SCIENCE BASED TARGETS

DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

SBTi AUTOMOTIVE SECTOR NET-ZERO STANDARD CONSULTATION DRAFT

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Version 0.0 - Public Consultation Draft

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“Science Based Targets initiative” and “SBTi” refer to the Science Based Targets initiative. This Standard is issued by the Science-based Targets Initiative (SBTi). Any feedback on SBTi Standards can be submitted to info@sciencebasedtargets.org for consideration of the SBTi.

[1]The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change.

VERSION HISTORY

Version	Change/update description	Release date	Effective dates
V0.0	**Public Consultation Draft**	12/06/2025	N/A

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EXECUTIVE SUMMARY

Disclaimer: *The Executive Summary is intended to provide an overview and guidance for stakeholders and does not constitute a normative part of this draft standard. For the full scope of proposed requirements, users should refer to the main body of the consultation draft. Any translated version of this document is for informational purposes only. Companies should refer to the original document in English in case of any inconsistency.*

Introduction

The Science Based Targets initiative (SBTi) Automotive Sector Net-Zero Standard offers a framework for automakers and auto parts manufacturers to set greenhouse gas (GHG) emissions reduction targets aligned with limiting global warming and achieving net-zero emissions by 2050 at the latest.

The draft standard will replace relevant sections of the SBTi's Land Transport Guidance (March 2024) to align with the updated SBTi Corporate Net-Zero Standard and incorporate best practices for decarbonization in the automotive sector. It lays out how automakers and auto parts manufacturers should use the latest version of the SBTi Corporate Net-Zero Standard, along with the sector-specific criteria, to set targets covering all relevant emissions.

The SBTi Automotive Sector Net-Zero Standard provides sector-specific pathways, criteria and calculation rules that extend beyond the Corporate Net-Zero Standard, demonstrating how companies can use both standards to set targets that are meaningful to their context. These sector-specific criteria are intended to encourage more companies to set targets, amplifying the overall impact of science-based target-setting.

Once the SBTi Automotive Sector Net-Zero Standard is finalized and published, it will supersede the Land Transport Guidance for automakers and auto parts manufacturers. The criteria in the Land Transport Guidance will, however, remain in force for other types of companies. Automakers and auto parts manufacturers with approved targets under the previous guidance will not need to update them until they expire, though earlier updates are encouraged. Such companies may use either the Land Transport Guidance or the Automotive Sector Net-Zero Standard for six months after the standard is published for use. After that, the new standard will become mandatory.

Key elements of the Standard

The draft SBTi Automotive Sector Net-Zero Standard introduces several significant changes to the current criteria for automakers and auto parts manufacturers:

- A direct link with the draft SBTi Corporate Net-Zero Standard Version 2.0, including clarity on how to apply the criteria from each Standard.
- A new aggregated indicator that combines scope 1, 2, and 3 emissions from the perspective of new vehicle manufacturers.

- New criteria that require companies to increase their share of low-emission vehicle sales, replacing the previous commitment to the Zero Emissions Vehicles Declaration.
- Regional emissions pathways designed to reflect economic and market differences.
- New criteria for auto part manufacturers to focus efforts on reducing emissions from material sourcing and manufacturing.
- Enhanced guidance on emissions calculations, including a detailed well-to-wheel methodology with standardized default inputs.

Structure of the Standard

The draft SBTi Automotive Sector Net-Zero Standard mirrors the structure of the draft Corporate Net-Zero Standard V2.0 to allow for the easy cross-reference of the two. It is organized into six chapters:

1. *Corporate net-zero commitment:* Includes criteria on how companies shall communicate their intentions to set net-zero science-based targets.
2. *Determining performance in the target base year*: Defines the organizational and operational boundaries companies shall use, in addition to how a company shall measure their climate-related performance in their target base year.
3. *Target setting*: Outlines how companies shall use data from their base year to develop targets using the SBTi's methodology.
4. *Addressing the impact of ongoing emissions*: Describes how companies shall take responsibility for the emissions they release during their transition to net-zero.
5. *Assessing and communicating progress*: Defines how companies shall measure and share progress against validated science-based targets, as well as how companies shall set new targets based on their previous performance.
6. *SBTi claims*: Focuses on ensuring that any claims companies make related to the Automotive Standard are accurate and verifiable.

Each chapter includes a table showing how the draft SBTi Corporate Net-Zero Standard Version 2.0 criteria apply to those using the draft SBTi Automotive Sector Net-Zero Standard.

Participating in the public consultation

The Automotive Sector Net-Zero Standard project was initiated in March 2024, and the Standard development process was adapted to follow the Standard Operating Procedure (SOP) for Development of SBTi Standards.

The draft was developed through extensive research and input from a dedicated Expert Advisory Group. This first draft will be open for public consultation from June 12 until August 11, 2025.

The SBTi welcomes all feedback on the draft standard, especially on the following topics (relevant criteria in brackets):

- Coverage of aggregated emissions from not-wholly-owned subsidiaries (AMSS-C1. 1.3b).

- Use of aggregated emissions to determine performance (AMSS-C1, AMSS-C5, APSS-C1, APSS-C6).
- Low-emission vehicle sales share to assess alignment with net-zero goals (AMSS-C2, AMSS-C7, APSS-C2).
- Additional requirement to assess performance separately for scope 3, category 1 for auto parts manufacturers, and category 11 for powertrain suppliers (APSS-C3, APSS-C4, APSS-C7, APSS-C8).
- Applicability of the draft SBTi Corporate Net-Zero Standard Version 2.0 together with the draft Automotive Standard.
- Regionalized pathways.

Submit feedback on the entire standard or specific aspects of it using the Automotive Sector Net-Zero Standard Consultation Survey. Whether you complete the entire survey or focus on the sections most relevant to you, your feedback will help strengthen the clarity, credibility, and ambition of the standard. The survey takes as little as 20 minutes, depending on the topics you choose to cover.

Next steps

After the public consultation closes, all input will be reviewed and summarized into a feedback report, with comments anonymised. All respondents will be notified once the report becomes available.

The draft Automotive Standard will then be refined based on the feedback received and will be re-released for a second public consultation and pilot testing. A final version of the standard will then be presented for approval by the SBTi Technical Council and adoption by the Board of Trustees.

All updates on the Automotive Standard development will be communicated on the SBTi's Automotive and Land Transport webpage, newsletter and social media channels.

A. INTRODUCTION

A.1 Introduction to SBTi

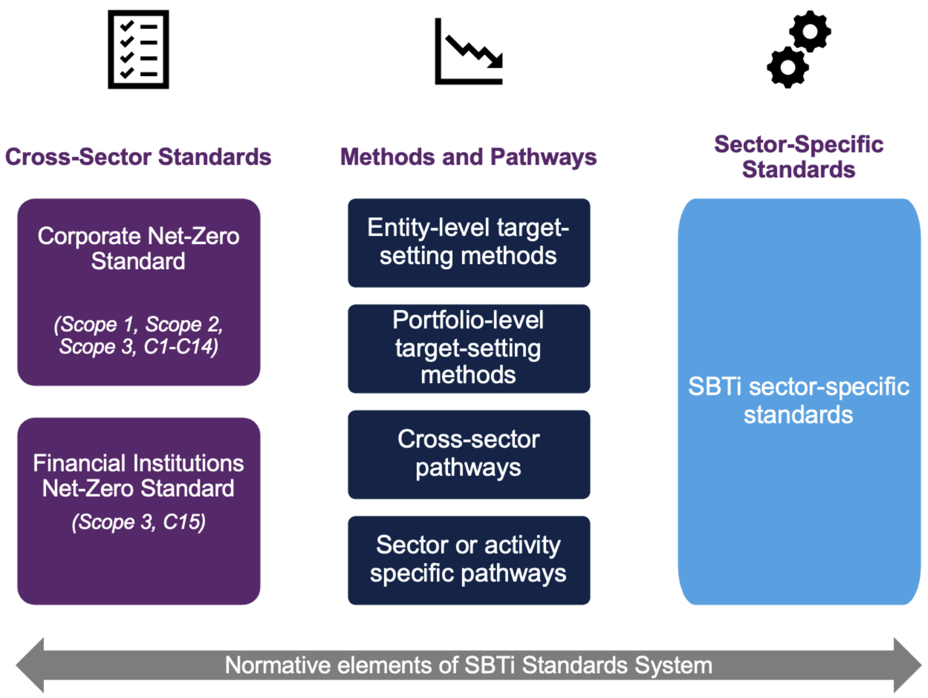
The Science Based Targets initiative (SBTi) is a corporate climate action organization that enables companies and financial institutions worldwide to do their part in reducing greenhouse gas emissions and achieving net-zero.[2] We develop standards, tools and guidance that enable companies to set GHG emissions reductions targets in line with what is needed to keep global heating to safer levels and reach net-zero by no later than 2050.

