PGIM QUANTITATIVE SOLUTIONS

# ESG SOLUTIONS: LOW CARBON EMISSION OUTCOMES

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To learn more about our capabilities, please contact PGIM Quantitative Solutions by email at contactus@pgim.com or by phone in the US at +1 (866) 748-0643 or in the UK at +44 (0) 20-7663-3400.

Our ESG Solutions capabilities are designed to provide outcomes that balance a variety of investor objectives and preferences.

Previous research showed how our capability can help investors who have a low active risk budget but want improved ESG exposure. We showcased outcomes that delivered index-like risk and return while significantly tilting toward companies with the best ESG practices (see ESG Solutions: Seeking a Strong Alternative to ESG Indexes). Building on this foundation, we demonstrated how we incorporate specific investor preferences – in this case, excluding the Energy Sector – and still achieve a similar outcome (see ESG Solutions: ESG Indexing with Exclusions).

Our current research extends the flexibility and practicality of our ESG Solutions framework by revising the primary objective of the portfolio. Rather than significantly tilting towards companies with the best ESG practices we focus on a different and more specific ESG attribute – carbon emissions. While other attributes could form the focal point of a portfolio (e.g., water usage or diversity metrics), in this piece we explore carbon emissions given the topic's current prominence, most notably in Paris Aligned Benchmarks (PAB) and Climate Transition Benchmarks (CTB). The goal of our research is to build portfolios with significantly lower carbon emission intensity levels relative to the benchmark, while delivering performance and risk comparable to the underlying index.

## Approach

The first step in building a low carbon emission portfolio is to decide on a target level of carbon emission reduction. We chose 50% given the commonality of this threshold in existing low carbon emission indexes. While carbon emission reduction is the explicit portfolio objective, we also demonstrate how portfolio risk and return outcomes vary at different levels of carbon emission reduction.

*PGIM is the investment management business of Prudential Financial, Inc. (PFI). PFI is the 11th largest investment manager (out of 431 firms surveyed) in terms of worldwide institutional assets under management based on Pensions & Investments' Top Money Managers list published June 2022. This ranking represents institutional client assets under management by PFI as of December 31, 2021. Participation in the P&I ranking is voluntary and open to managers that have any kind of U.S. institutional tax-exempt AUM. Managers self-report their data via a survey. P&I sends the survey to previously identified managers and to any new managers asking to participate in the survey/ranking. No compensation is required to participate in the ranking.

Let's be clear, building a portfolio focusing on low carbon emissions is not a unique objective. While plenty of strategies and indexes have this focus, they tend to be constructed in a manner similar to single-factor, smart beta portfolios. The input is carbon emissions and positions are weighted by carbon emission levels (with varying awareness of other risk considerations; rarely any other investment inputs).

We seek to deliver a better outcome and more intuitive portfolio exposures while also achieving the 50% carbon emission reduction target.

While broadly targeting stocks with lower emissions, we seek to refine that exposure by focusing on firms with attractive fundamental alpha attributes (e.g., value, growth, and quality). By employing our proprietary alpha model to gain fundamental company insights, we construct a portfolio with balanced exposures to value and growth, that fulfils the low carbon emission target but with a 'core' exposure. The benefit of this approach is that low carbon emitters can also be good investments that benefit the portfolio's return outcomes. Specifically, our valuation discipline helps us better align with attractively priced low carbon emitters, reducing the likelihood of exposure to a 'low carbon bubble' (i.e., investors chasing low carbon emitters).

Additionally, while targeting a meaningful reduction in carbon emissions, we want to ensure the portfolio does not take on other unanticipated exposures. For example, we want to avoid exposure to companies that are low carbon emitters but have high water usage practices, poor workplace health and safety practices, etc. As such, we incorporate safeguard exposures in our portfolio, specifically controlling exposures to our proprietary E, S, or G scores (which capture a broad set of environmental, social and governance practices).

