Columbia Center on Sustainable Investment
A JOINT CENTER OF COLUMBIA LAW SCHOOL AND COLUMBIA CLIMATE SCHOOL

IN COLLABORATION WITH

PRINCEVILLE CLIMATE TECH

# CLIMATE IMPACT SCREENING AND REPORTING: A VENTURE CAPITAL PERSPECTIVE

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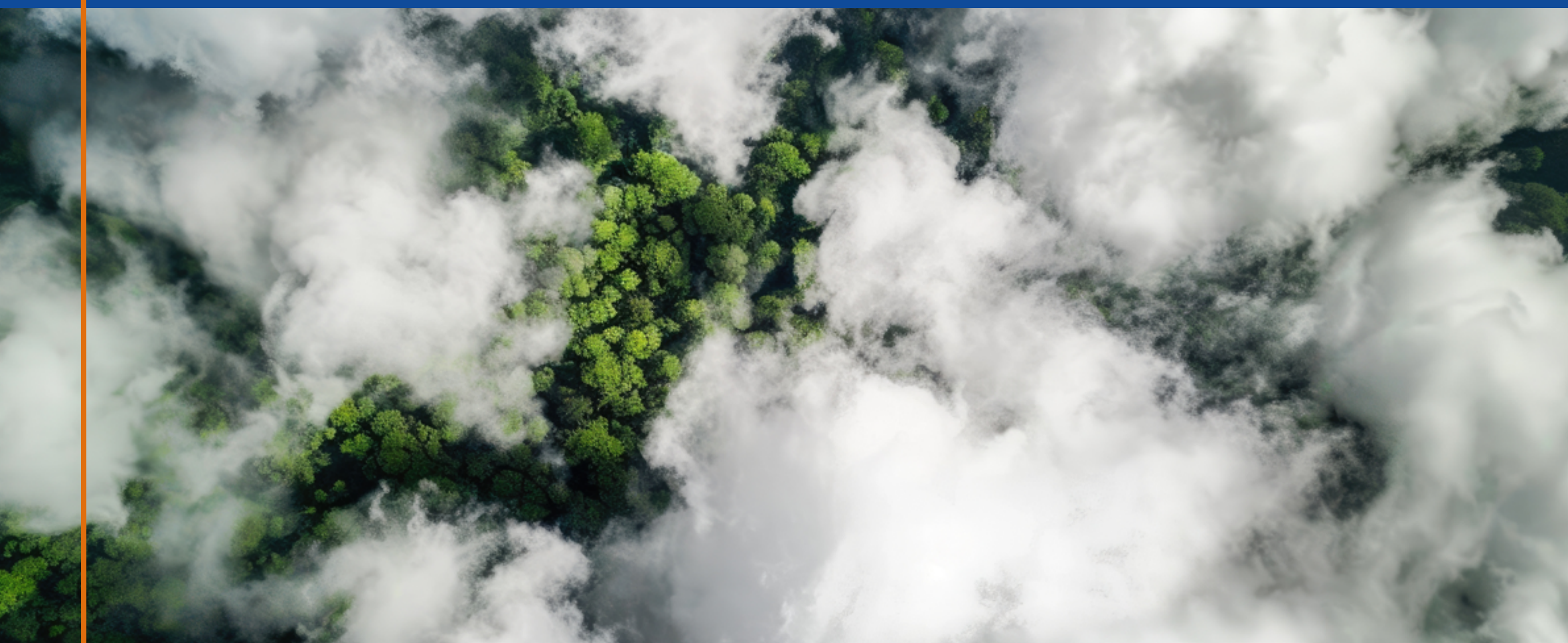

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# Executive Summary

This report is based on CCSI's comprehensive benchmarking of VCs' publicly available approaches combined with a literature review and practical insights collected through an interactive workshop and extensive bilateral conversations with VCs. It is tailored for venture capital investors seeking to optimize their climate impact through meticulous impact screening, measurement, and reporting. It is focused on key issues that the field is intensively debating and where consensus is yet to be achieved. It is not meant to complement and feed the breakthrough work done by Project Frame and the Venture Capital Alliance.

In Section 1, the report highlights the significance of methodologies for calculating avoided emissions, while focusing on two aspects that remain debated in the field: attribution and baselining. We emphasize that while attribution should complement, rather than supplant, the broader objectives of climate-conscious investment strategies, it is important for the field to standardize approaches to bolster accountability. We also emphasized establishing credible baselines for avoided emissions, underscoring the need for transparency, scrutiny, and precision.

Section 2 focuses on sector-based prioritization and the importance of setting threshold criteria to ensure the investment is aligned with the Paris Agreement objectives. We suggest adopting a three-step screening approach involving the expanding green taxonomies, emission intensity thresholds and decarbonization rates as benchmarks for investment in the pre-screening phase.

Section 3 explores the necessity of rigorous screening processes to identify and address indirect impacts of investments. While these required customized Key Performance Indicators (KPIs), seeking rigor in setting them is key to ensure that investment is not wasteful from a climate perspective.

Finally, in Section 4 the report delves into innovative approaches for measuring impact in climate adaptation financing, emphasizing the need for a formulation of a comprehensive Climate Adaptation Investment Thesis. With climate adaptation finance reaching USD 63 billion in 2021-2022, a 28% increase from the previous period, there is ample opportunity for investors to contribute significantly to addressing climate challenges.

In conclusion, we aim to underscore that in the realm of venture capital investing, climate due diligence is as pivotal as finance due diligence. While the provision of capital is essential for driving impactful climate solutions, it is the meticulous evaluation of climate mitigation and adaptation needs, scalability of breakthrough technologies, and their potential impacts that ensures the effectiveness and sustainability of such investments.

By prioritizing rigorous climate impact due diligence alongside financing, investors can not only be true to their stated climate objective but also ensure the long-term performance of their portfolio companies. This holistic approach is crucial for navigating the complexities of climate change and fostering a resilient and sustainable future for generations to come.

# Introduction

Climate finance flows have grown consistently over the past decade, but they still lag far behind what is needed to meet the goals of the Paris Agreement (PA). The world needs to decarbonize seven times as fast as the current rate to limit global warming to the temperature threshold of the PA.[1] According to the International Energy Agency's (IEA) Net-Zero Scenario, about one third of the emissions reductions occurring in 2050 depend on technologies that are currently only in development.[2] In addition, climate adaptation finance suffers from an even bigger investment gap and resilience towards physical impact could be drastically improved by the development of climate-adaptation intelligence and product technologies. While the private sector has hardly contributed to financing adaptation solutions, the need and demand is clear as climate-related economic damages could detract around 20% from global GDP by 2050.[3]

In this context, venture capital (VC) investing in climate technologies have a key role to play and a growing mass of Limited Partners (LPs) are recognizing it. Interestingly, while in 2023, funding for climate tech start-ups decreased to levels last seen five years earlier, relative to all start-up investment, climate tech investment has increased steadily.[4] VCs are also enlarging their interest and gradually taking more risk towards climate tech solutions for the biggest emissions sources, away from the traditional investment in micromobility, light-duty vehicles, or solar. This is particularly true in the North American, Chinese, and European markets.[5]

Despite this rapid growth in needs, demand, and opportunity, the effectiveness of the climate-oriented private markets is hampered by several factors, including nascent and inconsistent methodologies for climate impact, divergent approaches to definitions and metrics, data and measurement challenges, and questions about additionality, among other challenges. These challenges also enable perceived and actual greenwashing and overarchingly limit climate progress relative to potential.

Two organizations who have benefited from the support of a large community of VCs, Project Frame and the Venture Climate Alliance, have made inroads into reaching some consensus around methods for calculating avoided emissions, potential impact, and financed emissions as well as what aligning with net-zero means for VCs investing in climate tech.[6][7]

For this reason, this brief focuses on thorny issues that still remain to be explored and understood, before being standardized. CCSI and Princeville Capital convened a gathering of 15 venture capitalists at Columbia University on March 8, 2024 to discuss these issues. The following report incorporates research findings enriched by the insights and perspectives shared by the venture capitalists regarding implementation challenges and opportunities.

# Section One: New Frontiers in Climate Impact Sizing

In climate impact, sizing of technologies that have a direct impact on emissions reduction, attribution, and baselining remain issues where finding a consensus is a work in progress. While attribution is key to monitoring and reporting on the investor's enabled impact, baselining is fundamental to calculating potential impact.[8]

There is currently an extensive debate regarding the adoption of a methodology for attributing emissions avoidance credits. This deliberation is contingent upon various factors, including the stage of investments and the desired structure of such a methodology. However, this decision is accompanied by a recognition of the potential pitfalls inherent in existing methodologies, further complicating the discourse. The field is coalescing on the fact that attribution of emissions savings should be limited to direct technologies that avoid emissions at their source, while indirect technologies that facilitate or enhance the effectiveness of direct climate technologies cannot credibly claim such savings (see Section 3). It is also important to note that even the emission reduction claims from direct technologies are often challenging to measure accurately. This highlights the need for verification companies like BlueMark, which assess the alignment of avoided emissions claims with established methodologies, such as those proposed by Project Frame. BlueMark has performed these verifications for firms like Full Cycle Climate Partners, ensuring their claims are credible and transparent.[9]

Similarly, in baseline setting, there is no consensual database solution. Instead, some high-level principles seem to prevail around the need to have a tailored, careful, and transparent approach for each climate solution or investment. The section below captures the debate on each of these topics.

## 1. Attributing Avoided Emissions Credit to Different Stakeholders

Allocating enabled avoided emissions requires careful consideration of the roles played by each actor in the value chain of a product that will avoid emissions (e.g., an e-bus operator). The white paper, "Know Your Impact," by EIP makes the case that each participant—including the investor—can legitimately claim that they helped enable the savings compared to the initial status quo and they should claim 100% of the savings. However, when multiple actors exist within a value chain segment, such as installers, the enabled savings should be proportionally allocated based on their respective contributions.[10]

Another way to attribute avoided emissions involves adopting the methodology outlined in a research paper by GIC and Schroders. This approach offers a simplified framework suitable for private companies. It involves distributing the share of avoided emissions among different industry players. Primary players, like e-bus operators replacing fossil fuel counterparts, receive 50% of the share, acknowledging their pivotal role in deploying carbon-avoiding technologies. Secondary players, such as parts manufacturers or equipment providers supporting primary technology producers or service providers, receive either 20% or 30% of the share, reflecting their contribution to emissions reduction efforts. Tertiary players, like raw material providers for specific technologies, get 10% of the share, while certain service sector entities may receive no allocation. Other relevant players down the value chain receive 10% of the share, considering their involvement and impact on emissions reduction within the specific context.[11]

The EIP approach offers the advantage of eliminating the necessity for arbitrary assumptions when assigning roles in the value chains. However, it runs the risk of overstating the impact of each actor due to potential double counting (even if the investor takes an equity weighted share as discussed below). On the other hand, the GIC-Schroders approach mitigates the risk of double counting by limiting room for such occurrences. Nevertheless, the allocation of shares may appear arbitrary under this methodology.

A more nuanced refinement of the GIC-Schroders approach involves utilizing allocation based on each entity's contribution to the value added of the final product, as recommended by Carbon 4.[12] However, a potential challenge arises when the value added is negative, particularly during the initial stages of a product's life cycle where costs may exceed revenues. To tackle this issue, some have proposed proportioning the allocation according to each entity's contribution to the cost of the final product. Nonetheless, accurately assessing such contributions remains a complex task.

While the debate over selecting the appropriate attribution method continues, there is some agreement regarding vertical attribution and ownership-weighting, similar to the approach used in financed emissions already. Currently, the standard approach is to take the equity percentage as the attribution percentage that VCs use to estimate their share of the avoided emissions credits. This method is useful for communicating their role in a climate company's avoided emissions activities to their LPs and is particularly beneficial for awarding early investors. By doing so, this approach acknowledges the risk and effort associated with early-stage investments and offers a conservative estimation of the VC's impact.

However, an additional recommended approach involves factoring in the ratio of the investment value (book value of the equity or book value of the debt) that VCs hold in portfolio companies (PCs) to the total balance sheet capital as a weighting factor for the emissions savings facilitated. While these methodologies are well established for listed equities financed emissions accounting,[13] determining the book value of the equity for a private equity investor is more challenging given the lack of reporting requirements for the latter. This second attribution approach transparently communicates the role of different capital providers, including debt providers, in advancing a climate company's activities, providing a more accurate picture of the drivers behind increased avoided emissions from year to year. Although further refinement of weighting factors might be necessary, ownership weighting using these two methods represents a more precise and nuanced approach to distributing enabled carbon savings than attributing 100% of the emissions savings without considering proportional roles in financing and management.

In addition to selecting a credible attribution method, another pertinent question arises when considering attribution beyond the exit period. One viable approach is to retain the lifecycle avoided emissions of products deployed during the holding period on the emissions balance sheet. However, to ensure credibility, a robust model for lifecycle analysis is imperative and should be utilized for calculating potential impact, as outlined by Project Frame.

Nevertheless, a challenge persists regarding the relevance of attribution methods for early investors. How can they attribute emissions avoidance credits when the deployment of products and associated carbon savings will occur beyond the holding period? Similarly, how can early investors receive credit even after exiting from the investment, considering their crucial enabling role?

This dilemma underscores the need for innovative solutions and collaborative efforts to devise equitable and effective methods for attributing emissions avoidance credits. It may also entail developing frameworks that recognize and reward early-stage contributions to emissions reduction, even if the tangible impact materializes post-exit. Such approaches could help ensure that early investors are appropriately acknowledged for their instrumental role in driving positive environmental outcomes. This remains an area ripe for further research, with many questions still unanswered.

The pursuit of attribution should not overshadow the importance of a robust climate screening process to most effectively allocate their finite resources to support the energy transition, while also measuring other aspects of investments that yield benefits beyond carbon savings. However, for VCs operating on the "efficient frontier between financial returns and carbon savings,"[14] it is crucial to grasp what can legitimately be attributed, how to do so, and to track attributed avoided emissions over time. This serves as an indicator of success with stakeholders in general and limited partners in particular. Thus, while attribution is important, it should complement, rather than supplant, the broader objectives of climate-conscious investment strategies.

## 2. Setting a Transparent Baseline

In the evolving field of baseline setting, there is currently no one-size-fits-all database solution available. However, a partnership between Mirova and Robeco has emerged to address this gap by developing a database of emission avoidance factors that are granular and geographically specific.[15] While awaiting this development, setting a transparent and credible baseline is crucial. This is essential to ensure the credibility of the potential and planned impact of financed climate solutions, as evaluated following Project Frame's approach.

In line with WRI's seminal paper on "Estimating and Reporting the Comparative Emissions Impacts of Products," it is advised to choose a reference product that closely resembles what would typically be sold in the absence of the assessed product. This approach offers a clear comparison with real-world scenarios, rather than relying on existing market averages.[16] Transparently disclosing the reference or incumbent baseline product enhances credibility with impact-oriented investors.

