circuits also contribute to congestion along this path.

Figure 149: Dunwoodie-Motthaven Demand Congestion (nominal $M)



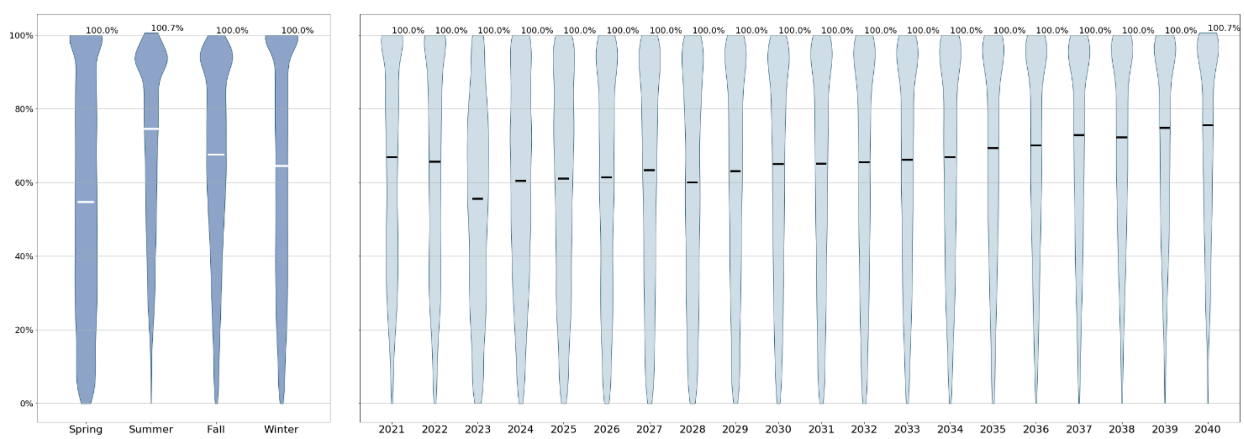
The projected demand congestion on this path along with the congested hours is presented in Figure 150 below. Congestion on this path increases over the years in the Baseline case as New York City load increases over the study period.

Figure 150: Dunwoodie-Motthaven Baseline Projected Demand Congestion and Congested Hours



The line utilization levels for the Dunwoodie to Motthaven lines are very spread out across the years. There is slightly higher utilization in the summer and fall periods that is driven by lower ratings in the summer as seen in the seasonal plots below. The average utilization also increases across the study period following load growth downstate as depicted by the dark colored lines within the body of the violin charts.

Figure 151: Dunwoodie-Motthaven Baseline Case Hourly Line Utilization



The relaxed case delta duration curve shows slight increase in flows when line limits are removed. For about 20% of the year, the flow increases on this path in the relaxed case compared to the Baseline Case. The heatmap for delta flows shows increased flow in the early morning and evening hours in the winter and slight increase in flow during the summer peak period.

Figure 152: Dunwoodie-Motthaven Delta Flow Duration Curve (Relax-Base)

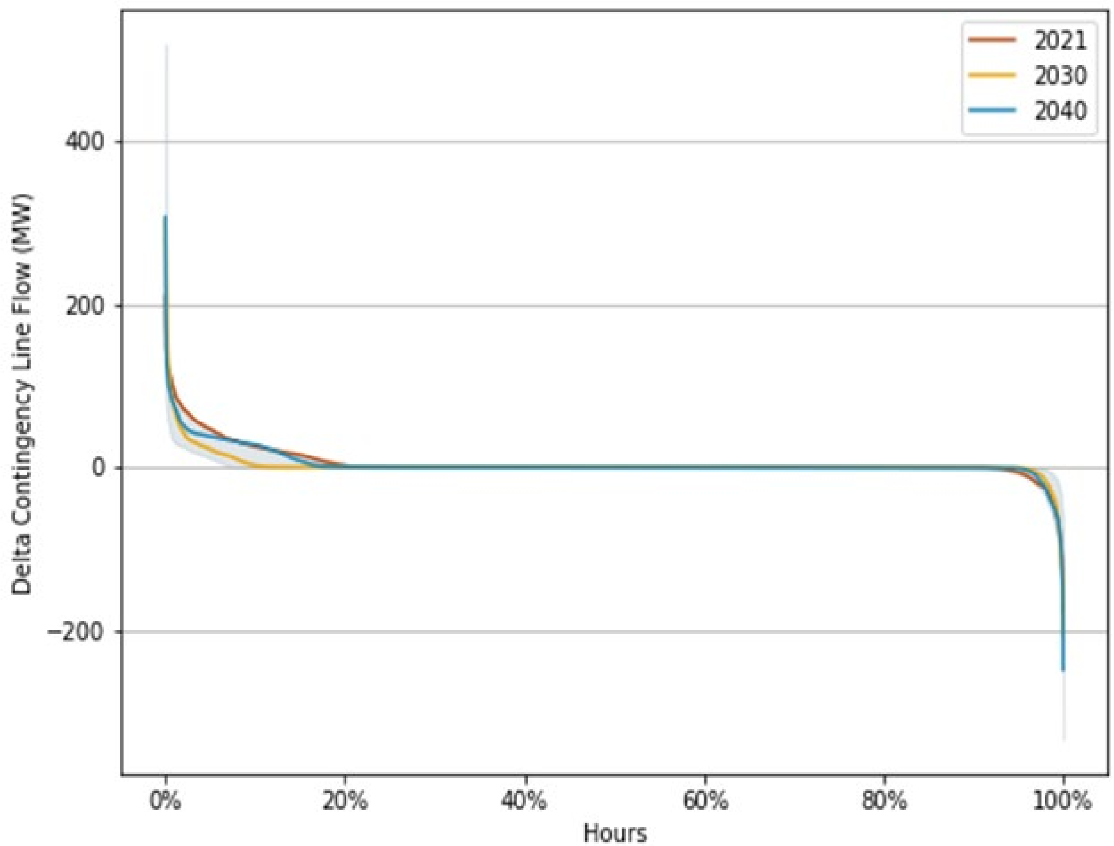
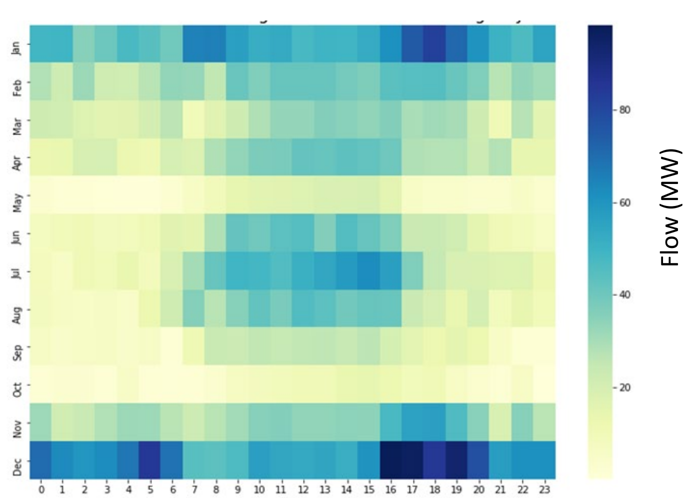
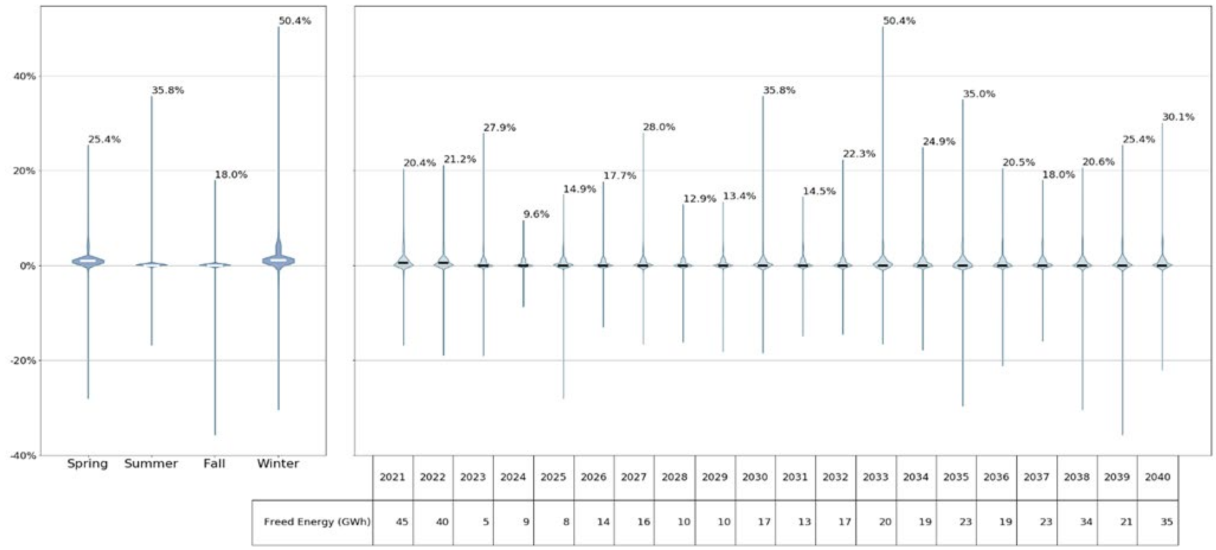


Figure 153: Dunwoodie-Motthaven Average Delta Flow



The delta line utilization violin plots show similar increase in utilization during the winter periods. Overall, the freed energy by relaxing the limits on the constraint is in the range of 5-45 GWh in the study period. There are not substantial increases in flows on this path when line limits are relaxed since only a limited number of hours were binding in the Baseline Case. Constraints further downstream of this path also limit the flow on the lines.

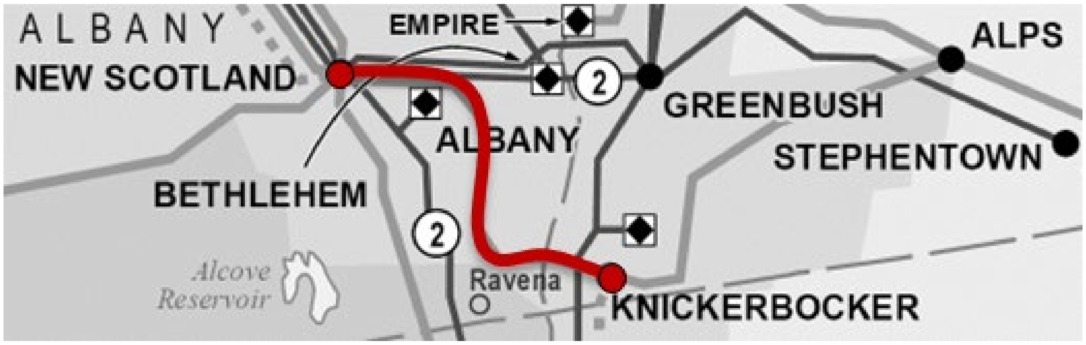
Figure 154: Dunwoodie-Motthaven Delta Hourly Line Utilization (Relax-



New Scotland – Knickerbocker 345 kV

The New Scotland to Knickerbocker 345 kV line is part of the AC Transmission project which is scheduled to be in service by 2024. Segment B of AC transmission project adds a new substation at Knickerbocker which taps the line from New-Scotland 345 kV to Alps 345 kV substation. Congestion on this new line is not reported since this segment is modeled to go into service in 2024.

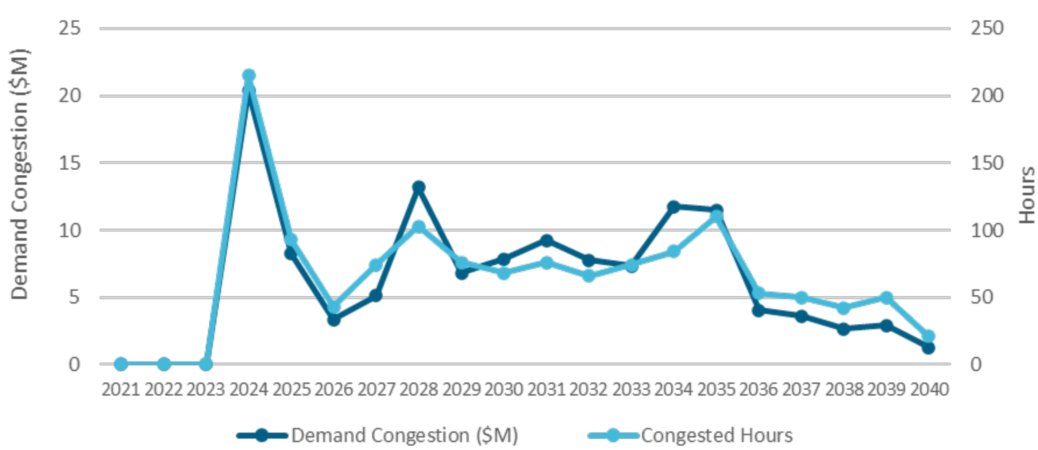
Figure 155: New Scotland-Knickerbocker Line Location and Parameters



Type	Single Circuit 345kV
Normal Op. Rating	1423/1852 MVA
Contingency Op. Rating	
Length	~12 mile
Owner	National Grid

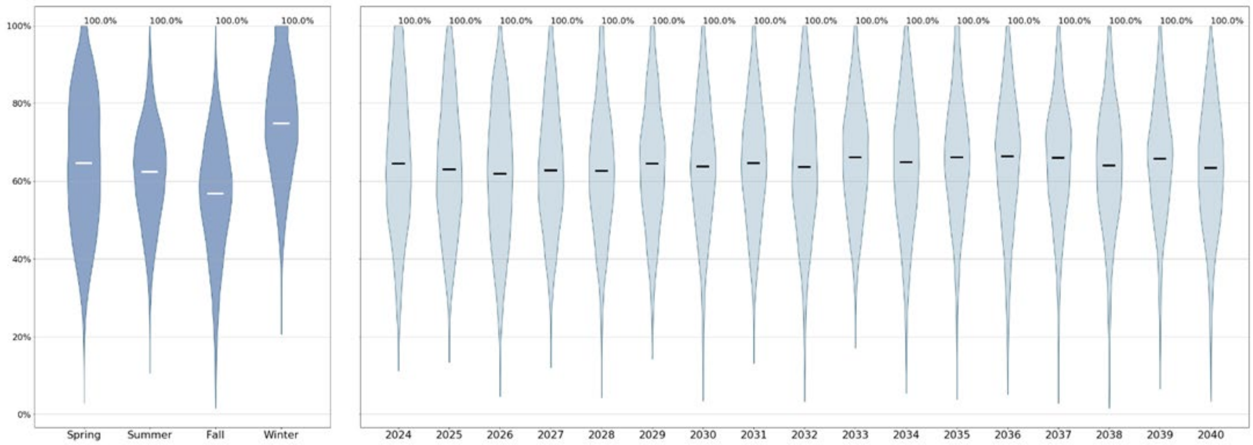
Congestion on this path is primarily due to increased flow on Central East due to increased transmission capacity as a result of AC transmission being modeled. The projected congestion and limited hours in the Baseline Case for this path is shown below.

Figure 156: New Scotland - Knickerbocker Demand Congestion and Congested Hours



The line utilization for New Scotland to Knickerbocker is slightly higher in the winter months as a result of Marcy South Series Compensation being bypassed which diverts more flow on Central East and through New Scotland – Knickerbocker as shown in the seasonal plots in Figure 157 below. Across the study period, average line utilization remains around 60-65%.

Figure 157: New Scotland-Knickerbocker Projected Baseline Hourly Line Utilization



Relaxing the constraints on this line results in higher flows especially during the evening hours in the winter period, as can be seen from the delta flow heat map plot below. The relaxed case does not show a significant increase in flows compared to the Baseline Case flows. Only about 10% of hours are seen to have higher flows along this path.

Figure 158: New Scotland-Knickerbocker Delta Flow Duration Curves (Relax-Baseline)

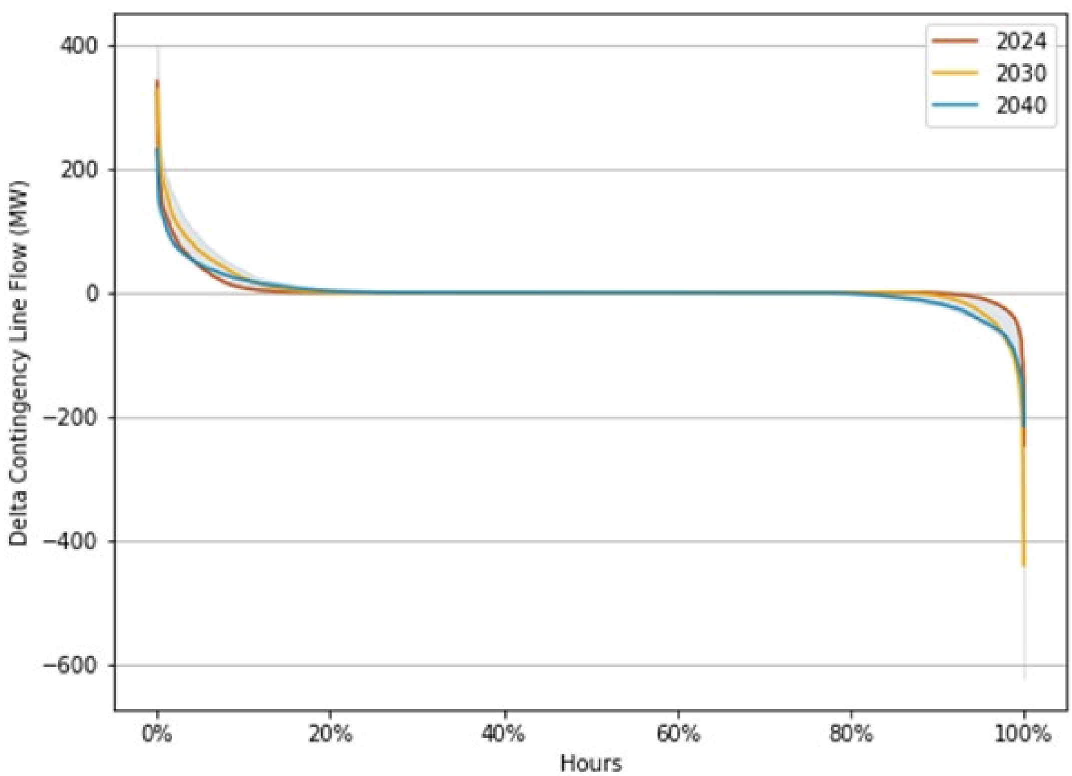
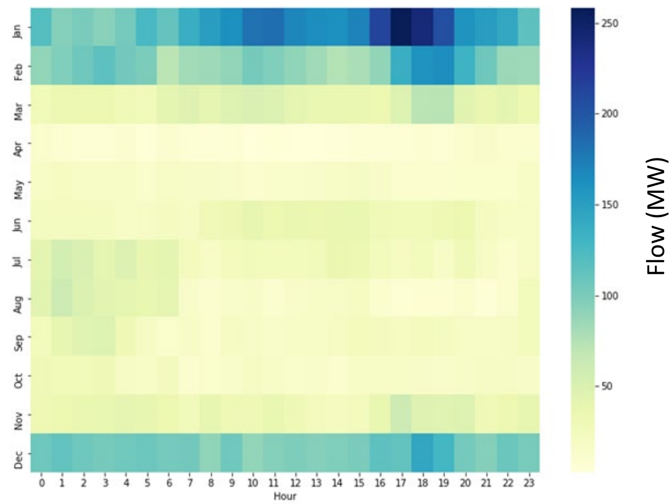
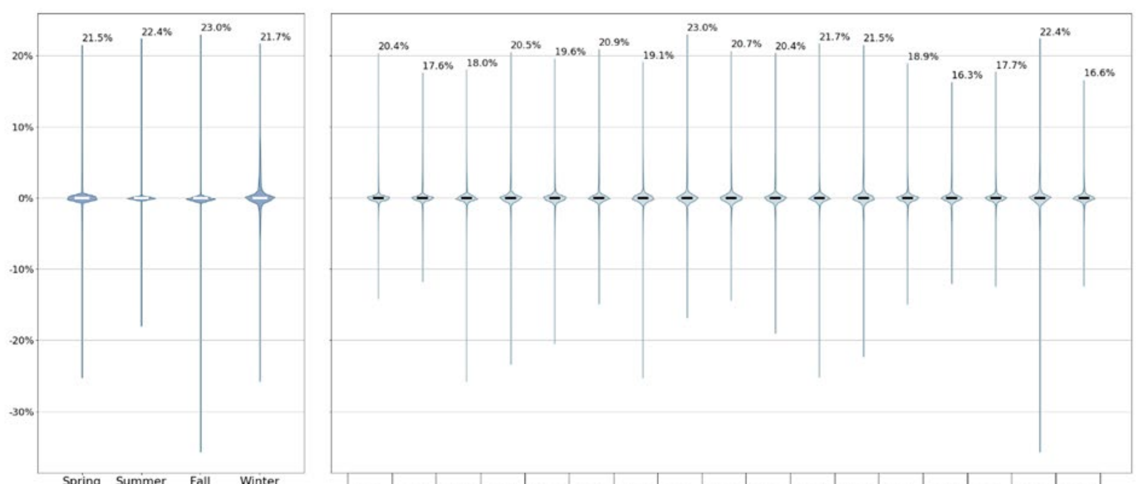


Figure 159: New Scotland-Knickerbocker Average Delta Flow



The delta violin plots for New Scotland-Knickerbocker shows higher spikes in the winter periods. Overall, the total increase in flow by relaxing this constraint ranges from 4-61 GWh from 2024-2040. Relaxing this constraint also increases flows and congestion on Central East and constraints further downstream of Knickerbocker.

Figure 160: New Scotland-Knickerbocker Delta Hourly Line Utilization

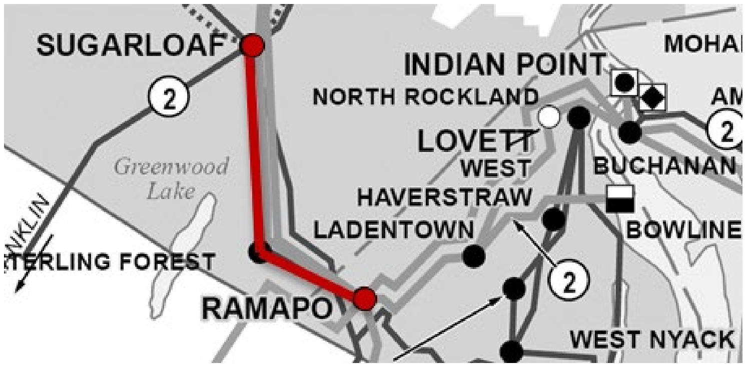


	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Freed Energy (GWh)	35	29	19	29	19	32	34	57	61	37	30	40	26	23	20	8	4

Sugarloaf-Ramapo 138 kV

Sugarloaf to Ramapo 138 kV line is located along the Marcy South path which carries flows from Zone E to the lower Hudson Valley. The line location and parameters are as shown in Figure 161.

