2013 CARIS 1 Base Case Results – Follow-Up Discussion

Timothy Duffy
Manager, Economic Planning
New York Independent System Operator

Electric System Planning Working Group

July 22, 2013

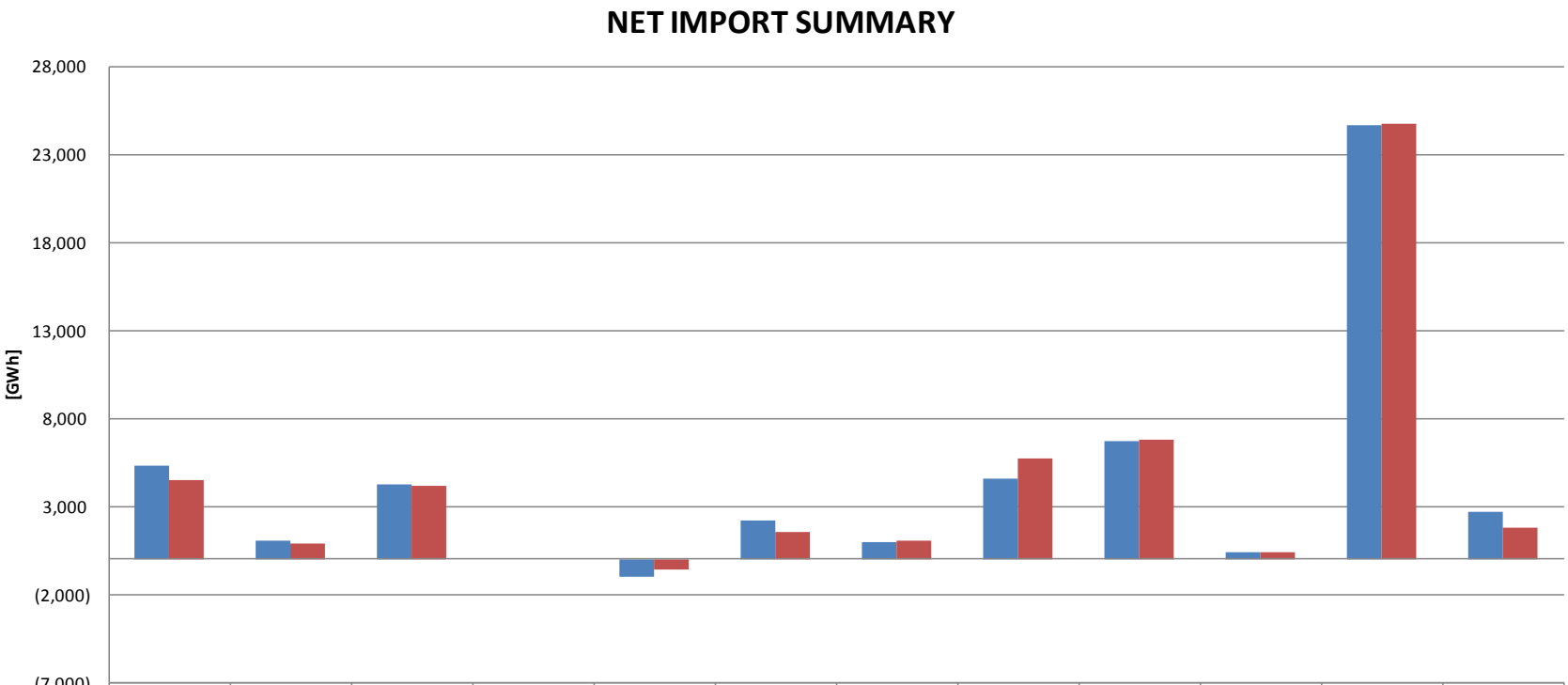
KCC

DRAFT – FOR DISCUSSION PURPOSES ONLY

Flat Hurdle Rates (Commitment/Dispatch)

- New England: $3 / $1
- PJM: $4 / $2
- IESO: $4 / $2

Net Import Energy (2011)

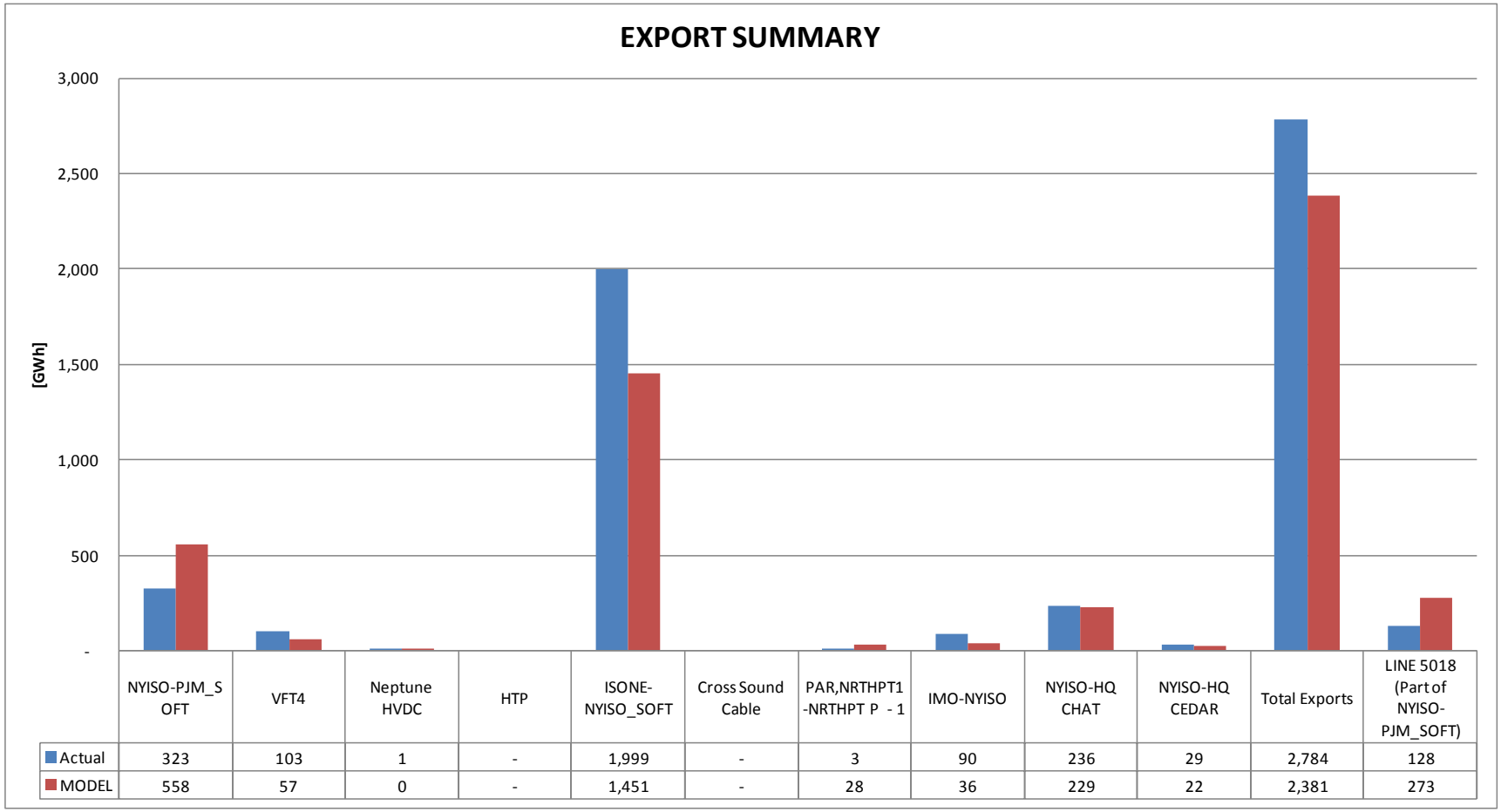


	NYISO-PJM_SOFT	VFT4	Neptune HVDC	HTP	ISONE-NYISO_SOFT	Cross Sound Cable	PAR,NRTHPT1-NRTHPT P - 1	IMO-NYISO	NYISO-HQ CHAT	NYISO-HQ CEDAR	Total Net Imports	LINE 5018 (Part of NYISO-PJM_SOFT)
Actual	5,322	1,092	4,293	-	(947)	2,213	984	4,614	6,684	428	24,683	2,741
MODEL	4,531	893	4,186	-	(545)	1,590	1,094	5,742	6,836	437	24,762	1,787

Import Energy (2011)

	NYISO-PJM_SOFT	VFT4	Neptune HVDC	HTP	ISONE-NYISO_SOFT	Cross Sound Cable	PAR,NRTHPT1-NRTHPT P - 1	IMO-NYISO	NYISO-HQ CHAT	NYISO-HQ CEDAR	Total Imports	LINE 5018 (Part of NYISO-PJM_SOFT)
Actual	5,645	1,195	4,295	-	1,051	2,213	987	4,704	6,921	457	27,468	2,869
MODEL	5,089	949	4,186	-	906	1,590	1,122	5,777	7,065	459	27,143	2,061