While the ideal method involves project-specific baseline reference scenarios for calculating avoided emissions, this data may frequently be inaccessible or necessitate extensive computational efforts. As such, we suggest adopting a methodology based on Schneider Electric's "Saved and Avoided Emissions" paper to enhance the precision of the emissions impact calculations. This approach distinguishes between brownfield sales and greenfield sales.[17]

In brownfield sales, the focus is on "saving" emissions by modernizing or replacing existing infrastructure with more efficient or cleaner technologies. The baseline assessment incorporates the current status of technology in the relevant market and thus, the baseline should be estimated by evaluating the existing infrastructure replaced by the PC product. For instance, replacing an aging diesel generator with a solar panel for on-site electricity would be considered within this framework.

Conversely, greenfield sales aim to reduce emissions by developing new projects to meet growing global demand. Introducing new technology in greenfield sales seeks to decouple emission growth from economic growth, thus avoiding a typical "business-as-usual" pattern and proactively mitigating future emissions (see Figure 1). In this context, the baseline accounts for the anticipated technology deployment in the relevant market. For example, evaluating a solar panel against a future hydrogen generator for on-site electricity would be an illustration of this approach.

By incorporating context-specific baselines, this approach improves the accuracy and transparency of realized impact calculations.

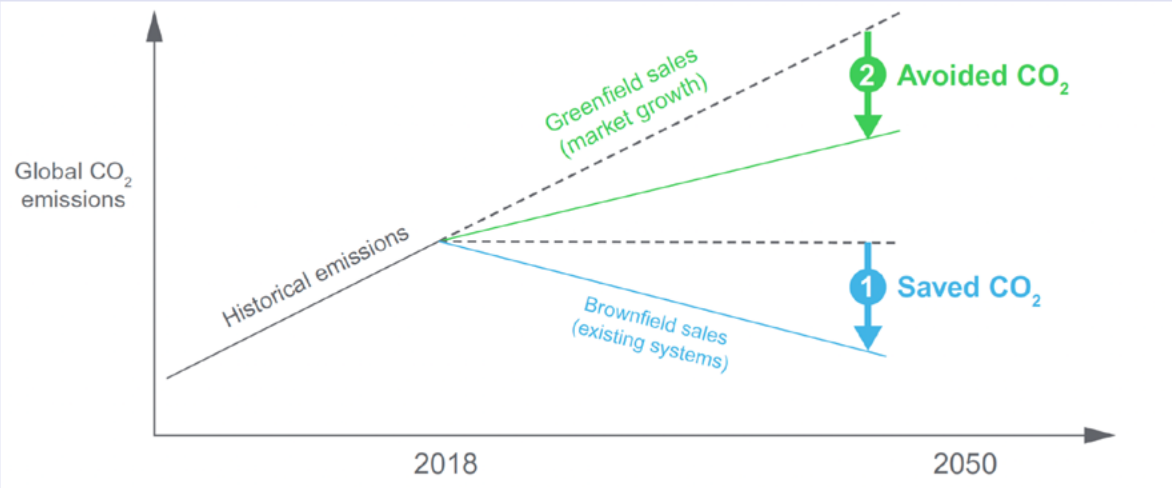



**Figure 1: Relationship between greenfield and brownfield sales**
*Source: Schneider Electric $CO_2$ Impact Methodology*

For greenfield sales, guidelines from the UNFCCC's Clean Development Mechanism are recommended.[18] This entails estimating the most probable baseline reference scenarios, eliminating infeasible ones due to technological or financial constraints, and considering the most common practices in the end-user sector and geography. Plausible baselines should factor in competing products, regulatory requirements, or the absence of alternatives. If multiple plausible baselines exist, a weighted average based on market shares is used to determine the final baseline for greenfield sales.

At the PC's level, the final baseline should combine both brownfield and greenfield sales based on sales figures. This approach is particularly recommended for calculating the most accurate "realized impact," as it requires access to sales data and close collaboration with the PC.

It is also important to accommodate a dynamic baseline with a recommended assessment period to be limited to one year. For subsequent assessments, there should be a reassessment of the baseline, taking into account advancements in incumbent technology displaced by the new climate solution and ensuring the consideration of up-to-date data.

While many VCs do not disclose their approach to baselining, EIP provides insight into their methodology.[19] They emphasize the importance of recognizing that baselines vary across regions and technologies due to market differences, such as variations in the electricity mix, current average intensities, and projected decarbonization trajectories of existing technologies. By considering these factors, EIP aims to develop accurate and context-specific baselines that reflect the unique characteristics of each investment. They also anticipate refining their baseline calculations as data availability improves, potentially through more detailed measurements of grid power carbon emission intensity. Indeed, as mentioned earlier, regularly adapting baselines to prevent overestimation of impact is crucial for maintaining the credibility of a fund.

# Section Two: Prioritization on a Sectoral Basis

Venture capitalists acknowledge the importance of sector-based considerations in their investment strategy, recognizing that comparing the criticality of technologies across sectors may lack relevance. This holds particularly true when applying emissions-based impact thresholds. The implementation of thresholds for investment can not only enhance the screening strategy, but also bring more integrity to the investment strategy and can channel investments with longer term impact. Many VCs have therefore established set thresholds for this purpose. However, establishing sector-specific decarbonization thresholds aligned with the goals of the PA poses challenges, particularly in the pre-investment phase. Currently, the VC community lacks a comprehensive and uniform application of emission-based metrics in pre-investment decision-making. This complexity is heightened by the varied stages and strategies investors use. The section below proposes an approach.

## 1. Introduction and Initial Screening for Taxonomy Alignment

For initial investment screening, it is advisable to ensure alignment with established green taxonomies, such as the European Union (EU) taxonomy. These taxonomies are regulatory instruments that aim to provide technical criterias to identify those economic activities (or technologies and technology providers) that support achieving global net-zero emissions and whose goal is to support investment flows towards these activities. There are now more than 30 that are in place or being developed all over the world.[20] These taxonomies assist investors in considering only those technologies within feasible net-zero scenarios and help maintain regulatory compliance, which is increasingly relevant as taxonomies gain acceptance and as other regulatory tools are being grounded on the taxonomies like in the EU.

Moreover, the IEA's Clean Energy Technology Guide and IEA's Energy Technology Perspectives (ETP),[21] offer an in-depth analysis of over 550 different technologies that are critical for decarbonization. By providing key parameters such as technology readiness, investment requirements, and their potential impact on emissions reduction, energy security, and economic growth, these tools can help guide investment toward the essential technologies involved in the sectoral pathways. In addition, the IEA publishes Clean Energy Progress[22] with a clear tracker of the progress of key technologies.

Last, the Institutional Investors Group on Climate Change (IIGCC) has defined climate solutions as those supporting the transition to net-zero in line with a 1.5°C pathway.[23] Their climate investment roadmap introduces a technology prioritization framework to underscore key climate solutions with significant climate mitigation potential. These resources provide valuable guidance for VCs seeking to align their investment strategies with climate objectives and transition to a low-carbon economy.

## 2. Enhancements to Taxonomy Alignment Approach: A 2-Step Screening Approach

Taxonomies and guidance documents, like those from the IIGCC, also categorize certain transitional technologies as green activities, provided that the activity does not go over thresholds of emission intensity. For instance, electricity generation from fossil fuels with a lifecycle emission phase of less than 100g of CO2/kWh is considered in the EU taxonomy and all other taxonomies aligning with the EU. For technologies, especially those that are transition solutions and those not listed in climate solution databases (e.g., IEA Clean Energy Technology Guide,[24] EU Taxonomy Compass[25]), and to enhance transparency and prioritize climate impact in decision-making—not just for post-investment reporting—CCSI suggests adopting quantitative emission-based threshold values during the pre-screening phase. These values should be based both on the emission intensity of the climate solution value chain and projected emissions avoidance.

Acknowledging the scarcity of methods for setting these thresholds, CCSI has developed an approach focused on sector-specific decarbonization rates necessary for the PA alignment. For this threshold approach, the methodology uses a two-step approach and aims to facilitate both an evaluation of the technology itself and its potential to contribute to rapid emission reductions, aligning with the necessary decarbonization rates. It acknowledges that venture capitalists' intervention is essential across the spectrum of innovative technologies, from seeding to supporting deployment at scale. This approach seeks to guide investors in aligning their investments with climate objectives and advancing the transition to a low-carbon economy.

### a. Emission Intensity Thresholds

To effectively limit global warming to 1.5°C, each industry must adhere to a specific sectoral net-zero pathway developed by authoritative sources such as the IEA. These pathways follow a decreasing curve of emission intensity (or absolute emissions). When emission intensity is used, the authoritative pathways take into account the growth of the sector to ensure that on an absolute value, the sector does not increase emissions. These pathways enable each industry to determine 1.5°C- aligned benchmark levels of emission intensity (or absolute emissions) for future value chains within these sectors. Given the risk that a decrease in emission intensity can hide a growth in absolute emissions, only benchmarking against authoritative pathways is credible. Hereafter, we are considering emission intensity benchmarks to ease the comparison between the company's climate solution's emission intensity level and the sectoral one.

This screen evaluates whether the product being considered for investment has an emission intensity that meets or is lower than the projected target for its sector by the end of its operational life. For instance, if a product installed today is expected to operate until 2040, its emission intensity must be at or below the forecasted figures for its sector in 2040. For solutions targeting energy efficiency, since energy efficiency is calculated in relative terms (relative to some baseline energy consumption for a unit of product), it needs to be compared with emission intensity in relative terms as well. Moreover, when the sectoral pathway is not directly comparable with the solution and the solution pertains to the manufacturing sector, which is an emissions-intensive sector, it is important for the company to be able to provide their transition plan for net zero. This will also aid in the assessment of financed emissions for the VCs.

**Step 1: Establish Sector or Subsector Target Emission Intensity**

The snapshot in Figure 2 presents the necessary decarbonization pathways for various sub-sectors in the transportation industry as per the IEA. To calculate the emission intensity of a specific sub-sector for any year, the total emissions of that year is divided by the market size for the same year, measured in physical units.

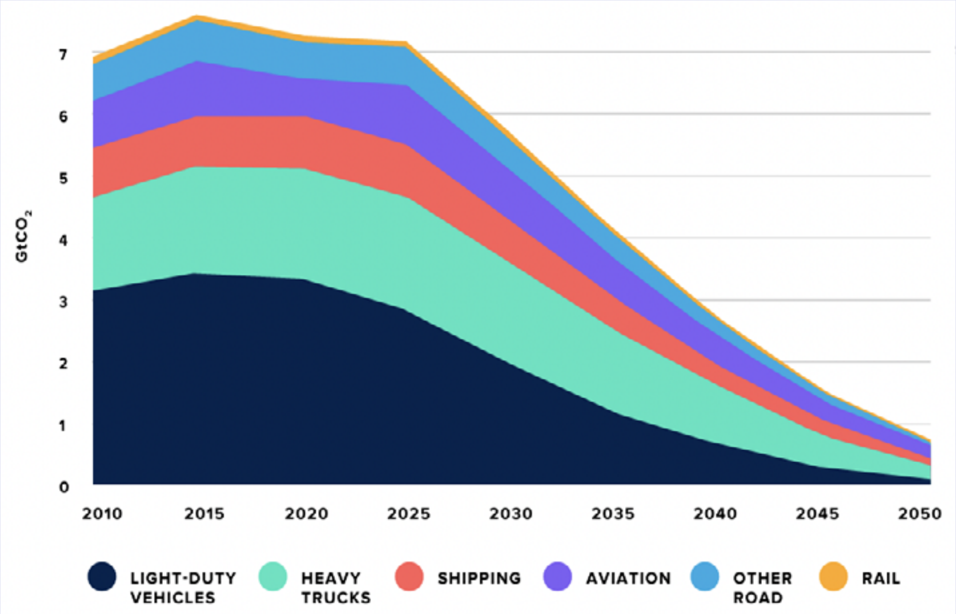



**Figure 2: Global $CO_2$ transport emissions by mode and share of emissions reductions to 2050**

*Source: IIGCC based on IEA, Net Zero Scenario*[26]

Note that reputable institutions like Climate Bonds Initiative (CBI), Transition Pathways Initiative (TPI) or the Science-Based Target Initiative (SBTi) also provide sectoral pathways, aligned with the IEA and those are built on the basis of emission intensity and can be used directly. As an example, if a climate solution under consideration fits within a value chain that operates in the power sector, the value chain's emission intensity can be compared to the power sector targets. According to the SBTi, which leverages the IEA Net Zero Scenario, the target emission intensity for electricity production in 2040, aligned with a 1.5°C scenario, is approximately 0.02 kg $CO_2$/kWh, or 20 g $CO_2$/kWh (see Figure 3). For comparison, the current emission intensity of the power sector in the United States is around 368 g $CO_2$/kWh.

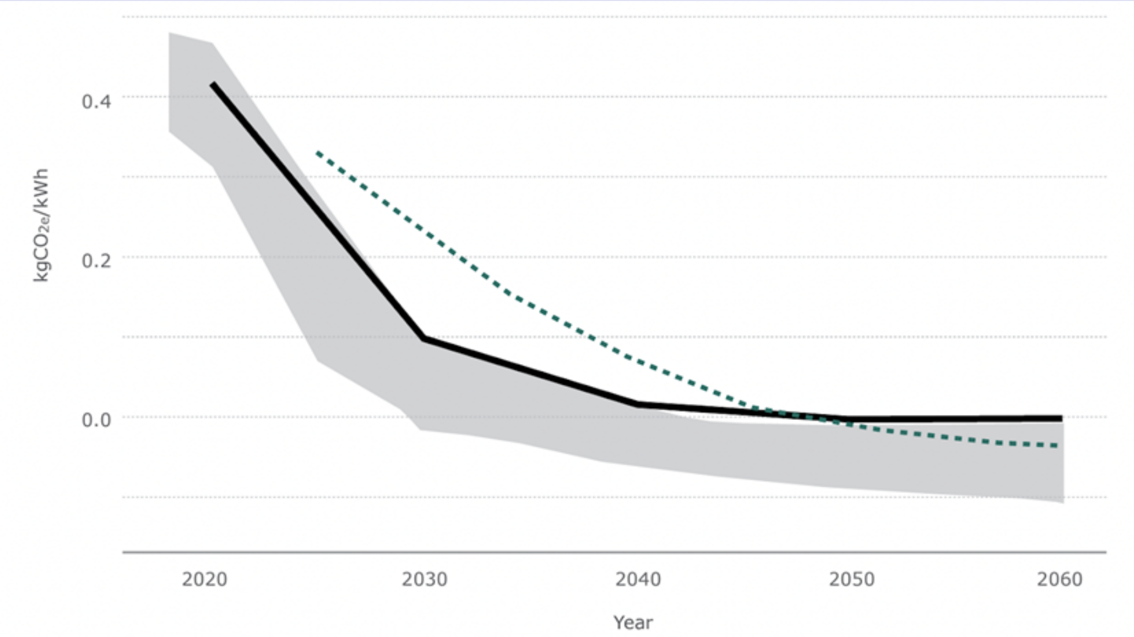



**Figure 3: The Sectoral Decarbonization Approach (SDA) pathways for the power sector**

*Source: SBTi Power Sector Targets*[27]

**Step 2: Calculate The Climate Solution Value Chain's Emission Intensity**

The next step involves measuring the emission intensity of the proposed climate solution to ensure they are below a specified limit. We refer to it as a "climate solution" because comparing the emissions of a single component to the entire sector can be complex. For example, in the transportation sector, an electric vehicle (EV) is considered a climate solution. If a company manufactures next-generation motors that are twice as efficient for EVs, the impact of this technology on the EV's overall operational emissions must be understood to compare it against the transportation sector's emission intensity targets. Similarly, if a company manufactures fuel cells or components of a fuel cell, the emission intensity of the final kWh delivered needs to be known to enable comparison with the power sector targets.