The SBTi is incorporated as a UK charity, with a subsidiary, SBTi Services Limited, which hosts the SBTi's target validation services. Our founding partners include CDP, the United Nations Global Compact, the We Mean Business Coalition, the World Resources Institute (WRI), and the World Wide Fund for Nature (WWF).

A.2 Framework of SBTi Standards

SBTi Standards are structured in a modular framework, comprising two cross-sector standards - the SBTi Corporate Net-Zero Standard[3] and the SBTi Financial Institutions Net-Zero Standard providing cross-sector requirements, guidance and recommendations to align value-chain activities with net-zero. Additionally, the suite of SBTi Standards includes multiple sector-specific standards intended for the heaviest emitting industries (Figure 1).

Figure 1. Overview of SBTi Standards System



[2] A company is a legal entity formed by one or more individuals to engage in and operate a business. This broad definition encompasses financial institutions and is the intended meaning when referencing companies under the SBTi Corporate Net-Zero Standard.
[3] The SBTi Corporate Net-Zero Standard is undergoing a major revision and so all references to its content in this draft sector standard are subject to change.

The SBTi Corporate Net-Zero Standard provides sector-agnostic requirements and recommendations for scope 1, scope 2 and scope 3 emissions, categories 1 to 14. The SBTi Financial Institutions Net-Zero Standard provides requirements and recommendations for financial activities (scope 3 emissions, category 15).

Companies shall assess their business activities against Scope and Applicability of the Automotive Sector Net-Zero Standard as detailed in Chapter A.4.

A.3 Application hierarchy of criteria between sector and cross-sector standards

The criteria stipulated in the SBTi Sector Standards are linked to and built upon the cross-sector criteria of the SBTi Corporate Net-Zero Standard (CNZS) (and the SBTi Financial Institutions Net-Zero Standard, if applicable).

All companies shall use the SBTi Corporate Net-Zero Standard as the starting point for setting SBTi targets. All companies shall calculate a complete GHG emissions inventory (as per CNZS-C5 in the SBTi Corporate Net-Zero Standard Version 2.0) and determine the applicability of SBTi sector-specific requirements (see CNZS-C6 in the SBTi Corporate Net-Zero Standard Version 2.0).

When a company falls within the scope of a sector with a specific standard or target-setting criteria that companies in that sector are required to follow, it must conform to that standard or those criteria within the applicable scope of that sector standard to seek validation.

In each chapter of the SBTi Automotive Sector Net-Zero Standard, all criteria from the SBTi Corporate Net-Zero Standard are referenced with their applicability to automotive companies clearly detailed.

The validation process for SBTi Sector targets follows the same cycle as the SBTi Corporate targets: SBTi Sector targets need to be validated and assessed together with the SBTi Corporate ones.

The following conformity assessments occur over a defined cycle for targets that are set over a five-year target time: entry check, initial validation and renewal validation. Please refer to the SBTi Corporate Net Zero Standard Version 2.0 and to the SBTi Services webpage for more information on targets' validation.

Each chapter and sub-section outlines the assessment stage of each criterion of the SBTi Standards. It provides information on when the conformance with the criterion will be validated.

A.4 Intended users of the SBTi Automotive Sector Net-Zero Standard

The criteria for automakers and auto parts manufacturers are aligned in intent, methods, and pathways, but the requirements for each type of company differ slightly and therefore the criteria are provided separately in each chapter.

A.4.1 Which companies are required to or may use the SBTi Automotive Sector Net-Zero Standard

Automakers

Any company engaged in vehicle manufacturing (see Table A.5.5.1) with production exceeding ten thousand units annually, shall follow the GHG emissions-related criteria for automakers covering scope 1, 2, and 3 emissions associated with those activities, and to the alignment criteria for vehicle sales across the company.

Auto parts manufacturers

Any company engaged in auto parts manufacturing (see Table A.5.5.1), where at least 20% of total company turnover is derived from auto parts production, shall adhere to the criteria for auto parts manufacturers within this standard.

Powertrain suppliers

Within auto part manufacturers that meet the threshold above, powertrain suppliers (defined in Annex A) shall apply criteria APSS-C4 and APSS-C8, which cover use-phase emission (scope 3, category 11) in addition to the rest of the auto parts criteria.

Companies producing both vehicles and auto parts

Companies manufacturing vehicles and meeting the automaker thresholds above, but also manufacturing auto parts, shall apply the automaker criteria for all activities that lead to a final vehicle being produced. Auto parts manufactured for use in a company's own vehicles shall be treated as part of the vehicle manufacturing criteria.

If auto parts sales make up more than 20% of total company revenue, then the auto parts criteria shall be applied to this portion of the company operations to assess performance and set targets that are separate to the automaker targets.

If auto parts sales make up less than 20% of total company revenue, the company may, but is not obliged to, apply the auto part criteria, and can instead cover this activity (and any other activity) using cross-sector criteria from the SBTi Corporate Net-Zero Standard Version 2.0.

Automakers offering financial services

According to the SBTi Glossary, the SBTi defines a financial institution (FI) as an entity that generates 5% or more of its revenue from investment, lending or insurance activities, and are therefore typically required to follow the SBTi Financial Institutions target-setting and validation pathway.

However, automakers often offer financial products such as loans that can generate significant revenue. This standard introduces an exemption to the use of SBTi Financial Institution requirements for automotive sector companies. Automotive sector companies that fall into the scope of this sector standard should apply the SBTi Corporate Net-Zero

Standard and this Standard and are not required to follow target setting requirements applicable to financial institutions for financial activities related to vehicle loans, regardless of the share of their revenue coming from these financial activities. This exemption is justified because emissions associated with vehicle loan revenue are already covered by other components of this Standard.

A.4.2 Definition of activities in the scope of this Standard

Table A.4.2.1 lists activities that fall within the scope of the SBTi Automotive Sector Net-Zero Standard according to the International Standard Industrial Classification of All Economic Activities (ISIC) Section and Class codes. All these activities are part of Section C – Manufacturing.

Table A.4.2.1. Activities within the scope of the SBTi Automotive Sector Net-Zero Standard and related ISIC Class codes

ISIC Section	ISIC Class	Activity	Automaker criteria apply	Auto parts criteria apply
C Manufacturing	**2211**	**Manufacture of tires**		✓
	2219	**Manufacture of rubber hoses and belts and other rubber products**		✓
	2220	**Manufacture of plastic hoses and belts and other plastic products**		✓
	2710	**Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus**		✓
	2720	**Manufacture of batteries and accumulators**		✓
	2730	**Manufacture of wiring and wiring devices**		✓
	2740	**Manufacture of lighting equipment for motor vehicles**		✓
	2811	**Manufacture of pistons, piston rings and carburetors**		✓
	2813	**Manufacture of pumps for motor vehicles and engines**		✓
	2910	**Manufacture of motor vehicles**	✓	

	2920	**Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers**		✓
	2930	**Manufacture of parts and accessories for motor vehicles**		✓
	3091	**Manufacture of motorcycles**	✓	

Note: for details on the contents of these classes, see ISIC, 2008.

In particular, ISIC Classes 2910 and 3091 are part of the manufacturing of road transport vehicles, and ISIC Classes 2920 and 2930 are part of the manufacturing of parts and components to the automotive sector.

Definition of activities outside the scope of this Standard

Table A.4.2.2 lists the activities (based on ISIC Sections and specific Classes) that relate to the subject covered in this Standard but fall beyond its current scope.

Table A.4.2.2 Activities (and related ISIC Classes) that relate with the subject covered in the SBTi Automotive Sector Net-Zero Standard but fall beyond its current scope

ISIC Section	ISIC Class	Activity
G Wholesale and retail trade; repair of motor vehicles and motorcycles	4510	Sale of motor vehicles
	4520	Maintenance and repair of motor vehicles
N Administrative and support service activities	7710	Renting and leasing of motor vehicles

Additional activities are indirectly related to the SBTi Automotive Sector Net-Zero Standard but fall outside its direct scope.

These include the following activities – detailed based on ISIC categories at the highest level (sections) and including most representative/relevant items:

- Agriculture, forestry and fishing (ISIC Section A), for biofuels.
- Mining and quarrying (ISIC Section B) for energy and minerals extraction.
- Manufacturing (ISIC Section C) for the parts related with fuels (needed for vehicle use and also as energy inputs for the production of fuels and vehicles).
- Manufacture of other transport equipment not elsewhere classified (ISIC Class 3099)

- Steam and air conditioning supply (ISIC Section D), needed for vehicle use and as energy inputs for the production of fuels and vehicles.
- Transportation and storage (ISIC Section H), relevant for vehicle and energy trade and distribution.

Emissions from capital goods manufacturing are excluded from the minimum boundary for the automaker criteria in this Standard. This applies to vehicle manufacturing, energy production, transport, and distribution facilities. This approach aligns with the GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard. Additionally, the construction sector (ISIC Section F) is not included in this Standard.

Please note that the activities outside the scope of this Standard fall within the scope of the SBTi Corporate Net-Zero Standard Version 2.0.