Export Energy (2011)



	NYISO-PJM_SOFT	VFT4	Neptune HVDC	HTP	ISONE-NYISO_SOFT	Cross Sound Cable	PAR,NRTHPT1-NRTHPT P - 1	IMO-NYISO	NYISO-HQ CHAT	NYISO-HQ CEDAR	Total Exports	LINE 5018 (Part of NYISO-PJM_SOFT)
Actual	323	103	1	-	1,999	-	3	90	236	29	2,784	128
MODEL	558	57	0	-	1,451	-	28	36	229	22	2,381	273

Hurdle Rates Testing/Adoption

- Tested $1, $2 and $3 dispatch hurdle rates for each of the neighboring control areas in various combinations
- Hurdle rates adopted which yielded model results best aligned with historic 2011 inter-control area flows
- Hurdle rates utilized as a calibration tool to tune the historic net flows

Hurdle Rate Sensitivity

- Tested higher hurdle rate for Exports to PJM ($9 commitment/$7 dispatch)
- Lower level of exports to PJM in latter years (NYISO still exporting to PJM)
- Minimal impact on NYCA production cost and demand congestion
  - *Average annual impact of -0.1% for production cost*
  - *Average annual impact of 1.2% for demand congestion*

Hurdle Rate Sensitivity: Summary Metrics

((Hurdle Rate Sensitivity Case) – (Base Case))/Base Case

Scenario Delta Summary	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
NYCA-Wide Production Costs	-0.1%	-0.1%	-0.2%	-0.1%	-0.1%	-0.1%	-0.1%	0.0%	0.0%	0.0%
NYCA Demand$ Congestion	0.7%	2.8%	2.0%	1.2%	0.4%	1.3%	1.4%	1.0%	0.6%	1.2%
Load LBMP Payments	-0.7%	-0.5%	-0.6%	-0.5%	-0.6%	-0.4%	-0.4%	-1.0%	-1.2%	-1.1%
Generator LBMP Payments	-1.4%	-0.9%	-1.1%	-1.0%	-0.9%	-0.8%	-0.8%	-2.2%	-2.4%	-2.1%
Load Payment Losses	-0.2%	-0.9%	-0.4%	-0.6%	0.2%	-0.3%	-0.2%	-0.7%	-0.5%	-0.7%
SO2 Costs	0.0%	0.0%	0.0%	-0.4%	-0.3%	0.7%	-0.7%	-2.3%	-1.8%	-2.5%
SO2 Emissions	-2.3%	-1.7%	-1.2%	-0.3%	-0.3%	0.6%	-0.7%	-2.1%	-1.6%	-2.3%
CO2 Costs	-1.4%	-0.7%	-0.8%	-0.6%	-0.5%	-0.4%	-0.6%	-1.9%	-2.2%	-2.0%
CO2 Emissions	-0.8%	-0.4%	-0.4%	-0.3%	-0.3%	-0.2%	-0.3%	-1.0%	-1.1%	-1.0%
NOX Costs	-1.9%	0.0%	-3.0%	-2.0%	-1.0%	0.0%	-1.6%	-2.5%	-3.6%	-3.1%
NOX Emissions	-1.8%	-1.1%	-1.0%	-0.9%	-0.8%	-0.5%	-0.7%	-1.9%	-1.8%	-1.8%
NYCA Avg. LBMP	-0.7%	-0.4%	-0.6%	-0.4%	-0.5%	-0.3%	-0.4%	-1.2%	-1.4%	-1.3%

Demand Congestion by Constraint: Explanatory Factors

Constraint	Explanatory Factors
Dunwoodie Shore Road	Outages of Y49, Y50, Neptune
Greenwood Lines	Steam turbine undergeneration in NYC
N.Scotland/Leeds	Outages of specific Capital-area units

Long Island Generation Payment

MAPS captured 61% Gen Payment in normal period (no outages on Y49, Y50 or Neptune) compared to 49% in outage period

2011 LONG ISLAND GEN PAY(*)	SCUC GEN PAY	MAPS GEN PAY	PERCENTAGE
NORMAL	$ 378,771,096	$ 229,161,260	61%
OUTAGE	$ 437,873,203	$ 214,503,504	49%
BOTH NORMAL AND OUTAGE	$ 816,644,299	$ 443,664,763	54%

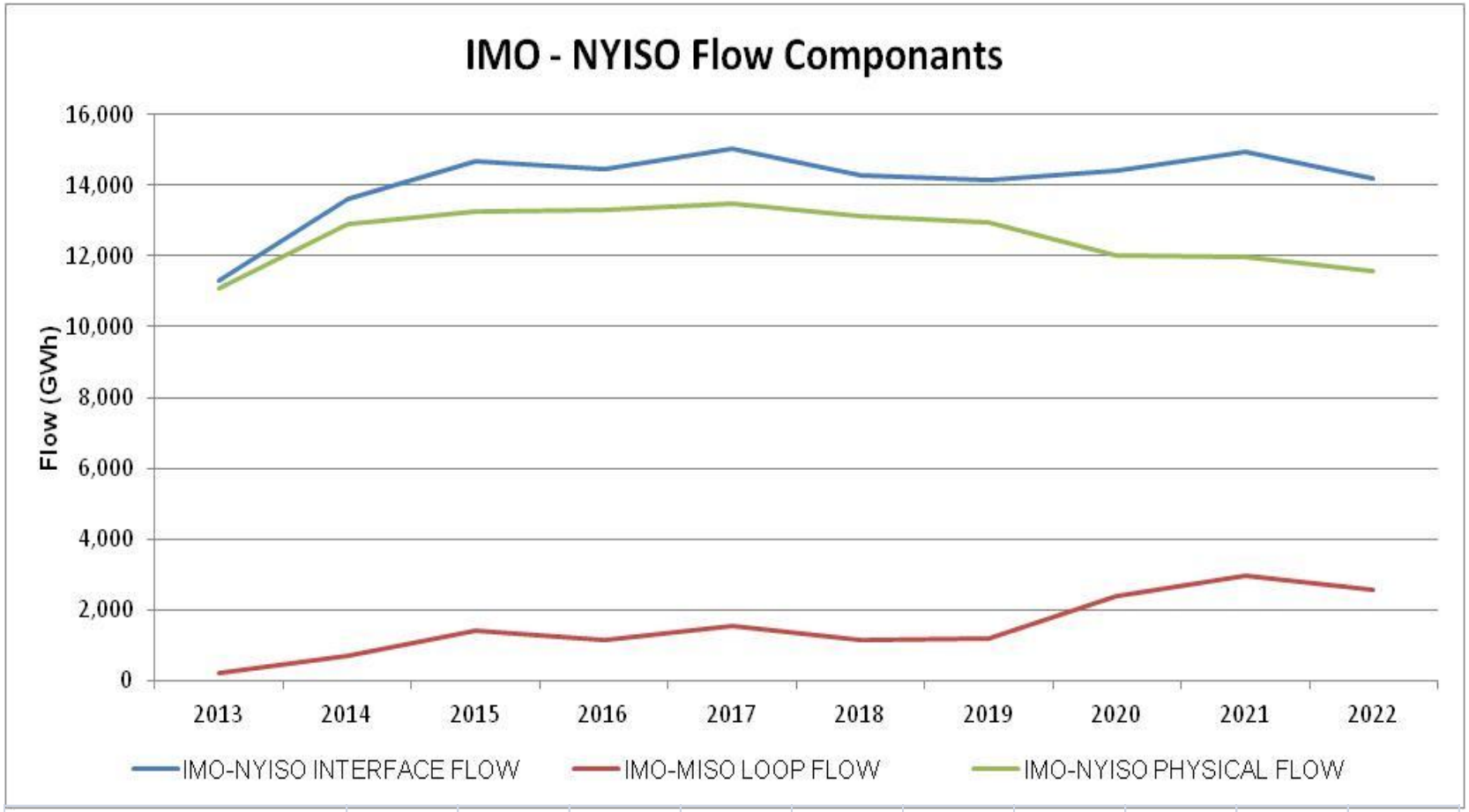
(*) NORMAL: No outages on Y49, Y50, Neptune

