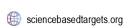


# SBTi CORPORATE NET-ZERO STANDARD VERSION 2.0 – PATHWAYS APPENDIX

Draft for Second Public Consultation
November 2025









# **ABOUT SBTi**

The Science Based Targets initiative (SBTi) is a corporate climate action organization that enables companies and financial institutions worldwide to play their part in combating the climate crisis.

We develop standards, tools and guidance which allow companies to set greenhouse gas (GHG) emissions reductions targets in line with what is needed to keep global heating below catastrophic levels and reach net-zero by 2050 at latest.

The SBTi is incorporated as a UK charity, with a subsidiary SBTi Services Limited, which hosts our target validation services. Partner organizations who facilitated SBTi's growth and development are CDP, the United Nations Global Compact, the We Mean Business Coalition, the World Resources Institute (WRI), and the World Wide Fund for Nature (WWF).

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# **DOCUMENT HISTORY**

Version	Release date	Updates on earlier version
1.0 Pathways to Net-Zero	October 2021	
2.0 Pathways to Net-Zero	Draft shared internally with SBTi May 31 2024	<ul> <li>Updated principles of scenario selection</li> <li>Updated set of scenarios included in cross-sector pathway</li> <li>Updated quantitative synthesis methods used to derive cross-sector pathway from constituent scenarios</li> <li>Updated benchmarks for target-setting using the Absolute Contraction Approach</li> </ul>
2.1 Pathways to Net-Zero	November 2024	Disaggregation of residual emissions at the sector level
2.2 Pathways to Net-Zero	January 2025	Updates based on TC feedback
2.3 SBTi Pathways	October 2025	<ul> <li>Disaggregation of cross sector pathway at the activity level</li> <li>Consolidation of SBTi sector pathways into a single framework</li> </ul>

# INTRODUCTION

This document describes the activity-based pathways that underpin all target-setting methods under the Corporate Net-Zero Standard (CNZS) v2.2. These pathways describe the decarbonization trajectory of the economy, or of specific activities within it, required to meet a given temperature goal. They are expressed through quantitative trajectories of relevant decarbonization metrics, such as greenhouse gas (GHG) emissions, the share of low-carbon heat, or other activity-specific indicators, and capture not only the required magnitude of change but also the pace of decarbonization consistent with global temperature outcomes.

The activity-based pathways replace the former SBTi cross-sector pathways developed for the first public consultation draft of CNZS v2.1 (SBTi, 2025), with a suite of disaggregated pathways tailored to emission- and non-emission-intensive activities. This evolution enables more granular, actionable, and sector-relevant target setting, ensuring stronger alignment between corporate targets and the underlying physical and technological drivers of decarbonization.

The technical methods for translating these pathways into targets are described separately in the Methods and Metrics Appendix (SBTi, 2025).

The activity-based pathways apply to two categories of activities, differentiated by their emission profile and activity type:

- Emission-intensive activities are those that generate high levels of greenhouse gas emissions, including CO<sub>2</sub> and other potent non-CO<sub>2</sub> gases such as methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O). This category covers energy-intensive sectors, including cement, steel, chemicals, maritime, and aviation, as well as FLAG activities, which generate substantial non-CO<sub>2</sub> emissions from livestock and fertilizer use.
- Non-emission-intensive activities comprise lower-intensity direct emissions and include owned transportation, low- and medium-temperature heating processes<sup>1</sup> (e.g. industrial ovens, dryers, space or water heating), and fugitive emissions from equipment operation and maintenance. These sources are typically less energy-intensive than the heavy industrial processes, but they represent a substantial portion of many companies' direct emissions.

Pathways are selected from up-to-date, publicly available mitigation scenarios through a process that combines scientific evidence, reflecting sustainability, feasibility, and social constraints on mitigation options, with principled expert judgment. For each activity, pathway selection follows the scenario-filtering framework described below.