A.4.3 Optional application of this Standard

Companies that do not meet the applicability thresholds in A.4.1 but still conduct activities within the scope of this Standard (listed in A.4.2) may optionally apply the SBTi Automotive Sector Net-Zero Standard. Alternatively, they may address these emissions following the SBTi Corporate Net-Zero Standard Version 2.0.

A.4.4 Addressing emissions from activities not covered in this standard

All GHG emissions from activities not within the scope of this Standard shall be addressed in accordance with the SBTi Corporate Net-Zero Standard Version 2.0.

A.4.5 Company categorization

The SBTi Corporate Net-Zero Standard Version 2.0 divides companies in two categories, A and B, with certain criteria mandatory only for A companies. This distinction is maintained for automotive sector companies for the cross-sector criteria: automotive sector companies falling into the B category may opt out of some specified criteria in the SBTi Corporate Net-Zero Standard Version 2.0 unless these are superseded by sector-specific criteria or it is otherwise mentioned that they apply to all companies. This categorization also applies to criteria within this sector-specific standard.

A.5 Terminology

Within the criteria contained within SBTi Standards, the terms “shall”, “should” and “may” are used as follows:

1. “Shall” indicates criteria that are required for the applicable activities.
2. “Should” indicates a recommendation. Recommendations are important for transparency and / or adherence to best practices, but are not required.
3. “May” indicates an option that is permitted, allowed, or permissible.

The terms 'can' and 'must' are used with distinct meanings. 'Can' indicates possibility or capability, referring to options or actions available to the user. 'Must' denotes external constraints that are not requirements of this document but are provided for informational purposes. These terms reflect how SBTi Standards are applied in practice. For instance, 'must' could pertain to compliance with applicable laws in a user's country, region or sector, while 'can' might describe permissible actions that do not affect validation, such as using a specific technology or approach that may not count towards validation but does not preclude it.

The SBTi Glossary provides a list of terms and definitions, and of acronyms used in the SBTi's technical resources.

A.6 Compliance with regulatory requirements

In addition to meeting the criteria within SBTi Standards, companies are responsible for meeting or exceeding the national, subnational, regional, legislation and/or regulation in the countries where the SBTi Standards are applied on topics covered in the SBTi Standards.

A.7 Language and translations

The working language for SBTi Standards is English. As appropriate, the SBTi shall arrange translations of SBTi Standards into languages other than English. Translated versions of a standard are for information only. In case of doubt, the official English language version shall be deemed definitive.

A.8 Consultation questions

This subsection presents the key consultation questions related to this chapter. Stakeholders are invited to review the questions below and submit responses via the online survey.

Section	Criterion	Question	Rationale
A.4	General	Do you agree with the proposed thresholds for determining which companies should apply this standard? If not, please explain why and suggest alternative thresholds. Feel free to include examples of companies types/structures that you believe should or should not be in scope based on these criteria.	

A.4	General	Do you agree with the exemption from applying SBTi's FI standards introduced here for automotive sector companies?	**Rationale:** This exemption is introduced so that automotive sector companies are considered corporates rather than FIs. The emissions associated with revenue generated by vehicle loans are the same vehicle use-phase emissions already covered by automakers' aggregated targets.

B. ABOUT THIS STANDARD

B.1 Purpose of the SBTi Automotive Sector Net-Zero Standard

The latest climate science sends a clear warning that we must dramatically curb temperature rise to avoid the catastrophic impacts of climate change. The Science Based Targets initiative develops standards that show companies and financial institutions how much and how quickly they must reduce their greenhouse gas (GHG) emissions to prevent the worst effects of climate change.

The road transport sector directly contributes approximately 21-23% of man-made GHG emissions depending on the exact metrics and boundaries used (ICCT, 2025). The future trajectory of road sector emissions will depend on many factors, including behavioural, operational and technological developments.

The Automotive sector emissions come primarily from vehicle usage (tailpipe emissions). This is the largest source of CO2 emissions, primarily from burning fossil fuels:

- **Passenger Cars:** responsible for about **45% of global transport emissions**.
- **Trucks & Buses:** account for around **30%** of transport emissions.
- **Motorcycles & Other Vehicles:** contribute **smaller fractions**.

This is why the automotive sector (comprising automakers and auto parts manufacturers) plays a decisive role in shaping the future emissions trajectory. The efficiency and emission intensity of new vehicles and components brought to market will determine which emission reductions are technically feasible. New vehicle technologies will also determine the extent to which complementary actions taken in the energy supply sector and by vehicle users, in response to external policy and financial signals, can result in real future emissions reductions.

The SBTi's vision is that “By 2050, the world will have transitioned towards a net-zero and equitable economy that serves the needs of the population within the limits of the planet”. The SBTi Automotive Sector Net-Zero Standard (hereby referred to as “this Standard”) supports SBTi's vision, and its purpose is to provide science-based pathways for automakers and auto parts manufacturers to rapidly transition to efficient and low-emissions powertrains and vehicles, seizing the unprecedented opportunity for electrification in road transport to deliver cost-effective, deep GHG emissions reductions.

B.2 Changes versus previous SBTi sector criteria

In March 2024, the SBTi released updated guidance for land transport. This included an interim method for automakers to set 1.5°C-aligned emissions reduction targets based on a 4.2% annual absolute reduction of WTW emissions.

The March 2024 update was needed to provide automakers, who requested the opportunity to set 1.5°C-aligned emissions reduction targets, the chance to do so as the previous Transport Sector Guidance and emission reduction trajectories were developed for less stringent emission reduction targets.

The parts of the Land Transport Guidance pertaining to automakers and auto parts manufacturers will be superseded by this SBTi Automotive Sector Net-Zero Standard, which is also aligned with the SBTi Corporate Net-Zero Standard Version 2.0.

This Standard introduces several enhancements and, upon publication, is intended to supersede both the applicable requirements from the transport sector guidance for the sectors covered in this Standard.

The most relevant changes to users are based on the following methods and principles:

- Replacing the previous approach of separate scope 1, 2 and scope 3 category 11 targets used in both the original Transport Sector Guidance and interim approach with new 1.5°C aligned, sector-specific pathways for new aggregate GHG emission intensity reduction on the basis of combining the most relevant scopes and categories for vehicle manufacture and use.
- Regionalized pathways to reflect the reality of economic and market differences.
- Introducing a vehicle-cycle GHG emission accounting methodology.
- Replacement of the requirement to commit to the Zero Emissions Vehicles (ZEV) Declaration by a 'low-emission vehicle sales share' criteria; with specific reporting requirements (both retrospective and future company strategy).
- Use phase emissions continue to be based on WTW, but this standard introduces a more detailed WTW methodology and associated default values for data inputs such as emission factors specifically designed for the vehicle use phase.
- More guidance on calculating emissions including data inputs such as default vehicle lifetime mileage, required to calculate use-phase emissions.

B.3 Structure of SBTi Automotive Sector Net-Zero Standard

The structure of SBTi Automotive Sector Net-Zero Standard is aligned with that of the SBTi Corporate Net-Zero Standard Version 2.0. The SBTi Automotive Sector Net-Zero Standard covers six key topics which are presented over the following six chapters:

1. **CORPORATE NET-ZERO COMMITMENT**
2. **DETERMINING PERFORMANCE IN THE TARGET BASE YEAR**
3. **TARGET-SETTING**
4. **ADDRESSING THE IMPACT OF ONGOING EMISSIONS**
5. **ASSESSING AND COMMUNICATING PROGRESS**
6. **SBTi CLAIMS**

Each chapter includes the intended outcomes describing how the criteria support the goals of this Standard. Each chapter also includes a table referencing the different criteria from the SBTi Corporate Net-Zero Standard Version 2.0 and how they apply within the SBTi Automotive Sector Net-Zero Standard.

After this table, each chapter includes (if any) the sector-specific criteria (identified by “**AMSS-C**” or “**APSS-C**[4]” followed by whole numbers) and sub-criteria (identified by “C”

[4] The acronyms stand for Automaker Sector Standard Criterion and Auto Part Sector Standard Criterion respectively.

followed by decimal numbers). Criteria identified by “AMSS-C” apply to automakers and criteria identified by “APSS-C” apply to auto parts manufacturers in this Standard. Criteria and sub-criteria are rules that companies shall adhere to in order to be validated by the SBTi-designated validation body.

Sections may also include recommendations (identified with an “R”) followed by numbers, which represent best practices companies are encouraged to pursue.

Some criteria within this Standard are marked with the term “optional”. This indicates an optional criterion that is not required. However, an optional criterion, if chosen, shall be adhered to fully. A company shall not selectively follow parts of the optional element. Adhering to these optional criteria may enable companies to be eligible for additional claims.

This Standard also includes a number of normative annexes and informative appendices to support the use and assessment of conformance against this Standard.

Table B.3.1. Description, classification and status of normative annexes to the SBTi Automotive Sector Net-Zero Standard.

