Constellation

Evaluating Power Purchasing Strategies for Your Business

How Power Purchasing Strategies Perform Across Varying Market Conditions

A Constellation White Paper—September 2022

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Executive Summary

Not All Power Purchasing Strategies are Created Equal

The method used to purchase power supply makes a significant impact on a retail customer's realized energy costs. The research detailed in this paper found that power purchasing strategies performed better than others regarding price and risk, and these often varied based on market conditions. When the market conditions moved from one extreme to another, a specific strategy's performance parameters also changed.

Across the spectrum of power market conditions, one truth remains constant: A blended purchasing strategy is most often a better way to procure power for most businesses.

Regardless of factors like a growing or flat economy and/or short-term power market fluctuations, a layered purchasing strategy has reduced budget risks and prices over the last 11 years in various market conditions across all four ISOs. By taking the time to deploy an approach that incorporates solution type, fixed percentages, frequency, and timing elements in an effective manner, a power buyer can improve their long-run outcomes.

How You Buy Your Energy Matters

Enterprise energy buyers in states[1] with competitive retail power markets enjoy a key benefit of being able to select their power supplier and related products, but also can choose from a variety of retail supply contract types, like monthly or multi-year agreements, made available in various power supply procurement structures.

Naturally, this autonomy of choice leads to some important questions, like,

- When is the best month or time to purchase?
- How will the power markets impact my budget?
- What is the best way to lower my cost and/or the risk?

Not to mention,

- How does a unique load shape or time horizon figure into the purchase?

Still, despite asking all the right questions, many energy buyers overlook one other critical factor that can help them control cost and minimize risk; that question is,

"How should I purchase my power?"

And the options for purchasing power in the forward markets are indeed vast, with just a few examples for consideration being,

- all months fixed, all-at-once
- all-at-once, during the Winter or Summer months only
- a proportionate blend of fixed purchases and index, with fixed purchases potentially layered-in over time

This amount of flexibility leads us to yet another question:

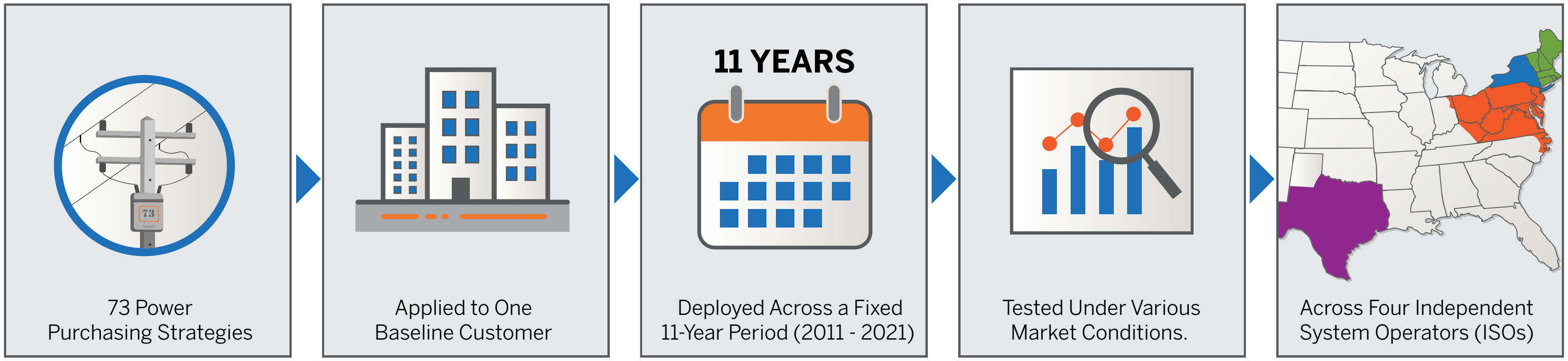
"Which power purchasing strategy is right for my business?"

But with the seemingly endless options available to purchase power in competitive markets, arriving at an optimum power purchasing strategy can seem daunting.

This white paper, which tested 73 different power purchasing strategies across four Independent System Operators (ISOs), can add clarity and confidence to that process.

Putting Power Purchasing Strategies to the Test

A Market Tested Study in Real-World Conditions



Constellation compiled and analyzed the price-performance and level of the associated risk of 73 hypothetical power purchasing strategies deployed against a baseline customer load profile over an 11-year period (2011 - 2021).

- In this paper, an update to a 2018 study also published by Constellation, the performance of these power purchasing strategies was measured across four ISOs:
  - ❍ **ERCOT** – Electric Reliability Council of Texas (the ISO covering most of Texas)
  - ❍ **ISONE** – Independent System Operator New England (the ISO covering most of New England)
  - ❍ **NYISO** – New York Independent System Operator (the ISO covering New York State)
  - ❍ **PJM** – a regional transmission organization (RTO) that coordinates the movement of wholesale electricity in all or parts of 13 states and the District of Columbia.

- Figure 1 summarizes the various parameters for the purchasing strategies under review in terms of price, timing, and execution components.
- The average $/MWh price for each purchasing strategy in each year was obtained and compared.
- The standard deviation was also derived for each purchasing strategy to measure the potential budget risk incurred by consistently deploying that strategy over the studied period.
- The 11-year period allowed for a mix of forward power market conditions and included years with significant index (LMP) volatility alongside those time periods that experienced relatively flat index prices.
- Intangibles due to shifts in the power markets, as seen by a post-shale gas boom, the significant deployment of renewable energy assets, plus erratic weather events, including polar vortexes and Winter Storm Uri (ERCOT), occurred during this period too, further cementing the real-world scope of the study.
- A sizable pricing variance exists in ERCOT primarily due to Winter Storm Uri in February 2021. For this reason, we have created alternative figures for ERCOT and have included them in the Appendix. These versions of the ERCOT Figures are labeled with an ALT (e.g., Figure 2D ALT) and show how the purchasing strategies would have performed if the price impacts caused by Winter Storm Uri were removed

Note: The Appendix also provides details about the basic assumptions used in developing the metrics presented in this paper, such as the generic load profile, ISO specifics, the time window covered in the study, as well as the definitions of the various purchasing strategy solution types.

Figure 1

Price Optimization		Timing Optimization	Execution of Purchases
Product/Solution Type (4)	**Percentage Fixed (3)**	**Timing of Purchases (2)**	**Execution of Purchases (3)**
• All-months fixed • On-peak periods fixed • Summer months fixed (JUN-AUG) • Winter months fixed (JAN-FEB)	• 100% • 50% • 25%	• LAST purchase occuring 6 months prior to flow date • FIRST purchase occuring 13 months prior to flow date	• All at once • In 3 equal 1/3 increments • In 12 equal 1/12 increments

Regional Highlights
High- and Low-Priced Purchasing Strategies (Figures 2A-2D[2])

The table below summarizes the purchasing strategy outcomes from each ISO across the time period contained in Figures 2A – 2D in $/MWh and the percentage difference at the bottom.

In PJM BGE (Figure 2A) we see that over the 11-year period the average price of the 73 purchasing strategies was $41.16 per MWh. The highest price purchasing strategy each year averaged $48.21 per MWh (about 17% above the average price), and the lowest price strategy each year averaged $36.75 per MWh (about 11% below the average price). Over the 11-year period, the average different low to high purchasing strategy was $11.46 per MWh or nearly 28%!

	PJM	ISONE	NYISO	ERCOT
Avg. Price of all purchasing strategies	$41.16	$42.98	$39.95	$40.13
Avg. of the Highest Prices each year	$48.21	$53.85	$49.39	$50.60
Avg. of the Lowest Prices each year	$36.75	$36.71	$34.96	$29.07
$ Difference Low to High	$11.46	$17.14	$14.43	$21.53
% Difference Low to High	27.8%	39.9%	26.1%	53.7%

The results for the remaining three ISOs are even more pronounced, with the most significant differences (roughly double) occurring in ERCOT (Figure 2D).

In ERCOT, the overall price difference between the highest and lowest prices averages across the 11-year period was about $21.50/MWh, nearly a 54% difference!

Regardless of the ISO/region, your purchasing strategy can significantly impact cost.

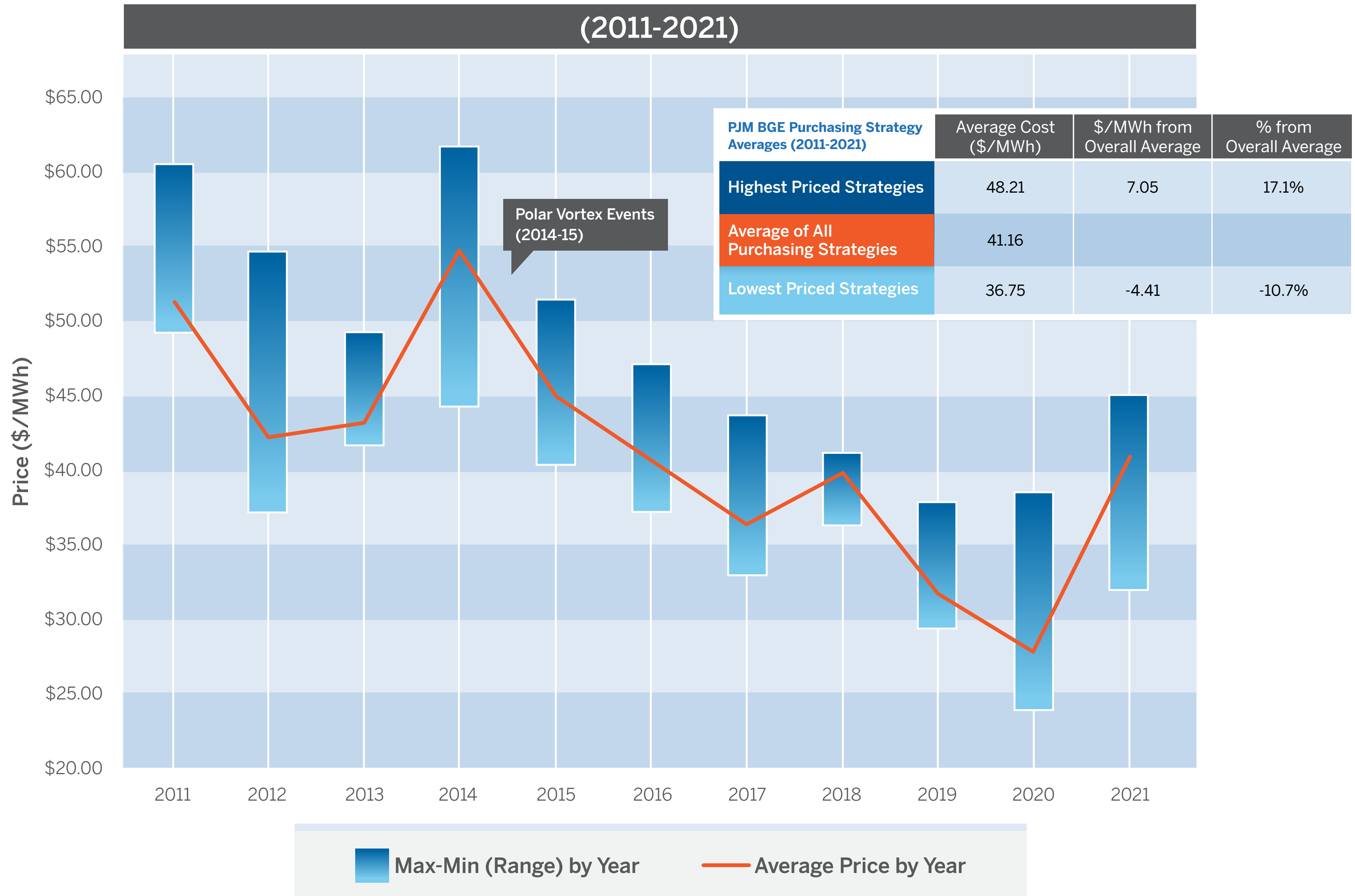
This sizable pricing variance exists primarily due to the Winter Storm Uri in February 2021. See the Appendix for more information on hypothetical

ERCOT outcomes absent the impact of Winter Storm Uri.

When viewing Figures 2A-2D the **red line** indicates the annual average price of all power purchasing strategies, and the **blue bars** overlay the range of lowest to highest priced strategies each year. "

Figure 2A

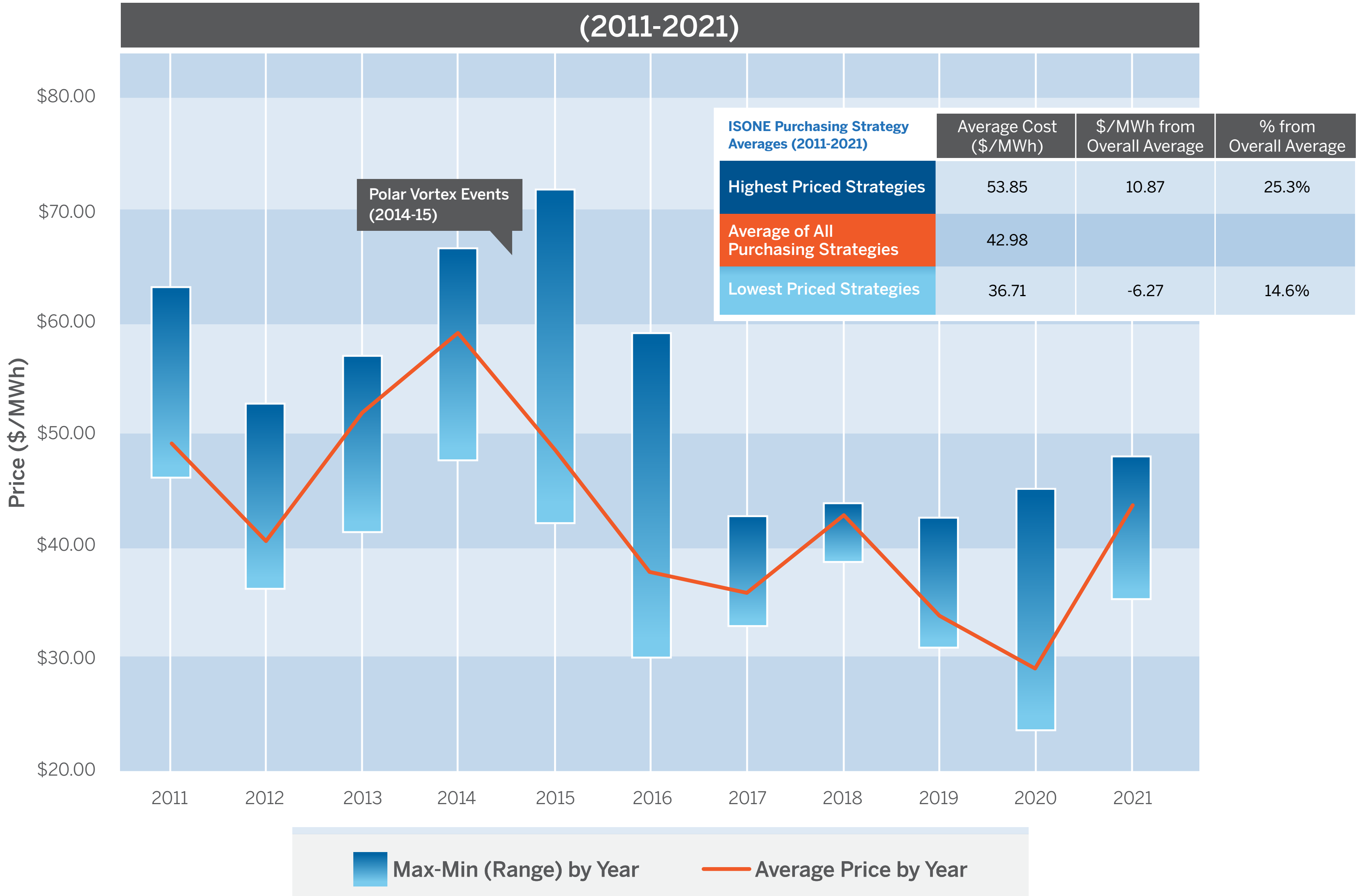
PJM BGE - Annual average, high, low range in prices for all purchasing strategies



PJM BGE Purchasing Strategy Averages (2011-2021)	Average Cost ($/MWh)	$/MWh from Overall Average	% from Overall Average
Highest Priced Strategies	48.21	7.05	17.1%
Average of All Purchasing Strategies	41.16		
Lowest Priced Strategies	36.75	-4.41	-10.7%

Figure 2B

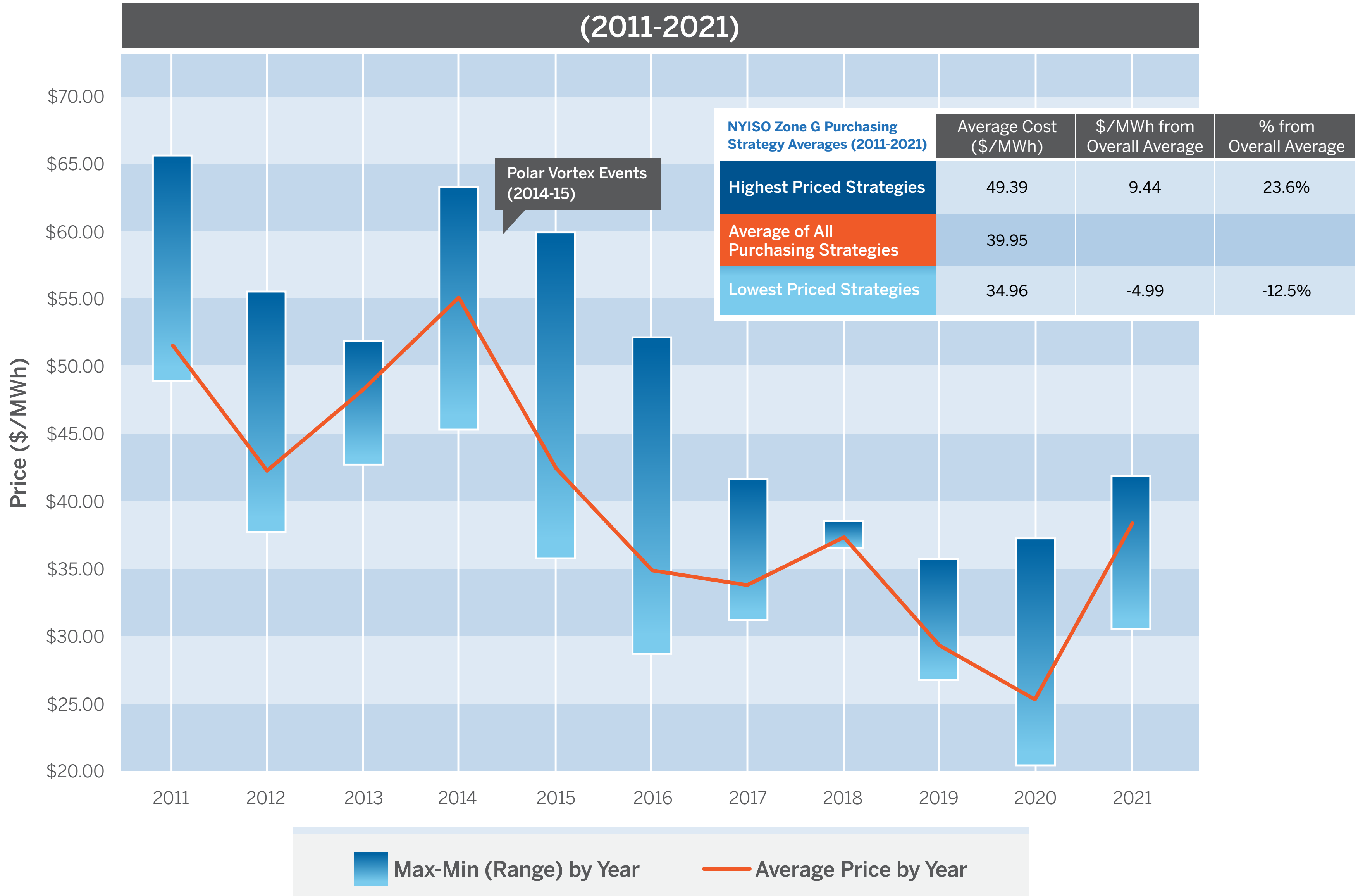
ISONE - Annual average, high, low range in prices for all purchasing strategies



ISONE Purchasing Strategy Averages (2011-2021)	Average Cost ($/MWh)	$/MWh from Overall Average	% from Overall Average
Highest Priced Strategies	53.85	10.87	25.3%
Average of All Purchasing Strategies	42.98		
Lowest Priced Strategies	36.71	-6.27	14.6%

Figure 2C

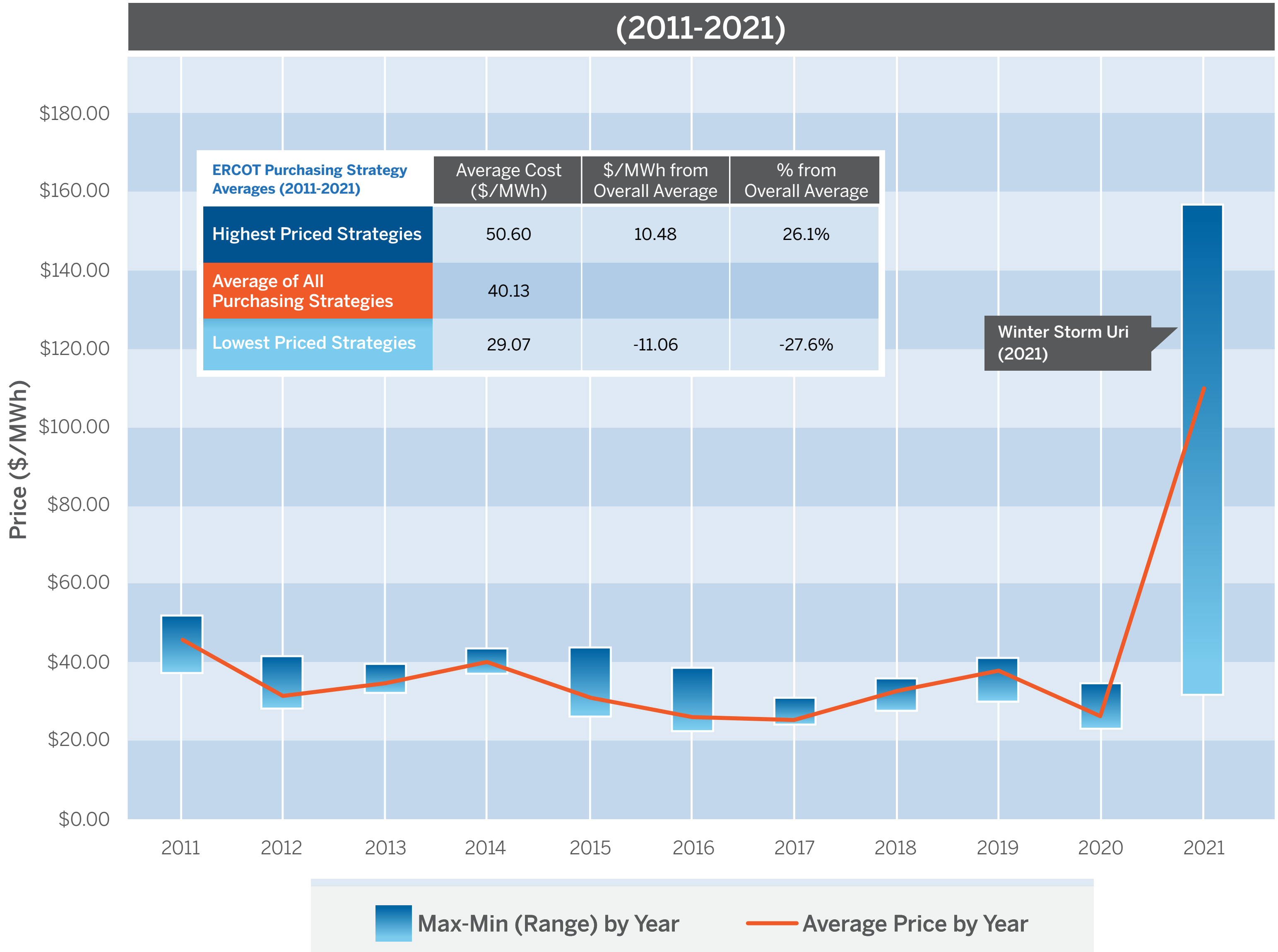
NYISO Zone G - Annual average, high, low range in prices for all purchasing strategies



NYISO Zone G Purchasing Strategy Averages (2011-2021)	Average Cost ($/MWh)	$/MWh from Overall Average	% from Overall Average
Highest Priced Strategies	49.39	9.44	23.6%
Average of All Purchasing Strategies	39.95		
Lowest Priced Strategies	34.96	-4.99	-12.5%

Figure 2D

ERCOT - Annual average, high, low range in prices for all purchasing strategies



ERCOT Purchasing Strategy Averages (2011-2021)	Average Cost ($/MWh)	$/MWh from Overall Average	% from Overall Average
Highest Priced Strategies	50.60	10.48	26.1%
Average of All Purchasing Strategies	40.13		
Lowest Priced Strategies	29.07	-11.06	-27.6%

Price and Standard Deviation (Risk) for Purchasing Strategies

How to View Figures 3A-3D

These figures show all 73 purchasing strategies across the 11-year period concerning their average price outcomes and standard deviations across each of the four ISOs. The reader will note that nine specific power purchasing strategies are called out on each of these figures. These are the same nine strategies highlighted in the "Bubble Charts" (Figures 4A-4D) in the next section.

Regional Highlights
Price and Risk Factors (Figures 3A-3C)

What do we find in the PJM, ISONE, and NYISO markets over the 11 period? (Figures 3A-3C)

The lowest price strategy was the "100% index" solution. Still, this price advantage was offset by this strategy's significant associated risk (as shown by its high standard deviation attribute on these charts).

The highest price strategy was in the "all-months fixed" product/solution.

Interestingly, the group of "all-months fixed" product/solutions do not seem to garner a proportional reduction in price risk avoidance that might have been expected compared to the "100% index" strategy.

Lower prices and risk avoidance were also observed in the "50% All-Months fixed" and in the "on-peak only fixed" product/solution groupings. These strategies typically performed better regarding price and risk relative to the either the "100% index" or the "all-months fixed" strategies.

The lowest prices and risks are often found in the "winter-months fixed" product/solution groupings. These typically ended up in the lower left-hand corner of these figures, indicating lower prices and lower risks on average across the period compared to any of the other strategies.

The exception to many of these observations in these three ISOs is visible in the ERCOT market (Figure 3D), where Winter Storm Uri substantially impacted the solutions that included index prices in February 2021. Because of this, we find very different results in Figure 3D pertaining to ERCOT due to the abnormally high index prices experienced in this region during February 2021 (February is defined as a 'winter' month in this study). In this case, the "100% index" along with the "summer-only" fixed product/solutions each ended up in the very highest risk and highest price areas of Figure 3D chart due to this occurrence.

