NEW CLIMATE INSTITUTE

A repository of sector-specific decarbonisation benchmarks informing 1.5°C-aligned corporate climate action

Version 1.0

April 2024

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Introduction

The global economy's pathway to net zero is crucial to limit global warming to 1.5°C: this temperature limit requires immediate action to achieve a reduction in global CO_2 emissions of about 48% from 2019 levels by 2030 and thereafter reach a state of net-zero global CO_2 and GHG emissions by around 2050 and around 2070 respectively (IPCC, 2022).

Against this scientific backdrop, guidance for corporate climate target setting published over the last two years mandates that companies align their short-, medium-, and longer-term targets with 1.5°C-compatible pathways with no or limited overshoot (Net Zero Tracker, 2023). These voluntary standards and guidelines include, among others, the UN High-Level Expert Group's report (UN HLEG, 2022)), the ISO Net Zero Guidelines (ISO, 2022), the SBTi Corporate Net Zero Standard (SBTi, 2024b) and the UNFCCC's Race to Zero Starting Line and Leadership Practices 3.0 criteria (Race to Zero, 2022).

Despite this consensus among existing guidance, corporate actors and other stakeholders like investors, regulators, courts, or civil society face the challenge of understanding available literature on a 1.5°C-compatible corporate target setting for specific sectors across the available literature.

A repository for 1.5°C-aligned corporate benchmarks

The repository of 1.5°C-aligned corporate benchmarks seeks to consolidate the broad range of decarbonisation benchmarks and milestones identified in existing literature, initiatives, and court rulings for each sector. This practice acknowledges the multiple approaches for establishing 1.5°C-aligned benchmarks to inform corporate climate action rather than asserting a singular method. The range of approaches to determine benchmarks and milestones might differ in terms of underlying emission scenarios and their assumptions on the scope of carbon dioxide removals and temperature overshoot, covering companies' emission scopes along the value chain, or their metrics such as absolute or intensity emission reductions, or non-GHG related benchmarks.

The repository of 1.5°C-aligned corporate benchmarks aims to collect available benchmarks and milestones across the literature to review them in terms of scope, limitations, and applicability.

Repositories for 1.5°C-aligned corporate benchmarks can serve multiple purposes and a range of users within the corporate climate accountability landscape (Hans *et al.*, 2023). First and foremost, it allows companies to inform their climate strategies and related target-setting for short-, medium-, and longer-term. The repository can subsequently, among other purposes, support independent assessors to validate and verify corporate targets, enable courts to judge the targets' adequacy, or assist researchers to identify existing gaps in the literature. Looking forward, an impartial institution such as the UNFCCC Secretariat could oversee the development and active management of sector-specific repositories.

An introduction to the benchmark collection approach

The benchmark repository builds on the review of decarbonisation benchmarks and milestones presented for corporates, countries, or the global economy. Figure 1 provides a non-conclusive overview of the literature identified as of April 2024. It is important to note that this document only collects existing benchmarks and milestones from the literature but does **not** develop new ones.

The existing literature captures a range of existing benchmarks identified by initiatives, researchers, and courts that have already been applied to corporates to date. During the collection process, we identify the benchmarks' applicability to corporate emission scopes, the temperature alignment of single benchmarks, consideration of other aspects such as the exclusion of non-GHG warming impacts, and further guidance and limitations presented by institutions such as underlying inputs used for the development of a benchmark. This document covers **economy-wide global benchmarks** (Section 1) and **16 focus sectors** (Section 2–17).

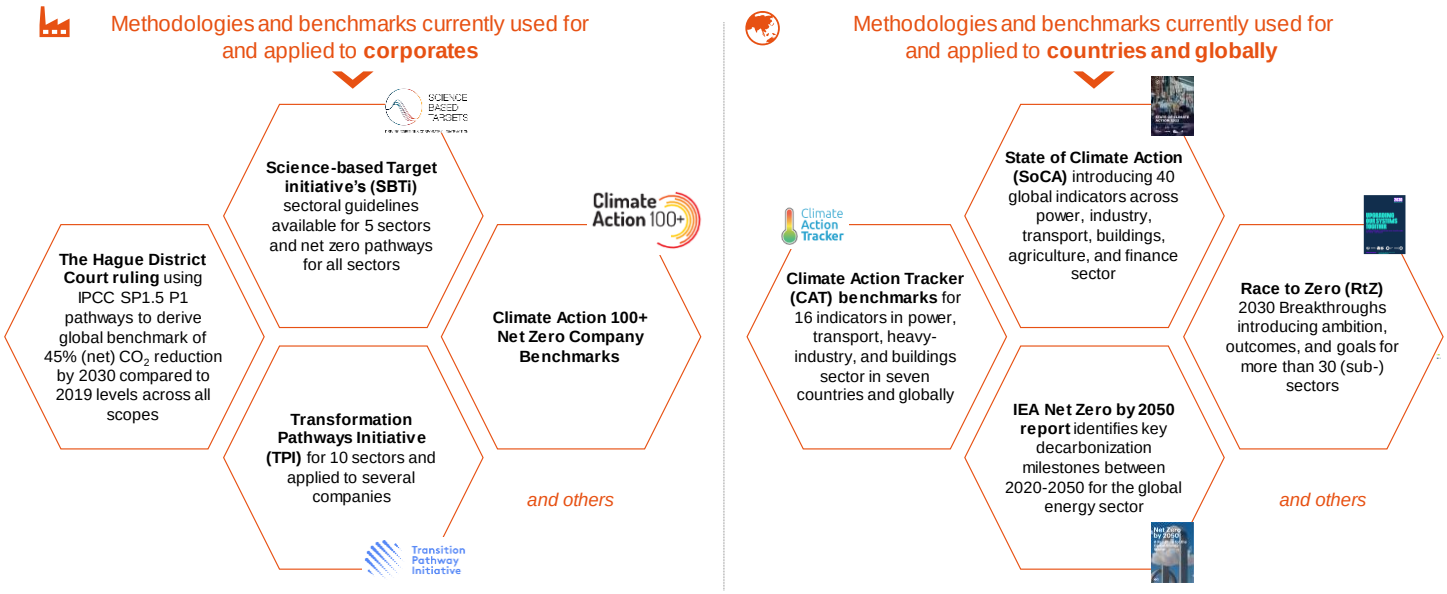

Figure 1: Ecosystem of existing methodologies to inform 1.5°C Paris Agreement aligned pathways, benchmarks and milestones for corporates, countries, and globally as of April 2024.

Limitations of existing benchmark repositories

There are several limitations to be aware of when using the benchmark repositories of this report.

- **Comprehensiveness**: This document might not provide a comprehensive overview of existing 1.5°C-aligned sectoral benchmarks, considering the wide range of available (sector-specific) literature. The overview above each repository indicates the literature reviewed for each sector, which can be complemented by other literature not yet considered.
- **Up-to-datedness**: The literature referenced in this document might be regularly updated by respective institutions to reflect the latest scientific findings or other developments. For this reason, any benchmarks in this document could become outdated, and users should refer to the referenced documentation before making further use of any specific benchmark.
- **Underlying assumptions**: Despite efforts to correctly display underlying assumptions and limitations for specific benchmarks across the 17 economy-wide and sectoral repositories, some information might be missing or wrongfully presented. This might occur due to limited documentation for respective benchmarks, recent updates, or the authors' misinterpretations. We advise users to do their own assessment of all presented information before making further use of any specific benchmarks.

Application of identified benchmarks

Users can use identified benchmarks to inform 1.5°C-compatible corporate target setting in the first place — or to assess whether corporate targets align with 1.5-aligned benchmarks. Applying identified benchmarks can generally be guided by the following assessment steps:

1. **What are the company's main emission sources across its value chain (scope 1, 2, 3)?**
2. **Which emission reduction targets does the company commit to for its largest emissions sources (excluding offsets and removals)?**
3. **How do these targets compare to existing sector-specific benchmarks in the literature?**

The methodology of the Corporate Climate Responsibility Monitor explains an assessment approach in more detail (Day *et al.*, 2024, chap. 2).

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1 Global economy-wide benchmarks

Last update	**28.04.2024**
Summary	The rationale is to use global economy-wide benchmarks as *minimum requirement* for multinationals to meet, especially if headquartered or realising substantial revenues in developed countries. The Hague District Court (2021) ruling starting point is for 2030 (CO_2 only across all scopes) with the idea to complement and substantiate with similarly derived benchmarks for 2025, 2030, 2040 and 2050 for both CO_2 only and all GHG (IPCC, 2018).

Global economy-wide benchmarks as *minimum requirement*

Indicator	Source	2025	2030	2035	2040	2045	2050 and after
CO_2 emissions across all emission scopes (Scope 1, Scope 2 & Scope 3)	**IPCC AR6** (IPCC, 2022, 2023)		▪ Net 48% reduction **below 2019** of CO_2 emissions across all emissions scopes **by 2030** (36–69% interquartile range) ▪ Net reduction of methane (CH_4) emissions by 34% by 2030 below 2019 levels		▪ Net 65% reduction **below 2019** of CO_2 emissions across all emissions scopes **by 2035** (50–96% interquartile range) ▪ Net 80% reduction **below 2019** of CO_2 emissions across all emissions scopes (61–109% interquartile range) **by 2040**		▪ Net 99% reduction below 2019 of CO_2 emissions across all emissions scopes **by 2050** (79–119% interquartile range) ▪ Net zero CO_2 emissions across all emissions scopes by **2050–2055** (2035–2070 interquartile range)
	The Hague District Court (The Hague District Court, 2021)		▪ Net 45% reduction **below 2019** of CO_2 emissions across all emissions scopes				▪ Net 100% reduction **below 2019** across all emissions scopes
	IPCC SP1.5°C (IPCC, 2018)		▪ Net 45% reduction **below 2010** of CO_2 emissions across all emissions scopes (40–60% interquartile range)				▪ Net 100% reduction **below 2010** across all emissions scopes (2045–2055 interquartile range)
All GHG across all emission scopes (Scope 1, Scope 2 & Scope 3)	**IPCC AR6** (IPCC, 2022, 2023)		▪ Net 43% reduction **below 2019** of GHG emissions across all emissions scopes **by 2030** (34–60% interquartile range)		▪ Net 60% reduction **below 2019** of GHG emissions across all emissions scopes **by 2035** (49–77% interquartile range) ▪ Net 69% reduction **below 2019** of GHG emissions across all emissions scopes **by 2040** (58–90% interquartile range)		▪ Net 84% reduction **below 2019** of GHG emissions across all emissions scopes (73–98% interquartile range) ▪ Net zero GHG emissions across all emissions scopes by **2070–2075** (2050–2090 interquartile range) under '*pathways with net-zero GHGs*' (C1a) ▪ Net zero GHG emissions across all emissions scopes by **2095–2100** (2050–n/a interquartile range) under '*pathways limiting warming to 1.5°C (>50% with no or limited overshoot)*' (C1)

Users should carefully read the introduction to the benchmark repositories and be mindful of existing limitations.

Global economy-wide benchmarks as *minimum requirement*

Indicator	Source	2025	2030	2035	2040	2045	2050 and after
	IPCC (IPCC, 2018)		*Note: Specified in Statement D1.1 in IIASA documentation but not in main summary for policymakers* ▪ Net 45% reduction **below 2010** of GHG emissions across all emissions scopes (39–51% interquartile range)				▪ Net reduction by 2050 **below 2010** across all emissions scopes (81–93% interquartile range) *not presented* ▪ Net 100% reduction in **2067** below 2010 in across all emissions scopes (2061–2083 interquartile range) as presented in Table 2.4 in Chapter 2
	SBTi Corporate Net Zero Standard for corporates (v1.1, April 2023) (SBTi, 2023a)				*Note: Long-term without a specific year assigned, with 95% minimum coverage of Scope 1 & Scope 2 emissions and 90% of Scope 3 emissions* ▪ **Absolute contraction (cross-sector):** 90% reduction below 2020 under *SBTi 1.5°C scenario* globally		
Scope 1 & Scope 2	**SBTi Corporate Net Zero Standard** for corporates (v1.1, April 2023) (SBTi, 2021d, 2021b)	*Note: Near-term without a specific year assigned, with 95% minimum coverage of Scope 1 & Scope 2 emissions* **Absolute reduction (cross-sector):** 4.2% emissions reduction per year (p.a.)					
Scope 2	**SBTi Corporate Net Zero Standard** for corporates in general, with adjustment to consider only high-quality RE procurement constructs (v1.1, April 2023) (SBTi, 2023a)	▪ **Share of RE in electricity procurement by 2025**: 80% high-quality renewables procurement	▪ **Share of RE in electricity procurement by 2030**: 100% high-quality renewables procurement				
Scope 3	**SBTi Corporate Net Zero Standard** for corporates in general (v1.1, April 2023) (SBTi, 2023a)	*Note: Near-term (5-10 years from submission date), with 67% minimum coverage of Scope 3 emissions if >40% of total emissions, and minimum ambition is SBTi well-below 2°C scenario* ▪ **Absolute contraction (cross-sector)**: at least 2.5% emissions reduction per year for well-below 2°C scenario (as the only requirement for scope 3 emissions) ▪ **Economic intensity (cross-sector)**: at least 7% year-on-year reduction of emissions per unit value added ▪ **Physical intensity (cross-sector):** at least 7% year-on-year reduction for a company defined physical emissions intensity metric ▪ **Engagement target (cross-sector)**: engagement with suppliers and/or customers to set own reduction targets (at minimum well below 2°C scenario), no specific target value set			*Note: Long-term without a specific year assigned, with 90% minimum coverage of Scope 3 emissions, and minimum ambition is SBTi 1.5°C scenario* ▪ **Absolute contraction (cross-sector):** 90% reduction below a 2020 base year as cross-sectoral benchmark. Note: sector-specific pathways and absolute reduction benchmarks available for several sectors. ▪ **Economic intensity**: 97% total reduction, no base year specified ▪ **Physical intensity:** 97% total reduction, no base year specified		

2 Automotive manufacturers

Last update	**28.04.2024**

Summary

Light–duty vehicles: Phase out of internal combustion engines (ICEs)

Several studies identify 1.5°C-aligned decarbonisation milestones for the phase-out of internal combustion engines (ICEs) replaced by electric and low-emission vehicles at the global and regional (CAT, 2020, p. 27; Teske *et al.*, 2022, p. 333; Boehm *et al.*, 2023, pp. 77–78; IEA, 2023a, pp. 80, 93; SBTi, 2024a, pp. 16–17).

Light–duty vehicles: Intensity of vehicles' use-phase emissions

The Science Based Targets Initiative (SBTi) and the Transition Pathways Initiative (TPI) define benchmarks to evaluate corporate intensity targets on the vehicles' use-phase emissions (downstream scope 3 category 11) emissions (SBTi, 2018c, 2018b; Dietz, Chiu, *et al.*, 2023, p. 8). The SBTi has indefinitely paused the use of its methodology for automakers' intensity targets since March 2022 as the method does not reflect a 1.5°C-compatible definition from SBTi's point of view (SBTi, 2022f).

Heavy–duty vehicles: Phase-in of zero emission vehicles (ZEVs)

Several studies identify 1.5°C-aligned decarbonisation milestones for the phase in of zero emission vehicles replacing internal combustion engines at the global and regional (UNFCCC, 2021b, pp. 10–11; Mission Possible Partnership, 2022b, p. 40; Boehm *et al.*, 2023, pp. 77–78; IEA, 2023a, pp. 93, 196; InfluenceMap, 2023).

Sector-specific benchmarks for automotive manufacturers

Scope	Source	2025	2030	2035	2040	2045	2050
Scope 1, Scope 2 & Scope 3	*None identified*						
Scope 1 & Scope 2	**ACT Automobile** sector methodology [company-specific] (ACT, 2020; WBA, 2022)	*Not specified in company case studies.*	*Not specified in company case studies.*		*Not specified in company case studies.*		*Not specified in company case studies.*
Scope 1	**One Earth Climate Model** for road transport 1.5°C compatible scenario, global scope. (Teske, 2022, p. 333) ***Notes**: [1] Scope 1 encompasses direct energy-related CO_2 emissions by automobile manufacturer. [2] Base year is 2019 with baseline of 183 $MtCO_2e$/year.*	▪ **Emission reductions below 2019 levels**: - 39%	▪ **Emission reductions below 2019 levels: -** 62%	▪ **Emission reductions below 2019 levels:** - 76%	▪ **Emission reductions below 2019 levels:** - 86%		▪ **Emission reductions below 2019 levels:** - 100%
Scope 2	**One Earth Climate Model** for road transport	▪ **Emission reductions below 2019 levels**: 357%	▪ **Emission reductions below 2019 levels: 247**%	▪ **Emission reductions below 2019 levels**: 734%	▪ **Emission reductions below 2019 levels: 300**%		▪ **Emission reductions below 2019 levels:** 0%

Sector-specific benchmarks for automotive manufacturers

Scope		Source	2025	2030	2035	2040	2045	2050
		1.5°C compatible scenario, global scope. (Teske, 2022, p. 333) *Note: [1] Scope 2 encompasses indirect emissions from electricity use and hydrogen or synfuel production by automobile manufacturer. [2] Base year is 2019 with baseline of 34.5 $MtCO_2e$/year.*						
Scope 3	***Total***	*None identified*						
	Upstream	*None identified*						
	Downstream	**Transition Pathway Initiative (TPI) guidance** for automobile manufacturers 1.5°C compatible and well-below 2°C scenarios, global scope. (Dietz, Chiu, *et al.*, 2023, p. 8) *Note: [1] gCO_2/km means tank-to-wheel emissions on real-world driving conditions following WLTP. [2] Only covering new passenger cars and use of sold products (scope 3). [3] Caveat: passenger cars are defined differently by different regulatory bodies.*	▪ **Carbon intensity (1.5°C compatible):** 85.7 gCO_2/km ▪ **Carbon intensity (well below 2°C):** 106.5 gCO_2/km	▪ **Carbon intensity (1.5°C compatible):** 30.7 gCO_2/km ▪ **Carbon intensity (well below 2°C):** 80.9 gCO_2/km		▪ **Carbon intensity (1.5°C compatible):** 2.7 gCO_2/km ▪ **Carbon intensity (well below 2°C):** 59.1 gCO_2/km		▪ **Carbon intensity (1.5°C compatible):** 0.4 gCO_2/km ▪ **Carbon intensity (well below 2°C):** 46.1 gCO_2/km
		2018 SBTi guidance for automobile manufactures (SBTi, 2018c, 2018b) *Note: Values read manually out of graph in Excel tool.*		*Note: Method parked by SBTi indefinitely!* ▪ **Carbon intensity for LDVs:** 92 gCO_2e/pkm under a *Below 2 Degrees scenario* globally		*Note: Method parked by SBTi indefinitely!* ▪ **Carbon intensity for LDVs:** 51 gCO_2e/pkm under a *Below 2 Degrees scenario* globally		*Note: Method parked by SBTi indefinitely!* ▪ **Carbon intensity for LDVs:** 17 gCO_2e/pkm under a *Below 2 Degrees scenario* globally
		2024 SBTi interim guidance for automobile manufacturers (SBTi, 2024a, pp. 16–17) *Note: Released on 21.03.2024 for interim use while SBTI develops a new 1.5°C-compatible SDA method.*			▪ **ZEV share in sales as per Glasgow Declaration:** 100% of total sales (passenger vehicles and vans) in leading markets	▪ **ZEV share in sales as per Glasgow Declaration:** 100% of total sales (passenger vehicles and vans) globally		▪ **Absolute contraction approach across entire portfolio sales:** 98.4% below 2020, leading to linear annual reduction of 3.3% between 2020-2050 and 4.0% between 2020-2030
		2022 One Earth Climate Model for road transport 1.5°C compatible scenario, global scope. (Teske, 2022, pp. 216, 333) *Note: [1] Scope 3 encompasses end-user emissions (of automobile manufacturer). [2] Base year is 2019 with baseline of 7,223 $MtCO_2e$/year (passenger 4,190 $MtCO_2e$ & freight 3,034 $MtCO_2e$) 3) Assumption: power sector is fully decarbonized by 2050, ICE passenger*	▪ **Emission reductions below 2019 levels (all road transport)**: -17% ▪ **Emission intensity (road passenger)**: 95 gCO_2/passenger.km ▪ **Emission intensity (road freight)**: 90 gCO_2/tonne.km	▪ **Emission reductions below 2019 levels (all road transport):** -34% ▪ **Emission intensity (road passenger)**: 85 gCO_2/passenger.km ▪ **Emission intensity (road freight)**: 80 gCO_2/tonne.km	▪ **Emission reductions below 2019 levels (all road transport): -**80% ▪ **Emission intensity (road passenger)**: 38 gCO_2/passenger.km ▪ **Emission intensity (road freight)**: 26 gCO_2/tonne.km	▪ **Emission reductions below 2019 levels (all road transport): -**91% ▪ **Emission intensity (road passenger)**: 29 gCO_2/passenger.km ▪ **Emission intensity (road freight)**: 14 gCO_2/tonne.km		▪ **Emission reductions below 2019 levels (all road transport): -**100% ▪ **Emission intensity (road passenger)**: 0 gCO_2/passenger.km ▪ **Emission intensity (road freight)**: 0 gCO_2/tonne.km