It is essential for the company being evaluated for investment to understand the broader climate solution value chain that its technology supports. This approach has its challenges but encourages transparency in identifying the ultimate climate solution value chain the company supports. Additionally, deciding which emission scopes to include in the emission intensity calculation depends on the sector's benchmarking guidelines. For instance, the power sector's emission intensity targets are based on Scope 1 (direct emissions from combustion of fuel during operation) and Scope 2 (purchased electricity and other indirect emissions). To enable appropriate and meaningful comparison, similar scopes need to be included when evaluating a climate solution's emissions in the power sector.

This screen serves as a technology check to ensure that the supported technology is 'sufficiently green' to enable the transition aligned with a 1.5°C trajectory. By comparing the emission intensity of the value chain under consideration to the sector's target at the end of its operational life, an investor can clearly determine whether the technology fits within a 1.5°C-aligned scenario. These thresholds apply to all stages of the investments, including at the early stage.

## b. Decarbonization Growth Rate Thresholds: Aligning Growth Rate of Product Deployment or Avoided Emissions of Climate Solution with Sectoral Requirements

While the previous emission intensity screen was benchmarking the emission intensity of the product against sector trajectories, this threshold benchmarks the climate solution's growth rate (in terms of deployment rate or the avoided emissions growth rate using the Project Frame methodology) against the required decarbonization rate of the sector.

As dictated by science, to meet net-zero targets, some industries must lower their carbon output quickly to keep us on the right path. If we fail to achieve targeted emission cuts by certain milestones –such as 2030– it becomes impossible to compensate for this shortfall in later years, resulting in a deviation from the intended net-zero pathway. While we are developing technologies to remove carbon from the atmosphere, delaying action increases the risk of causing permanent damage to the Earth.[28] In such a way, investors have a twofold role: they must mitigate risks associated with key technologies while ensuring their investments contribute to the necessary rate of emissions reduction to align with net-zero objectives.

**Step 1: Establish Sector's Required Rate of Decarbonization**

If the specific climate solution under consideration has been identified as one of the critical technologies (e.g., electrolyzers or lithium-ion battery storage) in a net-zero roadmap, such as those published by the IEA or IIGCC, the growth rate of the deployment targets of these critical technologies can be used as a benchmark. This allows for a direct comparison where the deployment rate of the climate solution under investment consideration is used.

For example, when evaluating an investment in grid-scale battery storage technology, the IEA provides the total installed capacity targets needed to meet emission reduction targets (Figure 4). Between 2022 and 2030, the Compound Annual Growth Rate (CAGR) for the installed capacity of grid-scale storage is approximately 58.97%. Subject to limitations highlighted below, investors can utilize this CAGR as a benchmark to assess the growth rate of any grid-scale battery storage technology company, ensuring all investments are aligned with 1.5°C climate scenarios.

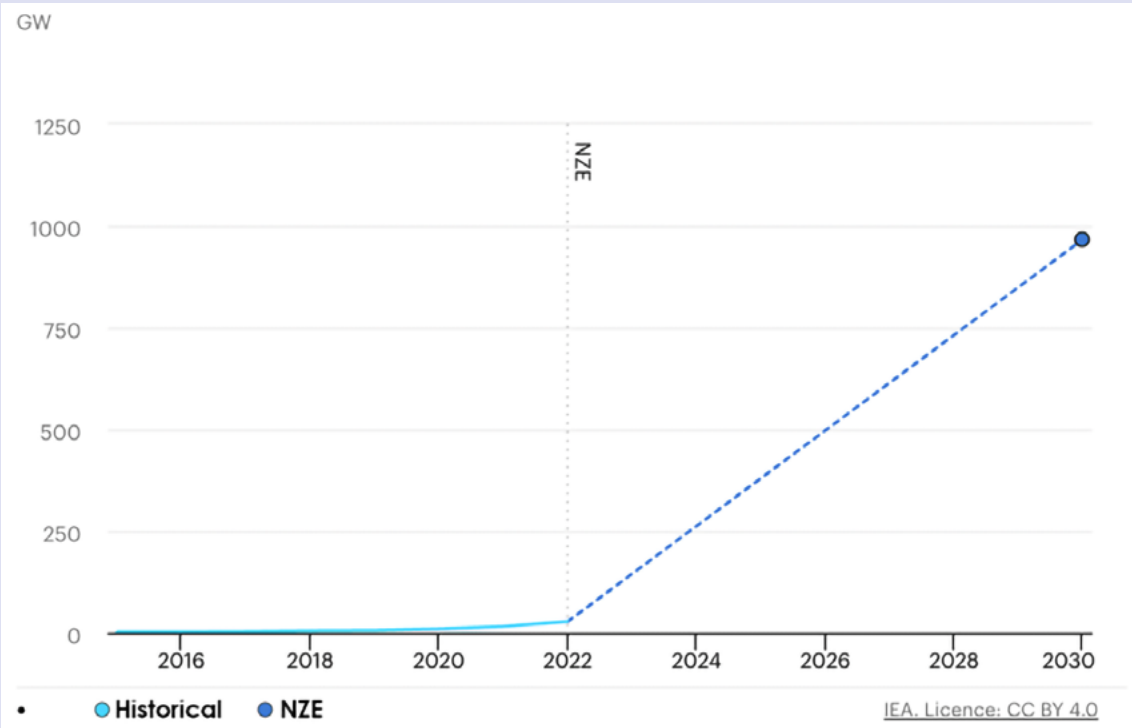



**Figure 4: Global installed grid-scale battery storage capacity, in the IEA Net Zero Scenario, 2015-2030**
*Source: IEA[29]*

In the absence of deployment targets specific to a technology, the emission reduction rate for the sector can be used as a proxy to understand the rate of deployment for any climate solution under investment consideration. For example, when evaluating an investment in electric motors for EVs, the transportation sector's emission reduction trajectory can serve as a reference. According to the IEA net-zero pathways, the transportation sector is projected to reduce its emissions from ~7432 Mt $CO_2e$ in 2024 to ~6353 Mt $CO_2e$ in 2028, resulting in a CAGR for avoided emissions of approximately 14.5% (Figure 5). Similarly, the CAGR for avoided emissions in other sectors can be calculated and used as a proxy to gauge the deployment rate required for specific technologies operating in those sectors.

These reduction targets are based on an analysis of the current and anticipated technological readiness of various decarbonization solutions needed for a sector. Consequently, while using these decarbonization rates (the CAGR of avoided emissions) may not be as precise as using specific technology deployment rates, they provide a minimum benchmark that all solutions within a sector should aim to achieve.

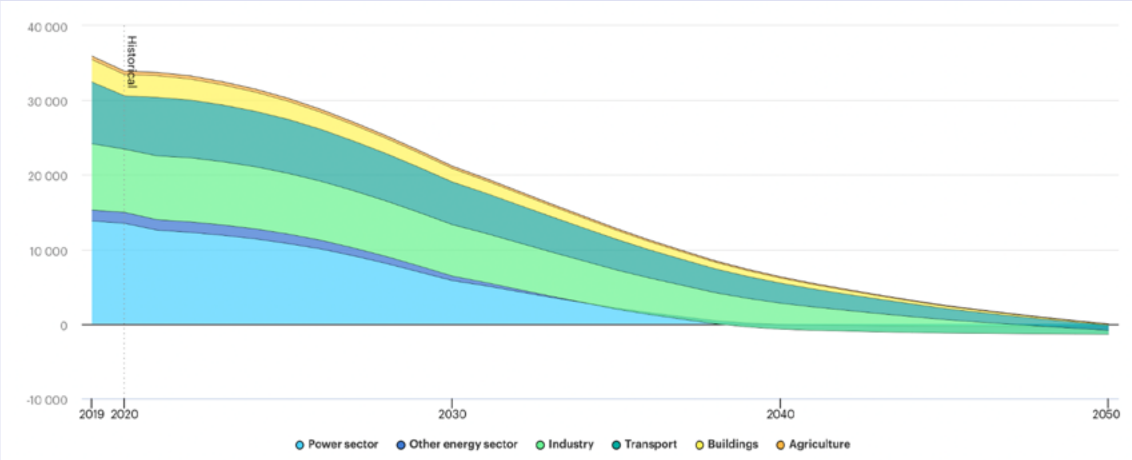



**Figure 5: $CO_2$ emissions by sector 2019-2050**

*Source: IEA*

**<u>Step 2: Project Prospective Company's Growth Rate in Terms of Deployment or Avoided Emissions and Compare with Sectoral Benchmarks</u>**

While the emission intensity screen uses the product's lifetime to determine the benchmark year, the decarbonization growth rate screen calculates the deployment rate or avoided emissions for the anticipated holding period. If the climate solution under consideration is identified as one of the critical technologies in a Net Zero Roadmap and has an established deployment rate target (such as grid-scale battery storage), the company's planned deployment for the holding period should be calculated, and the associated CAGR of deployment should be benchmarked against the CAGR of the deployment targets of the technology published in the roadmap.

When the technology does not have a specific deployment rate and the decarbonization rate of the sector (CAGR of avoided emissions) is used as the comparative metric, the next step is to calculate the company's planned impact in terms of avoided emissions during the first and last year of the holding period. These calculations should be based on grounded, realistic projections. Ideally, these projections should align with the planned impact definitions[30] outlined by Project Frame, developed from bottom-up using detailed company data.

A company that surpasses the emission reduction rate on a CAGR basis required by its sector is considered to be contributing effectively to the necessary decarbonization pace. For example, if an EV manufacturer's planned impact (Figure 6) over the holding period has a CAGR of approximately 20%, it would surpass the sector's required emission reduction rate, calculated at 14.2%.

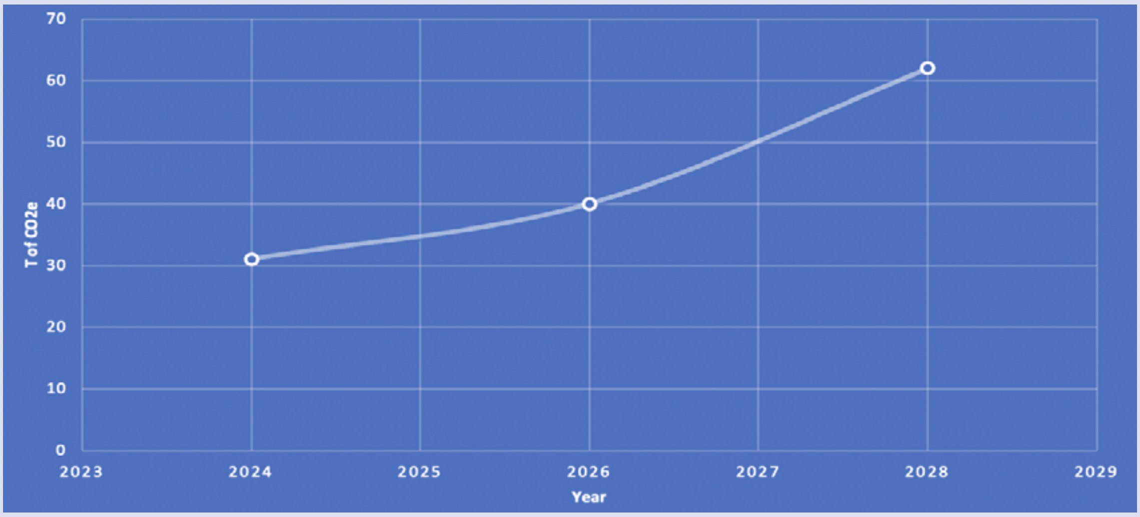



**Figure 6: Planned impact (T of $CO_2e$) for an EV manufacturer**

*Source: Representative Example developed by Authors for an EV Manufacturer*

This analysis can be refined further by examining specific sub-sectors or mitigation measures within sectors, recognizing that some may be more advanced in their decarbonization efforts compared to others (Figure 7). While accessing specific sub-sector decarbonization rates might pose challenges, it presents an opportunity to achieve a more precise understanding of decarbonization rates. When these specific sub-sector decarbonization rates are not available, the sectoral ones should be used. When the sectoral ones are not available, the absolute contraction approach should be used as per SBTi.[31]

To meet the emission reduction goals set by the PA, certain sub-sectors with commercially mature climate solutions, like light-duty vehicles, need to start reducing emissions more quickly and aggressively than other sectors. Likewise, the IEA also offers detailed insights on the necessary pace of emission cuts, differentiating between advanced and emerging economies across various sectors, such as the industrial sector. Generally, it is important to attempt to define the threshold rate of emissions reduction in as precise a manner as possible, taking into account the target market of the companies involved.