Annex	Description	Classification (normative or informative)	Status
Annex A: Key Terms	Key terms and acronyms introduced in this version of the SBTi Automotive Sector Net-Zero Standard that are not already included in the SBTi Glossary.	Normative	Draft for public consultation
Annex B: Indicators, benchmarks and methods	Provides sector-specific indicators designed to support the adoption of targets and the assessment of progress and performance over time.	Normative	Draft for public consultation
Annex C: Baselines and pathways	Overview of pathways and trajectories used in target-setting methods.	Normative	Draft for public consultation
Annex D: Reference Data	Reference for default data and indicators.	Normative	Draft for public consultation
Annex E: Vehicle energy intensity calculations	Additional information on conversion of vehicle energy intensity based on country-specific test procedures.	Normative	Draft for public consultation
Annex F: Energy efficiency ratios	Weighting factors for the assessment of the sales shares of low-emission vehicles.	Normative	Draft for public consultation
Annex G: Convergence approach	Convergence approach description for the applicable target setting criteria.	Normative	Draft for public consultation

Annex H: Percentage improvement approach	Percent improvement approach description for the applicable target setting criteria.	Normative	Draft for public consultation
Annex I: Durability correction for parts lifetimes	Correction method for parts whose default lifetimes are shorter than that of the vehicle.	Normative	Draft for public consultation
Annex J: Assignment of parts to vehicle powertrains	Default low-emission vehicle share for parts without powertrain documentation.	Normative	Draft for public consultation

B.4 Supporting documentation

This Standard is supported by documentation that helps to clarify, explain, and provide evidence for how a standard is applied or met. It helps ensure consistency, transparency, and accountability. These materials provide details on how to implement the standard effectively, concepts and metrics rationale, additional information on emission calculations, and vehicle manufacturing end-of-life emissions management.

Table B.4.1. Description, classification and status of documentation (non-normative) to support the implementation of the SBTi Automotive Sector Net-Zero Standard.

Appendices or document	Description	Classification (normative or informative)	Status
Appendix K: Life-cycle assessment components	Rationale for the life-cycle assessment approach taken in this Standard.	Informative	Draft for public consultation
Appendix L: Well-to-tank emissions	Additional information regarding the well-to-tank emission calculation of various energy carriers.	Informative	Draft for public consultation
Appendix M: Vehicle manufacturing and end-of-life emissions	Additional information regarding vehicle manufacturing and end-of-life emissions.	Informative	Draft for public consultation
Appendix N: Methodological considerations on the accounting of energy efficiency ratios for low-emission vehicles	Additional guidance on accounting for low-emission vehicles.	Informative	Draft for public consultation

Synthesis Report	Additional insights derived from research and scientific analysis that has informed this Standard.	Informative	Completed
Appendix O - Key Assumptions	Summary of key assumptions and dependencies underlying the pathways used in this Standard	Informative	To be prepared after public consultation

B.5 Development process

This Standard was prepared by SBTi's Sector Standard Team in accordance with the Standard Operating Procedure (SOP) for the Development of SBTi Standards and is subject to public consultation, Technical Council review and approval and, finally, adoption by the Board of Trustees.

The content of this document may change as a result of this process. The Project Terms of Reference for this revision process can be found here (SBTi Automotive Sector Net - Zero Standard ToR).

The SBTi Automotive Sector Net-Zero Standard was developed through a series of key steps, each of which was subject to review and approval in accordance with the standard development process for all sector-specific standards.

Figure 2. SBTi Standard development process

Purpose of The Public Consultation Draft

The public consultation process gives all stakeholders the opportunity to review and improve the proposed content, ensuring the final standard is robust and effective. We have included consultation questions at the end of each chapter, to gather public feedback on the key elements and options presented in this draft.

Next steps

Responses to feedback will be published in the Public Consultation Feedback Report, the Pilot Testing Feedback Report, and the Project Feedback log. A Basis for Conclusions Report will be published at launch to summarize the main points of feedback received on the project and the responses to it.

Between one and five years after the approval of an SBTi Standard, the SBTi shall oversee a formal consultation to undertake a review of the SBTi Standard to ensure and improve its continuing relevance and effectiveness in meeting its objectives. The exact review date will be determined based on the evolving needs of stakeholders and advancements in the relevant field.

Stakeholders are able to submit feedback not only during the public consultation phase but also throughout the course of the project through the Project Feedback Form.

1. CORPORATE NET-ZERO COMMITMENT

Intended outcome: Companies make a public commitment to achieve net-zero GHG emissions by no later than 2050. The commitment signals climate ambition to internal and external stakeholders and informs the companies' business strategy, targets, actions, investments and conduct in the near- and long-term.

1.1. Applicability of criteria from the SBTi Corporate Net-Zero Standard Version 2.0

The following table specifies the applicability of criteria from the SBTi Corporate Net-Zero Standard Version 2.0 for companies who apply both the SBTi Corporate Net-Zero Standard Version 2.0 and the SBTi Automotive Sector Net-Zero Standard in parallel.

SBTi Corporate Net-Zero Standard Version 2.0 Criterion	Applicability to companies using both standards in parallel
CNZS-C1. Companies shall publicly commit to reaching net-zero GHG emissions by no later than 2050.	Companies shall apply this criterion and corresponding sub-criteria at entity level, including all activities (activities covered by the Corporate Net-Zero Standard and Sector Standards).
CNZS-C2. Companies shall develop and make publicly available a climate transition plan within 12 months from initial validation which provides a roadmap of the actions that will be undertaken to achieve net-zero by no later than 2050.	Companies shall apply this criterion and corresponding sub-criteria at entity level, including all activities (activities covered by the Corporate Net-Zero Standard and Sector Standards).

Please note that the SBTi is currently researching the best way to clearly explain the applicability of the SBTi Corporate Net-Zero Standard Version 2.0 criteria within Sector Standards' scopes, which means that the above table might evolve in future versions of SBTi Standards.

1.2. Additional requirements introduced in this Standard

No additional requirements need to be followed by companies in the sector.

2. DETERMINING PERFORMANCE IN THE TARGET BASE YEAR

Intended outcome: Companies define organizational and operational boundaries and develop a thorough understanding of climate-related performance in the target base year. Determining performance in the target base year helps establish priority areas to guide target setting and other actions for improvement.

2.1. Applicability of criteria from the SBTi Corporate Net Zero Standard Version 2.0

The following table specifies the applicability of criteria from the SBTi Corporate Net-Zero Standard Version 2.0 for companies who apply both the SBTi Corporate Net-Zero Standard Version 2.0 and the SBTi Automotive Sector Net-Zero Standard in parallel.

SBTi Corporate Net-Zero Standard Version 2.0 Criterion	Applicability to companies using both standards in parallel
CNZS-C3. Companies shall clearly define, describe and publicly report their organizational structure and boundary for GHG emissions accounting and target-setting.	Companies shall apply this criterion and corresponding sub-criteria at the entity level, including all activities (activities covered by the SBTi Corporate Net-Zero Standard Version 2.0 and Sector Standards).
CNZS-C4. Companies shall select a target base year that accurately reflects the company's structure and performance.	Companies shall apply this criterion and corresponding sub-criteria at entity level, including all activities (activities covered by the SBTi Corporate Net-Zero Standard Version 2.0 and Sector Standards). (C4.3 applies to sector-specific indicators in the SBTi Automotive Sector Net-Zero Standard as well as those found in the Corporate Net-Zero Standard.)
CNZS-C5. Companies shall calculate a GHG emissions inventory for the target base year and for the consecutive years within the target time frame according to the GHG Protocol Standards.	Companies shall apply this criterion and corresponding sub-criteria at entity level, including all activities (activities covered by the SBTi Corporate Net-Zero Standard Version 2.0 and Sector Standards) and corresponding GHG emissions. In the SBTi Automotive Sector Net-Zero Standard, AMSS-C1 and APSS-C1 apply in addition to CNZS-C5.
CNZS-C6. Companies shall determine the applicability of SBTi sector-specific requirements.	Companies shall apply this criterion and corresponding sub-criteria at entity level, including all activities (activities covered by the SBTi Corporate Net-Zero Standard Version 2.0 and Sector Standards).