Sector-specific benchmarks for automotive manufacturers

Scope	Source	2025	2030	2035	2040	2045	2050
	cars and buses will not be produced after 2030 and BEVs dominate.						
	2023 One Earth Climate Model for road transport 1.5°C compatible scenario, global scope. (Teske *et al.*, 2023) ***Note**: [1] Scope 3 encompasses end-user emissions. [2] Base year is 2019 with baseline of 127 gCO_2/passenger.km and 88 gCO_2/tonne.km*	▪ **Emission intensity (road passenger)**: 123 gCO_2/passenger.km ▪ **Emission intensity (road freight)**: 78 gCO_2/tonne.km	▪ **Emission intensity (road passenger)**: 93 gCO_2/passenger.km ▪ **Emission intensity (road freight)**: 61 gCO_2/tonne.km	▪ **Emission intensity (road passenger)**: 36 gCO_2/passenger.km ▪ **Emission intensity (road freight)**: 28 gCO_2/tonne.km	▪ **Emission intensity (road passenger)**: 23 gCO_2/passenger.km ▪ **Emission intensity (road freight)**: 17 gCO_2/tonne.km	▪ **Emission intensity (road passenger)**: 7 gCO_2/passenger.km ▪ **Emission intensity (road freight)**: 1 gCO_2/tonne.km	▪ **Emission intensity (road passenger)**: 2 gCO_2/passenger.km ▪ **Emission intensity (road freight)**: 0 gCO_2/tonne.km
	Climate Action Tracker for road transport 1.5°C compatible scenario, global scope and country-specific available. (CAT, 2020) *Note: [1] Country-specific benchmarks available for EU-28, USA, China, India, Indonesia, South Africa, and Brazil. [2] Land-based transport encompasses road & rail, passenger & freight. [3] Domestic transport encompasses all modes and passenger or freight.*		▪ **EV (passenger) share in sales:** 75%-95% (higher end for developed countries) ▪ **EV (passenger) share in no. of fleet:** 20-40% ▪ **Carbon intensity of land-based transport:** 35-60 gCO_2/person.km ▪ **Share of zero emissions fuel for domestic transport:** 15% of total fuel		▪ **EV (passenger) share in sales:** 100% in almost all countries ▪ **EV (passenger) share in no. of fleet:** 65-90% ▪ **Carbon intensity of land-based transport:** 0-30 gCO_2/person.km ▪ **Share of zero emissions fuel for domestic transport:** 40-60% of total fuel		▪ **EV (passenger) share in sales:** 100% ▪ **EV (passenger) share in no. of fleet:** 85-100% ▪ **Carbon intensity of land-based transport:** 0-10 gCO_2/person.km ▪ **Share of zero emissions fuel for domestic transport:** 70-95% of total fuel
	UNFCCC for global level 1.5°C compatible scenario, global scope. (UNFCCC, 2021b, pp. 10–11)	▪ **BEV & FCEV electric <u>buses</u> share in sales:** 75% of total sales ▪ **ZEV <u>passenger vehicles and vans</u> share in sales:** 15% of total sales ▪ **BEV & FCEV <u>heavy goods vehicles</u> share in sales**: 8% of total sales		▪ **BEV & FCEV electric <u>buses</u> share in sales:** 100% of total sales **in leading markets (China, EU, Japan, US)** ▪ **ZEV <u>passenger vehicles and vans</u> share in sales:** 100% of total sales **in leading markets (China, EU, Japan, US)** excluding hybrid vehicles	▪ **BEV & FCEV <u>heavy goods vehicles</u> share in sales**: 100% of total sales **in leading markets (China, EU, Japan, US)** excluding hybrid vehicles		
	2023 IEA Net Zero Roadmap by 2050 for road transport 1.5°C compatible scenario, global scope. (IEA, 2023a, pp. 93, 196) ***Note:** All greyed-out benchmarks were previously listed in the 2021 report* (IEA, 2022a, pp. 20; 138).		▪ **Share of plug-in hybrid, battery & fuel cell electric vehicles in total sales:** ○ **Total**: 70% ○ **2/3-wheelers**: 78% ○ **Cars & vans**: 67% ○ **Buses**: 56% ○ **Heavy trucks**: 37% ▪ **Biofuel share**: 11% ▪ **Electricity share:** 8% ▪ **Hydrogen share:** 1% ▪ **Carbon intensity (road passenger)**:	▪ **Share of plug-in hybrid, battery & fuel cell electric vehicles in total sales:** ○ **Total**: 98% ○ **2/3-wheelers**: 100% ○ **Cars & vans**: 100% ○ **Buses**: 90% ○ **Heavy trucks**: 65% ▪ **ICE phase-out**: No new ICE cars sold after 2035 ▪ **Biofuel share**: 12% ▪ **Electricity share:** 22%	▪ **No new ICE truck sold after 2040** in advanced economies & China ▪ **Carbon intensity (road passenger)**: 12 gCO_2/passenger.km (*own calculation: 403 $MtCO_2$ divided by 33,841 billion passenger.km*) ▪ **Carbon intensity (heavy duty truck)**: 17 gCO_2/tonne.km (*own calculation: 856 $MtCO_2$ divided by 49,036 billion tonne.km*)	▪ **No new ICE truck sold after 2045** for the emerging market & developing economies	▪ **Share of plug-in hybrid, battery & fuel cell electric vehicles in total sales:** ○ **Total**: 100% ○ **2/3-wheelers**: 100% ○ **Cars & vans**: 100% ○ **Buses**: 100% ○ **Heavy trucks**: 100% ▪ **Biofuel share**: 3% ▪ **Electricity share:** 74% ▪ **Hydrogen share:** 16% ▪ **Carbon intensity (road passenger)**:

Sector-specific benchmarks for automotive manufacturers

Scope	Source	2025	2030	2035	2040	2045	2050
			61 gCO_2/passenger.km *(own calculation: 1,752 $MtCO_2$ divided by 28,608 billion passenger.km)* ▪ **Carbon intensity (heavy duty truck)**: 42 gCO_2/tonne.km (*own calculation: 1,610 $MtCO_2$ divided by 38,037 billion tonne.km*) ▪ *[Previous 2021 report] EV share in sales: 60% of global car sales are electric*	▪ **Hydrogen share:** 2% ▪ **Carbon intensity (road passenger)**: 30 gCO_2/passenger.km (*own calculation: 916 $MtCO_2$ divided by 30,355 billion passenger.km*) ▪ **Carbon intensity (heavy duty truck)**: 30 gCO_2/tonne.km (*own calculation: 1,284 $MtCO_2$ divided by 43,341 billion tonne.km*) ▪ *[Previous 2021 report] EV share in sales: 100% of global car sales are electric, no new ICE car sales* ▪ *[Previous 2021 report] Electric heavy goods vehicles share in sales: 50% of heavy truck sales are electric*			1 gCO_2/passenger.km (*own calculation: 37 $MtCO_2$ divided by 41,638 billion passenger.km*) ▪ **Carbon intensity (heavy duty truck)**: 3 gCO_2/tonne.km (*own calculation: 178 $MtCO_2$ divided by 60,335 billion tonne.km*)
	2023 State of Climate Action 1.5°C compatible scenario, global scope. (Boehm *et al.*, 2023, pp. 77–78) ***Note:*** *All greyed-out benchmarks were additionally listed in the State of Climate Action 2022 report (Boehm et al., 2022, p. 74).* *The light blue colour indicates that it is from the 2021 report (Boehm, Lebling, et al., 2021, p. 88).*	▪ ***Electric heavy goods vehicles share in sales**: 8% of BEV and FCEV sales as a percentage of global MHDV sales*	▪ **EV share in light-duty vehicle sales:** 75-95% ▪ **EV share in two- and three-wheelers sales:** 85% ▪ **EV share in light-duty vehicle fleets:** 20-40% ▪ **Share of BEV and FCEV in medium and heavy-duty commercial vehicle sales:** 30% ▪ **Share of BEV and FCEV in bus sales:** 60% ▪ **Share of kilometers travelled by passenger cars:** 35-43% of passenger.km ▪ **Number of kilometers of high-quality bike lanes:** 2 km/1,000 inhabitants ▪ **Number of kilometers of rapid transit:** 38 km/1 million inhabitants ▪ **EV share in sales:** 75%-95% globally ▪ **EV share in fleet**: 20-40% globally	▪ **EV share in light-duty vehicle sales:** 100% ▪ **EV share in sales:** 100% globally	▪ ***Electric heavy goods vehicles share in sales**: 100% of BEV and FCEV sales as a percentage of global MHDV sales in leading markets*		▪ **EV share in light-duty vehicle fleets:** 85-100% ▪ **EV share in two- and three-wheelers sales:** 100% ▪ **Share of BEV and FCEV in bus sales:** 100% ▪ **Share of BEV and FCEV in medium and heavy duty commercial vehicle sales: 99%** ▪ **EV share in fleet**: 85-100% globally ▪ **Electric busses share in sales:** 100% of BEV and FCEV sales as a percentage of bus sales globally ▪ **Electric heavy goods vehicles share in sales**: 99% of BEV and FCEV sales as a percentage of global MHDV sales ▪ ***Share of low-emissions fuels in the transport sector:** 95% share of low-emissions fuels in the transport sector*

Sector-specific benchmarks for automotive manufacturers

Scope	Source	2025	2030	2035	2040	2045	2050
			▪ **Electric busses share in sales:** 60% of BEV and FCEV sales as a percentage of bus sales globally ▪ **Electric heavy goods vehicles share in sales**: 30% of BEV and FCEV sales as a percentage of global MHDV sales ▪ ***Electric busses share in sales:*** *100% of BEV and FCEV sales as a percentage of bus sales in leading markets* ▪ ***Share of low-emissions fuels in the transport sector:*** *15% share of low-emissions fuels in the transport sector*				
	Mission Possible Partnership 1.5°C compatible scenario (*Accelerated Zero-Emissions Scenario*), global scope. (Mission Possible Partnership, 2022b, p. 40) *Note: [1] Country or region-specific benchmark available for Europe, US, China, and India. [2] Other emissions scenario available but the temperature alignment is not clear. [3] In the Accelerated scenario, carbon cost ranges from US$0-250/tCO₂ increasing linearly from 2023-2050, applied on GHG well-to-wheel for diesel and biodiesel.*		▪ **Global sales share for (long-haul segment):** ▪ **Hydrogen electric trucks:** 17% ▪ **Battery electric trucks:** 49% ▪ **Diesel trucks:** <30% ▪ **Biodiesel trucks:** *not specified* ▪ **No. of supporting infrastructure for:** ▪ **Electric chargers:** ~2-2.5 million ▪ **Hydrogen refuelling station:** ~20-25 thousands		▪ All trucks sold **by 2040** to be either **BETs** or **HETs** ▪ **Global sales share for (long-haul segment):** ▪ **Hydrogen electric trucks:** 46% ▪ **Battery electric trucks:** 54% ▪ **Diesel trucks:** 0% ▪ **Biodiesel trucks:** negligible ▪ **No. of supporting infrastructure for:** ▪ **Electric chargers:** ~7.5-8.5 million ▪ **Hydrogen refuelling station:** ~145-150 thousands		▪ **Global sales share for (long-haul segment):** ▪ **Hydrogen electric trucks:** 47% ▪ **Battery electric trucks:** 53% ▪ **Diesel trucks:** 0% ▪ **Biodiesel trucks:** negligible ▪ **No. of supporting infrastructure for:** ▪ **Electric chargers:** ~10-11 million ▪ **Hydrogen refuelling station:** ~190-200 thousands
	ACT Automobile sector methodology 1.5°C compatible scenario, company-specific scope. (ACT, 2020; WBA, 2022) *Note: Company specific benchmarks build on IEA Net Zero by 2050 report.*	▪ **Low-emission vehicle share in global sales:** ○ 34% for Daimler ▪ **Scope 3 emissions intensity:** ○ 43.1 gCO₂/passenger.km for Daimler	▪ **Low-emission vehicle share in global sales:** ○ 64% for Daimler ○ 64.5% for Volkswagen ○ 64.5% for Stellantis ○ 64.5% for Toyota				

Sector-specific benchmarks for automotive manufacturers

Scope	Source	2025	2030	2035	2040	2045	2050
	Influence Map (InfluenceMap, 2023) *Note: Historical vehicle emissions values are taken from the European Environmental Agency and adjusted for real-world emissions using research from the International Council on Clean Transportation. To model future vehicle emissions, InfluenceMap uses future vehicle production forecasts from IHS Markit.*		▪ **Zero emission vehicle (BEVs & hydrogen LDVs) share in total production (1.5°C compatibility):** 52% ZEV production (*informed by IEA's 1.5° Zero Emission scenario*) ▪ **Carbon intensity (2°C compatibility)** 71 gCO_2/passenger.km (*taken from the IEA's Sustainable Development Scenario (SDS) for road transport*)				

3 Energy utilities

Last update	**28.04.2024**
Summary	**Absolute emissions reduction and emissions intensity pathway of electricity generation (scope 1 and 2)** Several studies identify 1.5°C-aligned decarbonisation milestones for absolute emissions and emissions intensity of electricity generation globally and for specific geographies (Dietz, Gardiner, Jahn, *et al.*, 2021, p. 7; Boehm *et al.*, 2023, p. 29; CAT, 2023a, p. 20; IEA, 2023a, pp. 62, 79, 198–199). **Share of renewables and phase-out timeline of unabated fossil fuels** Several studies identify 1.5°C-aligned decarbonisation milestones for the share of renewables in total electricity generation and installed capacity, as well as the phase-out timeline of unabated coal, oil and fossil gas power plants globally and for specific geographies (IEA, 2022b, pp. 137–138; Teske, 2022; IEA, 2023a, pp. 62, 79; Boehm *et al.*, 2023, pp. 36, 38; CAT, 2023a, p. 5; IRENA, 2023, pp. 47–49, 65).

Sector-specific benchmarks for energy utilities

Scope	Source	2025	2030	2035	2040	2045	2050
Scope 1, Scope 2 & Scope 3	*None identified to date*						
Scope 1 & Scope 2	**Transition Pathway Initiative (TPI) guidance** for energy utilities 1.5°C compatible scenario, global scope. (Dietz, Gardiner, Jahn, *et al.*, 2021) *Note: Methods uses IEA Net Zero by 2050 scenario. Publication also provides a well-below 2°C scenario and respective benchmarks.*		▪ **Carbon intensity (globally):** 0.138 tCO_2/MWh *Regional breakdown (all in tCO_2/MWh for 1.5°C):* • **OECD**: 0.064 tCO_2/MWh • **Non-OECD**: 0.179 tCO_2/MWh • **North America**: 0.068 tCO_2/MWh • **EU**: 0.046 tCO_2/MWh	▪ **Carbon intensity (globally):** *none available* *Regional breakdown (all in tCO_2/MWh for 1.5°C):* • **OECD**: 0 tCO_2/MWh • **Non-OECD**: *none available* • **North America**: 0 tCO_2/MWh • **EU**: 0 tCO_2/MWh	▪ **Carbon intensity (globally):** 0.0 tCO_2/MWh *Regional breakdown (all in tCO_2/MWh for 1.5°C):* • **OECD**: *none available* • **Non-OECD**: 0 tCO_2/MWh • **North America**: *none available* • **EU**: *none available*		▪ **Carbon intensity (globally):** - 0.005 tCO_2/MWh *Note: No regional breakdown available.*
	SBTi guidance for energy utilities 1.5°C compatible scenario, global scope (SBTi, 2020d, 2021f) *Note: Regional breakdowns are available in tool but not inaccessible.*	▪ **Carbon intensity:** 0.247 tCO_2/MWh	▪ **Carbon intensity:** 0.1 tCO_2/MWh		▪ **Carbon intensity:** 0.018 tCO_2/MWh		▪ **Carbon intensity:** 0.001 tCO_2/MWh
	2023 SBTi Corporate Net Zero Standard for power sector (SBTi, 2021b, 2022c, 2023a) *Note: Absolute reduction of **97%** for 2050 directly taken out of SBTi Net Zero*	*Note: Near-term without a specific year assigned (only mentioned 5-10 years from submission date), with 95% minimum coverage of Scope 1 & Scope 2 emissions* **Absolute reduction (cross-sector):** 4.2% emissions reduction per year (p.a.)			*Note: Minimum coverage of 95% of Scope 1 & Scope 2 emissions* ▪ **Carbon intensity (power sector):** 0.009 tCO_2/MWh under *SBTi 1.5°C scenario* globally ▪ **Absolute contraction (power sector):** 97% reduction below 2020 under *SBTi 1.5°C scenario* globally		