<sup>&</sup>lt;sup>1</sup> Low and medium-temperature heat generally refers to heat below 400 °C, which can often be decarbonized through electrification (e.g. heat pumps, electric boilers) or renewable heat sources. Activities where most heat demand falls within this temperature range, are classified as light industrial processes (IEA, 2023).

# PATHWAY SELECTION PROCESS

Pathways relevant to each activity type are available from a range of modelling frameworks, capturing diverse technological, economic, and socio-political assumptions, and producing an ensemble of possible futures. To develop credible pathways for target-setting, scenario selection follows six guiding principles that address ambition, responsibility, scientific rigour, actionability, robustness, and transparency. These principles, adapted from the Principles for the Development of SBTi Standards and Technical Foundations (SBTi forthcoming), provide flexibility to integrate emerging science while maintaining coherence with SBTi's values and mission (Table 1).

Building on these principles, quantitative filters, presented in Table 2, are applied across a wide range of scenarios, establishing upper limits on key modelling parameters. These thresholds are designed to limit the reliance on options that could entail socio-economic or ecosystem trade-offs, whether due to their interaction with planetary boundaries, their novelty or technological immaturity, or their limited scalability, while ensuring that pathways remain consistent with the actions required to stay within the 1.5 °C-aligned carbon budget and achieve global net zero by 2050.

### Filtered scenario set

To identify relevant scenarios for inclusion in the pathway development, we first reviewed institutional scenarios that are widely cited in the grey literature. Then we consulted with internal and external advisory groups to identify credible scenarios. We reviewed each scenario for adherence to the principles and filtering criteria described in Table 1.

Upon applying these principles-driven criteria to the full suite of scenarios, including the AR6 Category C1 ensemble and institutional scenarios, 20 were identified as meeting all thresholds, including the International Energy Agency's Net Zero by 2050 Scenario (IEA NZE, 2023). These scenarios, originating primarily from three model families, constitute the filtered ensemble, which defines the 1.5 °C-aligned envelope used for activity-based pathway development<sup>2</sup>.

The 'cross-sector pathway' in CNZS v2.1 was defined as the median of both aggregate and individual greenhouse gas trajectories across the 20 scenarios (SBTi, 2025a). In CNZS v2.2, the filtered scenario ensemble continues to provide the 1.5 °C envelope within which activity-based pathways are developed, replacing the single 'cross-sector median' with pathways differentiated by activity type and emission profile.

SBTi Corporate Net-Zero Standard Version 2.0: Pathways Appendix

<sup>&</sup>lt;sup>2</sup> See the CNZS V2.1 cross sector pathways Appendix, for the complete list of filtered scenarios (SBTi, 2025).

Table 1. Principles for the Development of SBTi Standards and Technical Foundations, and application for scenario selection.

Principle	Description	Assessment Criteria in Scenario Selection
Ambitious	Requires that entities decarbonise in line with the ambition to limit warming to 1.5°C with no or limited overshoot.	This principle implies that only scenarios aligned with a 1.5 °C target are included in developing credible activity-based pathways for target setting. More specifically, scenarios should remain within a low or no-overshoot range and also achieve net-zero by 2050 at the latest.
Responsible	Requires a transition to net zero that emphasises the low risk of adverse outcomes for broader sustainability goals.	This principle implies that pathway development only includes scenarios that stay within the sustainability limits of bioenergy in primary energy consumption in any year before and by 2050, reflecting current scientific consensus on the amount of bioenergy that can be sustainably produced while minimizing detrimental impacts on food production, livelihoods, and biodiversity (Frank et al., 2021).
Rigorous	Use the best available science from authoritative sources, such as the IPCC, the International Energy Agency, and similar or related sources, as well as best practices in climate target setting and climate mitigation during pathway development.	This principle implies that scenario selection is based on the credibility of the modelling institution and the vetting process applied to the scenario's framework and underlying assumptions.
Transparent	All relevant information is publicly available and transparently documented, including explicit statements of assumptions and calculation procedures.	This principle implies that only scenarios that provide publicly available documentation of scenario methodology and underlying assumptions are included in the pathway development.
Robust	Requires technical foundations to be internally consistent and exhibit coherent logic.	This principle implies that pathway development only includes scenarios that limit reliance on land-based removals as a mitigation option for fossil and industrial processes.
Actionable	Requires all technical foundations to be practical, enabling the design and implementation of effective solutions that lead to measurable improvements in climate performance.	This principle implies that pathways should be supported by climate mitigation scenarios that rest on credible narratives on how key socio-economic factors, such as population, economic growth, and rate of technological development, may evolve. This restriction reflects broad concern over the plausibility and feasibility of large-scale carbon storage deployment along biophysical, infrastructural, and market-related lines (van de Ven et al., 2023) <sup>3</sup> .Pathway development only includes scenarios that remain within plausible limits for cumulative CCS deployment and early-stage novel CDR uptake, reflecting biophysical, infrastructural, and market feasibility constraints (Smith et al., 2023).