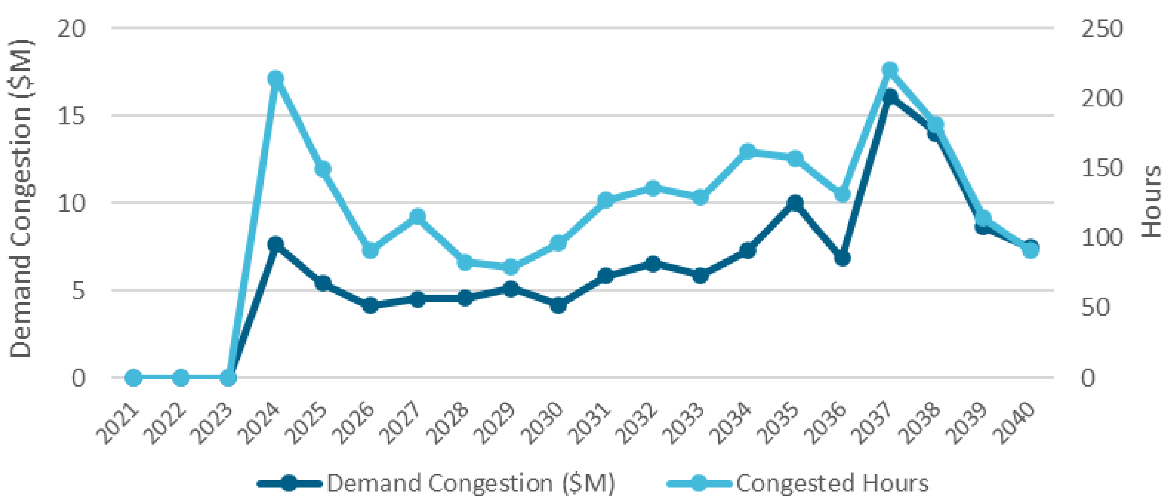
Figure 161: Sugarloaf-Ramapo Line Location and Parameters



Type	Single Circuit 138kV
Normal Op. Rating	236/282 MW
Contingency Op. Rating	270/309 MW
Length	~ 17 miles
Owner	O&R

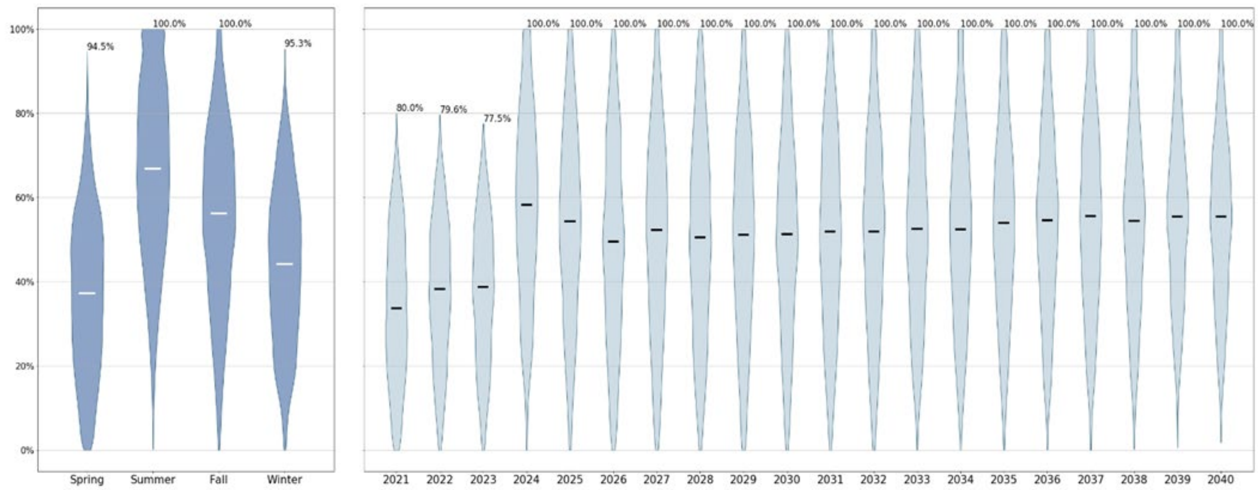
With upgrades associated with Segment B of AC Transmission, increased flow is observed on the 138 kV line from Sugarloaf to Ramapo. The projected congestion in the future years, starting in 2024 when AC transmission is modeled in service, is shown in the chart. Limiting contingencies include loss of higher kV circuits while securing this path.

Figure 162: Sugarloaf-Ramapo Baseline Case Projected Demand Congestion and Congested Hours



The line utilization and flow along this line is significantly increased after segment B is placed into service. Line utilization is higher in summer and fall due to the rating being lower compared to the winter months. Average line utilization increases from close to 40% prior the AC transmission, to over 50% starting in 2024. Overall, the limiting hours for the constraint are on the low side and occur in the summer and fall periods.

Figure 163: Sugarloaf-Ramapo Baseline Case Hourly Line Utilization



Since the line was only limiting for a low percentage of total hours, relaxing the limits on the line does not increase the flows to a great extent. The delta flow duration curve shows a slight increase in flows for less that 10% of hours in a year. The highest delta in flows occur during the peak load hours in June and July.

Figure 164 Sugarloaf-Ramapo Delta Flow Duration Curve (Relax-Baseline)

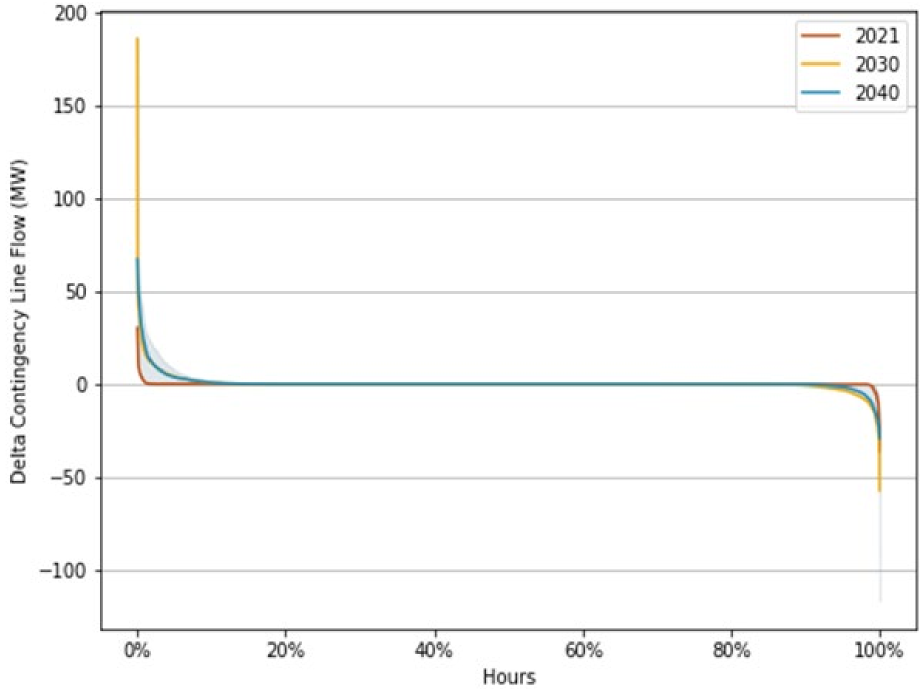
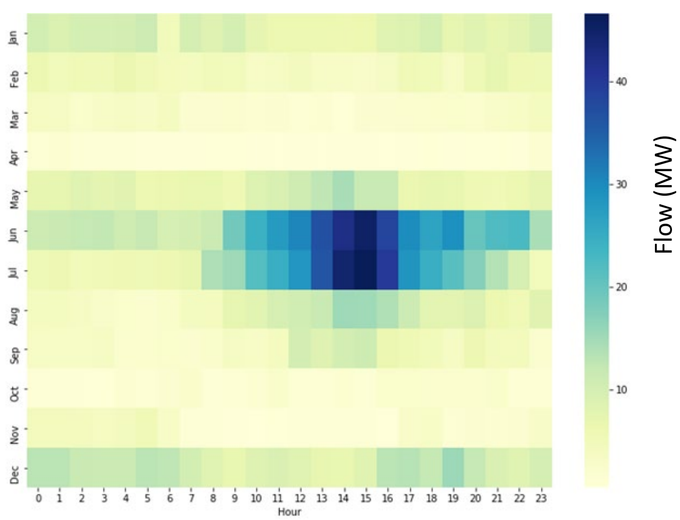
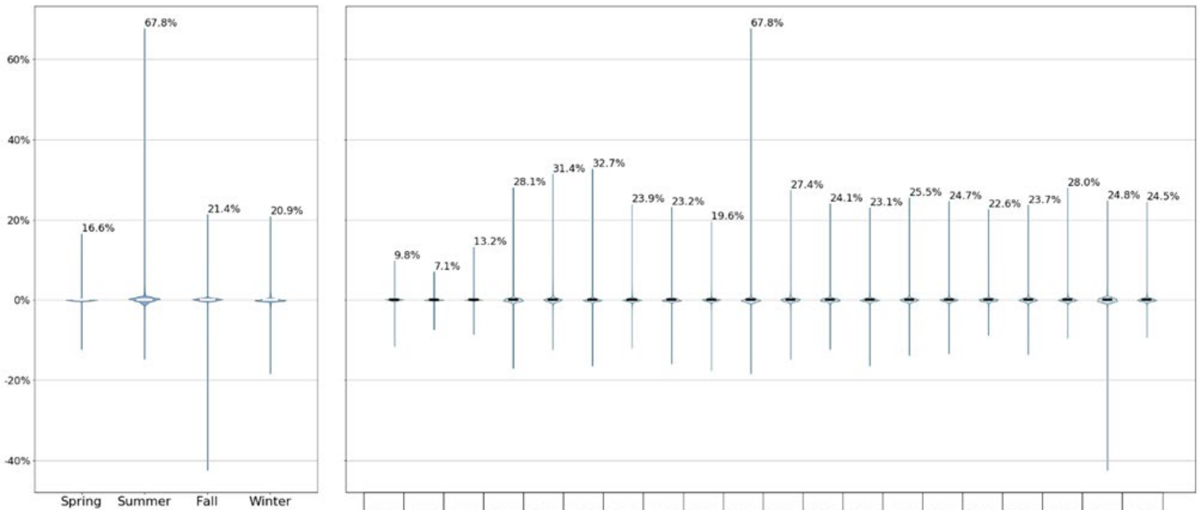


Figure 165: Sugarloaf-Ramapo Average Delta Flow



Constraints on this line are binding for less than 3% of the year in the Baseline Case. Relieving limits on this line only produces marginal increase in flows which are limited to the summer periods as shown by the spikes on the seasonal violin plots. Freed energy as a result of relieving this constraint is in the range of approximately 6-8 GWh in a year.

Figure 166: Sugarloaf-Ramapo Delta Hourly Line Utilization



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Freed Energy (GWh)	0	0	0	6	6	1	2	1	2	2	5	6	4	3	4	5	8	6	4	4

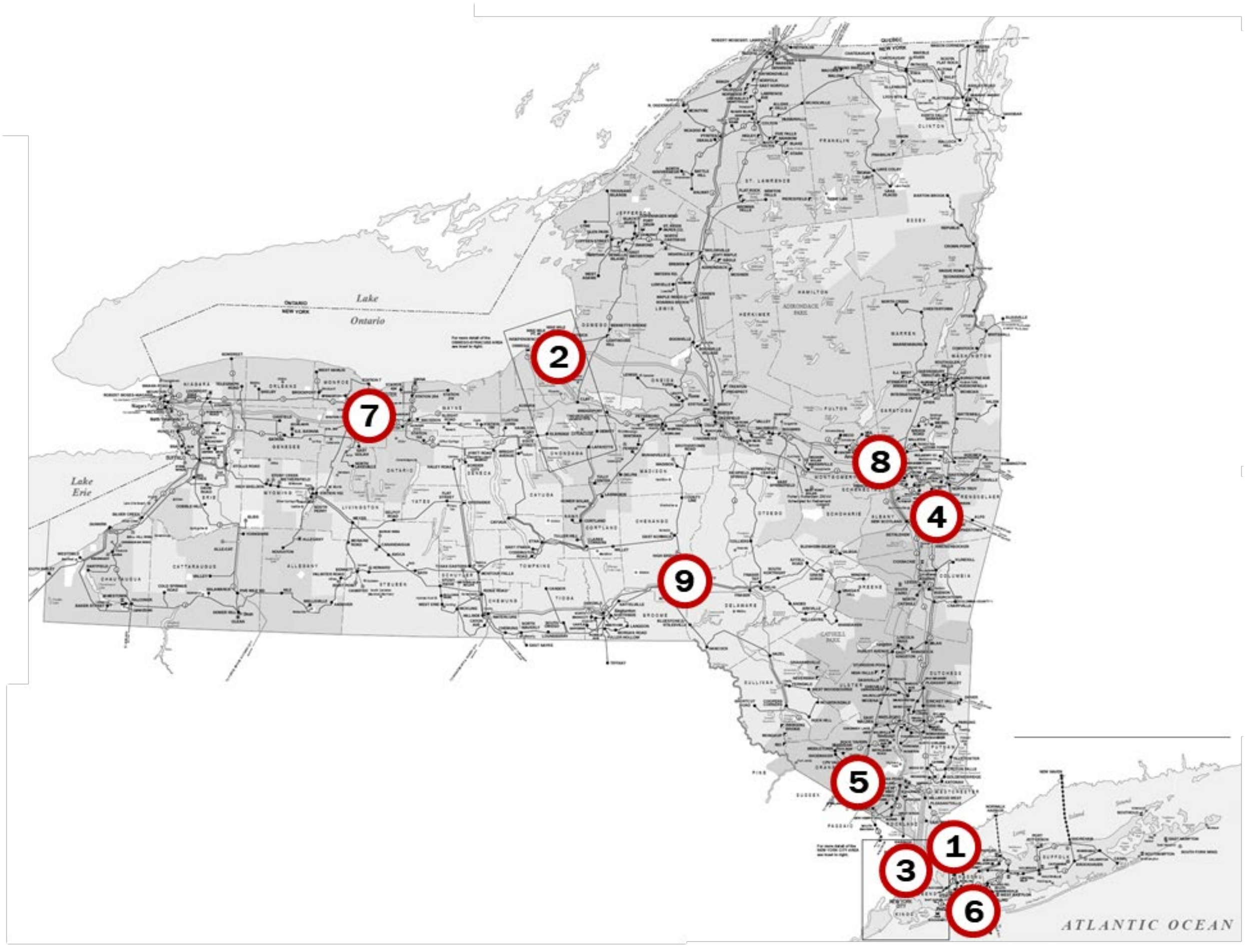
I.4. Contract Case Congestion Analysis

With additional contracted resources added to the system in the Contract Case, there is increased congestion the system both in the bulk as well as the lower kV level. The congestion analysis presented in this section analyzes some of the constrained paths in the Contract Case that are binding and may result in savings for the system if congestion on these paths is resolved. The following lines are studied in detail for the contract case.

1. Dunwoodie – Long Island 345 kV
2. Volney – Scriba 345 kV
3. Dunwoodie – Motthaven 345 kV
4. New Scotland – Knickerbocker 345 kV
5. Sugarloaf – Ramapo 138 kV
6. Barrett – Valley Stream 138 kV
7. Golah – Mortimer 115 kV
8. Stoner – Rotterdam 115 kV
9. Jennison – Sidney 115 kV

Location of each constraint is shown in the map below. Each constraint is further evaluated by relaxing the limits on the lines individually and comparing against the Contract Case flows to determine the impact of relieving congestion on the line.

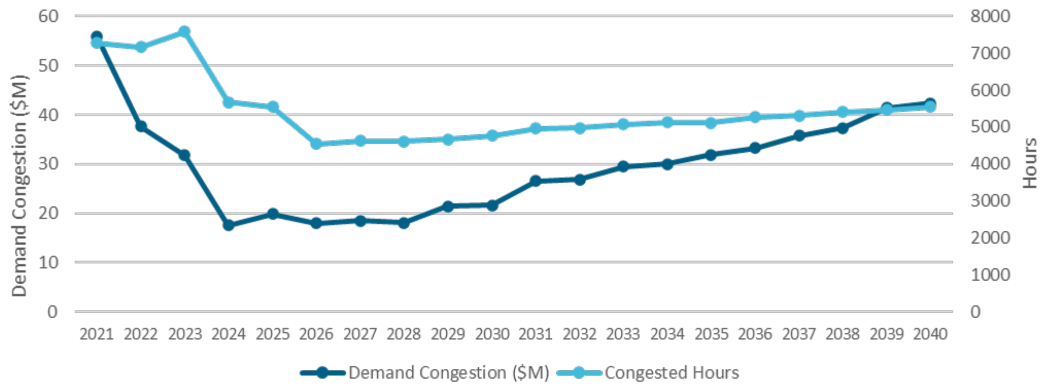
Figure 167: Locations of Contract Case constraints on New York State Map



Dunwoodie-Long Island 345 kV

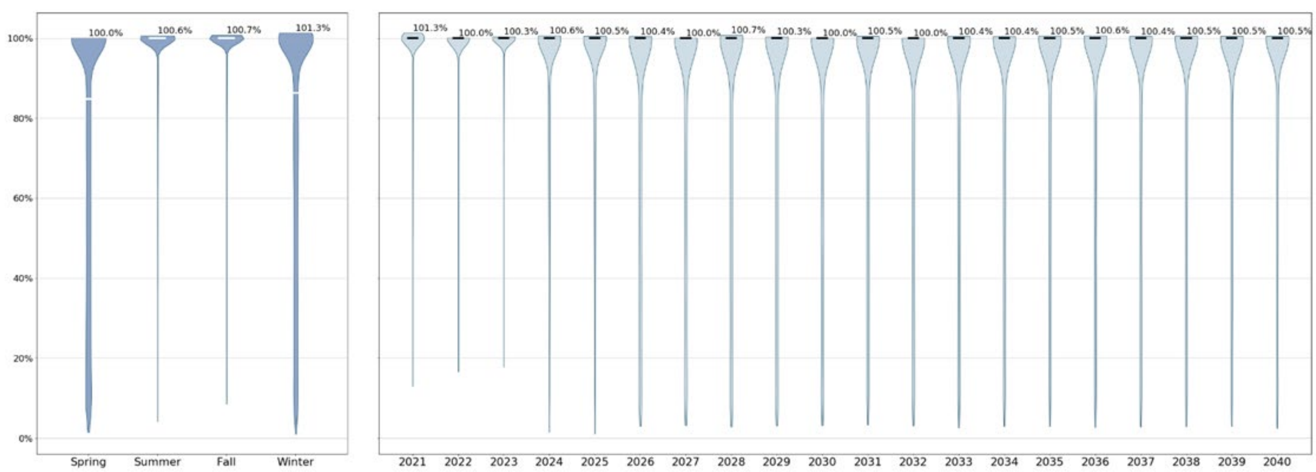
Line location, parameters and historical congestion for this line are presented in the above section for Baseline Case Congestion Analysis. The table below shows the Contract Case projected demand congestion and number of congested hours. The reason for congestion on the line is the same as the Baseline Case. Series Reactor operation during summer months on Y49 diverts more flow on Y50, increasing congestion on the line.

Figure 168: Dunwoodie-Long Island Contract Case Projected Demand Congestion and Congested Hours



The violin plots below show the flow on the lines in the Contract Case. These lines are heavily utilized throughout the year with flows reaching or nearing the limits in most hours of the year. Flows are particularly higher in the summer and fall periods.

Figure 169: Dunwoodie-Long Island Contract Case Hourly Line Utilization



Differences between the Contract Case flows and Baseline Case flows can be compared with flow duration charts shown below. The Contract Case has lower flows starting in 2024 as a result of offshore wind projects injecting power into Long Island. This pushes back on the flow on Dunwoodie-Long Island interface as it normally flows from Dunwoodie to serve load in Long Island. Flow increase compared to the Baseline Case usually occurs in the summer peak periods.