	Companies shall check whether other standards apply to them beyond the SBTi Corporate Net-Zero Standard Version 2.0 and the SBTi Automotive Sector Net-Zero Standard.
CNZS-C7. Companies shall identify relevant scope 3 emissions sources in the value chain, including significant scope 3 categories and emissions-intensive activities.	Companies shall apply this criterion as is to all activities (and corresponding GHG emissions) that are not covered by the SBTi Automotive Sector Net-Zero Standard, nor by any other Sector Standard or Criteria.
CNZS-C8. Companies shall identify applicable indicators and determine their performance for those indicators at the target base year.	Companies shall apply C8.1, C8.2.1 and C8.2.5 and C8.3 at entity level, including all its activities (activities covered by the SBTi Corporate Net Zero Standard and Sector Standards) and corresponding GHG emissions. Companies shall apply C8.2.2, C8.2.3 and C8.2.4 to all activities (and corresponding GHG emissions) that are not covered by the SBTi Automotive Sector Net-Zero Standard, nor by any other Sector Standard or Criteria. Additionally, companies shall apply AMSS-C1, AMSS-C2 and AMSS-C3 or APSS-C1 and APSS-C3 (for automakers/auto parts manufacturers respectively) for the activities and corresponding GHG emissions covered by the SBTi Automotive Sector Net-Zero Standard.
CNZS-C9. Companies shall obtain third-party assurance of their GHG emissions inventory.	Companies shall apply this criterion corresponding sub-criteria to the total GHG inventory done as per CNZS-C5, and on the GHG inventories done as per AMSS-C1, AMSS-C3 and APSS-C1 within the scope of the SBTi Automotive Sector Net-Zero Standard. When applying this criterion to the GHG inventories done as per AMSS-C1, AMSS-C3 and APSS-C1 within the scope of the SBTi Automotive Sector Net-Zero Standard, C9.2 is replaced by the following: “The assurance shall cover scopes 1, 2 and 3 emissions covered by the SBTi Automotive Sector Net-Zero Standard.” When applying this criterion to the GHG inventories done as per AMSS-C1, AMSS-C3 and APSS-C1 within the scope of the SBTi Automotive Sector Net-Zero Standard, R9.2 and R9.3 do not apply.
CNZS-C10. Companies shall aim to improve quality and traceability of their GHG emissions data over time.	Companies shall apply this criterion and corresponding sub-criteria to all its activities (activities covered by the SBTi Automotive Sector Net-Zero Standard and activities not covered by the SBTi Automotive Sector Net-Zero Standard) and corresponding GHG emissions.
CNZS-C11. Companies shall	Companies shall apply this criterion and corresponding sub-criteria

re-evaluate and, if necessary, recalculate their target base year GHG emissions inventory and other applicable indicators in response to significant changes.	to all its activities (activities covered by the SBTi Automotive Sector Net-Zero Standard and activities not covered by the SBTi Automotive Sector Net-Zero Standard) and corresponding GHG emissions.

Please note that the SBTi is currently researching the best way to clearly explain the applicability of the SBTi Corporate Net-Zero Standard Version 2.0 criteria within Sector Standards' scopes, which means that the above table might evolve in future versions of SBTi Standards.

2.2. Additional requirements introduced in this Standard

SUB-CHAPTER 1 - CRITERIA APPLICABLE TO AUTOMAKERS

Please note that this chapter is divided into two sub-chapters: sub-chapter 1 includes criteria applicable to automakers, and sub-chapter 2 includes criteria applicable to auto parts manufacturers. **Companies that both manufacture vehicles and auto parts shall apply criteria located in both sub-chapters**, if they meet the applicability conditions provided in section A.4 of this document.

AMSS-C1. Companies shall assess base year performance for aggregated scope 1, 2 and specified scope 3 emissions

Company segment: *Category A (mandatory); Category B (optional)*
Activity type: *Automakers*
Assessment stage: *Initial Validation, Renewal Validation*

C1.1 Companies shall determine base year performance for the indicator "Vehicle portfolio emission intensity (new vehicles)" in Table B1.

C1.2 Assessment shall be made for each vehicle category (defined in Annex A) (to be) sold by the automaker and for each of the three global regions (defined in Annex A).

C1.3 The boundary shall be aggregated emissions, according to the following corporate GHG accounting scopes and categories:

1.3.a. Companies shall calculate the aggregated emissions as the sum of the emission contributions from the "fuel-cycle" (vehicle use and related energy production - Scope 3, Category 11) and "vehicle-cycle" (vehicle manufacture [Scopes 1, 2 and Scope 3 category 1] and vehicle end-of-life processing [Scope 3, Category 12]) and combine them into a single estimate of the aggregated GHG emission intensity for the vehicles of each category sold/registered each year, according to a common functional unit, for each vehicle category: g CO_2e/vkm.

1.3.b. Where the company has over 15% stake in an entity considered an automaker and the consolidation approach chosen results in the emissions from this company falling into Scope 3 category 15 (investments), the aggregated emissions as per C1.3a of this subsidiary shall be included in the boundary for the purposes of assessing base year performance as if it were inside the organisational boundary.

C1.4 Companies shall calculate the vehicle-cycle and fuel-cycle components of the aggregated emissions using Annex B.

C1.5 Companies shall take into consideration the parts' lifespans and the vehicles' lifespans in the calculations of the GHG emissions from the contribution of parts to vehicle-cycle emissions. The parts' lifespans shall be defined using the default values that are adjusted for durability-related factors in Annex I.

C1.6 For the purpose of benchmarking and reporting on previous annual sales, and to designate the country and region to which new vehicles are allocated, the following data types shall be used, in the following order, depending on data availability:

- Annual vehicle sales (e.g. in Europe) or registration (e.g. in North America) data
- Factory shipments (e.g. in China) with explicit reporting of those shipments bound for export, by country/region of destination for final sale/registration.
- If none of the above data types are readily available in a given market, the automaker can report based on production volumes, and is required to provide documentation to attribute these to sales markets.

Recommendations:

R1.1 Companies with activities in the automotive sector should calculate emissions in the base year using data which has a high level of accuracy such as:

- Material shares following their bill of materials or equivalent, verified in-house data covering inbound provision of materials
- Vehicle sales shares.
- Vehicle in-use energy consumption according to vehicle test procedures listed in the guidelines for criterion AMSS-C2.
- Verified energy use data and associated emission factors from direct energy supplier agreements.
- Verified vehicle lifetime and mileage values, including annual mileage, were recorded by in-house telematics.
- Verified utility factors for PHEVs were monitored using in-house telematics.

R1.2 Companies should rely on data available in Annex D as a reference for default data and indicators.

AMSS-C2. Companies shall assess low-emission vehicle sales share covering their overall annual vehicle sales/registration portfolio for the target base year

Company segment: *All companies*

Activity type: *Automakers*
Assessment stage: *Initial Validation, Renewal Validation*

C2.1 Companies shall determine performance in the base year for low-emission vehicle sales share.

2.1.a. The low-emission vehicle sales share shall consist of those vehicles that meet an emission intensity (in g CO_2e/km) benchmark (65% lower than an ICEV of the same category using oil-based fuels, with benchmarks provided in Table C19, located in Annex C.

2.1.b. A vehicle's contribution to the low-emission vehicle sales share shall also depend on its WTW energy efficiency. These shall be based on the energy efficiency ratios, set out in Annex F, characterizing different vehicle powertrain configurations when using low-emission energy, with BEVs (due to the best energy efficiency performance among powertrains) as the benchmark.

2.1.c. Assessment shall be made for each vehicle category (defined in Annex A) sold by the automaker and for each of the three global regions (defined in Annex A).

AMSS-C3. Companies shall assess annual scope 3 category 1 emissions

Company segment: *All companies*
Activity type: *Automakers*
Assessment stage: *Initial Validation, Renewal Validation*

C3.1 Companies shall determine performance in the base year for the indicator "Scope 3 category 1 GHG emissions" in Table B1 in Annex B

SUB-CHAPTER 2 - CRITERIA APPLICABLE TO AUTO PARTS MANUFACTURERS

APSS-C1. Companies shall assess aggregated auto parts manufacture emission intensity covering their activities related to parts manufacturing

Company segment: *Category A (mandatory); Category B (optional)*
Activity type: *Auto parts manufacturers*
Assessment stage: *Initial Validation, Renewal Validation*

C1.1 Companies shall determine performance in the base year for the indicators in Table B2.

C1.2 Assessment shall be made for each vehicle category (defined in Annex A) (to be) sold by the automaker. Note that assessment of emission intensity performance is currently done at a global level, but that development of regional benchmarks and trajectories will be developed and tested in the process of developing the Target Setting Tool.

C1.3 The boundary shall be aggregated emissions associated with part or component (parts) manufacture and dismantling for disposal and recycling (end-of-life) according to the corporate GHG emission accounting scopes and categories as follows

1.3.a Companies shall calculate the sum of emission contributions from scope 1, scope 2 and scope 3 category 1 and category 12 as a single figure for the "aggregated" GHG emission intensity for the parts or components sold each year, according to a common unit, for components supplied for each vehicle category: g CO_2e/tonne.

C1.4 The calculation of emissions associated with materials supply and component manufacture shall consider the following elements:

1.4.a Emissions related to all materials associated with the manufacturing of parts shall be included, including emissions from direct and indirect energy use during manufacturing (scope 1 and scope 2, respectively), and embedded emissions in metals and materials procured for vehicle manufacturing on a cradle-to-gate basis (scope 3, category 1). A global market for materials and components shall be assumed for benchmarking purposes.

1.4.b Companies shall track and report emissions by major material groups used in the manufacture of parts, at a minimum including chemicals, steel, and aluminum.

1.4.c Emissions data shall also be disaggregated by vehicle category to support durability adjustments under criterion APSS-C1.2 and to ensure consistency with automaker aggregated emissions accounting as required under AMSS-C1.