Sector-specific benchmarks for energy utilities

Scope	Source	2025	2030	2035	2040	2045	2050
	Standard (v1.1). Caption of Figure 5a (Page 18) in SBTI NZT remains unclear whether this covers both scope 1 and 2 emissions. Updated SBTi Net Zero Tool (v1.0.3) does not include specific power sector pathway (only cross-sector pathway).						
	2023 Climate Action Tracker 1.5°C compatible scenario, global scope and country-specific available (CAT, 2023a, pp. 9, 12, 16, 20) *Note: Country-specific benchmarks available for Australia, Brazil, Chile, China, EU27, Germany, India, Indonesia, Japan, Mexico, Morocco, South Africa, Türkiye, UAE, UK, and the USA.* *Previous benchmarks from 2020 added in grey* (CAT, 2020).		▪ **Carbon intensity:** 48–80 gCO_2/kWh (previously 50–125 gCO_2/kWh in 2020 publication) ▪ **Share of renewables**: 81-89% (previously 55–90% in 2020 publication) ▪ **Share of unabated coal**: 4% (previously 0–2.5% in 2020 publication) ▪ **Share of fossil gas**: 5-7%	▪ **Carbon intensity:** 15–19 gCO_2/kWh ▪ **Share of renewables**: 91-95% ▪ **Share of unabated coal**: 1% ▪ **Share of fossil gas**: 2% ▪ **Developed countries** need to **phase out unabated gas** with minimal role of CCS	▪ **Carbon intensity:** 2-6 gCO_2/kWh (previously 5–25 gCO_2/kWh in 2020 publication) ▪ **Share of renewables**: 93-98% (previously 75–100% in 2020 publication) ▪ **Share of unabated coal**: 0% ▪ **Share of fossil gas**: 1%		▪ **Carbon intensity**: 0 gCO_2/kWh (previously <0 gCO_2/kWh in 2020 publication) ▪ **Share of renewables**: 95-100% (previously 95–100% in 2020 publication) ▪ **Share of unabated coal**: 0% ▪ **Share of fossil gas**: 0-1%
	2023 State of Climate Action for electricity generation 1.5°C compatible scenario, global scope (Boehm *et al.*, 2023, pp. 29, 31, 32, 36, 38, 39) ***Note:** All greyed-out benchmarks were additionally listed in the State of Climate Action 2022 report* (Boehm *et al.*, 2022). *The light blue colour indicates that it is from the 2021 report* (Boehm, Lebling, *et al.*, 2021, p. 42). *Note: Zero-carbon sources include solar, wind, hydro-power, geothermal, nuclear, marine, and biomass technologies.*		▪ **Carbon intensity**: 48-80 gCO_2/kWh ▪ **Share of zero-carbon sources in electricity generation**: 88-91% ▪ **Share of wind & solar in electricity generation**: 57-78% ▪ **Share of coal in electricity generation**: 4% ▪ **Share of unabated fossil gas in electricity generation**: 5-7% ▪ **Developed countries** need to **phase out coal** ▪ **Carbon intensity**: 50-125 gCO_2/kWh ▪ **Share of zero-carbon sources**: 74-92% ▪ **Share of unabated coal**: 0-2.5% ▪ **Share of unabated fossil gas**: 17% ▪ **Share of renewables:** 55–90% for all renewables, 37–72% for solar and wind		▪ **Carbon intensity**: 2-6 gCO_2/kWh ▪ **Share of zero-carbon sources in electricity generation**: 98-99% ▪ **Share of wind & solar in electricity generation**: 75-91% ▪ **Share of coal in electricity generation**: 0-1% ▪ **Share of unabated fossil gas in electricity generation**: 1% ▪ **Developing countries** need to **phase out coal and unabated gas** with minimal role of CCS ▪ **Carbon intensity:** 5-25 gCO_2/kWh using BEECS ▪ **Share of zero-carbon sources**: 87-100% ▪ **Share of unabated coal**: 0% ▪ **Share of unabated fossil gas**: 5%		▪ **Carbon intensity**: <0 gCO_2/kWh using BECCS ▪ **Share of zero-carbon sources in electricity generation**: 99-100% ▪ **Share of wind & solar in electricity generation**: 79-96% ▪ **Share of coal in electricity generation**: 0% ▪ **Share of unabated fossil gas in electricity generation**: 0% ▪ **Carbon intensity:** <0 gCO_2/kWh using BEECS ▪ **Share of zero-carbon sources**: 98-100% ▪ **Share of unabated coal**: 0% ▪ **Share of unabated fossil gas**: 0% ▪ **Share of renewables:** 98–100% for all renewables, 80–82% for solar and wind

Sector-specific benchmarks for energy utilities

Scope	Source	2025	2030	2035	2040	2045	2050
	UNFCCC for global level 1.5°C compatible scenario, global scope (UNFCCC, 2021b, p. 12)		▪ **Share of solar & wind**: at least 40% of global electricity generation ▪ **Share of renewables**: at least 60% of global electricity generation		▪ **Carbon intensity**: Full decarbonisation (i.e., 0 gCO_2/kWh) of global electricity system		
	2023 IEA Net Zero by 2050 1.5°C compatible scenario, global scope. (IEA, 2023a, pp. 91–92, 197–198) *Note: Previous benchmarks from 2020 added in grey* (IEA, 2022a, pp. 20; 117; 200).		▪ **CO2 emissions reduction in electricity & heat sector** (compared to 2021): 44% ▪ **Coal plants**: Phase-out of unabated coal in advanced economies ▪ **Oil-fired power plants:** Phase out of all large oil-fired power plants ▪ **Wind and solar annual capacity addition**: 1,141 GW (previously 1,020 GW in 2020 publication) ▪ **Installed renewable generation capacity**: 11,008 GW (68% of total) ▪ **Share of renewables (by total generation)**: 59% (40% from solar and wind) ▪ **Share of nuclear (by total generation)**: 10% ▪ **Carbon intensity**: 0.186 $kgCO_2$/kWh (global) ▪ **Carbon intensity**: 0.138 $kgCO_2$/kWh (global)	▪ **CO2 emissions reduction in electricity & heat sector** (compared to 2021): 80% ▪ **Carbon intensity**: 0.048 $kgCO_2$/kWh (global) and 0 $kgCO_2$/kWh (advanced economies) ▪ **Installed renewable generation capacity**: 17,460 GW (83% of total) ▪ **Share of renewables (by total generation)**: 78% (58% from solar and wind)	▪ **CO2 emissions reduction in electricity & heat sector** (compared to 2021): 97% ▪ **Coal plants**: Phase out of all unabated coal ▪ **Natural gas**: Unabated natural gas below 5% of generation, declines by over 80% ▪ **Installed renewable generation capacity**: 23,331 GW (80% of total) ▪ **Share of renewables (by total generation)**: 85% (66% from solar and wind) ▪ **Share of nuclear (by total generation)**: 9% ▪ **Carbon intensity**: 0.003 $kgCO_2$/kWh (global); 0 $kgCO_2$/kWh (China) ▪ **Carbon intensity**: - 0.001 $kgCO_2$/kWh (global)	▪ **Carbon intensity**: 0 $kgCO_2$/kWh (other emerging market and developing economies)	▪ **Installed renewable generation capacity**: 30,275 GW (82% of total) ▪ **Share of renewables (by total generation)**: 89% (71% from solar and wind) ▪ **Share of nuclear (by total generation)**: 8% ▪ **Carbon intensity**: - 0.004 $kgCO_2$/kWh (global) ▪ **Carbon intensity**: - 0.005 $kgCO_2$/kWh (global)
	IEA World Energy Outlook 2022 1.5°C compatible scenario, global scope. (IEA, 2022b, pp. 137–138)	▪ Nearly **50%** of electricity from **low-emissions sources** ▪ **Hydrogen and ammonia** start to co-fire with natural gas and coal	▪ **Phase out subcritical coal** ▪ **Over 40%** of electricity from **wind and solar PV; over 60%** from **renewables** ▪ **Wind and solar** annual capacity addition pass **1,050 GW** ▪ **27%** of total final energy consumption met through electricity		▪ **Global net zero emissions** in the electricity sector ▪ **Over 40%** of total final consumption **met by electricity**		▪ **1.5 Gt CO_2 captured** at power plants **annually** ▪ **Almost 70%** of electricity from **wind and solar PV; 8%** from **nuclear** ▪ **Nearly 90%** of electricity from **renewables** ▪ **Over 14,800 TWh** used to produce **hydrogen**
	IRENA World Energy Transitions Outlook 2023 1.5°C compatible scenario, global scope.		▪ **Share of renewables & variable RE**: 68% and 46% of global electricity				▪ **Share of renewables & variable RE**: 91% & 70% of global electricity generation

Sector-specific benchmarks for energy utilities

Scope	Source	2025	2030	2035	2040	2045	2050
	(IRENA, 2023, p. 65)		generation (~40,140 TWh total generation) ▪ **Installed renewable generation capacity**: 11,174 GW (77% of total) ▪ **Annual renewable capacity addition**: ~1,000 GW (China, EU US accounting for 75%) ▪ **Battery storage:** 359 GW				(~89,878 TWh total generation) ▪ **Installed renewable generation capacity**: 33,216 GW (94% of total) ▪ **Battery storage:** 4,098 GW
	2022 One Earth Climate Model 1.5°C compatible scenario, global scope. (Teske, 2022, pp. 296, 319)	▪ **Carbon intensity:** 0.29 $kgCO_2$/kWh ▪ **Share of renewables**: 52%	▪ **Carbon intensity:** 0.136 $kgCO_2$/kWh ▪ **Share of renewables**: 74% (52% from solar and wind)	▪ **Carbon intensity:** 0.053 $kgCO_2$/kWh ▪ **Share of renewables**: 89% (65% from solar and wind)	▪ **Carbon intensity:** 0.024 $kgCO_2$/kWh ▪ **Share of renewables**: 95% (68% from solar and wind)		▪ **Carbon intensity:** 0 $kgCO_2$/kWh ▪ **Share of renewables**: 100% (70% from solar and wind)
	2023 One Earth Climate Model 1.5°C compatible scenario, global scope. (Teske *et al.*, 2023)	▪ **Carbon intensity:** 0.272 $kgCO_2$/kWh	▪ **Carbon intensity:** 0.132 $kgCO_2$/kWh	**Carbon intensity:** 0.053 $kgCO_2$/kWh	▪ **Carbon intensity:** 0.023 $kgCO_2$/kWh		▪ **Carbon intensity:** 0 $kgCO_2$/kWh
	Carbon Tracker (Carbon Tracker, 2023, p. 5) *Note: Benchmarks informed by IEA's Below 2 Degrees scenario.*				▪ **99% of Unabated coal power phased out globally by 2040** (informed by IEA's Below 2 Degrees scenario)		▪ **95% unabated gas-fired phase-out globally by 2050** (informed by IEA's Below 2 Degrees scenario)
Scope 1	**2022 One Earth Climate Model** for energy utilities 1.5°C compatible scenario, global scope. (Teske, 2022, pp. 296, 319) ***Note:*** *Further consideration of scenario assumptions required. Calculation of reduction shares partially wrong throughout Table 13.2. Percentages presented here have been recalculated.*	▪ **Emission reductions below 2019 levels for**: **Coal:** -42% **Oil:** -7% **Gas:** -4%	▪ **Emission reductions below 2019 levels for**: **Coal:** -76% **Oil:** -26% **Gas:** -14%	▪ **Emission reductions below 2019 levels for**: **Coal:** -89% **Oil:** -61% **Gas:** -29%	▪ **Emission reductions below 2019 levels for**: **Coal:** -96% **Oil:** -75% **Gas:** -51%		▪ **Emission reductions below 2019 levels for**: **Coal:** -100% **Oil:** -81% **Gas:** -94%
Scope 2	**2022 One Earth Climate Model** for energy utilities 1.5°C compatible scenario, global scope. (Teske, 2022, p. 319) ***Note:*** *See above.*	▪ **Emission reductions below 2019 levels for**: **Coal:** -51% **Oil:** -7% **Gas:** -4%	▪ **Emission reductions below 2019 levels for**: **Coal:** -78% **Oil:** -26% **Gas:** -14%	▪ **Emission reductions below 2019 levels for**: **Coal:** -91% **Oil:** -61% **Gas:** -29%	▪ **Emission reductions below 2019 levels for**: **Coal:** -97% **Oil:** -75% **Gas:** -52%		▪ **Emission reductions below 2019 levels for**: **Coal:** -100% **Oil:** -81% **Gas:** -94%
Scope 3 ***Total***	**2022 One Earth Climate Model** for energy utilities	▪ **Emission reductions below 2019 levels for**: **Coal:** -49%	▪ **Emission reductions below 2019 levels for**: **Coal:** -79%	▪ **Emission reductions below 2019 levels for**: **Coal:** -91%	▪ **Emission reductions below 2019 levels for**: **Coal:** -98%		▪ **Emission reductions below 2019 levels for**: **Coal:** -100%

Sector-specific benchmarks for energy utilities

Scope		Source	2025	2030	2035	2040	2045	2050
		1.5°C compatible scenario, global scope. (Teske, 2022, p. 319) ***Note:** See above.*	**Oil:** -8% **Gas:** -7%	**Oil:** -31% **Gas:** -18%	**Oil:** -73% **Gas:** -33%	**Oil:** -90% **Gas:** -53%		**Oil:** -100% **Gas:** -94%
		SBTi guidance for energy utilities (SBTi, 2020d, 2021f)	*Note: Reverted identification out of tool's calculations as **no** manual or methodology exists! Guidance of 2020 specifies that Scope 3 target only mandatory if scope 3 emissions exceed 40% of total emissions, except for sold and distributed fossil fuels.* ▪ **Absolute contraction (energy utilities)**: 4.4% emissions reduction per year (p.a.) under *SBTi 1.5°C scenario* globally until 2035 ▪ **Economic intensity (energy utilities)**: the minimum threshold is 7% year-on-year reduction of emissions per unit value added (or revenue?) until 2035 ▪ **Physical intensity (energy utilities):** Unclear calculations in the tool on year-on-year reduction for a company defined physical emissions intensity metric until 2035					
	Upstream	**2023 IEA Net Zero by 2050** 1.5°C compatible scenario, global scope. (IEA, 2023a, pp. 62, 79, 198–199) *Note: Previous benchmarks from 2020 added in grey* (IEA, 2022a, pp. 20; 117; 200).	▪ No new conventional long lead time oil and gas projects approved for development after 2023 ▪ Nonetheless, continued investment is required in existing oil and gas assets and already approved projects ▪ No new coal mines, coal mine lifetime extensions, or new unabated coal plants ▪ No new oil and gas levels fields approved for development ▪ No new coal mines or mine extensions by 2021					
	Downstream	**SBTi Corporate Net Zero Standard** for fossil fuel sale, transmission & distribution (SBTi, 2023a) *Note: Defined as "companies that receive less than 50% of their revenue from fossil fuel sale, transmission, or distribution. For companies that receive 50% or more of their revenue from these activities, please refer to the Oil & Gas section above" by SBTi, 2021, p.29, footnote 18.*	▪ **Target setting (at least consistent with 1.5°C)**: Scope 3 targets to be set on scope 3 category 11 "use of sold products" irrespective of the share of these emissions compared to the total scope 1, 2 and 3 emissions of the company. Separate scope 3 targets may need to be set in this case.					

4 Fashion retailing

Last update	**28.04.2024**
Summary	We could identify only few sector-specific decarbonisation milestones for the fashion retailing industry in existing literature. Teske (Teske, 2022; Teske *et al.*, 2023) provides global benchmarks for both the *textile and leather industry* and the *manufactured fibres and synthetic rubber*. Given that emissions in the fashion industry occur in various sectors, including agriculture and energy, we also compare fashion retailing companies to global economy-wide decarbonisation trajectories to reduce GHG and CO_2 emissions by 43% and 48% by 2030 respectively to stand a reasonable chance of limiting global warming to 1.5°C (IPCC, 2022).

Sector-specific benchmarks for fashion retailers

Indicator	Source	2025	2030	2035	2040	2045	2050
Scope 1, Scope 2 & Scope 3	**UNFCCC** for apparel industry 1.5°C compatible scenario, global scope (UNFCCC, 2021a) *Note: **Not applicable** as rather industry agreement rather than science-informed benchmarks.*		*Note: **Not applicable** as rather industry agreement rather than science-informed benchmarks* ▪ **Emission reduction (for apparel industry): 30% reduction in GHG emissions** by 2030 for all Fashion Charter signatories				*Note: **Not applicable** as rather industry agreement rather than science-informed benchmarks* ▪ **Emission reduction (for apparel industry): Net zero emissions by 2050** for all Fashion Charter signatories
Scope 1 & Scope 2	**Transition Pathway Initiative (TPI) guidance** for 'other industry' including clothing and textiles sector Well below 2°C and 2°C scenario, global scope.(Dietz, Hastreiter and Scheer, 2021) *Note: 1) 'Other industry' includes construction materials, electronic devices (e.g., smartphones, laptops, etc.), clothing and textiles, beverages, printing and recording media, and furniture. 2) Limited to CO_2 emissions given that non- CO_2 is more relevant for Scope 3.*	▪ **Emissions intensity per unit of revenue (well below 2°C):** 13.52 tCO_2/million USD ▪ **Emissions intensity per unit of revenue (2°C):** 15.93 tCO_2/million USD	▪ **Emissions intensity per unit of revenue (well below 2°C):** 8.23 tCO_2/million USD ▪ **Emissions intensity per unit of revenue (2°C):** 10.39 tCO_2/million USD		▪ **Emissions intensity per unit of revenue (well below 2°C):** 3.02 tCO_2/million USD ▪ **Emissions intensity per unit of revenue (2°C):** 4.89 tCO_2/million USD		▪ **Emissions intensity per unit of revenue (well below 2°C):** 0.84 tCO_2/million USD ▪ **Emissions intensity per unit of revenue (2°C):** 2.80 tCO_2/million USD
	SBTi guidance for apparel and footwear companies 1.5°C compatible and well below 2°C scenario, global scope (SBTi, 2018a, pp. 22; 27) *Note: Note: Benchmark represents cross-sectoral despite present here as apparel-industry specific*		▪ **Annual linear reduction (1.5°C compatible):** -4.2% ▪ **Annual linear reduction (well below 2°C):** -2.5%				

Sector-specific benchmarks for fashion retailers

Indicator	Source	2025	2030	2035	2040	2045	2050
Scope 1	**Transition Pathway Initiative (TPI) guidance** for 'other industry' including clothing and textiles sector Well below 2°C and 2°C scenario, global scope. (Dietz, Hastreiter and Scheer, 2021) *Note: 1) 'Other industry' includes construction materials, electronic devices (e.g., smartphones, laptops, etc.), clothing and textiles, beverages, printing and recording media, and furniture. 2) Base year is 2019 with baseline of 10.35 tCO_2/million USD.*	▪ **Emissions growth rate (well below 2°C):** - 23.8% below base year ▪ **Emissions growth rate (2°C):** - 5.7% below base year	▪ **Emissions growth rate (well below 2°C):** - 40.4% below base year ▪ **Emissions growth rate (2°C):** - 16.1% below base year		▪ **Emissions growth rate (well below 2°C):** - 60.1% below base year ▪ **Emissions growth rate (2°C):** - 30.4% below base year		▪ **Emissions growth rate (well below 2°C):** - 75% below base year ▪ **Emissions growth rate (2°C):** - 41.5% below base year
	2022 One Earth Climate Model for textile and leather industry 1.5°C compatible scenario, global scope (Teske, 2022, p. 327) *Note: 1) Scope 1 encompasses direct energy-related CO_2 emissions requiring heat or fuels (Scope 1 of textile and leather producers = upstream Scope 3 of fashion retailers). 2) Base year is 2019 with baseline of 178 $MtCO_2e$/year*	▪ **Emission reductions below 2019 levels:** - 15%	▪ **Emission reductions below 2019 levels:** - 39%	▪ **Emission reductions below 2019 levels:** - 51%	▪ **Emission reductions below 2019 levels:** - 71%		▪ **Emission reductions below 2019 levels:** - 100%
	2022 One Earth Climate Model for manufactured fibres and synthetic rubber 1.5°C compatible scenario, global scope (Teske, 2022, p. 322) *Note: 1) Scope 1 of fibres and rubber producers (upstream Scope 3 of fashion retailers). 2) Base year is 2019 with baseline of 301 $MtCO_2e$/year*	▪ **Emission reductions below 2019 levels:** - 21%	▪ **Emission reductions below 2019 levels:** - 44%	▪ **Emission reductions below 2019 levels:** - 56%	▪ **Emission reductions below 2019 levels:** - 74%		▪ **Emission reductions below 2019 levels:** - 100%
Scope 2	**SBTi guidance** for apparel and footwear companies (SBTi, 2018a, p. 20)	▪ **Share of RE in electricity procurement**: 80% of total energy use	▪ **Share of RE in electricity procurement**: 100% of total energy use				
	Transition Pathway Initiative (TPI) guidance for 'other industry' including clothing and textiles sector Well below 2°C and 2°C scenario, global scope.	▪ **Emissions growth rate (well below 2°C):** - 27.6% below base year	▪ **Emissions growth rate (well below 2°C):** - 48.6% below base year ▪ **Emissions growth rate (2°C):** - 42% below base year		▪ **Emissions growth rate (well below 2°C):** - 81.2% below base year		▪ **Emissions growth rate (well below 2°C):** - 102.4% below base year ▪ **Emissions growth rate (2°C):** - 88.4% below base year