See the Appendix for more information on ERCOT outcomes absent the impact of Winter Storm Uri.

Figure 3A

PJM BGE - 2011-2021: Price v. Standard Deviation

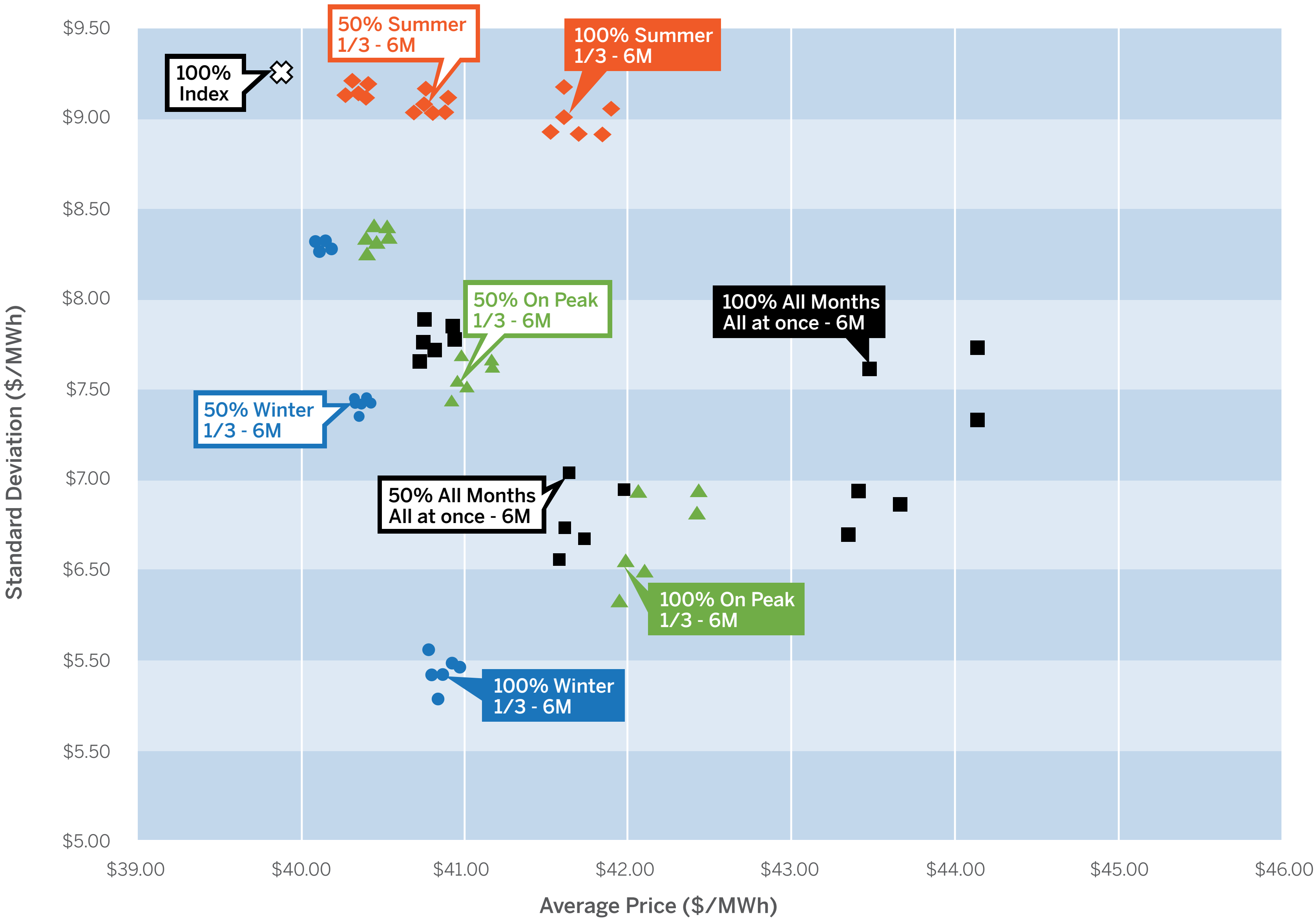


Figure 3B

ISONE - 2011-2021: Price v. Standard Deviation

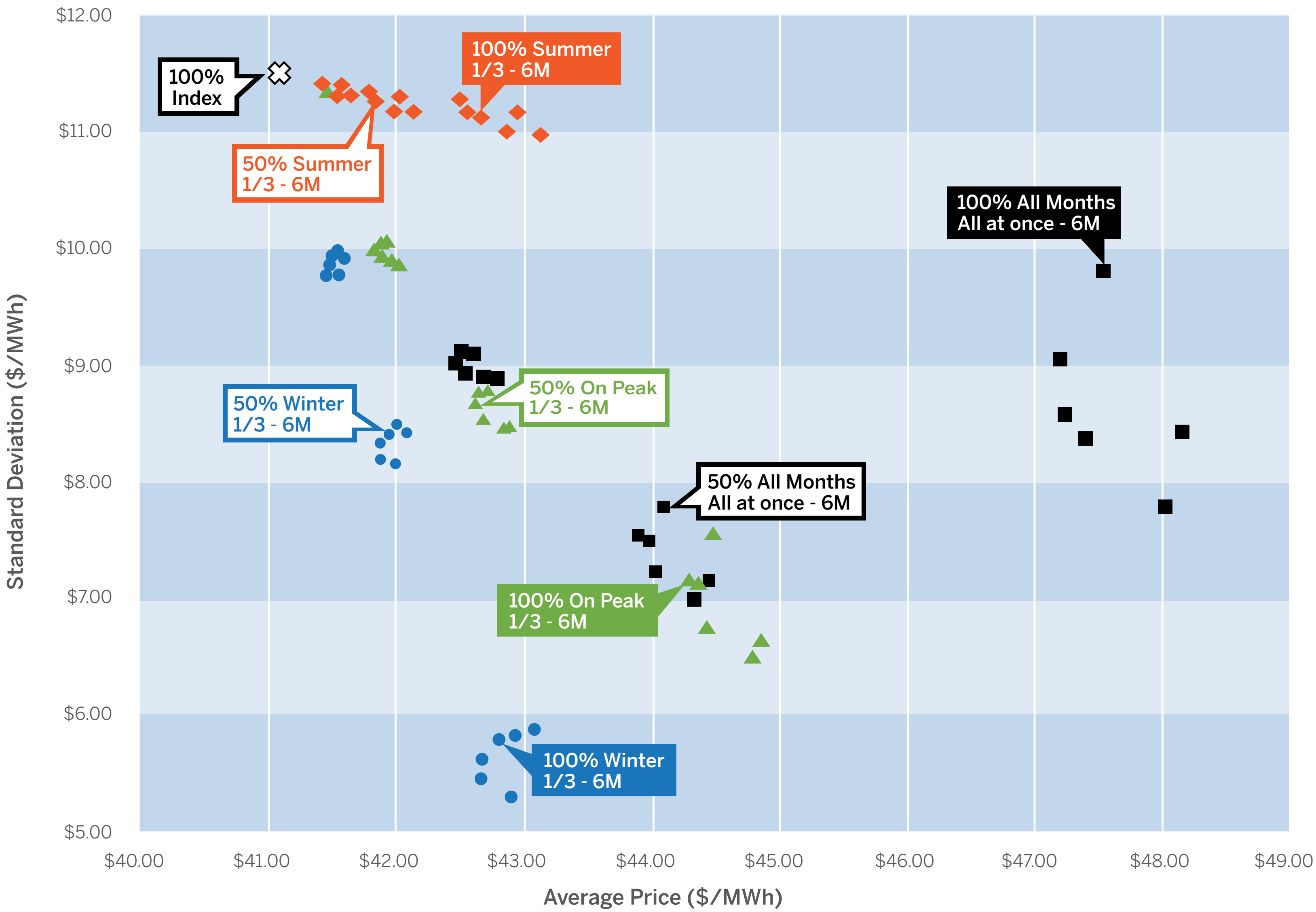


Figure 3C

NYISO Zone G - 2011-2021: Price v. Standard Deviation

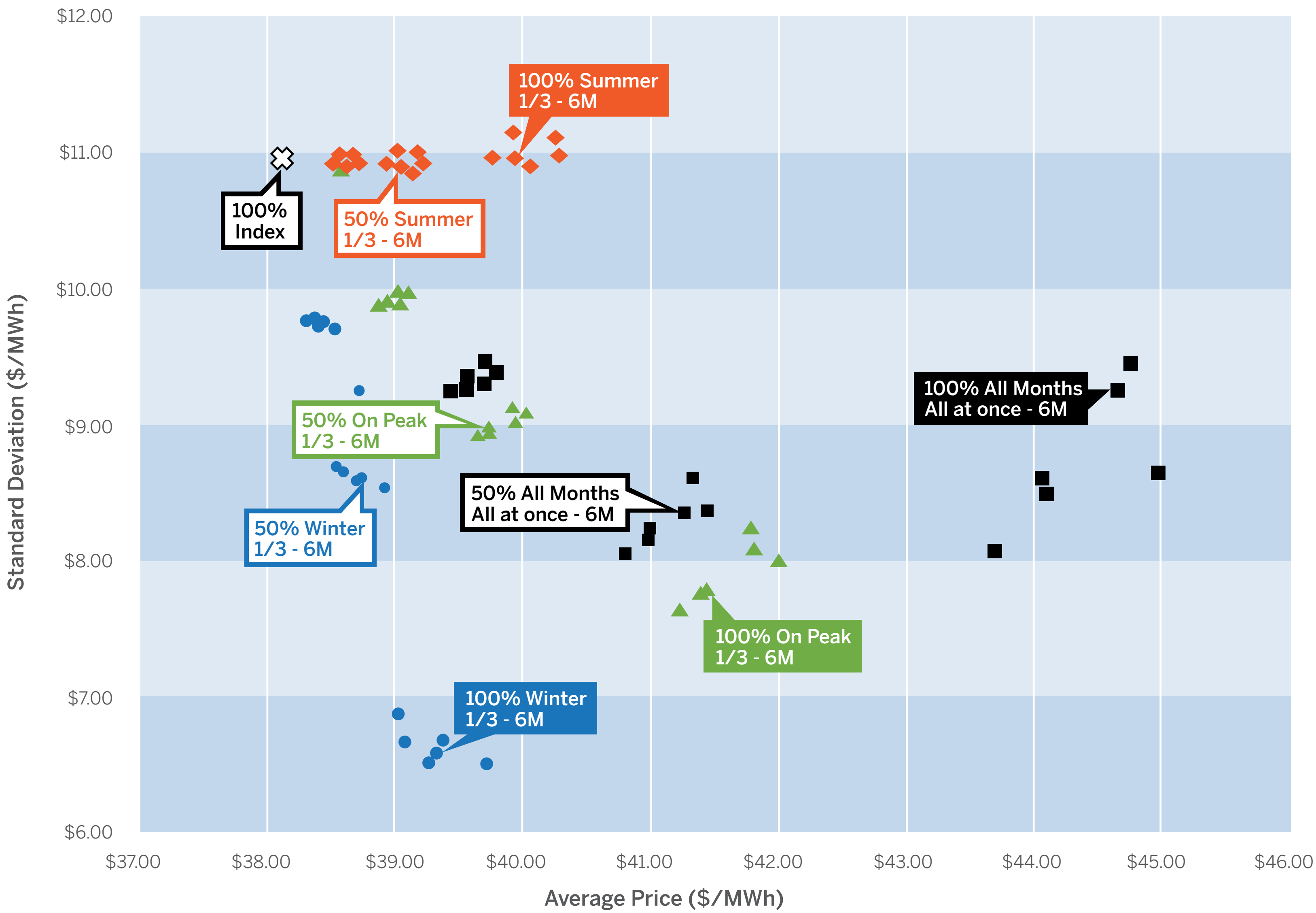
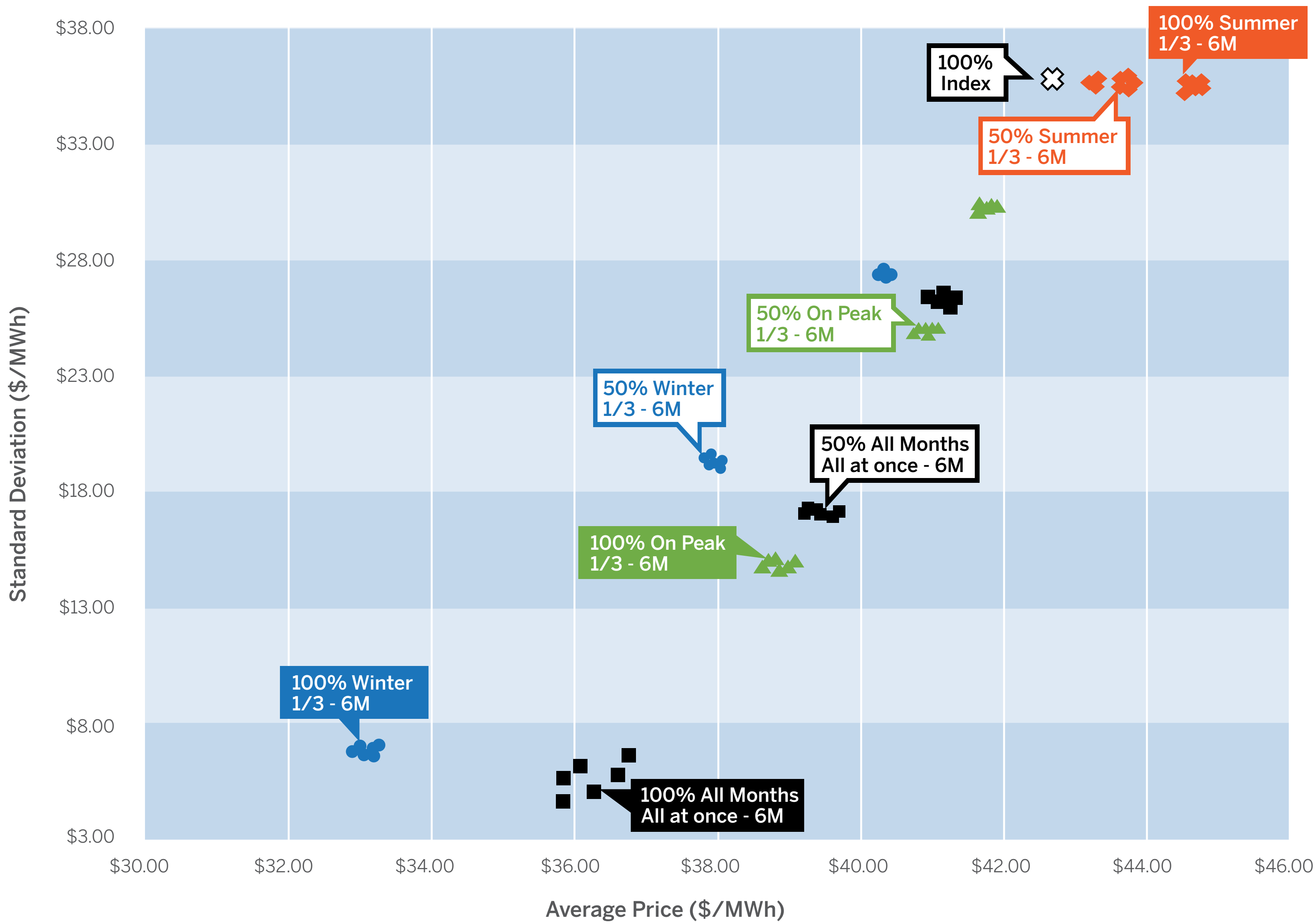


Figure 3D

ERCOT - 2011-2021: Price v. Standard Deviation



Comparing Purchasing Strategies (Figures 4A-4D)

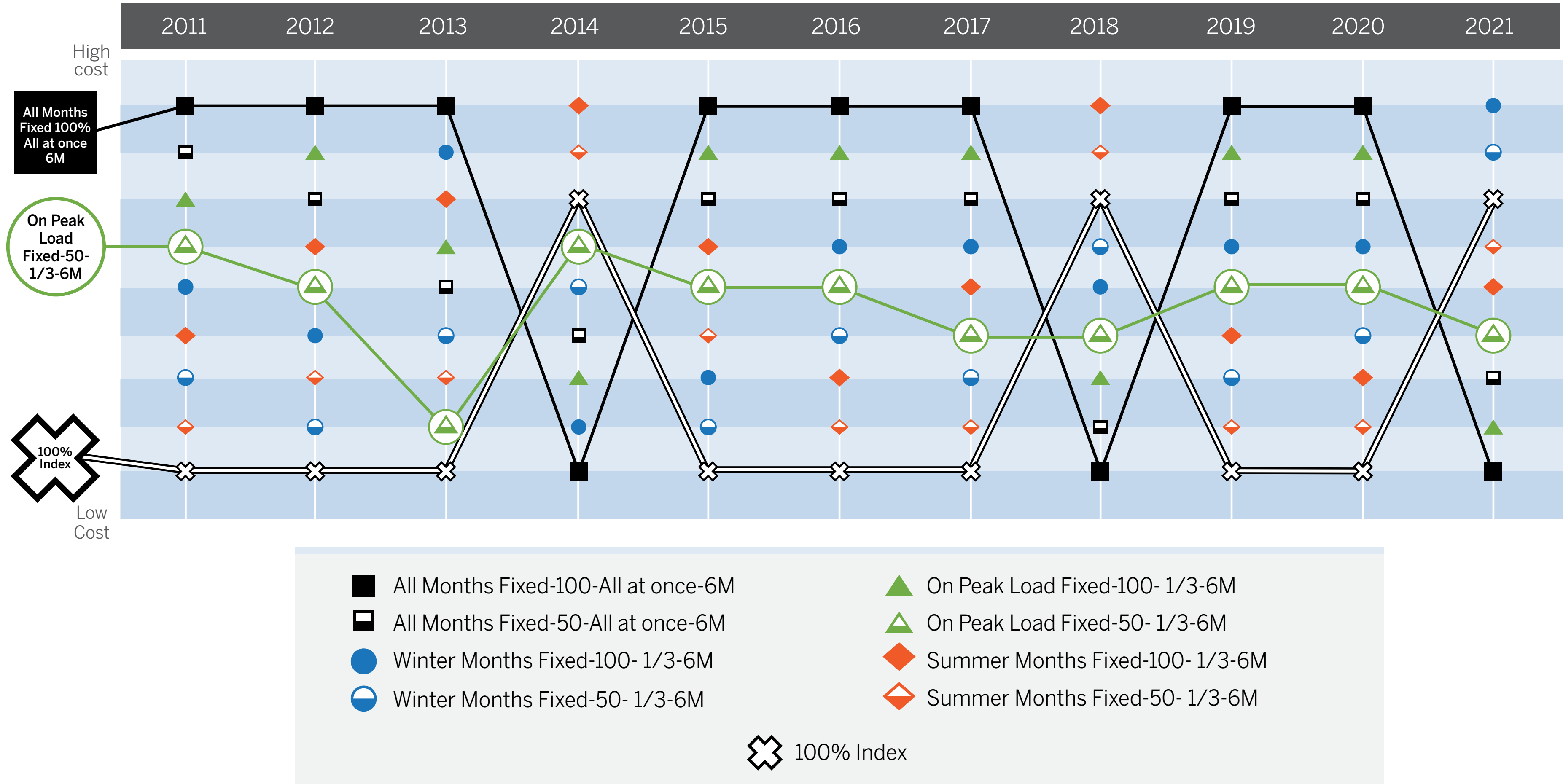
Nine specific solutions are named individually in these figures. These nine solutions were selected as a representative sample across all 73 purchasing strategies in the study and were called out in Figures 3A-3D in the previous section. Each was then compared from a price-performance perspective relative to one another for each year and across each ISO. These annual pricing performance outcomes for these nine specific strategies are shown in Figures 4A-4D.

We call these figures the "bubble charts". The main takeaway when examining the bubble charts is that no power purchasing strategy consistently produces the lowest price outcome each year. However, the managed strategies tend to perform with less volatility and therefore hold positions within the middle of the bunch, avoiding the extremes on either the low or high price side.

In each ISO, we find that the "100% index" strategy often secures the lowest price outcome but has wide performance swings in other years. Similarly, the "100% All Months Fixed, All-at-Once" purchasing strategy most often ends up in the highest priced position relative to the other strategies. At the same time, this strategy also experiences significant volatility in other years. Meanwhile, the "50% On-Peak Fixed, layered-in 1/3 increments" avoids the best/worst pricing performance over time and creates an interesting "middle of the road" outcome across the board. These price and risk performance metrics are consistent across all four ISOs.

Figure 4A

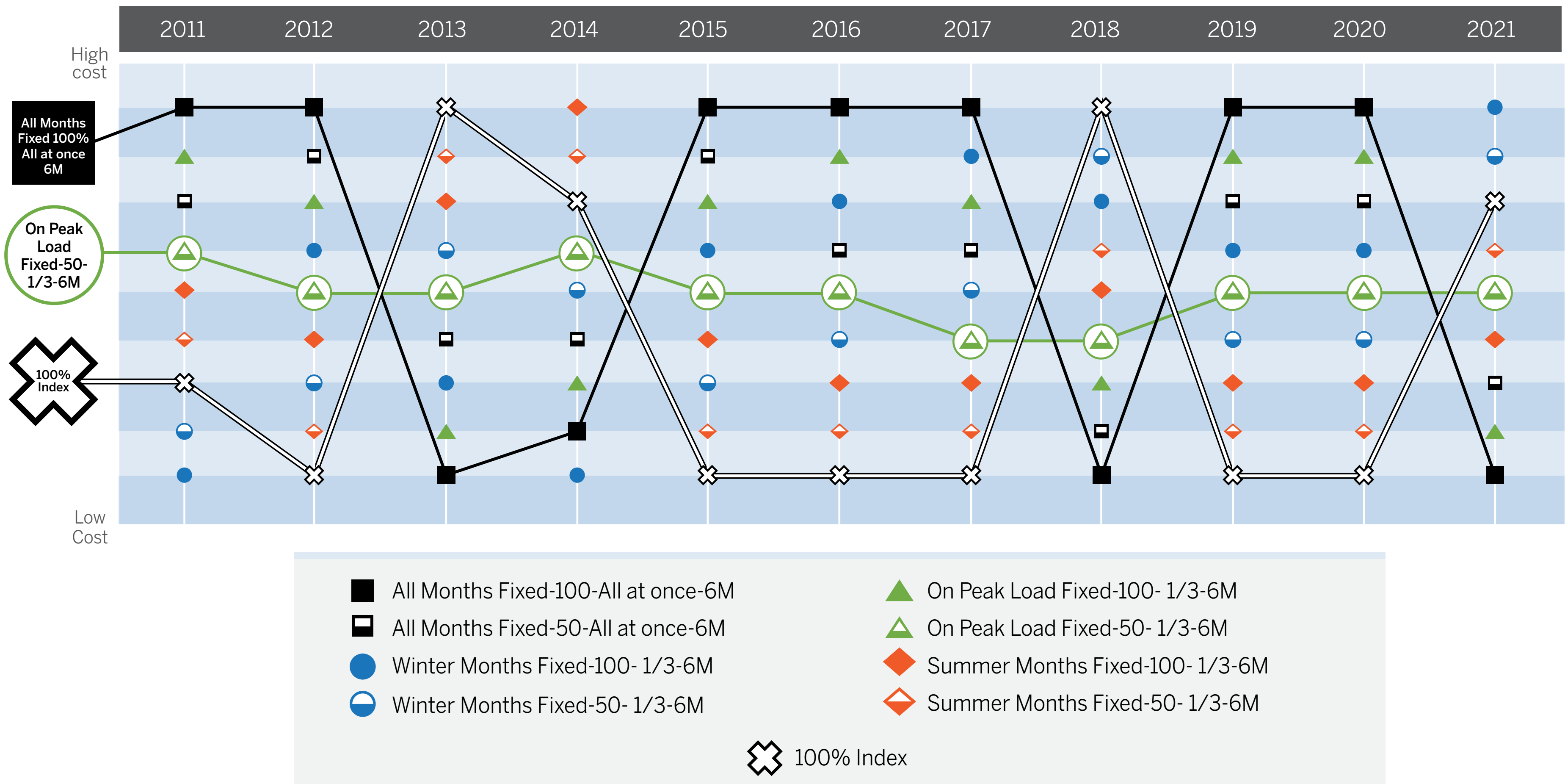
PJM - Nine Samples Strategies (2011-2021)



Note: As shown in Figure 2A the overall average price difference from low to high for all the purchasing strategies each year is 27.8%

Figure 4B

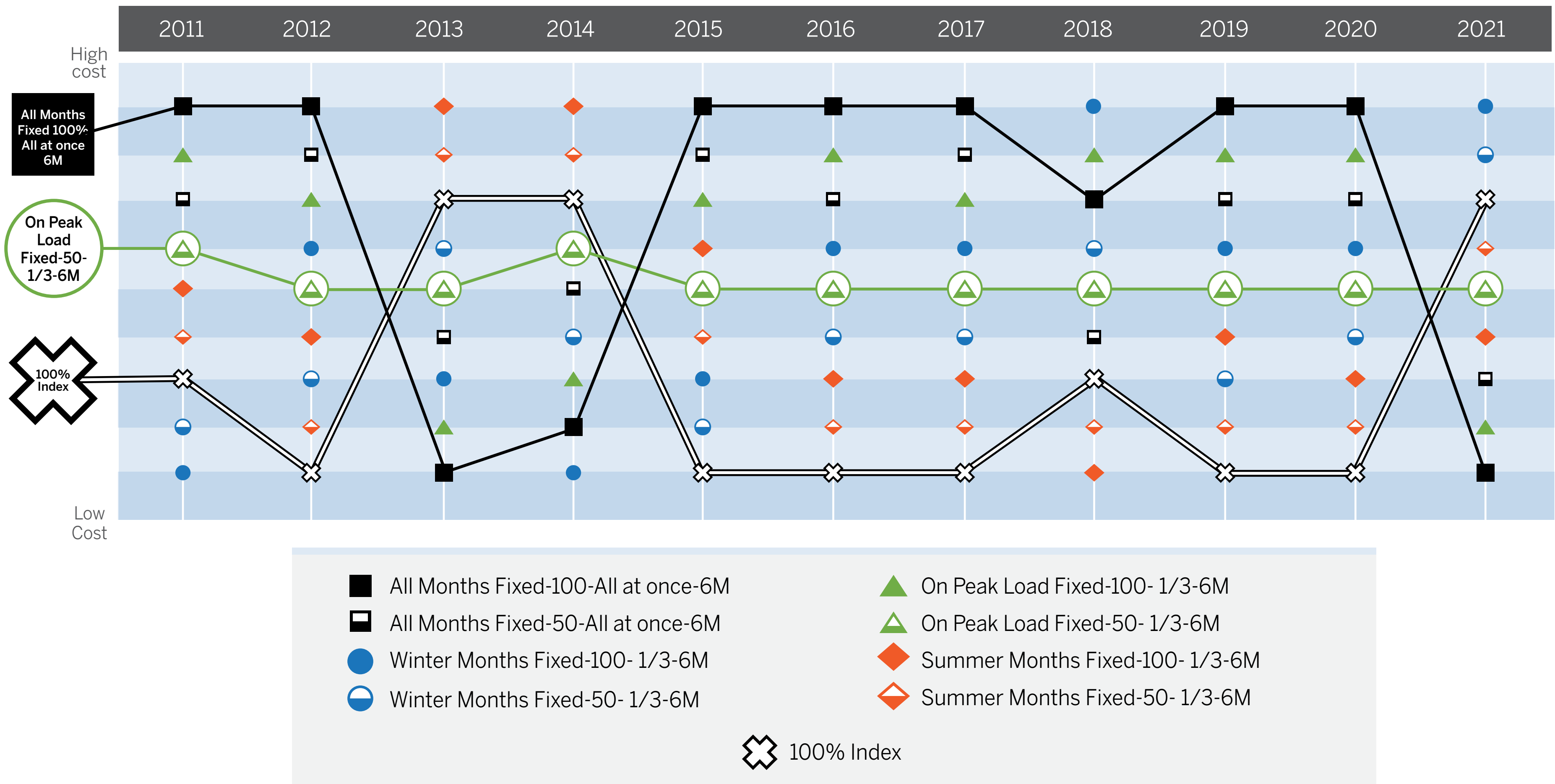
ISONE - Nine Samples Strategies (2011-2021)



