

ADAPT OR COLLAPSE

EPISODE 02

**Renewable assets:
turning avoided emissions
into investment value**

Table of contents

0

INTRODUCTION

1

BEYOND GHG FOOTPRINT: AVOIDED EMISSIONS, ENABLERS AND PAIN POINTS

2

CASE STUDY OF PHOTOVOLTAICS ENERGY PRODUCTION:
ENERGY PRODUCTION TRAJECTORIES AND AVOIDED EMISSIONS

3

CALCULATING AVOIDED EMISSIONS GENERATED BY RENEWABLE ASSETS:
A SOLUTION TO MANAGE CLIMATE RISKS FOR INVESTORS
AND FOSTER RESILIENCE FOR OPERATORS

4

AUTHORS AND CONTRIBUTORS

5

SOURCES

Introduction

Robust impact measurement of climate solutions is key to transition to a low-carbon economy. To direct capital effectively, stakeholders need assessment methodologies that are both standardized and robust, enabling clearer comparisons across solutions and greater confidence in investment decisions.

In this context, quantifying avoided emissions becomes a critical tool for steering capital toward high-impact investments. Beyond measuring direct performance, it provides a framework for understanding the broader systemic value of low-carbon solutions, helping investors and companies identify where financing can generate the greatest decarbonization effect and foster resilience.

Avoided emissions can be particularly powerful in illustrating the climate value of renewable energy assets. By quantifying, for example, the emissions avoided through photovoltaic electricity generation compared to conventional energy sources, these approaches make the contribution of such assets more tangible for investors and operators, especially in a context of significant capital allocation. They also reinforce an essential dimension: in a world exposed to physical and transition risks, renewable assets, grounded in local, physical production, avoided emissions play a key role in strengthening energy resilience while adapting to evolving needs and reducing dependence on fossil fuels.

However, for avoided emissions analysis to play this role credibly, it must rely on rigorous and transparent guidelines. Strong methodological foundations are necessary not only to improve consistency and comparability, but also to reduce confusion, prevent overstated climate claims, and support more reliable reporting for both financial and strategic decision-making.

A central question emerges: how can investors and companies identify the renewable energy assets that are both resilient and offer the highest potential for impact through avoided emissions, and therefore present the strongest case for both investment and energy resilience?

1. Beyond GHG Footprint: Avoided Emissions, enablers and pain points

Avoided emissions are increasingly used as a forward-looking indicator of climate value creation because they help reveal which products, services, and technologies enable decarbonization beyond a company's own footprint. For investors, this makes them particularly relevant: they can inform origination, diligence, portfolio construction, stewardship, and fundraising by highlighting where capital may drive the greatest real-economy emissions impact. However, this potential only holds if avoided-emissions claims are grounded in methodologies that are transparent, decision-useful, and sufficiently harmonized across market participants.

For investors, the core challenge is not whether avoided emissions are strategically relevant, but whether the underlying claims are credible enough to support capital allocation decisions. Estimating avoided emissions requires a comparative, life-cycle-based assessment between a low-carbon solution and a realistic reference scenario. That means evaluating not only the emissions profile of the solution itself, but also the emissions trajectory of the counterfactual it is expected to displace, including upstream production, use-phase performance, end-of-life treatment, and expected market evolution.

Small differences in assumptions, such as grid mix, utilization rates, product lifetime, substitution rates, or regulatory context, can materially change the result. This complexity is compounded by the coexistence of multiple frameworks. In practice, methodological differences in scope, time horizon, aggregation logic, and the treatment of expected versus realized impact still limit comparability across companies, funds, and asset classes. For investors, this is a practical problem: a metric intended to strengthen diligence and portfolio steering can instead introduce noise into decision-making and weaken the reliability of portfolio-level reporting.

There is also a credibility challenge. When avoided emissions are framed as a marketing narrative rather than as a rigorously bounded analytical metric, they can be confused with the broader "Scope 4" debate and perceived

as a substitute for standard GHG accounting. Yet their real value lies elsewhere: they help investors identify transition-enabling business models whose contribution to decarbonization may be obscured by conventional footprint metrics alone. Without methodological discipline, avoided emissions risk remaining an attractive story rather than a robust input into investment decisions.

Three guiding pillars underpin any rigorous avoided emissions claim:

1. METHODOLOGY

Converge on shared methodological principles: investors should rely on frameworks that use clear eligibility criteria, transparent reference scenarios, life-cycle-based comparison, and explicit treatment of uncertainty, attribution, and rebound effects.

Avoided emissions should be treated as an impact indicator, distinct from traditional emission reductions attributable to an organization. Their interpretation depends heavily on the chosen baseline, system boundaries, and forward-looking market assumptions. Clarifying this boundary prevents avoided emissions from being interpreted as conventional carbon-accounting reductions.