OUTAGE: Outages on Y49, Y50, Neptune

Projected Net Imports

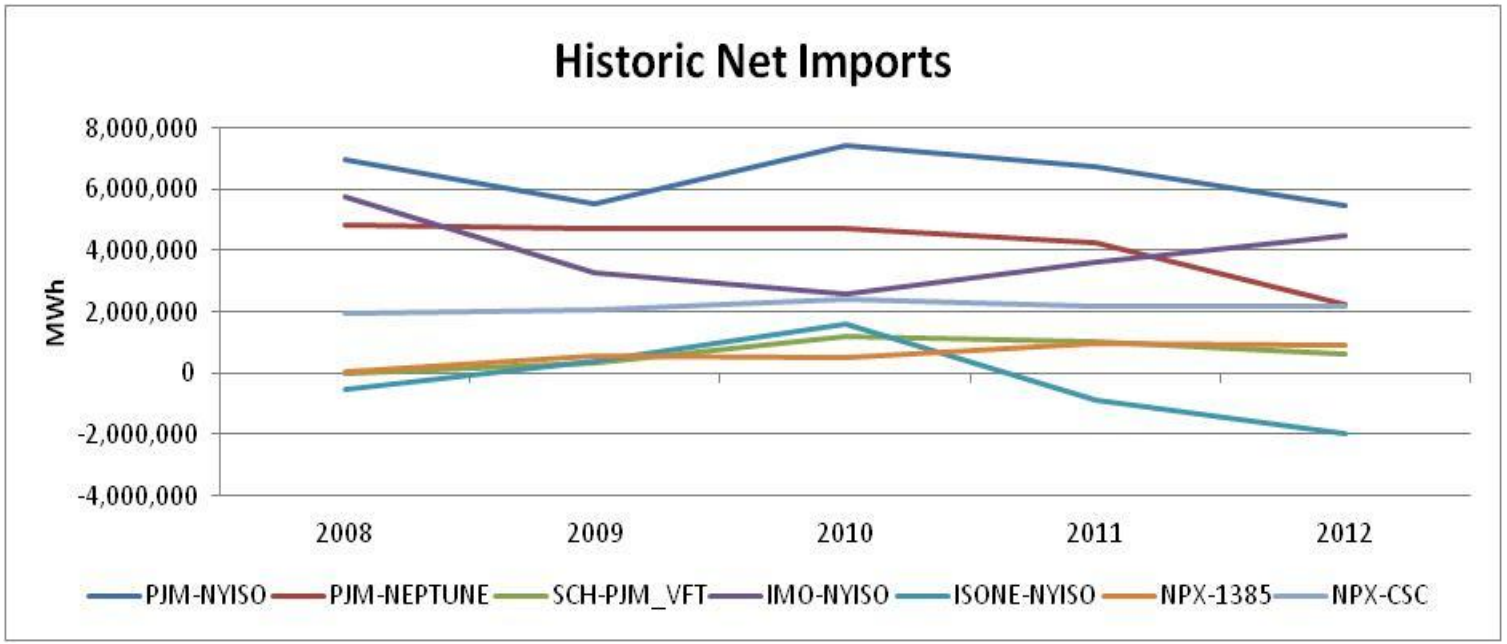
- **Shift in Imports from PJM to Exports to PJM after 2019 due to shift in relative economics**
  - ***PJM resources now relatively more expensive than NYISO and ISO-NE resources***
  - ***NYISO's and ISO-NE's fuel mix more heavily natural gas than PJM's***
- **Simultaneous decrease in Imports from IESO and increase in IESO/PJM Wheels is observed**
- **Pattern of ISO-NE imports (gradual decrease and increase in 2020) due to relative economics as CO_2 costs rise through period (affecting NYISO and ISO-NE) and then are applied region-wide**

Projected IMO-NYISO Flows



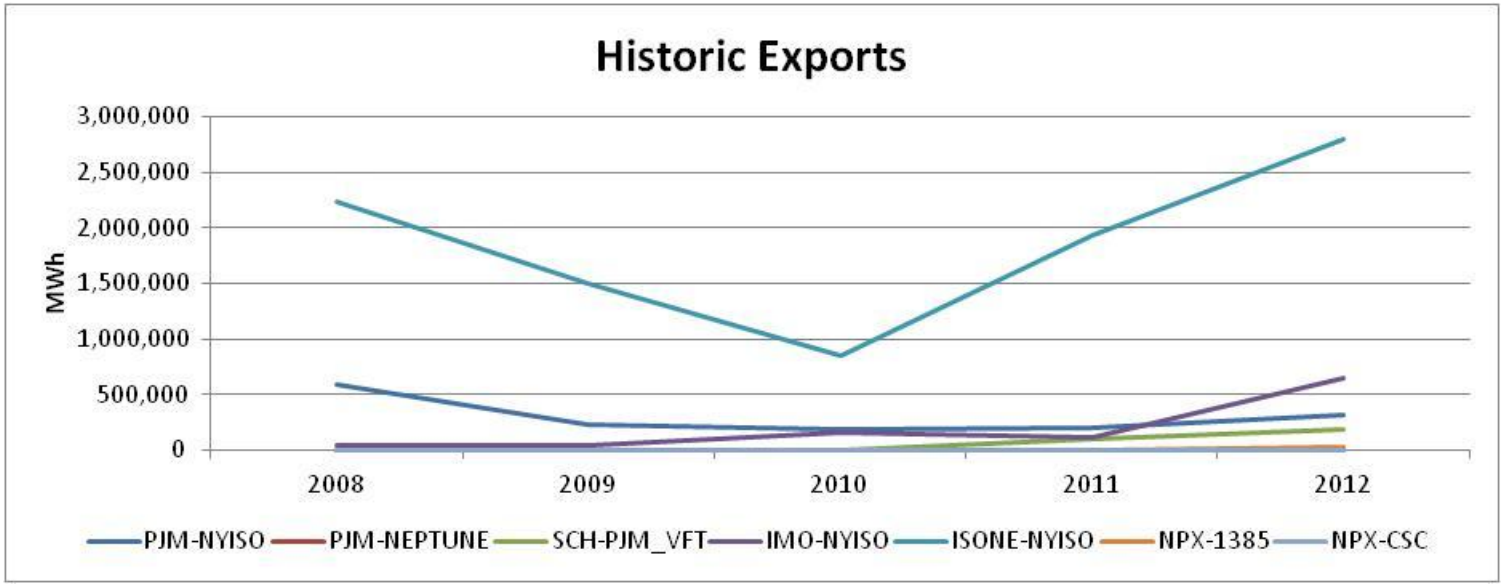
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
IMO-NYISO INTERFACE FLOW	11,328	13,611	14,661	14,437	15,049	14,262	14,146	14,388	14,940	14,169
IMO-MISO LOOP FLOW	223	697	1,415	1,143	1,568	1,152	1,190	2,390	2,970	2,583
IMO-NYISO PHYSICAL FLOW	11,106	12,914	13,246	13,295	13,481	13,110	12,955	11,999	11,970	11,586

Historic Real-Time Metered Flows



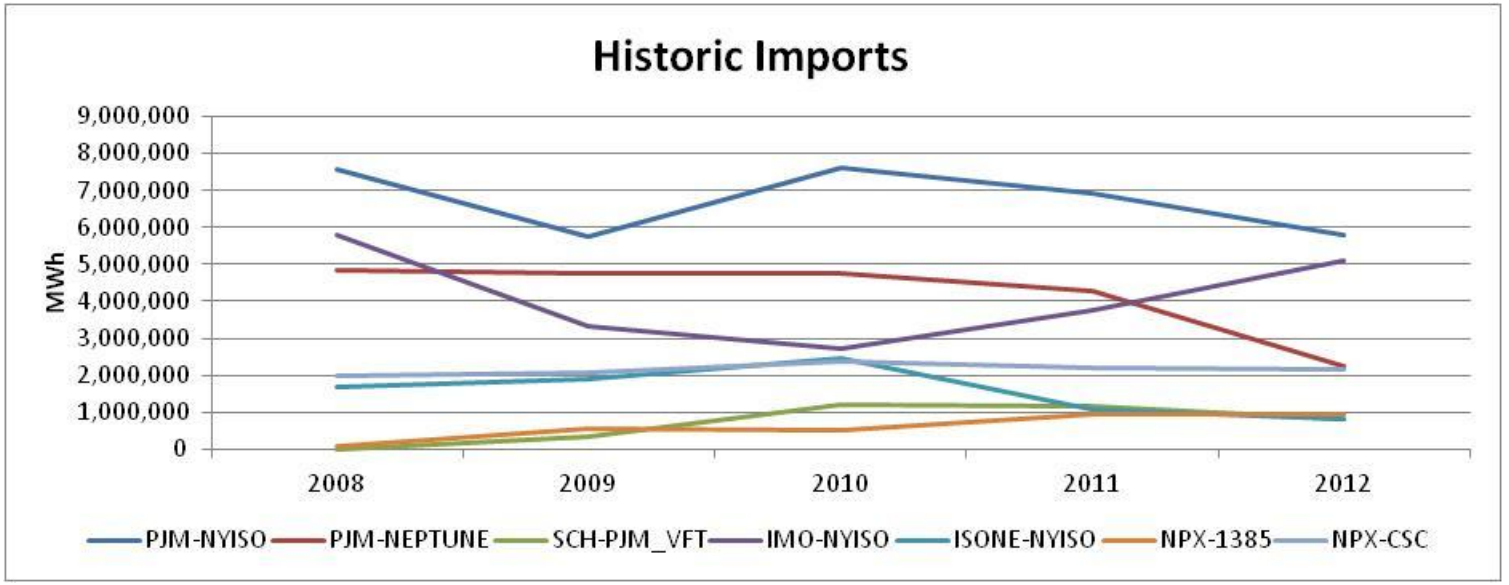
	PJM-NYISO	PJM-NEPTUNE	SCH-PJM_VFT	IMO-NYISO	ISONE-NYISO	NPX-1385	NPX-CSC
2008	6,957,442	4,825,017	0	5,749,370	-540,954	65,543	1,964,254
2009	5,535,962	4,738,776	343,005	3,290,576	403,206	544,813	2,054,232
2010	7,434,853	4,740,284	1,209,860	2,557,312	1,595,931	530,543	2,390,115
2011	6,713,476	4,281,443	1,052,044	3,637,959	-862,085	952,086	2,181,212
2012	5,495,094	2,238,247	631,576	4,460,754	-1,996,378	936,169	2,169,645