Note: As shown in Figure 2B the overall average price difference from low to high for all the purchasing strategies each year is 39.9%

Figure 4C

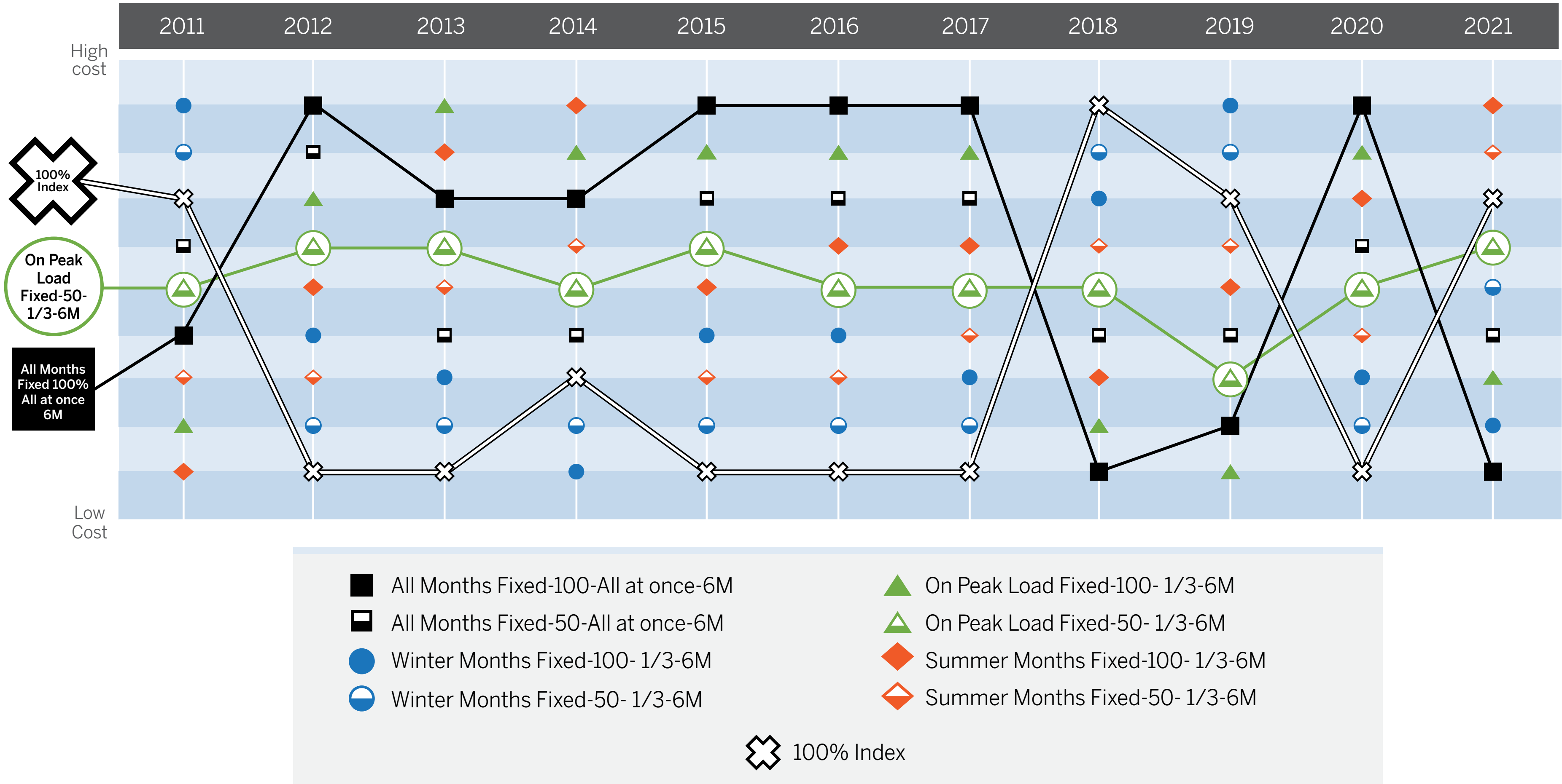
NYISO Zone G - Nine Samples Strategies (2011-2021)



Note: As shown in Figure 2C the overall average price difference from low to high for all the purchasing strategies each year is 26.1%

Figure 4D

ERCOT - Nine Samples Strategies (2011-2021)



Note: As shown in Figure 2D the overall average price difference from low to high for all the purchasing strategies each year is 53.7%

Price and Risk, the Best and Poorest Performers (Figures 5A-5D)

The lowest and highest purchasing strategies results over the period isolated for each of the four (4) ISOs are displayed in Figures 5A-5D.

Specifically, each figure shows the three power purchasing strategies with the:

- Lowest priced outcomes
- Lowest risk/volatility measure
- Highest priced outcomes
- Highest risk/volatility measure

Lowest Priced Outcomes

In PJM (Figure 5A), **the lowest priced spot from a price-performance perspective** is the "100% index". This finding makes sense considering the LMP index prices during this time frame were generally low.

The following **two lowest pricing outcome positions** are variations of the "winter months only" fixed strategy. These findings, too, make sense, considering the LMP index prices in PJM experienced some volatility during winter periods of 2014-15 due to polar vortexes, and the increase in cost for the LMP/index was avoided by these purchasing strategies because they fixed all or a portion of, their 'winter months' power costs in advance.

Lowest Risk/Volatility Measure

Meanwhile, from a risk avoidance point of view, different versions of the "all-months fixed" strategies held each of **the lowest three risk avoidance categories** for PJM during this period. Albeit by paying more than other blended strategies, which included a (generally lower cost) component of the hourly index in their mixes.

Highest Priced Outcomes

On the opposite side of the ledger, we find the **three highest-priced strategies** for PJM were all variants of the "all-months fixed" strategies. So, the successful risk avoidance metrics attributed to these types of purchasing strategies previously often came with a higher price tag.

Highest Risk/Volatility Measure

Finally, as expected, the strategy exhibiting the most elevated risk parameter was the "100% index" strategy. The **other two highest risk strategies** were variants of the "summer-only fixed" solution type. This outcome is mainly attributable to the fact that fixing the summer months during this period didn't help avoid the volatility that occurred primarily during the winter months. As a result, these strategies look similar to the "100% index" solution from a risk-performance point of view.

Top 3 Purchasing Strategies for ISONE, NYISO and ERCOT

The **top three power purchasing strategies in these same four categories** are also tabulated for ISONE, NYISO, and ERCOT and are shown in Figures 5B, 5C, and 5D, respectively. The outcomes for the NYISO (Figure 5C) are very similar to PJM (Figure 5A). Simultaneously, the ISONE region (Figure 5B) shows a slightly different set of outcomes for these metrics identifying benefits to the "summer months" fixed and the "on-peak load" fixed solutions. Finally, we see that the ERCOT results (Figure 5D) for each of these top three positions are held by a significantly different set of strategies compared to the other ISOs. This result is primarily due to the disproportionate effect of the LMP/index volatility experienced during Winter Storm Uri in February 2021 in ERCOT.

See the Appendix for more information on ERCOT outcomes absent the impact of Winter Storm Uri.

Figure 5A

PJM BGE: Strategies Resulting in Lowest Prices and Volatility (2011-2021)

	Product/Solution Type	Percentage Fixed	Purchase Timing (wrt Flow Date)	Purchasing Proportions
Lowest 3 Prices	100% Index	0	n/a	n/a
	Winter Months Fixed	25	13M	All at once
	Winter Months Fixed	25	13M	1/3
Lowest 3 Risk (Volatility)	All Months Fixed	100	6M	1/12
	All Months Fixed	100	13M	1/3
	All Months Fixed	100	13M	1/12

PJM BGE: Strategies Resulting in Highest Prices and Volatility (2011-2021)

	Product/Solution Type	Percentage Fixed	Purchase Timing (wrt Flow Date)	Purchasing Proportions
Highest 3 Prices	All Months Fixed	100	13M	All at once
	All Months Fixed	100	6M	All at once
	All Months Fixed	100	13M	1/3
Highest 3 Risk (Volatility)	100% Index	0	n/a	n/a
	Summer Months Fixed	25	6M	All at once
	Summer Months Fixed	25	13M	1/12

Figure 5B

ISONE: Strategies Resulting in Lowest Prices and Volatility (2011-2021)

	Product/Solution Type	Percentage Fixed	Purchase Timing (wrt Flow Date)	Purchasing Proportions
Lowest 3 Prices	100% Index	0	n/a	n/a
	Winter Months Fixed	25	6M	All at once
	Winter Months Fixed	25	13M	1/12
Lowest 3 Risk (Volatility)	All Months Fixed	100	6M	1/12
	All Months Fixed	100	13M	All at once
	All Months Fixed	100	6M	1/12

ISONE: Strategies Resulting in Highest Prices and Volatility (2011-2021)

	Product/Solution Type	Percentage Fixed	Purchase Timing (wrt Flow Date)	Purchasing Proportions
Highest 3 Prices	All Months Fixed	100	13M	All at once
	All Months Fixed	100	6M	1/12
	All Months Fixed	100	6M	All at once
Highest 3 Risk (Volatility)	100% Index	0	n/a	n/a
	Summer Months Fixed	25	6M	All at once
	Summer Months Fixed	25	13M	1/12

Figure 5C

NYISO Zone G: Strategies Resulting in Lowest Prices and Volatility (2011-2021)

	Product/Solution Type	Percentage Fixed	Purchase Timing (wrt Flow Date)	Purchasing Proportions
Lowest 3 Prices	100% Index	0	n/a	n/a
	Winter Months Fixed	25	13M	All at once
	Winter Months Fixed	25	13M	1/3
Lowest 3 Risk (Volatility)	All Months Fixed	100	6M	1/12
	All Months Fixed	100	13M	1/12
	All Months Fixed	100	13M	All at once

NYISO Zone G: Strategies Resulting in Highest Prices and Volatility (2011-2021)

	Product/Solution Type	Percentage Fixed	Purchase Timing (wrt Flow Date)	Purchasing Proportions
Highest 3 Prices	All Months Fixed	100	6M	1/12
	All Months Fixed	100	13M	All at once
	All Months Fixed	100	6M	All at once
Highest 3 Risk (Volatility)	100% Index	0	n/a	n/a
	Summer Months Fixed	25	6M	All at once
	Summer Months Fixed	25	13M	1/12

Figure 5D

ERCOT: Strategies Resulting in Lowest Prices and Volatility (2011-2021)

	Product/Solution Type	Percentage Fixed	Purchase Timing (wrt Flow Date)	Purchasing Proportions
Lowest 3 Prices	100% Index	100	13M	1/12
	Winter Months Fixed	100	6M	1/3
	Winter Months Fixed	100	13M	1/3
Lowest 3 Risk (Volatility)	All Months Fixed	100	6M	1/12
	All Months Fixed	100	13M	1/12
	All Months Fixed	100	13M	1/3

ERCOT: Strategies Resulting in Highest Prices and Volatility (2011-2021)

	Product/Solution Type	Percentage Fixed	Purchase Timing (wrt Flow Date)	Purchasing Proportions
Highest 3 Prices	All Months Fixed	100	13M	All at once
	All Months Fixed	100	6M	All at once
	All Months Fixed	100	6M	1/12
Highest 3 Risk (Volatility)	100% Index	0	n/a	n/a
	Summer Months Fixed	25	6M	All at once
	Summer Months Fixed	25	6M	1/12

Evaluating Price and Risk (Figures 3A and 5A)

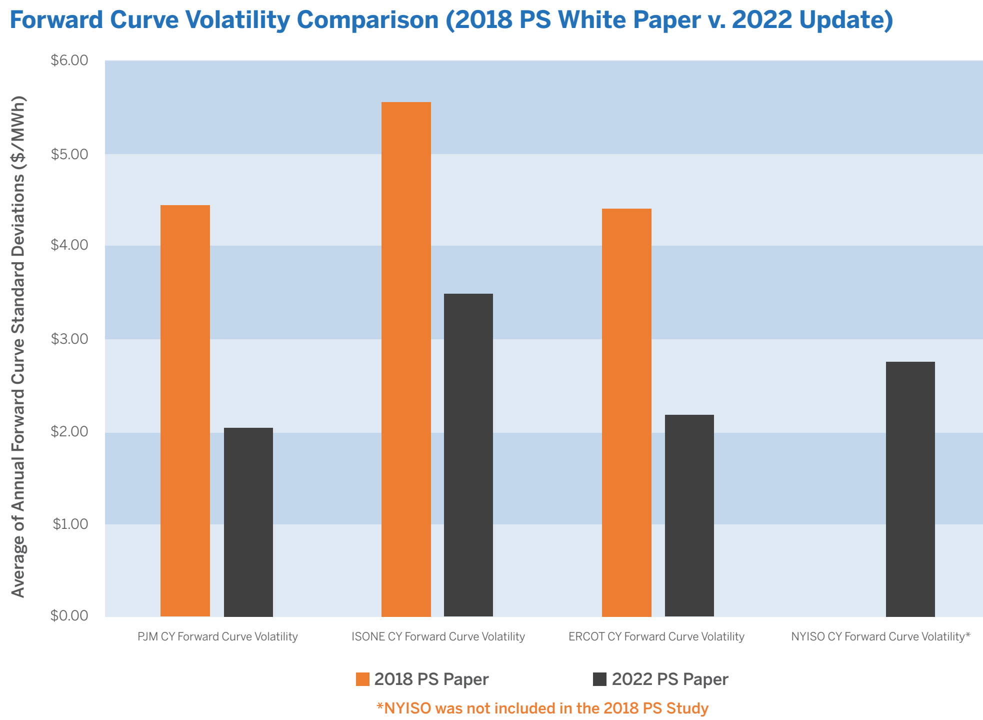
Interesting observations can be made by looking at PJM Figures 3A and 5A at the same time. For example, Figure 5A shows that the highest priced strategies are each a form of the "All Months" fixed solutions. Meanwhile, if we examine these same "All-Months" fixed strategies from the perspective shown in Figure 3A, we see that these strategies did not lower the risk as much as might have been expected by fixing costs in all the months. This demonstrates that a blended purchasing strategy can achieve lower risk *as well as* lower price performance in many cases.

On the other hand, the lowest priced strategies shown In Figure 5A include forms of the "winter-only" fixed solutions. If we examine the "winter only" solutions on Figure 3A we find them not only performing well pricewise, but risk avoidance-wise as well.[3]

Forward Prices and Changing Volatility

The economic and energy markets from 2011 to 2021 enjoyed relatively stable conditions. The exception again, is the February 2021 Winter Storm Uri event. This was a major weather event that most significantly affected the ERCOT market and caused widespread impacts outside of Texas as well. Despite this weather outlier, the energy market landscape was generally well behaved during this time period, following a steady recovery and expansion from the 2008-09 economic recession. From a power market perspective, the dual factors of low gas prices resulting from the shale gas boom and new natural gas-fired capacity each placed downward pressure on forward power prices. These factors helped establish a set of relatively flat forward power curves, especially when comparing this paper to the 2018 purchasing strategies white paper covering years 2003 – 2017. If we compare the volatility of the forward curves used in that previous paper, we find them nearly twice as volatile as those in this paper 2011 – 2021. See Figure 6 for a comparison of the forward curve volatility between the periods covered in each iteration of this white paper.

Figure 6



From an hourly index (LMP) point of view, these values were also relatively well behaved in each ISO during this period. Exceptions to this generalization regarding the relative flatness of the hourly index (LMP) price levels include:

- Winter LMP volatility in 2014-15 in PJM, ISONE, and NYISO due to the polar vortex events during those two winters.
- Summer LMP price levels in the ERCOT region in 2011 due to weather.
- Winter LMP price levels in ERCOT in 2021, especially in February during Winter Storm Uri. As previously discussed, these hourly costs are the most significant outlier affecting the results across the board in the ERCOT region.

Figures 7A-7D show the average hourly Day Ahead (DA) L(B)MPs for the Winter, Summer, and Shoulder month periods for each year and each respective ISO.

The joint takeaway across the periods mentioned above is that while the forward curve and LMP market dynamics significantly impacted the power purchasing strategy outcomes year by year, a managed strategy provides benefits in price performance and risk avoidance compared to a buy all-at-once process.