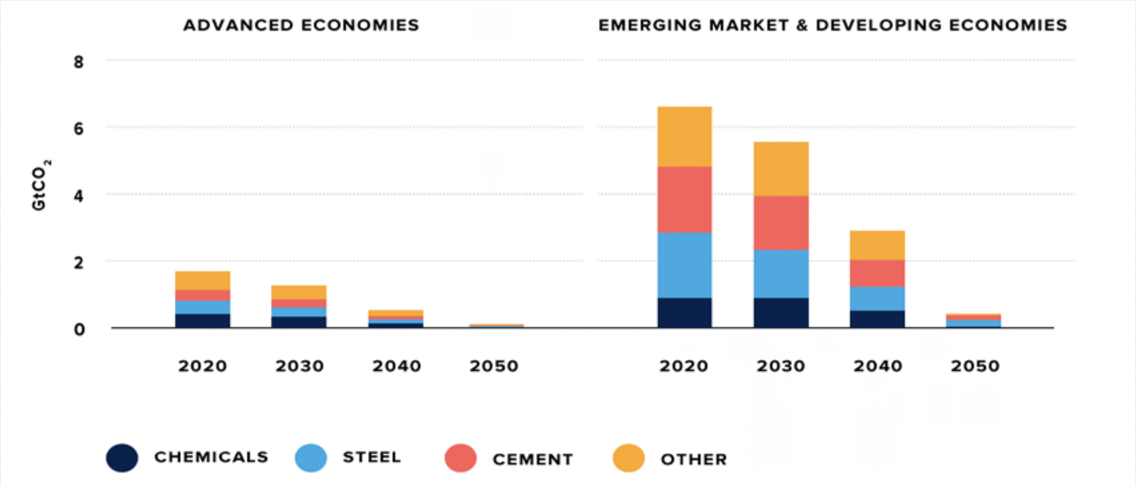



**Figure 7: Global CO2, emissions from industry by subsector**

*Source: IIGCC based on IEA, Net Zero Scenario[32]*

It is important to note that this screen is based on overall decarbonization rates for sectors or deployment rates for specific technologies and does not account for the varying objectives of different investor types. For instance, this threshold might be too lenient for growth-stage investors who may expect product deployment rates to increase at rates well above 100%, and too stringent for early-stage seed investors who may experience minimal or no growth during the initial years. For example, some early-stage companies may play a critical role beyond product deployment by demonstrating technology viability and spurring market movements; these effects will be captured by later entrants to the market. Consequently, future work, although extremely challenging, should aim to establish appropriate thresholds tailored to the specific requirements and expectations of different investor categories.

Moreover, this methodology is adequate for climate solutions that have a clear, core, and direct impact on climate mitigation; it is not adequate for solutions with indirect impacts or with an adaptation impact for which a customized analysis based on KPIs is required as discussed in the following sections.

Last, the threshold approach does not obviate the adoption of a theory of impact and investment thesis grounded in a strong analysis of the decarbonization levers in each sector. The threshold approach only comes to refine the screening when the VC is faced with opportunities that meet its theory of impact.

In the Annex, four examples illustrate the approach.

# Section Three: Indirect Impact Screening and Reporting

Venture capitalists fund enabling technologies crucial for advancing towards net-zero emissions. Although these enterprises do not directly curtail emissions, they significantly contribute by enhancing data collection and improving the accessibility of clean technologies. Examples include platforms offering comprehensive sustainability assessments through cloud-based Software as a Service (SaaS) or applications utilizing generative artificial intelligence and materials science to accelerate the innovation in low-carbon materials and chemicals. However, the metric of avoided emissions and the potential impact, as outlined by Project Frame, are not suitable for the evaluation and reporting of these companies' contributions.

The primary obstacle to using avoided emissions as a benchmark for enabling technologies in climate action is the intricacy of calculating these emissions and the substantial risk of double counting. Take, for example, a software designed to support solar developers in the planning and execution of solar projects. If this software were to claim the avoided emissions from the solar installations it facilitated, this would result in an attribution overlap, since the solar developer would likely also report these emissions savings. To address this question, Extantia Capital, a venture capital firm with a focus on climate innovation, designates a specific category of technologies known as "optimizers" or "maximizers". These technologies, while similar to enabling technologies, are distinguished by their capacity to significantly increase the efficiency of physical assets. For instance, an optimizer that allows an asset to produce 20% more clean electricity than what is typically expected can claim the avoided emissions for this additional output. This approach clarifies how to attribute avoided emissions credits between the optimizer technology and the clean energy asset itself, thereby mitigating the risk of double counting.[33]

However, when considering other types of software companies, like data-providers, the connection to avoided emissions becomes more tenuous. These companies typically operate several levels away from direct emissions reduction activities within the value chain. This degree of separation from direct emissions avoidance makes it inappropriate for such companies to claim avoided emissions credits, underscoring the need for a different approach in evaluating their impacts in the sphere of climate technology and software solutions. Investors can integrate a framework for screening and reporting on enabling companies, acknowledging the qualitative nature of this screening approach.

The specific guidance CCSI sees valuable when investing in enabling companies is as follows:

1. Identifying Indirect Impacts: Acknowledging the broader influence of enabling technologies in facilitating climate action, even if these impacts are not directly measurable in emissions savings. For example, the rationale behind investing in a company that provides a platform for simplifying the design and execution of solar projects lies in its ability to lower the deployment expense for clean energy projects, thereby accelerating its adoption.
2. Developing Suitable Key Performance Indicators (KPIs): In collaboration with the management of the PCs, crafting KPIs that reflect the unique contributions of each enabling company, considering their role in areas like ESG reporting, supply chain sustainability, or energy system integration. Some VCs also use the Impact Management Principles (IMP)'s five dimensions of impact (further referred to below in Figure 10) as a valuable guiding framework to develop a unique impact lens for the varied types of enabling companies. Following the example of a platform for designing and deploying solar projects, an appropriate KPI to measure its impact would be the volume of solar capacity (measured in kW) or the cost efficiency (cost per kW installed) that the platform has facilitated.
3. Measuring Indirect Impact, equipped with the KPI applied to the identified indirect impacts: Some software companies report on the emissions reductions of their customers and VCs echo this KPI; given the indirect contribution to these emissions reductions, developing more accurate and custom KPIs for each enabling company is crucial for effective impact management.

# Section Four: Climate Adaptation Investment Thesis

Over the next decade, the risk and impact of climate change could be more predictable than the potential economic consequences of interest rates, inflation, artificial intelligence, consumer preferences, or other variables influencing investment outcomes.[34] By some estimates, climate-related economic damages could detract around 20% from global GDP by 2050.[35] Emerging Markets and Developing Economies (EMDEs), while presenting a total market capitalization of USD 6.5 trillion, are expected to shoulder the predominant portion of those losses by 2030.[36]

Consequently, there is a growing demand for adaptation solutions all over the world and particularly in EMDEs to tackle both forthcoming and currently unprecedented climate hazards. Climate adaptation financing should therefore be prioritized. In 2022, funding for adaptation reached a record USD 63 billion, marking a 28% increase from the 2019-2020 period.[37] However, this amount significantly undershoots the projected annual requirement of USD 212 billion by 2030, needed solely for EMDEs.[38]

Although adaptation finance is sourced from both public and private funds, public financing has predominantly fueled it to date with resilience seen more as a risk to mitigate than an opportunity. Either for asymmetry in the information, lack of definitions and standards, investment horizon, or scalability of the climate adaptation solution, private investors have historically hesitated to enter the market. In 2021-2022, private investors contributed merely 2% of the total adaptation finance tracked (Figure 8).[39]

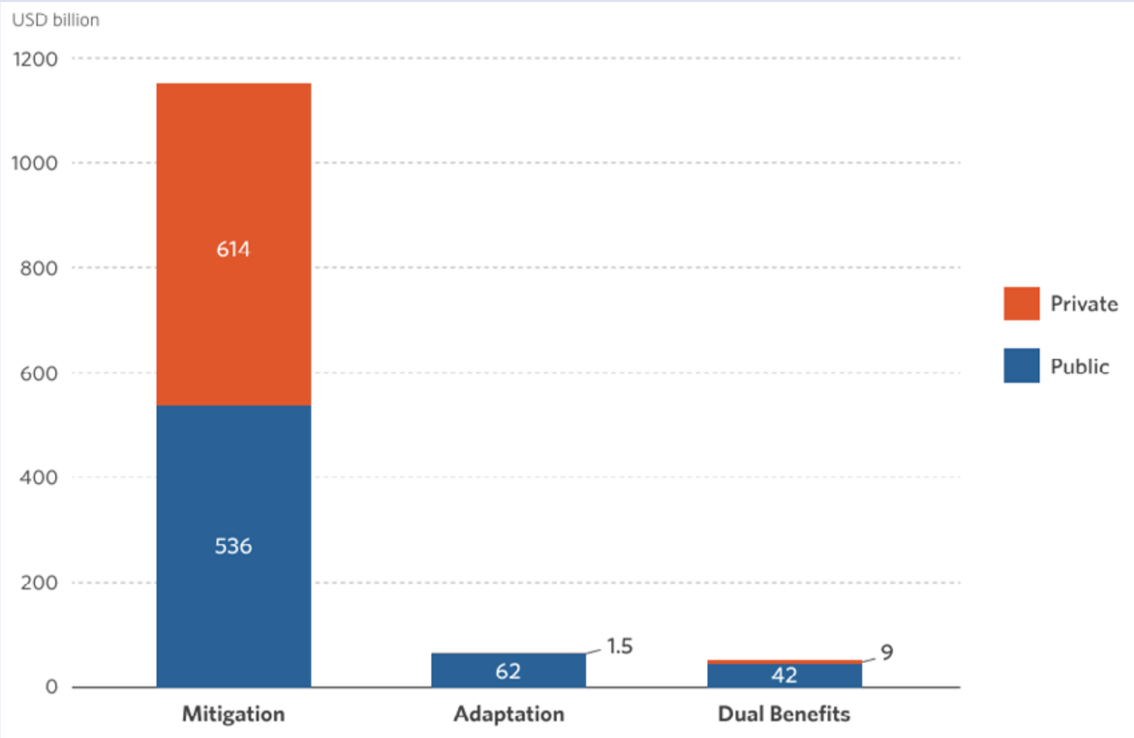



**Figure 8: Uses of climate finance with private-public splits in 2021-2022**

*Source: Climate Policy Initiative, Global Landscape of Climate Finance 2023*[40]

This implies that the private sector possesses a significant opportunity to intervene and mobilize capital for the financing of climate adaptation projects. While the financial performance of adaptation investment is not always evident, investment opportunities in climate resilience are found across diverse sectors, including healthcare, water utilities, and professional services, which are typically underrepresented in the shift towards a low-carbon economy.[41]

In conjunction with this market potential, investments in climate resilience have the capacity to augment the financial yields of decarbonization endeavors.[42] As investors increasingly prioritize decarbonization initiatives, the strategic allocation of capital towards climate adaptation solutions emerges as a crucial measure to enhance and safeguard the efficacy of such investments. For instance, integrating considerations influenced by climate change, such as changes in temperature patterns, shifts in precipitation levels, and alterations in ecosystem dynamics, into renewable energy projects enhances their resilience against the escalating impacts of climate change.

Similarly, incorporating analyses concerning sea level rise and flooding during the planning stages of energy-efficient buildings has the potential to enhance their viability as investments aligned with low-carbon objectives.[43] Furthermore, the progression of climate-smart agriculture, characterized by reduced carbon intensity and enhanced resilience to droughts and extreme weather events, not only promotes greater food security but also contributes to fortifying the long-term performance of investments.

While the nexus of mitigation and adaptation is already enticing to venture capital, investors often lack a clear understanding of climate adaptation financing, highlighting the need for effective frameworks to guide their investment choices. Various types of climate risks necessitate different responses, further complicating matters across different sectors.[44] Frameworks are however just now emerging to facilitate the investment process: the Global Adaptation and Resilience Investment Working Group (GARI) recently launched a framework to accompany investors in identifying companies offering adaptation solutions; the Lightsmith Climate Resilience Partners, also referred to as CRAFT (the Climate Resilience and Adaptation Finance and Technology-transfer facility), has promoted the development of an adaptation taxonomy to lead their investment strategy.[45] Similarly, the UNEP-DTU Partnership developed the TNA (Technology Needs Assessment) Adaptation Taxonomy as a tool for accurately understanding the current status of technology demands in developing countries.[46]

Conducting fundamental analysis is decisive for evaluating investments in adaptation solutions. Rather than relying solely on current revenue figures, investment decisions in adaptation companies are typically grounded in evaluating their business models and growth prospects with strong conviction.[47] Similarly, implementing systematic investment strategies driven solely by quantitative signals proves challenging due to limited data availability and the dependence of adaptation solutions on particular market contexts.[48] While all of this is generally true in mitigation investment, it is even more acute in adaptation investment, which for now has deterred its appeal for investors.

Thus, in this paper we are offering an approach for investors aiming to navigate this complex landscape. It starts by constructing an elaborate Climate Adaptation Investment Thesis that guides their investment strategy. To pursue this, the following foundational steps involve leveraging insights obtained from an analysis of benchmarked firms and pertinent documentation.

## 1. Conduct Climate Risk Assessment

Start with a thorough evaluation of climatic vulnerabilities within specific geographical locales, leveraging the comprehensive insights provided by the Intergovernmental Panel on Climate Change (IPCC)'s Sixth Assessment Report (IPCC AR6). This analysis should be augmented by examining national adaptation plans (NAPs), which detail the specific exposures of countries to climate risks and outline governmental strategies for adaptation. We also advocate for the utilization of specific supplementary instruments to accurately evaluate and quantify these risks, such as the ones explained below.

It is suggested to perform a climate vulnerability analysis. Investors can employ the Notre Dame Global Adaptation Initiative (ND-GAIN) Index to assess a nation's vulnerability—considering factors like exposure, sensitivity, and the capacity to adapt to adverse impacts—alongside economic, institutional, and social readiness to enhance resilience across vital sectors such as food, water, health, ecosystem services, human habitats, and infrastructure.[49] This analysis integrates 36 indicators, encompassing biophysical exposure to climate change, dependencies across sectors, and the availability of social resources for adaptation. Readiness indicators further encompass essential factors such as political stability, social inequality, and educational levels, which are pivotal in discerning viable adaptation strategies.

Similarly, it is necessary to conduct a physical climate risk modeling process that allows assessment of both physical and transitional risks. These models are instrumental in understanding the frequency and severity of physical hazards, such as hurricanes and floods, evaluating the implications of climate scenarios across different sectors, and quantifying the financial impact on portfolios under various climate projections.

## 2. Understand Adaptation Needs

Conceptualize a framework for a climate-resilient region that entails a comprehensive delineation of desired outcomes for adaptation, meticulously informed by the insights and empirical evidence presented in the IPCC AR6, and the NAPs.[50]

Overall, understanding adaptation needs is an indispensable step in developing contextually appropriate and effective strategies to address the impacts of climate change and build resilience in vulnerable communities and ecosystems. It requires a multidisciplinary approach, active stakeholder engagement, and careful consideration of socio-economic, environmental, and institutional factors.[51]

## 3. Identify a Solution Suite

The next and final step is to conduct a strategic analysis to identify a suite of feasible and commercially viable climate adaptation solutions. Such an analysis should be an integrative review of current trends in climate adaptation, such as global and regional adaptation strategies, policy developments, and funding flows towards adaptation solution efforts, alongside an assessment of technological innovations and sectoral advancements. Each solution should be assessed for its alignment with sectoral and geographic contexts. The incorporation of established strategies, such as the Adaptation SME Accelerator Project (ASAP) initiative spearheaded by the Lightsmith Group-led working group, will assist investors in identifying and prioritizing critical climate risks across various regions, with an emphasis on solutions that have a significant impact and can be implemented immediately.[52] The ASAP initiative provides an investment pipeline encompassing over 500 companies dedicated to climate adaptation solutions in EMDEs.