Stress-test the intentionality and treat avoided emissions as a diligence tool, not a headline claim: during screening and due diligence, use the metric to test whether a company's solution credibly displaces a higher-emitting alternative at scale and under realistic market assumptions. The purpose of this methodological discipline is not only to improve reporting quality. It is to make avoided emissions decision-useful for investors.

2. DATA

Make data readiness an investment issue from day one: investors should assess early whether the company can generate the operational, product-performance, and market data needed to support avoided-emissions analysis, rather than treating the metric as a late-stage reporting exercise.

Embed avoided-emissions data points into post-deal governance: product efficiency, energy use, utilization rates, replacement logic, and baseline assumptions should be integrated into 100-day plans, ESG roadmaps, or value-creation plans so that evidence improves over the holding period.

Use standardized external datasets and harmonized assumptions where possible: reference scenarios based on grid mixes, heating systems, transport modes, or other market benchmarks should rely on recognized public sources and consistent portfolio rules to improve comparability across assets and over time.

Default to conservative assumptions and transparent limitation statements: where data is incomplete, investors should favor conservative proxies, document uncertainty explicitly, and use third-party challenge where relevant so that avoided-emissions claims remain credible with investment committees and LPs.

3. GOVERNANCE

Separate expected impact from validated performance: early-stage or pre-deployment estimates can be decision-useful, but they should be clearly distinguished from calculations supported by observed customer uptake, operational data, or updated life-cycle evidence. This distinction is essential for internal governance as well as for credible communication with LPs.

Use collaboration to strengthen legitimacy, not to replace scrutiny: engagement with industry initiatives, technical experts, and other investors can improve comparability and align practice with emerging standards, but firm-level governance remains essential. External alignment should support a more disciplined challenge process, not provide a shortcut around it.

Define challenge points across the investment lifecycle: investors should not rely on a single avoided emissions estimate from entry to exit. Instead, assumptions should be re-examined at clear milestones, screening, due diligence, post-deal value creation, annual review, and exit preparation, so that the metric reflects the company's evolving operating reality.

These methodological principles become meaningful, and their consequences visible, when applied to a real asset operating in a specific geography, under specific climate conditions, and within a specific energy system. The following case study also aims at demonstrating how Altitude's data can be used to strengthen avoided emissions calculation and leverage resilient investment in renewable energy assets.

2. Photovoltaic Energy Case Study: Production Pathways and Avoided Emissions

LOCATION IS THE STARTING POINT OF AVOIDED EMISSIONS CALCULATION FOR RENEWABLE ENERGY ASSETS

For a renewable energy asset, the avoided emissions calculation does not begin with the asset itself but with the grid it connects to. A solar PV installation in northern France will be used as a case study.

The asset is operating on one of Europe's least-carbon intensive grids and therefore will generate substantially lower avoided emissions per MWh than an equivalent installation in a coal-dependent system. The region of the case study is characterized by moderate solar irradiation, a predominantly nuclear and renewable electricity mix, and a well-developed transmission infrastructure. This context makes rigorous, localized baseline construction essential. Avoided emissions must be calculated against a realistic counterfactual: not an abstract global average, but the actual marginal generation mix that the asset is displacing in its specific market and timeframe. Since solar power generates no direct greenhouse gas emissions during operation, this comparison must be conducted through a full lifecycle assessment (LCA), incorporating the emissions embedded in manufacturing, installation, maintenance, and decommissioning.

HOW TO USE ALTITUDE TO EXTRAPOLATE THE ASSET'S PRODUCTION TRAJECTORY?

Beyond the baseline question, investors need to understand how the asset's physical production will evolve over time, because avoided emissions are ultimately a function of energy output. By combining local grid baselines, production trajectories, climate scenarios, and physical risk exposure, the analysis shows how investors can assess not only the decarbonization potential of a renewable asset, but also the robustness of that potential over time.

Altitude's production resilience analysis addresses this directly. For the northwestern France solar asset, three

climate scenarios : IPCC SSP1-2.6 (a low-emissions pathway consistent with strong mitigation), SSP2-4.5 (an intermediate pathway), and SSP5-8.5 (a high-emissions, business-as-usual scenario), were modelled to assess how solar irradiation and local meteorological conditions are expected to evolve through 2050. The results, expressed as percentage changes relative to 2025 production levels, are summarized below.

Production is expected to be stable to positive across all three scenarios, including the high-emissions one. This can be explained by shifting cloud patterns and increased solar irradiation in this region under warming scenarios.

The P90 pessimistic estimates, capturing a downside production scenario, show a more differentiated picture, with some months under SSP5-8.5 registering small negative deviations in winter. For investors, this range between P50 and P90 estimates defines the envelope of production uncertainty that should be reflected in avoided emissions projections, rather than relying on a single central estimate.

CONNECTING PRODUCTION RESILIENCE TO AVOIDED EMISSIONS

These production figures are the quantitative foundation for dynamic avoided emissions modelling. The annual avoided emissions of a renewable asset can be expressed as the product of (i) the electricity generated over the period, (ii) the emission factor of the marginal energy displaced, and (iii) a lifecycle adjustment accounting for the asset's own embedded emissions.