Figure 7A

PJM-BGE DA LMP Averages by Year and Season

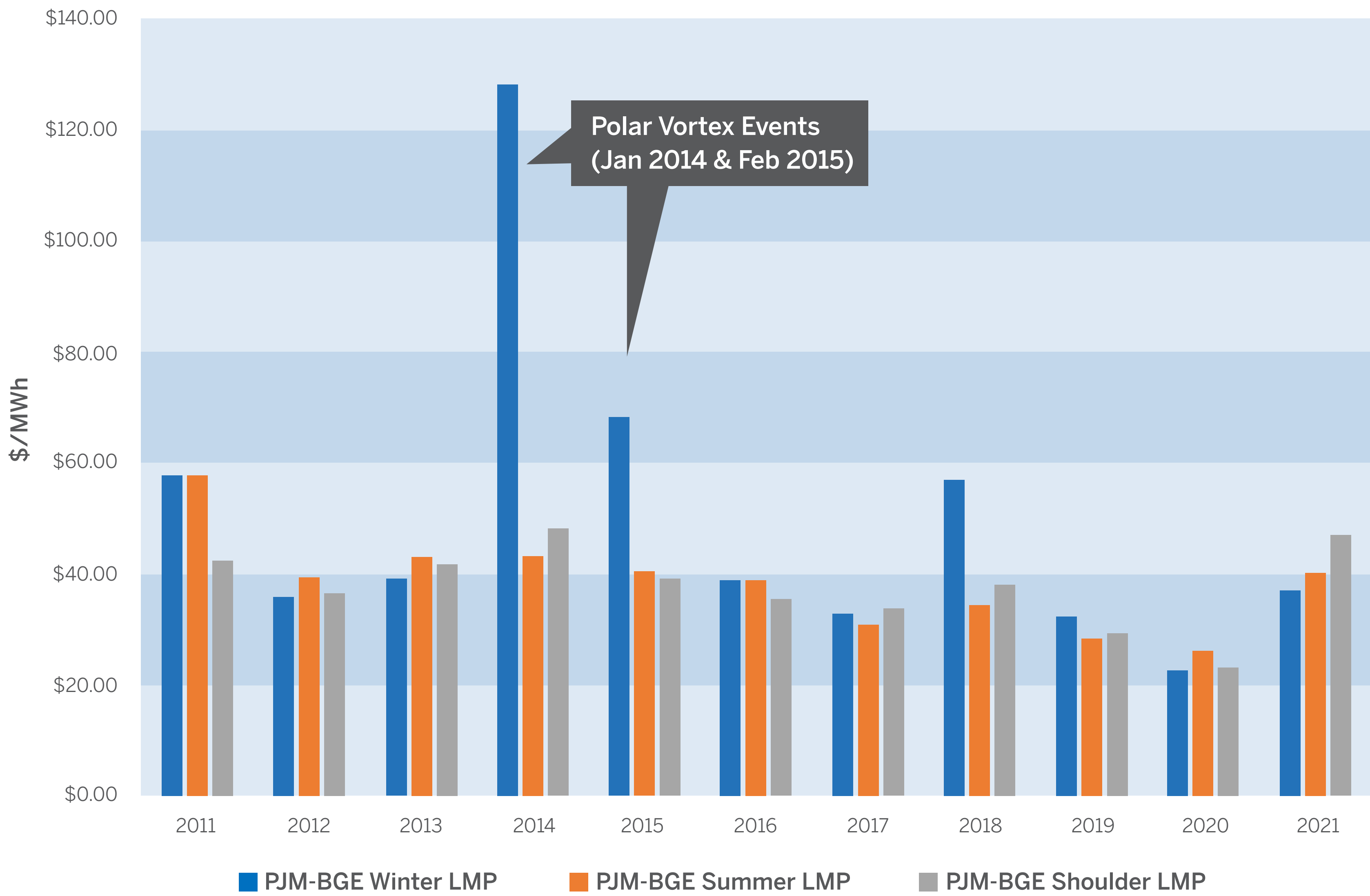


Figure 7B

ISONE-HUB DA LMP Averages by Year and Season

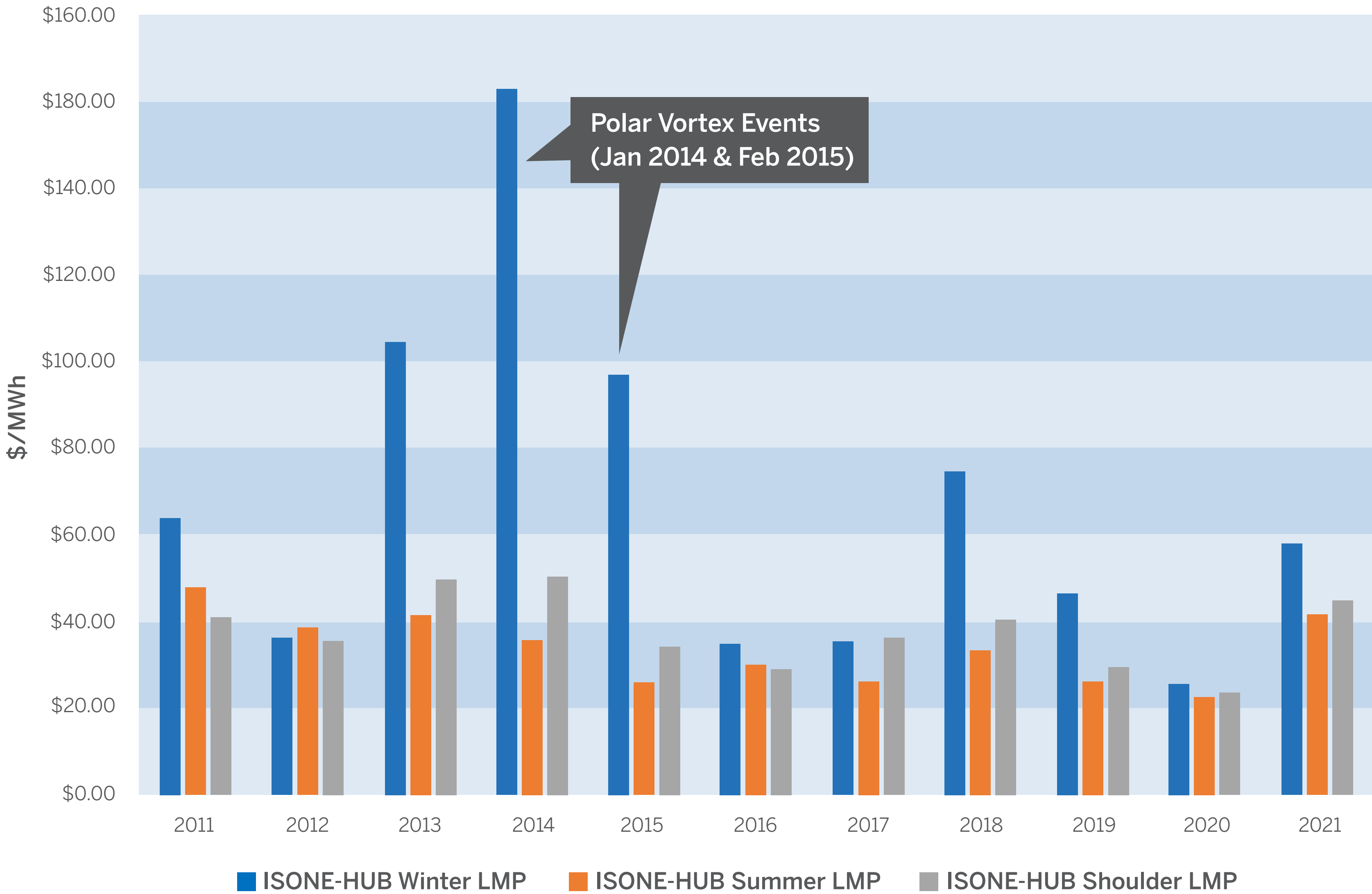


Figure 7C

NYISO Zone G DA LBMP Averages by Year and Season

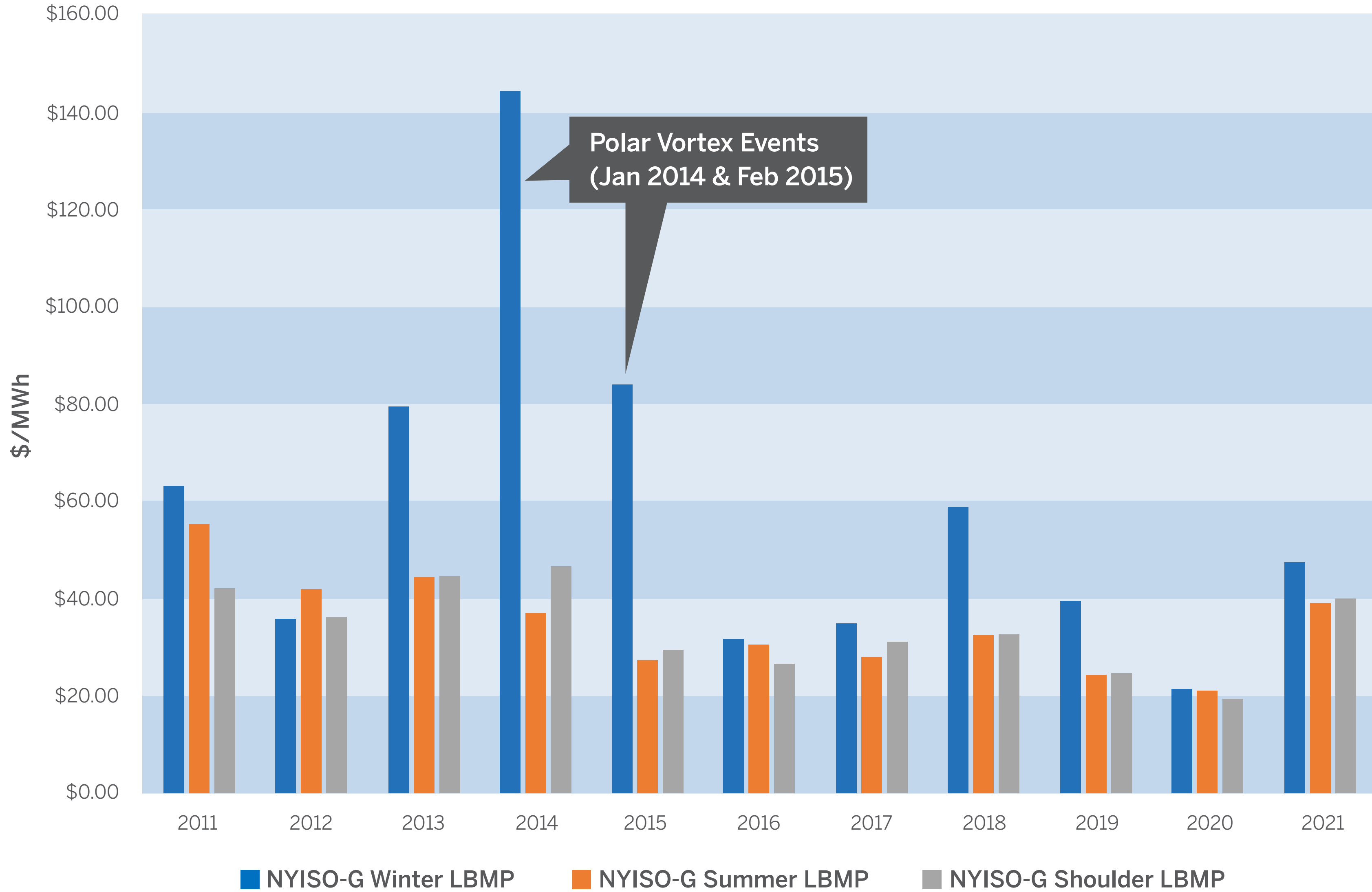
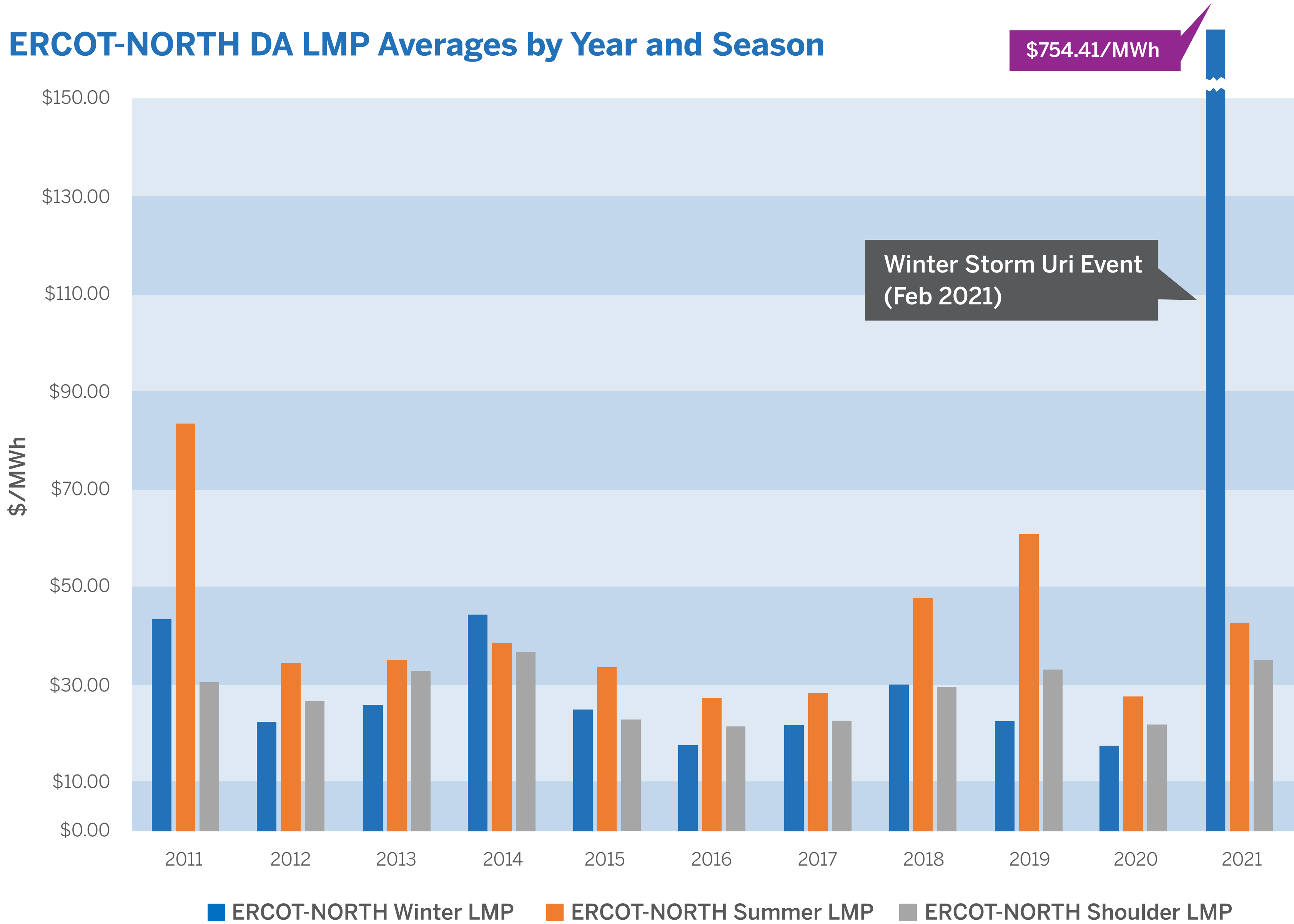


Figure 7D


ERCOT-NORTH DA LMP Averages by Year and Season
$754.41/MWh
Winter Storm Uri Event (Feb 2021)
$/MWh
$150.00
$130.00
$110.00
$90.00
$70.00
$50.00
$30.00
$10.00
$0.00
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
ERCOT-NORTH Winter LMP
ERCOT-NORTH Summer LMP
ERCOT-NORTH Shoulder LMP

Best Practices – Balancing Price and Risk

When the power purchasing strategy elements measured in this paper and depicted in Figure 1 are examined, we find various product types, fixed price proportions, the timing of, and frequency of purchases evaluated. The following section attempts to isolate each of these purchasing strategy parameters to capture the general performance metrics from each of these perspectives, namely:

- Product/Solution type
- Percentage of the price fixed
- Layering method, i.e., purchasing fixed quantities over time
- Timing of purchases

Product /Solution Type: Price Versus Risk (Figures 8A-8D)

When the outcomes of the power purchasing strategies are grouped to examine the differences between the product/solution types, we find both consistencies and distinctions across the four ISOs. Figures 8A-8D show the Price versus Standard Deviation results for each power purchasing strategy clustered by product/solution type. Each of these data points (except the single "100% index" solution) is derived from the average of 18 different purchasing strategy outcomes for each specific product/solution across each ISO. From 2011 to 2021, we find these general observations for the ISO's of PJM, ISONE, and NYISO (see Figures 8A-8C):

Figure 8A

PJM BGE - Price v. Standard Deviation by Product Strategy (2011-2021)

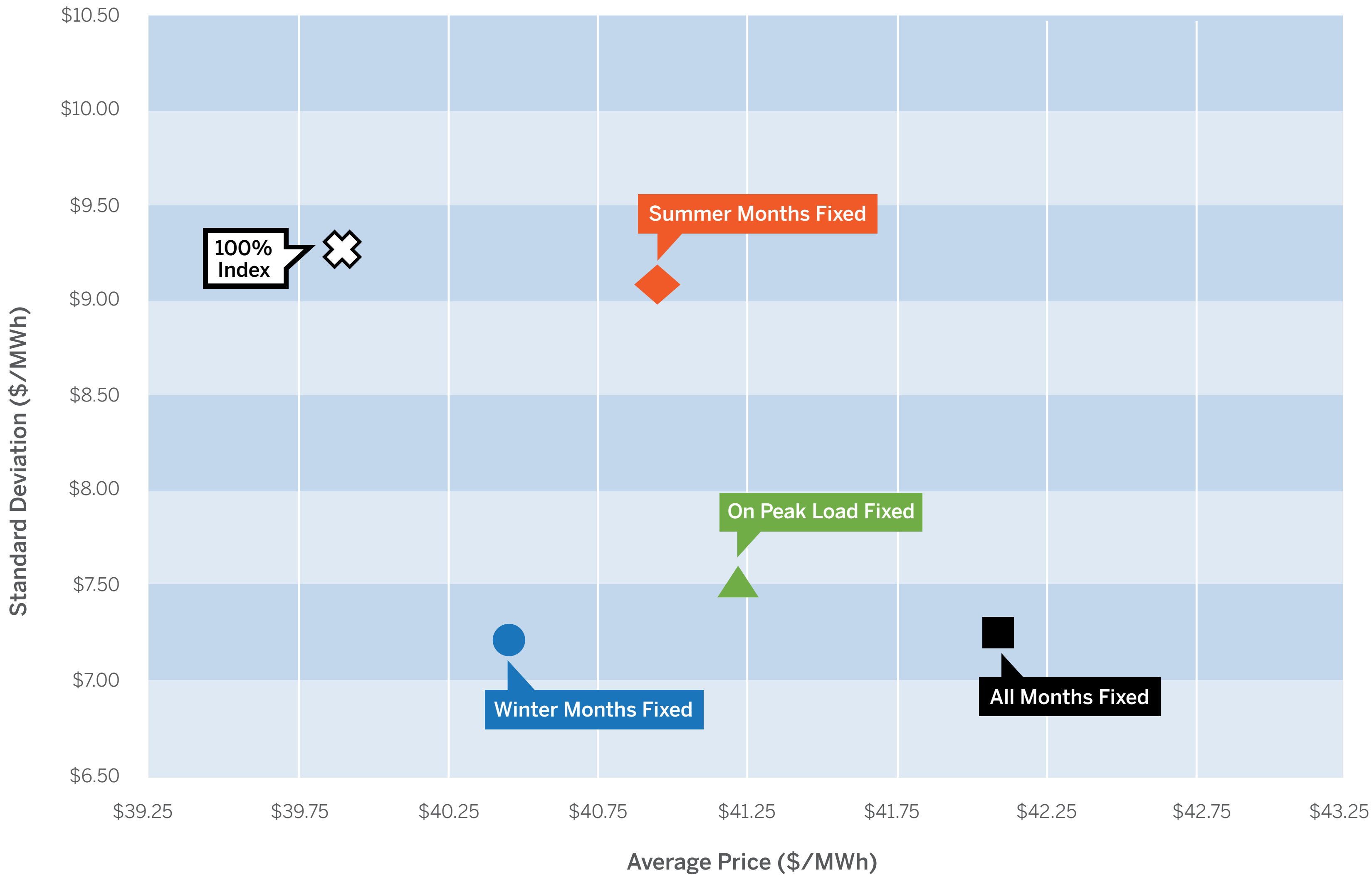


Figure 8B

ISONE - Price v. Standard Deviation by Product Strategy (2011-2021)

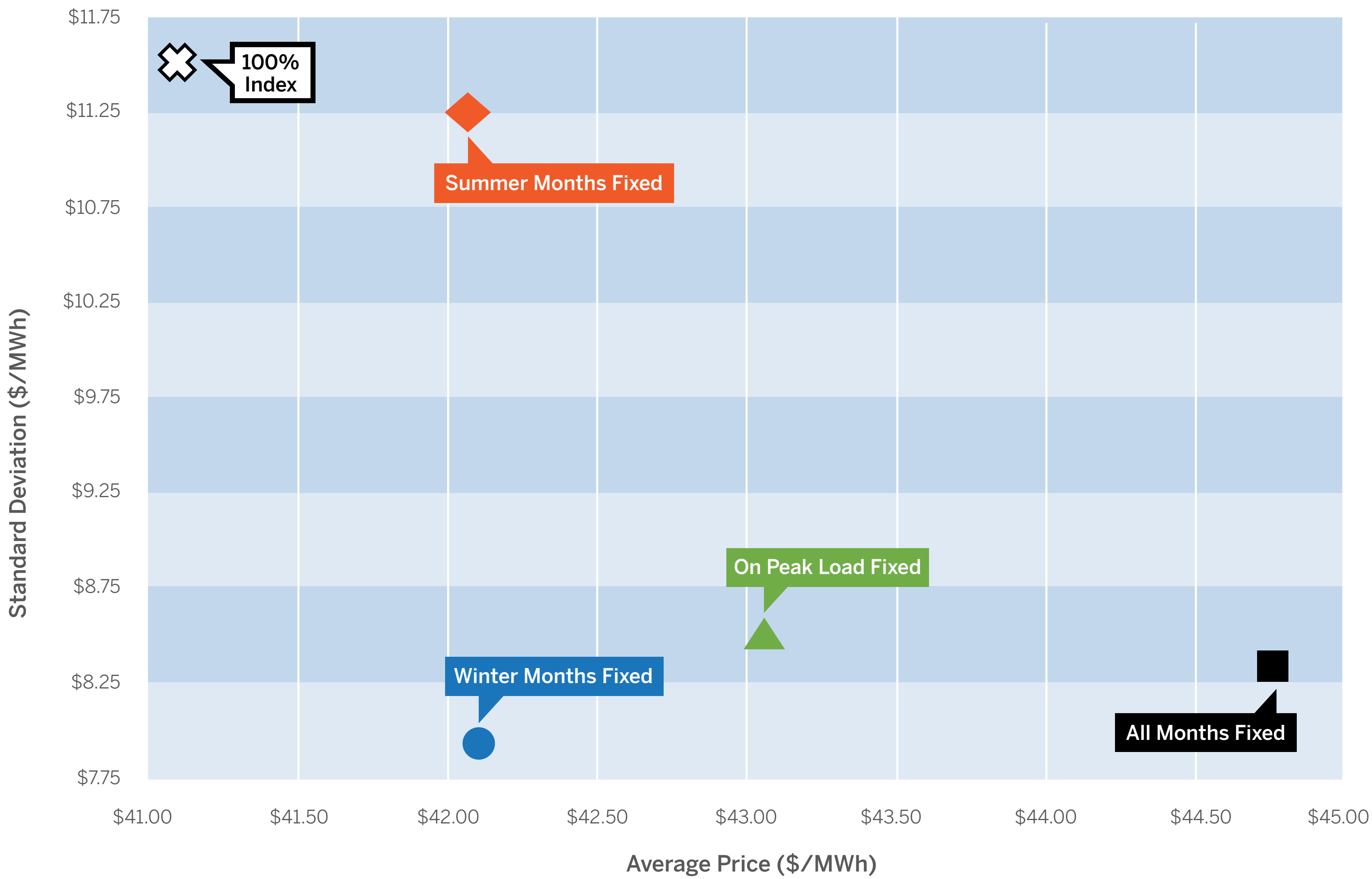


Figure 8C

NYISO Zone G - Price v. Standard Deviation by Product Strategy (2011-2021)

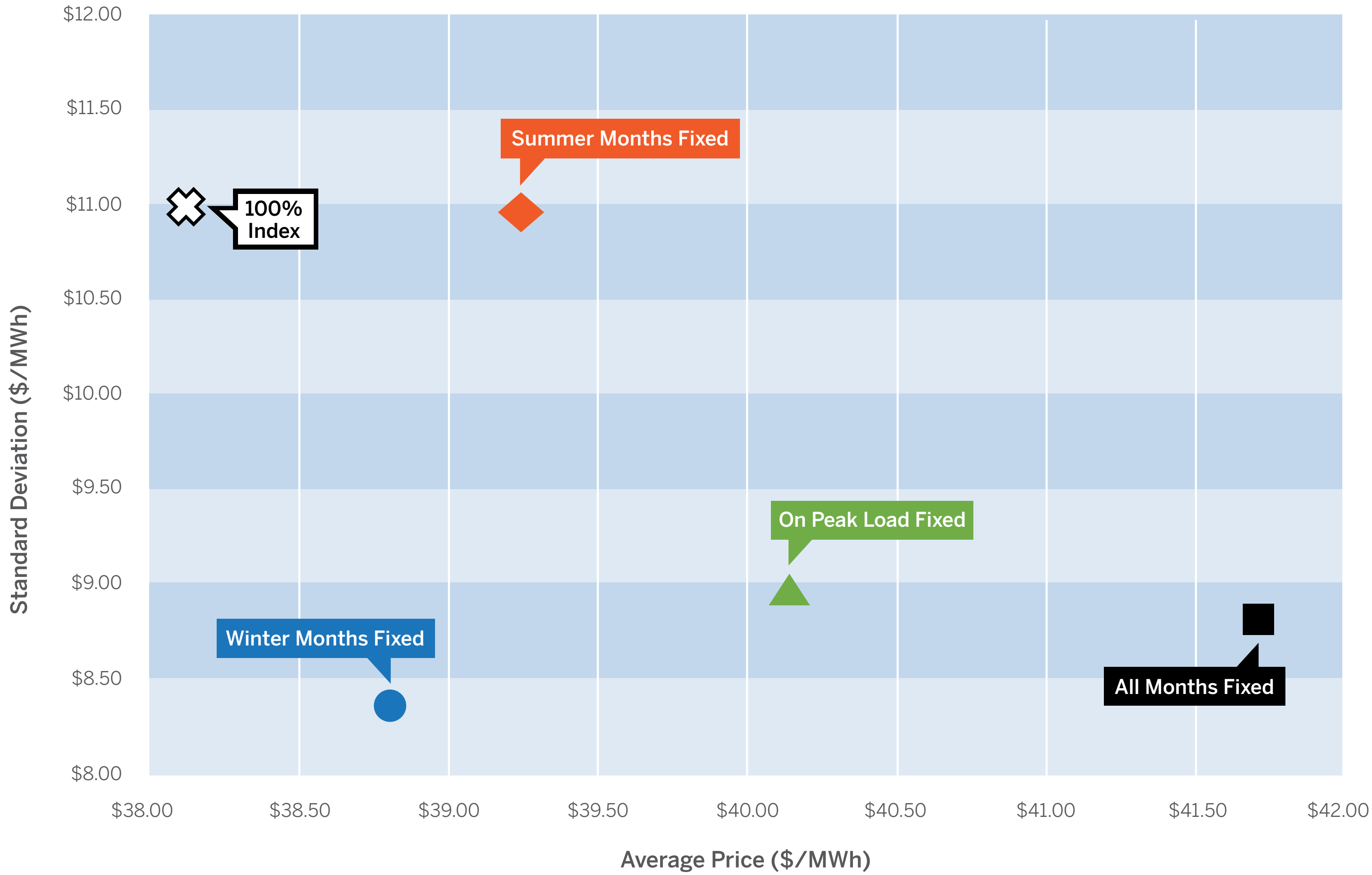
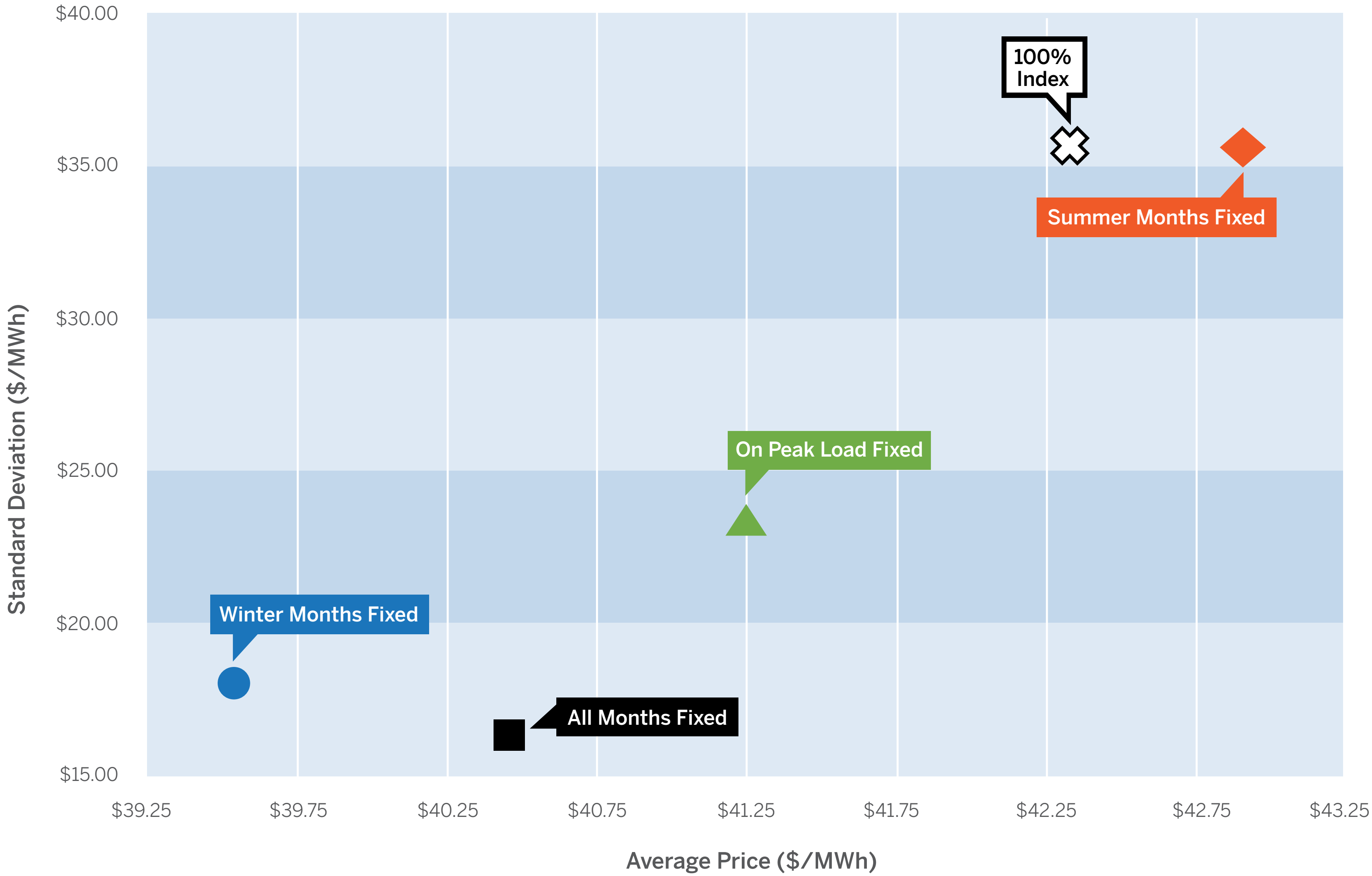


Figure 8D

ERCOT - Price v. Standard Deviation by Product Strategy (2011-2021)



100% Index Product - Typically exhibited the lowest price on average but also possessed the highest risk parameter.

The Winter-only Fixed Solutions - Exhibited a set of price outcomes nearly as low as the "100% index" solution but with considerably less risk. This demonstration is primarily due to the dual benefits derived from avoiding the high winter LMPs during the polar vortex years while at the same time benefiting from the relatively low LMP index prices in the non-winter months during this period.

The All-month Fixed Solutions - Exhibited the highest priced outcomes but at lower risk levels than the "100% index" strategy. However, the risk avoidance from the "all-months" solutions were not appreciably better than the "winter-only months" solutions and came at a higher price.

The Summer-only Fixed Solutions - Exhibited a higher price than the "100% index" solution but with nearly the same risk level. As noted previously, this outcome resulted from the lack of summer volatility in the LMP/index costs during the period studied. Consequently, fixing this component didn't deliver much risk avoidance value this time around.

The On-peak Period Only Fixed solution - Holds a middle ground position compared to the other groupings. This solution exhibited lower prices than the "all-months" fixed solution with an improved risk avoidance metric as well. Still, it was not as successful in terms of price and risk avoidance as the "winter-only" fixed solutions grouping.

The Effects of the Winter Storm Uri Anomaly - Figure 8D displays a significantly different perspective for the ERCOT region than we find in the other three ISOs. This set of outcomes was meaningfully impacted by the high LMP prices caused in the aftermath of Winter Storm Uri in February 2021 — affecting the results between the solution groupings quite pointedly. Despite this, we again find the "winter-only" fixed solutions grouping taking the best position (lower left corner) in this figure, similar to the other ISOs.

See the Appendix for more information on ERCOT outcomes absent the impact of Winter Storm Uri.

Percentage Fixed: Price Versus Risk (Figures 9A-9D)

When we group the power purchasing strategy outcomes based on percentage fixed, we find the results shown in Figures 9A-9D. These figures show the Price versus Standard Deviation results for each purchasing strategy clustered by percentage fixed derived from the average of 24 different purchasing strategy outcomes for each solution type and across each ISO. From 2011 through 2021, we find these general observations for the areas covered by PJM, ISONE, and NYISO (see Figures 9A-9C):

The 100% Load Fixed Grouping - tended to produce the lowest risk accompanied by its higher price attribute.

The 50% and the 25% Fixed Groupings - provided better pricing performance while incurring more risk in proportion to the increased exposure to index pricing inherent in these strategies.

The Effects of a Winter Storm Anomaly - In contrast, Figure 9D (ERCOT) offers a volte-face to these findings. Here we find that the *more* power prices are fixed, the *lower* the expenditure incurred and the lower the risk too. It is understood that this significantly different set of outcomes was predominantly driven by the elevated LMP prices caused in the aftermath of Winter Storm Uri in February 2021, which were largely avoided by the "100% fixed" solutions.

See the Appendix for more information on ERCOT outcomes absent the impact of Winter Storm Uri.