<sup>&</sup>lt;sup>3</sup> This reflects a simplified assumption that 75% of the volume of oil and gas basins, and 25% of the volume of saline aquifers, could be deployed for CO<sub>2</sub> storage. For more details about how this heuristic was derived, see supplementary material of Van de Ven et al. (2023).

Table 2. Filtering criteria applied in the scenario selection process for pathway development.

Filtering criterion	Value	Reference	Num. (%) of C1 scenarios meeting criterion	
Maximum primary energy from bioenergy in any year between 2010-2050	<100 EJ	Frank et al., 2021	30 (31%)	
Maximum CO2 removed via BECCS in any year between 2010-2050	<3 Gt CO2	Warszawski et al. 2021	35 (36%)	
Maximum CO <sub>2</sub> removed via afforestation in 2050	<3.6 Gt CO <sub>2</sub>	Fuss et al., 2018	80 (82%)	
Total cumulative CO <sub>2</sub> permanently stored in geological deposits, 2010-2050	<214 Gt CO <sub>2</sub>	van de Ven et al., 2023	83 (86%)	
Maximum CO₂ removed via novel CDR in 2020	<2.3 Mt CO <sub>2</sub>	Smith et al., 2023	92 (95%)	
Total cumulative AFOLU emissions, 2020-2050 >-99.54 Gt CO₂e		SBTi, 2022	95 (98%)	
Number of C1 scenarios that meet all filtering criteria		19 (20%)		

Figure 1 shows how the IEA NZE scenario compares with the filtered scenarios from the AR6 database in terms of mitigation drivers. The IEA NZE, originally published by the IEA in 2021, is a normative, policy-driven roadmap that sets out a pathway to reach Net-Zero energy-related and industrial process CO<sub>2</sub> by 2050. The scenario is characterized by a 2020-2050 cumulative net CO<sub>2</sub> budget of around 500 Gt and is aligned with a 50% chance of limiting warming to 1.5°C by 2100 (IEA, 2023). In addition to the overarching goal of reaching Net-Zero CO<sub>2</sub> in the energy sector by 2050, the NZE also includes relevant sustainable development metrics, including universal energy access by 2030 and a major reduction in air pollution. To accomplish this, primary mitigation levers in the NZE include rapid uptake of efficient technologies and increased materials recycling. The NZE also includes strong reliance on behavioural changes such as modal shifts for passenger and freight transport, energy demand in buildings, and end-use energy efficiency measures. These behavioral shifts place NZE below the most C1 scenarios in terms of final energy demand in 2050 (Figure 1). The NZE scenario is unique among many in that it does not explicitly model the land sector.