## 4. Adopt a Climate Adaptation Scorecard

Following the Climate Adaptation Investment Thesis, adopting a Climate Adaptation Scorecard will aid in evaluating companies. The adoption of a Climate Adaptation Scorecard requires a multidisciplinary approach, integrating insights from environmental science, economics, and strategic management. It also requires an agile methodology capable of adapting to the evolving nature of climate science and the dynamic landscape of technological innovation in climate adaptation solutions. Ultimately, this scorecard aims to provide a robust framework to facilitate informed decision making and investment in initiatives that not only address the immediate impacts of climate change but also foster long-term resilience and sustainability.

Below is a step by step approach to developing and implementing a Climate Adaptation Scorecard.

**1. Establishing Connection to Climate Adaptation**

Investors should verify that the company's activities directly address specific adaptation needs in the region and sector. Adaptation solutions should either provide climate adaptation intelligence services to respond to physical climate risks, or contribute to preventing or reducing material physical climate risks in the relevant context. Both types of companies are essential for enhancing the accessibility and availability of adaptation solutions. It is also possible that certain companies are unaware of their capacity to contribute to adaptation efforts. Thus, investors can have a profound impact by unlocking this potential through investment, establishing strategic partnerships, and actively engaging with these companies.[53]

| *Climate Adaptation Intelligence-related metrics* |
|---|
| $US total Climate Value at Risk estimated |
| No. of organizations / individuals supported in integrating climate-related considerations in decision-making |
| No. of organizations / individuals supported in disclosing climate-related financial risks |

| *Climate Adaptation Products & Services-related metrics* | |
|---|---|
| ↑ water availability | Clients Households Provided New Access; Water (L) Generated; Water (L) Saved |
| ↑ energy availability/reliability | Time/Value of Avoided Power Downtime; Renewable-based Backup Capacity Generation (MWH); Area (Absolute/%) of Transmission Line Undergrounded |
| ↑ agricultural potential | Average agricultural yield; Area of Degraded; Land (hectares) Reforested / Restored |
| ↓ weather-related disruption | Value of assets covered; # of customers served by the Company's data and analytics |
| ↓ weather-related damage | Gross Incurred Claim; Value of Extended Asset Life |

**Figure 9: Classification of adaptation solutions by type**

*Source: ASAP Taxonomy*[54]

Parallelly, investors should employ a robust taxonomy framework to guide their scorecard rating. The implementation of a taxonomy framework, such as the ASAP initiative or the TNA Taxonomy previously mentioned, not only standardizes the evaluation of adaptation solutions but also allows for a clear communication with external stakeholders (Figure 9). Ultimately, the use of an appropriate taxonomy will facilitate the investors' determination of relevant impact measurements.

**2. Impact Evaluation**

Following the adaptation alignment assessment, investors should ensure the company's effectiveness in addressing climate change. The overall impact assessment process should employ a structured framework to measure and quantify the changes led by the company to help adapt to climate change. Here, the IMP Framework is particularly useful (Figure 10).

The IMP reached global consensus that impact can be deconstructed into five dimensions: What, Who, How Much, Contribution and Risk

| IMPACT DIMENSION | IMPACT QUESTIONS EACH DIMENSION SEEKS TO ANSWER |
|---|---|
| WHAT | • What outcome(s) do business activities drive?<br>• How important are these outcomes to the people (or planet) experiencing them? |
| WHO | • Who experiences the outcome?<br>• How underserved are the affected stakeholders in relation to the outcome? |
| HOW MUCH | • How much of the outcome occurs - across scale, depth and duration? |
| CONTRIBUTION | • What is the enterprise's contribution to the outcome, accounting for what would have happened anyways? |
| RISK | • What is the risk to people and planet that impact does not occur as expected? |

**Figure 10: Impact Management Principles**

*Source: Impact Frontiers*[55]

The ASAP initiative can also assist by proposing KPIs that can vary depending on whether the solution is a climate adaptation intelligence service or a product/service solution. Notwithstanding, there is no one-size-fits-all approach or specific threshold to guide investment decisions based on quantifiable impact.

To further enhance the impact evaluation process, it is also recommended to utilize "lean data."[56] Such a process involves collecting data from the beneficiaries to measure the extent to which the adaptation solution decreases the physical climate risk by building up resilience. As an example, Acumen follows the lean data approach to guide their adaptation solution investments.[57] Equally relevant in this phase, investors should thoroughly evaluate the commercial potential and scalability of the company's adaptation solution.[58]

**3. Do Not Harm**

Climate adaptation solutions shouldn't create more harm than they solve. Just like in climate mitigation solutions, investors need to develop a robust do not harm framework as well as ensuring that the production of the solution minimizes current emissions or has a plan to reduce them in alignment with the Paris goals.

**4. Cost Benefit Analysis**

In developing a cost-benefit analysis in the realm of assigning a climate scorecard, investors should compare the costs of implementing a climate adaptation solution against the quantifiable societal benefits derived from such a solution. While this approach is in its early development, initiatives such as the Invesco Fund aim to establish a method for assessing the financial feasibility and overall impact of climate adaptation solutions.

The cost-benefit ratio serves as a metric to evaluate the efficacy and viability of climate adaptation solutions. Per regular cost-benefit analysis, climate adaptation solutions that reflect a positive ratio are more likely to be successful in implementation. In such a way, the analysis should encompass two main components: cost assessment and benefit assessment.

The cost assessment includes all operating expenses associated with the implementation of the climate adaptation solution by the company (i.e. direct costs, deployment, maintenance). The benefit assessment includes the societal benefits, which tend to be measured by avoided costs resulting from the implementation of such a solution (i.e. long-term savings, reduced risks, improved resilience).

The cost-benefit analysis can be utilized to address both climate adaptation intelligence solutions and climate adaptation products/services. For the first type of solutions, the directness of impact achieved through the implementation of the solution is not as straightforward, which challenges the cost-benefit analysis. This is a result of the facilitating role that this type of adaptation solution has. While the methodology for this is still unclear, proxy data can be used to evaluate this type of solution. Parallelly, for products and services, the cost-benefit analysis can be conducted in a straightforward manner, understanding that the costs and impacts for products and services tend to be quantifiable.

Ultimately, private investors are poised at a pivotal juncture, with a significant opportunity and responsibility to channel capital towards financing climate adaptation projects. There is a promising financial frontier for investors aiming to prioritize both climate adaptation (making systems more resilient to climate change impacts) and decarbonization (reducing carbon emissions). However, the pathway is marred by complexities stemming from a lack of comprehensive understanding around the nuances of climate adaptation financing. This gap underscores the paramount need for robust, articulate frameworks that can guide investment strategies effectively.

A deep, nuanced understanding of climate adaptation needs and priorities, bolstered by insights such as those previously mentioned, becomes indispensable for crafting a coherent adaptation investment strategy. This endeavor, while challenging, is exemplary for the private sector to not only mitigate against imminent climate risks but also to harness the untapped potential of climate adaptation efforts.

# Conclusion

The essence of due diligence within the context of climate impact investing stretches far beyond the conventional financial scrutiny. It mandates a holistic evaluation encompassing climate mitigation and adaptation needs, the identification of breakthrough and scalable technologies, their potential impact and a keen understanding of regulatory landscapes. This comprehensive approach ensures that investments are not only financially sound but also critical in averting the climate crisis.

Moreover, the integrity of climate impact investments heavily relies on robust impact measurement practices. The journey towards standardization and transparency in reporting practices is pivotal to facilitate comparability and credibility. It also reinforces the accountability of investments towards their stated environmental goals.

Venture capital's potential to unlock transformative climate solutions also brings to light the significance of strategic financing, especially in the underexplored territory of climate adaptation. Recognizing high-impact investment opportunities, particularly in regions and sectors most susceptible to climate change, is crucial. Collaborative efforts, including partnerships with governmental bodies, non-profits, and the broader private sector, amplify the reach and effectiveness of adaptation projects. Innovative financial instruments further enrich the ecosystem, enabling risk sharing and attracting diverse capital sources to bolster adaptation efforts.

In summary, as the landscape of climate change evolves, so too must the strategies employed by venture capital investors. An enhanced focus on rigorous due diligence, meticulous impact measurement, and strategic financing choices will be paramount. This comprehensive approach does not only amplify the potential for impactful climate outcomes but also ensures the resilience and sustainability of investments in the face of global climate challenges. Through this lens, venture capital can significantly contribute to steering our world towards a more sustainable and climate-resilient future, marking a critical step forward in the collective battle against climate change.

# Appendix: Applications of the Threshold Approach

Please note that while the companies mentioned below exist, the above numbers are based on estimates or publicly available data and not actual company data.

## I. Company A Evaluation:

**Product Description**

Company A is developing a long-term energy storage technology (metal-hydrogen technology) to enable further penetration of renewable energies. The current battery industry is dominated by lithium iron phosphate (LFP) technology, which has several drawbacks, such as fire safety concerns, temperature management issues, short lifespan, and degradation problems.

### What sector is the company operating in?

Power Sector. The company's solution could operate in other use cases but for the purpose of this example, we will consider its application in the grid-scale energy storage space.

### What is the GHG-reducing effect of the company's product?

**Primary Impact:** Company A enhances the integration and reliability of renewable energy sources. By providing efficient and scalable energy storage, Company A's technology allows for greater utilization of intermittent renewable energy (such as solar and wind), thereby reducing the reliance on fossil fuel-based peaker plants.

**Additional impact:** Company A's storage solutions have lifecycle emissions that are 75% lower compared to traditional LFP batteries. This reduction encompasses the manufacturing and disposal phases of the storage units, measured on a per kW installed capacity basis. Additionally, Company A's technology features a longer lifespan and greater efficiency, which results in fewer resources needed over time for maintenance, replacement, and disposal compared to shorter-lived technologies. This contributes to a reduction in the overall lifecycle emissions of the power produced.

### What is the emissions impact of a utility, power producer adopting this technology?

**Primary Impact:** By using energy stored from renewable sources during peak demand times, utilities can decrease their dependence on fossil fuel plants, directly reducing CO2 emissions economy-wide in the power sector.

**Additional Impact:** If LFP batteries contribute a certain baseline emissions level per kWh stored and delivered, Company A's technology would contribute 25% of that due to the 75% reduction in lifecycle emissions. This emission reduction is then translated into the overall emission intensity of the power producer. For example, if a grid sends 10% of its total capacity to storage, and if Company A's technology forms all of this storage capacity, the overall grid emission intensity could be recalculated to reflect the lower emissions impact of this technology. The overall reduction in the emission intensity would then be (10% x 75%) which is 7.5% in this example.

### What is the lifetime of the product?

Assume that the lifetime of the product is 20 years.

Screen 1 – Taxonomy Alignment

Hydrogen storage is included in the EU taxonomy as a green technology given that it makes a substantial contribution to climate change mitigation.

## Screen 2 – Emission Intensity Check

**Decision Node 1:** If the climate solution under consideration fits within a value chain that has established emission intensity target requirements along a sectoral pathway set by reputed organizations like SBTi or IEA, which are aligned with 1.5°C targets, then it is possible to benchmark the emission intensity of the value chain that the climate solution is a part of against these targets. However, there is a need to pay attention to the scopes (1, 2 or 3) covered by the sectoral pathway as it might not cover the entire value chain and exclude the segment of the climate solution.

**What Emission Intensity refers to in the context of Hydrogen Storage Technology:** To benchmark Company A within the power production ecosystem, it is essential to assess the emission intensity of the electricity that incorporates Company A's storage technology within its lifecycle. This involves considering how Company A's technology reduces lifecycle emissions and enhances the efficiency of energy storage, which subsequently impacts the emission intensity of the final electricity delivered.

### A. What are the emission intensity targets for the relevant sector (Power) in 2040 (end of lifetime of company A's solution):

To accurately benchmark the emission intensity, first understand the projected trajectory of the power sector. According to the SBTi, which utilizes the IEA Net Zero Scenario, the target emission intensity for electricity production in 2040, aligned with a 1.5°C scenario, is approximately 0.02 kg $CO_2$/kWh, or 20 g $CO_2$/kWh. For comparison, the current emission intensity of the power sector in the United States is around 368 g $CO_2$/kWh.

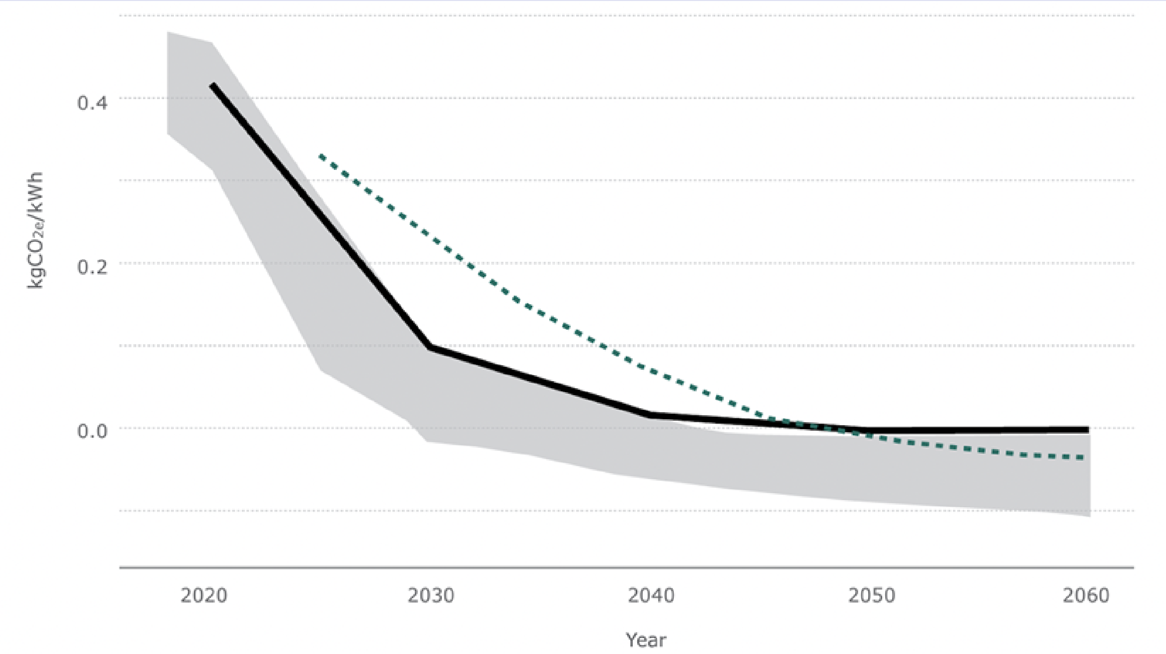



**Figure 11: Power sector emission intensity targets - 20 g $CO_2$/kWh for the year 2040**

*Source: SBTi Power Sector Targets*[59]

### B. Determining emission intensity of the product under consideration:

The calculation of the emissions of the final value chain, which is electricity produced in this case, includes the following scope in the above Sbti targets:

**Scope 1 Emissions:**

Included: Direct emissions from the combustion of fuel in the power plant. This includes all greenhouse gases (GHGs) emitted directly from operational activities, such as CO2, methane (CH4), and nitrous oxide (N2O) from the burning of fuel for electricity generation.