Figure 170: Dunwoodie-Long Island Flow Duration Curve

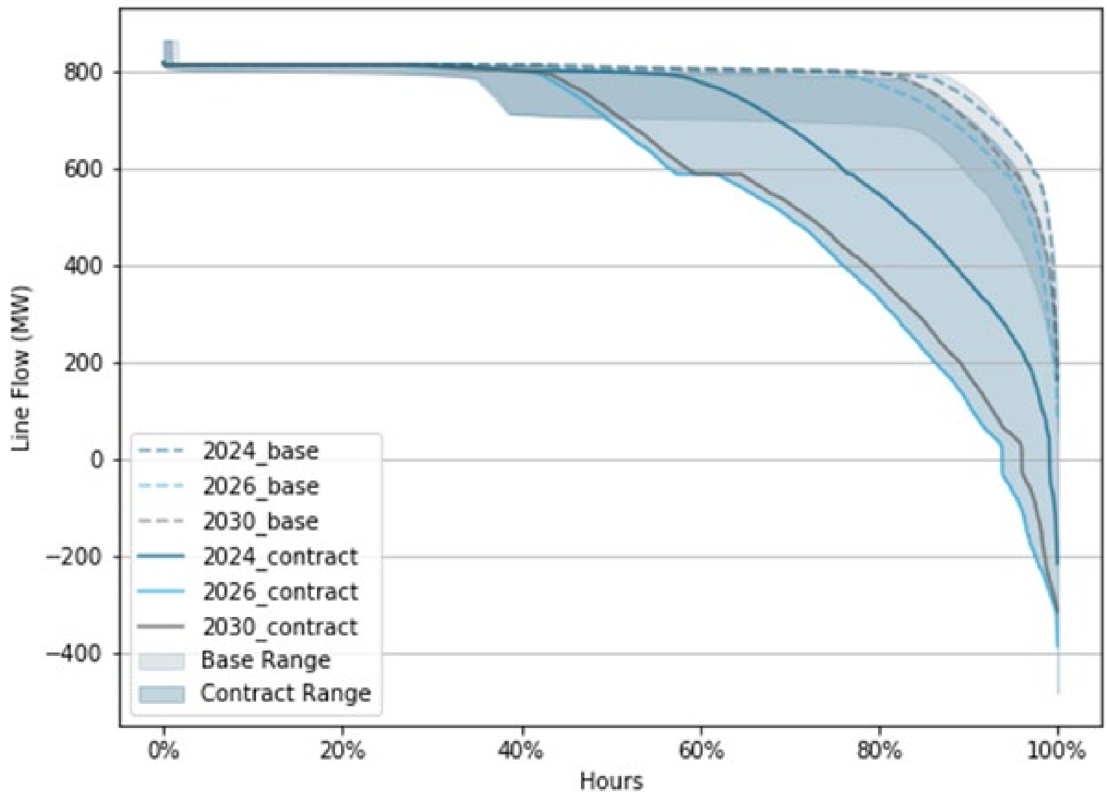
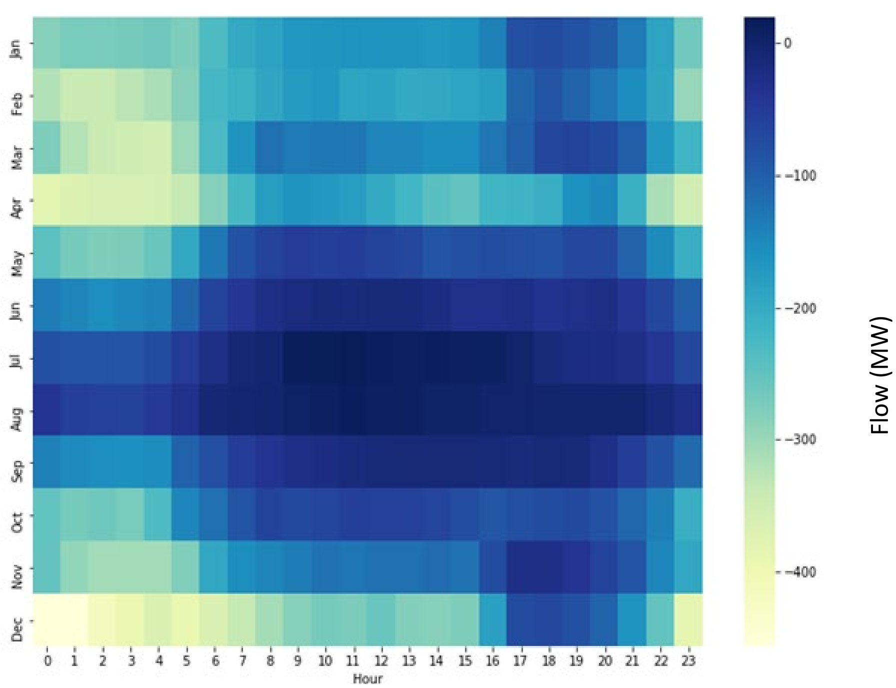


Figure 171: Dunwoodie-Long Island Average Delta Flow (Contract-Base)



A relaxation case was run for the Contract Case where the limits on Dunwoodie to Long Island interface was removed. Flows on the interface increases especially in the summer and fall season across most hours when the line was binding in the Contract Case.

Figure 172: Dunwoodie-Long Island Delta Flow Duration Curve

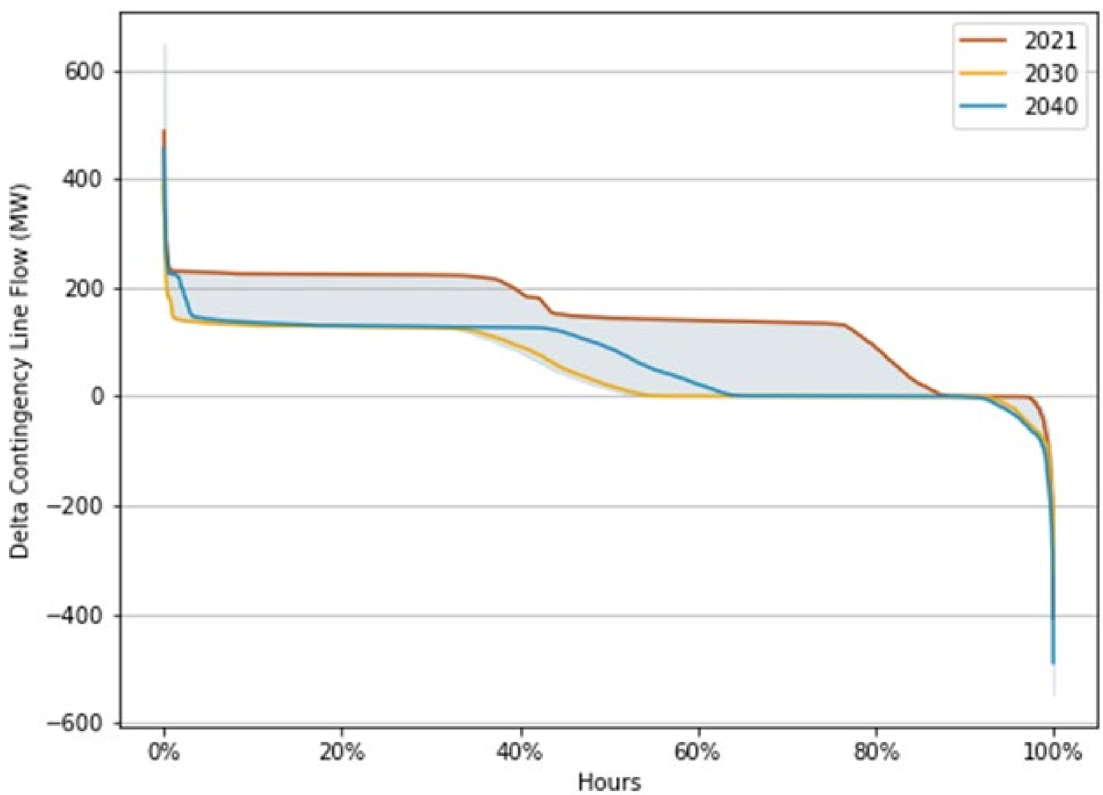
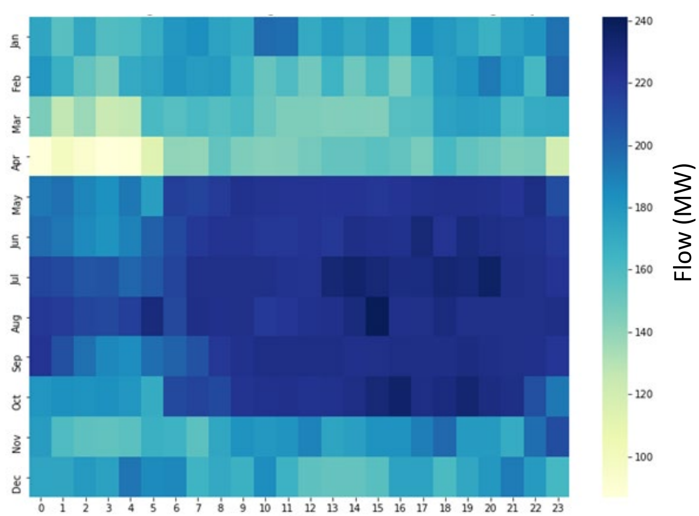
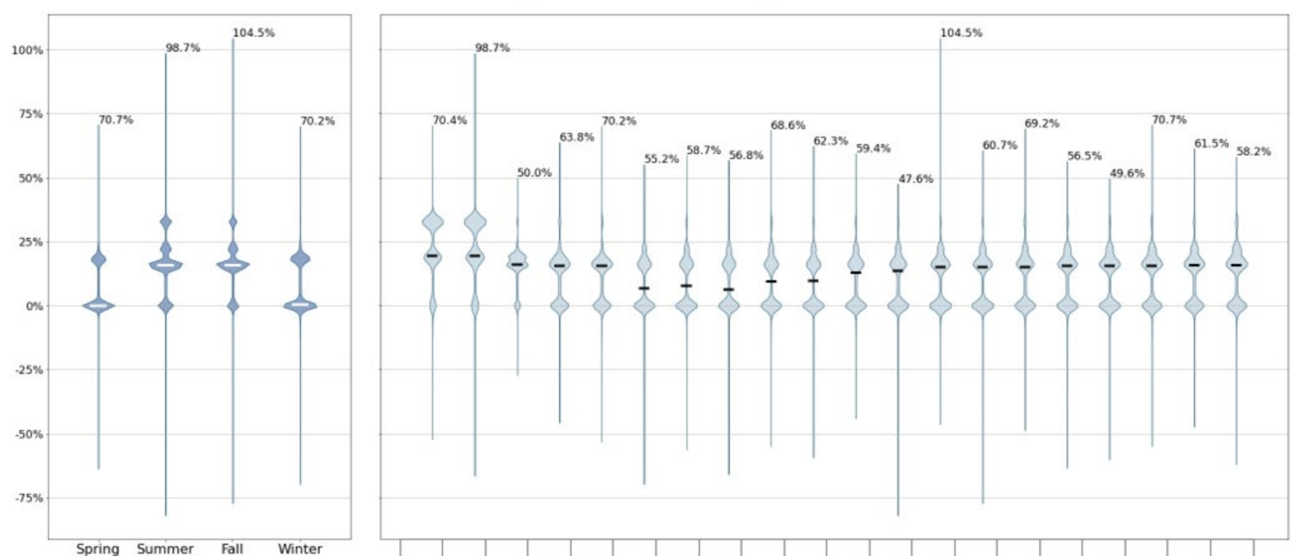


Figure 173: Dunwoodie-Long Island Average Delta Flow



Violin plots below show increase in flows for summer and fall season with higher peaks compared to winter and spring. Flow increases by about 20% overall across all years in the study period when line limits are relaxed. Even though the interface has lower overall flow compared to the Baseline Case, there is still congestion on the line in the Contract Case which is relieved when the limits are relaxed.

Figure 174: Dunwoodie-Long Island Delta Hourly Line Utilization (Relax-Contract)

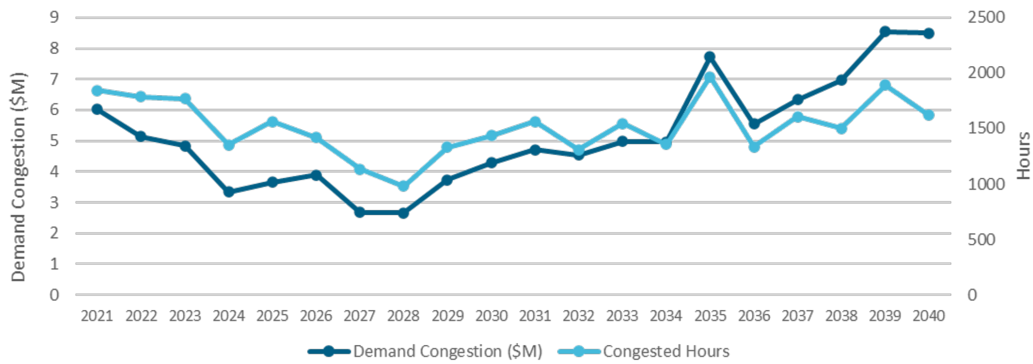


	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Freed Energy (GWh)	1294	1222	930	648	617	462	467	450	478	473	509	496	523	533	538	539	562	575	584	596

Volney-Scriba 345 kV

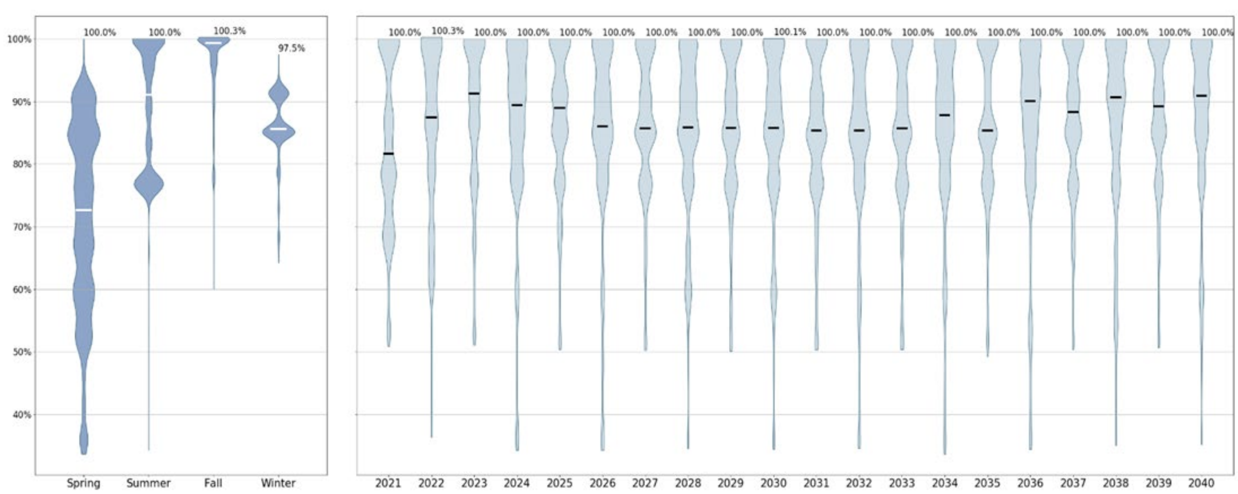
Line location, parameters and historical congestion for this line are presented in the above section for Baseline Case Congestion Analysis. The table below shows the Contract Case projected demand congestion and number of congested hours. The causes of congestion on this line are the same as the Baseline Case. The two parallel 345 kV lines have different line ratings which causes congestion when the line with lower rating is secured for the loss of the other.

Figure 175: Contract Case Projected Demand Congestion and Congested Hours



Congestion is lower overall compared to the Baseline Case as a result of additional low-cost renewable resources added to the system which causes fossil fueled generators in the Oswego complex to run less. Since this line is directly downstream of the Oswego generation, congestion and flow on this line is directly impacted by the amount of generation from these generators. The flow on the line is usually high in the summer period compared to the winter period with almost all of the congestion occurring during the summer and fall months. Line utilization of this path ranges from about 80-90% throughout the study period.

Figure 176: Volney-Scriba Contract Case Hourly Line Utilization



The flow duration curves below show that the flow on this path is lower compared to the Baseline Case flows. Flows are lower in the later years compared to the same period in the Baseline Case as more resources come online especially after 2024. The heatmap shows that flows are lower especially in the spring period and about the same during the summer peak periods when fossil fuel generator outputs are high.

Figure 177: Volney-Scriba Flow Duration

Curv

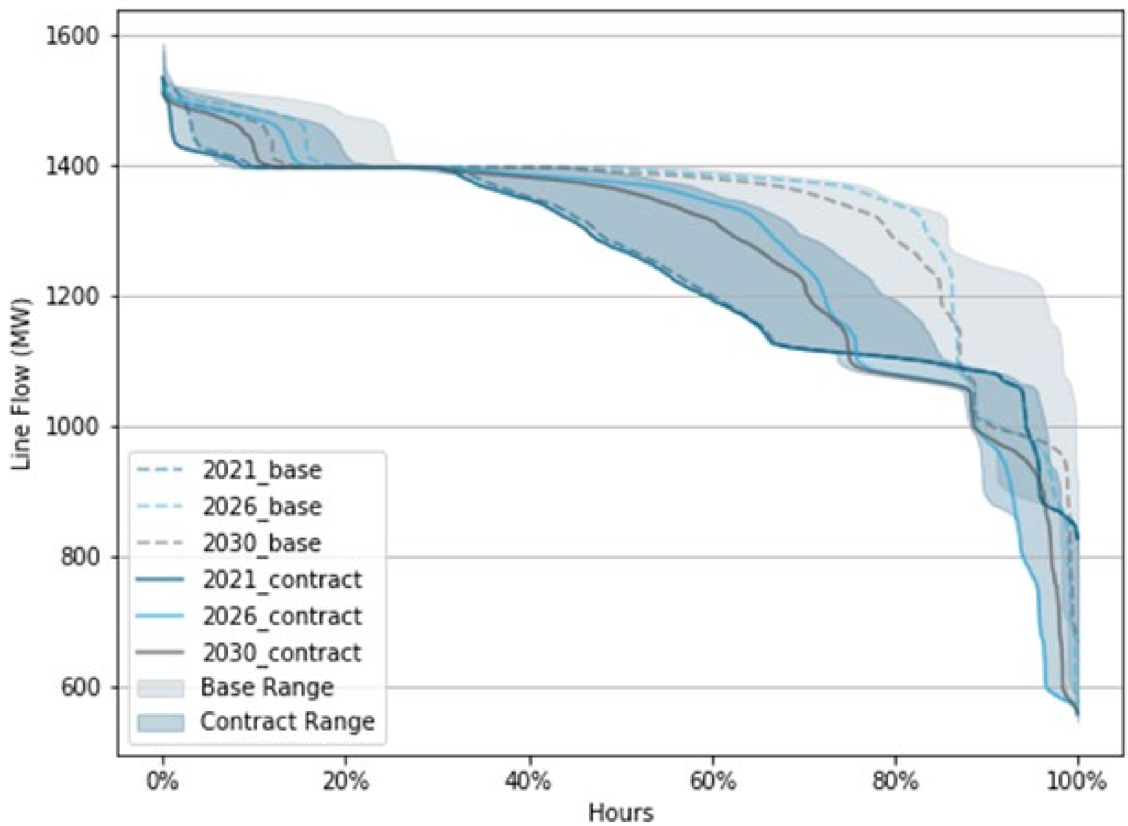
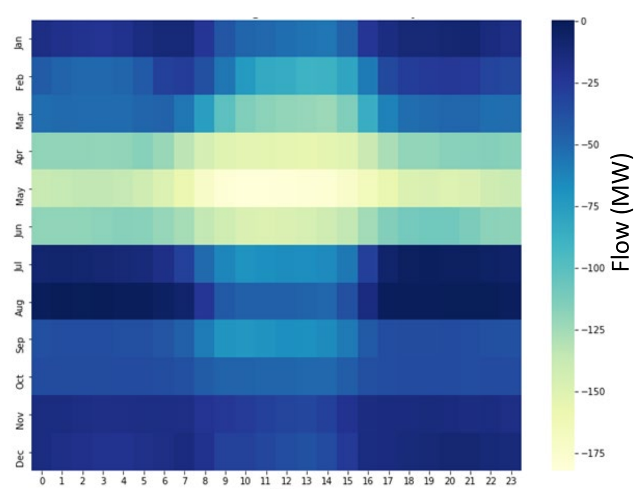


Figure 178: Volney-Scriba Average Delta Flow (Contract-Baseline)



The relaxed case flows when compared to the Contract Case flows for the path below show that the flow on the path increases for about 20-30% of the year. Flow increase in the relaxed case occurs mostly during the summer peak period in the afternoon hours when loads are highest and fossil fuel generators are operating at their peak.

Figure 179: Volney-Scriba Delta Flow Duration Curve (Relax-Contract)

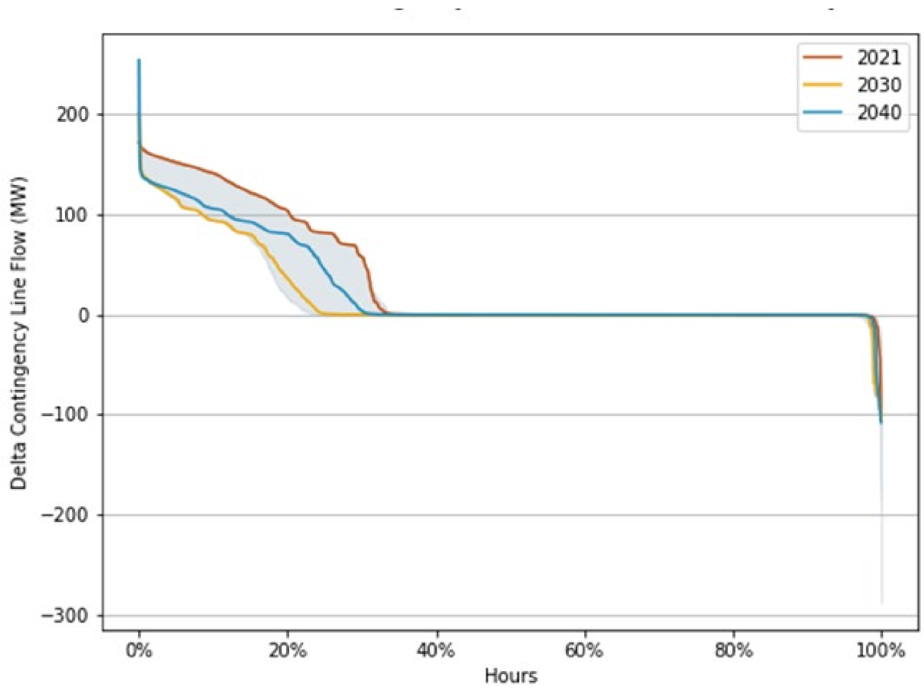
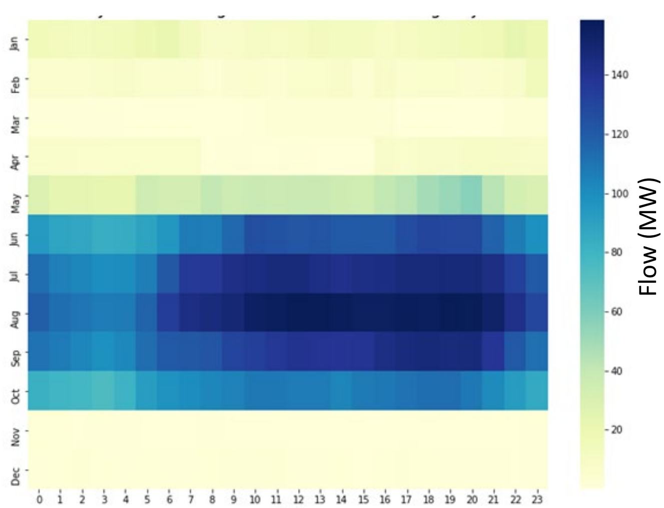
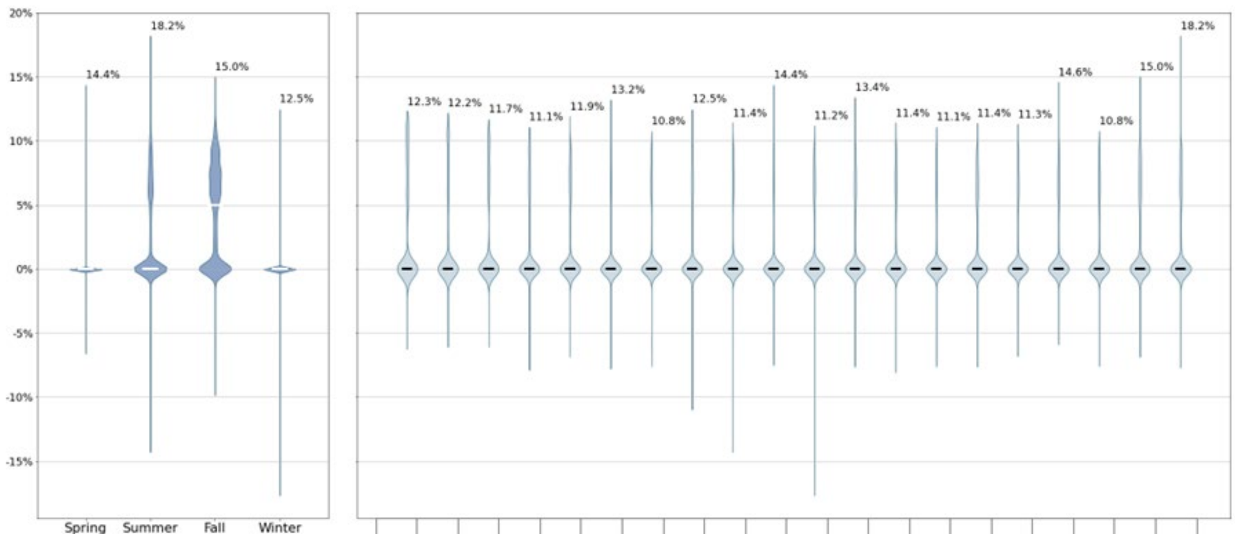


Figure 180: Volney-Scriba Average Delta Flow (Relax-Contract)



The seasonal violin plots below show increases in flows in the summer and fall season and relatively low changes during the winter and spring seasons. The freed energy as a result of relieving congestion on the line ranges from 152-316 GWh per year over the twenty-year study horizon.