Altitude's production modelling directly informs the first component, providing scenario-conditioned output trajectories that can be updated as the asset ages and as climate conditions shift. But the second component (the marginal grid emission factor) is equally dynamic. France's grid is among the lowest-carbon in Europe (50-60 gCO₂e/kWh), and it potentially could be decarbonizing further, as

nuclear capacity is renewed and offshore wind scales. This means the baseline against which the asset's production is measured will progressively shrink over the holding period: even if the asset generates the same or slightly more electricity in 2045 than in 2025, the emissions it avoids per MWh will be lower, because the grid it is displacing will itself be cleaner. Ignoring this compression effect leads to a structural overstatement of long-term avoided emissions, precisely the kind of methodological weakness that Part 1 of this article cautions against.

These data inputs must then be compared to a reference scenario (illustrated in the figure below) to assess the net avoided emissions enabled by solar generation relative to conventional alternatives. Altitude Advisory's teams consolidate these inputs into strategic avoided emissions calculations, applying the methodological caveats outlined in Part 1.

PHYSICAL RISKS: THE OTHER DIMENSION OF RESILIENCE

Production modelling captures the expected evolution of output under different climate futures, but it does not fully account for acute physical risks that can interrupt or permanently impair an asset's operations. For the French solar asset, Altitude's physical risk assessment identifies flood as the dominant concern, with a high-risk classification under SSP5-8.5 and an Average Annual Loss (AAL) in property damage rising from approximately 3.5% of asset value in 2026 to 4.3% by 2050. Business interruption losses linked to flood follow a similar upward trajectory, reaching approximately 3.6% of related revenues by mid-century.

Soil erosion and clay shrink-swell are assessed at medium risk, with potential structural consequences for panel foundations and racking systems, but without quantified AAL in the current framework.

Physical risks affect the durability and predictability of the asset's climate contribution. An investor allocating capital on the basis of the asset's long-term avoided emissions potential needs to factor in the probability that flood damage, erosion, or foundation failure could halt that contribution prematurely, require significant CAPEX to restore, or increase insurance costs in ways that alter the economics of the investment.

WHAT THIS MEANS FOR INVESTORS

Altitude's dual analytical approach, combining scenario-conditioned production modelling with granular physical risk assessment, provides investors with the inputs

needed to build dynamic, defensible avoided emissions estimates across the investment lifecycle. Rather than treating avoided emissions as a fixed attribute of an asset, this framework treats them as a living metric: one that responds to climate science, operational reality, and market evolution, and that can therefore inform capital allocation, stewardship decisions, and long-term performance reporting with genuine rigor.

To understand why this matters in practice, one can consider two solar assets with comparable installed capacity and similar entry-level avoided emissions. The first carries low physical risk and a stable production trajectory. The second faces a rising flood AAL (exceeding 4% of asset value annually by 2050) and meaningful production downside under pessimistic scenarios. A static avoided emissions calculation treats them as broadly equivalent. A dynamic one does not: the second asset's climate contribution will erode over time, with direct consequences for CAPEX, revenue stability, and LP reporting. In a context of rising climate volatility and expanding carbon pricing, the confidence in avoided emissions metrics enabled by this methodology can be a source of investment value.

ILLUSTRATIVE RESULT: WHY ASSUMPTIONS MATTER

For illustration, consider a 5 MW solar PV asset in northern France producing 5.5 GWh in 2025. Using a net avoided factor of 20 gCO₂e/kWh, based on a French grid factor of 55 gCO₂e/kWh minus 35 gCO₂e/kWh of PV lifecycle emissions (source : ADEME Data base), the asset generates around 110 tCO₂e of avoided emissions in 2025.