**Scope 2 Emissions:**

Included: Indirect emissions from the generation of purchased electricity used by the power producer that is not related to the production of electricity for sale. For instance, if your facility purchases electricity to power auxiliary equipment or facilities, these are Scope 2 emissions.

Scope 3 Emissions:

Excluded: Emissions from the extraction and delivery of the fuel to the site (upstream activities). These emissions fall under Scope 3, which typically includes all other indirect emissions not covered in Scope 2.

**Decision Node 1: As such, adopting Company A's technology would not directly affect the emission intensity calculations required for reporting to the SBTi for the specific kg $CO_2e$ per kWh of electricity produced metric, which primarily focuses on Scope 1 and Scope 2 emissions. For now, no source provides explicit targets that consider the entire lifecycle emissions of electricity produced including Scope 3. The adoption of Company A's technology would not change the emission intensity of the final delivered electricity as per the accounting boundaries set by the SBTi given that storage technologies do not have any operational emissions when integrated with renewable energy.**

Go to Decision Node 2

**Decision Node 2:** Since there is no change in the emissions of the final product (electricity) delivered with the adoption of Company A's technology compared to an LFP storage system—meaning it would neither add nor subtract emissions according to the accounting guidance—it is more appropriate to benchmark Company A's carbon footprint against a corporate 1.5°C-aligned transition plan.

### Calculating the emission intensity of the Product:

The emission intensity of the Product would be calculated as:

$$\frac{\text{(Total Emissions associated with manufacturing and disposal)}}{\text{(Number of lifecycles} \times \text{Amount of Energy Stored per Cycle)}}$$

This would provide emission intensity information in units of kg $CO_2$/kWh.

**If the product's carbon footprint is aligned with a 1.5°C trajectory, the company passes screen 2.**

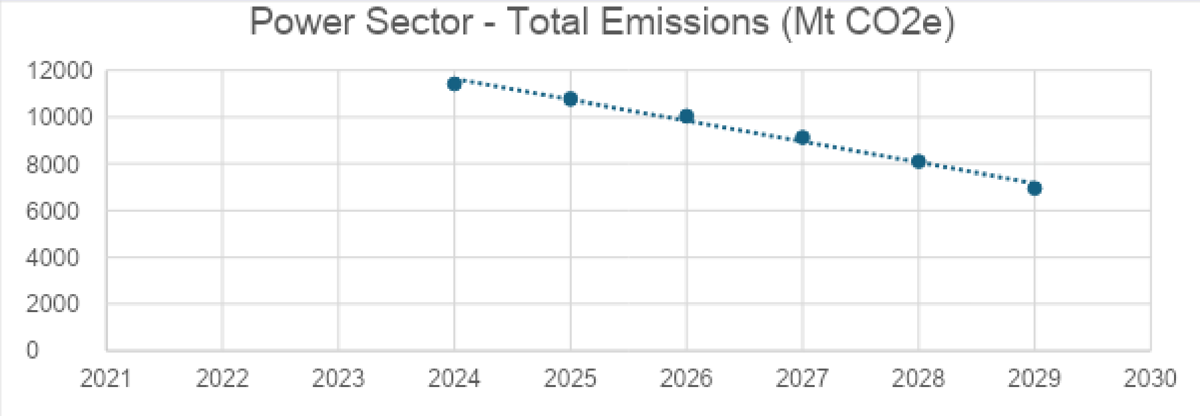
### Screen 3 – Decarbonization Growth Rate

**Decision Node 1:** If the specific climate solution under consideration has been identified as one of the critical technologies (e.g., electrolyzers or lithium-ion battery storage) in a net-zero roadmap such as the one published by the IEA or IIGCC, the growth rate of the deployment targets can be used to benchmark against the rate of deployment of the climate solution under consideration.

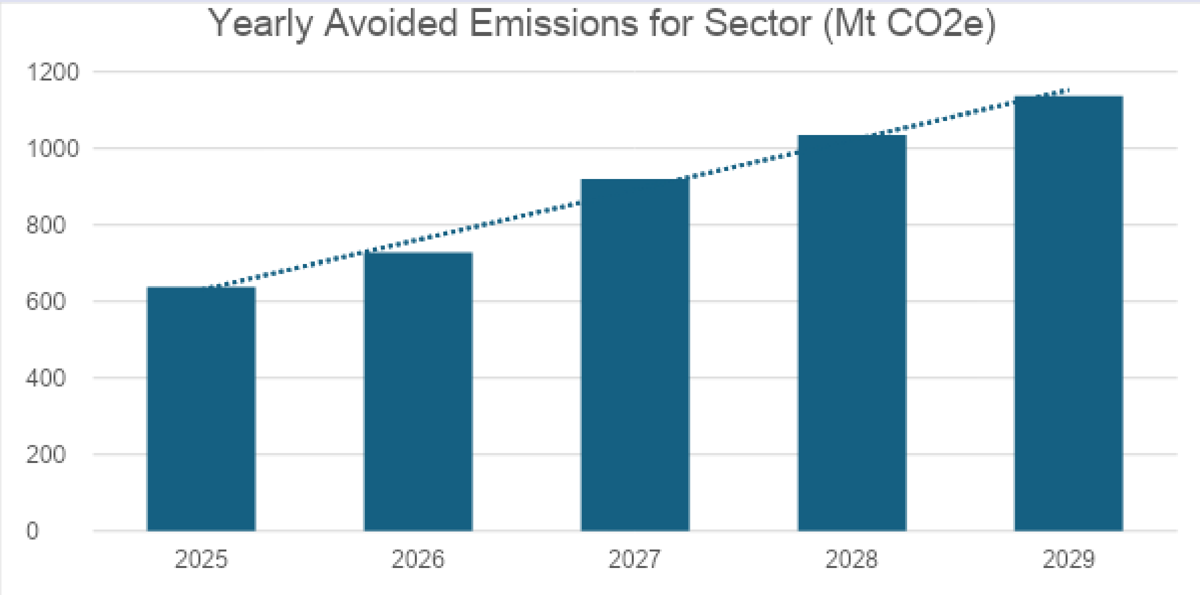
In this case, deployment targets for grid-scale energy storage were only provided as a generic climate solution (shown below). Therefore, it may not be appropriate to benchmark against metal hydride energy storage solutions, as they are at an earlier stage of commercial deployment compared to other grid-scale energy storage systems.

**Decision Node 2:** If deployment targets are not available for the specific climate solution under consideration, the next option is to use the required decarbonization rate of the sector as a proxy to understand how quickly emissions need to be reduced in that sector to stay within a 1.5°C-aligned scenario.

### A. Determining the required decarbonization rate of the sector to benchmark against:




*Source: IEA Net Zero Data Explorer*[60]




*Source: Authors' calculations*

**Figure 12: Emissions reduction trajectory of the power sector and annual avoided emissions**

The above two charts show the required decarbonization rate for the power sector. The CAGR of the avoided emissions in the sector is ~16% from 2025-2029.

### B. Avoided emissions of the product

***Primary Impact:*** *Avoided Reliance on Peaker Plants*

According to a report by the IEA emission factor database,[61] the carbon footprint of the power produced from peaker plants is estimated to be around 1365 lbs $CO_2$ per MWh (or 620 g $CO_2$ per kWh).

Below is an example assuming that the amount of energy stored and dispensed in year 1 (2024) amounts to 10 MWh (assumed to be growing at a CAGR of 4.5%). The avoided emissions are calculated assuming the baseline technology (the incumbent or BAU scenario) is a peaker plant. The avoided emissions for each year are calculated as the energy stored and dispensed through Company A's technology multiplied by the emission factor for peaker plants.

| Year | Assumed Electricity Produced From Power Producer (MWh) Sent to Storage Yearly | Emissions From Electricity Delivered Through Peaker Plants (g $CO_2e$ per kWh) | Emissions From Electricity Delivered Through Company A (g $CO_2e$ per kWh) | Avoided Emissions Yearly (kg of $Co_2e$) |
|---|---|---|---|---|
| 2024 | 10 | 620 | 0 | 6200 |
| 2025 | 11.8 | 620 | 0 | 7316 |
| 2026 | 13.924 | 620 | 0 | 8633 |
| 2027 | 16.43032 | 620 | 0 | 10187 |
| 2028 | 19.3877776 | 620 | 0 | 12020 |
| 2029 | 22.87757757 | 620 | 0 | 14184 |

**The CAGR of the avoided emissions from the product's deployment is ~18% from 2024-2029 through the reduced reliance on peaker plants.**

**Additional Impact:** Avoided Reliance on LFP Storage Technology (Not Quantified for Benchmarking Purposes as the penetration of LFPs in the market is not adequate enough for it to be the baseline)

According to a report by IEA emission factor database,[62] the carbon footprint of LFP batteries is estimated to be around 70-110 kg $CO_2$ per kWh of battery capacity.

Example calculation of emissions associated with electricity deliver from an LFP:

------------------------------------

**Embodied Emissions: 100 kg $CO_2$e per kWh**

**Battery Capacity: 1 kWh**

**Depth of Discharge: 80% (0.8)**

**Number of Cycles: 5,000**

**Round-Trip Efficiency: 90% (0.9)**

**Usable Capacity per Cycle: 1 kWh × 0.8 = 0.8 kWh**

**Total Energy Delivered: 0.8 kWh × 5,000 × 0.9 = 3,600 kWh**

**Emissions per kWh Delivered (LFP): 100 kg $CO_2$e / 3,600 kWh ≈ 28 g $CO_2$e per kWh**

**Emissions associated with electricity delivered from Company A's technology:**

------------------------------------

**Emissions per kWh Delivered (Company A): 7 g $CO_2$e per kWh (75% cleaner)**

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### C. Comparing avoided emissions of the product (company) vs the sector's required decarbonization rate

CAGR of avoided emissions in the sector: 16%

CAGR of avoided emissions from the company's product: 18%

**Based on this growth rate, the company would pass screen 3.**

## II. Company B Evaluation

### Product Description

Company B operates a marketplace that connects merchants (e.g. Starbucks, Cosco, Unilever) with consumers for unsold items. Company B enables food services, retailers, and manufacturers to save their food surplus from going to waste.

### What sector is the company operating in?

Food Sector

### What is the GHG-reducing effect of the company's product?

Company B enables food services, retailers, and manufacturers to save their food surplus from going to waste. That way Company B has a dual climate impact:

- Saving emissions from food waste processing
- Saving emissions from producing an equal amount of new food products in a baseline scenario in that consumers would buy new food products instead of saving the products offered on the Company's B marketplace.

### What is the emissions impact of a Food Sector Player adopting this technology?

By partnering with Company B, a company can reduce the amount of food waste sent to landfills. This reduction decreases methane production from decomposition, a potent greenhouse gas. Consequently, the company can report lower emissions in its Scope 3 category, specifically under waste management. This Scope 3 is included within the boundary of emissions considered in the SBTi FLAG sectors.

### Screen 1 – Taxonomy Alignment

A company like Company B, which helps reduce food waste, is considered part of the activities supported under the EU taxonomy as a green activity. Although not mentioned explicitly, the activities of this company align with the EU taxonomy's objectives of classifying sustainable activities that significantly contribute to climate change mitigation and the transition to a circular economy. This connection can also be inferred from strategies like the "Farm to Fork" initiative, which specifically targets reducing food waste in the EU.

### Screen 2 – Emission Intensity Check

**Decision Node 1:** If the climate solution under consideration fits within a value chain that has established emission intensity target requirements set by reputed organizations like SBTi or IEA, which are aligned with 1.5°C targets, then it is possible to benchmark the emission intensity of the value chain that the climate solution is a part of against these targets. Not only should the value chain have established targets, but the scope (Scope 1, 2, and 3) of emissions considered in the target should also be aligned.

In the SBTi FLAG guidance,[63] emissions associated with food waste primarily fall under Scope 3 emissions for a company operating in the food sector. These are indirect emissions that occur throughout the value chain of the reporting company, including both upstream and downstream activities.

### What Emission Intensity refers to in the context of Company B:

Company B operates within the food sector as a service provider connecting retail customers with surplus food that would otherwise be thrown away. This company integrates into the food value chain by partnering with local restaurants, cafes, bakeries, and grocery stores to prevent food waste. Company B operates a marketplace model, facilitating transactions between food businesses and consumers. This is very different from a battery storage company for example, which typically provide technical solutions and infrastructure to power producers and utilities. The integration of Company B into the food sector value chain is not through direct contracts with the emission intensive companies. As such, it would be incorrect to benchmark the emission intensity of any particular Food System Value chain with an SBTi target for "Company B."

**Decision Node 2:** Benchmark Company B's carbon footprint against a corporate 1.5°C-aligned transition plan.

**For Company B, the delivery of its service does not contribute any emissions associated with the FLAG (Forestry, Land Use, Agriculture) sectors. As such, the emissions can be assumed to be negligible, allowing Screen 2 to be considered an automatic pass.**

## Screen 3 – Avoided Emissions Growth Rate

Decision Node 1: If the specific climate solution under consideration has been identified as one of the critical technologies (e.g., electrolyzers or lithium-ion battery storage) in a net-zero roadmap such as the one published by the IEA or IIGCC, the growth rate of the deployment targets can be used to benchmark against the rate of deployment of the climate solution under consideration.