Sector-specific benchmarks for fashion retailers

Indicator	Source	2025	2030	2035	2040	2045	2050
	(Dietz, Hastreiter and Scheer, 2021) *Note: 1) 'Other industry' includes construction materials, electronic devices (e.g., smartphones, laptops, etc.), clothing and textiles, beverages, printing and recording media, and furniture. 2) Base year is 2019 with baseline of 13.0 tCO_2/million USD*	▪ **Emissions growth rate (2°C):** - 18.2% below base year			▪ **Emissions growth rate (2°C):** - 73.6% below base year		
	2022 One Earth Climate Model for textile and leather industry 1.5°C compatible scenario, global scope (Teske, 2022, p. 327) *Note: 1) Scope 2 encompasses indirect emissions from electricity during production, excl. fibres manufacturing & retail (Scope 2 of textile and leather producers = upstream Scope 3 of fashion retailers). 2) Base year is 2019 with baseline of 181 $MtCO_2e$/year*	▪ **Emission reductions below 2019 levels:** - 30%	▪ **Emission reductions below 2019 levels:** - 62%	▪ **Emission reductions below 2019 levels:** - 83%	▪ **Emission reductions below 2019 levels:** - 92%		▪ **Emission reductions below 2019 levels:** - 100%
	2022 One Earth Climate Model for manufactured fibres and synthetic rubber 1.5°C compatible scenario, global scope (Teske, 2022, p. 322) *Note: 1) Scope 2 of fibres and rubber producers (upstream Scope 3 of fashion retailers). 2) Base year is 2019 with baseline of 39 $MtCO_2e$/year*	▪ **Emission reductions below 2019 levels:** - 36%	▪ **Emission reductions below 2019 levels:** - 67%	▪ **Emission reductions below 2019 levels:** - 85%	▪ **Emission reductions below 2019 levels:** - 92%		▪ **Emission reductions below 2019 levels:** - 100%
	2023 One Earth Climate Model for textile and leather industry 1.5°C compatible scenario, global scope (Teske *et al.*, 2023) *Note: 1) Scope 2 emissions of textile and leather producers (upstream scope 3 of fashion retailers). 2) Base year is 2019 with baseline of 130 gCO_2/kWh (heat & fuel supply) and 456 gCO_2/kWh (electricity supply)*	▪ **Emission intensity (heat & fuel supply)**: 91 gCO_2/kWh ▪ **Emission intensity (electricity supply)**: 273 gCO_2/kWh	▪ **Emission intensity (heat & fuel supply)**: 57 gCO_2/kWh ▪ **Emission intensity (electricity supply)**: 132 gCO_2/kWh	▪ **Emission intensity (heat & fuel supply)**: 36 gCO_2/kWh ▪ **Emission intensity (electricity supply)**: 53 gCO_2/kWh	▪ **Emission intensity (heat & fuel supply)**: 23 gCO_2/kWh ▪ **Emission intensity (electricity supply)**: 23 gCO_2/kWh	▪ **Emission intensity (heat & fuel supply)**: 7 gCO_2/kWh ▪ **Emission intensity (electricity supply)**: 7 gCO_2/kWh	▪ **Emission intensity (heat & fuel supply)**: 0 gCO_2/kWh ▪ **Emission intensity (electricity supply)**: 0 gCO_2/kWh
	UNFCCC 2030 Solutions Implementation Roadmap (UNFCCC, 2023, p. 32)		▪ **Renewable electricity procurement: 100% for scope 2**				

Sector-specific benchmarks for fashion retailers

Indicator		Source	2025	2030	2035	2040	2045	2050
Scope 3	***Total***	**SBTi guidance** for apparel industry 1.5°C compatible, well below 2°C, and 2°C scenario, global scope (SBTi, 2018a, pp. 22; 27)		▪ **Absolute contraction:** ▪ **Annual linear reduction (1.5°C compatible):** at least – 4.2% ▪ **Annual linear reduction (well below 2°C):** at least – 2.5% ▪ **Annual linear reduction (2°C):** at least – 1.23% ▪ **Economic intensity:** reduction at an average of 7% YoY in tCO_2e/$ value added				
		2022 One Earth Climate Model for textile and leather industry 1.5°C compatible scenario, global scope. (Teske, 2022, p. 327) *Note: 1) Scope 3 emissions of textile and leather producers / upstream scope 3 of fashion retailers. 2) Incl. 25% of all CH_4 emissions from agriculture to reflect the non-energy-related emissions of fibres and animal skin production. 3) Base year is 2019 with baseline of 28 $MtCO_2e$/year*	▪ **Emission reductions below 2019 levels:** - 23%	▪ **Emission reductions below 2019 levels:** - 37%	▪ **Emission reductions below 2019 levels:** - 43%	▪ **Emission reductions below 2019 levels:** - 44%		▪ **Emission reductions below 2019 levels:** - 48%
	Upstream	**UNFCCC** for fashion industry 1.5°C compatible scenario, global scope. (UNFCCC, 2021b)	▪ At least **25% of raw materials** come from lower climate impact sources					▪ **Reductions in GHG emissions** related to textile fibre and materials production consistent with net zero industry emissions by 2050
	Downstream	*None identified*						

5 Food and agriculture

Last update	**28.04.2024**
Summary	We could identify only few sector-specific decarbonisation milestones for the agriculture and food industry in existing literature (Boehm, Lebling, *et al.*, 2021, pp. 129, 152; Dietz, Harvey, *et al.*, 2022, p. 14; SBTi, 2022b, pp. 44–45; Teske, 2022, p. 328; Boehm *et al.*, 2023, p. 125; Teske *et al.*, 2023 data in Dataset 2). We cannot use SBTi's Forests, Land and Agriculture (FLAG) guidance benchmarks to assess company's *emissions reduction* commitments as they integrally include land sequestration carbon dioxide removal (SBTi, 2022b, pp. 44–45). The TPI also allows companies in the food sector to rely on offsetting for target realisation but we interpret the benchmarks itself not relying on offsetting (Dietz, Harvey, *et al.*, 2022, p. 17). Therefore, we only consider these benchmarks to reduce emissions intensity by 52% by 2030 and 85% by 2050 to evaluate targets excluding offsetting. We also use sub-sector targets for the food and agriculture sector covering major emission sources (Roe *et al.*, 2019; Searchinger *et al.*, 2019; Boehm *et al.*, 2023, p. 125). We further compare companies in the agriculture and food industry to global economy-wide decarbonisation trajectories, including reductions of global methane emissions by 34% between 2019 and 2030 as particularly important for the global food and agriculture sector (IPCC, 2022).

Sector-specific benchmarks for forestry, land-use, and agriculture

Indicator	Source	2025	2030	2035	2040	2045	2050
Scope 1, Scope 2 & Scope 3	**SBTi FLAG guidance** for FLAG sector 1.5°C compatible and well below 2°C scenario, global scope (SBTi, 2022b, pp. 44–45) *Note: 1) Minimum coverage of 95% of Scope 1 & Scope 2 emissions and 67% of Scope 3. 2) In-supply chain removals ("insetting"?) can be accounted for in the FLAG target. 3) Emissions accounting must include land use change (LUC) CO_2 emissions, non- LUC non-CO_2 emissions, and carbon removals & storage*	▪ **Before 2025, commit to no deforestation** especially for deforestation-linked commodities (beef, palm oil, soy, cocoa, and timber & wood fibre)	▪ **Annual absolute reduction <u>including removals</u> (both 1.5°C compatible and well below 2°C scenario):** annually 3.03% between 2020-2030 → translating into 30.3% absolute reduction by 2030 below 2020 levels ▪ **Annual intensity reduction for 10 commodities (beef, chicken, dairy, leather, maize, palm oil, pork, rice, soy, wheat)** between 2020-2030 available, see Table 9 on page 45				
	UNFCCC for global level 1.5°C compatible scenario, global scope (UNFCCC, 2021b)		▪ **Emissions reductions**: 50 $GtCO_2e$ are mitigated by AFOLU practices and reducing inputs and waste				▪ Entire forestry, food & agriculture industry is **carbon negative**

Sector-specific benchmarks for forestry, land-use, and agriculture

Indicator	Source	2025	2030	2035	2040	2045	2050
			▪ Entire forestry, food & agriculture industry is **nature positive** ▪ **20% of major food supplier** by revenue implement **deforestation-free supply chain** and fully adopt **regenerative agriculture** and **land restoration** practices				
	Transitions Pathway Initiative for food producers (discussion paper) 1.5°C compatible, well below 2°C, and 2°C scenario, global scope. (Dietz, Harvey, *et al.*, 2022, p. 14) *Note: 1) Base year is 2020 with baseline of 2.751 tCO_2e/tonne agricultural input. **2) Methods allows offsets or negative emissions as part of their own corporate analyses (see Nestlé analysis).** 3) Scope 3 is upstream only and account for 95% of emissions*		▪ **Emissions intensity (1.5°C compatible):** 1.315 tCO_2e/tonne agricultural input (-52% below base year) ▪ **Emissions intensity (well below 2°C compatible):** 1.821 tCO_2e/tonne agricultural input (-34% below base year) ▪ **Emissions intensity (2°C compatible):** 1.906 tCO_2e/tonne agricultural input (-31% below base year)		▪ **Emissions intensity (1.5°C compatible):** 0.807 tCO_2e/tonne agricultural input (-71% below base year) ▪ **Emissions intensity (well below 2°C compatible):** 1.063 tCO_2e/tonne agricultural input (-61% below base year) ▪ **Emissions intensity (2°C compatible):** 1.295 tCO_2e/tonne agricultural input (-53% below base year)		▪ **Emissions intensity (1.5°C compatible):** 0.414 tCO_2e/tonne agricultural input (-85% below base year) ▪ **Emissions intensity (well below 2°C compatible):** 0.643 tCO_2e/tonne agricultural input (-77% below base year) ▪ **Emissions intensity (2°C compatible):** 0.958 tCO_2e/tonne agricultural input (-65% below base year)
Scope 1, Scope 2 & Scope 3	**2023 SBTi Corporate Net Zero Standard** for FLAG sector 1.5°C compatible, global scope. (SBTi, 2021b, 2022c, 2023a) *Note: 1) Absolute reduction of **72%** for 2050 directly taken out of updated SBTi Net Zero Tool (v1.0.3) under 'Calculations tab' & SBTi Net Zero Standard (v1.1). Tool further specifies that this covers both scope 1 and 2 while caption of Figure 5 (Page 18) in SBTI NZT remains unclear. 2) Note: Minimum coverage of 95% of Scope 1 & Scope 2 emissions*						▪ **Emissions reduction below 2020 level (1.5°C compatible):** 72% (long-term target)
Scope 1 & Scope 2	**2023 State of Climate Action** for food and agriculture sector 1.5°C compatible, global scope. (Boehm *et al.*, 2023, p. 125) *Note: All greyed-out benchmarks were additionally listed in the State of Climate*		▪ **GHG emissions intensity of agricultural production:** 500 gCO_2e/1,000 kcal ▪ **Crop yields:** 7.8 tonne/ha	▪ **GHG emissions intensity of agricultural production:** 450 gCO_2e/1,000 kcal ▪ **Crop yields:** 8.2 tonne/ha			▪ **GHG emissions intensity of agricultural production:** 320 gCO_2e/1,000 kcal ▪ **Crop yields:** 9.6 tonne/ha ▪ **Ruminant meat productivity:** 42 kg/ha

Sector-specific benchmarks for forestry, land-use, and agriculture

Indicator	Source	2025	2030	2035	2040	2045	2050
	Action 2022 report (Boehm, Lebling, *et al.*, 2021, pp. 129; 152). *Note: 1) 2022 SoCA edition provides further benchmarks at the global level* (Boehm *et al.*, 2022). *We consider these not directly applicable for corporate assessments.* *Additional note for 2023 report: 1) Food loss occurs before food gets to market. 2) Food waste occurs at the retail level and in homes, restaurants, etc. 3) The meat diet shift applies specifically to the high-consuming regions (Americas, Europe, and Oceania). It does not apply to populations that already consume less than 60 kcal/capita/day, have micronutrient deficiencies, and/or do not have access to affordable and healthy alternatives to ruminant meat. 4) Availability is used as a proxy for consumption*		▪ **Ruminant meat productivity:** 33 kg/ha ▪ **Share of food production lost:** 6.5% ▪ **Food waste:** 61 kg/capita ▪ **Ruminant meat consumption:** 79 kcal/capita/day ▪ **Enteric fermentation:** 17% reduction compared to 2017 levels ▪ **Manure management:** 21% reduction compared to 2017 levels ▪ **Manure on pasture:** 14% reduction compared to 2017 levels ▪ **Soil fertilization:** 23% reduction compared to 2017 levels ▪ **Rice cultivation:** 23% reduction compared to 2017 levels ▪ **Enteric fermentation:** 17% reduction compared to 2017 levels ▪ **Manure management:** 21% reduction compared to 2017 levels ▪ **Manure on pasture:** 13% reduction compared to 2017 levels	▪ **Ruminant meat productivity:** 35 kg/ha ▪ **Share of food production lost:** 6.5% ▪ **Food waste:** 61 kg/capita ▪ **Ruminant meat consumption:** 74 kcal/capita/day ▪ **Enteric fermentation:** 20% reduction compared to 2017 levels ▪ **Manure management:** 26% reduction compared to 2017 levels ▪ **Manure on pasture:** 15% reduction compared to 2017 levels ▪ **Soil fertilization:** 27% reduction compared to 2017 levels ▪ **Rice cultivation:** 29% reduction compared to 2017 levels			▪ **Share of food production lost:** 6.5% ▪ **Food waste:** 61 kg/capita ▪ **Ruminant meat consumption:** 60 kcal/capita/day ▪ **Enteric fermentation:** 29% reduction compared to 2017 levels ▪ **Manure management:** 39% reduction compared to 2017 levels ▪ **Manure on pasture:** 20% reduction compared to 2017 levels ▪ **Soil fertilization:** 39% reduction compared to 2017 levels ▪ **Rice cultivation:** 45% reduction compared to 2017 levels ▪ **Enteric fermentation:** 29% reduction compared to 2017 levels ▪ **Manure management:** 38% reduction compared to 2017 levels ▪ **Manure on pasture:** 19% reduction compared to 2017 levels
Scope 1	**2022 One Earth Climate Model** for agriculture and food sector (incl. tobacco) 1.5°C compatible scenario, global scope (Teske, 2022, p. 328) *Note: 1) Scope 1 encompasses fuel used on farms, heat used for food packaging and processing. 2) Base year is 2019 with baseline of 355 $MtCO_2e$/year*	▪ **Emission reductions below 2019 levels**: - 24%	▪ **Emission reductions below 2019 levels:** - 48%	▪ **Emission reductions below 2019 levels:** - 62%	▪ **Emission reductions below 2019 levels:** - 73%		▪ **Emission reductions below 2019 levels:** - 100%
Scope 2	**2022 One Earth Climate Model** for agriculture and food sector (incl. tobacco) 1.5°C compatible scenario, global scope (Teske, 2022, p. 328)	▪ **Emission reductions below 2019 levels**: - 35%	▪ **Emission reductions below 2019 levels:** - 67%	▪ **Emission reductions below 2019 levels:** - 86%	▪ **Emission reductions below 2019 levels:** - 93%		▪ **Emission reductions below 2019 levels:** - 100%

Sector-specific benchmarks for forestry, land-use, and agriculture

Indicator	Source	2025	2030	2035	2040	2045	2050
	Note: 1) Scope 2 encompasses electricity purchased for farming or food processing and packaging, with on-site generation able to reduce this emission. 2) Base year is 2019 with baseline of 975 $MtCO_2e$/year						
	2023 One Earth Climate Model for agriculture and food sector (incl. tobacco) 1.5°C compatible scenario, global scope (Teske *et al.*, 2023) *Note: 1) Scope 2 encompasses electricity purchased for farming or food processing and packaging, with on-site generation able to reduce this emission. 2) Base year is 2019 with baseline of 130 gCO_2/kWh (heat & fuel supply) and 456 gCO_2/kWh (electricity supply).*	▪ **Emission intensity (heat & fuel supply)**: 91 gCO_2/kWh ▪ **Emission intensity (electricity supply)**: 273 gCO_2/kWh	▪ **Emission intensity (heat & fuel supply)**: 57 gCO_2/kWh ▪ **Emission intensity (electricity supply)**: 132 gCO_2/kWh	▪ **Emission intensity (heat & fuel supply)**: 36 gCO_2/kWh ▪ **Emission intensity (electricity supply)**: 53 gCO_2/kWh	▪ **Emission intensity (heat & fuel supply)**: 23 gCO_2/kWh ▪ **Emission intensity (electricity supply)**: 23 gCO_2/kWh	▪ **Emission intensity (heat & fuel supply)**: 7 gCO_2/kWh ▪ **Emission intensity (electricity supply)**: 7 gCO_2/kWh	▪ **Emission intensity (heat & fuel supply)**: 0 gCO_2/kWh ▪ **Emission intensity (electricity supply)**: 0 gCO_2/kWh
Scope 3	**2022 One Earth Climate Model** for agriculture and food sector (incl. tobacco) 1.5°C compatible scenario, global scope (Teske, 2022, p. 328) *Note: 1) Scope 3 encompasses AFOLU emissions, N_2O, ammonia emissions, CH_4 emissions – cannot be reduced to 0 due to increasing demand 2) Base year is 2019 with baseline of 6,837 $MtCO_2e$/year*	▪ **Emission reductions below 2019 levels**: 21%	▪ **Emission reductions below 2019 levels:** - 34%	▪ **Emission reductions below 2019 levels:** - 38%	▪ **Emission reductions below 2019 levels:** - 38%		▪ **Emission reductions below 2019 levels:** - 42%

6 Oil and gas industry

Last update	**28.04.2024**

Summary

Development of new oil and gas fields and decrease in global production volumes

Several studies identify 1.5°C-aligned milestones to *not* develop any new oil and gas fields globally from 2021 / 2022 onwards (IEA, 2022a, pp. 20–21; 117; IISD, 2022, pp. iv–v; Teske, 2022, p. 319; CAT, 2023a). Several studies further identify 1.5°C-aligned benchmarks for the reduction in global oil and gas production volumes (UNFCCC, 2021b, p. 17; IEA, 2022a, pp. 20–21, 117; IISD, 2022, pp. iv–v; IEA, 2023a, pp. 117, 199; IRENA, 2023, pp. 47–49).

Emissions intensity of oil and gas companies (scope 1, 2, and 3)

The TPI provides emission intensity benchmarks for oil and gas companies for scope 1, 2, and 3 emissions from the use of sold products (Dietz, Gardiner, Hastreiter, *et al.*, 2021, pp. 9–10). The benchmark comprises all *energy products sold externally* by oil and gas companies including, for example, electricity generated from renewables (Dietz, Gardiner, Hastreiter, *et al.*, 2021, p. 13). The TPI allows oil and gas companies to rely on offsetting for target realisation but we interpret the benchmarks itself not relying on offsetting (Dietz, Gardiner, Hastreiter, *et al.*, 2021, p. 19). Therefore, we only consider these benchmarks to evaluate targets *excluding* offsetting. In August 2020, SBTi released a draft guidance for the oil and gas sector for public consultation (SBTi, 2020c). We do not consider this SBTi draft guidance.