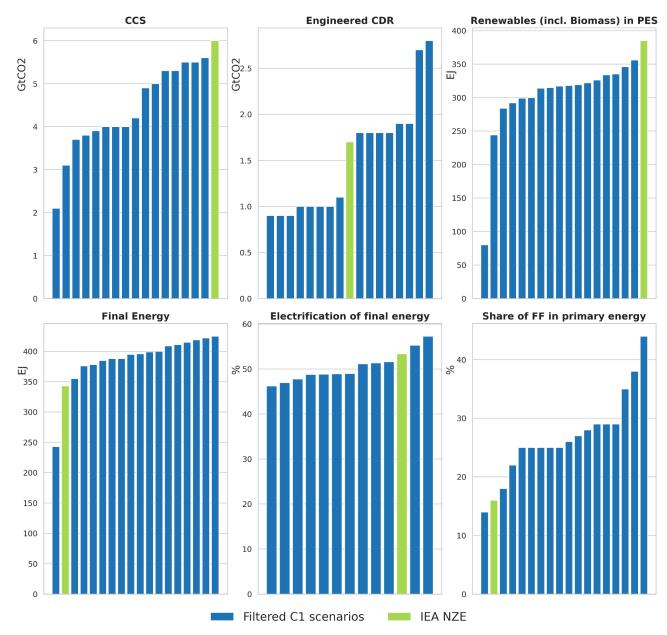


Figure 1. Among the set of filtered scenarios that achieve net-zero CO<sub>2</sub> emissions in energy and industrial processes by 2050, the IEA NZE lies at the lower bound for fossil fuel shares in both primary energy and total final energy consumption, indicating a faster phase-out of unabated fuels. It also exhibits a high ambition of electrification of final energy, reflecting the strong coupling between end-use decarbonization and clean power deployment that underpins its pathway design. FF:Fossil fuel, CCS: Carbon Capture and storage, PES: Primary Energy Supply.

### Application of the filtered ensemble to activity-based pathways

The filtered scenario ensemble provides the feasible range of 1.5 °C mitigation pathways with no or limited temperature overshoot, defining the envelope within which activity-based pathways are developed. Within this scenario set, the selection of suitable pathway for each activity depends on the availability of sector- and technology-level variables that can be translated into measurable activity metrics (e.g., fuel switching, electrification, low-carbon heat shares).

The IEA NZE lies near the median of the filtered AR6 C1 ensemble for key indicators (SBTi 2025a), but offers a more detailed bottom-up modelling structure that better suits these criteria. Specifically:

- It provides an explicit bottom-up representation of end-use technologies and transitions, capturing internally consistent linkages between energy supply. transformation, and end-use demand.
- It disaggregates emissions across major sources within the same process (e.g., clinker production, fuel combustion, and electricity use within cement manufacturing) allowing for the formulation of activity-based targets.

These characteristics position the IEA NZE as the most credible reference for activity-based pathways, as it provides sufficient detail for emission and non-emission-intensive activities to describe both the pace of emissions reduction and the underlying technology transitions (See Table 3).

### Pathways for benchmarking activities

Emission-intensive activities, including the production of cement, steel, chemicals, and aviation, are benchmarked against the IEA NZE and relevant SBTi sector pathways<sup>4</sup>, as documented in the corresponding sector standards. These activities use emission intensity metrics (e.g., tCO<sub>2</sub> per tonne of product or per unit of activity) derived from sectoral pathways.

Non-emission-intensive activities, including owned transport, space and water heating, and medium- and high-temperature heating, are benchmarked using the IEA NZE pathway, which provides the basis for both absolute emissions trajectories and outcome metrics (e.g., electrification rates, low-carbon heat shares, and technology uptake indicators).

Multi-gas fugitive emissions are not explicitly represented in the IEA NZE, which only covers methane emissions from fossil fuel operations. For these reasons, benchmark trajectories are drawn from the median of the filtered AR6 C1 ensemble, which reflects the central tendency of scenarios consistent with 1.5 °C pathways with no or limited overshoot. Fugitive emissions are benchmarked using separate trajectories for methane (CH<sub>4</sub>) and fluorinated gases (F-gases).

 Hydrofluorocarbon (HFC) emissions in the filtered AR6 C1 ensemble represent fugitive releases from refrigeration, air-conditioning, and foam-blowing applications. These pathways capture equipment-related leakage during operation and end-of-life losses across multiple HFC species (e.g., HFC-125, HFC-134a, HFC-143a, HFC-227ea, HFC-32, HFC-43-10, HFC-245fa) (IPCC, 2022). The median HFC trajectory across the filtered ensemble defines the non-CO2 fugitive benchmark for fluorinated gases within the energy and industrial sectors.