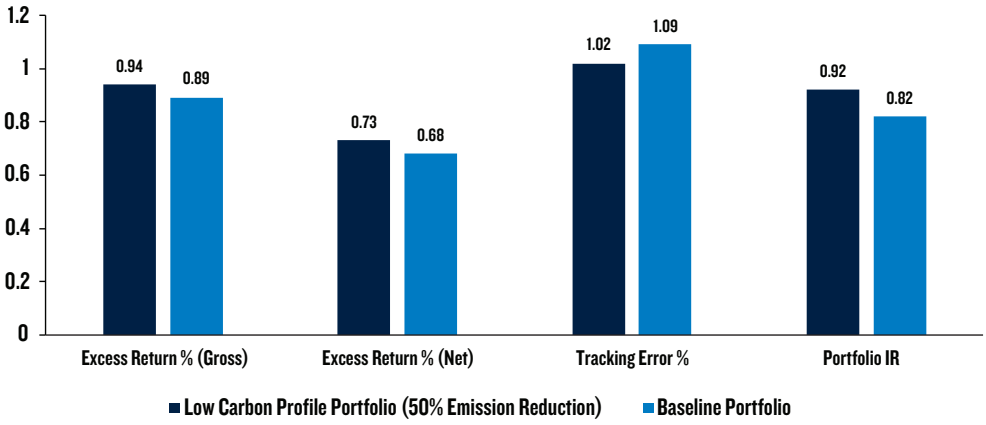
Lastly, for this specific solution we aim to produce a portfolio risk level that is comparable to an index (e.g., enhanced indexing). To accomplish this task, we must carefully control for key risk exposures (e.g., active stock/sector/industry/country positions). The benefit of this approach is that alpha is generated primarily from stock selection, not from taking large active positions around sectors/industries/countries. For example, overweights in Information Technology and underweights in Energy are common exposures in low carbon portfolios

For consistency with our previous studies, we maintain a focus on the MSCI World universe, although our framework can easily be applied to other investment universes. We generate a frontier of portfolio outcomes targeting different levels of carbon emission reductions and varying active risk levels to better inform trade-offs and identify the optimal portfolio solution.

## Portfolio Solution

To reach an optimal solution we simulate the performance of a portfolio with the previously described specifications to successfully achieve a 50% reduction in carbon emissions (relative to the benchmark) in each period throughout our backtest. The simulated portfolio modestly outperforms the index by +0.94% gross per year (+0.73% net), demonstrating the benefit of targeting low carbon emitters with attractive investment attributes. Our careful risk controls also keep tracking error in check at 1.02%, a level we believe is palatable to low active risk investors (Figure 1).