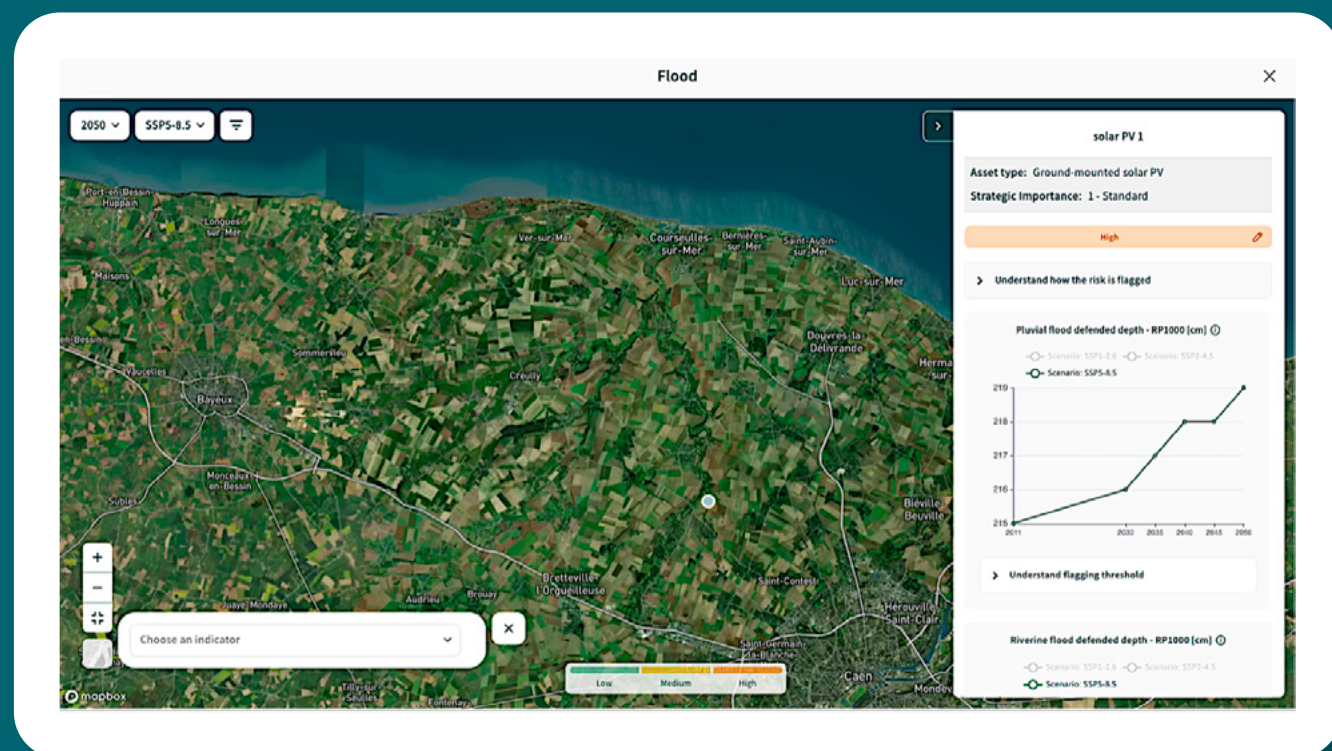
A static calculation would keep this 5.5 GWh production level unchanged over the holding period, implying a flat avoided-emissions profile of around 110 tCO₂e per year. Altitude adds value by replacing this fixed assumption with scenario-based production trajectories. Under a P50* scenario showing a +2.1% increase by 2040, output would rise to 5.6 GWh and avoided emissions to around 112 tCO₂e. Under a downside P90 scenario showing a 3% production loss, output would fall to 5.3 GWh and avoided emissions to around 106 tCO₂e.

The example shows that the avoided-emissions result is not driven only by the emission factor. It also depends on whether the asset can maintain or increase production under future climate conditions. This is where Altitude materially strengthens the analysis: it translates climate scenarios into production trajectories, which directly change the avoided emissions generated over time and help investors distinguish between assets with similar starting points but different long-term impact profiles.

* P50 and P90 are statistical probability-of-exceedance metrics (often called percentile estimates) used to measure risk, uncertainty, and expected output.

The figures below are based on a real photovoltaic asset located in northern France. They illustrate how Altitude translates asset-level climate data into forward-looking production estimates, under different climate scenarios. Rather than relying on generic solar assumptions, the analysis is grounded in the asset's actual location, local meteorological conditions, and exposure to evolving physical risks.

Figure 1 : Geographical view of the Solar PV Asset located in northern France



Annual production evolution (P50 median estimate, vs. 2025)

	2030	2035	2040	2045	2050
SSP1-2.6	+0.3%	+0.9%	+1.2%	+2.1%	+2.2%
SSP2-4.5	+0%	+0%	+0.3%	+0.8%	+0.7%
SSP5-8.5	+0.4%	+0.5%	+0.6%	+0.9%	+1.1%

Source: Altitude

Projected annual production evolution of a real photovoltaic asset in northern France under each SSP scenario, P50 median estimate, compared with 2025.