**A. Determining the required deployment rate of the climate solution (or in this case, mitigation measure which is avoiding food waste) of the sector to benchmark against:**

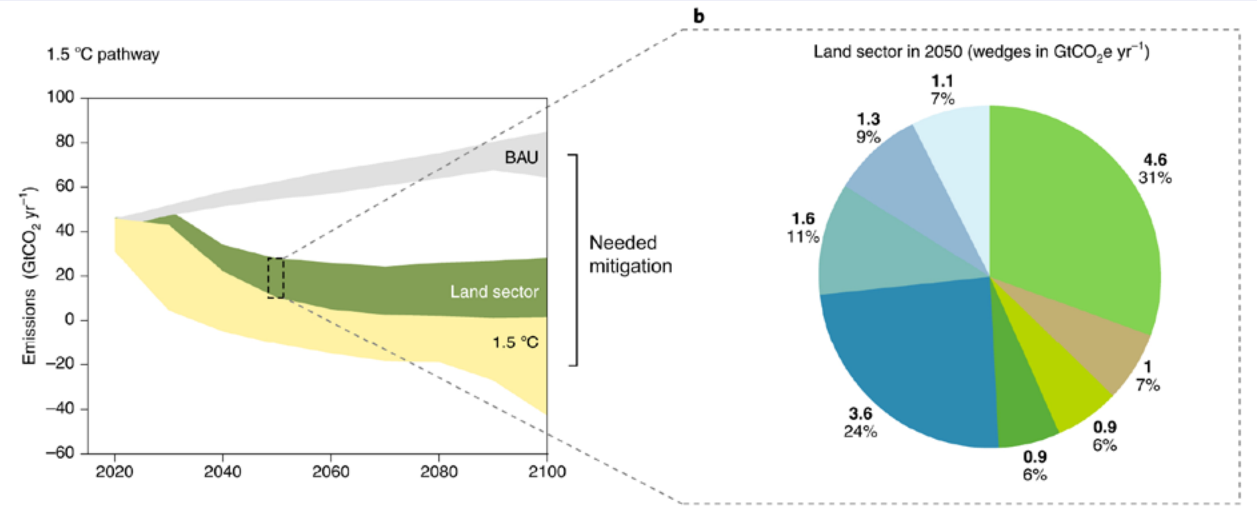


**Figure 13: Land-sector roadmap for 2050**

*Source: Roe et al. 2019*[64]

There are several mitigation measures outlined for the food sector to reduce emissions in line with a 1.5°C- trajectory. The measure relevant for benchmarking is reducing food waste. It is projected that food waste needs to be reduced by 50% by 2050 from current levels to stay on this pathway.[65] Consequently, from now until 2050, the CAGR for avoided food waste is 2.63%.

**B. Avoided emissions of the product**

If Company B's growth in avoided food waste (or emissions as a proxy) increases at a rate of 2.63% or higher each year, it can be considered that the company is mitigating emissions at a pace exceeding the decarbonization rate of its overall sector. This contributes to the sector's efforts to remain within the 1.5°C- warming limit outlined in the SBTi target.

## III. Company C Evaluation

**Product Description**

Company C is a gas power plant with a power intensity of 970 lbs/MWh, providing grid-scale electricity.

**What sector is the company operating in?**

Power Sector

**What is the GHG-reducing effect of the company's product?**

Based on the current grid power emission intensity, the gas power plant under consideration has a lower emission intensity than the average. Therefore, introducing this power plant will help reduce the overall emissions of the power sector.

**What is the emissions impact of a Power Player adopting this technology?**

N/A - The gas power plant is the primary technology in the power production value chain.

### Screen 1 – Taxonomy Alignment

The EU taxonomy specifies an emission intensity limit for gas power plants permissible as a transition solution, aligning with the power sector standard. This limit is set at 100 g CO2e/kWh, equivalent to approximately 220 lbs/MWh (on a life cycle basis, assuming CCS is in place). The proposed power plant provided has an emission intensity of 970 lbs/MWh. Additionally, the taxonomy includes several other requirements for a gas plant to be considered compliant, such as prohibiting investing in power generation that competes with renewable energy (RE). **Therefore, this gas plant would not meet these criteria.**

For more details, you can refer to the following source: Gas and Nuclear Activities in the EU Taxonomy Regulation.

### Screen 2 – Emission Intensity Check

**Purpose of Check:** Screen 2 evaluates whether the product being considered for investment fits within a value chain whose final product delivered has an emission intensity that meets or is lower than the projected target for its sector by the end of its operational life. For instance, if a product installed today is expected to operate until 2040, the final product's emission intensity must be at or below the forecasted figures for its sector in 2040. Assume the gas power plant's lifetime is up to 2040 (normally, it is much longer).

**Decision Node 1:** If the climate solution under consideration fits within a value chain that has established emission intensity target requirements along a sectoral pathway set by reputed organizations like SBTi or IEA, which are aligned with 1.5°C targets, then it is possible to benchmark the emission intensity of the value chain that the climate solution is a part of against these targets. However, there is a need to pay attention to the scopes (1, 2 or 3) covered by the sectoral pathway as it might not cover the entire value chain and exclude the segment of the climate solution.

What Emission Intensity refers to in the context of Gas Power Plant: The emission intensity of the gas power plant refers to Scope 1 emissions (combustion of natural gas) and Scope 2 emissions (purchased electricity, etc.).

**A. What are the emission intensity targets for the relevant sector (Power) in 2040 (end of lifetime of Company C's solution):**

To accurately benchmark the emission intensity, first understand the projected trajectory of the power sector. According to the SBTi, which utilizes the IEA Net Zero Scenario, the target emission intensity for electricity production in 2040, aligned with a 1.5°C scenario, is approximately 0.02 kg $CO_2$/kWh, or 20 g$CO_2$/kWh. For comparison, the current emission intensity of the power sector in the United States is around 368 g $CO_2$/kWh.

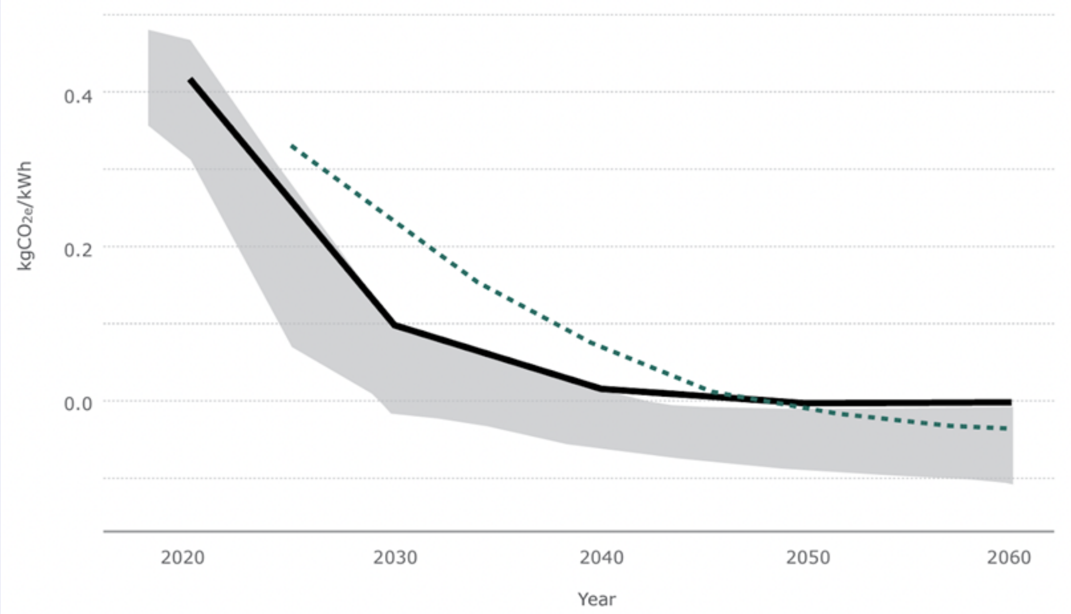


**Figure 14: Power sector emission intensity targets - 20 $gCO_2$/KWh for the year 2040**

*Source: SBTi Power Sector Targets*[66]

### B. Determining the emission intensity of the product under consideration

The gas plant emission intensity is 970 lbs/MWh (provided) or 440 g/kWh.

**Decision Node 1: As such, the gas power plant's emission intensity (440 g/kWh) exceeds the threshold intensity in 2040 for the sector (20 g/kWh).**

**There is no need to move to Screen 3 when previous screens failed.**

## IV. Company D Evaluation

### Product Description

Company D is a predictive maintenance software layer on electric rotating industrial equipment that helps spot faulty equipment before they overconsume thereby preventing lost energy (and therefore emissions). The solution can be thought of as an energy-efficiency product.

### What sector is the company operating in?

Industrial Sector

### What is the GHG-reducing effect of the company's product?

The emissions-reducing effect can be thought of in terms of energy consumption per unit of industrial output. In the baseline, there's an additional energy consumption due to the faulty motors, while in the climate solution scenario, all motors operate at their optimal efficiency (80kW per unit of output).

### What is the emissions impact of an Industrial Player adopting this technology?

After adopting this predictive maintenance technology, the final product's (any industrial product such as steel, etc) emission intensity that utilizes these motors as part of the manufacturing process will be lowered.

### Screen 1 – Taxonomy Alignment

Efficiency measures are not explicitly included in the taxonomies, particularly in the EU taxonomy we are initially examining. Many other taxonomies follow its model with regional variations. However, according to the IEA, efficiency measures are integral to climate solutions and should not be disregarded simply because they are not explicitly mentioned in the taxonomy.

An energy efficiency measure also meets the climate mitigation criteria and the "Do no Harm" criteria.

## Screen 2 – Emission Intensity Check

Assume the predictive maintenance technology has a lifetime of that of the motor itself that the software supports, and assume it is 2030.

**Decision Node 1:** If the climate solution under consideration fits within a value chain that has established emission intensity target requirements along a sectoral pathway set by reputed organizations like SBTi or IEA, which are aligned with 1.5°C targets, then it is possible to benchmark the emission intensity of the value chain that the climate solution is a part of against these targets. However, there is a need to pay attention to the scopes (1, 2 or 3) covered by the sectoral pathway as it might not cover the entire value chain and exclude the segment of the climate solution.

What Emission Intensity refers to in the context of the predictive maintenance software for industrial motors: The emission intensity of the value chain that this technology is a part of refers to the final emissions of the industrial product. For example, if the predictive maintenance software is installed on motors used exclusively in the steel sector, it is essential to understand how the emission intensity of steel production changes with the implementation of this software on the motors used in the steel manufacturing process. Generally, the industrial sector's emissions encompass Scope 1 (direct emissions from the manufacturing process) and Scope 2 (purchased electricity and other indirect emissions). The adoption of this technology (Company D) is expected to reduce the Scope 2 emissions of the industrial product. Moreover, given that Company D's technology is only among a suite of solutions needed to decarbonize the same product (steel or any other industrial product), its relative contribution to decarbonization needs to be known.

### A. What are the emission intensity targets for the relevant sector (Industrial) in 2030 (end of lifetime of Company D's solution):

To accurately benchmark the emission intensity, it is essential to first understand the projected trajectory of the industrial sector. According to the IEA Net Zero Scenario, the total emissions for the industrial sector in 2030, aligned with a 1.5°C scenario, are known, as well as the projected percentage increase in total production. Therefore, the percentage decrease in emission intensity of the industrial product (like steel) can be calculated without needing to determine the actual emission values.

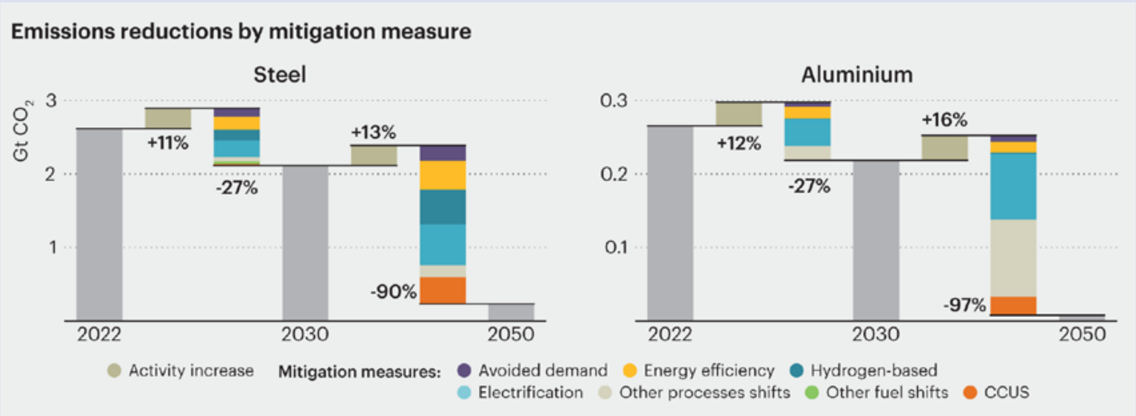


**Figure 15: Emission reduction potential by mitigation measures in steel and aluminum**

*Source: IEA*[67]

*Reduction in emission intensity of the steel sector:*

Emission Intensity in the year 2022: **Y/X** Where Y represents the 2022 emissions and X represents the 2022 product output (total sector's output volume).

Emission Intensity in the year 2030: **0.84Y/1.11X** Based on the above graphic where the emission reduction % is shown (27%) and the emissions increase associated with production volume increase is shown (11%) in 2030.

% Decrease in Emission Intensity: 24.32% = **[(Y/X-0.84Y/1.11X)÷Y/(X×100)]**

% Attributable to Energy Efficiency: about 4.9% (assuming that the yellow bar is approximately 1/5th the total emission reduction)

### B. Determining the emission intensity of the product under consideration

**Assumption:** In the baseline scenario, 50% of motors are faulty and waste 1.5 kW, leading to inefficient operation.

**Baseline Scenario Calculation:**

- Effective Average Power Consumption per Unit of Industrial Output:
    - Faulty motors consume 81.5 kW.
    - Non-faulty motors consume 80 kW.
    - Since 50% of the motors are faulty and 50% are not, the average power consumption is:

**Average Power Consumption: 80.75 kW = (80kW +81.5kW)/2**

**Emission Intensity:**

- Baseline Scenario: Includes additional energy consumption due to faulty motors.
- Climate Solution Scenario: Assumes all motors operate at optimal efficiency (80 kW per unit of output).

**Difference in Emission Intensity:**

- The reduction in emission intensity between the baseline scenario (with faulty motors) and the climate solution scenario (without faulty motors) is approximately 0.93%.

**Interpretation:**

- The climate solution scenario results in a 0.93% decrease in emission intensity, indicating a slight improvement in overall energy efficiency per unit of industrial output.

**Key Points:**

- Uptime and operational duration are assumed to be constant, as the focus is on the percentage of faulty motors.
- The value proposition of the proposed 'climate solution' is its ability to identify and fix faulty motors, thereby improving efficiency.

**Decision Node 1: Given that the introduction of Company D technology only helps reduce the emission intensity of the final product (steel, in this case) by 0.93% in 2030, it would not pass Screen 2, which requires a 4.5% reduction in emission intensity attributable to energy efficiency decarbonization measures. Although Company D can be considered a climate solution according to the taxonomy (Screen 1), it does not warrant climate-focused capital as it does not achieve the significant impact needed to align with 1.5°C pathways.**

**There is no need to move to Screen 3 when previous screens failed.**

# Endnotes


1 Emma Cox, Will Jackson-Moore, Leo Johnson, and Tarik Moussa, *State of Climate Tech 2023: How Can the World Reverse the Fall in Climate Tech Investment?* (London: PricewaterhouseCoopers, October 2023), https://www.pwc.com/gx/en/issues/esg/state-of-climate-tech-2023-investment.html.