Figure 181: Volney-Scriba Delta Hourly Line Utilization

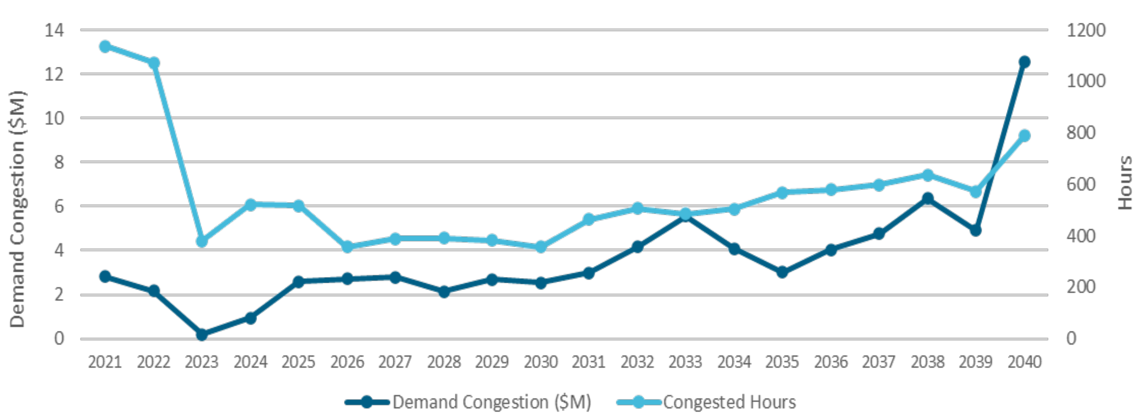


	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Freed Energy (GWh)	316	287	259	193	220	184	157	153	152	164	199	182	205	190	224	178	226	207	255	220

Dunwoodie-Motthaven 345 kV

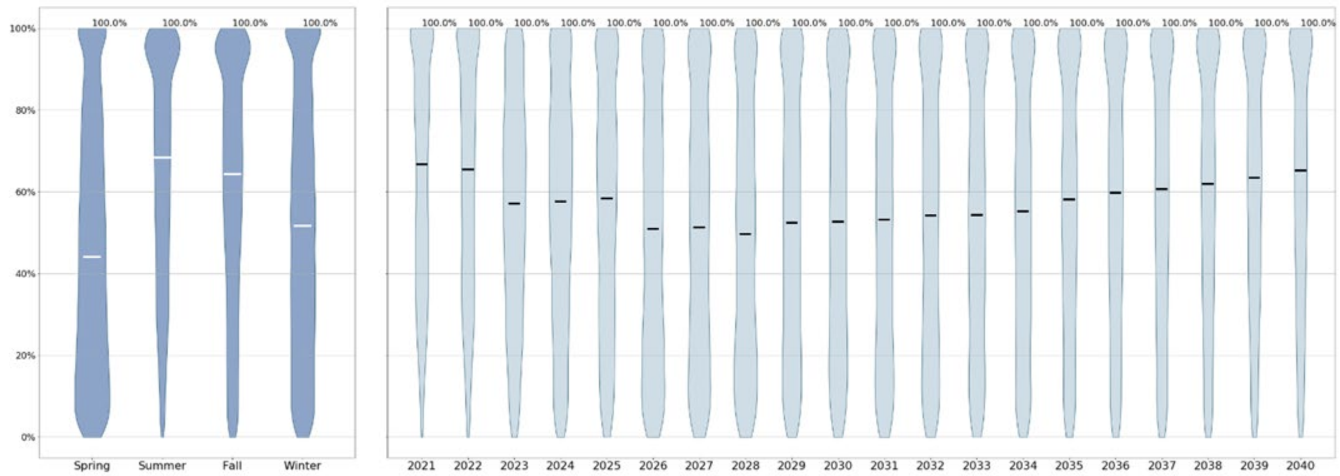
Line location, parameters and historical congestion for this line are presented in the above section for Baseline Case Congestion Analysis. The table below shows the Contract Case projected demand congestion and number of congested hours. Congestion on Dunwoodie-Motthaven is lower overall when compared to the Baseline Case. This result is caused in part by offshore wind resources that are modeled in-service in the Contract Case. The offshore wind resources supply load in New York City and Long Island, and thereby push back on the flows on this path, reducing congestion.

Figure 182: Dunwoodie-Motthaven Contract Case Projected Demand Congestion and Congested Hours



Line utilization on Dunwoodie-Motthaven in the Contract Case is similar to the Baseline Case. The line utilization is spread out throughout the year and is mostly higher during the summer and fall seasons. Line utilization varies from about 50% to 70% in the study period from 2021-2040.

Figure 183: Dunwoodie-Motthaven Contract Case Hourly Line Utilization



Comparing flows on this path in the Contract Case with that in the Baseline Case shows that the flows are lower for about 50% of the year. The flow duration curve below shows the Contract Case flow range (shown in darker blue) to be lower than the Baseline Case flows (shown in lighter blue). The heatmap shows that the flows do increase in a few hours in the summer period especially during the afternoon peak load hours. Overall, there are limited hours with flows increasing in comparison to the Baseline Case.

Figure 184: Dunwoodie-Motthaven Flow Duration Curve

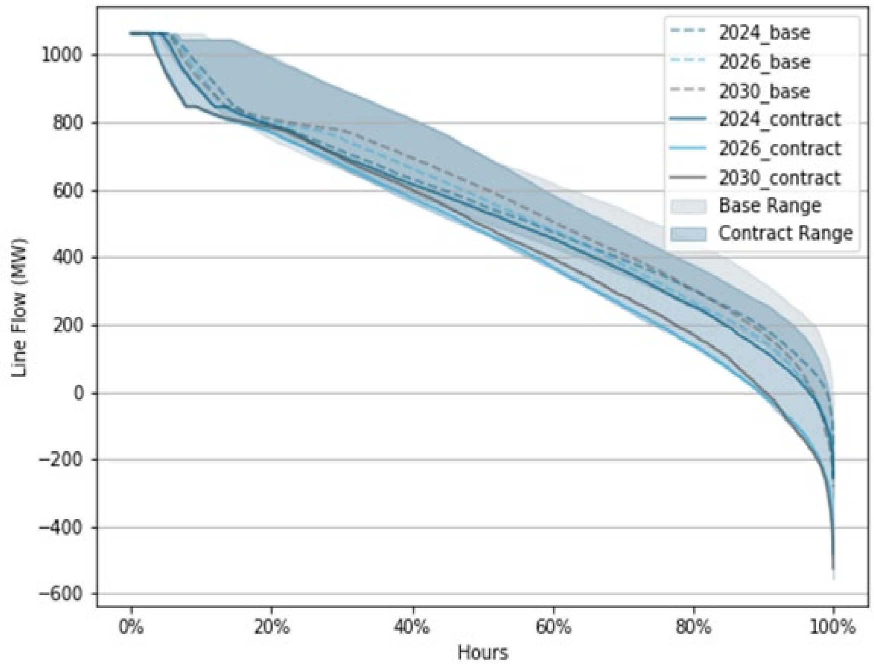
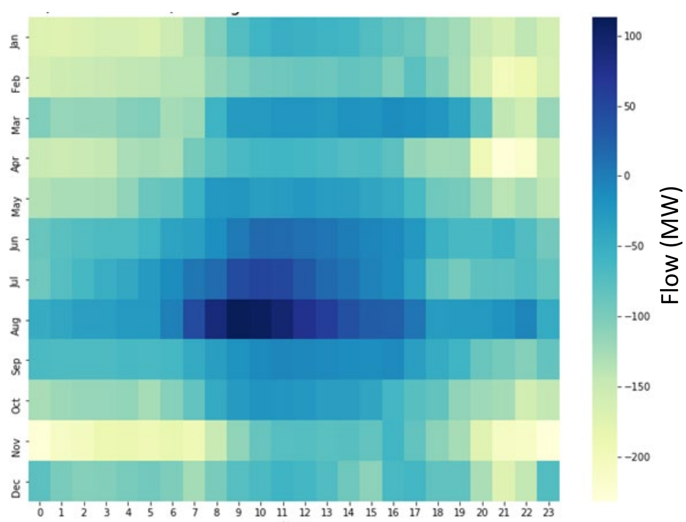


Figure 185: Dunwoodie-Motthaven Average Delta Flow (Contract-Baseline)



The relaxed case flows compared to the Contract Case shows that the flow does not have a significant increase when limits are removed from the lines in the relaxed case. Line flows increase for about 20% of the year in the relaxed case compared to the Contract Case. The heatmap shows that a large increase occurs in the peak load hours in the summer, and morning and evening hours in the winter season.

Figure 186: Dunwoodie-Motthaven Delta Flow Duration Curve (Relax-Contract)

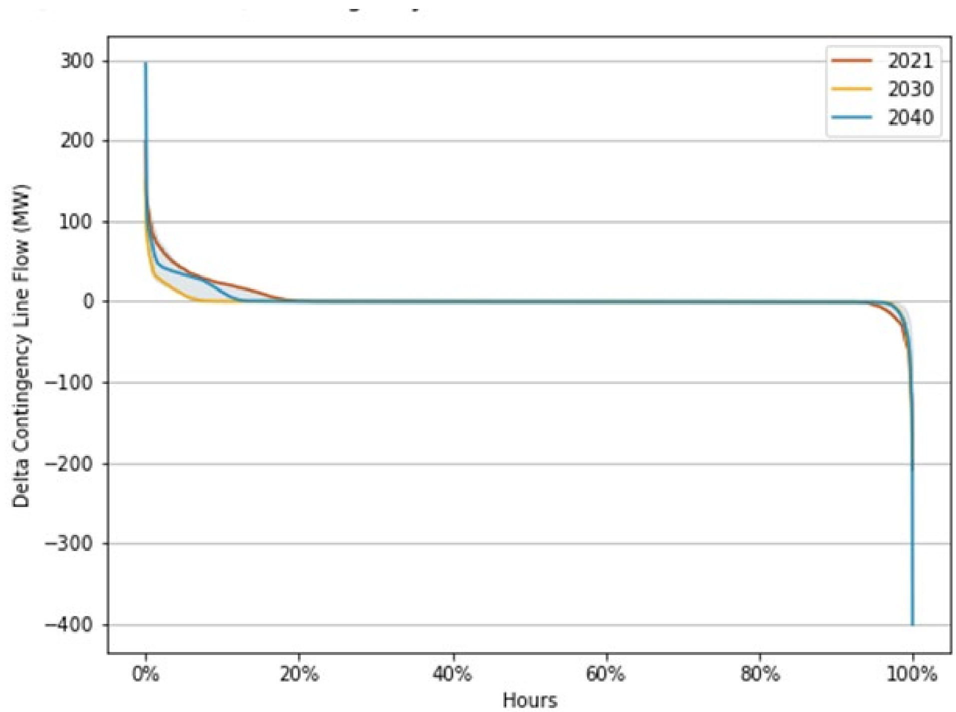
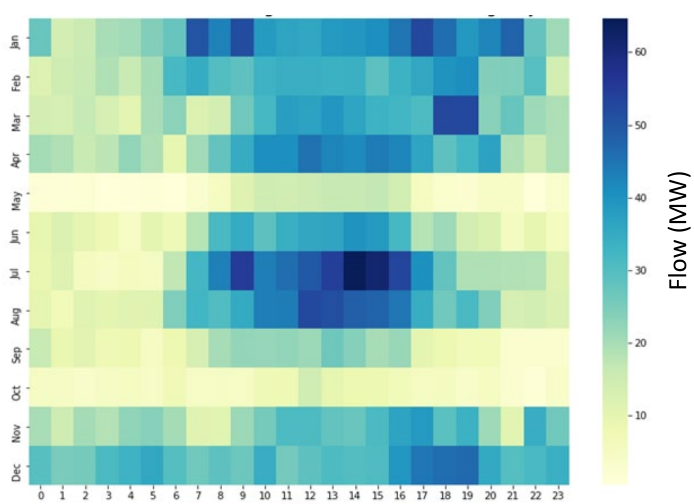
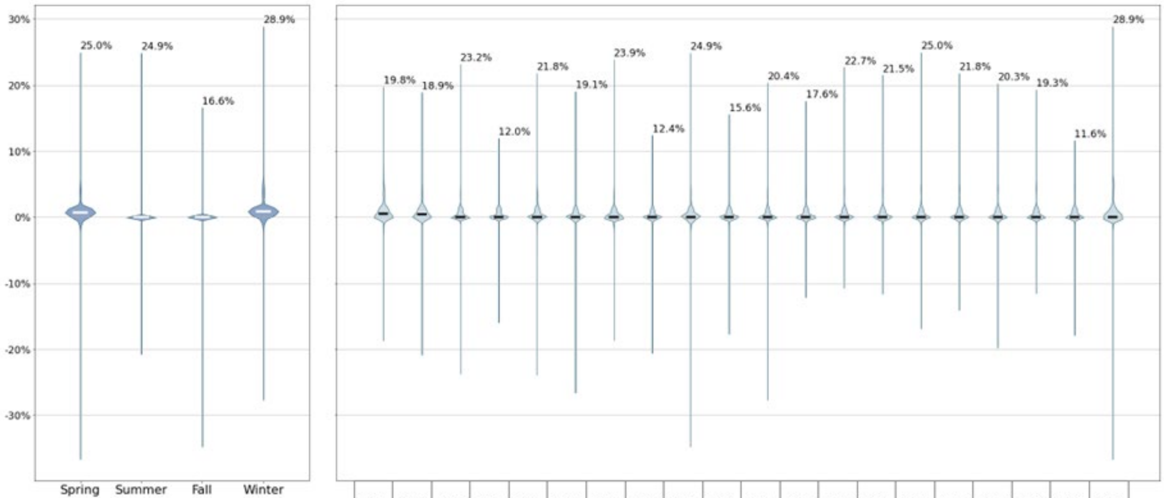


Figure 187: Dunwoodie-Motthaven Average Delta Flow (Relax-Contract)



The limited increase in line flows along this path can also be seen on the violin plots below. Slight increases during the winter and spring season flows can be observed by the bulges and higher spikes in the violin plots. Constraints downstream of this path limit the level of flows through this path in the relaxed case.

Figure 188: Dunwoodie-Motthaven Delta Hourly Line Utilization

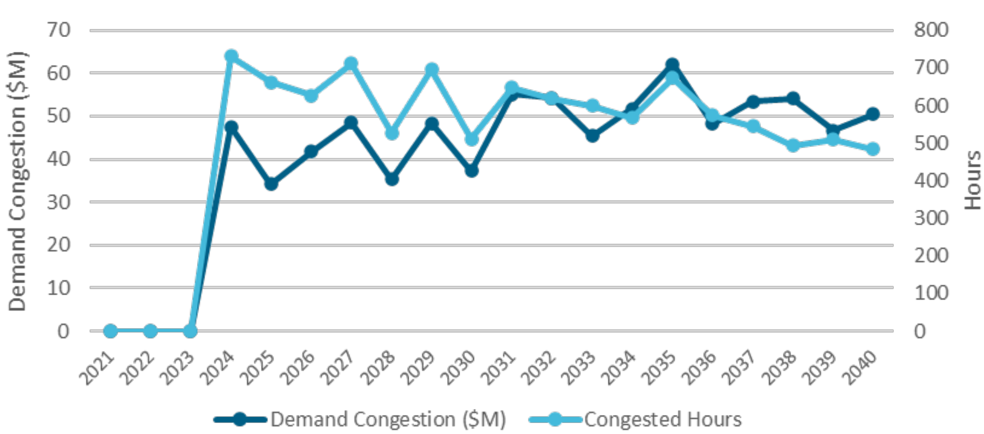


	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Freed Energy (GWh)	37	40	8	11	10	7	9	8	6	4	12	13	14	13	16	17	17	20	15	26

New Scotland-Knickerbocker 345 kV

Line location and parameters for this line are presented in the above section for Baseline Case Congestion Analysis. The table below shows the Contract Case projected demand congestion and number of congested hours. Congestion on this path increases significantly with increased flow in the Contract Case compared to the Baseline Case as a result of additional resources being modeled in upstate zones.

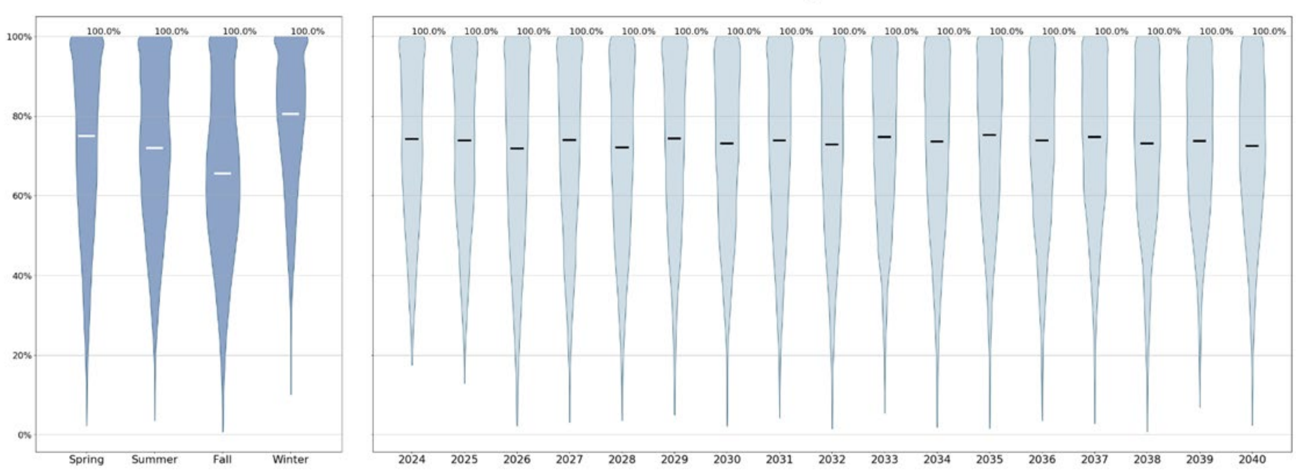
Figure 189: New Scotland-Knickerbocker Contract Case Projected Demand Congestion and Congested Hours



Increased flow in the Contract Case can also be seen in the line utilization compared to the Baseline Case. Summer line utilization increases in the Contract Case compared to the Baseline

Case. Average line utilization is about 70% across all years in the study period.

Figure 190: New Scotland-Knickerbocker Contract Case Hourly Line Utilization



The flow duration curve below shows the clear difference in flows in the Contract Case relative to the Baseline Case. Flows increase for more than 70% of the year in the Contract Case. The heatmap shows that the flow increase occurs mostly in the early morning to afternoon hours most likely due to new UPV resources generating more upstream of the constraint.