Figure 9A

PJM BGE - Price v. Standard Deviation by % Fixed (2011-2021)

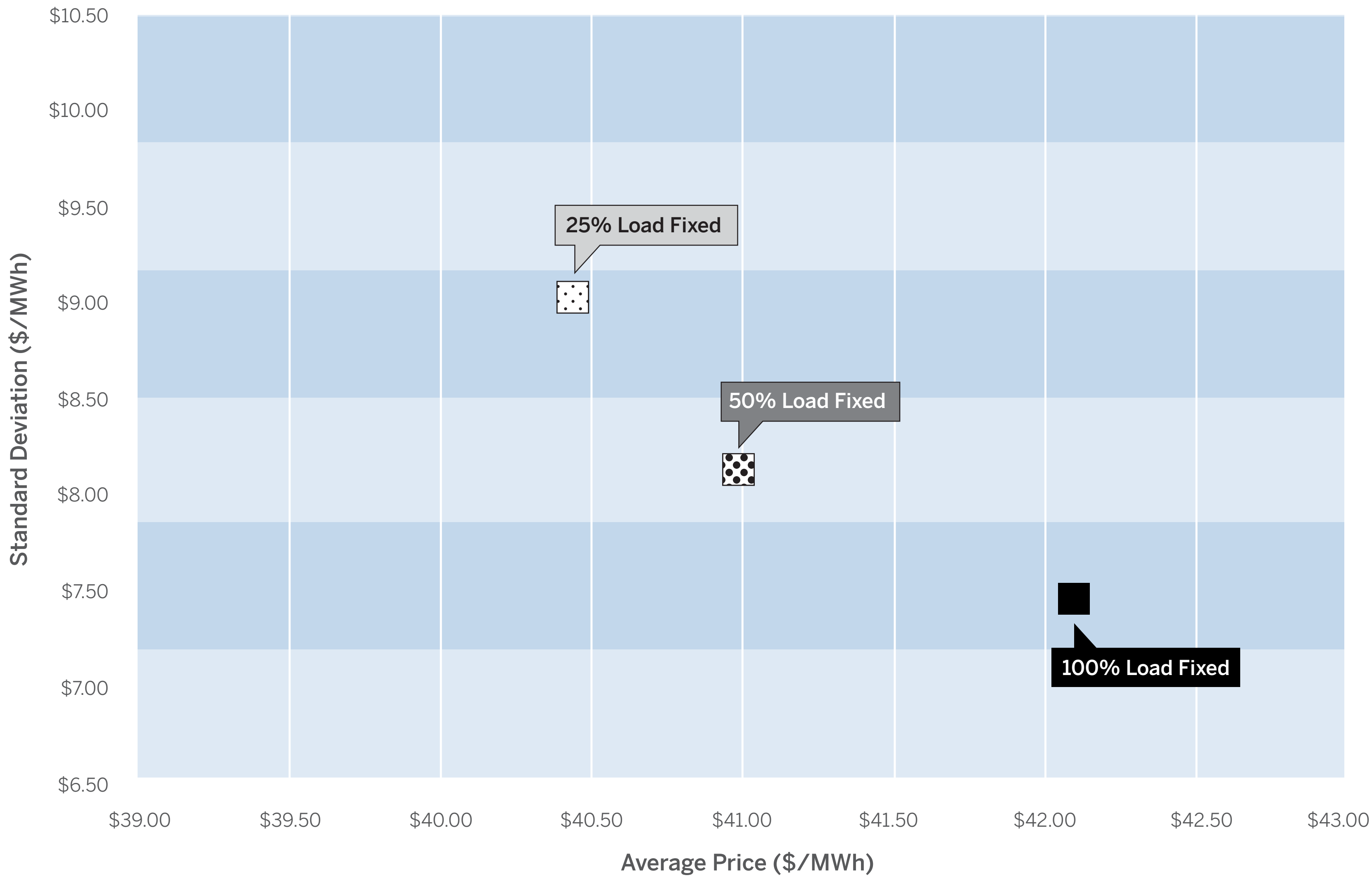


Figure 9B

ISONE - Price v. Standard Deviation by % Fixed (2011-2021)

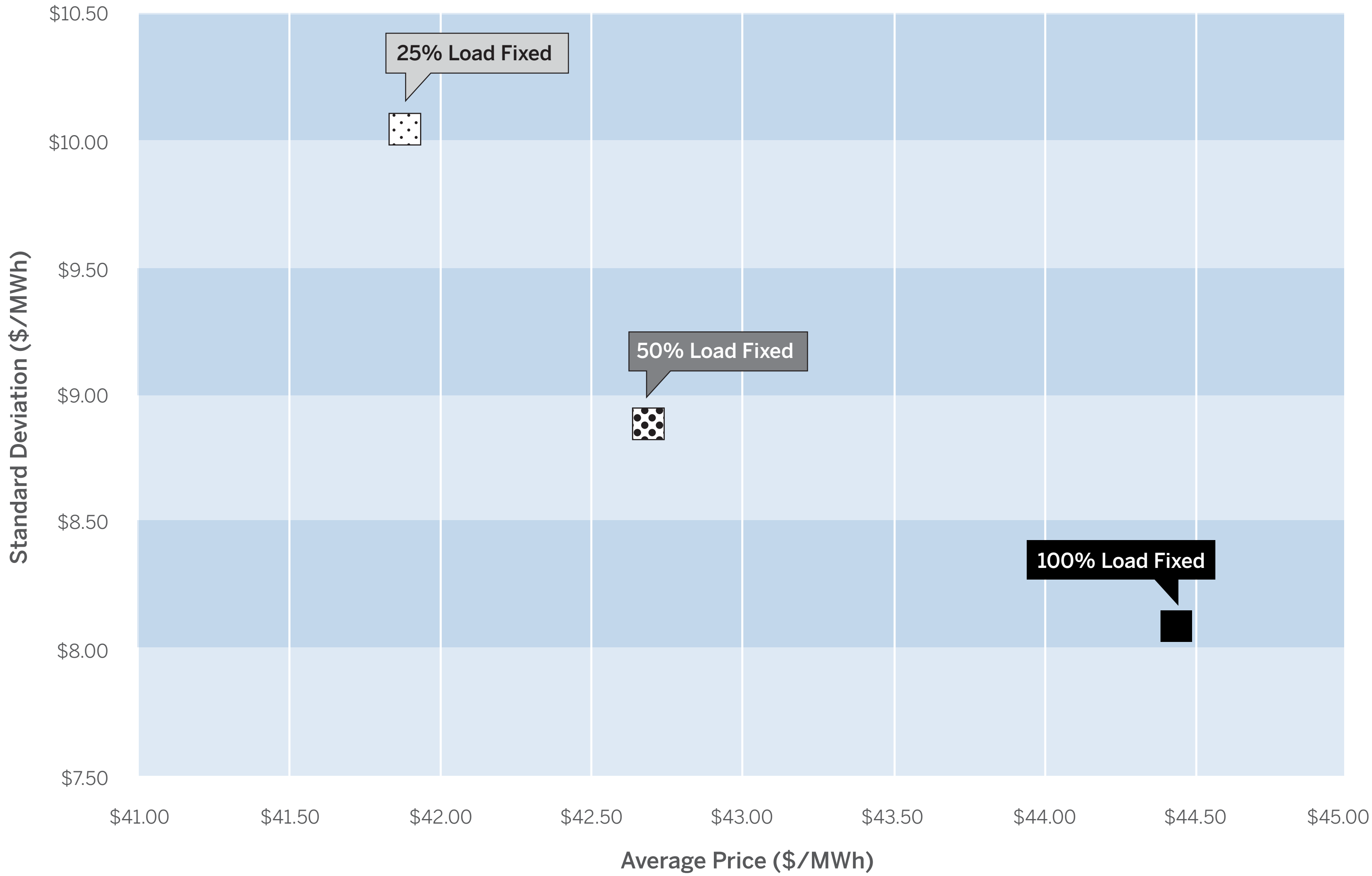


Figure 9C

NYISO Zone G - Price v. Standard Deviation by % Fixed (2011-2021)

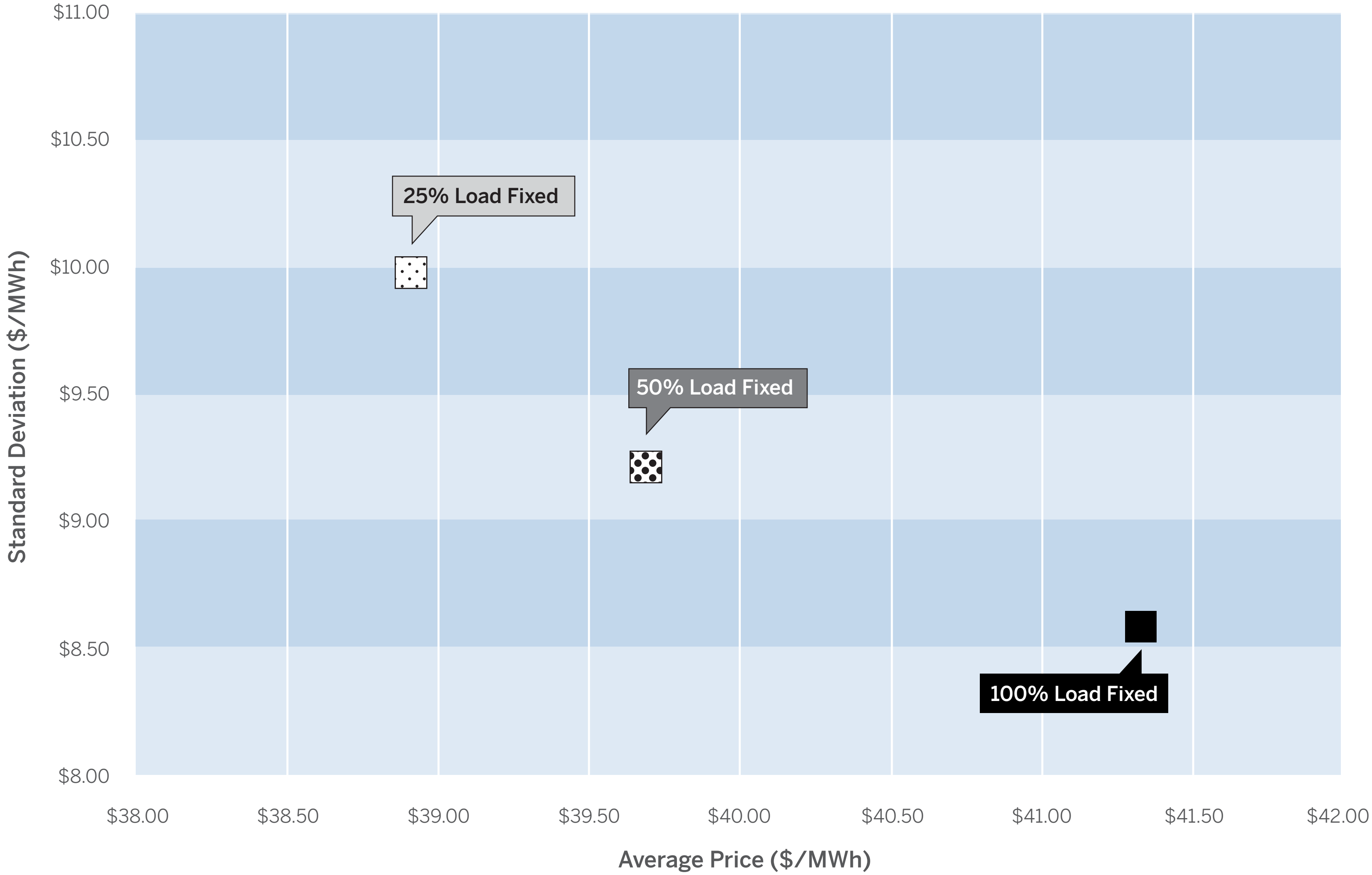
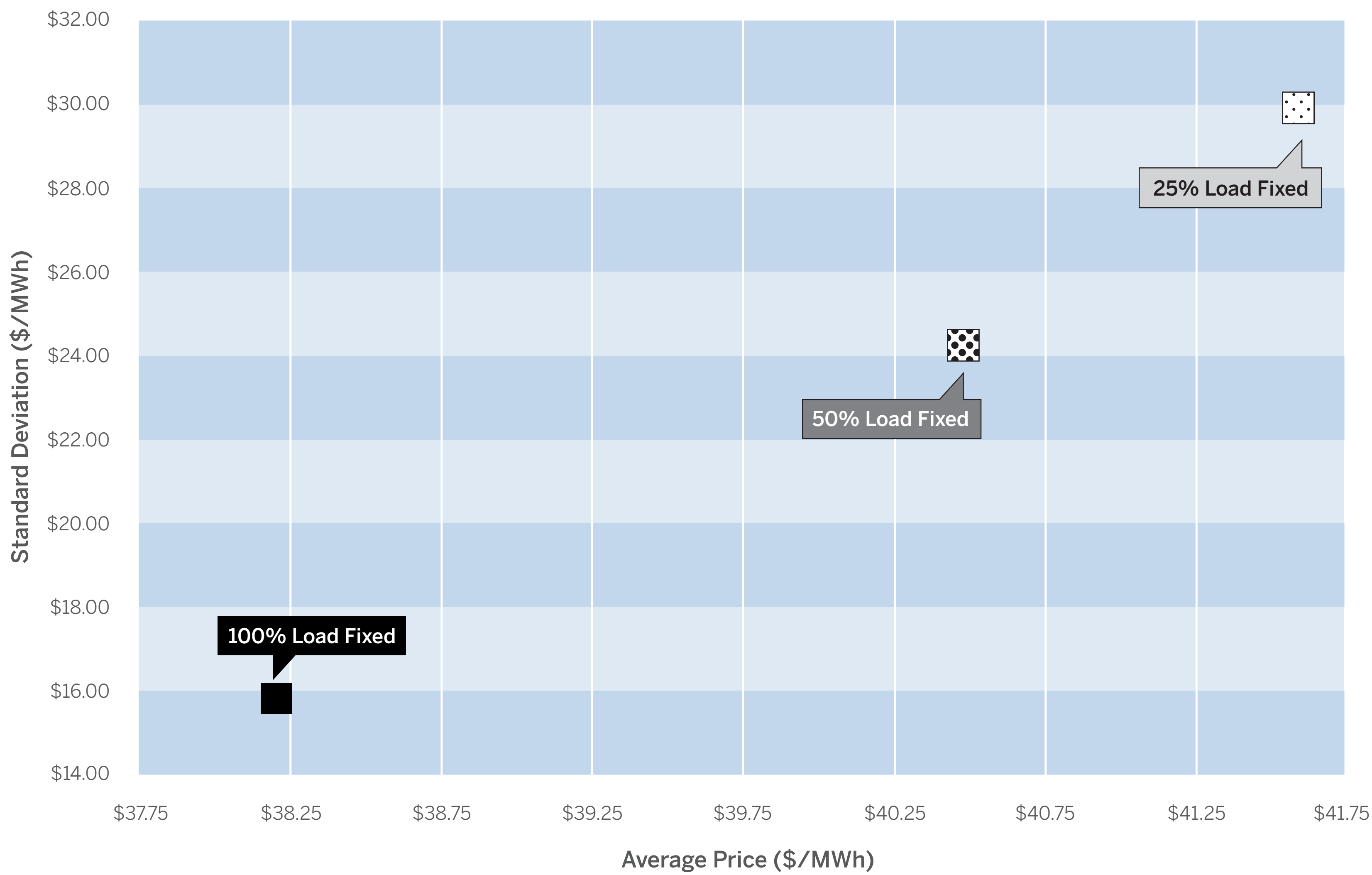


Figure 9D

ERCOT - Price v. Standard Deviation by % Fixed (2011-2021)



Frequency of Purchases (Layering): Price Versus Risk

A Layered Purchasing Strategy is much like the principles of dollar-cost averaging, time diversification, and asset allocation utilized in the finance industry. For instance, a dollar-cost averaging investment strategy—which allows stock purchasers to buy a fixed dollar amount of an investment on a regular schedule, regardless of the share price—can be utilized in a power purchasing strategy in a similar manner. Rather than purchasing a company's power requirements all-at-once, risk can be mitigated by utilizing a layered purchase strategy that incrementally buys the power required in proportions before the flow period.

When the power purchasing strategy outcomes based on the frequency or 'layering' of purchases are grouped, we find Figures 10A-10D. These results show the Price versus Standard Deviation results for each purchasing strategy clustered by layering strategy for fixed price purchasing increments derived from the average of 24 different purchasing strategy outcomes for each solution type and across each ISO.

Layered Strategies (i.e., purchasing in 1/3 or 1/12 increments vs. all-at-once) exhibit a marginal risk avoidance benefit but not as much as those found in Constellation's 2018 purchasing strategies study. As we previously observed when discussing Figure 6, the forward curve volatility used in this study was significantly less (nearly half) than the forward curves referenced in the previous study, which measured results across a different time period. Nevertheless, in this study's timeframe (2011-2021), the risk reduction benefits of layering are still apparent, even with lower pricing volatility in the current period. These figures show that layered-in purchasing strategies still lowered risk, albeit less so than in the 2018 study's timeframe.

Figure 10A

PJM BGE - Price v. Standard Deviation by Layering Strategy (2011-2021)

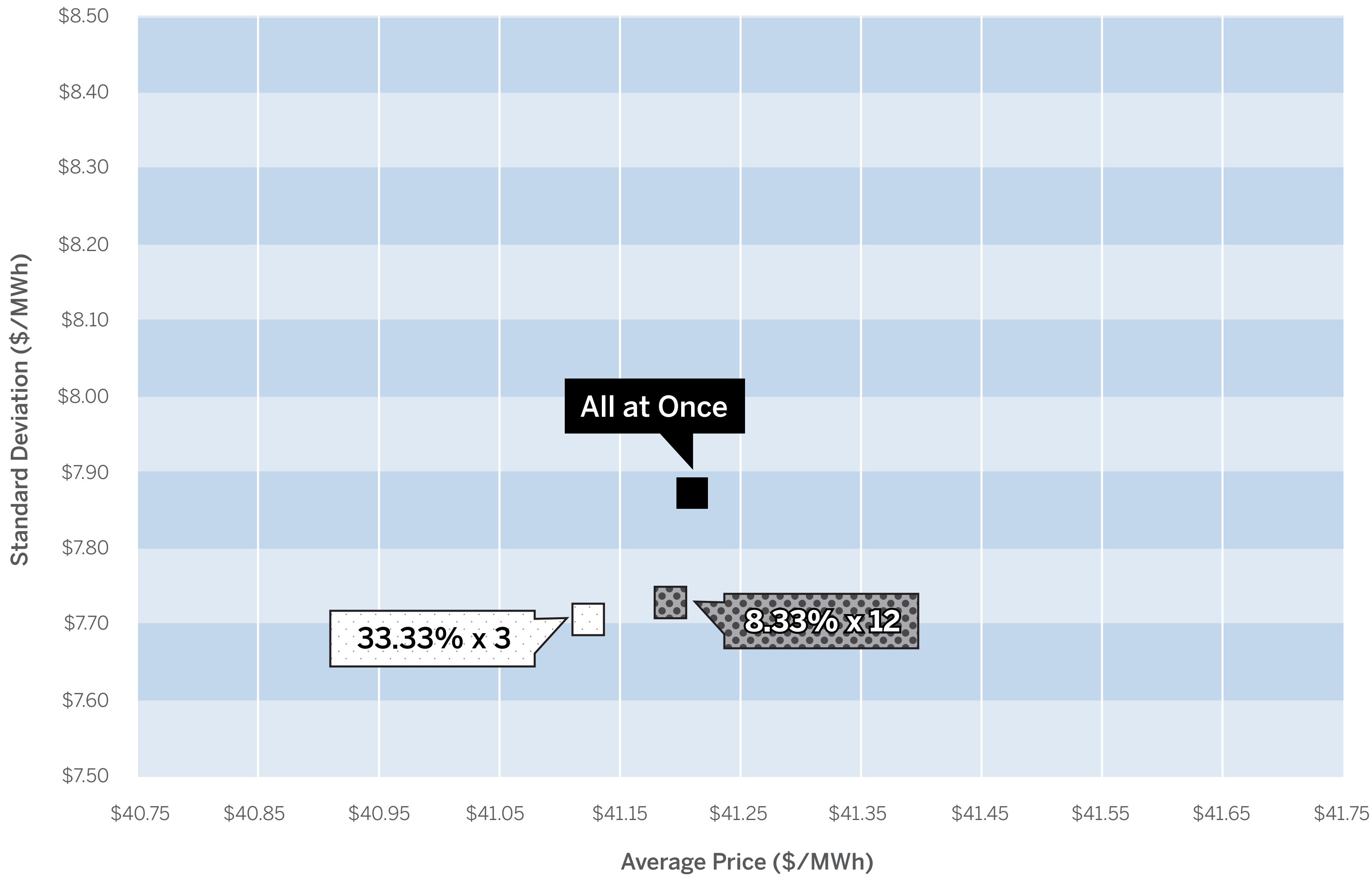


Figure 10B

ISONE - Price v. Standard Deviation by Layering Strategy (2011-2021)

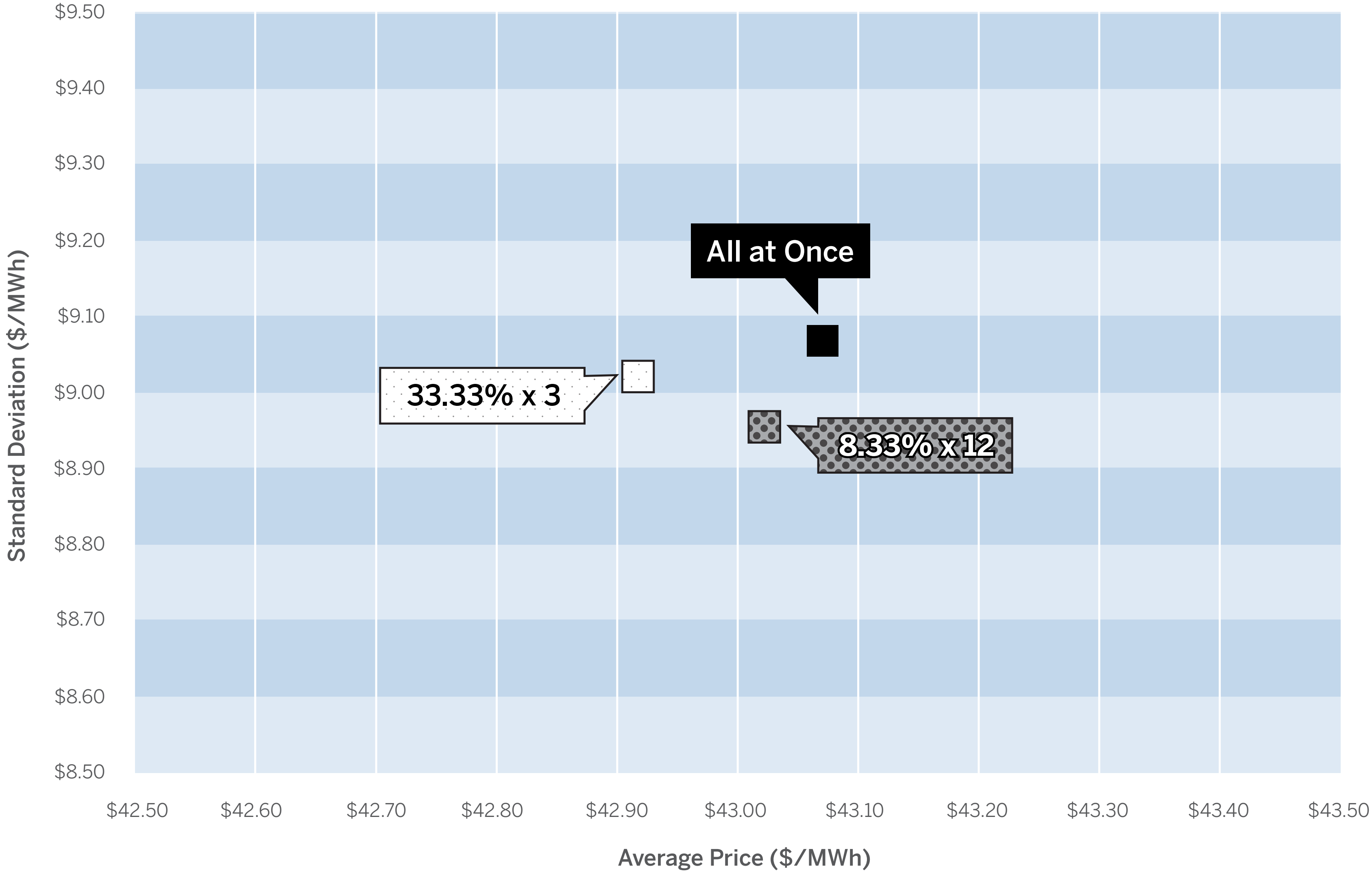


Figure 10C

NYISO Zone G - Price v. Standard Deviation by Layering Strategy (2011-2021)