2 International Energy Agency, Net Zero Emissions by 2050: A Roadmap for the Global Energy Sector (Paris: International Energy Agency, May 2021), https://www.iea.org/reports/net-zero-by-2050.

3 Maximillian Kotz, Anders Levermann, Leonie Wenz, *The economic commitment of climate change*, (Nature 628, 551–557 (2024), https://doi.org/10.1038/s41586-024-07219-0.

4 Cox, Jackson-Moore, Johnson, and Moussa, *State of Climate Tech 2023.*

5 Cox, Jackson-Moore, Johnson, and Moussa, *State of Climate Tech 2023.*

6 Project Frame, *Pre-investment Considerations: Diving Deeper into Assessing Future Greenhouse Gas Impact* (Cambridge: Prime Coalition, April 2023), https://projectframe.how/preinvestment-ghg-assessment.

7 The Venture Climate Alliance, https://ventureclimatealliance.org/.

8 Project Frame, *Pre-investment Considerations.*

9 BlueMark, *Managing for Climate Mitigation Impacts, Full Cycle Case Study* (May 2023), https://www.bluemarktideline.com/wp-content/uploads/2023/05/MTM-IV-Case-Studies_FullCycle.pdf.

10 Peter Fox-Penner, Morgan Sheil, and Gabriella Rocco, *Know Your Impact: Our Approach to Emissions Reductions Measurement* (New York: Energy Impact Partners, November 2022), https://www.energyimpactpartners.com/wp-content/uploads/2022/12/Know-Your-Impact-Our-Approach-to-Emissions-Reductions-Measurement-Energy-Impact-Partners-2022.pdf.

11 Andrew Howard, Mervyn Tang, Low Ping Yee, Rachel Teo, and Wong De Rui, *A Framework for Avoided Emissions Analysis* (Singapore: GIC, November 2021), https://www.gic.com.sg/thinkspace/long-term-investing/a-framework-for-avoided-emissions-analysis/.

12 Carbon Impact Analytics, Carbone 4. "Methodological Guide for Investors and Asset Managers: Carbon Impact Analytics." Version 2, September 2018, https://www.oxfamfrance.org/app/uploads/2021/03/Annexe-2-Methodologie-complete-en-anglais.pdf.

13 These methods are inspired by PCAF, even though PCAF hasn't developed a standard for private equity and VCs yet (https://carbonaccountingfinancials.com/about) and only relates to financed emissions.

14 Fox-Penner, Sheil, and Rocco, *Know Your Impact.*

15 Mirova, "Mirova and Robeco Announce I Care and Quantis to Develop a Global Standard for Calculating Emissions Avoided By Low-Carbon Solutions," press release, January 1, 2024, https://www.mirova.com/en/news/mirova-robeco-icare-quantis-global-standard-avoided-emissions-low-carbon-solutions-US.

16 Stephen Russell, *Estimating and Reporting the Comparative Emissions Impacts of Products* (Washington, DC: World Resources Institute, March 2019), https://www.wri.org/research/estimating-and-reporting-comparative-emissions-impacts-products.

17 Schneider Electric, *$CO_2$ Impact Methodology: Saved and Avoided Emissions by Schneider Electric Offers*, (Rueil-Malmaison: Schneider Electric, September 2022), https://www.se.com/us/en/download/document/CO2_methodology_guide/.

18 United Nations Framework Convention on Climate Change, Clean Development Mechanism Standard: Determining Coverage of Data and Validity of Standardized Baselines, UN Doc. CDM-EB77-A05-STAN (December 2020), https://cdm.unfccc.int/sunsetcms/storage/contents/stored-file-20201215164216092/methSB_stan01.pdf.

19 Fox-Penner, Sheil, and Rocco, *Know Your Impact.*

20 Xiaoyun Xu, Wenhong Xie, Manshu Deng, *Global Green Taxonomy Development, Alignment, and Implementation* (London: Climate Bonds Initiative, February 2022), https://www.climatebonds.net/files/reports/cbi_taxonomy_ukpact_2022_01f.pdf.

21 International Energy Agency, *ETP Clean Energy Technology Guide* (Paris: International Energy Agency, September 2023), https://www.iea.org/data-and-statistics/data-tools/etp-clean-energy-technology-guide.

22 International Energy Agency, *Tracking Clean Energy Progress 2023* (Paris: International Energy Agency, July 2023), https://www.iea.org/reports/tracking-clean-energy-progress-2023.

23 Institutional Investors Group on Climate Change, *Climate Investment Roadmap: A Tool to Help Investors Accelerate the Energy Transition Through Investment and Engagement* (London: Institutional Investors Group on Climate Change, July 2022), https://www.iigcc.org/resources/climate-investment-roadmap.

24 International Energy Agency, *ETP Clean Energy Technology Guide.*

25 European Commission, “EU Taxonomy Compass,” https://ec.europa.eu/sustainable-finance-taxonomy/taxonomy-compass.

26 Institutional Investors Group on Climate Change, *Climate Investment Roadmap.*

27 Andres Chang, Jeroen Scheepmaker, Oskar Krabbe, and Annemarie Kerkhof, *Setting 1.5°C-Aligned Science-Based Targets:Quick Start Guide for Electric Utilities* (London: CDP, June 2020), https://sciencebasedtargets.org/sectors/power.

28 Intergovernmental Panel on Climate Change, *Climate Change 2022: Impacts, Adaptation and Vulnerability* (Geneva: Intergovernmental Panel on Climate Change, 2022), Working Group II Contribution to Sixth Assessment Report, https://www.ipcc.ch/report/ar6/wg2/.

29 Max Schoenfisch and Amrita Dasgupta, “Grid-scale Storage,” *International Energy Agency*, July 11, 2023, https://www.iea.org/energy-system/electricity/grid-scale-storage.

30 “Potential impact is based on what the broad solution could achieve, assuming a standardized trajectory of success, whereas planned impact is based on what the specific company deploying the solution intends to achieve per a realistic analysis of its business model.” Source: Project Frame, *Pre-investment Considerations.*

31 A list of available decarbonization pathway is mentioned in the annex here: *Climate Bonds Initiative Sustainability-Linked Bond Database Methodology* (London: Climate Bonds Initiative, June 2023), https://www.climatebonds.net/files/files/CBI_Method_SLBD(1).pdf.

32 Institutional Investors Group on Climate Change, *Climate Investment Roadmap.*

33 Iris ten Have, Lucy Lyons, Torben Schreiter, and Francesco Pomponi, “From Code to Climate Action: Can We Quantify the Impact of Climate Software Solutions?” *Medium*, November 15, 2023, https://medium.com/extantia-capital/from-code-to-climate-action-can-we-quantify-the-impact-of-climate-software-solutions-5fd96340a28d.

34 Lori Collins with contributions from Umar Ashfaq, Turbold Baatarchuluu, Erica Downing, Tara Guelig, Jay Koh, and Linda-Eling Lee, *Investing in Climate Resilience: Unlocking a Growing Market of Adaptation Solutions* (New York: Global Adaptation & Resilience Investment Working Group, March 2024), https://img1.wsimg.com/blobby/go/66c2ce28-dc91-4dc1-a0e1-a47d9ecdc17d/downloads/GARI%202024%20-%20Investing%20in%20Climate%20Resilience%20-%20.pdf?ver=1710422174956.

35 Maximillian Kotz, Anders Levermann, Leonie Wenz, *The economic commitment of climate change.*

36 Collins with contributions from Ashfaq, Baatarchuluu, Downing, Guelig, Koh, and Lee, *Investing in Climate Resilience*; Kaminker, Herrera Estrada, Madaan, Manohar, Thye, and Weber, *Climate Resilience.*

37 Esther Sekyoung Choi, Eunkyung Jang and Valerie Laxton, “What It Takes to Attract Private Investment to Climate Adaptation,” *World Resources Institute* (commentary), May 10, 2023, https://www.wri.org/insights/private-sector-climate-adaptation-finance.

38 Choi, Jang and Laxton, “What It Takes to Attract Private Investment to Climate Adaptation.”

39 Barbara Buchner, Baysa Naran, Rajashree Padmanabhi, Sean Stout, Costanza Strinati, Dharshan Wignarajah, Gaoyi Miao, Jake Connolly and Nikita Marini, *Global Landscape of Climate Finance 2023* (San Francisco: Climate Policy Initiative, November 2023), https://www.climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2023/.

40 Buchner, Naran, Padmanabhi, Stout, Strinati, Wignarajah, Miao, Connolly and Marini, *Global Landscape of Climate Finance 2023.*

41 Kaminker, Herrera Estrada, Madaan, Manohar, Thye, and Weber, *Climate Resilience.*

42 Collins with contributions from Ashfaq, Baatarchuluu, Downing, Guelig, Koh, and Lee, *Investing in Climate Resilience.*

43 Collins with contributions from Ashfaq, Baatarchuluu, Downing, Guelig, Koh, and Lee, *Investing in Climate Resilience.*

44 Kaminker, Herrera Estrada, Madaan, Manohar, Thye, and Weber, *Climate Resilience.*

45 Intergovernmental Panel on Climate Change, *Climate Change 2022: Impacts, Adaptation and Vulnerability*; Collins with contributions from Ashfaq, Baatarchuluu, Downing, Guelig, Koh, and Lee, *Investing in Climate Resilience*; Chiara Trabacchi, Jay Koh, Serena Shi, and Tara Guelig, *Adaptation Solutions Taxonomy* (New York: Lightsmith Group, July 2020), https://lightsmithgp.com/wp-content/uploads/2020/09/asap-adaptation-solutions-taxonomy_july-28-2020_final.pdf.

46 UNEP DTU Partnership, Green Technology Center, *Taxonomy of Climate Change Adaptation Technology, A guidebook for countries conducting a Technology Needs Assessment for Adaptation,* https://tech-action.unepccc.org/wp-content/uploads/sites/2/2021/04/report-on-taxonomy-of-climate-change-adaptation-technology-including-factsheets-finalbrief-tna-adaptation-taxonomy.pdf.

47 Collins with contributions from Ashfaq, Baatarchuluu, Downing, Guelig, Koh, and Lee, *Investing in Climate Resilience.*

48 Buchner, Naran, Padmanabhi, Stout, Strinati, Wignarajah, Miao, Connolly and Marini, *Global Landscape of Climate Finance 2023.*

49 “Country Index,” Notre Dame Global Adaptation Initiative, https://gain.nd.edu/our-work/country-index/.

50 Intergovernmental Panel on Climate Change, *Climate Change 2022: Impacts, Adaptation and Vulnerability.*

51 *Climate Resilience Investments in Solutions Principles (CRISP)* (New York: Global Adaptation & Resilience Investment Working Group and Lightsmith Group), https://img1.wsimg.com/blobby/go/66c2ce28-dc91-4dc1-a0e1-a47d9ecdc17d/downloads/CRISP%202024%20-%20Climate%20Resilience%20Investments%20in.pdf?ver=1711122784102.

52 "Adaptation SME Accelerator Project (ASAP)," Lightsmith Group, https://lightsmithgp.com/asap/.

53 *Climate Resilience Investments in Solutions Principles (CRISP).*

54 "Adaptation SME Accelerator Project (ASAP), Adaptation Solution Taxonomy, July 2020," Lightsmith Group, https://lightsmithgp.com/wp-content/uploads/2020/09/asap-adaptation-solutions-taxonomy_july-28-2020_final.pdf.

55 "A Shared Logic for Managing Impacts on People and the Planet," Impact Frontiers, https://impactfrontiers.org/norms/five-dimensions-of-impact/.

56 Sasha Dichter, Tom Adams, and Alnoor Ebrahim, "The Power of Lean Data," *Stanford Social Innovation Review*, 2016, https://ssir.org/articles/entry/the_power_of_lean_data#:~:text=Most%20impact%20reporting%20focuses%20on,services%20that%20an%20enterprise%20provides.

57 Dichter, Adams, and Ebrahim, "The Power of Lean Data."

58 Emma Cox, Ashok Varma, and Elliott Cappell, "How Climate Adaptation Can Both Protect and Grow Your Business," *PwC Global Insights*, August 15, 2023, https://www.pwc.com/gx/en/issues/esg/how-climate-adaptation-can-both-protect-and-grow-your-business.html.

59 Andres Chang, Jeroen Scheepmaker, Oskar Krabbe, and Annemarie Kerkhof, *Setting 1.5°C-Aligned Science-Based Targets:Quick Start Guide for Electric Utilities* (London: CDP, June 2020), https://sciencebasedtargets.org/sectors/power.

60 International Energy Agency, *Net Zero by 2050 Data Explorer* (Paris: International Energy Agency, May 2021), https://www.iea.org/data-and-statistics/data-tools/net-zero-by-2050-data-explorer.

61 International Energy Agency, *Emissions Factors 2022*, (Paris: International Energy Agency, September 2022), https://www.iea.org/data-and-statistics/data-product/emissions-factors-2022.

62 International Energy Agency, *Emissions Factors 2022.*

63 Anderson, CM., Bicalho, T., Wallace, E., Letts, T., and Stevenson, M, Forest, *Land and Agriculture Science-Based Target-Setting Guidance* (Washington, DC: World Wildlife Fund, 2022), https://sciencebasedtargets.org/resources/files/SBTiFLAGGuidance.pdf.

64 Stephanie Roe, Charlotte Streck, Michael Obersteiner, Stefan Frank, Bronson Griscom, Laurent Drouet, Oliver Fricko, Mykola Gusti, Nancy Harris, Tomoko Hasegawa, Zeke Hausfather, Petr Havlík, Jo House, Gert-Jan Nabuurs, Alexander Popp, María José Sanz Sánchez, Jonathan Sanderman, Pete Smith, Elke Stehfest and Deborah Lawrence, "Contribution of the Land Sector to a 1.5°C World," *Nature Climate Change* 9 (2019): 817-828, https://doi.org/10.1038/s41558-019-0591-9. The colors in the chart b) correspond to the various mitigation measures for the land sector that are all detailed in Roe et al, 2019.

65 Roe et al, "Contribution of the Land Sector to a 1.5°C World," *Nature Climate Change* 9 (2019).

66 Andres Chang, Jeroen Scheepmaker, Oskar Krabbe, and Annemarie Kerkhof, *Setting 1.5°C-Aligned Science-Based Targets:Quick Start Guide for Electric Utilities* (London: CDP, June 2020), https://sciencebasedtargets.org/sectors/power.

67 International Energy Agency, Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach, 2023 update (Paris: International Energy Agency, 2023), https://iea.blob.core.windows.net/assets/9a698da4-4002-4e53-8ef3-631d8971bf84/NetZeroRoadmap_AGlobalPathwaytoKeepthe1.5CGoalinReach-2023Update.pdf.

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