Historic Real-Time Metered Flows



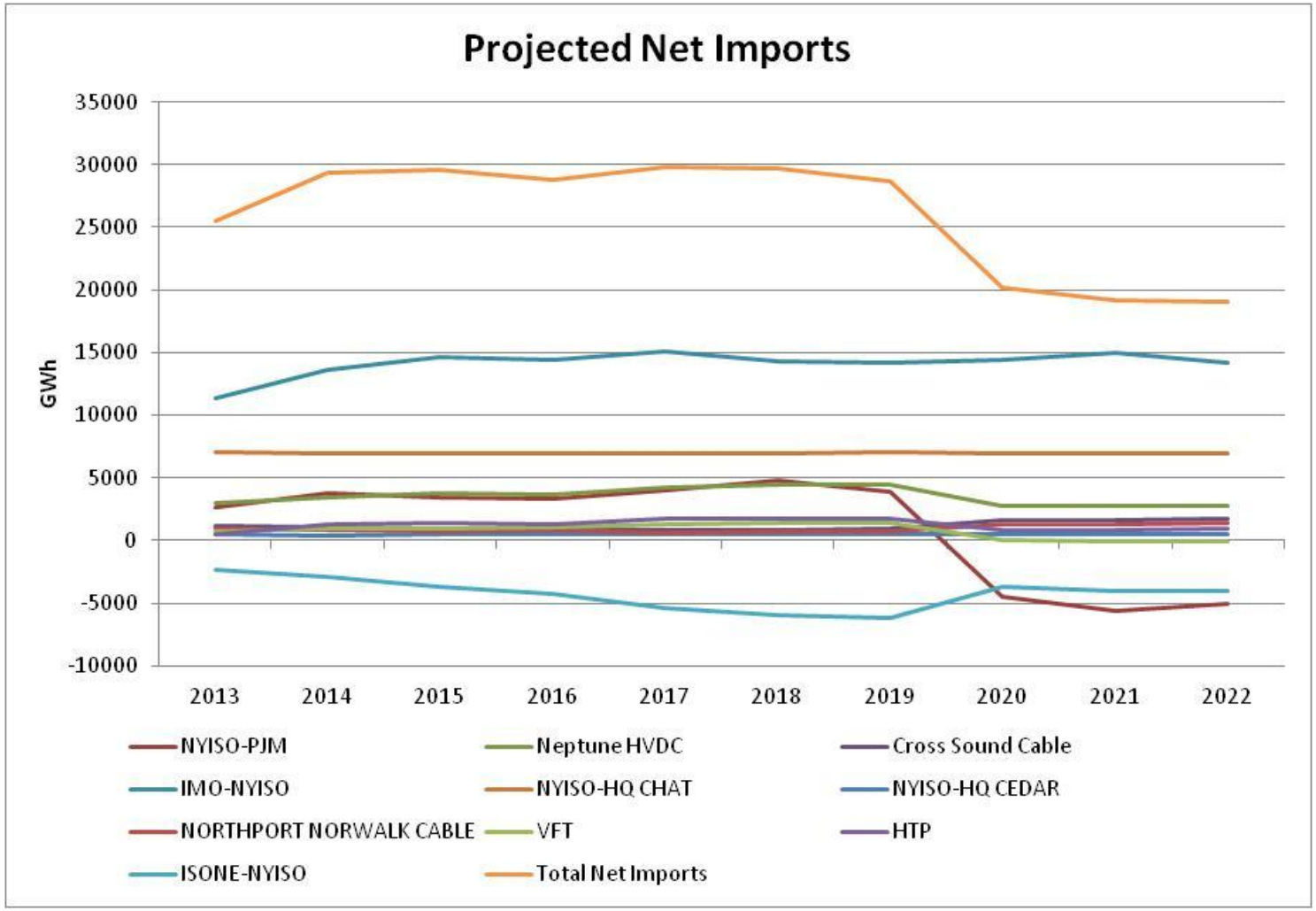
	PJM-NYISO	PJM-NEPTUNE	SCH-PJM_VFT	IMO-NYISO	ISONE-NYISO	NPX-1385	NPX-CSC
2008	588,552	94	0	40,699	2,238,362	6	128
2009	231,181	130	636	35,218	1,493,805	989	102
2010	190,094	155	64	163,733	855,521	444	67
2011	200,762	45	105,133	120,225	1,932,723	2,097	79
2012	315,388	0	178,894	644,857	2,801,325	21,896	0

Historic Real-Time Metered Flows



	PJM-NYISO	PJM-NEPTUNE	SCH-PJM_VFT	IMO-NYISO	ISONE-NYISO	NPX-1385	NPX-CSC
2008	7,545,994	4,825,110	0	5,790,069	1,697,408	65,549	1,964,382
2009	5,767,143	4,738,906	343,641	3,325,793	1,897,011	545,802	2,054,335
2010	7,624,947	4,740,439	1,209,924	2,721,046	2,451,453	530,988	2,390,183
2011	6,914,237	4,281,487	1,157,177	3,758,184	1,070,638	954,183	2,181,291
2012	5,810,482	2,238,247	810,470	5,105,611	804,946	958,064	2,169,645