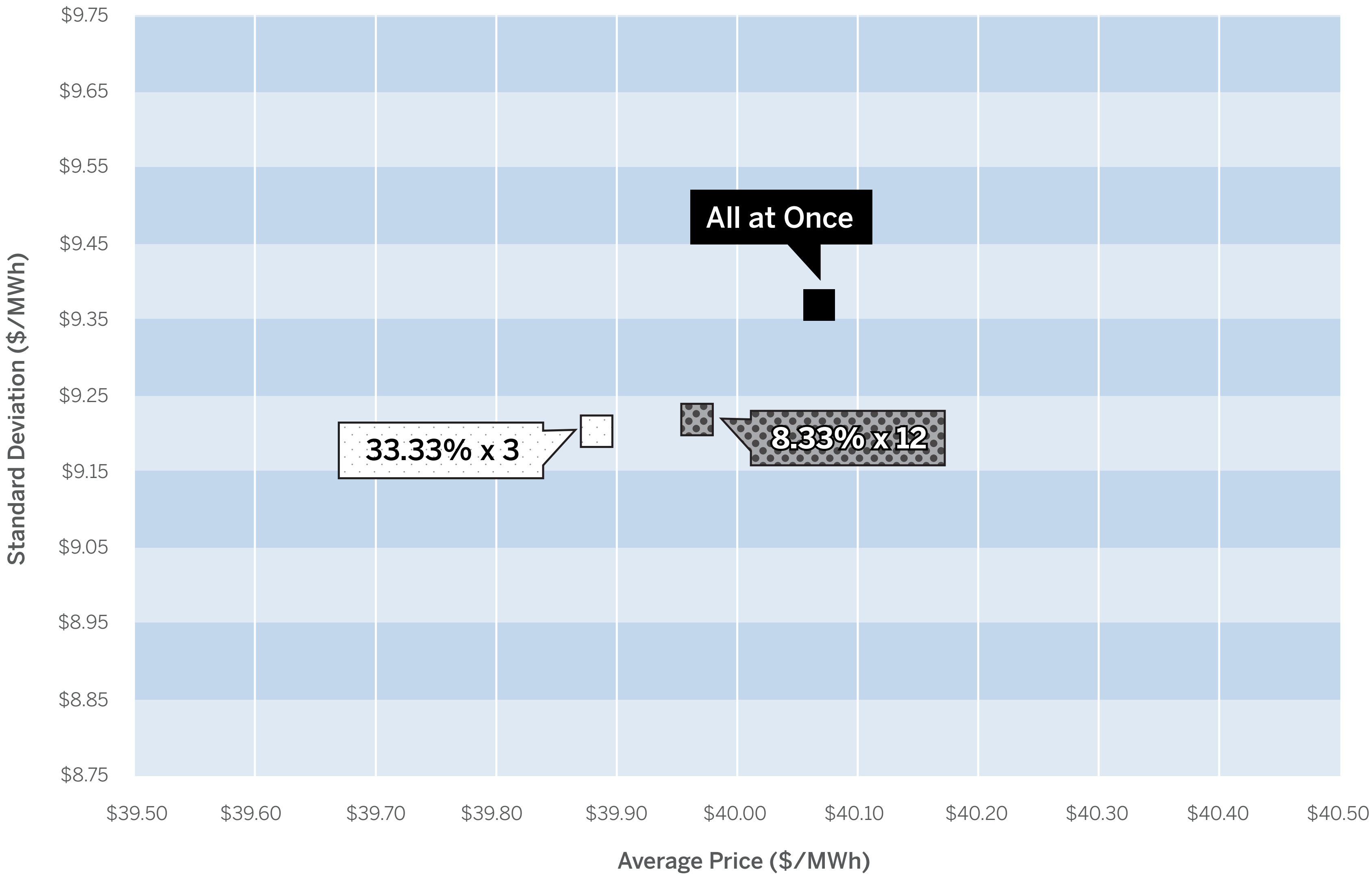
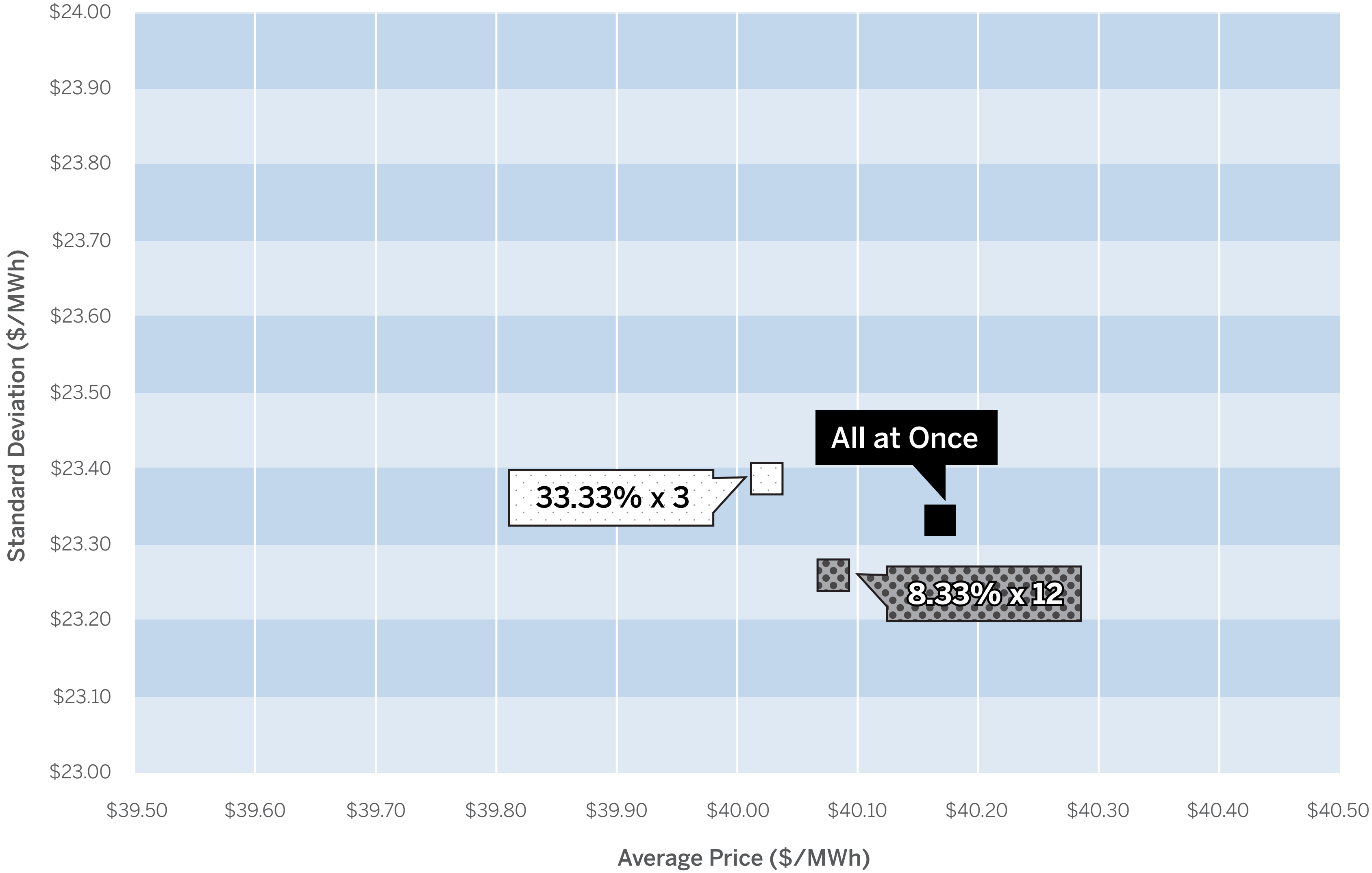


Figure 10D

ERCOT - Price v. Standard Deviation by Layering Strategy (2011-2021)



Timing of Purchase Strategy: Price Versus Risk

When the power purchasing strategy outcomes are grouped to examine the differences between the purchasing end date (36 in each group), we find a very different set of results compared to our 2018 study. In the 2018 paper, we found that there was a meaningful benefit for those purchases made well in advance of the flow date during the first half of the study period, while in the second half, waiting closer to the flow date paid off for the hypothetical buyers in the second half of the study. This result was primarily due to the forward curves generally rising in the first half of the study period covered by the previous study and then predominantly falling during the second half. However, in the timeframe being analyzed as part of this study, the forward curves have been relatively flat across the time period. Consequently, Figures 11A-11D do not show much appreciable price or risk avoidance benefits concerning the purchasing strategy timing sequence.

Figure 11A

PJM BGE - Price v. Standard Deviation by Timing Strategy (2011-2021)

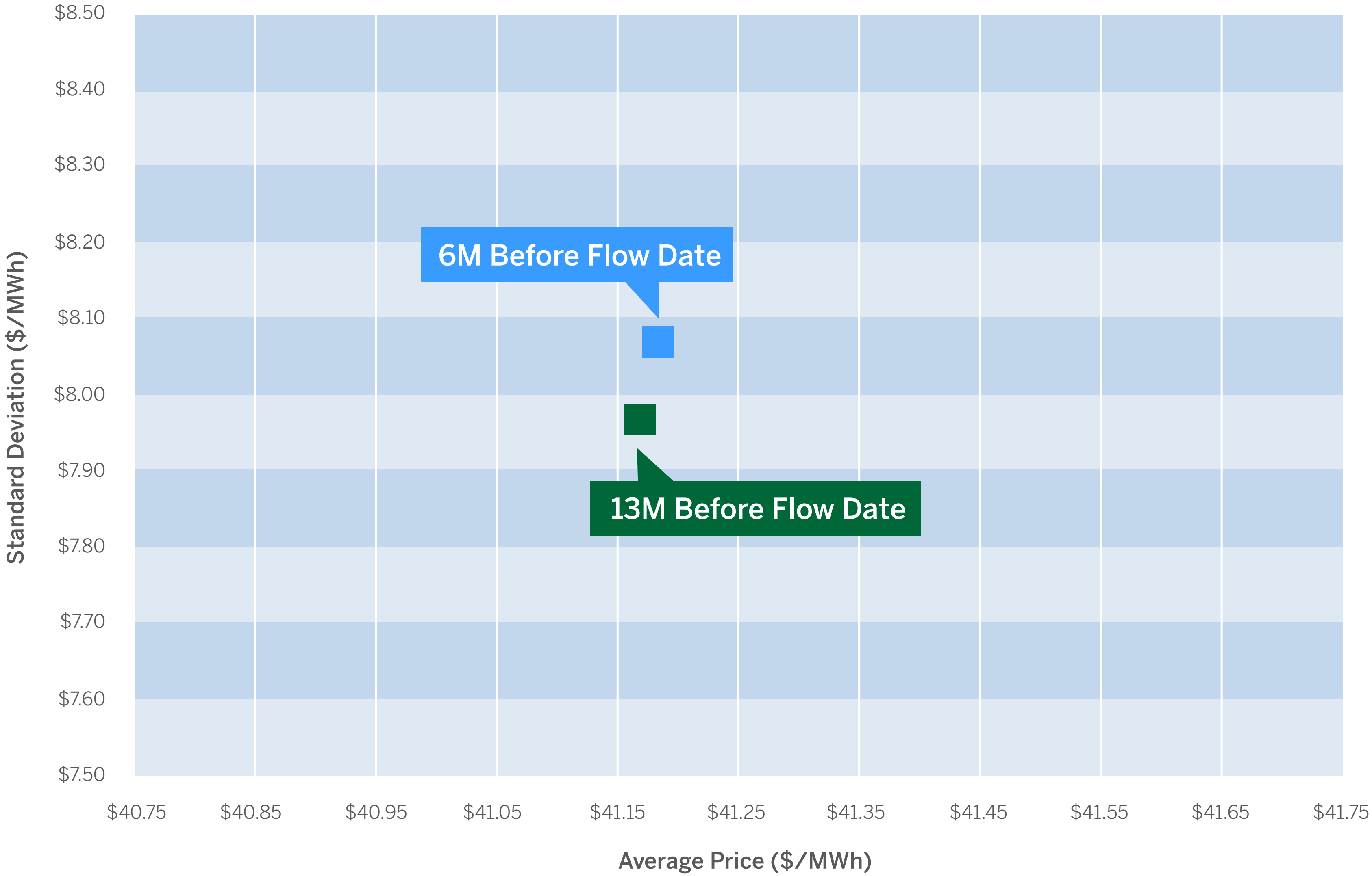


Figure 11B

ISONE - Price v. Standard Deviation by Timing Strategy (2011-2021)

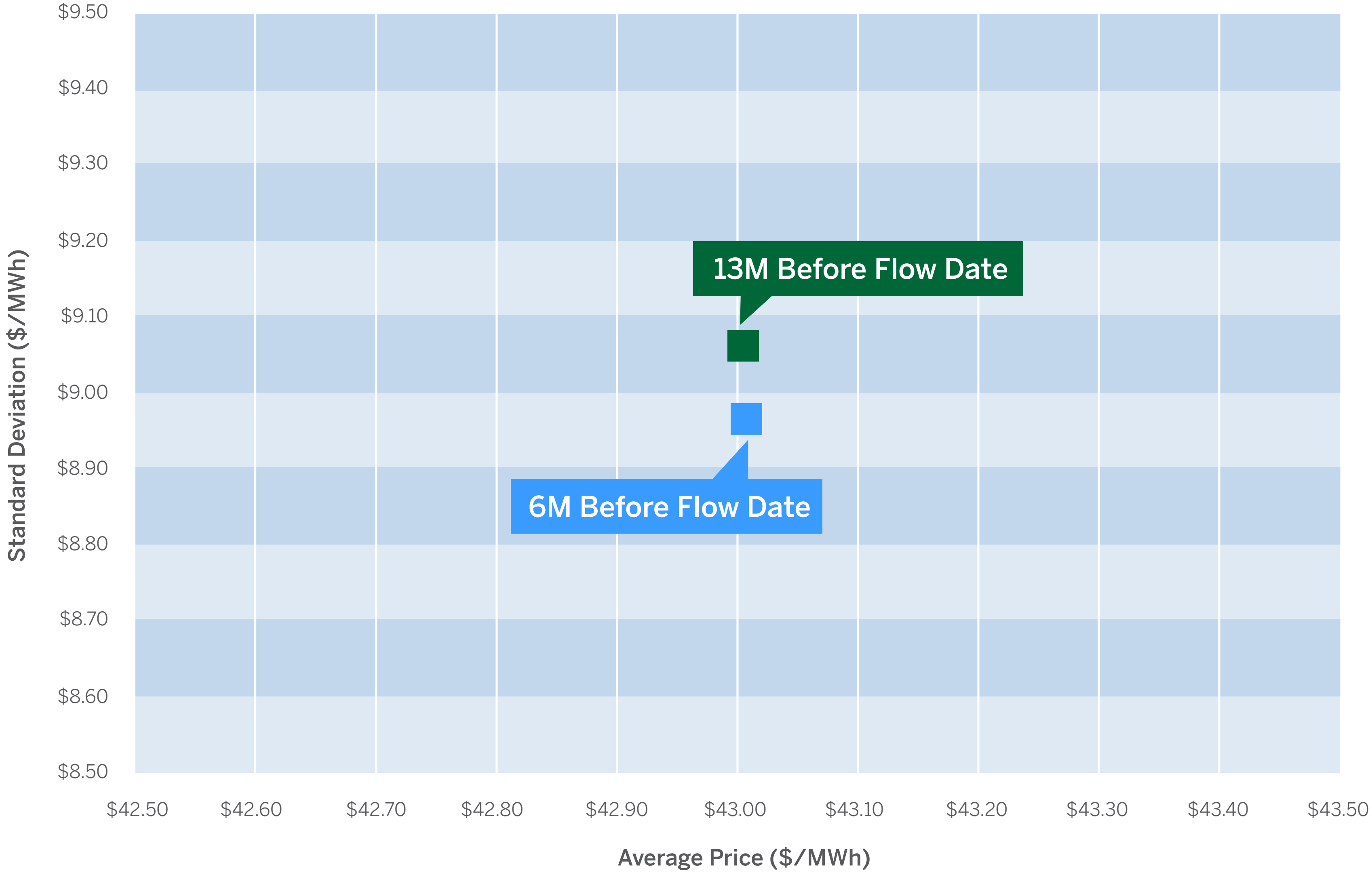


Figure 11C

NYISO Zone G - Price v. Standard Deviation by Timing Strategy (2011-2021)

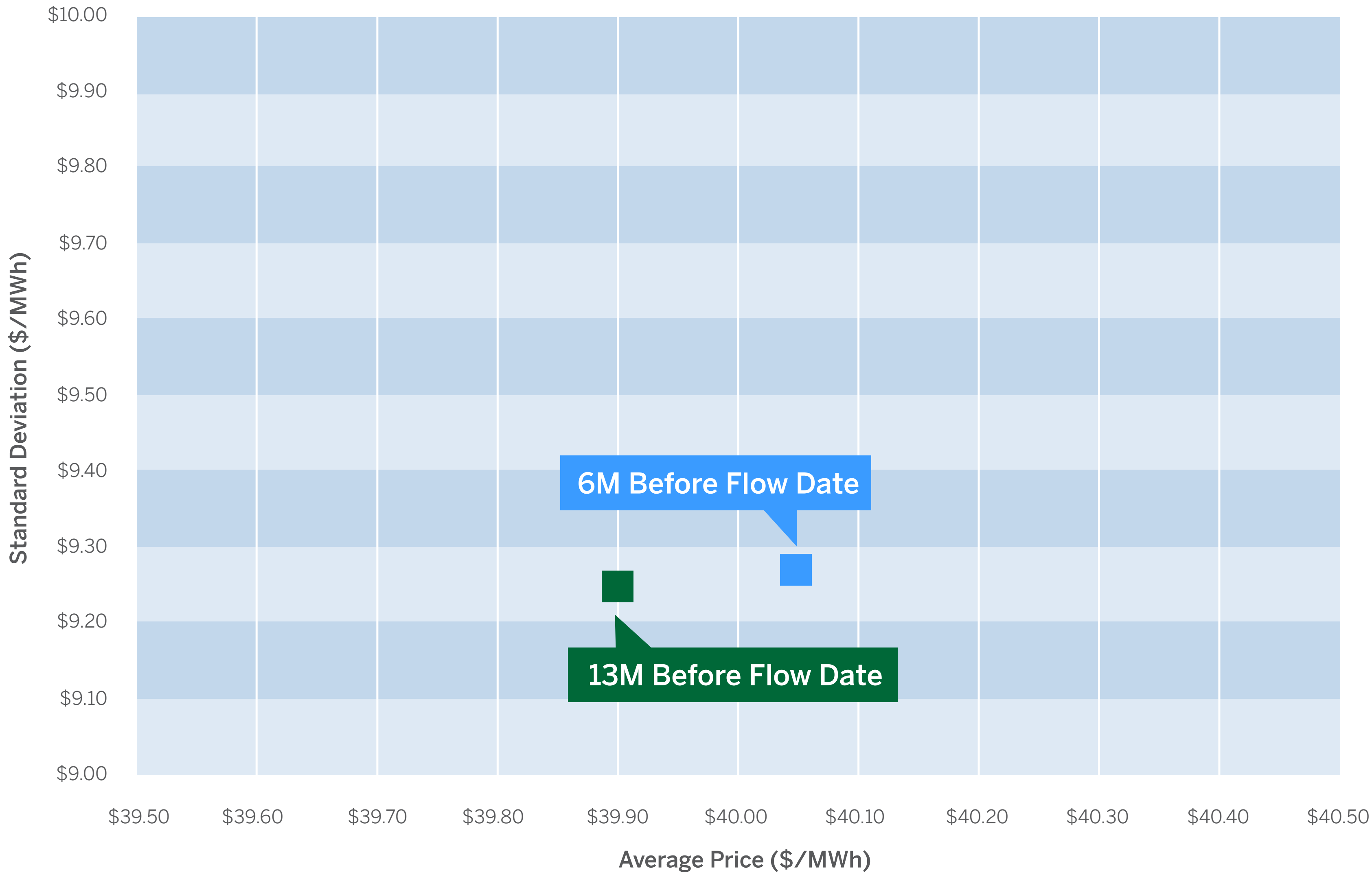
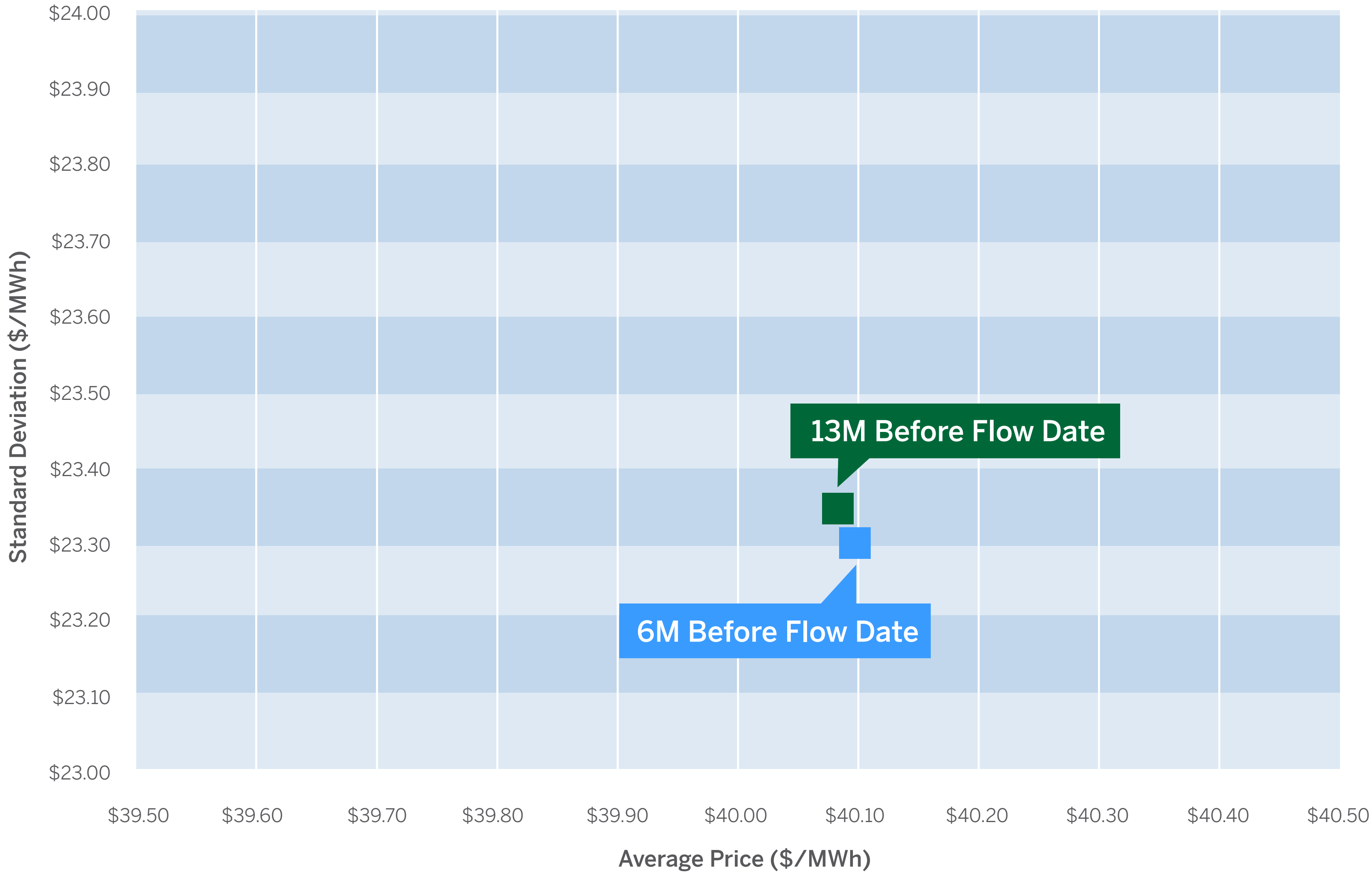


Figure 11D

ERCOT - Price v. Standard Deviation by Timing Strategy (2011-2021)



Key Takeaways

1 Start with a Strategy

Customers in states with competitive retail power markets enjoy the ability to choose their power supplier and how their power purchases are structured. This flexibility means they can cultivate a Power Purchasing Strategy based on their unique needs.

2 Understand Your Variables First

To arrive at a solid Power Purchasing Strategy, consumers should know about their unique variables, such as their:

Load profiles, including how and when power is used

Usage Patterns, including on-peak vs. off-peak, seasonal, and hourly usage patterns

3 Once a Strategy is in Place, How One Purchases Matters

The research detailed in this paper found that including a Layered Power Purchasing component in the procurement strategy improved that strategy's performance from a risk avoidance perspective. The purpose of including a layered-in approach is not necessarily to achieve a lower price outcome but rather to lower the risk of the price outcomes over time. This is similar in purpose to the dollar cost averaging investment strategy used in many financial investment situations. Meaning, that despite the changes in power market conditions, one truth remains constant: A Layered-in Purchasing Strategy is the better way to purchase power for most businesses. A more sophisticated layering method might include disproportional fixed price purchases that allow for smaller purchases when forward prices are relatively high and larger purchases when forward prices are relatively low.

4 Overall, depending on a customer's usage profile,

a power buyer can lower risk, proactively manage their budget, and realize risk avoidance when taking the time and effort to develop a managed approach to buying their power.

A Comment on Today's Markets

Today's competitive power markets are experiencing both forward curve and index pricing volatility that hasn't been seen for over decade. The volatility for the 2011 – 2021 period covered in this white paper was about half the levels of the volatility measured in the 2018 version of this paper which covered 2005 – 2017.

The high growth rate of natural gas supply during the 2009 – 2019 shale era was a period where supply exceeded demand. Current conditions are indicating that long period of abundant natural gas supply may be over, and a new set of economic conditions are on the horizon.

The COVID induced recession imposed financial discipline on the oil and gas industry just as demand for US LNG exports was rapidly rising and gas fired generation was continuing to replace coal generation facilities. Demand for gas fired generation could now be exceeding supply for the foreseeable future. This has resulted in an imbalance where demand for natural gas could continue to outpace supply.

In addition, demand for intermittent renewable generation resources, which by nature require dispatchable generation such as thermal, hydro, or nuclear to help balance grid, increasing customer interest in energy efficiency/demand response solutions, and changes in expectations of the financial markets, will each significantly affect power market dynamics in the years to come.

To be successful, decision-makers in the competitive power markets will need to become increasingly market savvy when it comes to their procurement strategies. Use of more complex market-based concepts and layering-in strategies will become increasingly important. Power buyers will also need to become increasingly familiar with how the financial markets are influencing the capital investments in the energy production sector with changing ROI expectations and the increasing emphasis on ESG. Constellation will continue to monitor and report on these metrics and provide our customers the latest trends impacting power purchasing decisions.

About the Author

Richard Spilky

Richard's energy career began in 1988 when he worked in Caterpillar's Electric Power Generation group. Here, he first learned about "competing" with the incumbent utilities and the importance of understanding tariffs. Since then, Richard has gained over 30 years of experience supporting business growth initiatives in regulated and competitive businesses across the U.S. In his current primarily advisory role to various internal and external stakeholders, Richard utilizes industry best practices when navigating complex policies and regulations related to energy needs in a cost-effective manner. He also supports Constellation by guiding state legislative bodies and regional regulatory commissions on how the political landscape affects customers and competitive retail energy markets at large.

About Constellation

Constellation is a leading competitive supplier of power, natural gas, renewable energy, and energy management products and services for homes and businesses across the continental U.S. We provide integrated energy solutions that help customers strategically buy, manage, and use their energy. Our customers, including three fourths of Fortune 100 companies, rely on our commitment to clean energy, innovation, reliability, and service. That is the kind of value our customers and our communities can expect from Constellation.

Disclaimer

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Appendix

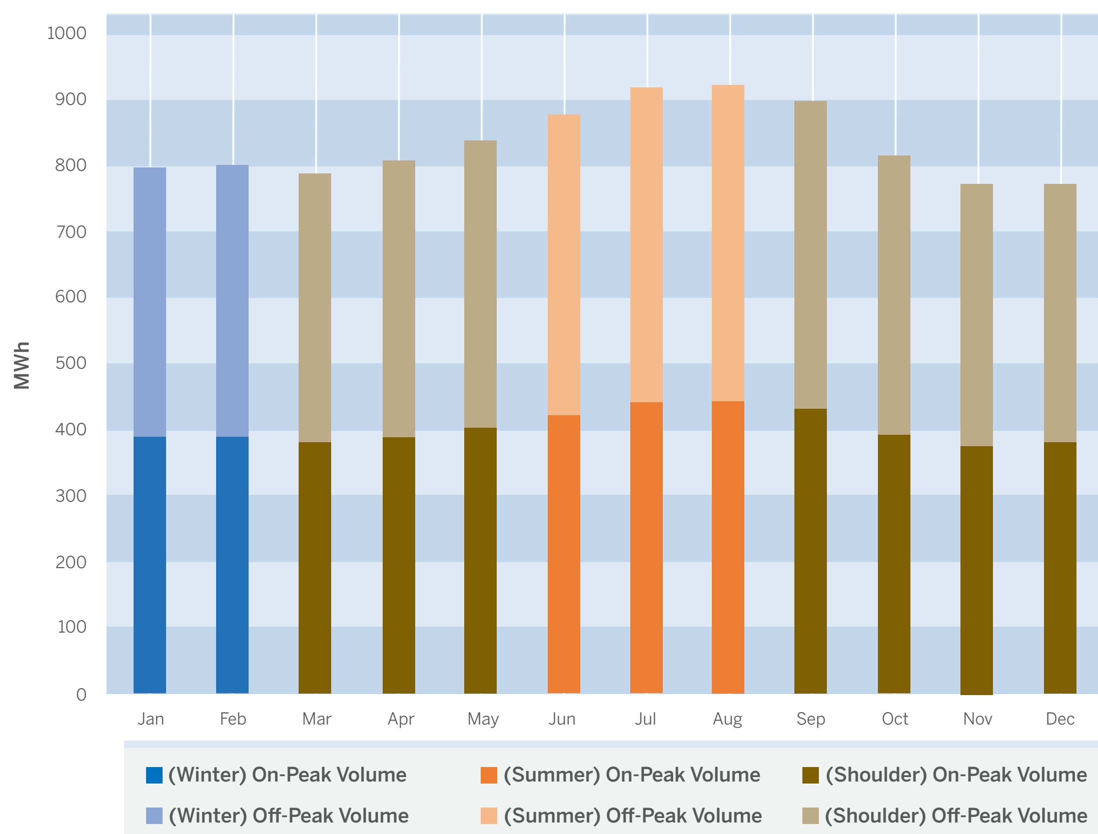
This section provides an overview of the assumptions and other parameters used in the development of the outcomes described in this paper.