Figure 191: New Scotland-Knickerbocker Flow Duration Curve

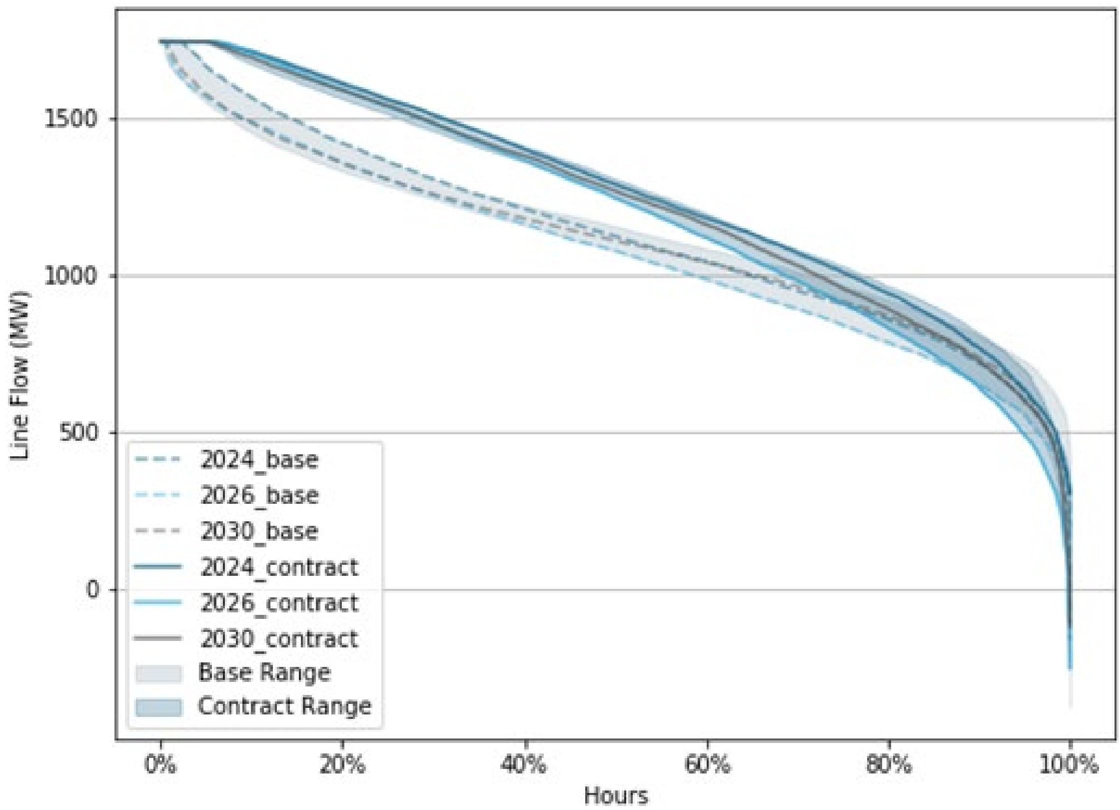
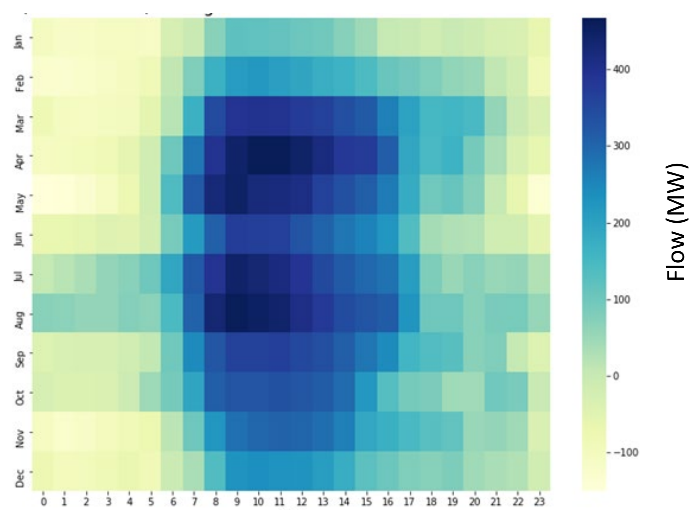


Figure 192: New Scotland-Knickerbocker Average Delta Flow



The relaxed case flows which removes limits on the line is compared to the Contract Case flows in the duration curve chart below. It shows flows increasing for about 20% of the year across the study period. The heatmap shows increase in flow occurring mostly in the winter period in January.

Figure 193: New Scotland-Knickerbocker Delta Flow Duration Curve (Relax-Contract)

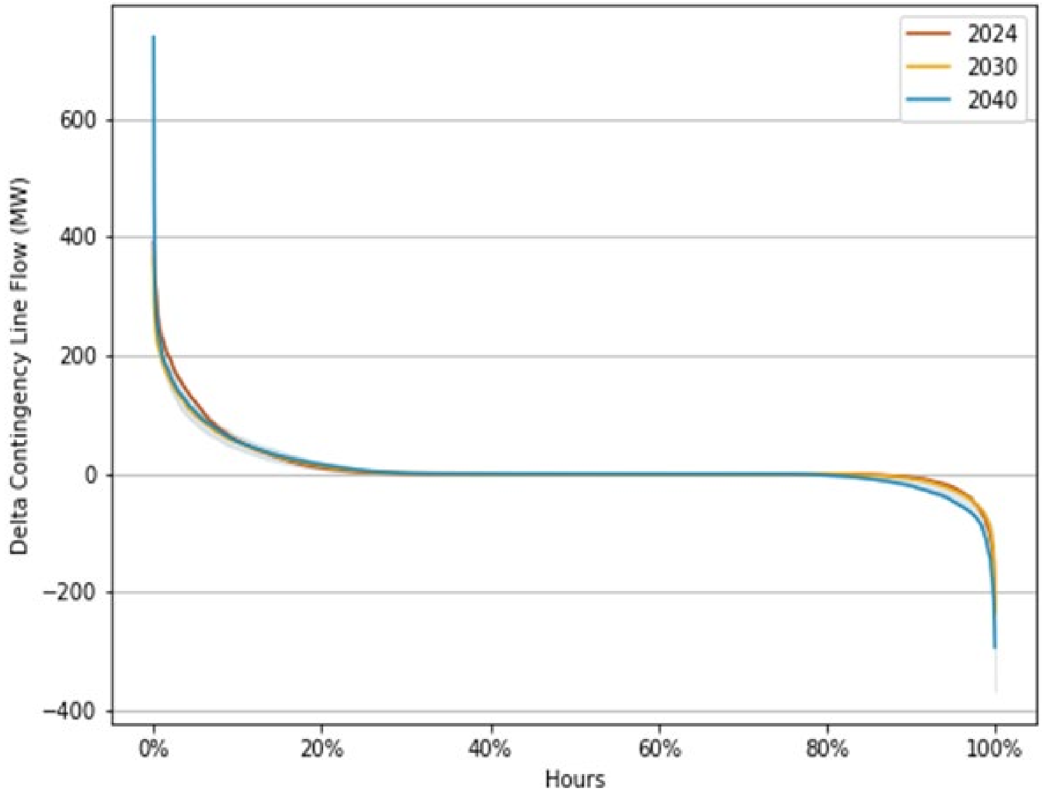
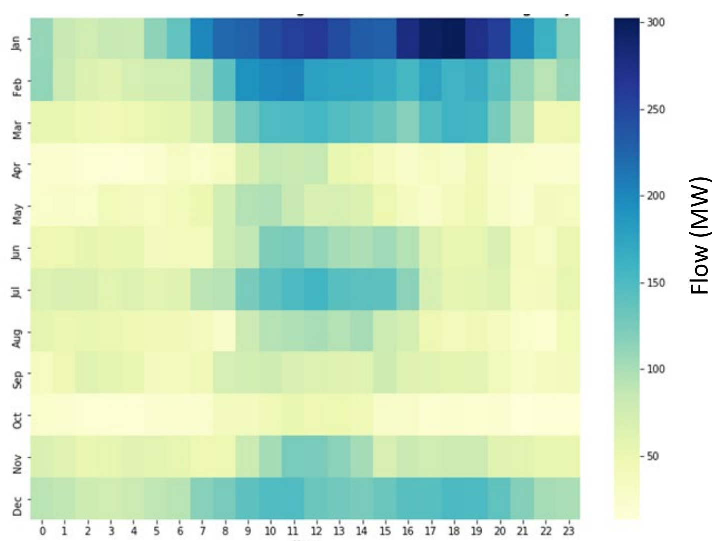
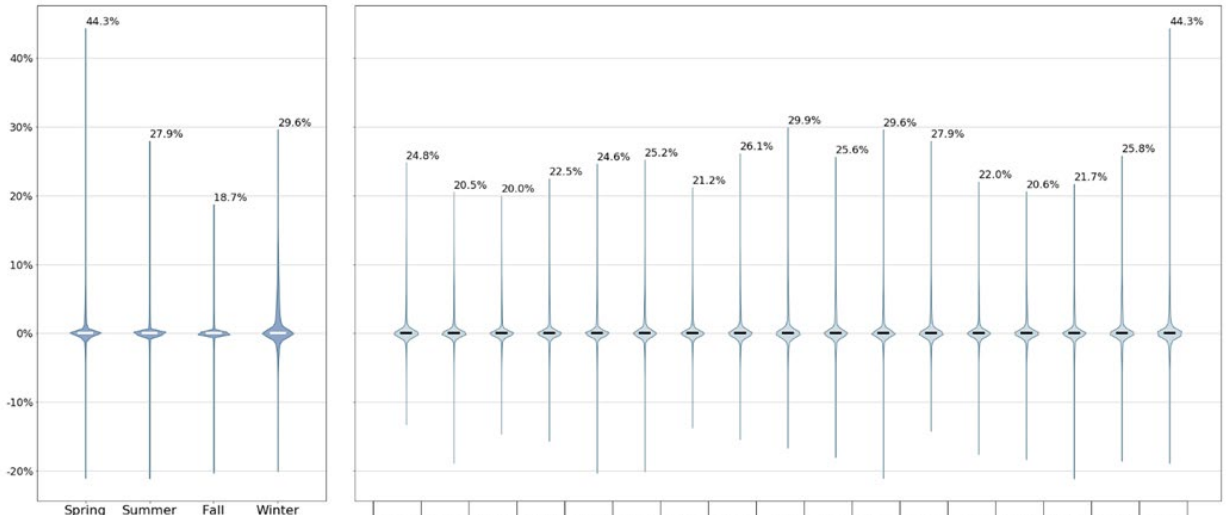


Figure 194: New Scotland-Knickerbocker Average Delta Flow (Relax-Contract)



Relaxed case flow increases in comparison to the Contract Case can be observed in the violin plots below. Freed energy from relaxing the limits on this line ranges from 60-118 GWh per year from 2024-2040. Relaxing this constraint will put more pressure back on the Central East interface and downstream constraints, which limits the flow along this path in the relaxed case.

Figure 195: New Scotland-Knickerbocker Delta Hourly Line Utilization

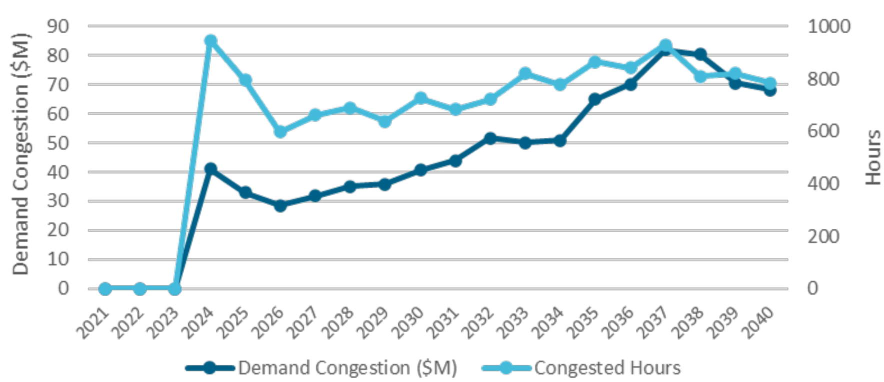


	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Freed Energy (GWh)	113	107	79	98	77	103	95	101	119	111	100	118	93	96	60	89	80

Sugarloaf-Ramapo 138 kV

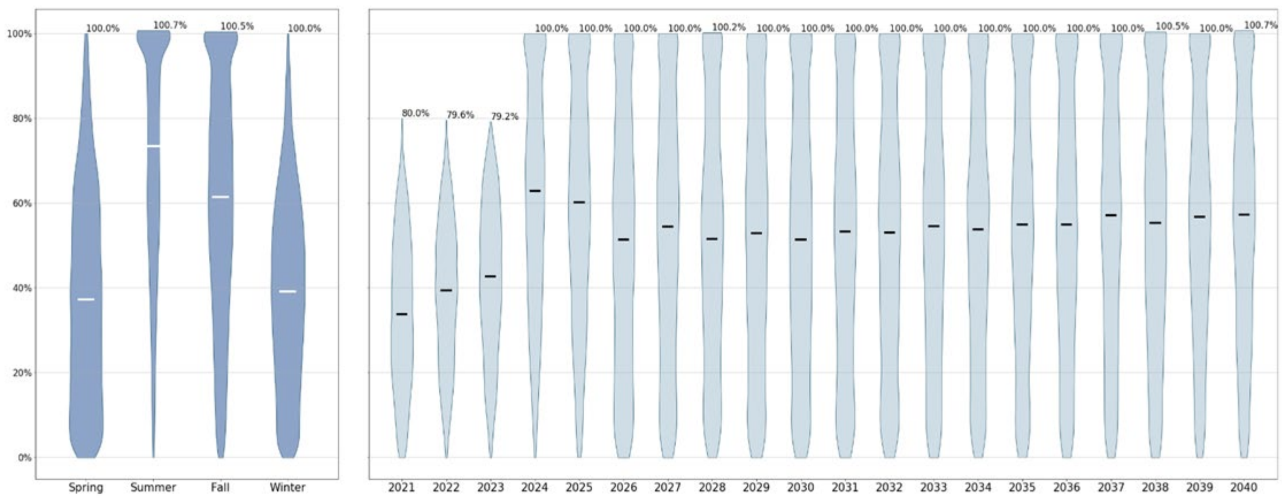
Line location and parameters for this line presented in the above section for Baseline Case Congestion Analysis. The table below shows the Contract Case projected demand congestion and number of congested hours. The congestion in the future projected years starting 2024 are primarily driven by congestion shifted to local transmission downstream of the Segment B project of AC Transmission Public Policy projects placed into service (with the addition of Rock Tavern to Sugarloaf line).

Figure 196: Sugarloaf-Ramapo Contract Case Projected Demand Congestion and Congested Hour



Line utilization on Sugarloaf-Ramapo 138 kV increases slightly during the summer period compared to the Baseline Case line utilization. The flow utilization in this path significantly increased with a portion of Segment B of the AC Transmission Public Policy project in-service in 2024. Higher flow utilization is observed in summer and fall because the seasonal rating is lower than in winter period.

Figure 197: Sugarloaf-Ramapo Contract Case Hourly Line Utilization



Compared to the Baseline Case, the flow increases slightly especially during the early morning and afternoon hours mostly occurring during the summer peak load period. Higher flows are a result of upstate renewable resources flowing to serve downstate loads.

Figure 198: Sugarloaf-Ramapo Flow Duration

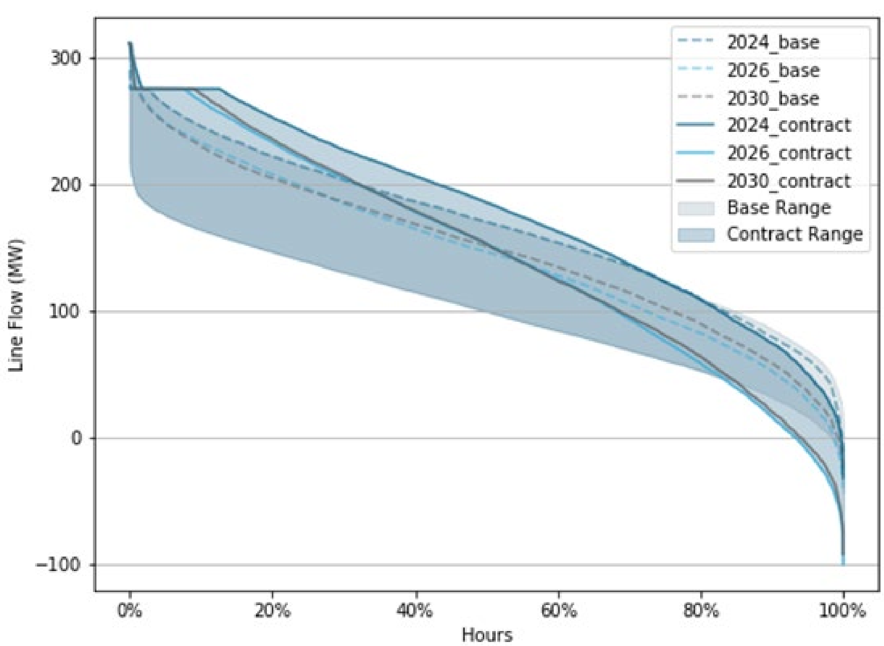
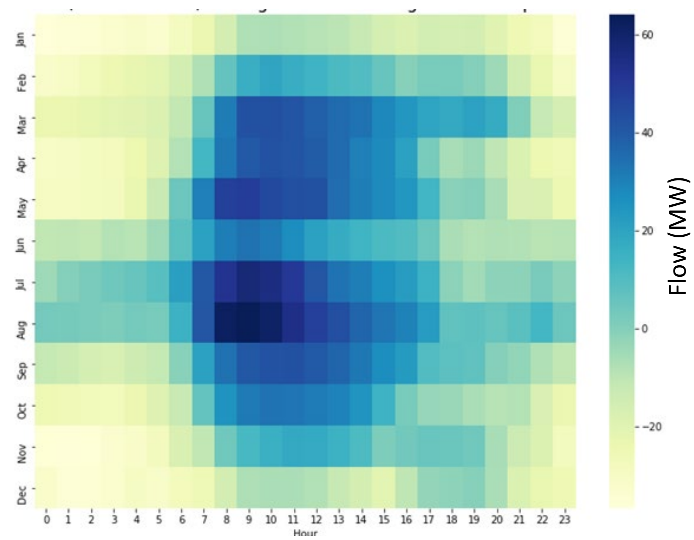


Figure 199: Sugarloaf-Ramapo Average Delta Flow (Contract-Baseline)



The relaxed case flows when compared to the Contract Case for Sugarloaf-Ramapo show an increase for about 20% of the year. Flow increases are mostly concentrated during the peak load hours in summer.

Figure 200: Sugarloaf-Ramapo Delta Flow Duration Curve (Relax-Contract)

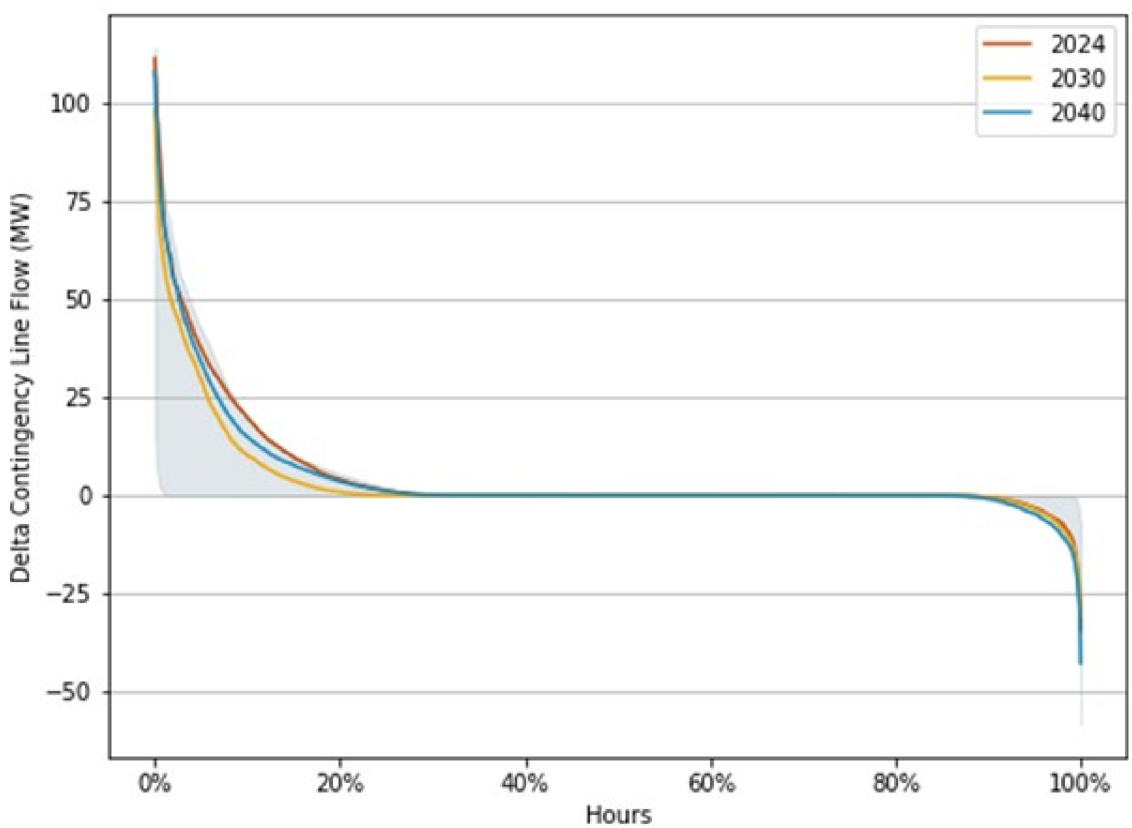
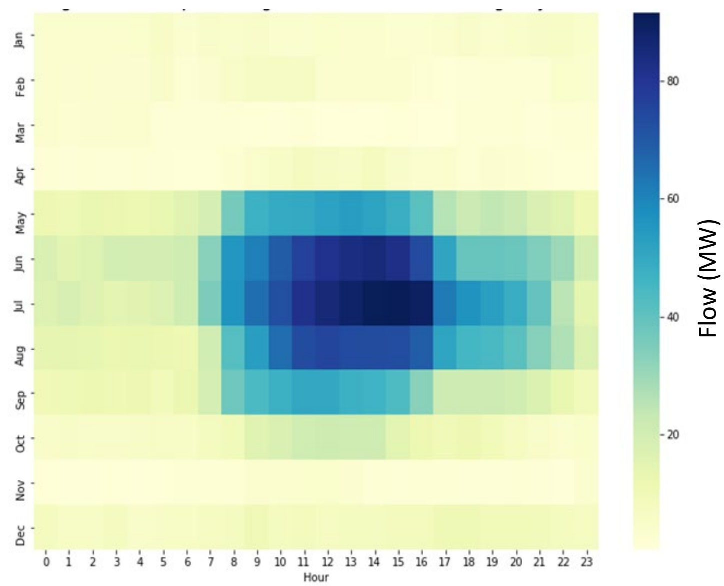
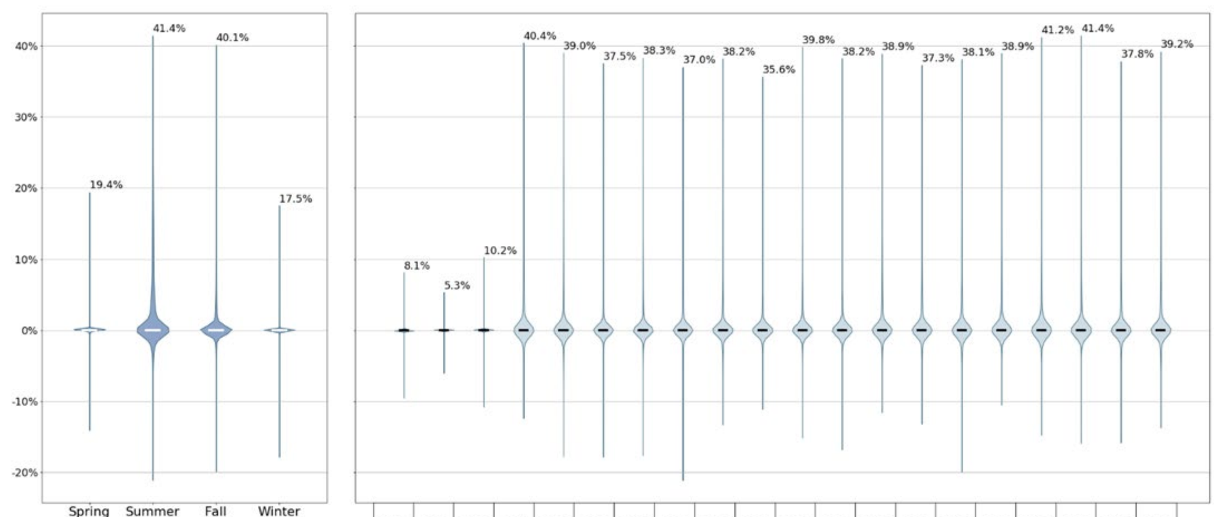


Figure 201: Sugarloaf-Ramapo Average Delta Flow (Relax-Contract)



Line utilization in relaxed case increase in the summer and fall months can be seen in the violin plots below. Freed energy ranges from 23-47 GWh from 2024-2040.