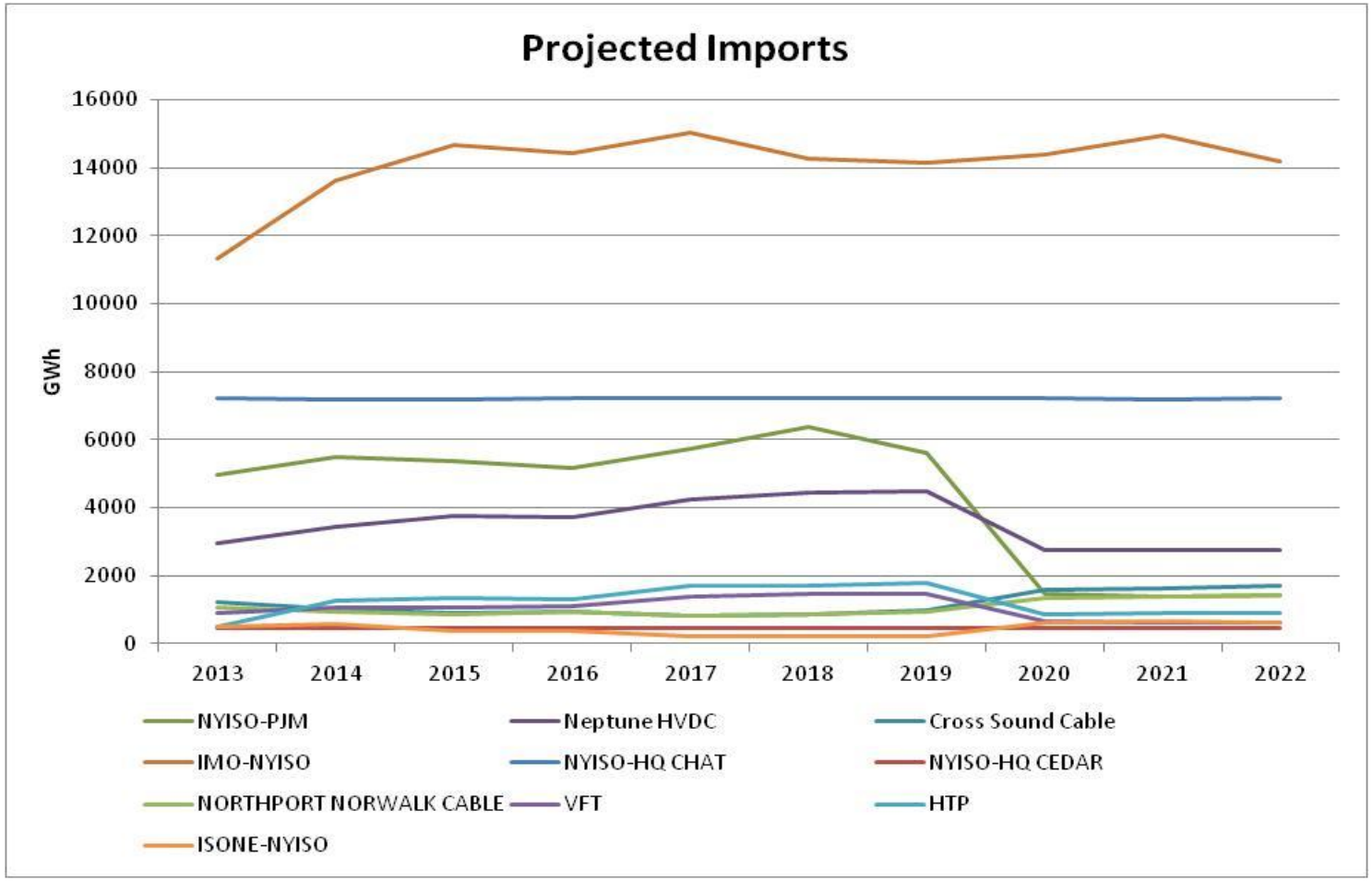
Projected Flows: Net Imports



Projected Flows: Net Imports

Net Imports Metric (GWh)	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
NYISO-PJM	2679.58	3788.9	3452.64	3362.71	3953.62	4843.05	3927.26	-4460.85	-5655.69	-5089.82
Neptune HVDC	2936.26	3452.06	3765.77	3712.66	4251.31	4433.01	4490.24	2770.8	2753.73	2740.56
Cross Sound Cable	1217.91	1020.28	901.99	929.5	805.95	848.59	970.31	1572.04	1615.96	1716.28
IMO-NYISO	11328.21	13611.18	14661.16	14437.17	15048.92	14261.72	14145.84	14388.49	14939.79	14169.39
NYISO-HQ CHAT	7004.7	6953.81	6961	6997.23	6987.39	6999.39	7004.7	6989.42	6969.38	6974.46
NYISO-HQ CEDAR	439.15	433.87	436.42	438.06	437.56	439.14	439.14	437.5	437.13	436.84
NORTHPORT NORWALK CABLE	982.65	803.01	716.8	818.03	625.66	694.31	763.06	1261.07	1310.2	1351.37
VFT	757.92	978.32	977.08	1021.83	1312.39	1356.86	1358.44	79.69	-30.66	-69.6
HTP	512.23	1261.12	1352.18	1309.76	1706.56	1708.3	1779.11	852.48	884.2	893.4
ISONE-NYISO	-2313.61	-2895.2	-3694.01	-4234.9	-5357.6	-5930.09	-6220.18	-3703.61	-4023.74	-4015.26
Total Net Imports	25545	29407.35	29531.03	28792.05	29771.76	29654.28	28657.92	20187.03	19200.3	19107.62

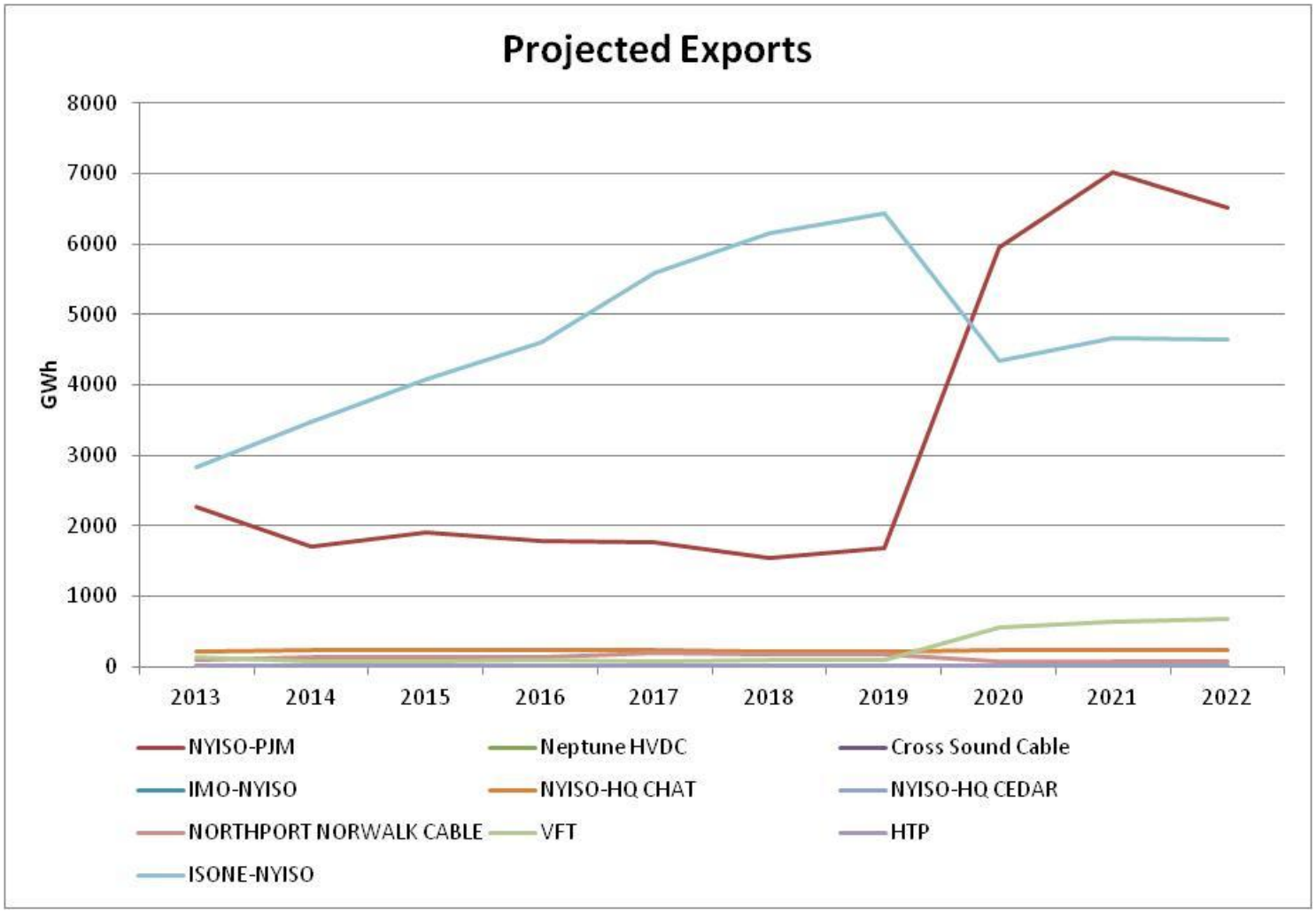
Projected Flows: Imports



Projected Flows: Imports

Imports Metric (GWh)	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
NYISO-PJM	4954.31	5483.94	5364.27	5150.35	5713.31	6393.13	5601.99	1485.85	1370.55	1428.65
Neptune HVDC	2936.26	3452.07	3765.77	3712.66	4251.31	4433.01	4490.24	2770.8	2753.73	2740.56
Cross Sound Cable	1217.91	1020.28	901.99	929.5	805.95	848.59	970.32	1572.04	1615.96	1716.28
IMO-NYISO	11345.67	13611.39	14661.32	14437.18	15048.92	14261.87	14147.4	14389.14	14940.26	14173.27
NYISO-HQ CHAT	7229.42	7181.33	7188.52	7224.75	7214.38	7224.11	7229.43	7216.94	7196.9	7201.98
NYISO-HQ CEDAR	461.32	456.05	458.6	460.24	459.74	461.32	461.32	459.68	459.31	459.02
NORTHPORT NORWALK CABLE	1083.83	932.63	856.36	947.15	817.8	875.11	936.46	1341.27	1381.23	1417.84
VFT	900.99	1055.81	1050.65	1119.13	1391.91	1450.94	1450.59	646.03	609.17	612.22
HTP	512.88	1261.89	1352.94	1310.55	1707.24	1708.98	1779.79	853.27	885.1	894.3
ISONE-NYISO	510.96	588.22	392.59	376.93	222.67	224.81	216.5	630.84	647.33	619.69
Total Imports	31153.55	35043.61	35993.01	35668.44	37633.23	37881.87	37284.04	31365.86	31859.54	31263.81