**Figure 1: Portfolio Attributes**

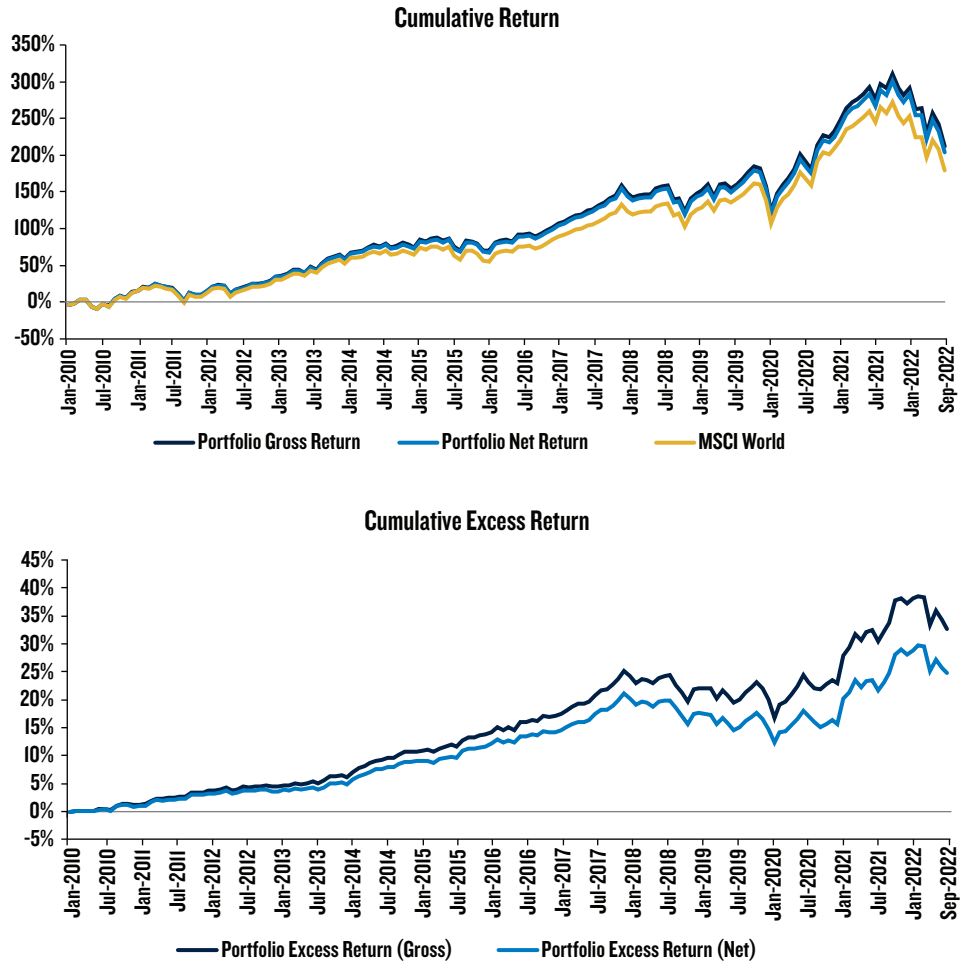



*From 12/31/2009 to 9/30/2022. Inception of the Simulated 50% Carbon Emission Reduction strategy is 12/31/2009 Benchmark: MSCI World Index. Source: PGIM Quant, MSCI.*

Figure 2 depicts the cumulative performance of the strategy and benchmark, making it apparent that close tracking of the benchmark is attained. We then plot the cumulative excess performance of the portfolio. Excess performance cumulates in a relatively steady manner through time, again demonstrating the advantages of focusing on low carbon emitters with attractive fundamentals. In addition, implementing risk controls helps ensure that key underlying risk attributes are similar to the benchmark and achieve lower tracking error. It should also be noted that our simulated portfolio holds, on average, 600 names. This portfolio selectivity (relative to MSCI low carbon leaders, which hold over 1000 names) helps to avoid many of the worst carbon emitters while providing significant diversification to manage the portfolio's risk profile.

We've shown that our low carbon solution delivers modest outperformance; the question that remains is whether this alpha generation is due to low carbon exposure or the fundamental attributes we additionally target to fulfil the low carbon exposure. To answer this, we simulate performance of a portfolio where the low carbon emission objective is removed. Other aspects of the portfolio remain the same. This 'baseline' delivers gross outperformance of +0.89% (+0.68% net). The low carbon emission portfolio gains a further 5bps of excess return. In addition, the tracking error for the baseline portfolio is slightly higher (1.09% vs 1.02%). We show that low carbon emission exposure is modestly beneficial from a tracking error perspective, as the reduction consistently emerges in different simulations. A natural follow-up question is, why? One explanation could be a fund flows argument: as investor preferences drive demand for low carbon emitters relative to higher carbon emitters, fund flows increase, leading to higher stock prices for low carbon emitters. This outperformance, however, is not fundamentally driven, and our value discipline would limit exposure to expensive low carbon emitters, tempering this as an overwhelming driving force. Alternatively, low carbon emitters proxy for firms that have more efficient operations (i.e., if emissions are a proxy for resources consumed given the size of the firm). Further research will be aimed at better isolating the transmission mechanism for this additional outperformance.

**Figure 2: Cumulative Performance**

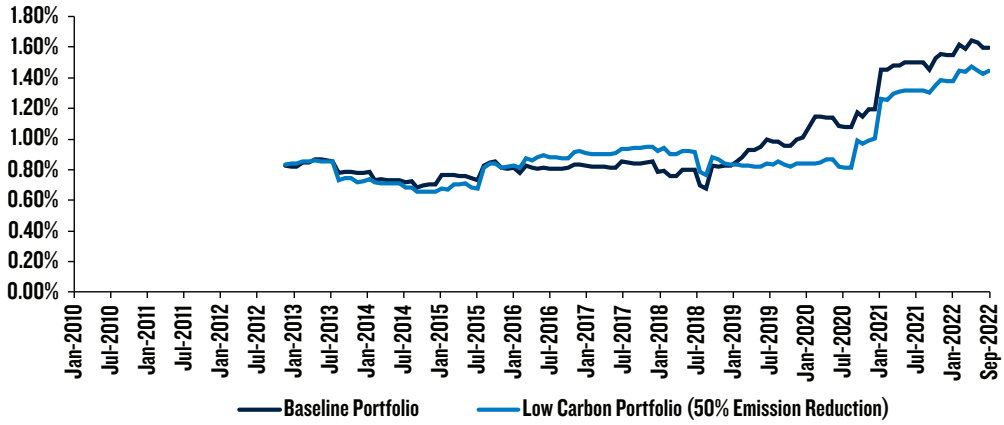



*From 12/31/2009 to 9/30/2022. Inception of the Simulated 50% Carbon Emission Reduction strategy is 12/31/2009 Benchmark: MSCI World Index. Source: PGIM Quant, MSCI.*