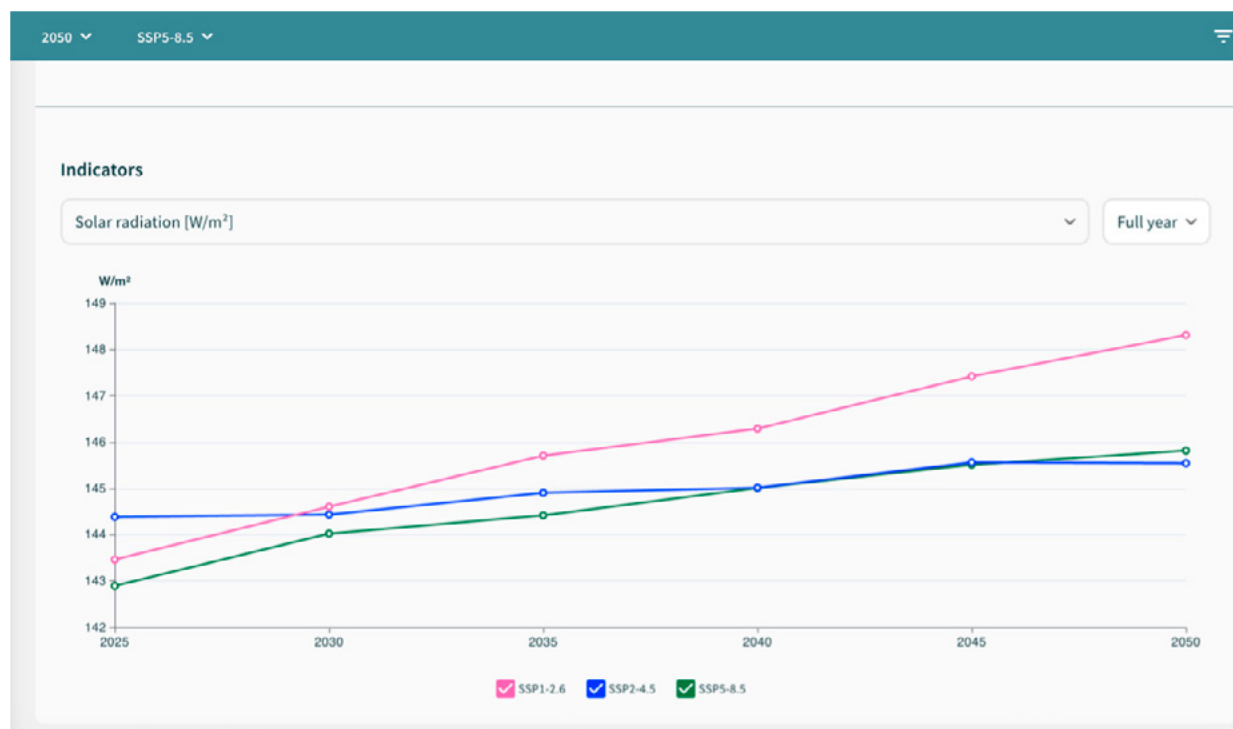


Figure 2 : Evolution of the solar radiation (W/m2) under each SSP scenario (vs. 2025) projected on Altitude

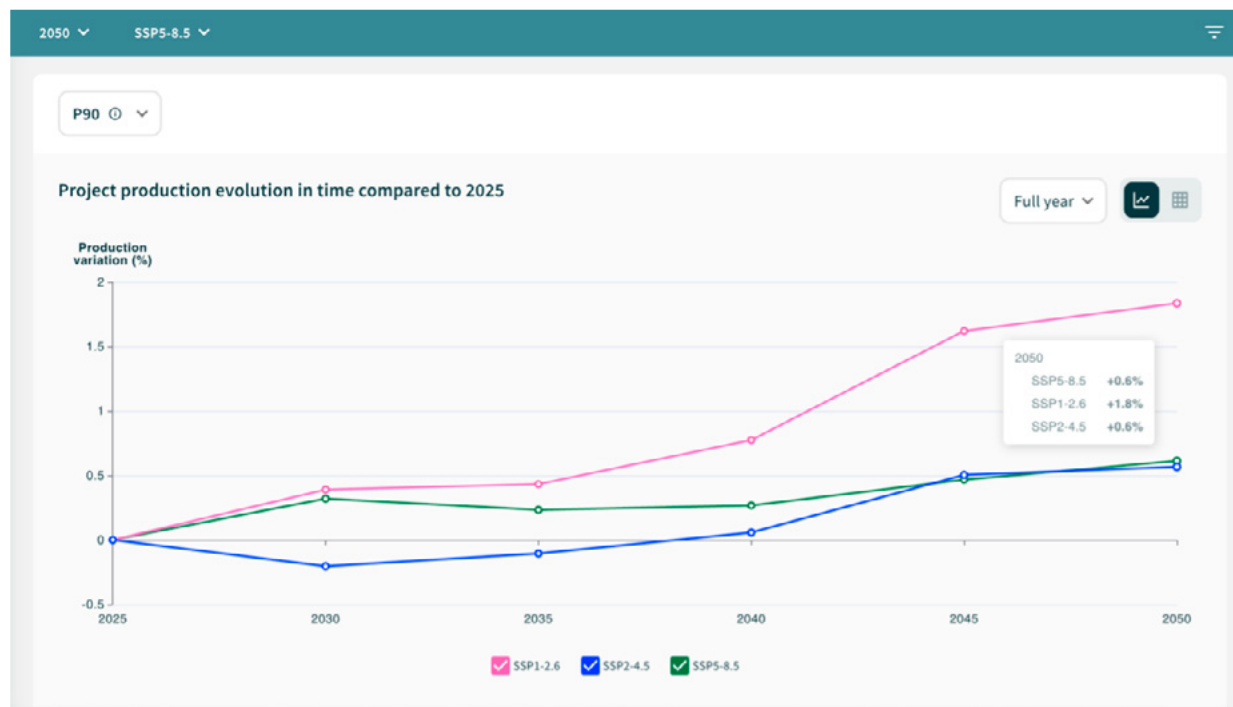


Figure 3 : Altitude screen shot of the annual production evolution under each SSP scenario (P90 median estimate, vs. 2025)