Sector-specific benchmarks for oil & gas companies

Indicator	Source	2025	2030	2035	2040	2045	2050
Scope 1, Scope 2 & Scope 3	**Transition Pathway Initiative (TPI) guidance** for oil & gas producers (Dietz and Byrne, 2023, p. 10)		▪ **Emissions intensity**: 43.16 gCO_2e/MJ under *1.5 Degree scenario* globally		▪ **Emissions intensity**: 17.31 gCO_2e/MJ under *1.5 Degree scenario* globally		▪ **Emissions intensity**: 5.85 gCO_2e/MJ under *1.5 Degree scenario* globally
	UNFCCC for global level (UNFCCC, 2021b, p. 17, 2023, pp. 20–21)		▪ **Oil production:** reduced by 40% below 2019 levels ▪ **Unabated gas production**: share reduced to 17% ▪ **Oil and gas methane emissions:** reduced by 75% below 2020				▪ **Emissions**: Net 100% reduction (net zero) across all emissions scopes
	CAT Power Benchmarks Power Sector (CAT, 2023a)	**Oil & gas fields**: no new oil and gas fields in 2023/immediately	**Share of fossil gas in global electricity generation: 5**-7%		**Share of fossil gas in global electricity generation:** 1%		▪ **Share of fossil gas in global electricity generation:** 0-1%
	IRENA World Energy Transitions Outlook 2023 (IRENA, 2023, pp. 47–49)		▪ **Share of energy supply of fossil fuels under 1.5 Degree scenario:** 60%	▪ **Share of energy supply of fossil fuels under 1.5 Degree scenario:** 47%	▪ **Share of energy supply of fossil fuels under 1.5 Degree scenario: 35**%		▪ **Share of energy supply from fossil fuels under 1.5 Degree scenario:** 16% ▪ **Share of fossil fuels in global electricity**

Sector-specific benchmarks for oil & gas companies

Indicator	Source	2025	2030	2035	2040	2045	2050
							generation under 1.5 Degree scenario: 5%
Scope 1 & Scope 2	**SBTi** guidance for oil & gas producers (SBTi, *forthcoming*) ***Note:*** *Option to add latest draft status of 08/2020 and other resources for internal comparison. No date for final release communicated.*						
	IEA Net Zero by 2050 for global level (IEA, 2023a, pp. 117, 199) (IEA, 2022a, pp. 20–21; 101, 117, 195)	▪ **Oil & gas fields**: No new oil and gas fields approved for development by 2021	▪ **Unabated natural gas-fired generation: 9**% lower by 2030 below 2022 globally ▪ **Unabated natural gas:** 16% of electricity generation ▪ **Absolute emissions levels electricity and heat sectors:** 0.1 for oil and 2.7 $GtCO_2e$ for gas ▪ **Absolute emissions levels combustion activities:** 7.9 for oil and 5.8 $GtCO_2e$ for gas ▪ **Emissions intensity of global oil and gas operations:** more than 50% lower ▪ **Large oil-fired power plants:** Phase out large oil-fired power plants in the 2030s ▪ **Unabated natural gas-fired generation:** Global peak in 2030	▪ **Unabated natural gas-fired generation: 56**% lower by 2030 below 2022 globally (peaks in 2030) ▪ **Unabated natural gas:** 3% of electricity generation ▪ **Absolute emissions levels electricity and heat sectors:** 0.1 for oil and 2.7 $GTCO_2e$ for gas ▪ **Absolute emissions levels combustion activities:** 7.9 for oil and 5.8 GTCo2eq for gas	▪ **Absolute emissions levels electricity and heat sectors:** 0.04 for oil and 1.4 $GtCO_2e$ for gas ▪ **Absolute emissions levels combustion activities:** 5.3 for oil and 3.3 $GtCO_2e$ for gas ▪ **Unabated natural gas-fired generation:** 90% lower by 2040 below 2021 globally ▪ **Unabated natural gas:** below 5% of electricity generation ▪ **Share of unabated natural gas in total energy supply**: 21% ▪ **Share of oil in total energy supply**: 25%	▪ **Fossil fuel GHG emissions (coal, oil and gas):** fall by 95% to 2040 ▪ **Absolute emissions levels electricity and heat sectors:** 0.02 for oil and 0.6 $GTCO_2e$ for gas ▪ **Absolute emissions levels combustion activities:** 3.2 for oil and 1.8 GTCo2eq for gas	▪ **CCUS:** Nearly all remaining plants retrofitted with CCUS or fully converted to use low-emissions fuels ▪ **Fossil fuel GHG emissions (coal, oil and gas):** fall by 97% to 2050; nearly 80% of fossil fuel demand in 2050 is for non-combustion applications or used with CCUS ▪ **Absolute emissions levels scope 1 and 2:** 0.1 for oil and 0.03 $GTCO_2e$ for gas ▪ **Unabated natural gas-fired generation: 92**% lower below 2022 globally ▪ **Share of unabated natural gas:** 0.2% ▪ **Absolute emissions levels electricity and heat sectors:** 0.02 for oil and 0.6 $GTCO_2e$ for gas ▪ **Absolute emissions levels combustion activities:** 0.4 for oil and 0.4 GTCo2eq for gas ▪ **Share of unabated natural gas in total energy supply**: 3% ▪ **Share of oil in total energy supply**: 8% ▪ **Demand for oil:** reduction by 75% below 2020 ▪ **Demand for natural gas:** reduction by 55% below 2020

Sector-specific benchmarks for oil & gas companies

Indicator		Source	2025	2030	2035	2040	2045	2050
		UNFCCC for global level (UNFCCC, 2021b, p. 17)		▪ **Production volume**: 40% reduction below 2019 of oil & gas production				
		IISD Navigating Energy Transitions for global level (IISD, 2022, pp. iv–v)	▪ **Oil & gas fields**: No new oil and gas fields approved for development by 2022	▪ **Production volume of oil**: 15% reduction of oil production below 2020 by 2030 ▪ **Production volume of gas**: 30% reduction of gas production below 2020 by 2030				▪ **Production volume of oil & gas**: min. 65% reduction of oil & gas production below 2020 by 2050
Scope 1		**Net-Zero 1.5 Sectoral Pathways** for global oil and gas utilities (Teske, 2022, p. 319) ***Note:*** *Further consideration of scenario assumptions required. Calculation of reduction shares partially wrong throughout Table 13.2.*	▪ **Oil & gas fields**: No new oil and gas fields approved for development by 2022 ▪ **Emission reductions below 2019 levels for oil**: 7% by 2025 ▪ **Emission reductions below 2019 levels for gas**: 4% by 2025	▪ **Emission reductions below 2019 levels for oil**: 26% by 2030 ▪ **Emission reductions below 2019 levels for gas**: 14% by 2030		▪ **Emission reductions below 2019 levels for oil**: 75% by 2040 ▪ **Emission reductions below 2019 levels for gas**: 51% by 2040		▪ **Emission reductions below 2019 levels for oil**: 81% by 2050 ▪ **Emission reductions below 2019 levels for gas**: 94% by 2050
Scope 2		**Net-Zero 1.5 Sectoral Pathways** for global oil and gas utilities (Teske, 2022, p. 319) ***Note:*** *See above.*	▪ **Emission reductions below 2019 levels for oil**: 7% by 2025 ▪ **Emission reductions below 2019 levels for gas**: 4% by 2025	▪ **Emission reductions below 2019 levels for oil**: 26% by 2030 ▪ **Emission reductions below 2019 levels for gas**: 14% by 2030		▪ **Emission reductions below 2019 levels for oil**: 75% by 2040 ▪ **Emission reductions below 2019 levels for gas**: 52% by 2040		▪ **Emission reductions below 2019 levels for oil**: 81% by 2050 ▪ **Emission reductions below 2019 levels for gas**: 94% by 2050
Scope 3	***Total***	**Net-Zero 1.5 Sectoral Pathways** for global oil and gas utilities (Teske, 2022, p. 319) ***Note:*** *See above.*	▪ **Emission reductions below 2019 levels for oil**: 8% by 2025 ▪ **Emission reductions below 2019 levels for gas**: 7% by 2025	▪ **Emission reductions below 2019 levels for oil**: 31% by 2030 ▪ **Emission reductions below 2019 levels for gas**: 18% by 2030		▪ **Emission reductions below 2019 levels for oil**: 90% by 2040 ▪ **Emission reductions below 2019 levels for gas**: 53% by 2040		▪ **Emission reductions below 2019 levels for oil**: 100% by 2050 ▪ **Emission reductions below 2019 levels for gas**: 94% by 2050

7 International aviation

Last update	**28.04.2024**

Summary

Use of sustainable aviation fuels (SAFs)

Several studies identify 1.5°C-aligned decarbonisation milestones for the use of sustainable aviation fuels (SAFs) in international aviation (UNFCCC, 2021b, p. 12, 2023, p. 30; Boehm *et al.*, 2023, p. 78; IEA, 2023a, p. 94).

Intensity of jet fuel emissions

The TPI and SBTi base their benchmarks on an intensity-based metric exclusively focusing on the use of jet fuel emissions (scope 1) (Dietz, Byrne, Sheer, *et al.*, 2021, p. 14; SBTi, 2021e, 2021c, p. 19). While the TPI uses the IEA's *Net Zero by 2050* report to derive 1.5°C-compatible benchmarks towards 2050 (Dietz, Byrne, Sheer, *et al.*, 2021, p. 14; IEA, 2023a, p. 198), the SBTi uses the IEA's *Energy Technology Perspectives* (ETP) report to derive a 'well-below 2°C'-aligned benchmark (IEA, 2020; SBTi, 2021e, p. 11). All benchmarks exclusively focus on jet fuel emissions and do not consider any non-GHG climate forcers from flying, which account for about two thirds of aviation's climate impact (Lee *et al.*, 2021).

Absolute emission reductions of global aviation sector

Several studies identify 1.5°-aligned absolute emission reductions for the global aviation sector (CAT, 2022; Teske, 2022, p. 333; IEA, 2023a, p. 198; Teske *et al.*, 2023 data in Dataset 2). The International Council on Clean Transportation (ICCT) further provides absolute reductions in line with a 1.75°C temperature limit (Graver et al., 2022, p. i).

Sector-specific benchmarks for international aviation

Indicator	Source	2025	2030	2035	2040	2045	2050
Scope 1, Scope 2 & Scope 3	**Climate Action Tracker (CAT)** assessment of international aviation (CAT, 2022) *Note: Base year is 2019 with baseline of 621 $MtCO_2$/year*		▪ **CO_2 emission reductions below 2019 levels**: 55%		▪ **CO_2 emission reductions below 2019 levels**: 77%		▪ **CO_2 emission reductions below 2019 levels**: 89%
	SBTi Interim Technical Report as of February 2023 1.5°C scenario, global scope. (SBTi, 2023d, pp. 5–6) *Note: 1) Calculated on well-to-wake basis. 2) Other scenarios available: Breakthrough 1.75°C scenario by ICCT, 1.5°C NZE IEA, and well below 2°C IEA. 3) Base year is 2019 with baseline approx. 600 $MtCO_2$/year. 4) Emissions intensity numbers read out of Figure 1).*		▪ **CO_2 emission reductions below 2019 levels (Interim 1.5°C):** -29.6% ▪ **CO_2 emission reductions below 2019 levels (1.5°C NZE IEA):** -38.5% ▪ **CO_2 emission reductions below 2019 levels (well below 2°C & Breakthrough 1.75°C):** -29.6%		▪ **CO_2 emission reductions below 2019 levels (Interim 1.5°C):** -73.2% ▪ **CO_2 emission reductions below 2019 levels (1.5°C NZE IEA):** -71.7% ▪ **CO_2 emission reductions below 2019 levels (well below 2°C & Breakthrough 1.75°C):** -51.6%		▪ **CO_2 emission reductions below 2019 levels (Interim 1.5°C):** -97.4% ▪ **CO_2 emission reductions below 2019 levels (1.5°C NZE IEA):** -90.1% ▪ **CO_2 emission reductions below 2019 levels (well below 2°C & Breakthrough 1.75°C):** -65.2% ▪ **Emissions intensity:**

Sector-specific benchmarks for international aviation

Indicator	Source	2025	2030	2035	2040	2045	2050
			▪ **Emissions intensity:** ▪ **Interim 1.5°C scenario:** 650-750 gCO_2e/ revenue.tonne.km ▪ **1.5°C NZE IEA scenario:** 650-750 gCO_2e/ revenue.tonne.km ▪ **Well below 2°C scenario & Breakthrough 1.75°C:** 650-750 gCO_2e/revenue.tonne.km		▪ **Emissions intensity:** ▪ **Interim 1.5°C scenario:** 200-300 gCO_2e/ revenue.tonne.km ▪ **1.5°C NZE IEA scenario:** 300-350 gCO_2e/revenue.tonne.k ▪ **Well below 2°C scenario & Breakthrough 1.75°C:** 400-500 gCO_2e/revenue.tonne.km		▪ **Interim 1.5°C scenario:** 0-50 gCO_2e/ revenue.tonne.km ▪ **1.5°C NZE IEA scenario:** 100-150 gCO_2e/ revenue.tonne.km ▪ **Well below 2°C scenario & Breakthrough 1.75°C:** 350-400 gCO_2e/revenue.tonne.km
	Air Transport Action Group (ATAG) Waypoint 2050 Well below 2°C scenario (estimated by ICCT), global scope (ATAG, 2021, p. 24) *Note: 1) Base year is 2019 with baseline approx. 600 $MtCO_2$/year. 2) Other scenarios available but no estimate of temperature alignment*				▪ **Transition** of fleets **towards hybrid or electric** from 2035–2040		▪ **Emission reductions below 2019 level:** 100% (technology 22% + operations 10% + SAF 61% + offset 7%) ▪ **Zero-emission plane share:** 20% (hydrogen), 2% (electricity)
	International Council on Clean Transportation (ICCT) Vision 2050 1.75°C (*Breakthrough*), well below 2°C (*Transformation*), and 2°C scenario (*Action*), global scope (Graver *et al.*, 2022, pp. 12; 20) *Note: 1) Fuel carbon intensity data available for jet fuels, biofuels, and synfuels, all scenarios & all years in gCO_2e/MJ. 2) Assumption: domestic and intra-European routes of less than 750 km, no. of passengers >100,000 annually, 20% traffic shift from air to rail, starting in 2030. 3) Carbon intensity figure is estimated based on graph (Fig. 8). 4) Base year is 2019 with baseline approx. 600 $MtCO_2$/year*		▪ **Share of SAF in:** ▪ **2°C scenario:** 3% of fuel use (12 MT biofuel) ▪ **Well below 2°C scenario:** 8% of fuel use (23 MT biofuel, 2 MT e-fuel) ▪ **1.75°C scenario:** 17% of fuel use (46 MT biofuel, 5 MT e-fuel) ▪ **Carbon source for e-kerosene (point source vs. DAC):** ▪ **2°C scenario:** 100% vs. 0% ▪ **Well below 2°C scenario:** 67% vs. 33% ▪ **1.75°C scenario:** 67% vs. 33% ▪ **Carbon intensity:** ▪ **2°C scenario:** 85-90 gCO_2e/MJ ▪ **Well below 2°C scenario:** 80-85 gCO_2e/MJ		▪ **Carbon source for e-kerosene (point source vs. DAC):** ▪ **2°C scenario:** 67% vs. 33% ▪ **Well below 2°C scenario:** 58% vs. 42% ▪ **1.75°C scenario:** 46% vs. 54% ▪ **Carbon intensity (gCO_2e/MJ):** ▪ **2°C scenario:** 60-70 ▪ **Well below 2°C scenario:** 55-60 ▪ **1.75°C scenario:** 40		▪ **Emission reductions below 2019 level:** 97% (technology 15% + operations 17% + SAF 65% + demand change 3%) ▪ **Zero-emission plane share:** 22% (hydrogen), 0.01% (electricity) ▪ **Share of SAF in:** ▪ **2°C scenario:** 50% of fuel use (100 MT biofuel, 120 MT e-fuel) ▪ **Well below 2°C scenario:** 80% of fuel use (100 MT biofuel, 150 MT e-fuel) ▪ **1.75°C scenario:** 100% of fuel use (100 MT biofuel, 215 MT e-fuel) ▪ **Carbon source for e-kerosene (point source vs. DAC):** ▪ **2°C scenario:** 67% vs. 33% ▪ **Well below 2°C scenario:** 50% vs. 50%

Sector-specific benchmarks for international aviation

Indicator	Source	2025	2030	2035	2040	2045	2050
			▪ **1.75°C scenario:** 75-80 gCO_2e/MJ				▪ **1.75°C scenario:** 25% vs. 75% ▪ **Carbon intensity:** ▪ **2°C scenario:** 45-50 gCO_2e/MJ ▪ **Well below 2°C scenario:** 25-30 gCO_2e/MJ ▪ **1.75°C scenario:** 0-5 gCO_2e/MJ
	World Benchmarking Alliance (WBA) ACT methodology document (ACT, 2021)	**Carbon intensity**: 0.089 kgCO2e/pkm	▪ **Carbon intensity**: 0.073 kgCO2e/pkm		▪ **Carbon intensity**: 0.042 kgCO2e/pkm		▪ **Carbon intensity**: 0.025 kgCO2e/pkm
Scope 1 & Scope 2	**SBTi** guidance for the aviation sector (SBTi, 2021e, 2021c) *Note: We could not obtain the specific benchmark levels as it requires a reverse interpretation to obtain emission-level milestones.*	*Note: (1) Exclusively focusing on jet fuel emissions, and (2) excludes non-CO_2 factors* ▪ **Carbon intensity (tank-to-well)**: [unclear] gCO_2/revenue tonne kilometre under *well below 2°C scenario*	*Note: (1) Exclusively focusing on jet fuel emissions, and (2) excludes non-CO_2 factors* ▪ **Carbon intensity (tank-to-well)**: [unclear] gCO_2/revenue tonne kilometre under *well below 2°C scenario*		*Note: (1) Exclusively focusing on jet fuel emissions, and (2) excludes non-CO_2 factors* ▪ **Carbon intensity (tank-to-well)**: [unclear] gCO_2/revenue tonne kilometre under *well below 2°C scenario*		*Note: (1) Exclusively focusing on jet fuel emissions, and (2) excludes non-CO_2 factors* ▪ **Carbon intensity (tank-to-well)**: [unclear] gCO_2/revenue tonne kilometre under *well below 2°C scenario*
Scope 1	**Transition Pathway Initiative (TPI) guidance** for airlines 1.5°C compatible and well below 2°C scenario, global scope. (Dietz, Byrne, Sheer, *et al.*, 2021, p. 14) *Note: 1) Exclusively focusing on **tank-to-well (jet fuel, flight, or aircraft only) emissions**, excluding well-to-tank (fossil fuel extraction) and non-CO_2 factors. 2) RTK means revenue-tonne-kilometre (passengers and freight x distance).*	▪ **Carbon intensity (1.5°C compatible):** 1,071 gCO_2/RTK ▪ **Carbon intensity (well below 2°C):** 1,071 gCO_2/RTK	▪ **Carbon intensity (1.5°C compatible):** 616 gCO_2/RTK ▪ **Carbon intensity (well below 2°C):** 662 gCO_2/RTK		▪ **Carbon intensity (1.5°C compatible):** 309 gCO_2/RTK ▪ **Carbon intensity (well below 2°C):** 422 gCO_2/RTK		▪ **Carbon intensity (1.5°C compatible):** 108 gCO_2/RTK ▪ **Carbon intensity (well below 2°C):** 284 gCO_2/RTK
	2022 One Earth Climate Model for aviation 1.5°C compatible scenario, global scope. (Teske, 2022, p. 333) *Note: Scope 1 encompasses direct energy-related CO_2 emissions by airlines manufacturer.*	▪ **Emission reductions below 2019 levels**: - 39%	▪ **Emission reductions below 2019 levels:** - 62%	▪ **Emission reductions below 2019 levels:** - 76%	▪ **Emission reductions below 2019 levels:** - 86%		▪ **Emission reductions below 2019 levels:** - 100%
Scope 2	*Not available*						
Scope 3 ***Upstream***	**2023 State of Climate Action** 1.5°C compatible scenario, global scope. (Boehm *et al.*, 2023, p. 78)		▪ **Share of SAF in global aviation fuel supply**: 13% ▪ **Share of SAF in global aviation fuel supply**: 13-18%				▪ **Share of SAF in global aviation fuel supply**: 100% ▪ **Share of SAF in global aviation fuel supply**: 78-100%