C1.5 The calculation of emissions imputable to dismantling for disposal and/or recycling – i.e. end-of-life (EoL) emissions (scope 3, category 12), based on global value chains – shall be according to the 'cut-off' approach adopted by GREET-2, as further detailed in Appendix M. This includes emissions associated with the regulated treatment of waste products but does not include emissions associated with recycling materials.

C1.6 For parts whose lifetime is lower than the lifetime of the vehicle, auto parts manufacturers that can demonstrate that durability differs from default values can adopt durability-related correction factors, as detailed in Annex H. The GHG emission intensity corrected for durability is the relevant metric for this criterion, in these cases. Durability-corrected data for auto parts can be handed over to automakers for the calculation of aggregated emissions at the vehicle level, for the criterion AMSS-C1.

Recommendations:

R1.1 Because individual parts can find application in a wide range of different vehicle categories, auto parts manufacturers should attribute their parts to each vehicle category using mass-based emission intensities.

R1.2 Due to the multiplicity of part types, and in order to avoid potentially unfair advantages or disadvantages for facilities producing multiple part types (as compared to facilities focusing on the production of a specific vehicle parts and while still encouraging energy and emission savings from system integration), the tracking of emission intensities before the mass allocation should be carried out by grouping together parts according to the main material needed for their manufacture.

R1.3 Companies should rely on data available in Annex D as a reference for default data and indicators.

APSS-C2. Companies shall assess and disclose the sales share of parts that they sell for vehicles defined as low-emission, also taking into account vehicle energy efficiency ratios.

Company segment: *Category A (mandatory); Category B (optional)*
Activity type: *Auto parts manufacturers*
Assessment stage: *Initial Validation, Renewal Validation*

C2.1 Performance shall be assessed by the sales share of parts linked to each vehicle category (defined in Annex A) and for each of the three global regions (defined in Annex A).

C2.2 The boundary shall be total annual component (parts) sales. Companies shall calculate the total contribution of their component (parts) sales to annual low-emission vehicle sales shares.

C2.3 Low-emission vehicles shall be determined as in AMSS-C2.

C2.4 Parts equipping new vehicles produced by SBTi-validated automakers can be considered as contributing to the low-emission vehicles sales share

C2.5 Companies shall differentiate whether the parts they produce are supplied to low-emission vehicles or not based on the total share of new low-emission vehicles produced by the automakers to which the parts are supplied. In cases where companies are unable to establish the powertrain of the vehicle to which their parts are supplied, the parts are designated to the least performant powertrain according to the attribution methods detailed in Annex J.

C2.6 Due to the multiplicity of routes for parts to different road vehicle applications, and the fact that individual parts can find application in a wide range of different vehicle categories, while the criterion needs to be fulfilled by vehicle category, auto parts manufacturers also need to attribute their parts to each vehicle category, based on the vehicle category for which they are manufactured. In case of ambiguity, average market shares by vehicle category or company-specific shares, supported by documented evidence, can be used to allocate parts to different vehicle categories.

Recommendations:

R2.1 The disclosure of the share of sales of parts for low-emissions vehicles should be further broken down into two datapoints: share of sales of parts destined for new low-emissions vehicles and share of sales of parts destined for existing low-emissions vehicles (i.e. replacement parts).

APSS-C3. Companies shall assess annual scope 3 category 1 emissions

Company segment: *Category A (mandatory); Category B (optional)*
Activity type: *Auto parts manufacturers*

Assessment stage: *Initial Validation, Renewal Validation*

C3.1 Companies shall determine performance in the base year for the indicator "Scope 3 category 1 GHG emissions" in Table B1 in Annex B.

APSS-C4. Companies shall assess annual scope 3 category 11 emissions

Company segment: *Category A (mandatory); Category B (optional)*
Activity type: *Powertrain suppliers*
Assessment stage: *Initial Validation, Renewal Validation*

C4.1 Companies shall determine performance in the base year for the indicator "Scope 3 category 11 GHG emissions" in Table B1 in Annex B.

CONSULTATION QUESTIONS

This subsection presents the key consultation questions related to this chapter. Stakeholders are invited to review the questions below and submit responses via the online survey.

Section	Criterion	Question	Rationale
2 Determining performance in the target base year	AMSS-C1.3b	Do you agree that automakers must also cover the aggregated emissions of their subsidiaries even when these fall outside of operational control? What is the appropriate threshold (in terms of financial stake in the company) above which this is required? (15% is proposed).	**Rationale:** This standard assumes that automakers take an operational control (rather than financial control) approach, as per the GHG Corporate Standard, to ensure full coverage of their global vehicle manufacturing operations and responsibilities. Should they decide to take a financial control approach, there is the risk that only scope 1 and 2 emissions from subsidiaries would be covered (in scope 3 category 15). This criterion ensures that if such activities are significant, the aggregated emissions, particularly from the use of sold products by subsidiaries, are included in the boundary.
2 Determining performance in the target base year	AMSS-C3, APSS-C3	Do you agree there is value in the inclusion of an additional requirement to assess performance separately for scope 3 category 1 (purchased goods and services) for automakers?	**Rationale:** Purchased parts or materials are currently included in base year assessment and targets as part of the aggregated target. However, as this is an area where an automaker can have significant influence, a separate assessment and target to ensure sufficient focus is put on this area is also required.
2 Determining performance in the target base year	AMSS-C1, APSS-C1	Do you agree with including the End-of-Life (EoL) component (scope 3 Category 12) in the aggregate indicator in criteria AMSS-C1 and APSS-C1, or would you feel it is better to remove it?	**Rationale:** What happens to a vehicle or part at the end of its life is far from the manufacturer's control and so companies are likely to rely on default values, and therefore including this in the aggregated calculation may have limited impact and could shift focus away from life-cycle stages where companies have greater influence.
2 Determining	AMSS-C2,	Do you feel the low-emission vehicle definition is	**Rationale:** Alignment would enhance interoperability and reduce

performance in the target base year	APSS-C2	sufficiently aligned to existing sectoral regulations and requirements, to enhance interoperability and reduce reporting burden? If not, what changes would you suggest, aligning to which other regulations / requirements?	reporting burden.
2 Determining performance in the target base year	APSS-C2	It is proposed that Category B companies not be required to assess and disclose the sales share of parts for low-emission vehicles. Do you agree with this exemption?	**Rationale:** This requirement may be difficult to meet for smaller companies and so could be left as optional.
2 Determining performance in the target base year	All	Do you agree with having the China region (including China and Hong Kong) as a third separate regional grouping?	**Rationale:** China is presented separately, as the significant differences in its automotive and energy markets make a distinct scenario essential for generating meaningful results.
2 Determining performance in the target base year	AMSS-C1, APSS-C1	The aggregated emission intensity indicator is currently proposed as a mandatory target in the standard. Do you think this approach should remain, or would it be more appropriate for companies to only disclose base year performance, or for the indicator to be an optional target?	**Rationale:** The current draft of the standard includes the aggregated emission intensity indicator as a mandatory target. However, given the varying levels of data availability and methodological maturity across companies, particularly in early implementation stages, it is important to assess whether this requirement is appropriate for all actors in the sector.
2 Determining performance in the target base year	CNZS V2.0 criteria	Do you think the way CNZS V2.0's criteria applicability is explained is clear enough to enable an efficient applicability of both standards in parallel? If not, do you have any suggestions to improve on this aspect?	**Rationale:** Gathering feedback from stakeholders on the way SBTi Standards interoperability is explained will help identify the best solution to provide clarity and efficiency to the standards' users.

3. TARGET SETTING

Intended outcome: Companies set public, science-based, measurable, time-bound targets to improve climate performance and align with pathways consistent with the global goal of reaching net-zero emissions by mid-century.

3.1. Applicability of criteria from the SBTi Corporate Net Zero Standard Version 2.0

The following table specifies the applicability of criteria from the SBTi Corporate Net-Zero Standard Version 2.0 for companies who apply both the SBTi Corporate Net-Zero Standard Version 2.0 and the SBTi Automotive Sector Net-Zero Standard in parallel.

SBTi Corporate Net-Zero Standard Version 2.0 Criterion	Applicability to companies using both standards in parallel
CNZS-C12. Companies shall assess their current climate-related performance against net-zero aligned benchmarks.	C12.1 and C12.3 applies to sector-specific indicators in the SBTi Automotive Sector Net-Zero Standard as well as those found in the Corporate Net-Zero Standard Version 2.0. Companies shall apply C12.2.1, C12.2.2 and C12.2.3 at entity level, including all its activities (activities covered by the SBTi Corporate Net-Zero Standard Version 2.0 and Sector Standards) and corresponding GHG emissions. Companies shall apply C12.2.4, C12.2.5 and C12.2.6 to all activities (and corresponding GHG emissions) that are <u>not</u> covered by the SBTi Automotive Sector Net-Zero Standard Version 2.0, nor by any other Sector Standard or Criteria. C12.1, C12.3 and C12.4 shall apply to both the scope of the SBTi Corporate Net-Zero Standard Version 2.0 and the scope of the SBTi Automotive Sector Net-Zero Standard on sector-specific indicators
CNZS-C13. Companies shall set one or multiple targets to achieve net-zero emissions within the timeframe specified in the net-zero commitment.	Companies shall apply this criterion and corresponding sub-criteria at entity level, including all activities (activities covered by the Corporate Net-Zero Standard Version 2.0 and Sector Standards) and corresponding GHG emissions.
CNZS-C14. Companies shall set targets to abate scope 1 emissions from sources that are owned or controlled by the company.	Companies shall apply this criterion and corresponding sub-criteria at entity level, including all activities (activities covered by the SBTi Corporate Net-Zero Standard Version 2.0 and the Automotive Sector Net-Zero Standard) and corresponding GHG emissions. Companies shall apply AMSS-C5 and APSS-C6 on the activities and corresponding GHG emissions covered in the scope of the SBTi Automotive Sector Net-Zero Standard, in addition to CNZS-C14.