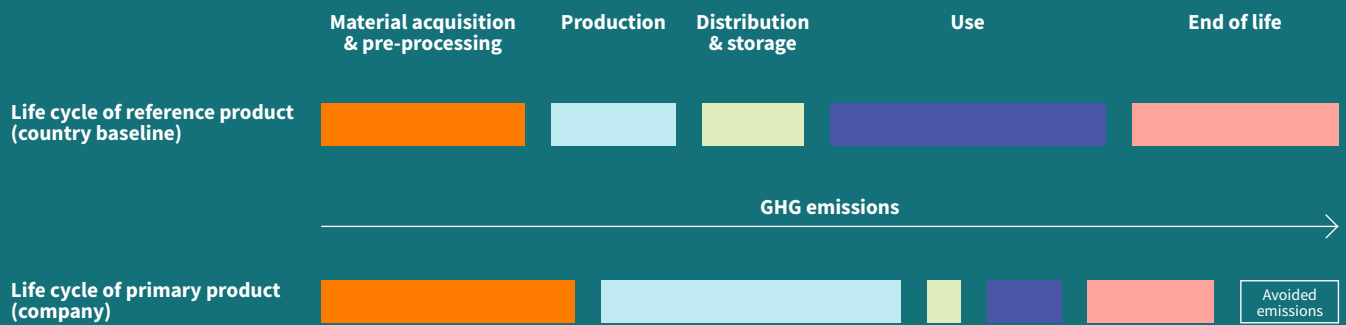


Figure 4 : Lifecycle comparison showing how avoided emissions are derived by comparing the full lifecycle emissions of a low-carbon solution with those of a realistic reference alternative.