As outlined, the goal of our research is to build portfolios with significantly lower carbon emission intensity levels relative to the benchmark, while delivering performance and risk comparable to the underlying index. Risk is a sensitive point for an investor who may be transitioning from a passive ESG allocation to an active solution, like the one described in this note. As such, we further examine the active risk profile of the portfolio. While active risk is on average ~1%, it has recently increased, due to several unexpected market events, including the COVID shock. Importantly, this is not due to low carbon emission or ESG-related constraints. Figure 3 depicts the rolling 3-year tracking error of a baseline portfolio and compares that to our low carbon emission portfolio solution. We find that both portfolios experience an increase in tracking error following the COVID shock. While we believe this to be a transitory impact, we demonstrate in the Frontier Analysis section how investors who are averse to a tracking error increase from 1% to 1.5% can be helped to refine their selection of portfolio active risk and understand the trade-off with active return and carbon emission reduction outcomes.

**Figure 3: Tracking Error**

**Rolling 36 Months**




*From 12/31/2009 to 9/30/2022. Inception of the Simulated 50% Carbon Emission Reduction strategy is 12/31/2009. Benchmark: MSCI World Index. Source: PGIM Quant, MSCI.*

In addition to the fundamental attributes that we target to help fulfil carbon exposure targets, we also target additional ESG attributes to help limit positions in low carbon emitters that harm the environment or society in other ways. Exposure to stocks with unattractive E, S, or G attributes is possible while still achieving a low carbon emission outcome. Our simulation results reveal the importance of these additional targets on E, S, and G. We find our E constraint is binding, suggesting that low carbon emitters could have other harmful E practices (impacts on biodiversity, water usage, etc.). Certainly, an investor concerned about carbon emission would not find this acceptable. As such, these insights help illustrate the need to go beyond simple single-factor low carbon emission approaches to more sophisticated, multi-dimensional approaches that ensure investor objectives and preferences are met.

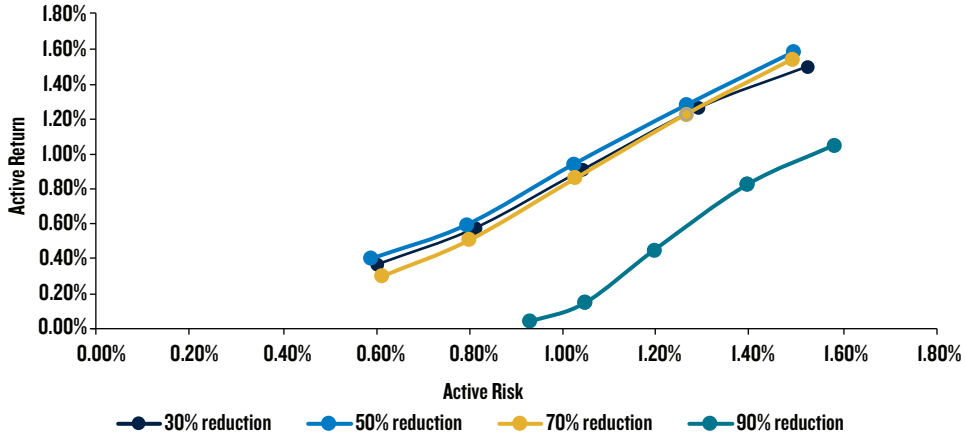
## Frontier Analysis

We recognize that investor preferences and objectives could vary from the solution described in the previous section. An investor may have a lower (or higher) active risk budget. If so, how does this trade-off with return and carbon emission reduction possibilities impact that risk budget? More to the point, since investors may vary in terms of the magnitude of the carbon emissions they seek, what are the implications of targeting higher (or lower) carbon emission reductions?

To help inform investor decision-making and guide investors in identifying the most attractive portfolio solution we repeat our simulations using different targets (such as 30%, 50%, 70%, 90%) and plot portfolio outcomes across these different carbon emission reduction target levels and active risk levels. This produces 'frontiers' for each carbon emission reduction level.