Load Profile

The baseline load profile utilized was a hypothetical 10,000 MWh per year customer exhibiting a monthly on and off-peak load shape shown in Appendix Figure A. This baseline load shape was derived using the average of a large sample of existing Constellation commercial and industrial power customers. This baseline load shape was used throughout the analysis to simulate the expected price and volatility for the different power purchasing strategies described.

Appendix Figure A

Monthly Load Profile



ISO Specifics

Purchasing strategies were evaluated across four ISOs. Historical forward curves (for fixed-priced power) and LMP prices (for indexed-priced power) were obtained and incorporated into the calculations for these four ISOs. The specific zones/hubs utilized within each ISO for both the forward curves and the monthly on and off-peak average LMPs are shown in Appendix Figure B.

Appendix Figure B

Primary Data Sources: Purchasing Strategies White Paper, 2022 Update

	PJM	ISONE	NYISO	ERCOT
Forward Curves	Constellation-BGE	Constellation-MA HUB	Constellation-Zone G/LHV	Constellation-ERCOT North
DA L(B)MPs	PJM-BGE	ISONE - Mass HUB	NYISO Zone G/LHV	ERCOT North

Purchasing Strategies

An 11-year period from 2011 to 2021 was analyzed, and each purchasing strategy's outcome was measured with respect to power flows during calendar years.

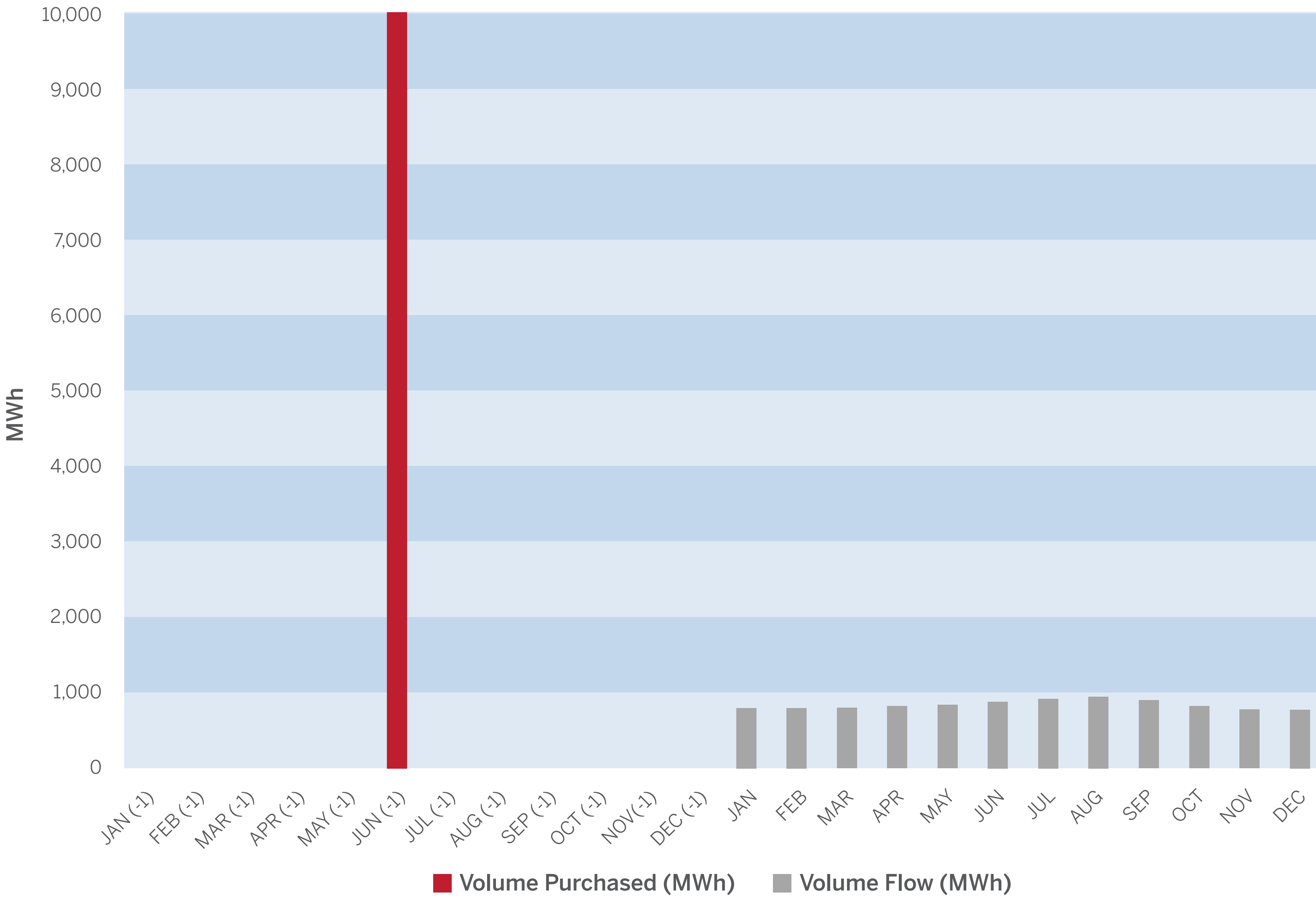
The variables considered are:

- Product/Solution Types: This represents the specific months and/or time periods of the customer's power consumption that was fixed,
  - All-Months (for both on and off-peak periods[4])
  - Only the on-peak periods for all months
  - Only the summer months (June – August) for both the on and off-peak periods
  - Only the winter months (January - February) for both the on and off-peak periods

- The load percentage that was fixed, 25%, 50%, and 100% proportions as applied to the different product/solution types above.
- The time before the flow date at which the purchases were referenced, i.e., six months prior to the first delivery month or thirteen months prior to the first delivery month.
- The increments or 'layering' in which the fixed power purchase was made, i.e., the entire fixed load purchased all-at-once, in twelve equal purchases of 8.33% each, or in three equal purchases of 33.33% each, all prior to the delivery month. See Appendix, Figures C1 through C6, which show examples illustrating the layering methods utilized in these purchasing strategies.

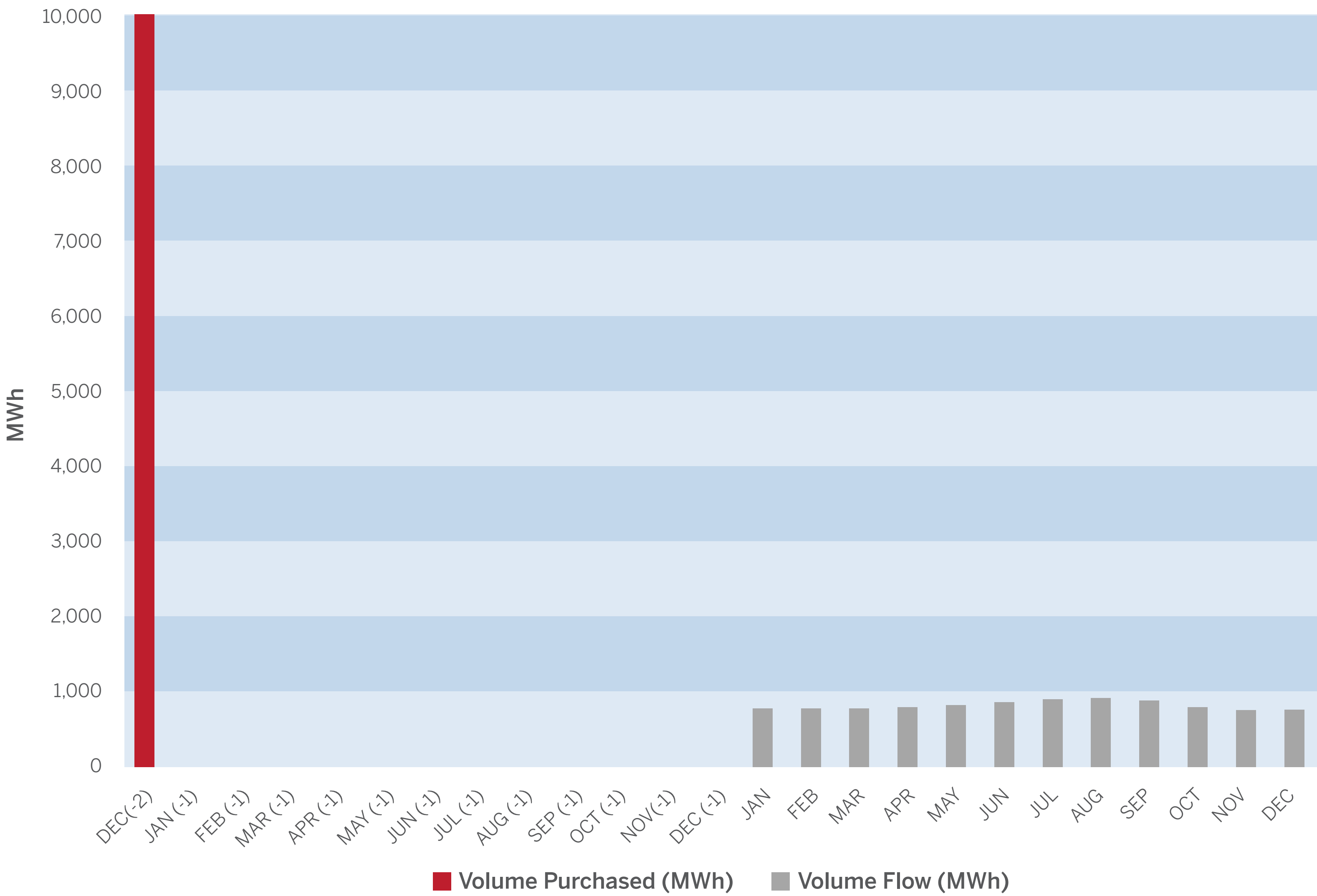
Appendix Figure C1

Purchasing All Months, All-at-Once, 6M before flow date



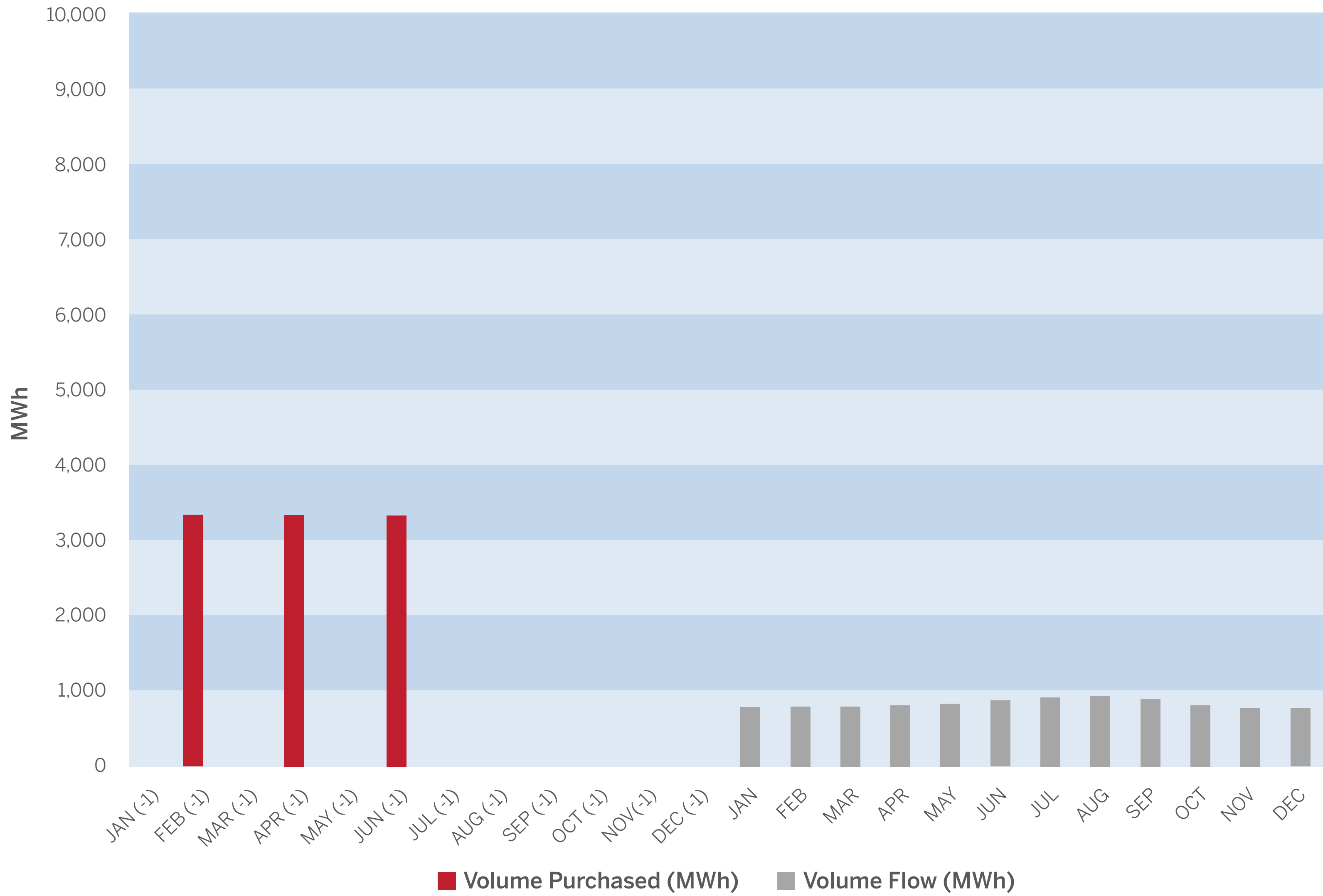
Appendix Figure C2

Purchasing All Months, All-at-Once, 13M before flow date



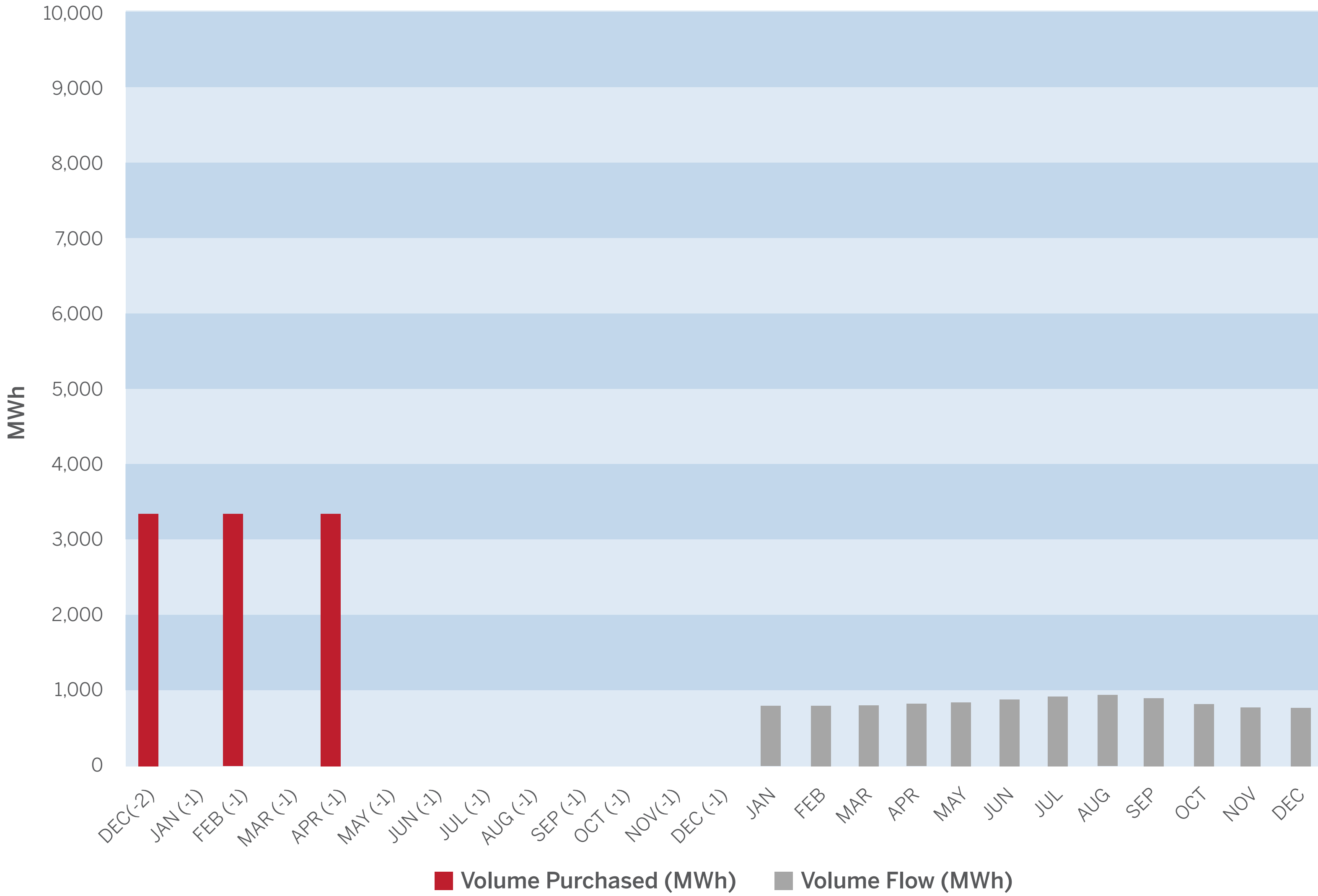
Appendix Figure C3

Purchasing All Months, 1/3 at-a-time, ending with 6M before flow date



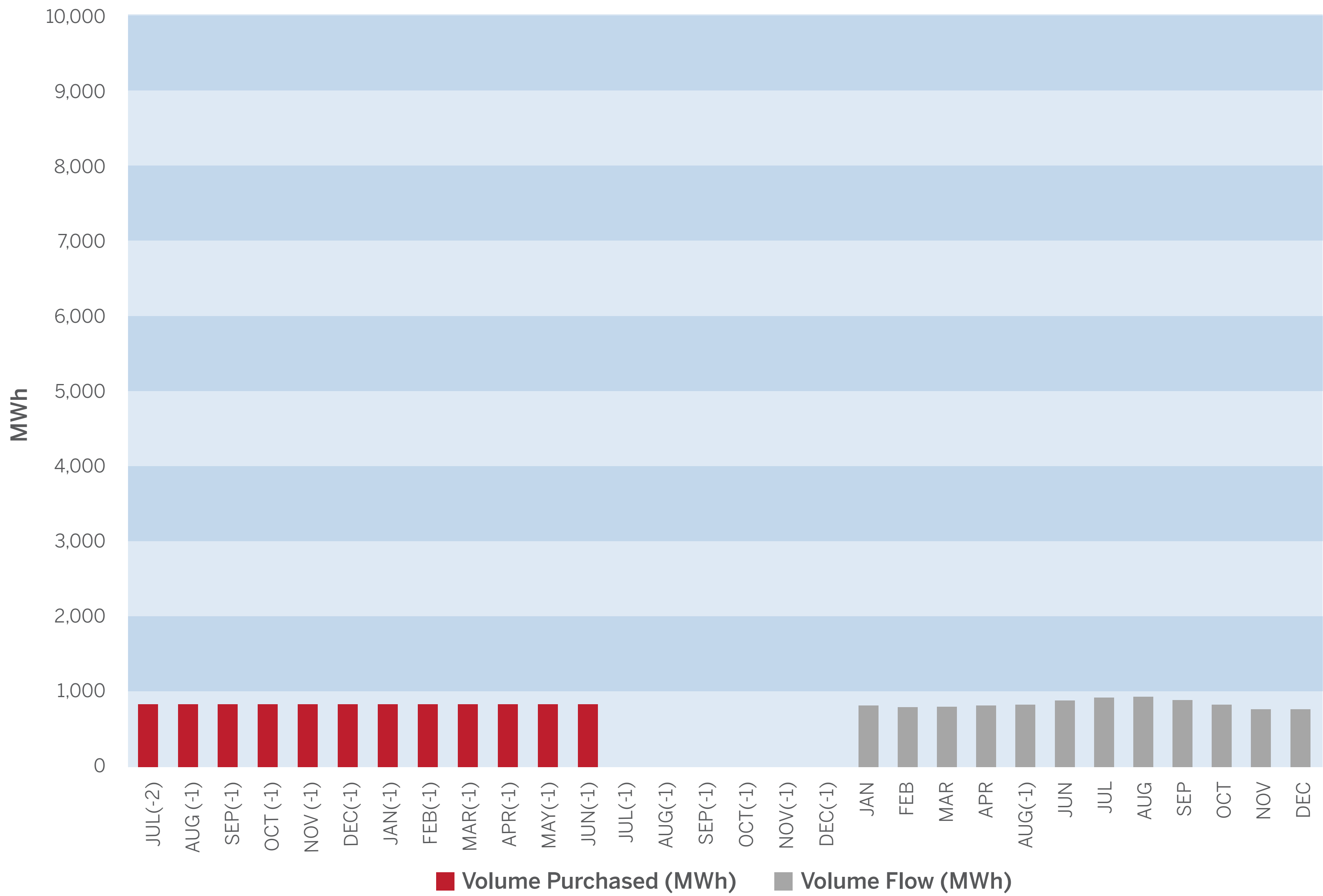
Appendix Figure C4

Purchasing All Months, 1/3 at-a-time, starting with 13M before flow date



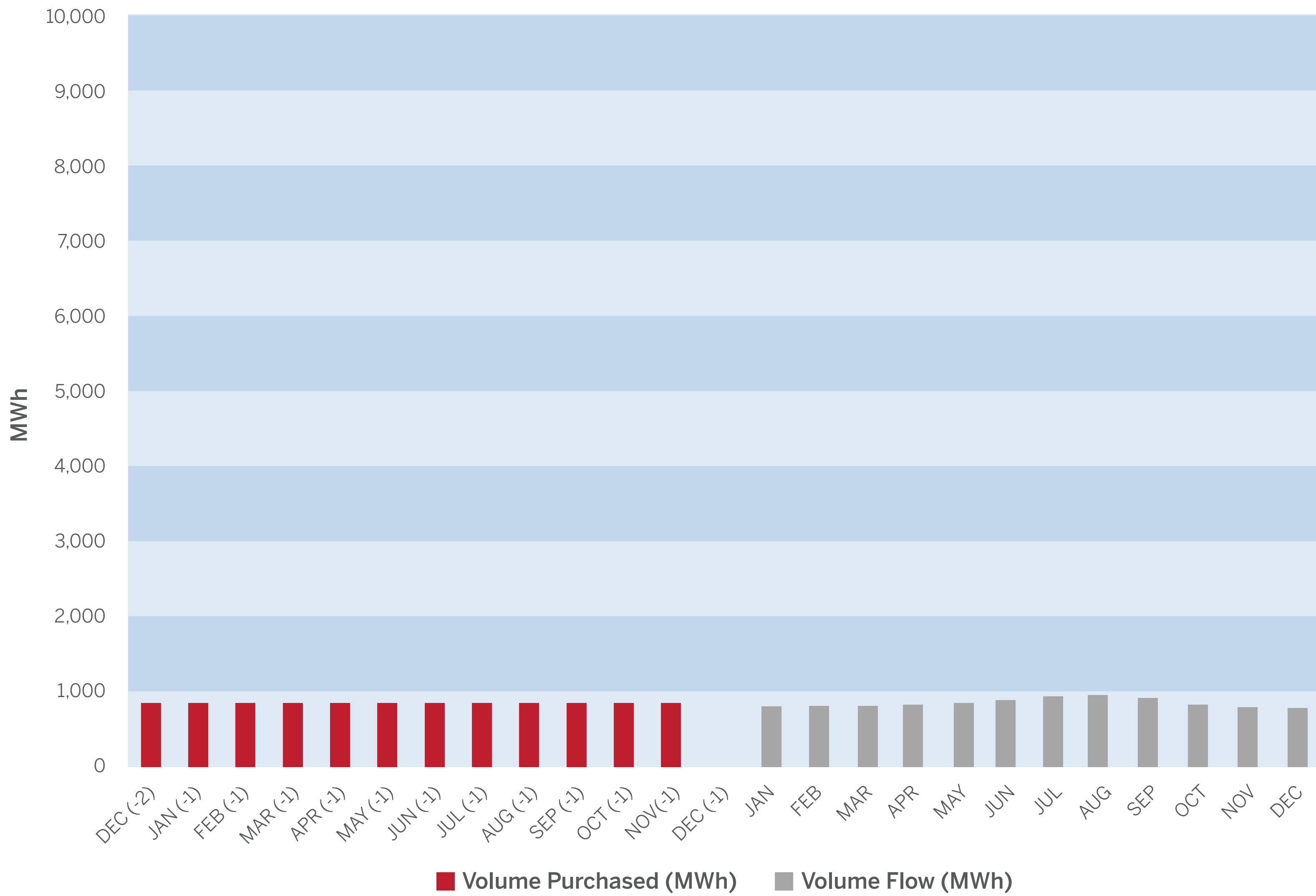
Appendix Figure C5

Purchasing All Months, 1/12 at-a-time, ending with 6M before flow date



Appendix Figure C6

Purchasing All Months, 1/12 at-a-time, starting with 13M before flow date



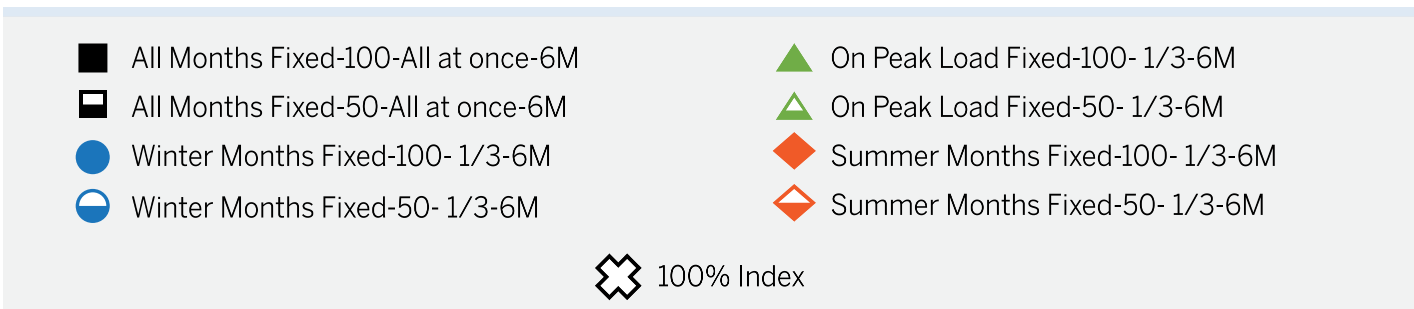
This process generated 72 (4 X 3 X 2 X 3 = 72) different power purchasing strategies plus a 100% LMP index option (no power fixed), resulting in a total of 73 purchasing strategies which were simulated in the four ISOs during each of the 11 calendar years in the study period. Consequently, a total of 3,212 (73 X 11 X 4 = 3,212) different purchasing strategy scenarios were simulated for this study! The average $/MWh price for each purchasing strategy in each year was obtained and compared. Finally, the standard deviation was derived for each purchasing strategy over the time period in order to measure the budget risk a hypothetical power buyer might incur by deploying that purchasing strategy consistently over the time period.