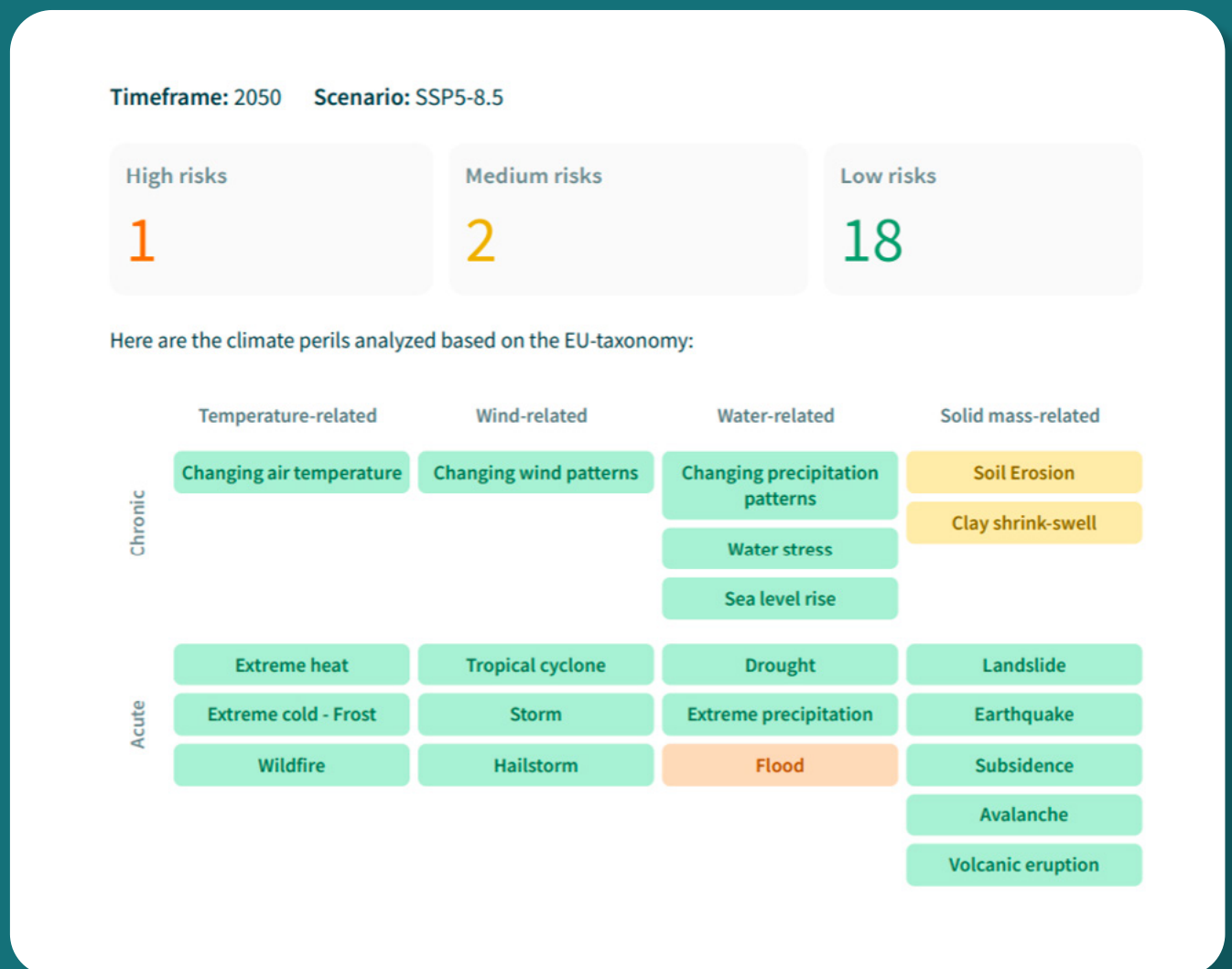


Figure 5 : Altitude dashboard illustrating how asset-level chronic and acute physical risk exposure.

Taken together, these figures show how a real photovoltaic asset in northern France can be assessed through a forward-looking resilience lens. This combination is central to dynamic avoided-emissions analysis: it helps determine not only how much low-carbon electricity the asset may generate, but also how robust that generation is under future climate conditions. For investors, this makes avoided emissions a more decision-useful metric, linking climate impact to production reliability, physical resilience, and long-term asset value.

3. Calculating Avoided Emissions generated by Renewable Assets: a solution to manage climate risks for investors and foster resilience for operators

According to IRENA's 1.5°C scenario, renewables are projected to grow from 16% of the global energy mix in 2020 to 77% by 2050, requiring annual deployment of around 1,000 GW between 2023 and 2050. Beyond decarbonization, this transformation elevates energy from a sustainability topic to a core resilience challenge: ensuring that energy systems remain reliable, predictable, and robust under increasing physical and climate-related disruptions.

Clean energy plays a critical role in building a more resilient future in uncertain times. Recent geopolitical instability has exposed structural dependencies on global fossil fuel supply chains, reinforcing the importance of energy security as a core dimension of resilience. As highlighted by the World Economic Forum's Energy Trilemma, balancing sustainability, affordability, and security has become increasingly complex, particularly in a context of volatility and fragmentation of global markets. While fossil fuels have traditionally been perceived as stable sources of energy, their pricing remains highly vulnerable to external shocks such as geopolitical tensions, regulatory changes, and supply bottlenecks. In contrast, renewable energy sources, being domestically produced and not reliant on fuel inputs, contribute to reducing exposure to such disruptions while enhancing long-term price stability.

In this context, investing in companies and assets with strong renewable energy portfolios is not only a climate-aligned decision but also a strategic resilience lever.

At the portfolio level, integrating these dimensions enables investors to not only maximize climate impact but also strengthen resilience to transition and physical risks. As carbon pricing mechanisms expand and climate volatility increases, allocating capital based on both avoided emissions and the robustness of energy production becomes a forward-looking strategy to manage financial

performance and long-term sustainability.

More broadly, this transition also creates the conditions for scaling energy resilience projects, at a time when traditional approaches centered solely on carbon pricing have revealed their limits. Leveraging avoided emissions as a capital allocation signal can help redirect investment toward assets that strengthen both climate impact and system robustness, potentially addressing the shortcomings of past initiatives that struggled to gain traction at scale in Europe (e.g. Carbon, photovoltaics made in France). Ultimately, this underscores the deep interconnection between energy resilience and geopolitical stability, positioning resilient energy systems as a cornerstone of long-term economic and strategic security.

Overall, avoided emissions are a key metric for investors to appraise the full climate impact of a company / asset. The theory behind AE is extremely simple at the end (it's a delta analysis). However, a "fair and meaningful" assessment of avoided emissions, one that makes sense, may be extremely complex in practice. It's important to be aware of the pitfalls, anticipate these, and deploy a set of "tips & tricks" to ensure these are accounted for. This allows a more representative, holistic and balanced view in terms of impact, and the business case to create value in a context of the low carbon transition.

Authors and contributors

STEFANO BONELLI

SENIOR EXPERT AT ALTITUDE ADVISORY

Stefano is a senior expert at AXA Climate, with >20 years of experience in climate change and Low Carbon Transition. Before joining AXA, he was a partner at ERM. His experience includes carbon inventories, net-zero strategy, climate change mitigation, adaptation & risk, carbon pricing and MACC, as well as broader sustainability advisory. He has worked with a large number of companies to define their climate change initiatives. Main sectors of experience include Finance, Food & Beverages, Services (including consulting and maintenance), Real Estate, Manufacturing, Healthcare, Retail, Power, Infrastructure. , Stefano has conducted more than 200 field assignments across 25+ countries.