	Note: Scope 1 GHG emissions are included in: ● The aggregated target as per AMSS-C5 and APSS-C6 (for scope 1 emissions related to automotive activities of the company); ● A scope 1 target on the total company scope 1 GHG emissions as per CNZS-C14.
CNZS-C15. Companies shall set targets to abate scope 2 emissions from purchased or acquired electricity, steam, heat and cooling.	Companies shall apply this criterion and corresponding sub-criteria at entity level, including all activities (activities covered by the SBTi Corporate Net-Zero Standard Version 2.0 and the SBTi Automotive Sector Net-Zero Standard) and corresponding GHG emissions. Companies shall apply AMSS-C5 and APSS-C6 on the activities and corresponding GHG emissions covered in the scope of the SBTi Automotive Sector Net-Zero Standard Version 2.0, in addition to CNZS-C15. Note: Scope 2 GHG emissions are included in: ● The aggregated target as per AMSS-C5 and APSS-C6 (for scope 2 emissions related to automotive activities of the company);; ● A scope 2 target on the total company scope 2 GHG emissions as per CNZS-C15.
CNZS-C16. Companies shall set near-term targets to abate scope 3 emissions across their value chains.	Companies shall apply this criterion as is to all activities (and corresponding GHG emissions) that are not covered by the SBTi Automotive Sector Net-Zero Standard, nor by any other Sector Standard or Criteria. It is superseded by AMSS-C5, AMSS-C6, AMSS-C7 and/or APSS-C6, APSS-C7 and APSS-C8 as relevant for activities and corresponding GHG emissions covered in the scope of the SBTi Automotive Sector Net-Zero Standard.
CNZS-C17. Companies shall neutralize any residual emissions that remain at the net-zero year.	Companies shall apply this criterion and corresponding sub-criteria at entity level, including all activities (activities covered by the SBTi Corporate Net-Zero Standard Version 2.0 and Sector Standards) and corresponding GHG emissions.
CNZS-C18. Companies shall set and implement removal targets to increase the volume of removals between now and the net-zero target year.	Companies shall apply this criterion and corresponding sub-criteria at entity level, including all activities (activities covered by the SBTi Corporate Net-Zero Standard Version 2.0 and Sector Standards) and corresponding GHG emissions.
CNZS-C19. Companies shall publicly report the target base year and target information in line with best practice and applicable regulations, within	Companies shall apply this criterion for all the targets set by applying the SBTi Corporate Net-Zero Standard Version 2.0 and Sector Standards. Companies shall not apply C19.1.8, C19.1.9, C19.1.10 on the targets set by applying the SBTi Automotive Sector Net-Zero Standard.

6 months from validation.	C19.2.13.2. shall be replaced by "For alignment targets, the target value is dependent on the metric used for the specific indicator used, see Annex B: Indicators, Benchmarks and Methods." in the scope of the SBTi Automotive Sector Net-Zero Standard
CNZS-C20. Companies shall recalculate their targets when significant changes occur that could compromise the validity of the existing targets.	Companies shall apply this criterion for all the targets set by applying the SBTi Corporate Net-Zero Standard Version 2.0 and Sector Standards.

Please note that the SBTi is currently researching the best way to clearly explain the applicability of the SBTi Corporate Net-Zero Standard Version 2.0 criteria within Sector Standards' scopes, which means that the above table might evolve in future versions of SBTi Standards.

3.2. Additional requirements introduced in this Standard

Please note that this chapter is divided into two sub-chapters: sub-chapter 1 includes criteria applicable to automakers, and sub-chapter 2 includes criteria applicable to auto parts manufacturers. **Companies that both manufacture vehicles and auto parts shall apply criteria located in both sub-chapters**, if they meet the applicability conditions provided in section A.4 of this document.

SUB-CHAPTER 1 - CRITERIA APPLICABLE TO AUTOMAKERS

3.1.1 General target-setting criteria

AMSS-C4. **Companies shall identify target-setting priorities by assessing their current climate-related performance against net-zero aligned benchmarks.**

Company segment: *All companies*
Activity type: *Automakers*
Assessment stage: *Initial Validation, Renewal Validation*

C4.1 Companies shall assess their current level of performance against the net-zero aligned benchmarks included in Annex B for indicators identified in AMSS-C1, AMSS-C2 and AMSS-C3.

C4.2 For activities where companies have already achieved net-zero-aligned performance, they shall maintain that level of performance.

C4.3 For activities where a gap exists between the current and desired level of performance, companies shall set targets to close this gap.

3.1.2 Addressing operational (scope 1 and 2) emissions and value chain (scope 3) emissions

AMSS-C5. Companies shall set targets to reduce vehicle aggregated emissions intensity covering their overall annual vehicle sales/registration portfolio

Company segment: *Category A (mandatory); Category B (optional)*
Activity type: *Automakers*
Assessment stage: *Initial Validation, Renewal Validation*

C5.1 Companies shall set targets using the same granularity (vehicle type, region) and aggregated boundary as in AMSS-C1. Note: Options for flexibility in meeting targets at an aggregated level rather than per region will be explored after the public consultation.

C5.2 Target Setting methods:

5.2.a. Minimum ambition of targets for LDVs (cars and vans) shall be assessed against a defined emission intensity trajectory, globally and for each region and vehicle category, located in Annex C, using a convergence method that aligns with regional and global emission intensities by 2035, and calculated according to Annex G methods via the Automotive Target-Setting Tool.

5.2.b. Minimum ambition of targets for 2/3 wheelers, buses, light and medium/heavy trucks shall be assessed against a defined emission intensity trajectory for each region and vehicle category, located in Annex C, using a contraction (percent improvement) method, calculated according to the formulas in Annex H via the Automotive Target-Setting Tool

C5.3 Automakers shall also disclose supporting information regarding how they intend to reduce vehicle and component manufacturing emissions (as part of the vehicle-cycle) as described in Annex B.

C5.4 Vehicle components from auto parts manufacturers with a validated SBT can be considered as compliant with the AMSS-C1 criterion. The aggregated emissions related to these parts can be exempted from specific calculations to demonstrate the SBTi alignment by automakers and it can instead rely on emission intensities aligned with the benchmarking and the trajectory setting for the materials, assembly and dismantling for disposal/recycling of those parts.

AMSS-C6. Companies shall set targets to reduce scope 3 category 1 emissions

Company segment: *All companies*
Activity type: *Automakers*
Assessment stage: *Initial Validation, Renewal Validation*

C6.1 Companies shall set targets, using the target-setting method specified, for the indicator "Scope 3 category 1 GHG emissions" in Table B1 in Annex B

3.1.3 Targets to address relevant downstream scope 3 emissions sources

AMSS-C7. Companies shall set targets to increase their low-emission vehicle sales share covering their overall annual vehicle sales/registration portfolio for the target base year

Company segment: *All companies*
Activity type: *Automakers*
Assessment stage: *Initial Validation, Renewal Validation*

C7.1 Minimum ambition of targets for each vehicle category shall be assessed against a defined minimum sales share for each region and vehicle category, located in Annex D using a convergence method within each regionalized country grouping calculated according to Annex G. Convergence with the regional low-emission sales shares trajectories shall be aligned by 2035, as set out in Annex C.

C7.2 Companies shall calculate low-emission vehicle sales share aligned to the definition in AMSS-C2.

C7.3 Targets shall be set for each vehicle category (defined in Annex A) (to be) sold by the automaker and for each of the three global regions (defined in Annex A). Note: Options for flexibility in meeting targets at an aggregated level rather than per region will be explored after the public consultation.

SUB-CHAPTER 2 - CRITERIA APPLICABLE TO AUTO PARTS MANUFACTURERS

3.2.1 General target-setting criteria

APSS-C5. Companies shall determine target-setting priorities by evaluating their current climate-related performance against net-zero aligned benchmarks

Company segment: *All companies*
Activity type: *Auto parts manufactures*
Assessment stage: *Initial Validation, Renewal Validation*

C5.1 Companies shall assess their current level of performance against the net-zero aligned benchmarks included in Annex B for indicators identified in APSS-C1. The aggregated emission boundary set out in APSS-C1 shall be used for the benchmark assessment.