Finally, it should be noted that the study did not examine non-energy cost components such as capacity, transmission, or ancillary costs.

Symbols/Colors

Appendix Figure D shows the symbols and colors used in many of the charts indicating the product/solution types representing the specific months and/or time periods of the load profile customer's power consumption that was fixed.

Appendix Figure D



Glossary

- **BGE** – A specific trading point in PJM - Baltimore Gas & Electric
- **DA** – Day Ahead
- **ERCOT** – Electric Reliability Council of Texas (the ISO covering most of Texas)
- **Flow Date** – Month when the power begins flowing. In this paper, the flow date happens January of each calendar year.
- **ISO** – Independent System Operator (i.e., NYISO, ISONE, PJM, and ERCOT in this paper)
- **ISONE** – Independent System Operator New England (the ISO covering most of New England)
- **LBMP** – Locational Based Marginal Price (i.e., an hourly energy price component in NYISO)
- **LMP** – Locational Marginal Price (i.e., an hourly energy price component in PJM, ISONE, and ERCOT)
- **Mass HUB** – A specific trading point in ISONE
- **NYISO** – New York Independent System Operator (the ISO covering New York State)
- **Off-Peak** – Usage not included during the On-Peak periods
- **On-Peak** – Usage hour-ending 7 AM-10 PM, Monday through Friday on non-holidays
- **PJM** – Pennsylvania, Jersey & Maryland (an ISO named initially after the first three states that joined but has since included many other jurisdictions in its footprint)
- **Summer** – Months of June, July, and August in this paper
- **Winter** – Months of January and February in this paper
- **Zone G/LHV** – A specific trading point in NYISO

ERCOT – Impact from Winter Storm Uri

In February 2021, Winter Storm Uri substantially impacted the solutions that included index prices across ERCOT. The outcomes shown in the figures in the body of this paper for ERCOT capture the effects of this event. To illustrate just how large the impact, we've created the following figures where we exclude the impacts of Winter Storm Uri. Each of these figures are labeled with an ALT notation (e.g., Figure 3D (ALT).

Revisiting the table from {page 7} that summarizes the purchasing strategy outcomes from each ISO in Figures 2A – 2D we've added an ERCOT (ALT) column on the far right. You can see how large an impact Uri had across the high, low, and average purchasing strategies – a greater than 21% swing between the low and high results.

	PJM	ISONE	NYISO	ERCOT (ALT)
Avg. Price of all purchasing strategies	$41.16	$42.98	$39.95	$33.44
Avg. of the Highest Prices each year	$48.21	$53.85	$49.39	$39.90
Avg. of the Lowest Prices each year	$36.75	$36.71	$34.96	$29.07
% Difference Low to High	27.8%	39.9%	26.1%	32.4%

Figure 3D (ALT)

ERCOT - 2011-2021: Price v. Standard Deviation

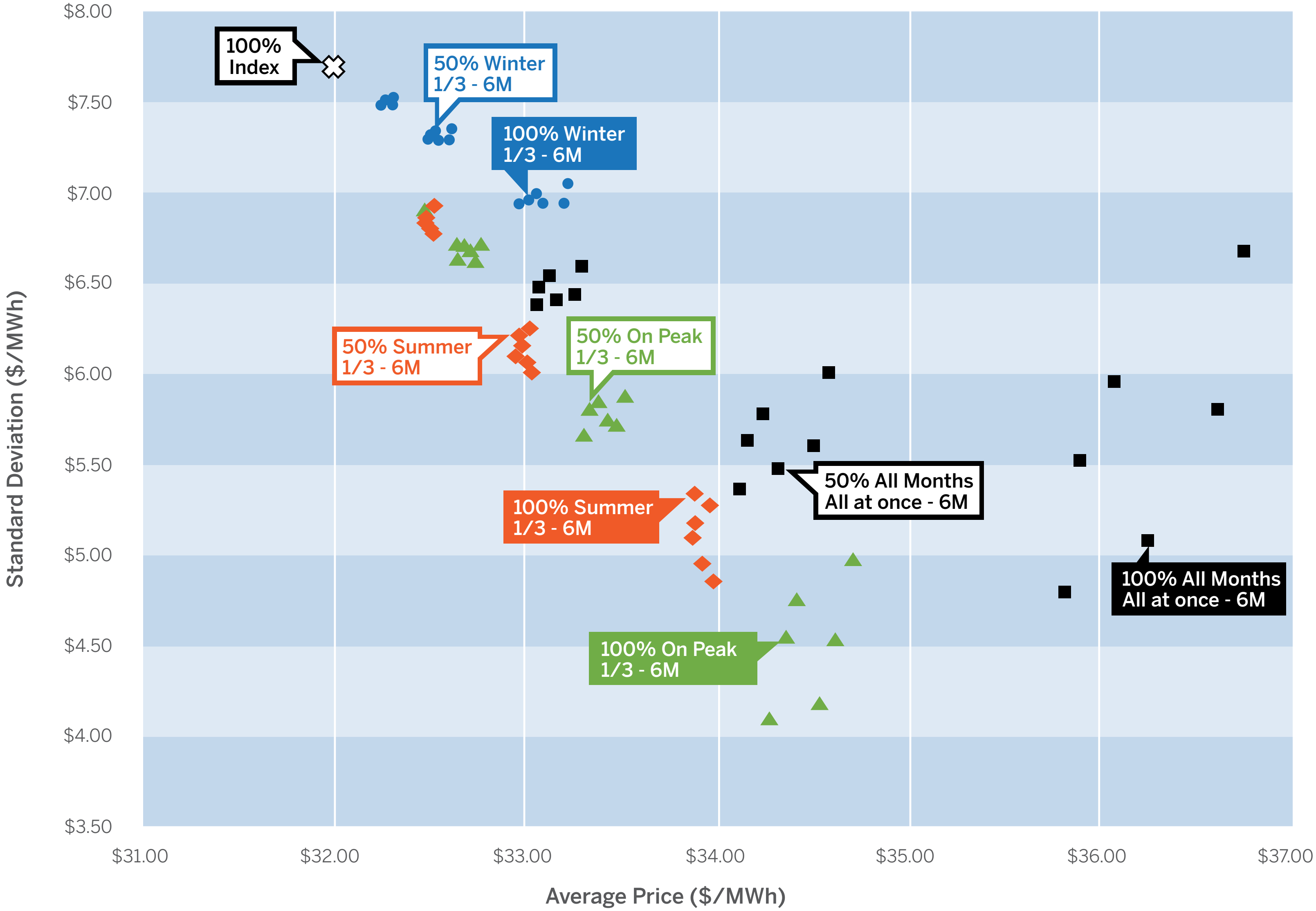
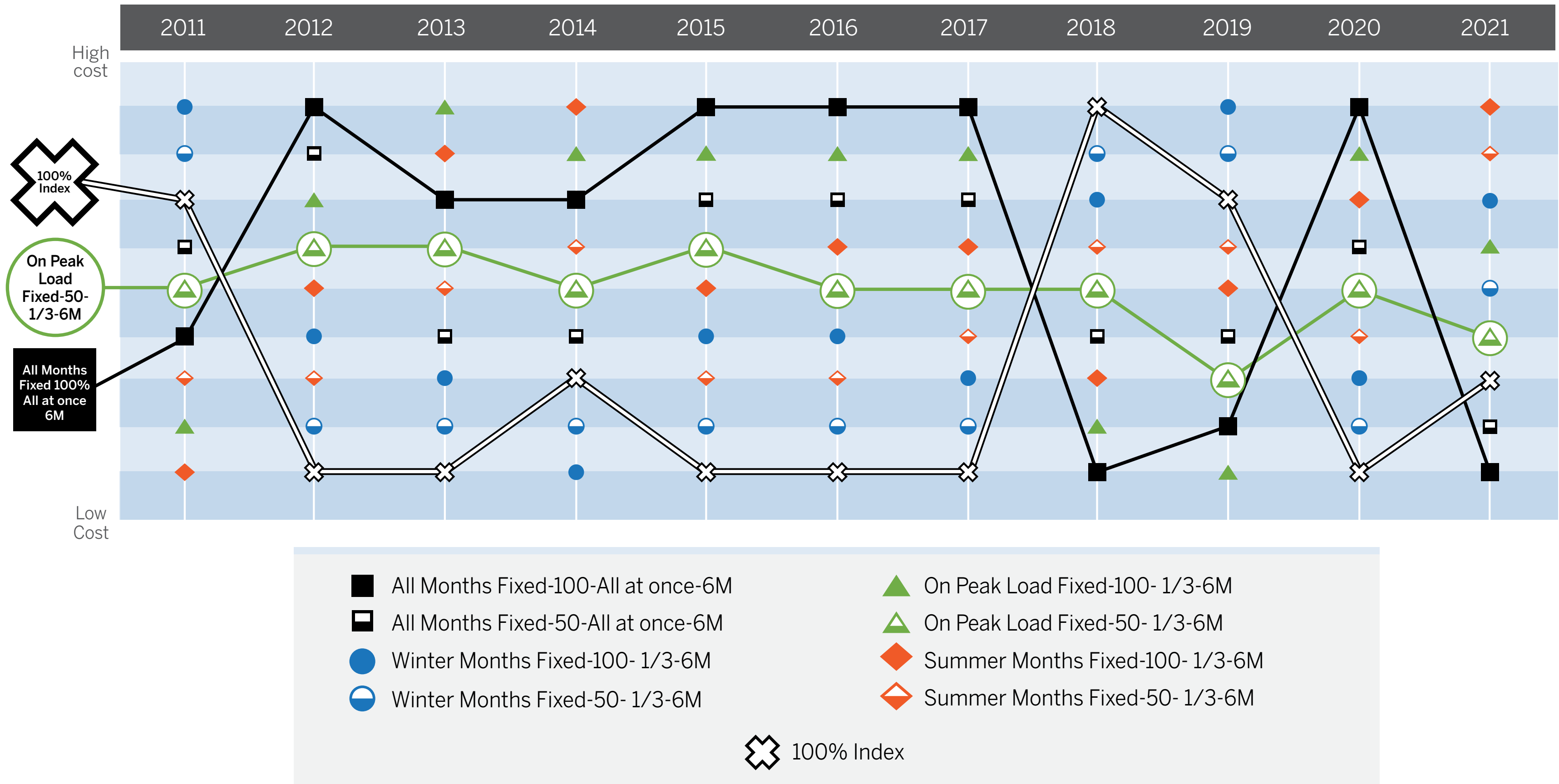


Figure 4D (ALT)

ERCOT - Nine sample strategies (2011-2021)



As shown in the table on page 67 the overall average price difference from low to high for all the purchasing strategies each year is 32.4%

Figure 5D (ALT)

ERCOT: Strategies Resulting in Lowest Prices and Volatility (2011-2021)

	Product/Solution Type	Percentage Fixed	Purchase Timing (wrt Flow Date)	Purchasing Proportions
Lowest 3 Prices	100% Index	0	n/a	n/a
	Winter Months Fixed	25	13M	1/12
	Winter Months Fixed	25	6M	1/3
Lowest 3 Risk (Volatility)	All Months Fixed	100	6M	1/12
	All Months Fixed	100	6M	1/12
	All Months Fixed	100	13M	1/12

ERCOT: Strategies Resulting in Highest Prices and Volatility (2011-2021)

	Product/Solution Type	Percentage Fixed	Purchase Timing (wrt Flow Date)	Purchasing Proportions
Highest 3 Prices	All Months Fixed	100	13M	All at once
	All Months Fixed	100	6M	1/12
	All Months Fixed	100	6M	All at once
Highest 3 Risk (Volatility)	100% Index	0	n/a	n/a
	Summer Months Fixed	25	13M	1/12
	Summer Months Fixed	25	6M	All at once

Figure 8D (ALT)

ERCOT - Price v. Standard Deviation by Product Strategy (2011-2021)

Figure 9D (ALT)

ERCOT - Price v. Standard Deviation by % Fixed (2011-2021)

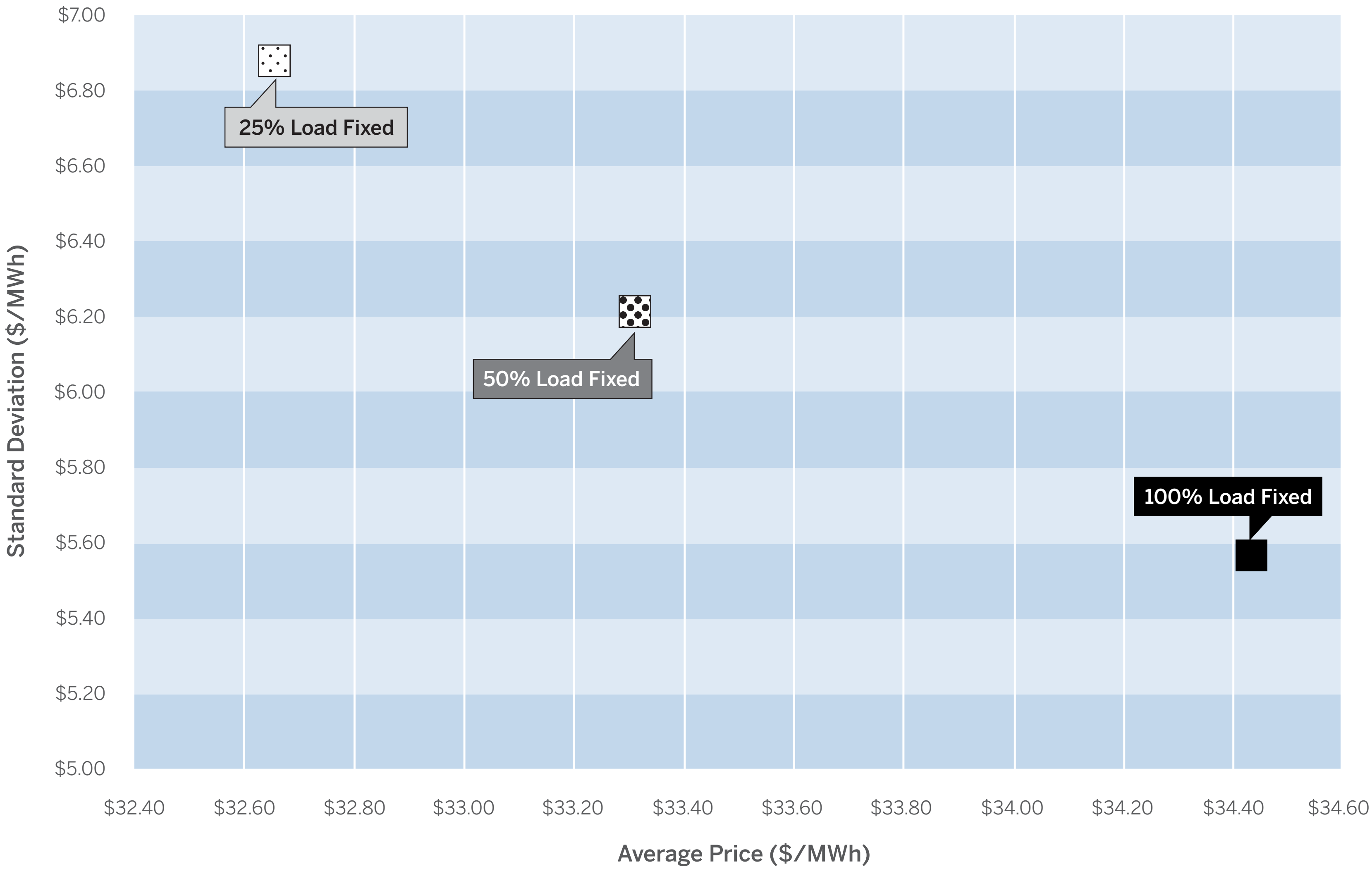


Figure 10D (ALT)

ERCOT - Price v. Standard Deviation by Layering Strategy (2011-2021)

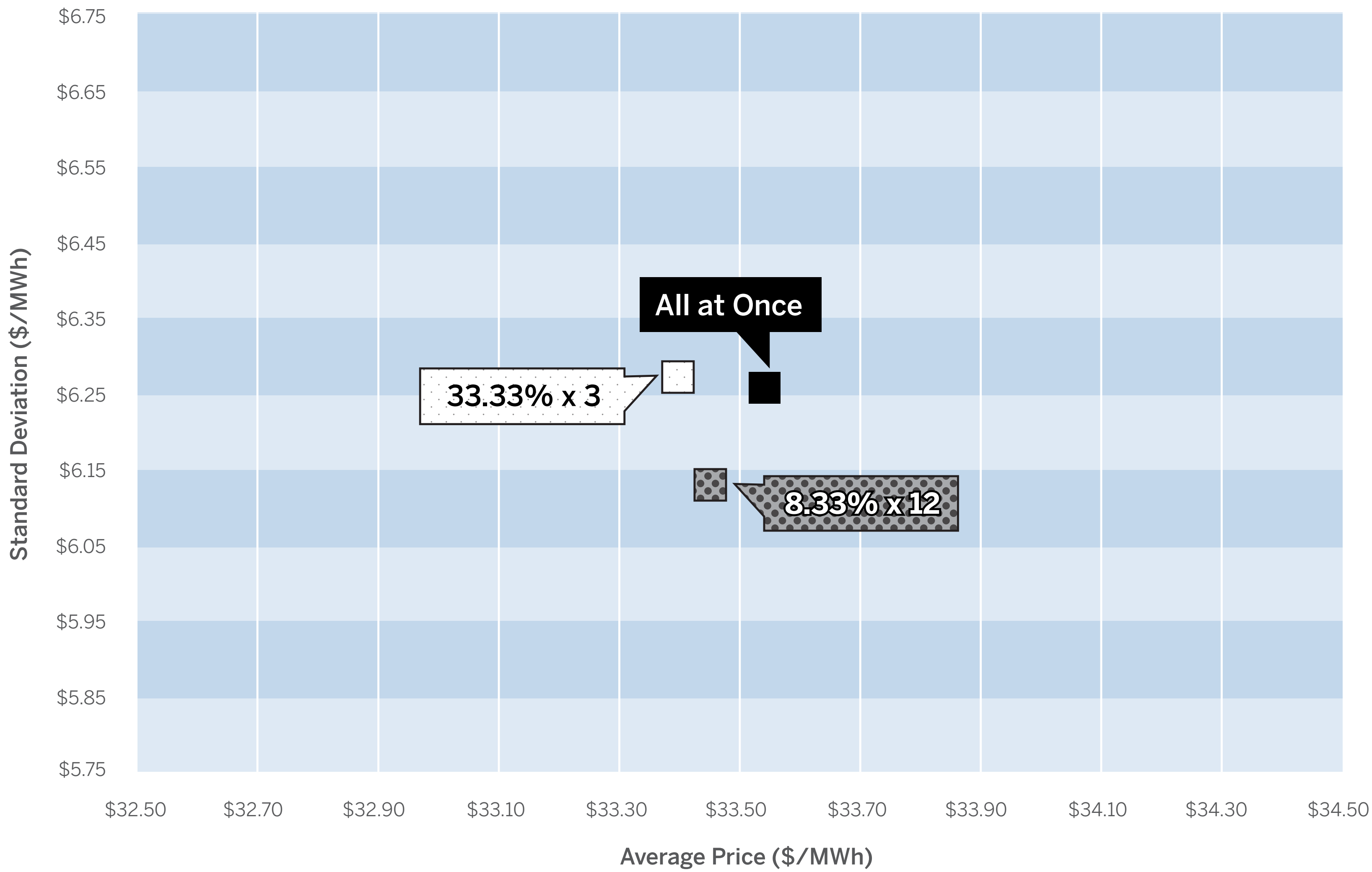
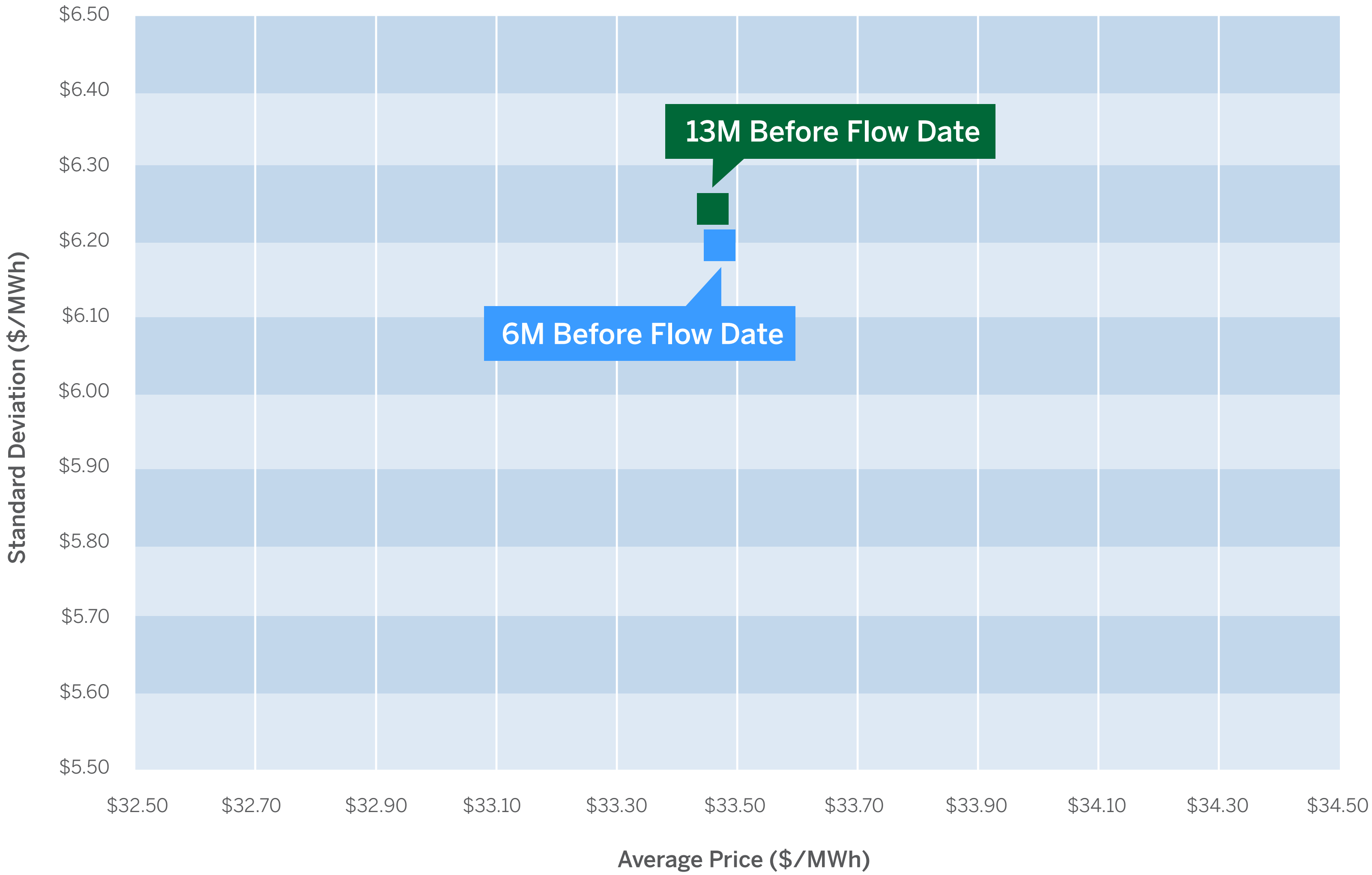


Figure 11D (ALT)

ERCOT - Price v. Standard Deviation by Timing Strategy (2011-2021)



Overall, the pricing/risk performance of the various power purchasing strategies in ERCOT would have been in-line with the outcomes in the other three ISOs had it not been for the substantial impact on index prices caused by Winter Storm Uri.

Endnotes

[1] The 14 competitive states/jurisdictions for purposes of this paper are those states (and Washington DC) that enable full retail power choice for all customers and in which the utilities, for the most part, do not own any generation assets (and in that way might be described as 'wires-only' delivery service utilities). Those 14 competitive jurisdictions are CT, DC, DE, IL, MA, MD, ME, NH, NJ, NY, OH, PA, RI, and TX. Other states that allow limited retail choice are CA, OR, WA, MT, NV, AZ, VA, and MI. These eight states are, for the most part, still vertically integrated. Customers in both groups can benefit from the concepts described in this paper, although only those limited customers enabled to choose their retail supplier can do so in the second group of states. For more information on this topic, see https://www.resausa.org/energy-by-state/.

[2] Throughout this paper, figures ending in A, B, C, and D will represent the data from the ISOs in PJM, ISONE, NYISO, and ERCOT, respectively, i.e., [A: PJM], [B: ISONE], [C: NYISO] and [D: ERCOT].

[3] Depending on the ISO of interest, similar insights can be drawn in the other ISOs as described in this section when comparing Figures 3B and 5B (ISONE), 3C and 5C (NYISO), and 3D and 5D (ERCOT), respectively. These comparisons show the relative merits of the highest and lowest price and risk levels.

[4] The On-Peak definition used in the context of this paper is the NERC definition, namely, usage from 7 AM to 10 PM Monday through Friday on non-holidays. Off-Peak periods are all other hours.