ELISE DUPUCH

CONSULTANT AT ALTITUDE ADVISORY

Elise is a consultant at AXA Climate, specializing in low-carbon transition strategies. At AXA Climate, she supports both corporates and investors in their decarbonization pathways, from carbon footprinting to action plan development and definition of Net Zero trajectories. She is trained in carbon accounting methodologies (GHG Protocol, CDP, SBTi, avoided emissions, NZI, ACT Evaluation) and in the design and monitoring of decarbonization plans for economic and social actors. A graduate of ESCP's Master in Management program with a specialization in Sustainability, "Rethinking Business Models," Elise also holds a Philosophy degree from Paris Nanterre (2024).

GUSTAVE ZANINI

SENIOR CONSULTANT AT ALTITUDE ADVISORY

Gustave is a Senior Consultant dedicated to the Low Carbon transition at AXA Climate. He has conducted more than 30 missions dedicated to climate finance which have allowed him to develop a strong sectoral expertise, especially in the real estate and energy sectors. He also specialized in the alignment of investment and financing portfolios to climate scenarios (SBT framework and net-zero alliances). During his previous experiences, Gustave worked at EcoAct, an international climate consultancy firm and OC&C, a strategy consulting firm based in Hong Kong, where he grew up. A graduate of Sciences Po Strasbourg with a Master's degree in Corporate Strategy and Finance, Gustave has built his professional career around Sustainable Finance.

ANAIS LORAND

HEAD OF CLIMATE & BIODIVERSITY CONTENT
AT ALTITUDE ADVISORY

Anaïs Lorand is Head of Climate & Biodiversity Content at Altitude, where she leads the development of the analytical content available on the Altitude platform. She supports private equity and infrastructure funds, as well as corporates, in assessing and managing their exposure to physical, biodiversity, and transition climate risks, with a particular focus on adaptation. Before joining Altitude, Anaïs worked as an economist at the Banque de France (IEDOM), contributing to macroeconomic and territorial analysis. She holds an economics degree from Université Paris-Dauphine.

Sources

WBCSD, Guidance on Avoided Emissions v2.0 (2025) :

<https://www.wbcsd.org/resources/guidance-on-avoided-emissions-helping-business-drive-innovations-and-scale-solutions-toward-net-zero>

WBCSD — Avoided Emissions hub (main page) :

<https://www.wbcsd.org/actions/avoided-emissions/>

Project Frame + Prime Coalition + WBCSD + ICF

— Avoided Emissions & Climate Investing: A Guide for Investors and Businesses (2025) :

<https://www.wbcsd.org/resources/avoided-emissions-climate-investing-a-guide-for-investors-and-businesses/>

Prime Coalition — Announcement & Access to the Investor Guide:

<https://www.primecoalition.org/press/guide-for-assessing-avoided-emissions>

GHG Protocol, Estimating and Reporting Avoided Emissions (2021) :

<https://ghgprotocol.org/estimating-and-reporting-avoided-emissions>

Ceres — Investing in the Future: Unlocking Value Through Avoided Emissions (August 2024) :

<https://www.ceres.org/resources/reports/investing-in-the-future-unlocking-value-through-avoided-emissions>

World Economic Forum: Why clean energy is key to building more resilient future in uncertain times :

<https://www.weforum.org/stories/2025/04/clean-energy-resilience-uncertain-times/>

Disclaimer

This document is for informational purposes only and does not constitute investment research or financial analysis relating to transactions in financial instruments as per MIF Directive (2014/65/ EU), nor does it constitute on the part of AXA Climate an offer to buy or sell any investments, products or services, and should not be considered as solicitation or investment, legal or tax advice, a recommendation for an investment strategy or a personalised recommendation to buy or sell securities. Due to its simplification, this document is partial, and opinions, estimates, and forecasts herein are subjective and subject to change without notice. There is no guarantee that forecasts made will come to pass. Data, figures, declarations, analyses, predictions, and other information in this document are provided based on our state of knowledge at the time of creation of this document. While every care is taken, no representation or warranty (including liability towards third parties), express or implied, is made regarding the accuracy, reliability, or completeness of the information contained herein. Reliance upon information in this material is at the sole discretion of the recipient. This material does not contain sufficient information to support an investment decision. Issued in France by AXA Climate, registered with the Trade and Companies Registry of Paris under the number B 493 363 378, registered as an insurance intermediary at the French single register of insurance, banking, and finance intermediaries under the number 07029015 (www.orias.fr) and whose registered office is at 14-16 Boulevard Poissonnière, 75009, Paris – France.

Visit our website

🖱 www.AXA-altitude.com

And our LinkedIn page

in [AXA Altitude](#)

Contact us if you have any inquiry at

altitude@axaclimate.com