Projected Flows: Exports



Projected Flows: Exports

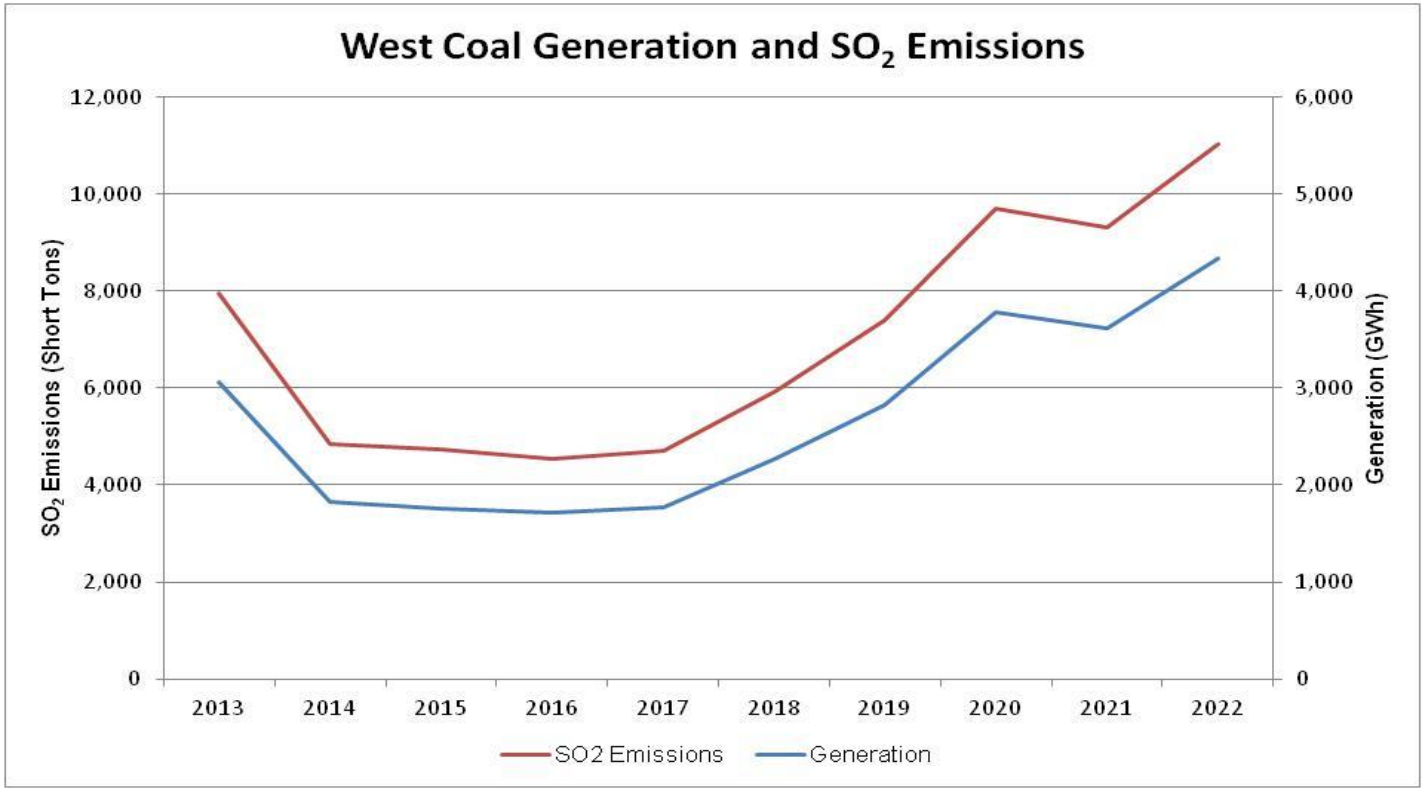
Exports Metric (GWh)	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
NYISO-PJM	2274.73	1695.04	1911.63	1787.65	1759.69	1550.07	1674.73	5946.7	7026.25	6518.47
Neptune HVDC	0	0.01	0	0	0	0	0	0	0	0.01
Cross Sound Cable	0	0	0	0	0	0	0	0	0	0
IMO-NYISO	17.46	0.21	0.15	0.01	0	0.15	1.56	0.65	0.47	3.88
NYISO-HQ CHAT	224.72	227.52	227.52	227.52	226.98	224.72	224.72	227.52	227.52	227.52
NYISO-HQ CEDAR	22.18	22.18	22.18	22.18	22.18	22.18	22.18	22.18	22.18	22.18
NORTHPORT NORWALK CABLE	101.18	129.61	139.56	129.12	192.15	180.8	173.4	80.2	71.03	66.47
VFT	143.07	77.49	73.57	97.31	79.52	94.07	92.15	566.34	639.82	681.81
HTP	0.66	0.77	0.76	0.79	0.68	0.68	0.68	0.8	0.9	0.9
ISONE-NYISO	2824.58	3483.42	4086.6	4611.83	5580.28	6154.9	6436.68	4334.46	4671.07	4634.96
Total Exports	5608.58	5636.25	6461.97	6876.41	7861.479	8227.57	8626.1	11178.85	12659.24	12156.2

IESO Import Increases in 2013

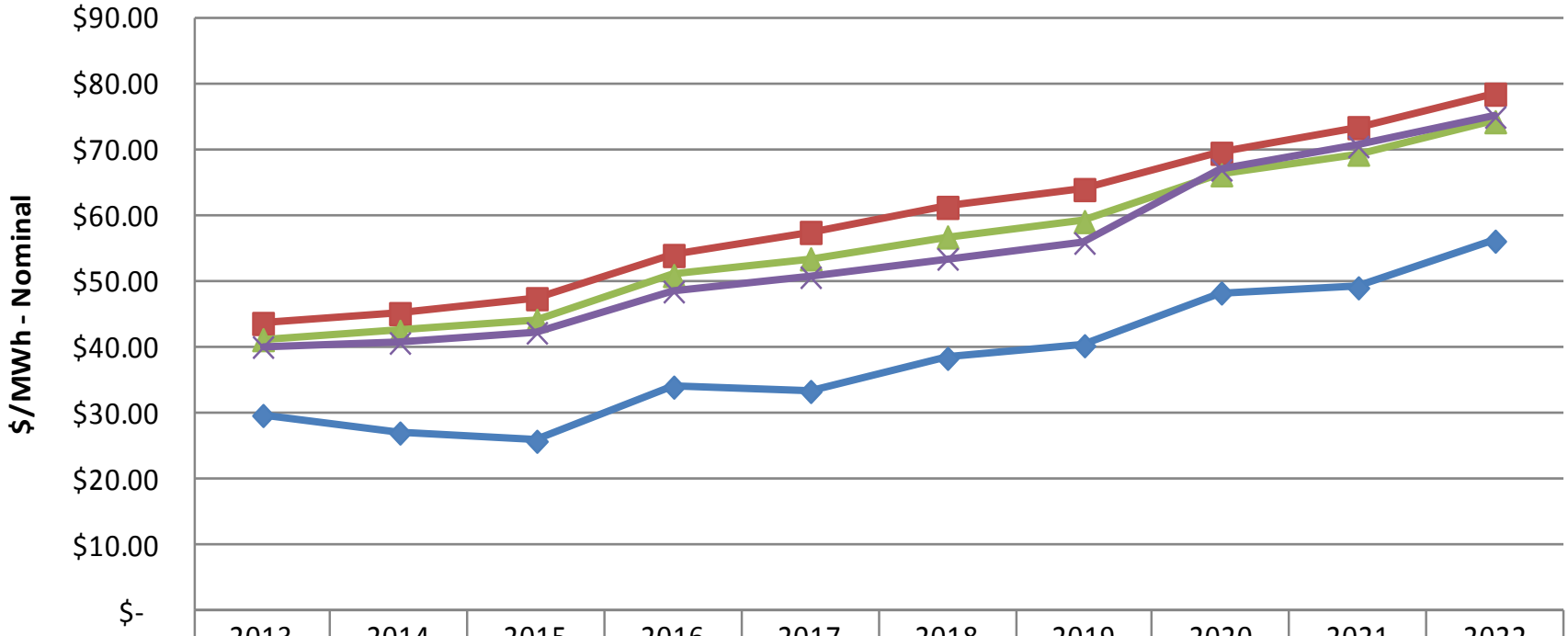
- Driven by Bruce Nuclear units returning to service
- "In October 2012 Bruce A units 1 and 2 were restarted and achieved commercial operation, supplying a combined capacity of 1,500 MW to the Ontario grid after being shutdown for 17 years. "
- http://www.powerauthority.on.ca/nuclear/bruce-restart-and-refurbishment-project-3000-mw-tiverton

Increase in West Zone Emission Levels

- Driven by an increase in production from West coal units



Simple Average LBMP ($/MWh)