Figure 4 summarizes the 20 variants: five active risk levels tested against four carbon emission targets:

**Figure 4: Active Return vs. Active Risk**




*Source: PGIM Quant. For illustrative purposes only. There can be no guarantee that the objective will be achieved. Please see 'Notes to Disclosure' page for Important Information including risk factors and additional disclosures.*

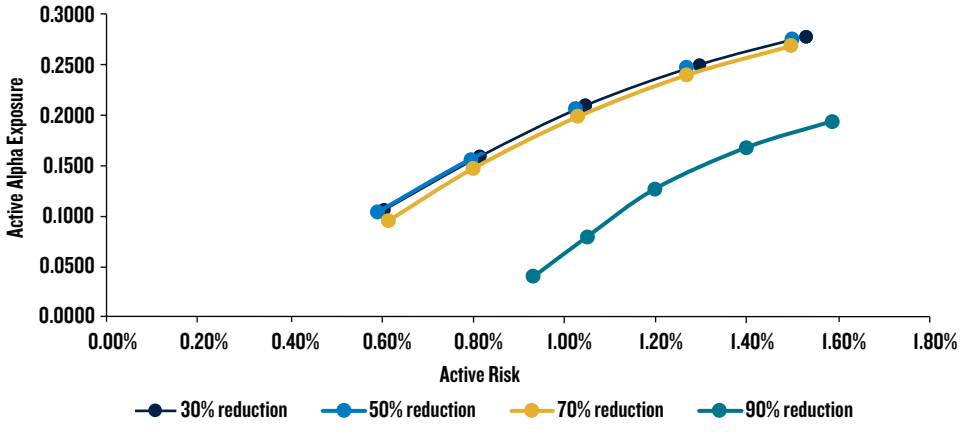
All 20 tests achieved the carbon emission and E, S, and G targets we specified in the backtests.

The frontiers help investors pinpoint a solution that corresponds to a desired active risk level and aid in evaluating the return implications of choosing different levels of carbon emission reduction. Evaluating how the frontiers shift also assists in understanding the impact of increasing the carbon emission reduction target. Interestingly, the 50% carbon emission reduction frontier consistently outperforms the 30% and 70% frontiers, which show an unexpected intersection: if there is enough risk budget, the 70% target outperforms the 30% target; however, when the active risk budget is limited, a higher target (i.e. 70%) would lead to a lower alpha exposure (as shown Figure 5), thus impacting performance negatively in the long run.

To reinforce this point, we repeat the generation of the frontiers but replace realized active return with alpha exposure. This exercise clearly shows that targeting 30% or 50% carbon reduction does not lead to any change in alpha exposure.

With the same level of alpha exposure, the performance of the 50% reduction frontier is consistently above the 30% frontier. This suggests that there is a certain degree of "alpha" that is not reflected in our current factors but was captured by the targeted exposure from the carbon emission reduction for this investment universe.

**Figure 5: Active Alpha Exposure vs. Active Risk**

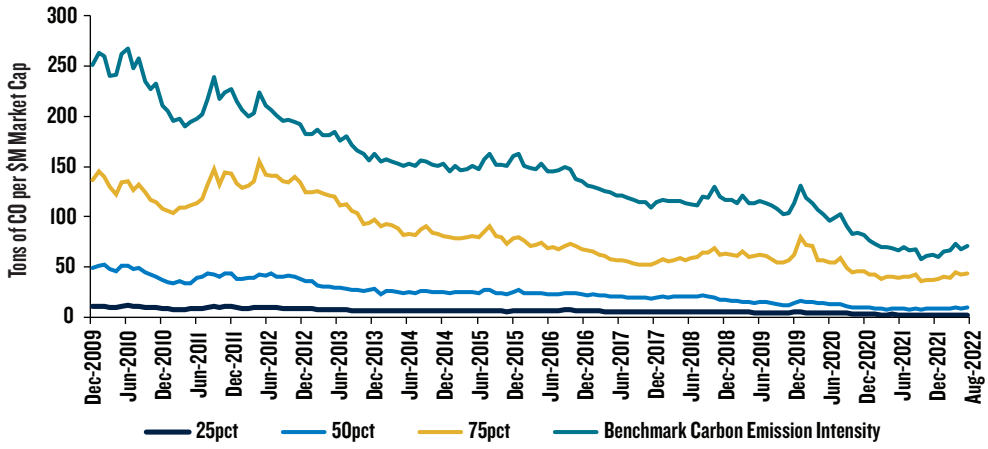



*Source: PGIM Quant. For illustrative purposes only. There can be no guarantee that the objective will be achieved. Please see 'Notes to Disclosure' page for Important Information including risk factors and additional disclosures.*

When choosing the recommended solution from these frontiers, it should be noted that our decision goes further to examine the feasibility of achieving desired carbon emission reductions in the future. Essentially, one may examine the frontiers and decide that a 70% reduction in carbon emissions can be achieved with risk and return only modestly 'worse' than the 50% reduction solutions.