<sup>&</sup>lt;sup>4</sup> SBTi sector pathways refers to pathways developed or endorsed by SBTi for sector-specific activities. These pathways are developed from the filtered scenario enveloped described in the pathway development process, and excluding scenarios that lack sufficient sectoral details. In some cases, additional methodological steps such as harmonization are applied to define activity or sector-specific benchmarks consistent with the 1.5 °C-aligned decarbonization trajectory.

Although the scenario ensemble reports additional non-CO<sub>2</sub> gas pathways, including methane and SF<sub>6</sub>, integrated assessment models (IAMs) aggregate these emissions across fugitive, process, and combustion sources. As a result, the reported trajectories do not isolate fugitive components with sufficient source-level resolution for benchmarking. For example, methane trajectories combine upstream leakage from natural gas systems with incomplete combustion in industrial activities, buildings, and gas engines, while SF<sub>6</sub> trajectories encompass both fugitive releases from electrical equipment and process use in magnesium and semiconductor manufacturing (IPCC, 2022). Because these gases are more appropriately addressed through sector-specific operational measures, such as oil and gas system transformation for methane and improved containment and substitution in power applications for SF<sub>6</sub>, they are treated within the relevant sector-specific guidance.

# **LIMITATIONS**

The filtered scenario ensemble used for pathway development relies primarily on mitigation pathways derived from IAMs featured in the IPCC's AR6 database, complemented by the IEA Net NZE scenario. While these models are important to understanding transformations across the energy-economy-land-climate system, they also exhibit limitations that affect their applicability.

IAMs capture system-level interactions but often simplify or omit certain dynamics that can shape real-world mitigation outcomes. These simplifications mean that IAMs may not fully capture the operational, temporal, or regional granularity needed to inform activity-level target setting.

The IEA NZE complements these system-level perspectives through a detailed, bottom-up modelling structure that includes explicit end-use technologies, sectoral transitions, and technology deployment trajectories. However, it provides a single normative pathway without exploring uncertainty ranges. In addition, for industrial activities, the IEA NZE aggregates multiple subsectors (such as food processing, textiles, machinery, and construction) under a single "light industries" category, reporting only aggregated indicators like heating technology shares. This aggregation limits the sectoral and technological detail needed to capture variations in energy use and technology uptake across non-emission-intensive activities.

Equity considerations are also not explicitly embedded within either IAM or IEA modelling frameworks. Consequently, mitigation responsibilities may not fully reflect burden-sharing or historical-emissions principles.

Recognising these limitations, the SBTi maintains an iterative update process to pathway development. The 1.5 °C envelope defined by the filtered scenario ensemble will be revised periodically to reflect updated global mitigation scenarios, evolving scientific insights, and improvements in understanding of decarbonisation feasibility. This process ensures that activity-based pathways remain scientifically robust, policy-relevant, and aligned with the latest advances in climate science.

Table 3. Reference pathways for Scope 1 emission-intensive (pink) and non-emission-intensive (yellow) activities.

Pathway⁵	Activity	Unit	2025	2030	2035	2040	2045	2050	
	Cement production	Emission intensity (tco2e/tonne cement)	0.508	0.446	0.334	0.219	0.127	0.033	<u>(SBTi.</u> 2022a)
	Iron-ore based steel production	Emission intensity (tco2e/tonne steel)	2.04	1.71	1.25	0.77	0.44	0.11	(ODT:
	Scrap-based steel production	Emission intensity (tco2e/tonne steel)	0.44	0.37	0.31	0.24	0.17	0.11	(SBTi, 2023a)
IEA (2021)	Operation of owned or controlled transport fleet (stock flow)	Share of EVs in 2/3 wheeler (%)	40%	54%	66%	77%	89%	100%	
		Share of EVs in LDV	11%	20%	37%	53%	70%	86%	
	(Stock now)	Share of EVs in HDV	13%	23%	37%	53%	65%	79%	
	Operation of owned or controlled vehicle fleet (using vehicle stock flow as the activity basis, and applying a Tank-to-Wheel methodology for emissions accounting)	Light-duty vehicles (gCO2/vkm)	180.9	137.3	98.3	59.2	31.6	4.1	(IEA, 2021)
		Heavy-duty vehicles (gCO2/tkm)	52.9	35.9	27.3	18.8	13.5	8.3	