Figure 202: Sugarloaf-Ramapo Delta Hourly Line Utilization



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Freed Energy (GWh)	0	0	0	43	35	23	26	30	26	28	30	33	38	37	36	43	47	43	35	36

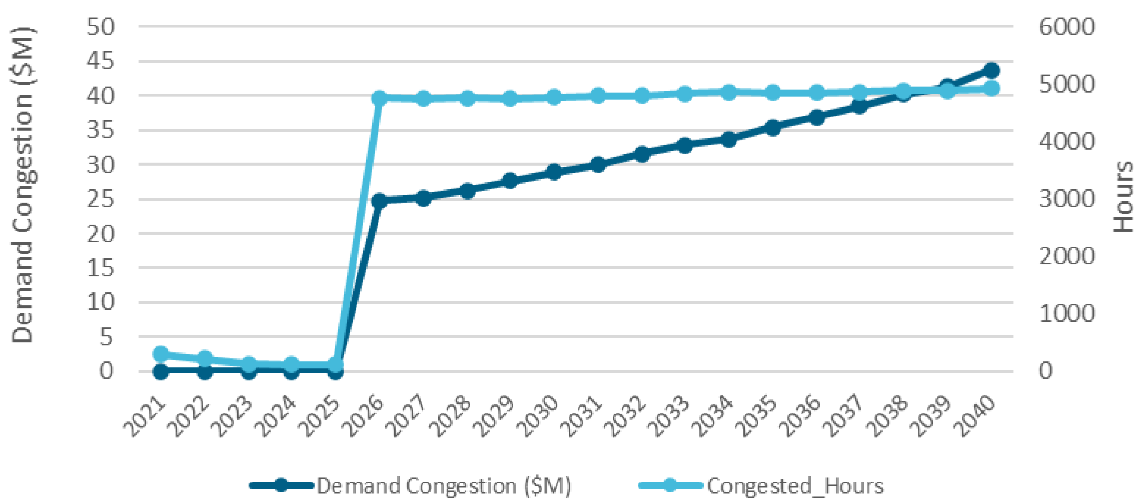
Barrett-Valley Stream 138 kV

The Barrett to Valley Stream constraint is studied in the Contract Case as a result of congestion occurring on the line due to offshore wind resources being modeled as interconnecting at the Barrett substation. Congestion is due to the contingency which secures a line with the loss of another parallel line going from Barrett to Valley Stream. Specific upgrades to the system at the point of interconnection for future offshore wind projects were not modeled as part of this study but will be studied as part of the Public Policy Transmission Project.

Figure 203: Barrett-Valley Stream Line Location and Parameters

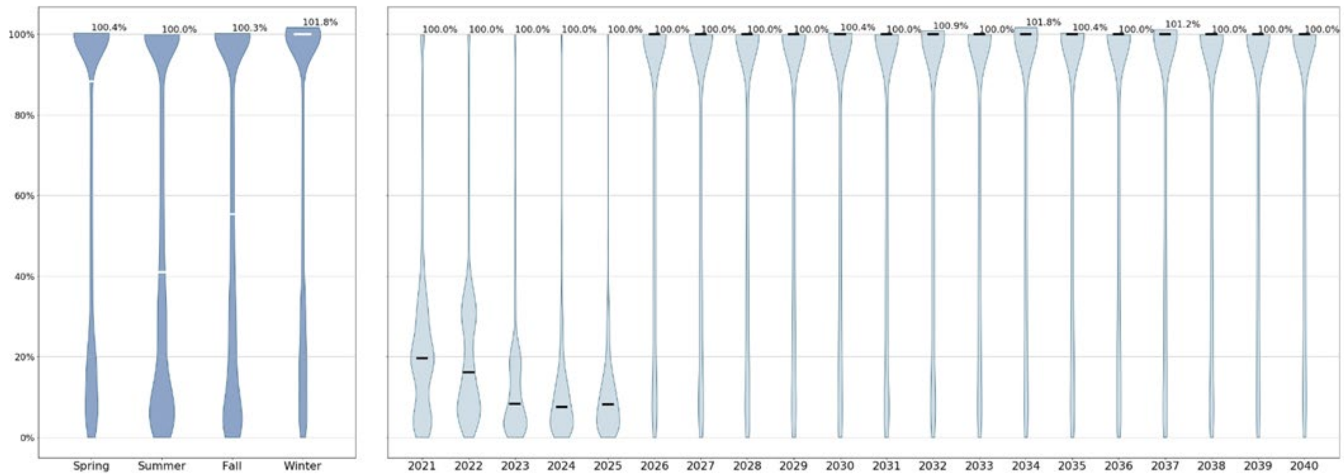
Type	Double Circuit 138 kV	
Normal Op. Rating	160/176 MW	168/184 MW
Contingency Op. Rating	261/271 MW	268/279 MW
Length	~4 Miles	
Owner	Long Island Power Authority	

Figure 204: Barrett-Valley Stream Contract Case Projected Demand Congestion and Congested Hour



This line is congested very little prior to 2026 but the congestion increases significantly after offshore wind project is modeled in-service. The unit is injecting at a lower kV bus which is not designed to handle the amount of power produced by a large project. The violin plots below show a significant increase in line utilization starting in 2026 across all seasons.

Figure 205: Barrett-Valley Stream Contract Case Hourly Line Utilization



Comparing the flows in the Contract Case to that in the Baseline Case in the plots below, it is clear that the flow increases considerably in the years after 2026. The Contract Case flow duration curve range is greater than the Baseline flow range as the early years in the Contract Case still has flows similar to the Baseline case but increases in the years after 2026. The heatmap shows that the line has increased flows on almost all hours of the year in the Contract Case when the project is modeled.

Figure 206: Barrett to Valley Stream Flow Duration Curve

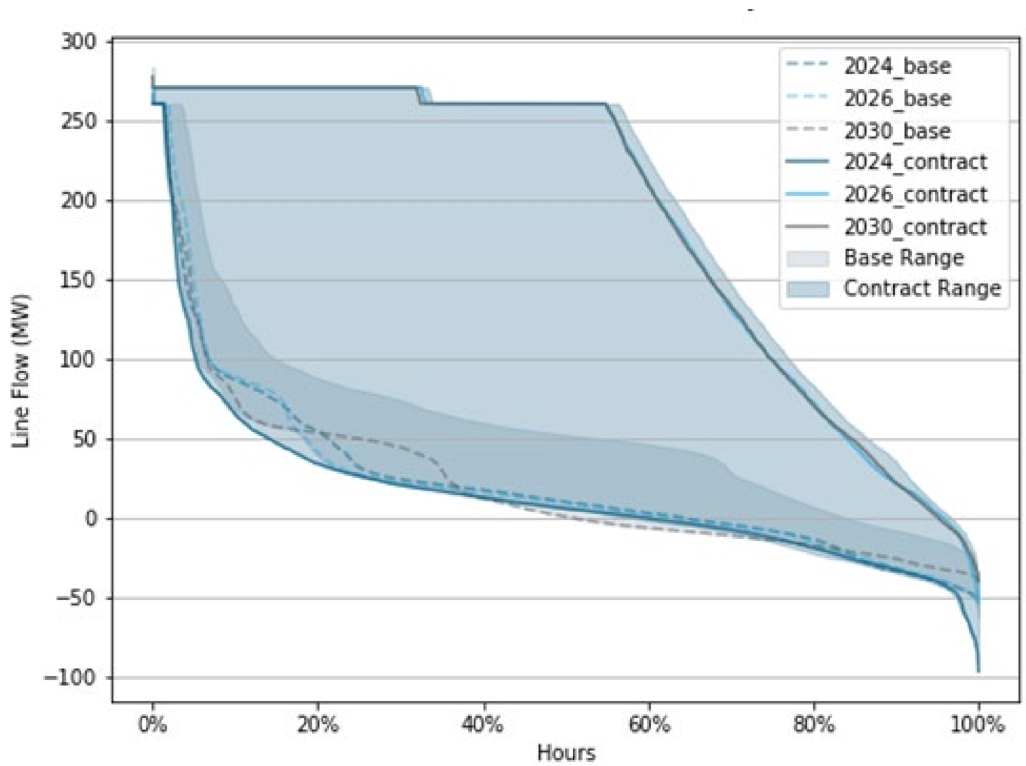
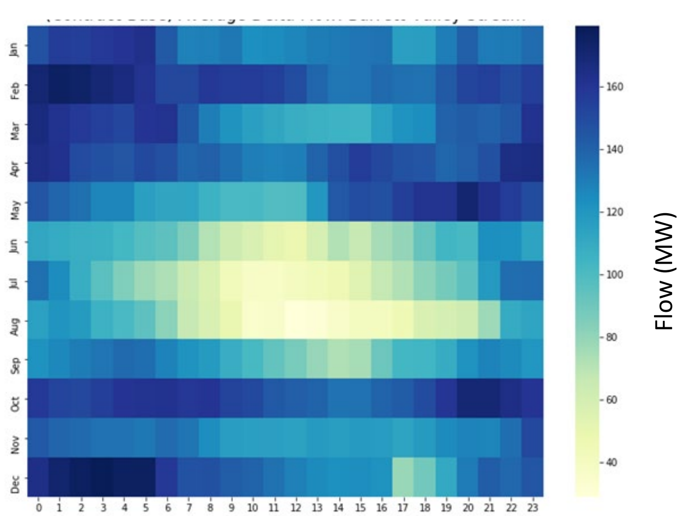


Figure 207: Barrett-Valley Stream Average Delta Flow (Contract-Baseline)



Relaxing the line limits on Barrett-Valley Stream increases the flow on the line significantly in the relaxed case compared to the Contract Case. The flow duration curves below shows a large delta in the later years compared to early years in the study period. Relaxing the limits on the line allows all of the renewable energy to export out of the interconnection point to serve load. The heatmap shows that the flow increases on almost all hours throughout the year.

Figure 208: Barrett-Valley Stream Delta Flow Duration Curve (Relax-Contract)

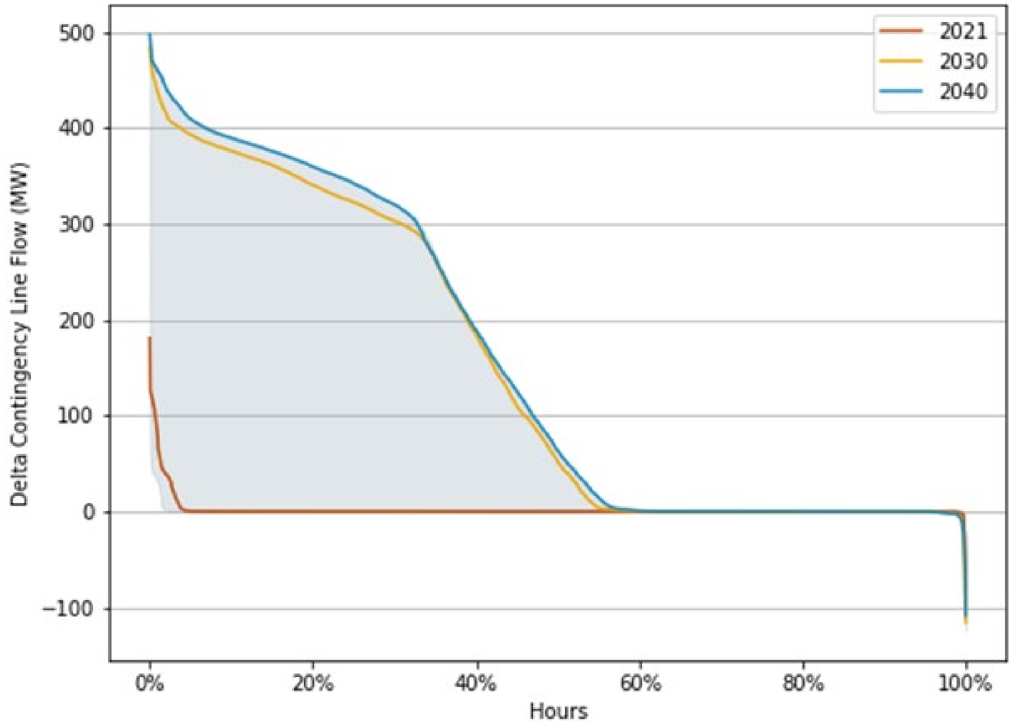
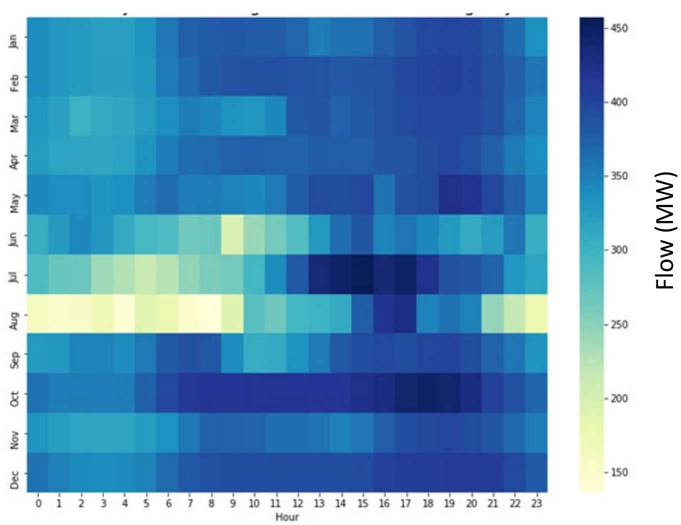
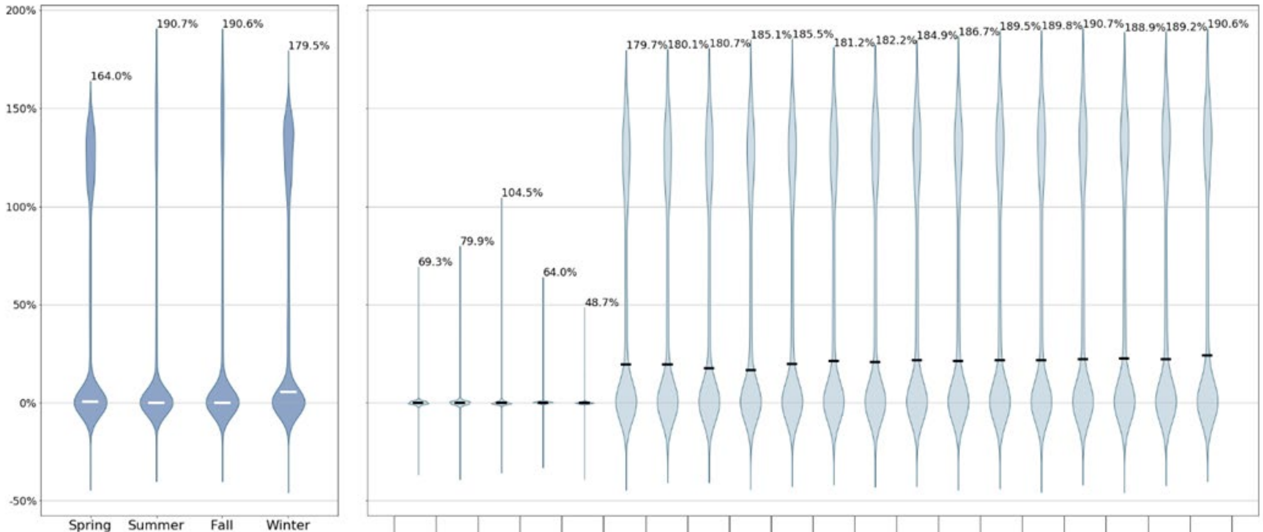


Figure 209: Barrett-Valley Stream Average Delta Flows



The violin plots below show increased flow on the path when line limits are relaxed compared to the Contract Case. Line utilization along this path is increased significantly with flows nearing four times the flow on the Contract Case after 2026. On average, line utilization increases about 25% after 2026 with very high peaks. The freed energy metric amounts to approximately 1,300 GWh per year on average after 2026 when line limits are relaxed.

Figure 210: Barrett-Valley Stream Delta Hourly Line Utilization



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Freed Energy (GWh)	16	15	6	4	3	1274	1270	1266	1263	1279	1290	1292	1295	1298	1308	1316	1324	1333	1335	1348

Golah-Mortimer 115 kV

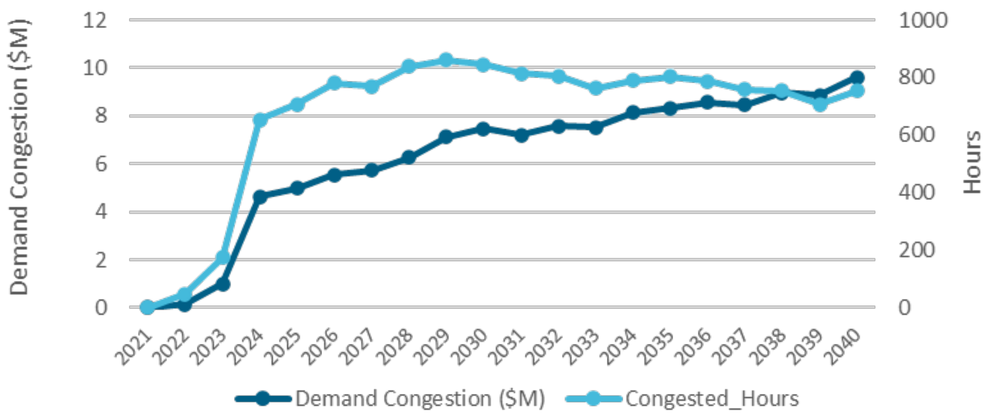
This constraint lies in pocket W1 in the Contract and Policy Cases. Additional analysis on the pockets is presented in Appendix J. This line is located in western New York closer to Rochester. This is a single circuit 115 kV line which flows power from the Golah 115 kV bus to the Mortimer 115 kV bus. The line location and parameters are shown below.

Figure 211: Golah-Mortimer Line Location and Parameters

Type	Single Circuit 115 kV
Normal Op. Rating	120/148 MW
Contingency Op. Rating	
Length	~10 Miles
Owner	National Grid

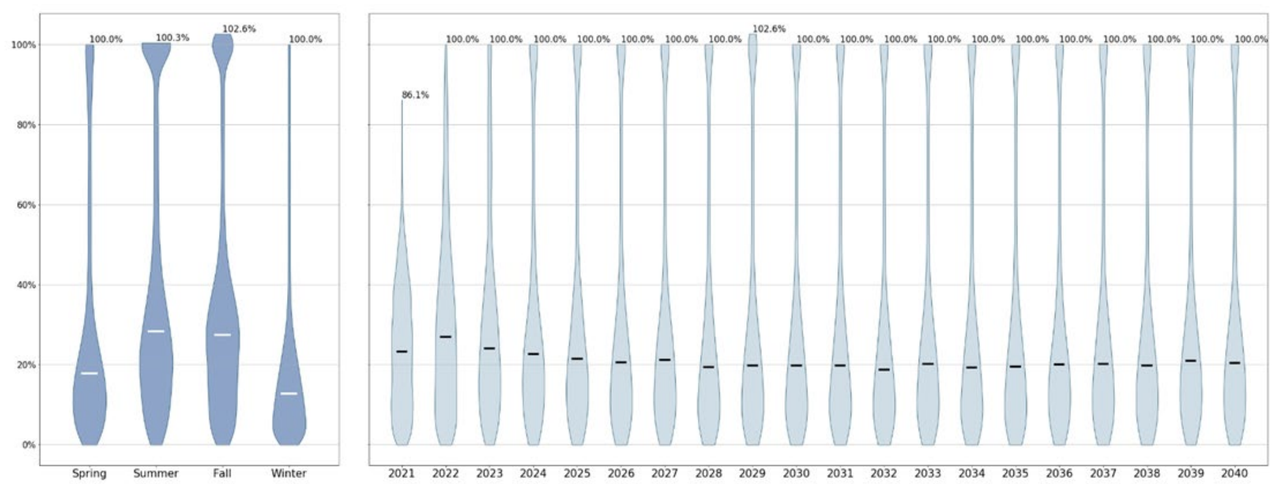
Congestion on this path is primarily due to UPV resources sited upstream of constraints that flow into load centers in zone B. The congestion increases on the line as more resources are added upstream of the constraint along the 115 kV corridor.

Figure 212: Golah-Mortimer Contract Case Projected Demand Congestion and Congested Hours



The line is mostly congested during the summer and fall period. Line utilization is on average around 20% across all years in the study period with peak periods showing full line utilization. Gradual increases in line flow and utilization result from upstate resources coming online.

Figure 213: Golah-Mortimer Contract Case Hourly Line Utilization



When compared to the Baseline Case, flows along this path are higher in the Contract Case on almost all hours of the year as seen on the flow duration curve below. The heatmap shows that the flow increase is highest during the afternoon and morning hours, indicating that the flow is mostly from UPV resources upstream of the constraint.