However, an analysis on carbon emission data could temper the enthusiasm for this solution. Figure 6 plots the carbon emission intensity for the benchmark along with the carbon emission intensity of stocks at different points in the distribution within the universe (e.g., 25th percentile, median, 75th percentile). First, we find that more than 75% of the stocks in the universe are lower carbon emitters than that of the benchmark. This allows for larger emission reductions relative to improvements in other ESG related targets (e.g., ESG scores, etc.). However, there is clear compression in the distribution over time, with the expectation this will continue in the future.

**Figure 6: Carbon Emission Intensity**

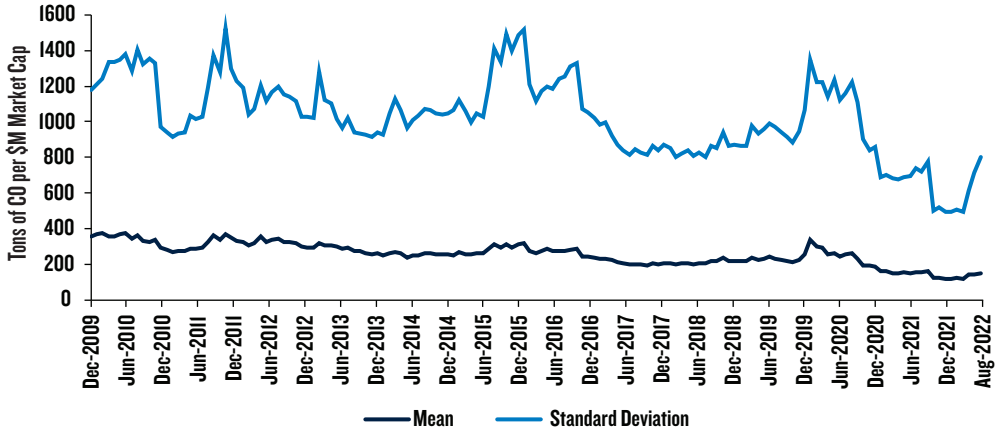



*As of 8/31/2022 Source: PGIM Quant. For illustrative purposes only. There can be no guarantee that the objective will be achieved. Please see 'Notes to Disclosure' page for Important Information including risk factors and additional disclosures.*

We further find that the average and standard deviation in carbon emission intensity has decreased over time (Figure 7). These combined insights suggest that it could be harder to achieve the same emission reduction while maintaining a constant level of active risk in the future.

**Figure 7: Carbon Emission Intensity**

**Mean and Standard Deviation**




*As of 8/31/2022 Source: PGIM Quant. For illustrative purposes only. There can be no guarantee that the objective will be achieved. Please see 'Notes to Disclosure' page for Important Information including risk factors and additional disclosures.*

## Conclusion

Our research set out to build a portfolio with a low carbon emission intensity level compared to the benchmark by establishing the carbon emission intensity outcome as an explicit portfolio objective. Targeting stocks with low carbon emissions that also have other attractive alpha attributes, we carefully controlled key risk exposures. This led to a portfolio with a significantly lower carbon emission intensity level relative to the benchmark, while delivering modest outperformance and maintaining comparable risk compared to the underlying benchmark.

The frontier study across different carbon emission target levels and active risk levels clearly identified a trade-off between the active return, active risk, and the carbon emission intensity reduction level. This allowed us to identify the preferred solution for each investor.

Our ESG Solutions capability offers asset owners the flexibility and customization to develop solutions that can be used as alternatives to traditional PABs and CTBs, or further adapt portfolios to target different ESG attributes such as water usage and diversity measures. PGIM Quant can accommodate varied and specific investor preferences to deliver robust investment solutions that align with the ESG requirements of asset owners.

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**Notes to Disclosure**

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