<sup>&</sup>lt;sup>5</sup> Pathways derived from a suite of scenarios and/or involve additional methodological steps are labeled as SBTi (sector) pathways. Activity-based pathways descending from the same modelling database are labelled by their source.

IEA (2022)	Medium temperature process heating	Absolute emissions (% emission reduction compared to 2020 levels)		Company base year dependent					(IEA. 2023)
IEA (2023)	Chemical production <sup>6</sup> (Whole sector)	Emission intensity (tco2/tonne Chemical)	2.13	1.87	1.40	0.95	0.52	0.10	
	Ammonia production	Emission intensity (tco2/tonne ammonia)	2.198	1.756	1.235	0.718	0.404	0.09	(SBTi,
	Methanol production	Emission intensity (tco2/tonne methanol)	2.25	1.91	1.47	1.03	0.56	0.09	forthcoming)
	High Value Chemical production	Emission intensity (tco2/tonne HVC)	0.945	0.830	0.645	0.460	0.250	0.04	
	Space and water heating	Absolute emissions (% emission reduction compared to 2020 levels)	Company base year dependent					-100%	(IEA, 2023)
	Medium temperature process heating (100-400 °C)	Share of low-carbon process heating	51%	62%	70%	79%	87%	95%	

<sup>&</sup>lt;sup>6</sup> More detailed chemical specific pathways are being developed as part of the SBTi's ongoing chemical sector guidance.

		(%)							
SBTi power <sup>7</sup>		Emission intensity (KgCO2/KWh)	0.191	0.058	0.013	0.003	0.002	0.001	(ODT:
sector pathway	Electricity generation	Share of low-carbon generation (%)	67%	87%	97%	99%	99%	99%	(SBTi, forthcoming)
SBTi <sup>8</sup> Maritime pathway	Operation of maritime transportation vehicles	Emissions generated from maritime transport (gCO <sub>2</sub> /t.nm)		Vessel Dependent					(SBTi. 2023b)
SBTi Building pathway	Building in-use operations	Emission intensity (kg CO <sub>2</sub> e/m²)		Building type dependent					(SBTi. 2025b)
SBTi <sup>9</sup> Aviation pathway	Operation of aviation (Sector total) Using the Well-to-Wheel methodology for emissions accounting	Emissions intensity (gCO <sub>2</sub> e/RPK)	874.3	710.6	486.0	265.6	113.1	25.61	(SBTi, 2021)
SBTi FLAG Commodity Pathways	FLAG commodity production	Emissions intensity (tCO₂e/tonne)	Commodity dependent					(SBTi. 2022b)	
SBTi <sup>8</sup> Automotive pathway	Road vehicle manufacturing and use over the lifecycle (using new vehicle flow as the activity basis, and	Emissions intensity (gCO <sub>2</sub> /v.km)	Vehicle dependent					(SBTi, 2024)	

The pathway is currently under public consultation and may be subject to revision before final adoption.
 8,9 The pathway is scheduled for revision to align with updated scientific evidence.
 The pathway is currently under public consultation and may be subject to revision before final adoption.

	applying a Life Cycle methodology for emissions accounting)				
IPCC AR6 filtered scenarios envelope	Non-fossil fugitive HFC emissions generated from equipment & processes	Absolute emissions (% reduction compared to 2020 levels)	Company base year dependent	-91%	Byers et al. (2022)

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DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