Figure 214: Golah-Mortimer Flow Duration Curve

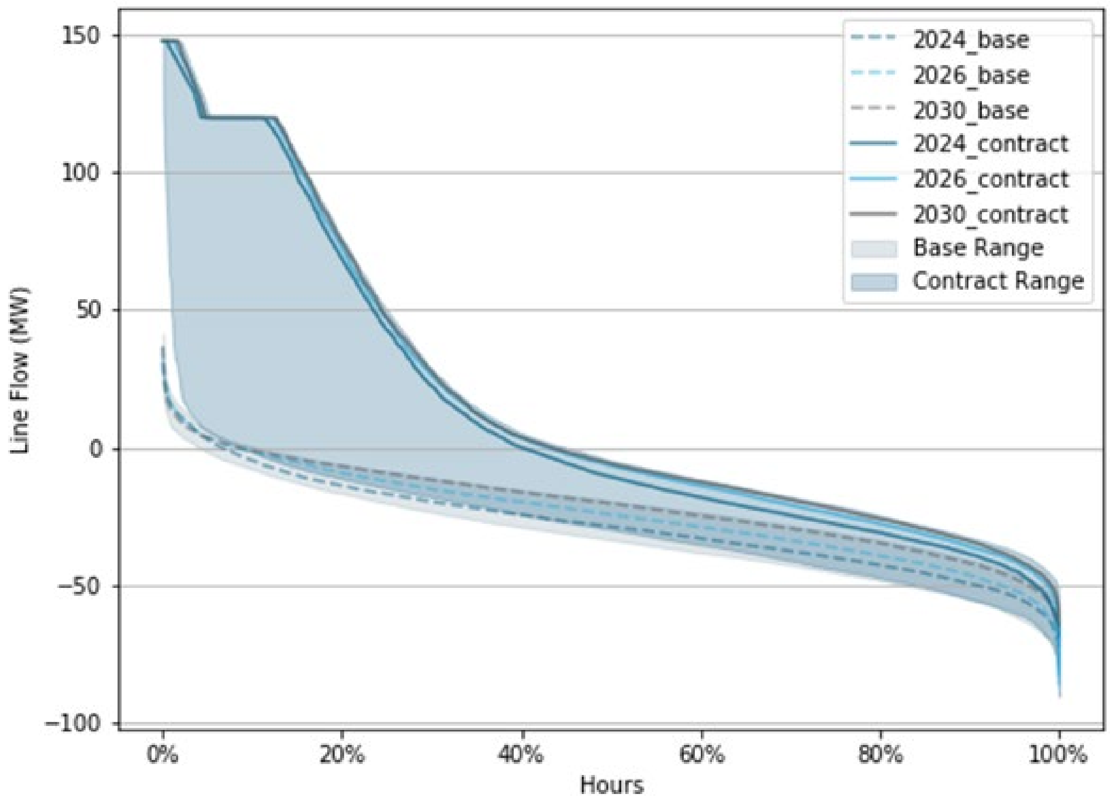
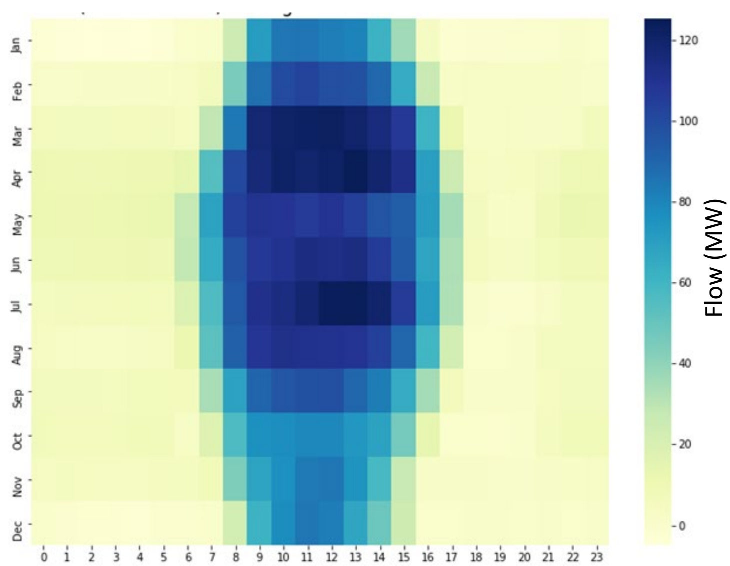


Figure 215: Golah-Mortimer Average Delta Flow



The relaxed case flows are marginally higher with about 10% of the hours showing increased flows compared to the Contract Case. Flow increase occurs during the afternoon hours in the summer months.

Figure 216: Golah-Mortimer Delta Flow Duration Curve (Relax-Contract)

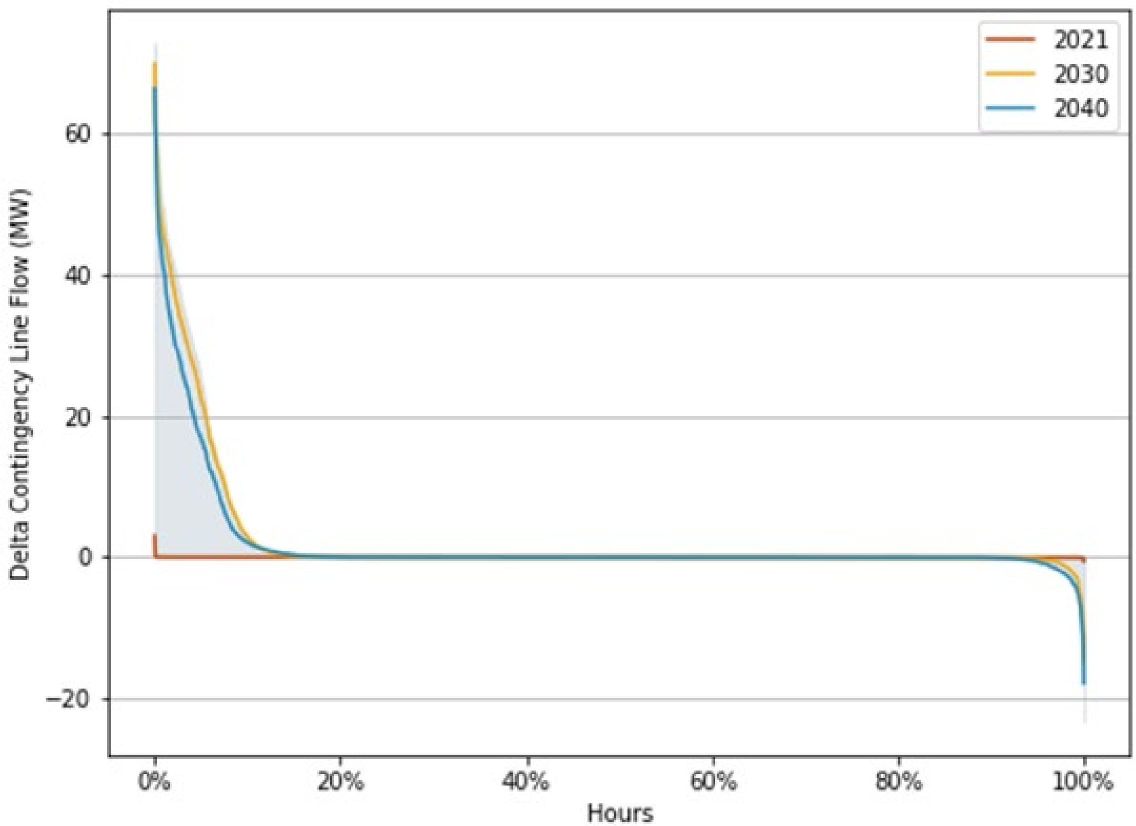
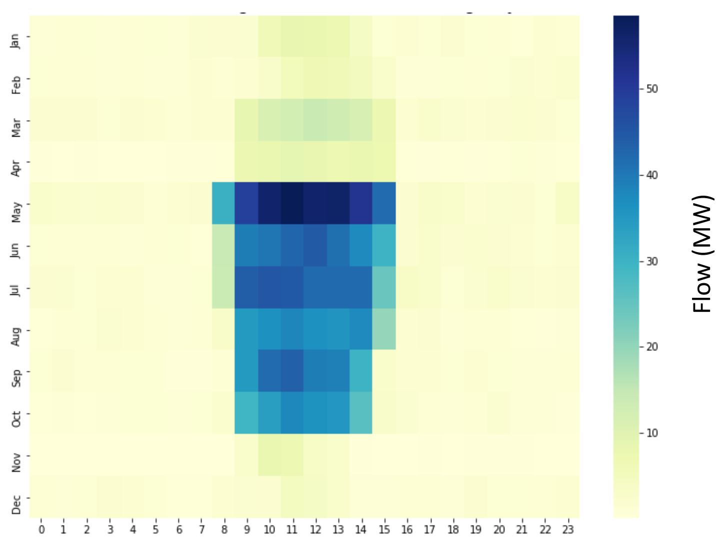
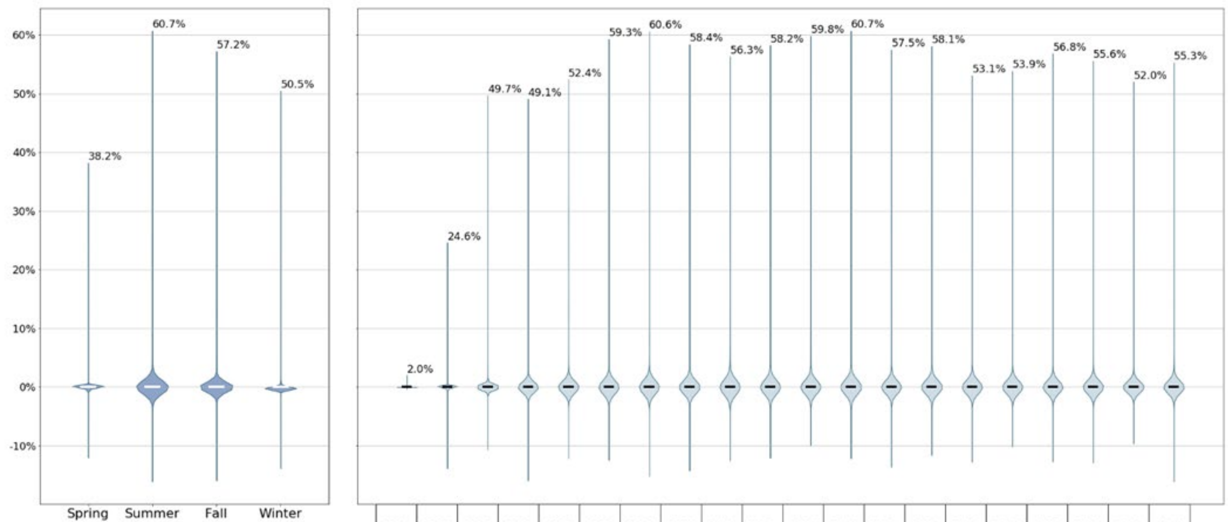


Figure 217: Golah-Mortimer Average Delta Flow (Relax-Contract)



Marginal increase in flow under relaxed case can be seen in the violin plots below. Higher peaks in the delta violin plots for individual years are observed with increasing renewable energy injections.

Figure 218: Golah-Mortimer Delta Hourly Line

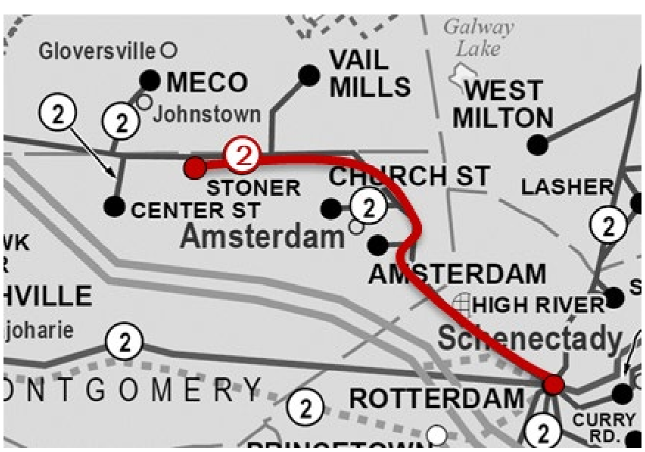


	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Freed Energy (GWh)	0	0	2	13	15	18	19	19	22	20	19	20	17	18	18	18	16	17	15	16

Stoner-Rotterdam 115 kV

Stoner to Rotterdam is a 115 kV double circuit line along the 115 kV corridor from the Inghams 115 kV to the Rotterdam 115 kV substation, which is directly downstream of the Central East interface. This constraint lies in Pocket Y1 in the Contract and Policy Cases. A lot of contracted UPV resources are modeled along this corridor in Montgomery County looking to interconnect at various tap buses along this path. The line location and parameters are shown below.

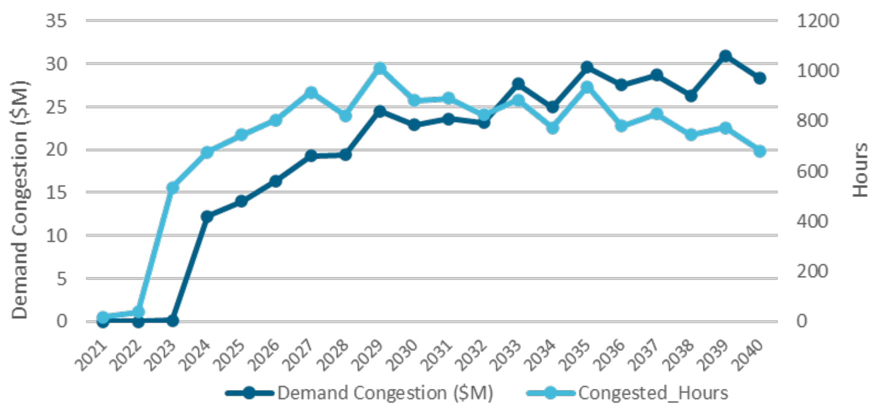
Figure 219: Stoner-Rotterdam Line Location and Parameters



Type	Double Circuit 115 kV
Normal Op. Rating	74/74 MW
Contingency Op. Rating	74/ 111 MW
Length	~23 miles
Owner	National Grid

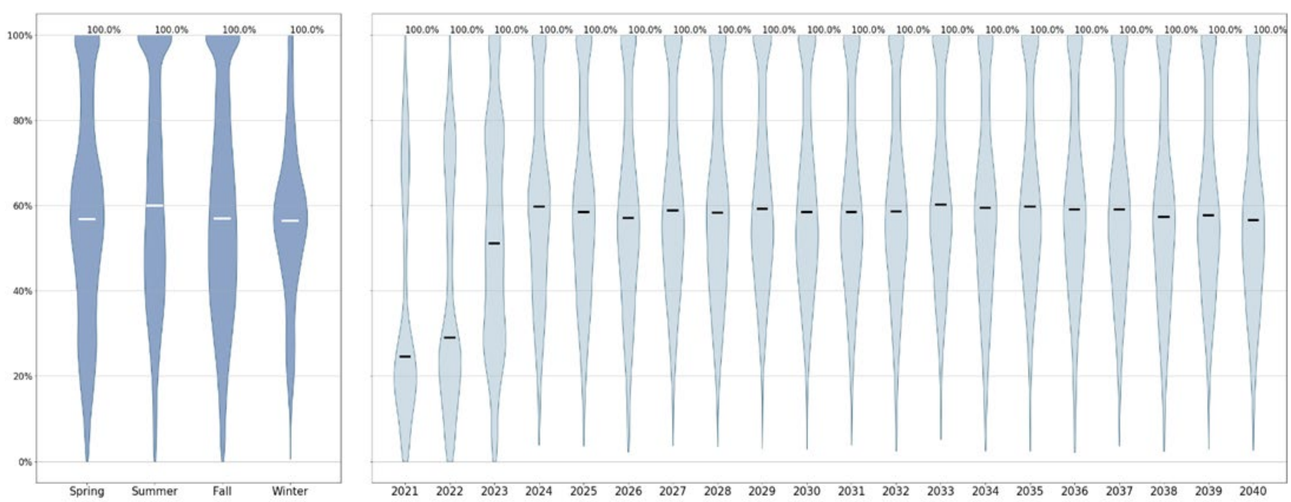
Congestion on this path in the Contract Case is projected to increase as more resources are added upstream of the line. The demand congestion and congested hour chart below shows increasing amounts of congestion as the study progresses due to modeling additional resources in-service in the Contract Case.

Figure 220: Stoner-Rotterdam Contract Case Projected Demand Congestion and Congested Hour



The violin plots for line utilization show a gradual increase in average line utilization in successive study years. Line utilization is slightly higher in the summer and fall periods due to increased output from UPV resources. On average, the line utilization is about 60%.

Figure 221: Stoner-Rotterdam Contract Case Hourly Line Utilization



Compared to Baseline Case flows, flows in the Contract Case along this path is larger for most hours in the year as shown in the flow duration curve below. The heatmap shows that the highest flow increase occurs during the late morning and afternoon hours with shape similar to a solar PV curve. This indicates that the flow on the line increases due to new contracted UPV resources injecting energy along this path during these hours.

Figure 222: Stoner-Rotterdam Flow Duration Curve

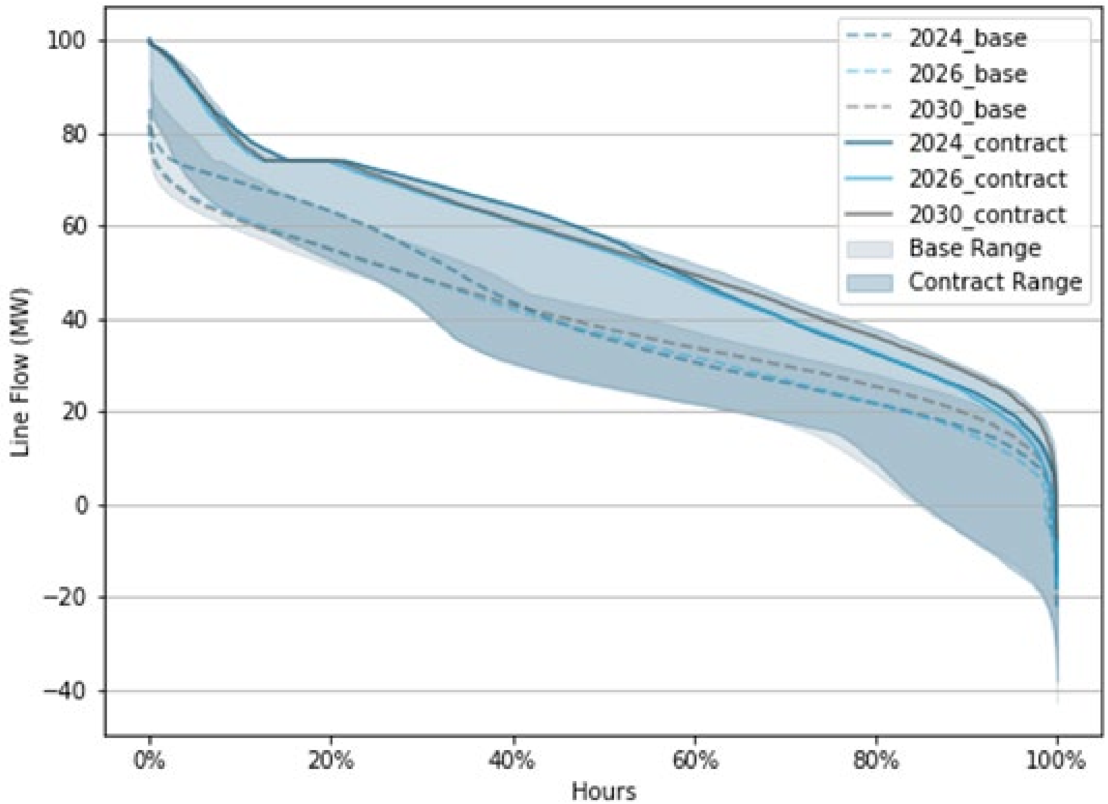
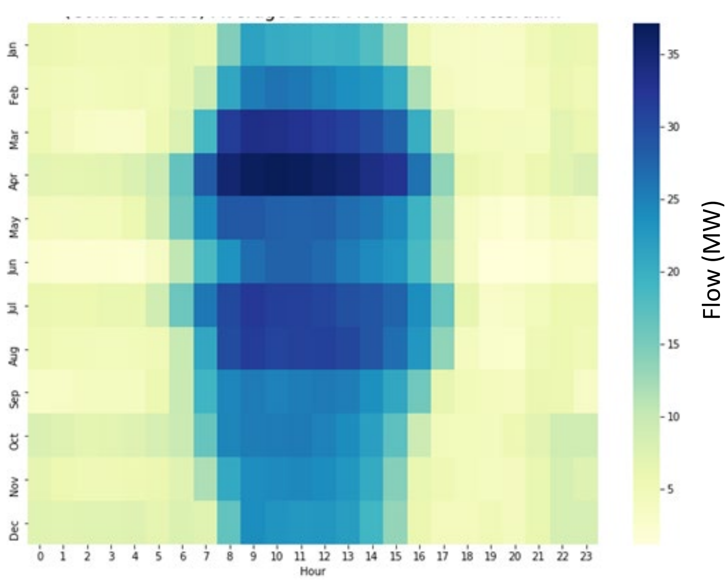


Figure 223: Stoner-Rotterdam Average Delta Flow (Contract-Baseline)



Relaxing the constraint by removing line limits along the path does not significantly change the flow on the line. The flow duration curve below shows the delta change in flow in the relaxed case as compared to the flow in the Contract Case. The relaxed case has higher flows in about 20% of the year in years after 2024. The heatmap shows that the increase in flow in the relaxed case occurs when UPV output is expected to be high and when more flow is expected flowing across the Central East interface.