Sector-specific benchmarks for international aviation

Indicator	Source	2025	2030	2035	2040	2045	2050
	Note: *All greyed-out benchmarks were additionally listed in the State of Climate Action 2022 report* (Boehm *et al.*, 2022).						
	UNFCCC 1.5°C compatible scenario, global scope. (UNFCCC, 2021b, p. 12, 2023, p. 30)		▪ **Share of SAF in global aviation fuel supply**: 13-15% ▪ **Share of SAF in global aviation fuel supply**: 10%				▪ **Share of SAF in global aviation fuel supply**: 100%
	2023 IEA Net Zero by 2050 1.5°C compatible scenario, global scope (IEA, 2023a, pp. 94, 198) *Note: All greyed-out benchmarks were additionally* listed in the previous report (IEA, 2022a, p. 138).		▪ **Carbon intensity:** 85 gCO_2/passenger.km (*own calculation: 932 $MtCO_2$ divided by 10,969 billion passenger.km*) ▪ **Share of SAF in final energy consumption:** 10% biofuel, 1% synthetic hydrogen-based fuel ▪ **Avoided demand from behavioural measures**: 9% ▪ **Share of SAF in global aviation fuel supply**: 18% of fuels used in aviation are low-emissions, including ~16% of liquid biofuel use in total fuel use and ~2% of synthetic kerosene ▪ **Avoided demand from behaviour measures (index 2020=100)**: 20	▪ **Carbon intensity:** 65 gCO_2/passenger.km (*own calculation: 744 $MtCO_2$ divided by 11,417 billion passenger.km*) ▪ **Share of SAF in final energy consumption:** 22% biofuel, 4% synthetic hydrogen-based fuel ▪ **Avoided demand from behavioural measures**: 14%	▪ **Carbon intensity:** 43 gCO_2/passenger.km (*own calculation: from 554 $MtCO_2$ divided by 12,843 billion passenger.km*) ▪ **Share of SAF in global aviation fuel supply**: 50% of fuels used in aviation are low-emissions		▪ **Carbon intensity:** 13 gCO_2/passenger.km (*own calculation: 208 $MtCO_2$ divided by 16,545 billion passenger.km*) ▪ **Share of SAF in final energy consumption:** 33% biofuel, 37% synthetic hydrogen-based fuel ▪ **Avoided demand from behavioural measures**: 20% ▪ **Share of SAF in global aviation fuel supply**: 78% of fuels used in aviation are low-emissions, including ~45% of liquid biofuel use in total fuel use and ~33% of synthetic kerosene ▪ **Avoided demand from behaviour measures (index 2020=100)**: 38
Downstream	**2022 One Earth Climate Model** for aviation 1.5°C compatible scenario, global scope (Teske, 2022, pp. 216, 333) *Note: 1) Scope 3 encompasses end user emissions of aircraft manufacturers (Scope 1 emissions of airlines). 2) Base year is 2019 with baseline of 936 million tCO_2/year, 425 gCO_2/passenger.km and 2,360 gCO_2/tonne.km*	▪ **Emission reductions below 2019 levels:** increase of 54% ▪ **Emission intensity (air passenger)**: 347 gCO_2/passenger.km **Emission intensity (air freight)**: 2,092 gCO_2/tonne.km	▪ **mission reductions below 2019 levels:** increase of 27% ▪ **Emission intensity (air passenger)**: 302 gCO_2/passenger.km **Emission intensity (air freight)**: 1,822 gCO_2/tonne.km	▪ **Emission reductions below 2019 levels:** 51% ▪ **Emission intensity (air passenger)**: 129 gCO_2/passenger.km **Emission intensity (air freight)**: 776 gCO_2/tonne.km	▪ **Emission reductions below 2019 levels:** -90% ▪ **Emission intensity (air passenger)**: 31 gCO_2/passenger.km **Emission intensity (air freight)**: 189 gCO_2/tonne.km		▪ **Emission reductions below 2019 levels:** -100% ▪ **Emission intensity (air passenger)**: 0 gCO_2/passenger.km **Emission intensity (air freight)**: 0 gCO_2/tonne.km
	2023 One Earth Climate Model for aviation 1.5°C compatible scenario, global scope (Teske *et al.*, 2023) *Note: 1) Scope 3 encompasses end-user emissions. 2) Base year is 2019 with baseline of 425 gCO_2/passenger.km and 2,358 gCO_2/tonne.km*	▪ **Emission intensity (air passenger)**: 351 gCO_2/passenger.km **Emission intensity (air freight)**: 2,113 gCO_2/tonne.km	▪ **Emission intensity (air passenger)**: 302 gCO_2/passenger.km ▪ **Emission intensity (air freight)**: 1,822 gCO_2/tonne.km	▪ **Emission intensity (air passenger)**: 129 gCO_2/passenger.km **Emission intensity (air freight)**: 776 gCO_2/tonne.km	▪ **Emission intensity (air passenger)**: 31 gCO_2/passenger.km **Emission intensity (air freight)**: 189 gCO_2/tonne.km	▪ **Emission intensity (air passenger)**: 6 gCO_2/passenger.km **Emission intensity (air freight)**: 37 gCO_2/tonne.km	▪ **Emission intensity (air passenger)**: 0 gCO_2/passenger.km **Emission intensity (air freight)**: 0 gCO_2/tonne.km

8 Supermarket retail

Last update	**28.04.2024**
Summary	We could not identify sector-specific decarbonisation milestones for the mixed-good retailer industry in existing literature. For this reason, we compare mixed-good retailers to available 1.5°C-aligned benchmarks for agriculture (see above under *Agriculture & Food*) and global economy-wide benchmarks. The latter require to reduce GHG and CO_2 emissions by 43% and 48% respectively to stand a reasonable chance of limiting global warming to 1.5°C (IPCC, 2022).

Sector-specific benchmarks for the retail sector

Indicator	Source	2025	2030	2035	2040	2045	2050
Scope 1, Scope 2 & Scope 3	**UNFCCC** for global level (UNFCCC, 2021b, 2023, p. 32)		▪ **Environmental impact of shopping baskets (non-defined):** reduced by 50%				▪ **Emissions**: Entire consumer goods supply chain is net zero by 2050
Scope 1 & Scope 2							
Scope 2							
Scope 3 ***Total***							
Upstream							
Downstream							

9 Steel industry

Last update	**28.04.2024**

Summary

Intensity of steel production (scope 1 and 2)

Several studies identify 1.5°C-aligned decarbonisation milestones for the emissions intensity for steel production covering scope 1 and 2 (CAT, 2020; Boehm, Lebling, *et al.*, 2021, p. 66; SBTi, 2021a, 2021d, pp. 18, 27; Boehm *et al.*, 2022; SBTi, 2022c; Boehm *et al.*, 2023, p. 61; SBTi, 2023c; Dietz, Amin, *et al.*, 2023, p. 22; Teske *et al.*, 2023 data in Dataset 2). Several studies identify separate global milestones for primary and secondary steel production (Dietz, Amin, *et al.*, 2023; Teske *et al.*, 2023)

Low-emission steel plants

Several studies identify global milestones to introduce low-carbon and near-zero steel plants by 2030 and 2050 (UNFCCC, 2021b, p. 15, 2023, p. 32; Delasalle *et al.*, 2022, p. 69; IEA, 2022a, pp. 20; 129).

Sector-specific benchmarks for the steel industry

Indicator	Source	2025	2030	2040	2050
Scope 1, Scope 2 & Scope 3	**UNFCCC** for global level (UNFCCC, 2021b, 2023, p. 32)		▪ **Operational (near) zero emission steel plants:** 70 ▪ **Green steel production:** well over 100 Mt of green steel per annum		▪ **Emissions**: Net 100% reduction (net zero) across all emissions scopes
Scope 1 & Scope 2	**Transition Pathway Initiative (TPI) steel discussion paper** (Dietz, Amin, *et al.*, 2023, p. 22) **Transition Pathway Initiative (TPI) guidance** for steel makers (Dietz, Gardiner, *et al.*, 2022, p. 8)		▪ **Carbon intensity combined**: 0.96 tCO_2e/tonne steel under a *1.5 Degrees scenario* globally ▪ **Carbon intensity primary**: 1.27 tCO_2e/tonne steel under a *1.5 Degrees scenario* globally ▪ **Carbon intensity secondary**: 0.32 tCO_2e/tonne steel under a *1.5 Degrees scenario* globally ▪ **Carbon intensity**: 1.13 tCO_2e/tonne steel under a *1.5 Degrees scenario* globally	▪ **Carbon intensity combined**: 0.33 tCO_2e/tonne steel under a *1.5 Degrees scenario* globally. ▪ **Carbon intensity primary**: 0.39 tCO_2e/tonne steel under a *1.5 Degrees scenario* globally ▪ **Carbon intensity secondary**: 0.23 tCO_2e/tonne steel under a *1.5 Degrees scenario* globally ▪ **Carbon intensity**: 0.46 tCO_2e/tonne steel under a *1.5 Degrees scenario* globally	▪ **Carbon intensity combined**: 0.10 tCO_2e/tonne steel under a *1.5 Degrees scenario* globally. ▪ **Carbon intensity primary**: 0.06 tCO_2e/tonne steel under a *1.5 Degrees scenario* globally ▪ **Carbon intensity secondary**: 0.16 tCO_2e/tonne steel under a *1.5 Degrees scenario* globally ▪ **Carbon intensity**: 0.05 tCO_2e/tonne steel under a *1.5 Degrees scenario* globally
	SBTi Corporate Net Zero Standard for iron and steel sector (SBTi, 2021d, pp. 18; 27, 2021b, 2022c) *Note: Absolute reduction of **93%** for 2050 directly taken out of updated SBTi Net Zero Tool (v1.0.3) under 'Calculations tab'. SBTi Net Zero Standard (v1.0) specifies 91%. Tool further specifies that this covers both scope 1 and 2 while caption of Figure 5 (Page 18) in SBTI NZT remains unclear.*	*Note: Near-term without a specific year assigned, with 95% minimum coverage of Scope 1 & Scope 2 emissions* ▪ **Absolute reduction (cross-sector):** 4.2% emissions reduction per year (p.a.)			*Note: Minimum coverage of 95% of Scope 1 & Scope 2 emissions* ▪ **Carbon intensity (iron & steel sector):** 0.11 tCO_2/tonne steel under *SBTi 1.5°C scenario* globally ▪ **Absolute contraction (iron & steel sector):** 93% reduction below 2020 under *SBTi 1.5°C scenario* globally

Sector-specific benchmarks for the steel industry

Indicator	Source	2025	2030	2040	2050
	SBTi steel sector guidance (SBTi, 2023c, p. 62) *Note: Numbers slightly updated from those taken from the draft guidance.*	▪ **Emissions intensity (100% ore-based):** 2,111 $kgCO_2$/tonne steel as *1.5°C compatible* benchmark ▪ **Emissions intensity (100% scrap-based):** 436 $kgCO_2$/tonne steel as *1.5°C compatible* benchmark	▪ **Emissions intensity (100% ore-based):** 1.71 tCO2/t hot rolled steel or a 29% reduction below 2020, as *1.5°C compatible benchmark* ▪ **Emissions intensity (100% scrap-based):** 0.37 tCO2/t hot rolled steel or a 26% reduction below 2020, as *1.5°C compatible benchmark*	▪ **Emissions intensity (100% ore-based):** 0.77 tCO2/t hot rolled steel, or a 55% reduction below 2020, *as 1.5°C compatible benchmark* ▪ **Emissions intensity (100% scrap-based):** 0.24 tCO2/t hot rolled steel or a 35% reduction below 2020, as *1.5°C compatible benchmark*	▪ **Emissions intensity (100% ore-based):** 0.11 tCO2/t hot rolled steel or an 86% reduction below 2020, *as 1.5°C compatible benchmark* ▪ **Emissions intensity (100% scrap-based):** 0.11 tCO2/t hot rolled steel or a 54% reduction below 2020, as *1.5°C compatible benchmark*
	Climate Action Tracker for countries and global level (CAT, 2020) *Note: Country-specific benchmarks available for EU, USA, China, India, Indonesia, South Africa, and Brazil.*		▪ **Emissions intensity:** 1,335–1,350 $kgCO_2$/tonne steel as *PA Final Benchmark* globally, representing a 25–30% reduction below 2015 ▪ **Share of electricity in total final energy demand:** 35% as *PA Final Benchmark* globally	▪ **Share of electricity in total final energy demand:** 45–55% as *PA Final Benchmark* globally	▪ **Emissions intensity:** 0–130 $kgCO_2$/tonne steel as *PA Final Benchmark* globally, representing a 95–100% reduction below 2015 ▪ **Share of electricity in total final energy demand:** 50–55% as *PA Final Benchmark* globally
	State of Climate Action at global level (Boehm, K. Lebling, *et al.*, 2021, p. 66; Boehm *et al.*, 2023, p. 61)*Note: The benchmark on low-carbon steel facilities is now excluded in the SoCA 2022 Table 4 due to scope. SoCA 2021 Table 9 as still valid. All other benchmarks remained the same.*		▪ **Carbon intensity:** 1,340–1,350 $kgCO_2$/tonne steel as 1.5°C compatible benchmark ▪ **Low-carbon steel facilities in operation:** 20 low-carbon steel facilities in operation as 1.5°C compatible benchmark ▪ **Share of electricity in industry sector total final energy demand:** 35% as 1.5°C compatible benchmark	▪ **Share of electricity in industry sector total final energy demand:** 40–45% as 1.5°C compatible benchmark	▪ **Carbon intensity:** 0–130 $kgCO_2$/tonne steel as 1.5°C compatible benchmark ▪ **Low-carbon steel facilities in operation:** All facilities in operation are low-carbon steel facilities as 1.5°C compatible benchmark ▪ **Share of electricity in industry sector total final energy demand:** 50–55% as 1.5°C compatible benchmark
	UNFCCC for global level (UNFCCC, 2021b, p. 15)		▪ **Total number of low-carbon steel facilities**: 20 zero-carbon, commercial-scale facilities (at >1 million tons per annum) operational		
	Mission Possible Partnership on steel sector (Delasalle *et al.*, 2022, p. 69) *Note: Other general global sector milestones on page 69.*	▪ **Total number of low-carbon steel facilities**: First 5 near-zero-emissions steel projects achieve final investment decision (FID) status	▪ **Total number of low-carbon steel facilities**: 70 near-zero-emissions primary steel mills in operation		
	IEA Net Zero by 2050 for global level (IEA, 2023b, pp. 95, 198)		▪ **Clean technologies:** Most new clean technologies in heavy industry demonstrated at scale; 8% steel production is low-emissions ▪ **Emissions reduction**: 24.3% ▪ **Scrap as share of input (recycling, re-use):** 38% of total steel production	▪ **Clean technologies:** All industrial electric motor sales are best in class by 2035 ▪ **Clean technologies:** Around 90% of existing capacity in heavy industries reaches end of investment cycle by 2040	▪ **Clean technologies:** More than 90% of heavy industrial production is low-emissions; 95% steel production is low-emissions ▪ **Emissions reductions below:** 90.6% ▪ **Scrap as share of input (recycling, re-use):** 46% of total steel production
	SSEE discussion paper for steel (Kampmann *et al.*, 2023, p. 7)	▪ **BF-BOF retrofitted:** with 50% CCUS	▪ **New BF-BOF retrofitted:** 90% of CCUS by 2030-2035		
	TPI Carbon Performance Assessment of Steelmakers.		▪ **Combined steel carbon intensity**: 0.96 tCO2/t steel	▪ **Combined steel carbon intensity:** 0.33 tCO2/t steel	▪ **Combined steel carbon intensity:** 0.10 tCO2/t steel

Sector-specific benchmarks for the steel industry

Indicator		Source	2025	2030	2040	2050
		(Dietz, Amin, *et al.*, 2023, p. 22)		▪ **Primary carbon intensity:** 1.27 tCO2/t steel ▪ **Secondary carbon intensity**: 0.32 tCO2/t steel	▪ **Primary steel carbon intensity**: 0.39 tCO2/t steel ▪ **Secondary steel carbon intensity:** 0.23 tCO2/t steel	▪ **Primary steel carbon intensity:** 0.06 tCO2/t steel ▪ **Secondary steel carbon intensity:** 0.16 tCO2/t steel
Scope 1		**Net-Zero 1.5 Sectoral Pathways** for global steel industry (Teske, 2022, p. 326)	▪ **Emission reductions below 2019 levels**: 29% by 2025	▪ **Emission reductions below 2019 levels:** 54% by 2030	**Emission reductions below 2019 levels:** 83% by 2040	**Emission reductions below 2019 levels:** 100% by 2050
Scope 2		**SBTi Corporate Net Zero Standard** for corporates in general, with adjustment to consider only high-quality RE procurement constructs (SBTi, 2021d)	▪ **Share of RE in electricity procurement**: 80% high-quality renewables procurement	▪ **Share of RE in electricity procurement**: 100% high-quality renewables procurement		
		Net-Zero 1.5 Sectoral Pathways for global steel industry (Teske, 2022, p. 326)	▪ **Emission reductions below 2019 levels**: 29% by 2025	▪ **Emission reductions below 2019 levels:** 66% by 2030	▪ **Emission reductions below 2019 levels:** 93% by 2040	▪ **Emission reductions below 2019 levels:** 100% by 2050
		2023 One Earth Climate Model for steel 1.5°C compatible scenario, global scope (Teske *et al.*, 2023)	▪ **Carbon intensity primary steel (energy-related CO2 emissions):** 0.99 t CO2/t steel ▪ **Carbon intensity primary steel (energy-related CO2 emissions):** 0.23 t CO2/t steel	▪ **Carbon intensity (energy-related CO2 emissions):** 0.94 t CO2/t steel ▪ **Carbon intensity primary steel (energy-related CO2 emissions):** 0.11 t CO2/t steel	▪ **Carbon intensity (energy-related CO2 emissions):** 0.56 t CO2/t steel ▪ **Carbon intensity primary steel (energy-related CO2 emissions):** 0.02 t CO2/t steel	▪ **Emission reductions below 2019 levels:** 100% by 2050 for both primary and secondary steel
Scope 3	***Total***	**Net-Zero 1.5 Sectoral Pathways** for global steel industry (Teske, 2022, p. 326)	▪ **Emission reductions below 2019 levels**: 11% by 2025	▪ **Emission reductions below 2019 levels:** 38% by 2030	▪ **Emission reductions below 2019 levels:** 73% by 2040	▪ **Emission reductions below 2019 levels:** 89% by 2050
	Upstream	*None identified*				
	Downstream	*None identified*				

10 Cement industry

Last update	**28.04.2024**

Summary

Intensity of operational emissions in cement production (scope 1 and 2)

Several studies identify 1.5°C-aligned decarbonisation milestones for the emissions intensity for cement production covering scope 1 and 2 (CAT, 2020, p. 41; SBTi, 2022a, 2022d; Boehm *et al.*, 2023, p. 61; Teske *et al.*, 2023 data in dataset 2). The Transition Pathways Initiative (TPI) defines 1.5°C-aligned benchmarks for scope 1 emissions only (Dietz, Hastreiter and Jahn, 2021, p. 9).