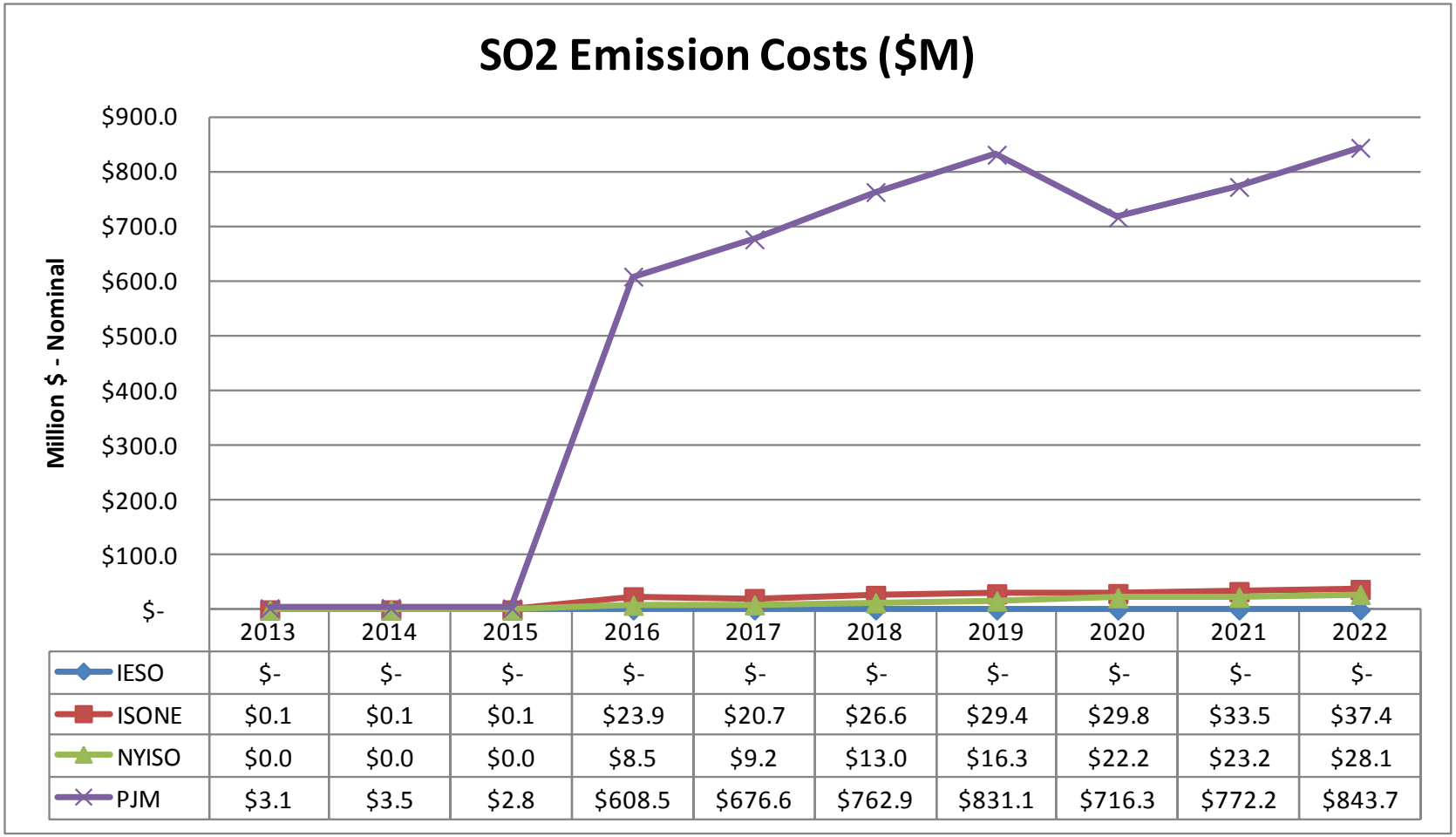
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
IESO	$29.69	$27.03	$25.78	$33.99	$33.33	$38.35	$40.27	$48.26	$49.04	$56.11
ISONE	$43.64	$45.13	$47.40	$53.94	$57.44	$61.24	$63.94	$69.44	$73.32	$78.40
NYISO	$41.19	$42.46	$44.12	$50.91	$53.43	$56.76	$59.09	$66.18	$69.31	$74.22
PJM	$40.07	$40.68	$42.23	$48.46	$50.66	$53.43	$55.83	$66.93	$70.46	$74.93

SO_2 Emission Costs ($M)

SO2 Emission Costs ($M)	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
IESO	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
ISONE	$ 0.1	$ 0.1	$ 0.1	$ 23.9	$ 20.7	$ 26.6	$ 29.4	$ 29.8	$ 33.5	$ 37.4
NYISO	$ 0.0	$ 0.0	$ 0.0	$ 8.5	$ 9.2	$ 13.0	$ 16.3	$ 22.2	$ 23.2	$ 28.1
PJM	$ 3.1	$ 3.5	$ 2.8	$ 608.5	$ 676.6	$ 762.9	$ 831.1	$ 716.3	$ 772.2	$ 843.7
System Total	**$ 3.3**	**$ 3.6**	**$ 2.9**	**$ 641.0**	**$ 706.5**	**$ 802.4**	**$ 876.7**	**$ 768.4**	**$ 828.9**	**$ 909.2**

Note: Increase in 2016 due to increase in per-ton cost associated with implementation of Mercury and Air Toxics Standards.

SO_2 Emission Costs ($M)

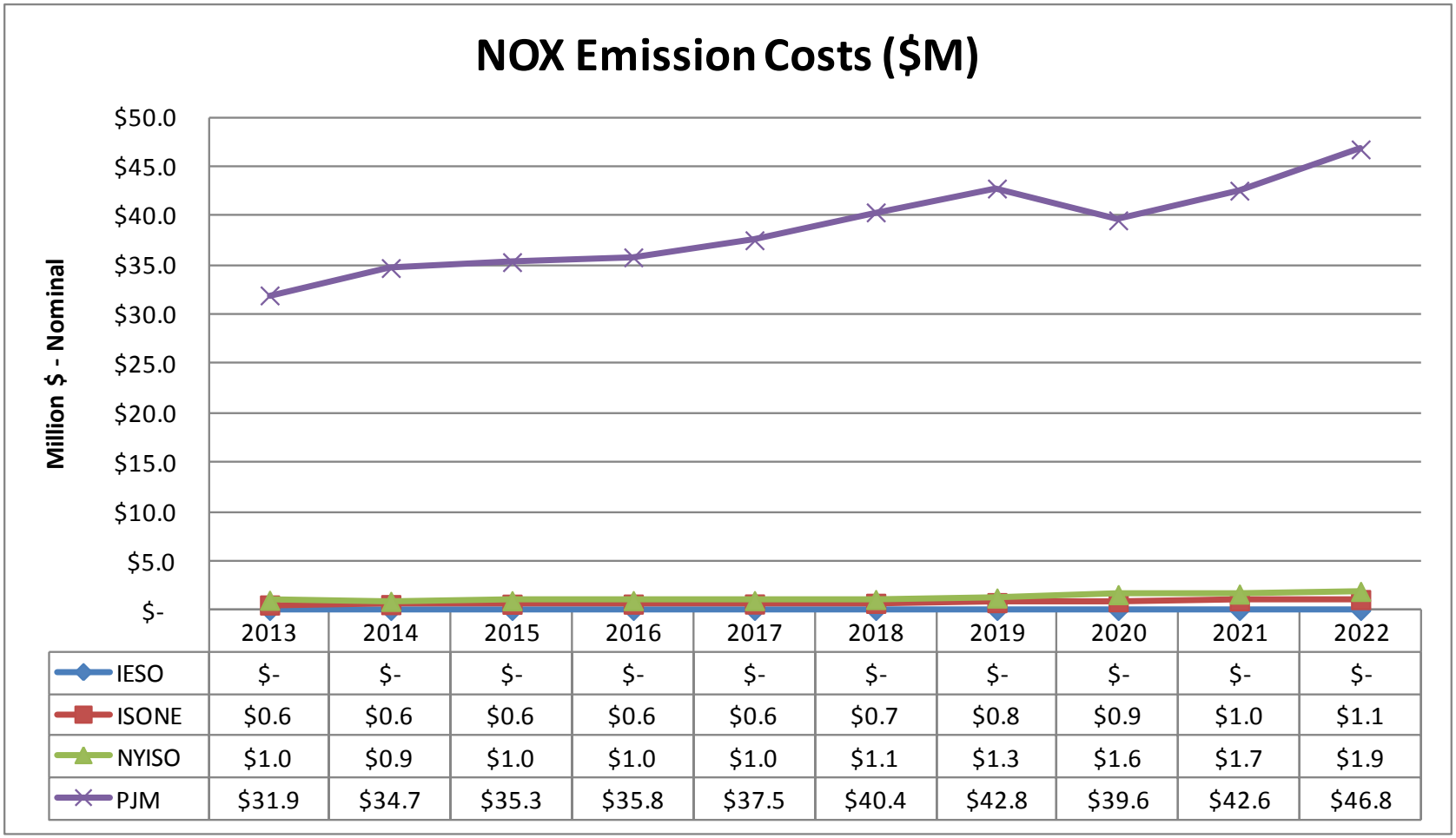


	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
IESO	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
ISONE	$0.1	$0.1	$0.1	$23.9	$20.7	$26.6	$29.4	$29.8	$33.5	$37.4
NYISO	$0.0	$0.0	$0.0	$8.5	$9.2	$13.0	$16.3	$22.2	$23.2	$28.1
PJM	$3.1	$3.5	$2.8	$608.5	$676.6	$762.9	$831.1	$716.3	$772.2	$843.7