Figure 224: Stoner-Rotterdam Delta Flow Duration Curve (Relax-Contract)

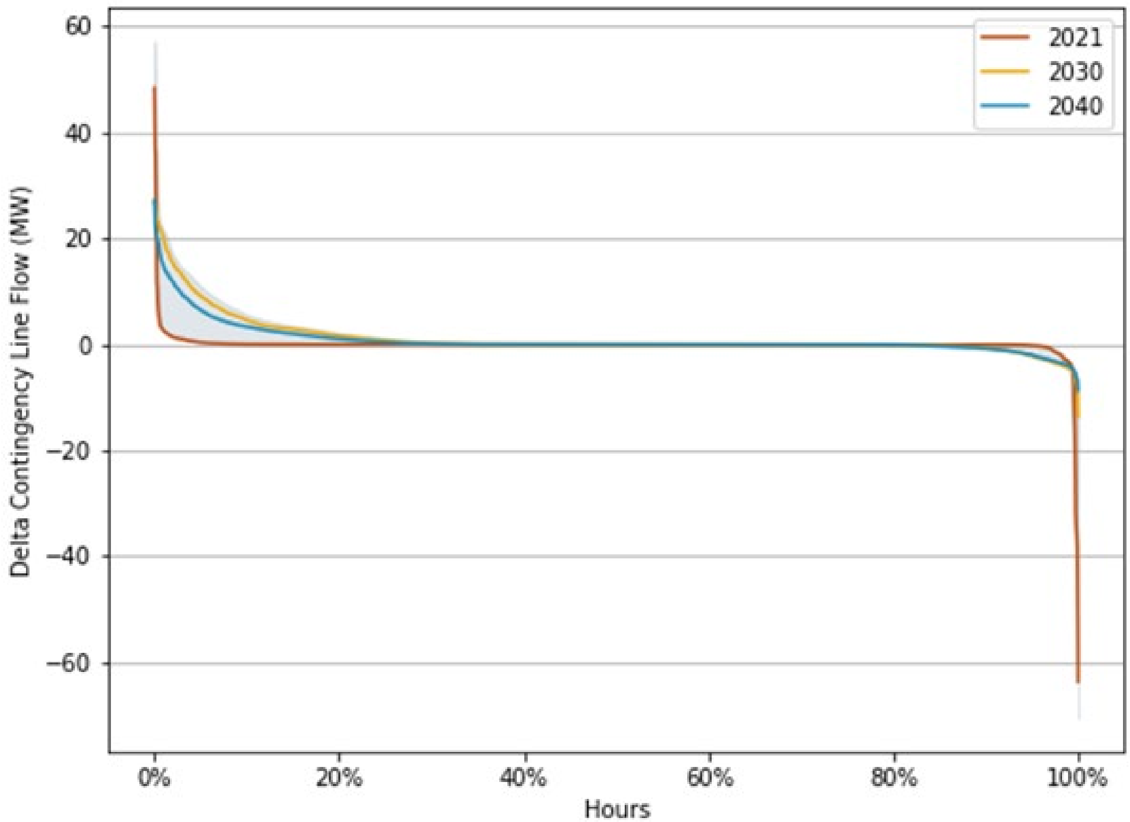
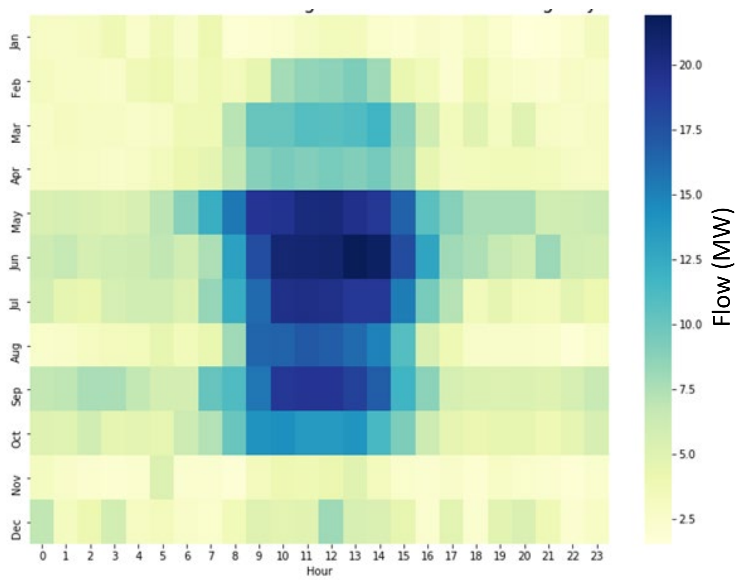
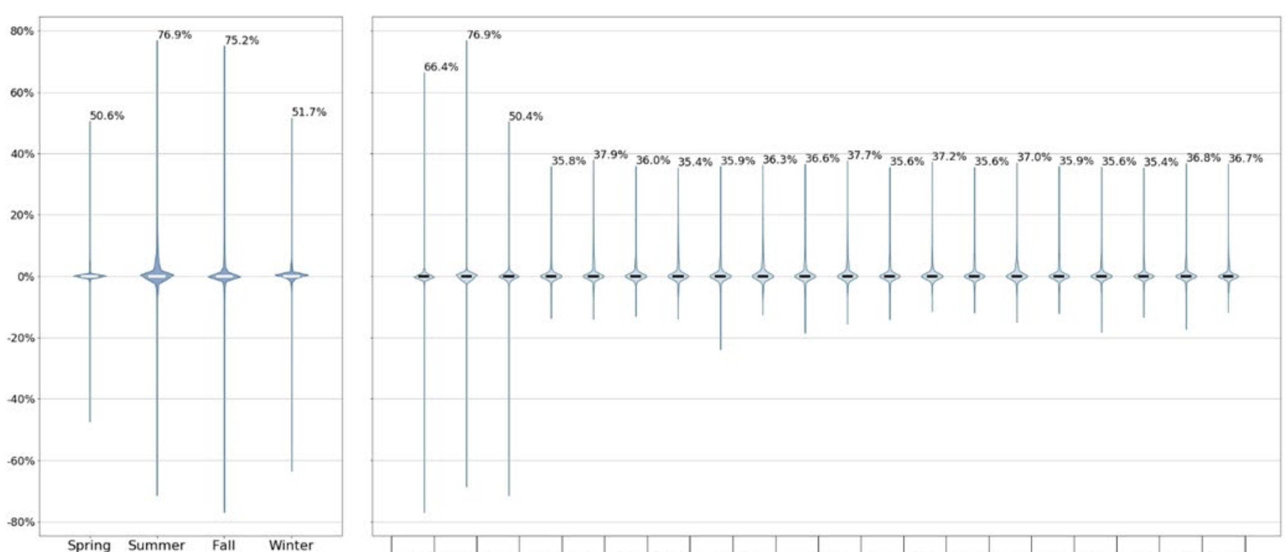


Figure 225: Stoner-Rotterdam Average Delta Flow (Relax-Contract)



Relaxing line limits along this path allows for additional UPV resources to inject energy into the system and reduces curtailment. Increased utilization in the relaxed case can be seen in the violin plots below. Overall line utilization increase remains low but there are periods with high peaks indicating additional injection of power through this path in limited hours.

Figure 226: Stoner-Rotterdam Delta Hourly Line Utilization



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Freed Energy (GWh)	0	0	4	8	9	10	10	9	13	10	11	9	10	8	11	8	9	7	8	6

Jennison-Sidney 115 kV

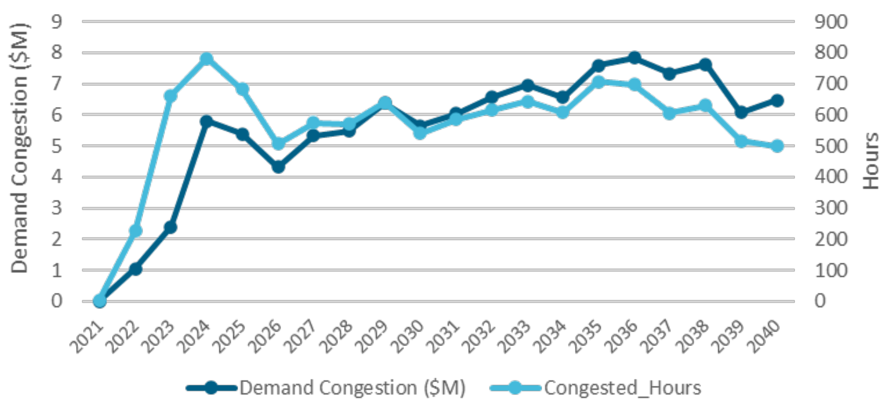
The Jennison-Sidney line is located in pocket Z2 in the Contract and Policy Cases. This line is directly downstream of paths that connect to contracted resources in the Southern Tier comprising of LBW and UPV resources. The line location and parameters are as shown below:

Figure 227: Jennison-Sidney Line Location and Parameters

Type	Single Circuit 115kV
Normal Op. Rating	70/ 107 MW
Contingency Op. Rating	110/ 110 MW
Length	~10 Miles
Owner	NYSEG

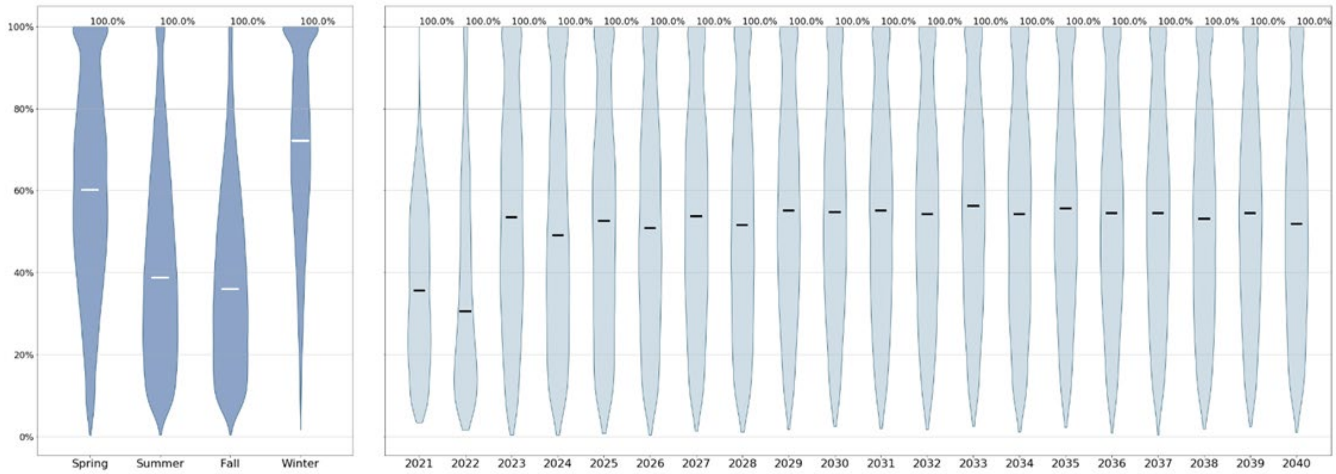
Congestion on this line increases as more resources are added in the upstate region in the Contract case. The congested hours and demand congestion metrics for this line are shown below.

Figure 228: Jennison-Sidney Projected Contract Case Demand Congestion and Congested Hour



Line utilization for this line in the Contract case increases in 2023 to about 50% as more resources are modeled in-service. Line utilization is higher in the winter and spring time period compared to summer and fall.

Figure 229: Jennison-Sidney Contract Case Hourly Line Utilization



A comparison of flows with the Baseline Case shows that the flows in the Contract Case is higher for most hours of the year. In the flow duration curve below, the darker blue region represents the Contract Case flow range whereas the lighter shade represents Baseline flows. The heatmap shows that the flow increase is spread throughout the year. Increased flow in the Contract case results from nearby wind resources being modeled in the Contract Case.

Figure 230: Jennison-Sidney Flow Duration Curve

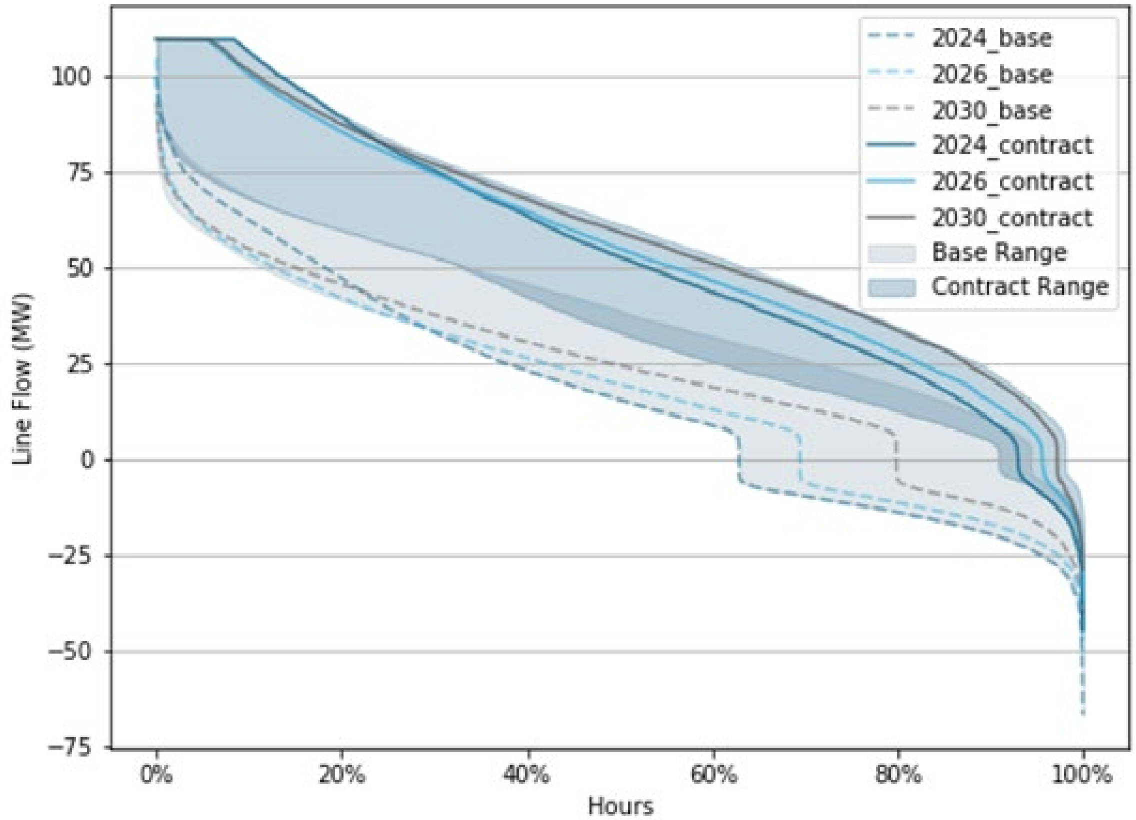
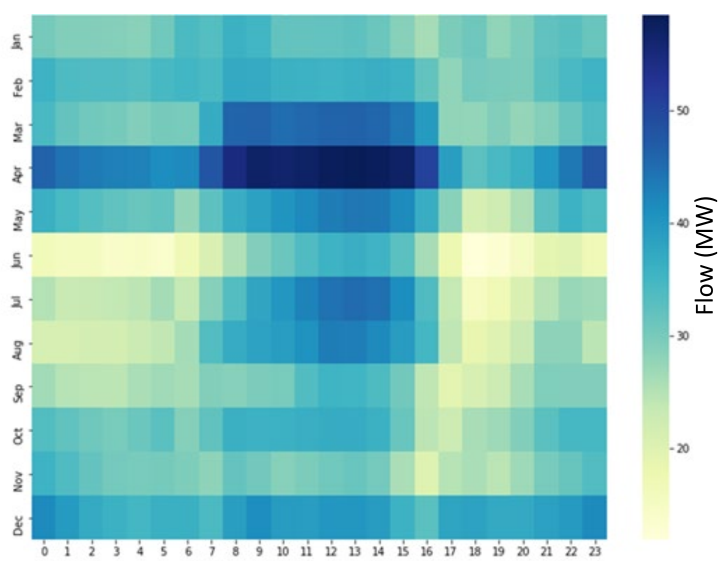


Figure 231: Jennison-Sidney Average Delta Flow (Contract-Baseline)



The relaxed case flows are marginally higher compared to the Contract Case flows. Flows on the line increases for about 20% of the year. Higher flows in the relaxed case usually occurs during the winter and spring period. Higher line flows are most likely due to nearby wind resources injecting additional energy on the line due to relieving congestion on the line.

Figure 232: Jennison-Sidney Delta Flow Duration Curve (Relax-Contract)

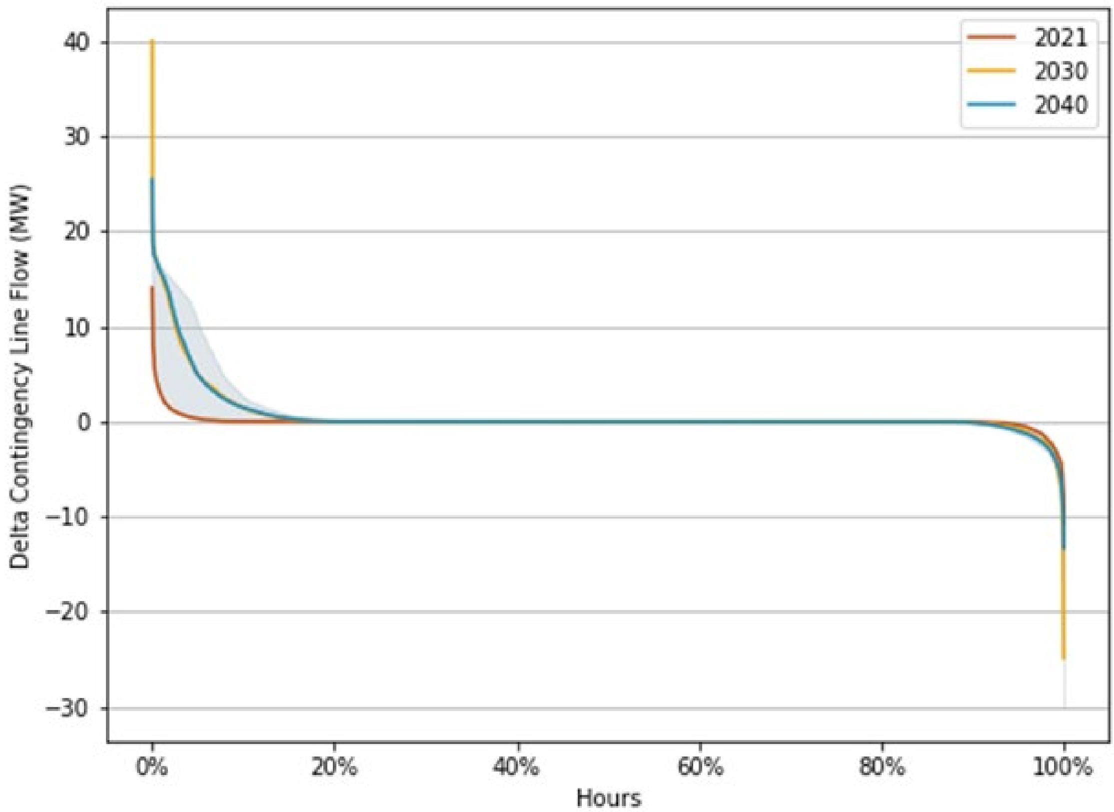
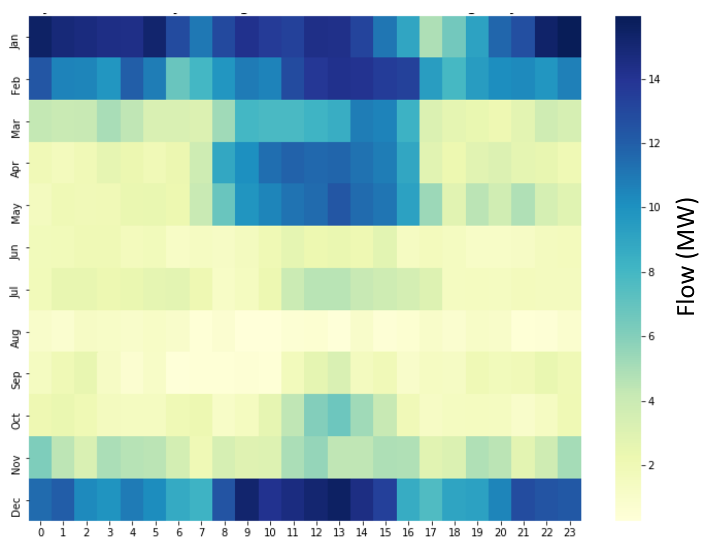
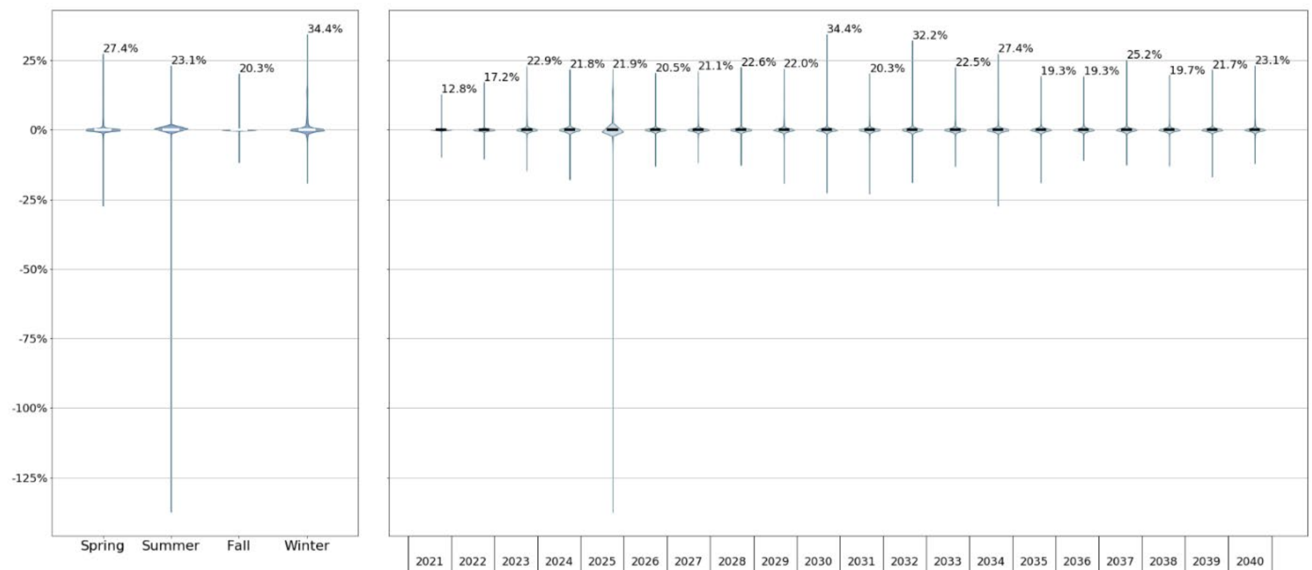


Figure 233: Jennison-Sidney Average Delta Flow



Line utilization in the relaxed case increases only marginally compared to the Contract Case as seen below in the delta line utilization plots. Relaxing line limits along this path only adds about 5 GWh per year of flow on the line.

Figure 234: Jennison-Sidney Delta Hourly Line Utilization



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Freed Energy (GWh)	0	2	6	8	7	5	5	5	5	5	5	6	6	6	6	6	6	5	5	5