Absolute emission reductions of global cement sector

A few studies identify 1.5°-aligned absolute emission reductions for the global cement sector (SBTi, 2021d, 2022c; Teske, 2022, p. 323; Teske *et al.*, 2023 data in dataset 2).

Sector-specific benchmarks for the cement industry

Indicator	Source	2025	2030	2040	2050
Scope 1 & Scope 2	**2023 One Earth Climate Model** for cement 1.5°C compatible scenario, global scope (Teske *et al.*, 2023 data in Dataset 2)	▪ **Emission reductions below 2019 levels**: 10%	▪ **Emission reductions below 2019 levels**: 26%	▪ **Emission reductions below 2019 levels**: 48%	▪ **Emission reductions below 2019 levels**: 60%
	SBTi Corporate Net Zero Standard for cement sector (SBTi, 2021d, p. 27, 2021b, 2022c) *Note: Absolute reduction of **95%** for 2050 directly taken out of updated SBTi Net Zero Tool (v1.0.3) under 'Calculations tab'. SBTi Net Zero Standard (v1.0) specifies 94%. Tool further specifies that this covers both scope 1 and 2 while caption of Figure 5 (Page 18) in SBTI NZT remains unclear.*	*Note: Near-term without a specific year assigned, with 95% minimum coverage of Scope 1 & Scope 2 emissions* ▪ **Absolute reduction (cross-sector):** 4.2% emissions reduction per year (p.a.)			*Note: Minimum coverage of 95% of Scope 1 & Scope 2 emissions* ▪ **Carbon intensity (cement sector):** 0.03 tCO_2/tonne steel under *SBTi 1.5°C scenario* globally ▪ **Absolute contraction (cement sector):** 95% reduction below 2020 under *SBTi 1.5°C scenario* globally
	SBTi guidance for the cement sector (SBTi, 2022a, 2022d) *Note: Intensity indicators for 2025, 2030 and 2035 directly taken out of updated SBTi tool (v2.1) under 'Calculations tab'.*	▪ **Carbon intensity:** 0.539 tCO_2/tonne under a *SBTi 1.5°C Scenario*	▪ **Carbon intensity:** 0.463 tCO_2/tonne under a *SBTi 1.5°C Scenario*	▪ **Carbon intensity:** 0.344 tCO_2/tonne under a *SBTi 1.5°C Scenario* by 2035	
	Climate Action Tracker for countries and global level (CAT, 2020, p. 41) *Note: Not entirely clear whether this covers scope 2 emissions for corporate analyses.*		▪ **Cement emissions intensity:** 360–370 $kgCO_2$/tonne cement as *PA Final Benchmark* globally, representing a 40% reduction below 2015 levels		▪ **Emissions intensity:** 55–90 $kgCO_2$/tonne cement as *PA Final Benchmark* globally, representing a 85–90% reduction below 2015 levels *Note: Additional aspirational benchmark of 100% that may be achieved with innovative technologies and developments current being researched.*

Sector-specific benchmarks for the cement industry

Indicator		Source	2025	2030	2040	2050
		State of Climate Action at global level (Boehm *et al.*, 2023, p. 61)		▪ **Carbon intensity:** 360–370 $kgCO_2$/tonne cement as 1.5°C compatible benchmark		▪ **Carbon intensity:** 55–90 $kgCO_2$/tonne cement as 1.5°C compatible benchmark
		Mission Possible Partnership for concrete and cement (Mission Possible Partnership, 2023, p. 16)				▪ **Carbon intensity:** 0.49 CO2/t cement, or an 18% reduction below 2020 ▪ **SCM proportion in cement composition**: 48%
Scope 1		**Transition Pathway Initiative (TPI) guidance** for cement producers (Dietz, Hastreiter and Jahn, 2021, p. 9)		▪ **Carbon intensity:** 0.42 tCO_2/tonne under a *1.5°C Degree* scenario	▪ **Carbon intensity:** 0.2 tCO_2/tonne under a *1.5°C Degree* scenario	▪ **Carbon intensity:** 0.03 tCO_2/tonne under a *1.5°C Degree* scenario
		UNFCCC for global level (UNFCCC, 2021b, 2023, p. 32)		▪ **Carbon intensity:** 463 kg CO2/t cement	▪ **Share of carbon neutral concrete:** 25% as percentage of total global production by 2035	▪ **Share of carbon neutral concrete:** 100% as percentage of total global production
		IEA Net Zero by 2050 for global level (IEA, 2023a, p. 96)		▪ **CO2 emissions: 1,899 $MtCO_2$** (approx. 23% reduction below 2019) ▪ **Clean technologies:** Most new clean technologies in heavy industry demonstrated at scale ▪ **Production share via innovative routes:** 9% of global cement production	▪ **CO2 emissions: 906 $MtCO_2$** (approx. 63% reduction below 2019) ▪ **Clean technologies:** All industrial electric motor sales are best in class by 2035 ▪ **Clean technologies:** Around 90% of existing capacity in heavy industries reaches end of investment cycle by 2040	▪ **CO2 emissions: 133 $MtCO_2$** (approx. 95% reduction below 2019) ▪ **Clean technologies:** More than 90% of heavy industrial production is low-emissions ▪ **Production share via innovative routes:** 93% of global cement production ▪ **Cumulative emissions reduction:** 6% ▪ **Coal use eliminated from cement production**
		Net-Zero 1.5 Sectoral Pathways for global cement industry (Teske, 2022, p. 323)	▪ **Emission reductions below 2019 levels**: 7% by 2025	▪ **Emission reductions below 2019 levels:** 20% by 2030	▪ **Emission reductions below 2019 levels:** 40% by 2040	▪ **Emission reductions below 2019 levels:** 58% by 2050
		2023 One Earth Climate Model for cement 1.5°C compatible scenario, global scope (Teske *et al.*, 2023)	▪ **Energy-related emissions reductions below 2019 (per ton clinker):** 15% ▪ **Energy-related emissions reductions below 2019 (per ton cement):** 22%	▪ **Energy-related emissions reductions below 2019 (per ton clinker): 47%** ▪ **Energy-related emissions reductions below 2019 (per ton cement):** 51%	▪ **Energy-related emissions reductions below 2019 (per ton clinker):** 87% ▪ **Energy-related emissions reductions below 2019 (per ton cement):** 88%	▪ **Energy-related emissions reductions below 2019 (per ton clinker):** 100% ▪ **Energy-related emissions reductions below 2019 (per ton cement):** 100%
Scope 2		**Net-Zero 1.5 Sectoral Pathways** for global cement industry (Teske, 2022, p. 323)	▪ **Emission reductions below 2019 levels**: 53% by 2025	▪ **Emission reductions below 2019 levels**: 78% by 2030	▪ **Emission reductions below 2019 levels:** 96% by 2040	▪ **Emission reductions below 2019 levels: 100%** by 2050
Scope 3	***Total***	**Net-Zero 1.5 Sectoral Pathways** for global cement industry (Teske, 2022, p. 323)	▪ **Emission reductions below 2019 levels**: 37% by 2025	▪ **Emission reductions below 2019 levels**: 69% by 2030	▪ **Emission reductions below 2019 levels:** 92% by 2040	▪ **Emission reductions below 2019 levels:** 100% by 2050
	Upstream	*None identified*				
	Downstream	*None identified*				

11 Electronics

Last update	**28.04.2024**
Summary	We could not identify sector-specific decarbonisation milestones for the electronics industry in existing literature. For this reason, we compare electronics companies to global economy-wide decarbonisation trajectories to reduce GHG and CO_2 emissions by 43% and 48%, respectively. These emission reductions are necessary to stand a reasonable chance of limiting global warming to 1.5°C (IPCC, 2022). Given that CO_2 is the most relevant GHG in the electronics sector's emission profile and the sector has readily accessible decarbonisation options, we consider that companies should meet at least the global benchmark of a 48% CO_2 reduction by 2030 below 2019 levels.

Sector-specific benchmarks for electronic devices industry

Indicator	Source	2025	2030	2040	2050
Scope 1, Scope 2 & Scope 3	*None identified*				
Scope 1 & Scope 2	**Transition Pathway Initiative (TPI) guidance** for 'other industry' including electronic devices industry (Dietz, Hastreiter and Scheer, 2021) *Note: 'Other industry' includes construction materials, electronic devices (e.g., smartphones, laptops, etc.), clothing and textiles, beverages, printing and recording media, and furniture.*	▪ **Emission intensity per unit of revenue:** 13.52 tCO2/mUSD under a *Below 2 Degree Scenario*	▪ **Emission intensity per unit of revenue:** 8.23 tCO2/mUSD under a *Below 2 Degree Scenario*	▪ **Emission intensity per unit of revenue:** 3.02 tCO2/mUSD under a *Below 2 Degree Scenario*	▪ **Emission intensity per unit of revenue:** 0.84 tCO2/mUSD under a *Below 2 Degree Scenario*
Scope 1	**Transition Pathway Initiative (TPI) guidance** for 'other industry' including electronic devices industry (Dietz, Hastreiter and Scheer, 2021) *Note: 'Other industry' includes construction materials, electronic devices (e.g., smartphones, laptops, etc.), clothing and textiles, beverages, printing and recording media, and furniture.*	▪ **Scope 1 emissions growth rate (compared to 2019):** Minus 23.8% under a *Below 2 Degree Scenario*	▪ **Scope 1 emissions growth rate (compared to 2019):** Minus 40.4% under a *Below 2 Degree Scenario*	▪ **Scope 1 emissions growth rate (compared to 2019):** Minus 60.1% under a *Below 2 Degree Scenario*	▪ **Scope 1 emissions growth rate (compared to 2019):** Minus 75.0% under a *Below 2 Degree Scenario*
Scope 2	**UNFCCC** for global level (UNFCCC, 2021b)		▪ **Electricity use (for ICT sector)**: 80% of industry electricity decarbonised by 2030 ▪ **Electricity use (for mobile sector):** 70% of industry electricity decarbonised by 2030		▪ **Electricity use (for ICT sector)**: 100% of industry electricity decarbonised by 2030 ▪ **Electricity use for (mobile sector):** 100% of industry electricity decarbonised by 2030
	Transition Pathway Initiative (TPI) guidance for 'other industry' including electronic devices industry (Dietz, Hastreiter and Scheer, 2021) *Note: 'Other industry' includes construction materials, electronic devices (e.g.,*	▪ **Scope 2 emissions growth rate (compared to 2019):** Minus 27.6% under a *Below 2 Degree Scenario*	▪ **Scope 2 emissions growth rate (compared to 2019):** Minus 48.6% under a *Below 2 Degree Scenario*	▪ **Scope 2 emissions growth rate (compared to 2019):** Minus 81.2% under a *Below 2 Degree Scenario*	▪ **Scope 2 emissions growth rate (compared to 2019):** Minus 102.4% under a *Below 2 Degree Scenario*

Users should carefully read the introduction to the benchmark repositories and be mindful of existing limitations.

Sector-specific benchmarks for electronic devices industry

Indicator		Source	2025	2030	2040	2050
		smartphones, laptops, etc.), clothing and textiles, beverages, printing and recording media, and furniture.				
Scope 3	***Total***	*None identified*				
	Upstream	*None identified*				
	Downstream	*None identified*				

12 Information and communication technology

Last update	**28.04.2024**
Summary	We could identify few sector-specific decarbonisation milestones for the technology service industry in existing literature, especially for company's scope 3 emissions. Only SBTi provides benchmarks for ICT sector including mobile network operators, fixed networks operators and data centre operators (SBTi, 2020a, p. 9) . For this reason, we compare technology service companies to global economy-wide decarbonisation trajectories to reduce GHG and CO_2 emissions by 43% and 48%, respectively. These reduction levels are necessary to stand a reasonable chance of limiting global warming to 1.5°C (IPCC, 2022). Given that CO_2 is the most relevant GHG in the sector's emission profile with readily accessible decarbonisation options, we consider that companies should meet at least the global benchmark of a 48% CO_2 reduction below 2019 levels.

Sector-specific benchmarks for Technology – Services

Indicator	Source	2025	2030	2040	2050
Scope 1, Scope 2 & Scope 3					
Scope 1 & Scope 2	**SBTi guidance for ICT sector (mobile networks operators, fixed networks operators, data centres operators)** (SBTi, 2020b, p. 9) (SBTi, 2020a, p. 15)	▪ **Absolute emissions reductions for data centre operators**: 29% below 2019 levels under a 1.5°C pathways	▪ **Absolute emissions reduction for whole ICT sector (mobile networks operators, fixed networks operators and data centres operators):** 45% reduction below 2020 levels ▪ **Absolute emissions reductions for data centres operators:** 53% reduction below 2020 levels ▪ **Absolute emissions reductions for mobile networks operators:** 45% reduction below 2020 levels ▪ **Absolute emissions reductions for fixed networks operators:** 62% reduction below 2020 levels ▪ **Absolute emissions reductions for data centre operators**: 54% below 2019 levels under a 1.5°C pathways		▪ **Near zero emissions in line with the power sector**
Scope 2					
Scope 3 ***Total***					
Upstream					
Downstream					

13 International shipping

Last update	**28.04.2024**

Summary

Use of low emissions fuels

Several studies identify 1.5°C-aligned decarbonisation milestones for the use of low emissions fuels in international shipping (Smith *et al.*, 2021, p. 11; UNFCCC, 2021b, p. 15, 2023, p. 24; IEA, 2022a, p. 138, 2023a, p. 94; Teske, 2022; Boehm *et al.*, 2023, p. 78).

Intensity of ocean activities (scope 1)

The TPI defines 1.5°C-aligned intensity benchmarks for the scope 1 emissions intensity of international shipping (Dietz, Byrne, Hastreiter, *et al.*, 2021, p. 14).

Absolute emission reductions of global shipping sector

Several studies identify 1.5°-aligned absolute emission reductions for the global shipping sector (IRENA, 2021; Teske, 2022, p. 333; CAT, 2023b; IEA, 2023a, p. 196; SBTi, 2023b; Teske *et al.*, 2023) and one study identifies intensity emission reductions (Teske *et al.*, 2023 data in Dataset 2).

Sector-specific benchmarks for international shipping

Indicator	Source	2025	2030	2035	2040	2045	2050
Scope 1, Scope 2 & Scope 3	**A Strategy for the Transition to Zero-Emission Shipping** (Smith *et al.*, 2021)				▪ **Majority of international shipping is fully decarbonised**		
	A pathway to decarbonise the shipping sector by 2050 (IRENA, 2021) ***Note**: IRENA provides no specific data points for each year, but **Figure v** has been interpretated as follows:* ▪ *2018 emissions: 740 $MtCO_2e$ (in line w/ CAT)* ▪ *2025: 630 $MtCO_2e$* ▪ *2030: 550 $MtCO_2e$* ▪ *2040: 350 $MtCO_2e$*	▪ **CO_2 emissions**: 15% below **2018** levels (Estimate: 630 $MtCO_2$, see note on right ide)	▪ **CO_2 emissions**: 26% below **2018** levels (Estimate: 550 $MtCO_2$, see note n right side)		▪ **CO_2 emissions**: 53% below **2018** levels (Estimate: 350 $MtCO_2$, see note on right side)		▪ **CO_2 emissions**: 80% below **2018** levels (144 $MtCO_2$)
	2023 One Earth Climate Model for shipping 1.5°C compatible scenario, global scope (Teske *et al.*, 2023) *Note: Unsure which scope these benchmarks cover.*	▪ **CO_2 emissions intensity reduction for passenger transport (g CO2 /pkm): 0.6**% above 2019 levels ▪ **CO_2 emissions intensity reduction for shipping freight transport (g**	▪ **CO_2 emissions intensity reduction for passenger transport (g CO2 /pkm): -30**% below 2019 levels ▪ **CO_2 emissions intensity reduction for freight**		▪ **CO_2 emissions intensity reduction (g CO2 /pkm): -**86% below 2019 levels ▪ **CO_2 emissions intensity reduction (g CO2/tkm):** -88% below 2019 levels		▪ **CO_2 emissions intensity:** 0 emissions by 2045

Sector-specific benchmarks for international shipping

Indicator	Source	2025	2030	2035	2040	2045	2050
		CO2/tkm): -3% below 2019 levels	**transport (g CO2/tkm):** -35% below 2019 levels				
Scope 1 & Scope 3	**SBTi maritime sector guidance** (SBTi, 2023b, p. 15) (SBTi, 2022e, pp. 11–19)		▪ **Emissions intensity reduction:** 0.36% below 2020 levels under a *1.5°C pathway* globally		▪ **Emissions intensity reduction:** 96% below 2020 levels under a *1.5°C pathway* globally		▪ **Emissions intensity reduction:** 100% below 2020 levels under a *1.5°C pathway* globally
Scope 1	**Transition Pathway Initiative (TPI) guidance** for international shipping (Dietz, Byrne, Hastreiter, *et al.*, 2021, p. 14)	**Emissions intensity: 5.63** gCO2/tonne-km under *1.5°C pathway* globally	▪ **Emissions intensity:** 4.31 gCO2/tonne-km under *1.5°C pathway* globally		**Emissions intensity:** 1.58 gCO2/tonne-km under *1.5°C pathway* globally		▪ **Emissions intensity:** 0.4 gCO2/tonne-km under *1.5°C pathway* globally
	Net-Zero 1.5 Sectoral Pathways for global navigation sector – scope 1 for **vessel manufacturers**. (Teske, 2022, p. 333) *Note: We understand these benchmarks to represent the scope 1 emissions for vessel manufacturers, and not of shipping operators.*	▪ **Emission reductions below 2019 levels**: 38% by 2025	▪ **Emission reductions below 2019 levels:** 61% by 2030		▪ **Emission reductions below 2019 levels:** 86% by 2040		▪ **Emission reductions below 2019 levels:** 100% by 2050
Scope 2	**Net-Zero 1.5 Sectoral Pathways** for global navigation sector – scope 2 for **vessel manufacturers**. (Teske, 2022, p. 333) *Note: We understand these benchmarks to represent the scope 2 emissions for vessel manufacturers, and not of shipping operators.*	▪ **Emission reductions below 2019 levels**: 0% by 2025	▪ **Emission reductions below 2019 levels:** 0% by 2030		▪ **Emission reductions below 2019 levels:** 0% by 2040		▪ **Emission reductions below 2019 levels:** 0% by 2050
Scope 3 ***Total***	**Net-Zero 1.5 Sectoral Pathways** for global navigation sector – scope 3 for **vessel manufacturers**. (Teske, 2022, p. 333) *Note: We understand these benchmarks to represent the scope 3 emissions for vessel manufacturers, and not of shipping operators.*	▪ **Emission reductions below 2019 levels**: increase of 359% by 2025	▪ **Emission reductions below 2019 levels:** increase of 228% by 2030		▪ **Emission reductions below 2019 levels:** 36% by 2025		▪ **Emission reductions below 2019 levels:** 100% by 2050
Upstream	**UNFCCC** for global level		▪ **Share of zero emissions shipping fuels:** At least 5%, aiming for 10% of international				▪ **Share of zero emission shipping fuels:** 100% of zero