NO_x Emission Costs ($M)

NOX Emission Costs ($M)	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
IESO	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
ISONE	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.6	$ 0.7	$ 0.8	$ 0.9	$ 1.0	$ 1.1
NYISO	$ 1.0	$ 0.9	$ 1.0	$ 1.0	$ 1.0	$ 1.1	$ 1.3	$ 1.6	$ 1.7	$ 1.9
PJM	$ 31.9	$ 34.7	$ 35.3	$ 35.8	$ 37.5	$ 40.4	$ 42.8	$ 39.6	$ 42.6	$ 46.8
System Total	**$ 33.5**	**$ 36.2**	**$ 36.9**	**$ 37.4**	**$ 39.2**	**$ 42.2**	**$ 44.8**	**$ 42.0**	**$ 45.2**	**$ 49.8**

NO_x Emission Costs ($M)



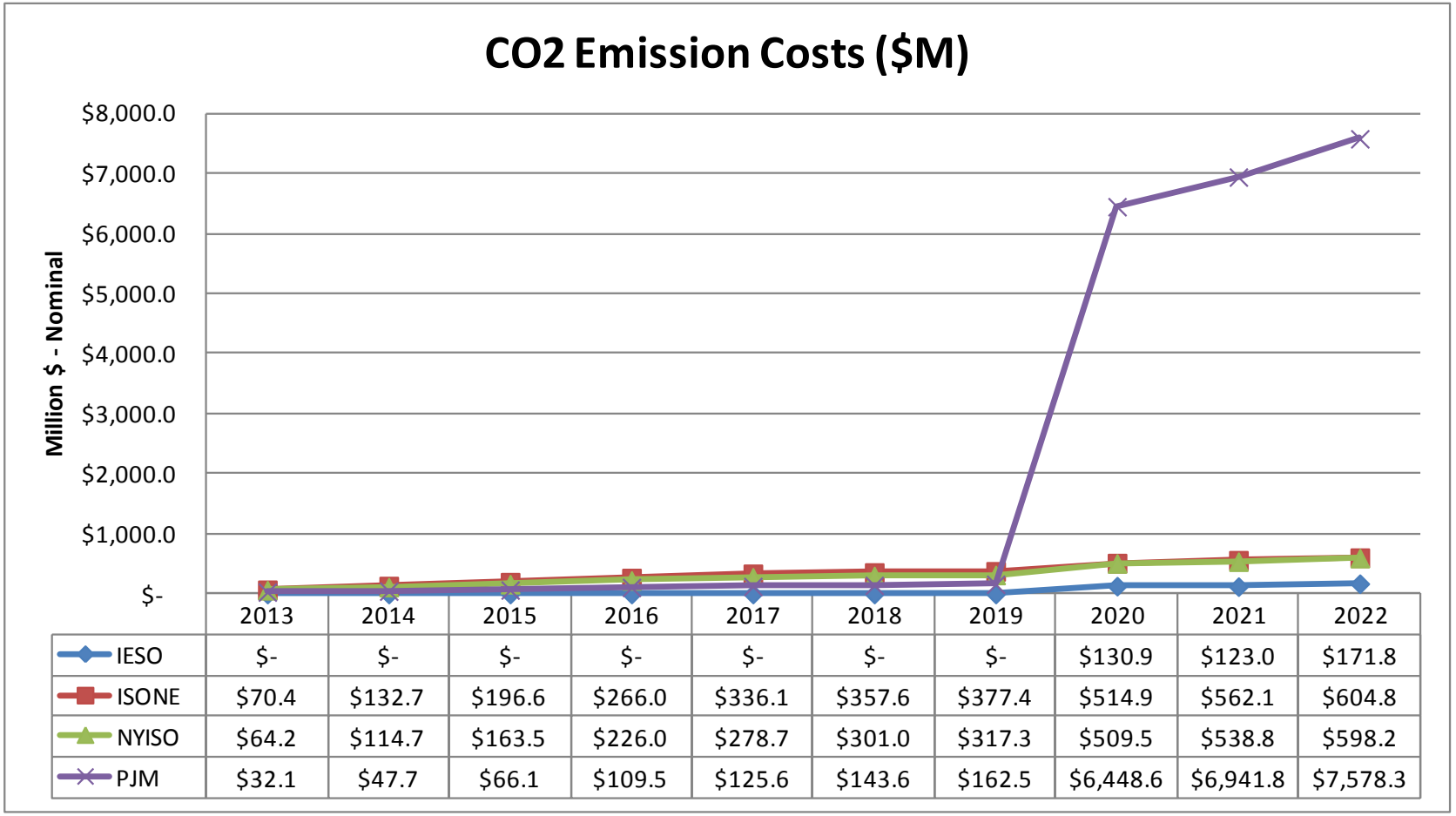
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
IESO	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
ISONE	$0.6	$0.6	$0.6	$0.6	$0.6	$0.7	$0.8	$0.9	$1.0	$1.1
NYISO	$1.0	$0.9	$1.0	$1.0	$1.0	$1.1	$1.3	$1.6	$1.7	$1.9
PJM	$31.9	$34.7	$35.3	$35.8	$37.5	$40.4	$42.8	$39.6	$42.6	$46.8

CO_2 Emission Costs ($M)

CO2 Emissions Cost ($M)	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
IESO	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 130.9	$ 123.0	$ 171.8
ISONE	$ 70.4	$ 132.7	$ 196.6	$ 266.0	$ 336.1	$ 357.6	$ 377.4	$ 514.9	$ 562.1	$ 604.8
NYISO	$ 64.2	$ 114.7	$ 163.5	$ 226.0	$ 278.7	$ 301.0	$ 317.3	$ 509.5	$ 538.8	$ 598.2
PJM	$ 32.1	$ 47.7	$ 66.1	$ 109.5	$ 125.6	$ 143.6	$ 162.5	$ 6,448.6	$ 6,941.8	$ 7,578.3
System Total	**$ 166.7**	**$ 295.1**	**$ 426.1**	**$ 601.4**	**$ 740.3**	**$ 802.2**	**$ 857.2**	**$ 7,603.8**	**$ 8,165.6**	**$ 8,953.1**

Note: Increase in 2020 due to expansion of CO2 emissions program to IESO and entirety of PJM.

CO_2 Emission Costs ($M)

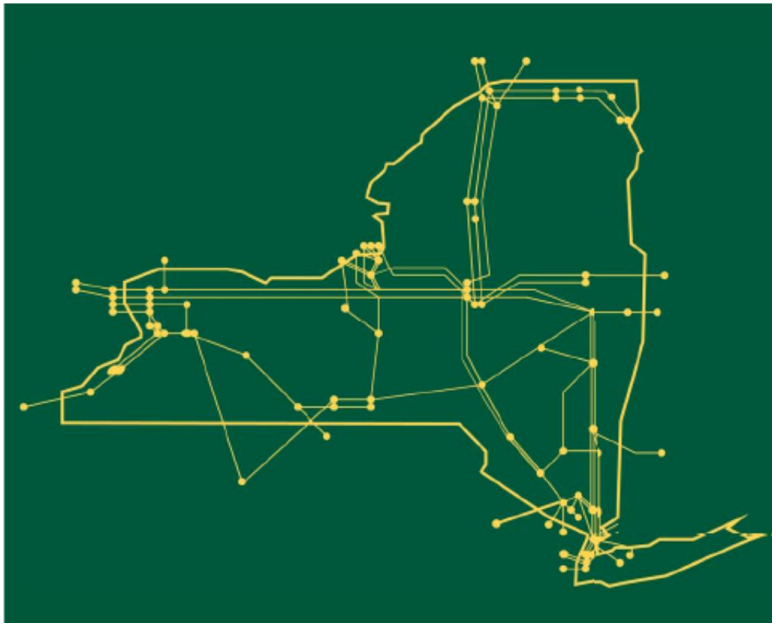


	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
IESO	$-	$-	$-	$-	$-	$-	$-	$130.9	$123.0	$171.8
ISONE	$70.4	$132.7	$196.6	$266.0	$336.1	$357.6	$377.4	$514.9	$562.1	$604.8
NYISO	$64.2	$114.7	$163.5	$226.0	$278.7	$301.0	$317.3	$509.5	$538.8	$598.2
PJM	$32.1	$47.7	$66.1	$109.5	$125.6	$143.6	$162.5	$6,448.6	$6,941.8	$7,578.3

Renewable Portfolio Standard Modeling

- Modeling only Main Tier in EEPS/RPS Scenario
- Captures vast majority (95%) of RPS
- Avoids uncertainty with allocating Customer Tier (behind the meter) impacts to individual load zones

The New York Independent System Operator (NYISO) is a not-for-profit corporation responsible for operating the state's bulk electricity grid, administering New York's competitive wholesale electricity markets, conducting comprehensive long-term planning for the state's electric power system, and advancing the technological infrastructure of the electric system serving the Empire State.



www.nyiso.com