Sector-specific benchmarks for international shipping

Indicator	Source	2025	2030	2035	2040	2045	2050
	(UNFCCC, 2021b, p. 15, 2023, p. 24)		shipping fuels and 15% of domestic shipping fuels by 2030 ▪ **Share of zero emission shipping fuels:** 5% of zero emission international shipping fuels and 15% of zero emission domestic shipping fuels by 2030				emission international and domestic shipping fuels
	State of Climate Action at global level (Boehm *et al.*, 2023, p. 78)		▪ **Share of zero-emission fuels in maritime shipping:** 5% globally				▪ **Share of zero-emission fuels in maritime shipping:** 93% globally
	IEA Net Zero by 2050 2023 update (IEA, 2023a, pp. 94, 196)		**Low emissions fuel share:** total 19% o Biofuels: 8% o Hydrogen: 4% o Ammonia: 6% o Methanol: 1% ▪ **CO_2 emissions**: 20% below **2019** levels (Estimate: 705 $MtCO_2$)		**Low emissions fuel share:** total 36% o Biofuels: 13% o Hydrogen: 7% o Ammonia: 15% o Methanol: 1% **CO_2 emissions**: 61% below **2019** levels (Estimate: 348 $MtCO_2$)		**Low emissions fuel share:** 95% o Biofuels: 19% o Hydrogen: 19% o Ammonia: 44% o Methanol: 3% **CO_2 emissions**: 68% below **2019** levels (Estimate: 122 $MtCO_2$) ▪ **Share in total shipping energy consumption** o Ammonia: 46% o Hydrogen: 17% o Bioenergy: 21%
	A Strategy for the Transition to Zero-Emission Shipping (Smith *et al.*, 2021, p. 11)		▪ **Share of Scalable Zero-Emission Fuels (SZEF):** 5% (by energy content)				
	Net-Zero 1.5 Sectoral Pathways for global navigation sector – SAF (Teske, 2022, p. 212)	*Pending*	*Pending*		*Pending*		*Pending*
Downstream	*None identified*						

14 Industrial corporations (general)

Last update	**28.04.2024**
Summary	*No summary available.*

Sector-specific benchmarks for industry (general)

Indicator	Source	2025	2030	2035	2040	2045	2050
Scope 1, Scope 2 & Scope 3	**SBTi Corporate Net Zero Standard** for corporates (SBTi, 2021d)			*Note: Long-term without a specific year assigned, with 95% minimum coverage of Scope 1 & Scope 2 emissions and 90% of Scope 3 emissions* ▪ **Absolute contraction (cross-sector):** 90% reduction below 2020 under *SBTi 1.5°C scenario* globally			
Scope 1 & Scope 2	**SBTi Corporate Net Zero Standard** for corporates (SBTi, 2021d, 2021b)	*Note: Near-term without a specific year assigned, with 95% minimum coverage of Scope 1 & Scope 2 emissions* ▪ **Absolute reduction (cross-sector):** 4.2% emissions reduction per year (p.a.)					
	Transition Pathway Initiative (TPI) guidance for 'other industry' (Dietz, Hastreiter and Scheer, 2021) *Note: 'Other industry' includes construction materials, electronic devices (e.g., smartphones, laptops, etc.), clothing and textiles, beverages, printing and recording media, and furniture.*	▪ **Emission intensity per unit of revenue:** 13.52 tCO2/mUSD under a *Below 2 Degree Scenario*	▪ **Emission intensity per unit of revenue:** 8.23 tCO2/mUSD under a *Below 2 Degree Scenario*		▪ **Emission intensity per unit of revenue:** 3.02 tCO2/mUSD under a *Below 2 Degree Scenario*		▪ **Emission intensity per unit of revenue:** 0.84 tCO2/mUSD under a *Below 2 Degree Scenario*
	Climate Action Tracker for countries and global level (CAT, 2020)		▪ **Share of electricity in total final energy demand:** 35-43% as *PA Final Benchmark* globally		▪ **Share of electricity in total final energy demand:** 51-54% as *PA Final Benchmark* globally		▪ **Share of electricity in total final energy demand:** 60-69% as *PA Final Benchmark* globally
	State of Climate Action at global level (Boehm *et al.*, 2022)		▪ **Share of electricity in total final energy demand:** 35% as 1.5°C compatible benchmark				▪ **Share of electricity in total final energy demand:** 50–55% as 1.5°C compatible benchmark
	IEA Net Zero by 2050 for global level (IEA, 2022a)		▪ **Clean technologies:** Most new clean technologies in heavy industry demonstrated at scale		▪ **Clean technologies:** All industrial electric motor sales are best in class by 2035 ▪ **Clean technologies:** Around 90% of existing capacity in heavy industries reaches end of investment cycle by 2040		▪ **Clean technologies:** More than 90% of heavy industrial production is low-emissions

Scope 1		**Transition Pathway Initiative (TPI) guidance** for 'other industry' (Dietz, Hastreiter and Scheer, 2021) *Note: 'Other industry' includes construction materials, electronic devices (e.g., smartphones, laptops, etc.), clothing and textiles, beverages, printing and recording media, and furniture.*	▪ **Scope 1 emissions growth rate (compared to 2019):** Minus 23.8% under a *Below 2 Degree Scenario*	▪ **Scope 1 emissions growth rate (compared to 2019):** Minus 40.4% under a *Below 2 Degree Scenario*		▪ **Scope 1 emissions growth rate (compared to 2019):** Minus 60.1% under a *Below 2 Degree Scenario*		▪ **Scope 1 emissions growth rate (compared to 2019):** Minus 75.0% under a *Below 2 Degree Scenario*
Scope 2		**SBTi Corporate Net Zero Standard** for corporates in general, with adjustment to consider only high-quality RE procurement constructs (SBTi, 2021d)	▪ **Share of RE in electricity procurement**: 80% high-quality renewables procurement	▪ **Share of RE in electricity procurement**: 100% high-quality renewables procurement				
		Transition Pathway Initiative (TPI) guidance for 'other industry' (Dietz, Hastreiter and Scheer, 2021) *Note: 'Other industry' includes construction materials, electronic devices (e.g., smartphones, laptops, etc.), clothing and textiles, beverages, printing and recording media, and furniture.*	▪ **Scope 2 emissions growth rate (compared to 2019):** Minus 27.6% under a *Below 2 Degree Scenario*	▪ **Scope 2 emissions growth rate (compared to 2019):** Minus 48.6% under a *Below 2 Degree Scenario*		▪ **Scope 2 emissions growth rate (compared to 2019):** Minus 81.2% under a *Below 2 Degree Scenario*		▪ **Scope 2 emissions growth rate (compared to 2019):** Minus 102.4% under a *Below 2 Degree Scenario*
Scope 3	***Total***	**SBTi Corporate Net Zero Standard** for corporates in general (SBTi, 2021d)	*Note: Near-term without a specific year assigned, with 68% minimum coverage of Scope 3 emissions* ▪ **Absolute contraction (cross-sector)**: 2.5% emissions reduction per year (p.a.) ▪ **Economic intensity (cross-sector)**: at least 7% year-on-year reduction of emissions per unit value added ▪ **Physical intensity (cross-sector):** at least 7% year-on-year reduction for a company defined physical emissions intensity metric ▪ **Engagement target (cross-sector)**: engagement with suppliers and/or customers to set own reduction targets, no specific target value set		*Note: Long-term without a specific year assigned, with 90% minimum coverage of Scope 3 emissions* ▪ **Economic intensity**: 97% total reduction, no base year specified ▪ **Physical intensity:** 97% total reduction, no base year specified			
	Upstream	*None identified*						
	Downstream	*None identified*						

15 Pulp and paper

Last update	**28.04.2024**
Summary	We could identify only very few sector-specific decarbonisation milestones for the pulp and paper sector in the existing literature. Only the TPI provides emission intensity milestones for scope 1 and 2 for paper producers (Dietz, Irwin, Rauis, *et al.*, 2021). As for companies operating in the *food and agriculture sector*, we do not consider the 1.5°C-aligned benchmarks presented by SBTi's FLAG guidance for the assessment of companies in the pulp and paper sector. The FLAG guidance's benchmarks include both reductions and in-supply chain removals (SBTi, 2022b, pp. 44–45), the latter sometimes referred to 'insetting' within a company's value chain. SBTi explicitly acknowledges that the definition of insetting and its suitability towards emission reduction targets remains uncertain, but still allows for its use (SBTi, 2021d, p. 30, Box 3). We cannot use SBTi's FLAG guidance benchmarks to assess company's *emissions reduction* commitments as they integrally include emission removals. For these reasons, the assessment of pulp and paper companies currently requires a case-specific approach (e.g., considering the relevance of scope 3 emissions). Future research needs to put further emphasis on determining sector-specific decarbonisation milestones for the pulp and paper industry in line with the Paris Agreement across the sector's entire value chain.

Sector-specific benchmarks for

Indicator		Source	2025	2030	2040	2050
Scope 1, Scope 2 & Scope 3						
Scope 1 & Scope 2		**Transition Pathway Initiative (TPI) guidance** for paper producers (Dietz, Irwin, Rauis, *et al.*, 2021, p. 8)	▪ **Emissions intensity**: 0.43 tCO_2e/t under *Below 2 Degrees scenario* globally	▪ **Emissions intensity**: 0.35 tCO_2e/t under *Below 2 Degrees scenario* globally	▪ **Emissions intensity**: 0.17 tCO_2e/t under *Below 2 Degrees scenario* globally	▪ **Emissions intensity**: 0.06 tCO_2e/t under *Below 2 Degrees scenario* globally
Scope 2						
Scope 3	***Total***					
	Upstream					
	Downstream					

16 Chemicals industry

Last update	**28.04.2024**
Summary	We could identify very few and non-conclusive sector-specific decarbonisation milestones for the chemical industry and its various sub-sectors in existing literature (UNFCCC, 2021b, p. 12; Mission Possible Partnership, 2022a, p. 11; Teske, 2022, p. 322; IEA, 2023a, pp. 97, 198; Teske *et al.*, 2023 data in Dataset 2). For this reason, the assessment of chemical companies currently requires a case-specific approach (e.g., considering particularities of a given sub-sector a company operates in or the overall relevance of scope 3 emissions). Future research needs to put further emphasis on determining sector-specific decarbonisation milestones for the chemical industry in line with the Paris Agreement across the sector's entire value chain.

Sector-specific benchmarks for chemical industry

Indicator	Source	2025	2030	2035	2040	2045	2050
Scope 1 & Scope 2	**Missions Possible Partnership Pathway for Ammonia** (Mission Possible Partnership, 2022a, p. 11)						▪ **Share of green ammonia:** 67-91% ▪ **Share of blue ammonia**: 3-26%
Scope 1	**IEA Net Zero by 2050** for global level (IEA, 2023a, p. 96)		▪ **Share of production via innovative routes**: 13% ▪ **Share of recycling -reuse in plastics collection**: 27% ▪ **Share of recycling — reuse in secondary production**: 14%				▪ **Share of production via innovative routes**: 93% ▪ **Share of recycling -reuse in plastics collection**: 54% ▪ **Share of recycling — reuse in secondary production**: 35%
	Net-Zero 1.5 Sectoral Pathways for global chemicals industry (Teske, 2022, p. 322) ***Note:*** *Further consideration of scenario assumptions required. Further six industrial sub-sectors covered in Table 13.5. on page 322 (pharmaceutical company, agricultural chemicals, inorganic chemicals and consumer products, manufactured fibres and synthetic rubber, bulk petrochemicals and*	▪ **Emission reductions below 2019 levels**: 21% by 2025	▪ **Emission reductions below 2019 levels**: 44% by 2030		▪ **Emission reductions below 2019 levels**: 74% by 2040		▪ **Emission reductions below 2019 levels**: 100% by 2050

		intermediates, plastic resins).						
Scope 2		**Net-Zero 1.5 Sectoral Pathways** for global chemicals industry (Teske, 2022, p. 322) ***Note:*** *See above.*	▪ **Emission reductions below 2019 levels**: 34% by 2025	▪ **Emission reductions below 2019 levels**: 66% by 2030	▪	▪ **Emission reductions below 2019 levels**: 93% by 2040	▪	▪ **Emission reductions below 2019**: 100% by 2050
		2023 One Earth Climate Model for chemicals 1.5°C compatible scenario, global scope (Teske *et al.*, 2023)	▪ **Emissions intensity (energy only) reductions below 2019 levels:** 29%	▪ **Emissions intensity (energy only) reductions below 2019 levels:** 59%	▪	▪ **Emissions intensity (energy only) reductions below 2019 levels**: 75%	▪	▪ **Emissions intensity (energy only) reductions below 2019 levels:** 92%
		UNFCCC for global level (UNFCCC, 2021b, p. 12)		▪ **Electricity use from renewable sources:** 60% of global chemicals sector	▪	▪ **Electricity use from renewable sources:** 100% for global chemicals sector		
Scope 3	***Total***	**Net-Zero 1.5 Sectoral Pathways** for global chemicals industry (Teske, 2022, p. 322) ***Note:*** *See above.*	▪ **Emission reductions below 2019 levels**: 27% by 2025	▪ **Emission reductions below 2019**: 52% by 2030	▪	▪ **Emission reductions below 2019 levels**: 69% by 2040	▪	▪ **Emission reductions below 2019 levels**: 73% by 2050
	Upstream							
	Downstream							

17 Construction & real estate

Last update	**28.04.2024**
Summary	*No summary available.*

Sector-specific benchmarks for construction and real estate companies

Indicator		Source	2025	2030	2035	2040	2045	2050
Scope 1, Scope 2 & Scope 3		**UNFCCC** for global level (UNFCCC, 2021b, p. 11) UNFCCC climate solutions implementation roadmap 2030 (UNFCCC, 2023, p. 73)		▪ **Embodied emissions:** At least 40% less embodied carbon compared to current practice ▪ Net zero operations: 100% of projects completed				
		IEA Net Zero by 2050 for global level (IEA, 2023a, pp. 120, 198)		▪ **CO2 emissions for residential buildings**: **1,377** MtCO2 ▪ **CO2 emissions for services buildings: 432** MtCO2		**CO2 emissions for residential buildings: 541** MtCO2 **CO2 emissions for services buildings: 144** MtCO2 **Annual residential building retrofit rate: 2.5%** by 2030		**CO2 emissions for residential buildings: 108** MtCO2 **CO2 emissions for service buildings:** 14 MtCO2
Scope 1 & Scope 2								
Scope 1		**Net-Zero 1.5 Sectoral Pathways** for global buildings industry (Teske, 2022, p. 332) ***Note:*** *Further consideration of scenario assumptions required. Further two sub-sectors covered in Table 13.14. on page 332 (residential buildings and commercial buildings).*	▪ **Emission reductions below 2019 levels**: 37% by 2025	▪ **Emission reductions below 2019 levels**: 58% by 2030		▪ **Emission reductions below 2019 levels**: 82% by 2040		▪ **Emission reductions below 2019 levels**: 100% by 2050
Scope 2		**Net-Zero 1.5 Sectoral Pathways** for global buildings industry (Teske, 2022, p. 332) ***Note:*** *See above.*	▪ **Emission reductions below 2019 levels**: 37% by 2025	▪ **Emission reductions below 2019 levels**: 69% by 2030		▪ **Emission reductions below 2019 levels**: 92% by 2040		▪ **Emission reductions below 2019 levels**: 100% by 2050
Scope 3	***Total***	**Net-Zero 1.5 Sectoral Pathways** for global buildings industry (Teske, 2022, p. 332) ***Note:*** *See above.*	▪ **Emission reductions below 2019 levels**: increase by 16% by 2025	▪ **Emission reductions below 2019 levels**: 5% by 2030		▪ **Emission reductions below 2019 levels**: 28% by 2040		▪ **Emission reductions below 2019 levels**: 48% by 2050
	Upstream							

	Downstream	**IEA Net Zero by 2050** for global level (IEA, 2022a, pp. 20; 147)	▪ **Appliances**: No new sales of fossil fuel boilers ▪ **Lighting:** 50% share of LED in sales by 2020	▪ **Zero emissions buildings**: All new buildings are zero-carbon-ready ▪ **Retrofits**: 2.5% of buildings are retrofitted to be zero-carbon-ready each year ▪ **Lighting:** 100% share of LED in sales		▪ **Appliances & Cooling**: Most appliances and cooling systems sold are best in class by 2035 ▪ **Retrofits**: 50% of existing buildings retrofitted to zero-carbon-ready levels **by 2040**		▪ **Zero emissions buildings**: More than 85% of buildings are zero-carbon-ready ▪ **Retrofits:** more than 85% of existing buildings retrofitted to zero-carbon-ready levels
		UNFCCC for global level (UNFCCC, 2021b, p. 11)		▪ **Zero emissions buildings:** 100% of projects due to be completed in 2030 or after are net zero carbon in operation with at least 40% less embodied carbon compared to current practice				▪ **Zero emissions buildings:** 100% of projects (new and existing) are net zero carbon across the whole life cycle
		State of Climate Action at global level (Boehm *et al.*, 2023, p. 44) ***Note:*** *All greyed-out benchmarks were additionally listed in the State of Climate Action 2022 report* (Boehm *et al.*, 2022, p. 47).		▪ **Building energy intensity combined:** 85-120 kWh/m^2 ▪ **Retrofitting rate:** 2.5–3.5% of buildings retrofitted per year ▪ **Share of new buildings that are zero-carbon in operation:** 100% ▪ **Carbon intensity of building operations combined**: 13-16 kgCO2/m^2 ▪ **Carbon intensity for residential buildings operations:** 10-16 kgCO2/m2 as global benchmark ▪ **Carbon intensity for commercial buildings operations:** 15-21 kgCO2/m2 as global benchmark ▪ **Buildings energy intensity for residential:** 70-80 on 100 index for 2015 levels ▪ **Buildings energy intensity for commercial:** 70-90 on 100 index for 2015 levels		▪ **Retrofitting rate**: 3.5% of buildings retrofitted per year		▪ **Energy intensity of building operations combined:** 55-80 kWh/m^2 ▪ **Carbon intensity of building operations combined**: 0-2 kgCO2/m^2 ▪ **All buildings well insulated and fitted with zero**-carbon technologies ▪ **Carbon intensity for residential buildings operations:** 0 kgCO2/m2 as global benchmark ▪ **Carbon intensity for commercial buildings operations:** 0 kgCO2/m2 as global benchmark ▪ **Buildings energy intensity for residential:** 40-80 on 100 index for 2015 levels ▪ **Buildings energy intensity for commercial:** 55-85 on 100 index for 2015 level
		Climate Action Tracker for countries and global level (CAT, 2020) *Note: Certain indicators not available at global-level, only on regional-level for USA, EU27, Brazil, India, China, and South Africa*		▪ **Renovation rate for residential and commercial:** 2.5-3% of buildings renovated as *PA Final Benchmark* globally		▪ **Emissions intensity for residential:** 90% reduction below 2015 as *PA Final Benchmark* globally ▪ **Emissions intensity for commercial:** 90-95% reduction below 2015 as *PA Final Benchmark* globally ▪ **Buildings energy intensity for residential:** *no global benchmark, only regional available*		▪ **Emissions intensity for residential:** 95-100% reduction below 2015 as *PA Final Benchmark* globally ▪ **Emissions intensity for commercial:** 100% reduction below 2015 as *PA Final Benchmark* globally ▪ **Buildings energy intensity for residential:** *no global benchmark, only regional available*

						▪ **Buildings energy intensity for commercial:** *no global benchmark, only regional available* ▪ **Renovation rate for residential and commercial:** 3.5% of buildings renovated as *PA Final Benchmark* globally		▪ **Buildings energy intensity for commercial:** *no global benchmark, only regional available*

Annex – Sector template

Sector-specific benchmarks for						
Indicator		**Source**	**2025**	**2030**	**2040**	**2050**
Scope 1, Scope 2 & Scope 3						
Scope 1 & Scope 2						
Scope 2						
Scope 3	***Total***					
	Upstream					
	Downstream					

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