C5.2 For activities where companies have already achieved net-zero-aligned performance, they shall maintain that level of performance.

C5.3 For activities where a gap exists between the current and desired level of performance, companies shall set targets to close this gap.

3.2.2 Addressing operational (scope 1 and 2) emissions and value chain (scope 3) emissions

APSS-C6. Companies shall set targets to reduce annual auto parts manufacture emission intensity, covering their activities related to parts manufacturing

Company segment: *Category A (mandatory); Category B (optional)*
Activity type: *Auto parts manufacturers*
Assessment stage: *Initial Validation, Renewal Validation*

C6.1 Companies shall set targets using the same granularity (vehicle type, region) and aggregated boundary as in APSS-C1. Note: Options for flexibility in meeting targets at an aggregated level rather than per region will be explored after the public consultation.

C6.2 Minimum ambition of targets shall be assessed against GHG emission intensity trajectories contained in Annex C, based on the IEA NZE pathways, for each of the material groups: steel, aluminum and chemicals, as well as other materials, part assembly and dismantling for disposal/recycling (EoL).

C6.3 Auto parts manufacturers shall also disclose supporting information regarding how they intend to reduce the emission intensity of the materials used in parts manufacturing (with EI below historical benchmarks for steel, aluminum and chemicals), the emissions for tasks unrelated to material production but necessary for the manufacture of the auto parts (parts assembly and dismantling for disposal and/or recycling /EoL) and the durability of their products whose lifetime is lower than the lifetime of the vehicle. Auto parts manufacturers also need to disclose information regarding part durability, based on recommended lifetimes of the parts, as this is needed - for parts having a lower lifetime than the vehicles - for the determination of life-cycle emissions for vehicle manufacturing.

APSS-C7. Companies shall set targets to reduce scope 3 category 1 emissions

Company segment: *Category A (mandatory); Category B (optional)*
Activity type: *Auto parts manufacturers*
Assessment stage: *Initial Validation, Renewal Validation*

C7.1 Companies shall set targets, using the target-setting method specified, for the indicator “Scope 3 category 1 GHG emissions” in Table B1 in Annex B.

APSS-C8. Companies shall set targets to reduce scope 3 category 11 emissions

Company segment: *Category A (mandatory); Category B (optional)*

***Activity type:** Powertrain suppliers*
***Assessment stage:** Initial Validation, Renewal Validation*

C8.1 Companies shall set targets, using the target-setting method specified, for the indicator “Scope 3 category 11 GHG emissions” in Table B1 in Annex B.

CONSULTATION QUESTIONS

This subsection presents the key consultation questions related to this chapter. Stakeholders are invited to review the questions below and submit responses via the online survey.

Section	Criterion	Question	Rationale
3 Target Setting	CNZS V2.0 Criteria	Do you think the way CNZS V2.0's criteria applicability is explained is clear enough to enable an efficient applicability of both standards in parallel? If not, do you have any suggestions to improve on this aspect?	**Rationale:** Gathering feedback from stakeholders on the way SBTi Standards interoperability is explained will help identify the best solution to provide clarity and efficiency to the standards' users.
3.1 and Annex B, C, G, H	General	Do you agree with the methodological approach adopted to define benchmarks and compliance trajectories?	**Rationale:** Current methodologies attempt to strike a balance between the need for accuracy and limitations inherently arising from the choice of specific scenarios and from limitations in data availability. They may have excluded important data sources and/or assessments that could narrow uncertainties and/or improve the quality of the benchmarks and the trajectories taken into consideration.

4. ADDRESSING THE IMPACT OF ONGOING EMISSIONS

Intended outcome: Companies take responsibility for ongoing emissions, a key driver of continued negative climate impacts during the transition to net-zero, through additional mitigation measures. In doing so, they contribute to broader societal net-zero transformation and strengthen their climate credibility.

4.1. Applicability of criteria from the SBTi Corporate Net Zero Standard Version 2.0

The table below outlines which SBTi Corporate Net-Zero Standard Version 2.0 criteria apply to companies using both it and the Automotive Sector Net-Zero Standard in parallel.

SBTi Corporate Net-Zero Standard Version 2.0 Criterion	Applicability to companies using both standards in parallel
CNZS-C21. Companies seeking additional recognition for addressing ongoing emissions shall take responsibility for ongoing emissions that continue to be released into the atmosphere on an annual basis.	Companies shall apply this criterion and corresponding sub-criteria at entity level, including all activities (activities covered by the SBTi Corporate Net-Zero Standard Version 2.0 and Sector Standards) and corresponding GHG emissions.
CNZS-C22. Companies seeking additional recognition for addressing ongoing emissions shall publicly report actions to take responsibility for ongoing emissions.	Companies shall apply this criterion and corresponding sub-criteria at entity level, including all activities (activities covered by the SBTi Corporate Net-Zero Standard Version 2.0 and Sector Standards) and corresponding GHG emissions.

Please note that the SBTi is currently researching the best way to clearly explain the applicability of the SBTi Corporate Net-Zero Standard Version 2.0 criteria within Sector Standards' scopes, which means that the above table might evolve in future versions of SBTi Standards.

4.2. Additional requirements introduced in this Standard

No additional requirements apply to companies in this sector.

5. ASSESSING AND COMMUNICATING PROGRESS

Intended outcome: Companies assess and communicate their progress against targets at the end of each target cycle, evaluate their performance level against net-zero benchmarks and set new targets to continue their transformation to net-zero.

5.1. Applicability of criteria from the SBTi Corporate Net Zero Standard Version 2.0

The table below outlines which SBTi Corporate Net-Zero Standard Version 2.0 criteria apply to companies using both it and the Automotive Sector Net-Zero Standard in parallel.

SBTi Corporate Net-Zero Standard Version 2.0 Criterion	Applicability to companies using both standards in parallel
CNZS-C23. Companies shall substantiate progress against targets with mitigation measures that are accurate, permanent, transparent, and verifiable.	Companies shall apply this criterion for all targets set under the SBTi Corporate Net-Zero Standard Version 2.0 and Sector Standards.
CNZS-C24. Companies shall determine progress on their targets and other indicators at the end of the target timeframe.	Companies shall apply this criterion for all targets set under the SBTi Corporate Net-Zero Standard Version 2.0 and Sector Standards.
CNZS-C25. Based on the performance achieved at the end of the target cycle and any remaining gap towards achieving net-zero emissions, companies shall establish new targets to address this gap.	Companies shall apply this criterion for all targets set under the SBTi Corporate Net-Zero Standard Version 2.0 and Sector Standards. C25.2. applies to sector-specific indicators in the SBTi Automotive Sector Net-Zero Standard as well as those found in the Corporate Net-Zero Standard Version 2.0.
CNZS-C26. Companies shall demonstrate conformance with this Standard for the previous cycle to be eligible for Renewal Validation.	Companies shall apply this criterion for all targets set under the SBTi Corporate Net-Zero Standard Version 2.0 and Sector Standards.
CNZS-C27. Companies shall publicly report on their target progress at the end of their target cycle.	Companies shall apply this criterion for all targets set under the SBTi Corporate Net-Zero Standard Version 2.0 and Sector Standards. C27.6 applies this way to targets set by applying the SBTi Automotive Sector Net-Zero Standard: “Any communication related to target progress or renewal validation shall adhere to requirements stipulated in

	the Claims Section of the SBTi Automotive Sector Net-Zero Standard and any other applicable SBTi policies.

Please note that the SBTi is currently researching the best way to clearly explain the applicability of the SBTi Corporate Net-Zero Standard Version 2.0 criteria within Sector Standards' scopes, which means that the above table might evolve in future versions of SBTi Standards.

5.2. Additional requirements introduced in this Standard

No additional requirements apply to companies in this sector.

6. SBTi CLAIMS

Intended outcome: Companies ensure that all claims covered in this Standard, including those regarding target achievement, are accurate, verifiable, and adhere to high-integrity standards and applicable regulations.

6.1. Applicability of criteria from the SBTi Corporate Net Zero Standard Version 2.0

The table below outlines which SBTi Corporate Net-Zero Standard Version 2.0 criteria apply to companies using both it and the Automotive Sector Net-Zero Standard in parallel.

SBTi Corporate Net-Zero Standard Version 2.0 Criterion	Applicability to companies using both standards in parallel
CNZS-C28. Companies shall ensure all net-zero related claims are accurate, transparent, and verifiable and compatible with the requirements in the SBTi Corporate Net Zero Standard and applicable regulations.	Companies shall apply this criterion to all targets set under the SBTi Corporate Net-Zero Standard Version 2.0 and Sector Standards. To apply C28.2 to targets within the scope of the SBTi Automotive Sector Net-Zero Standard, companies shall refer to the Claims chapter of this Standard.
CNZS-C29. Companies shall ensure that any claim occurring before initial validation is accurate and transparent and reflects the company's assessment stage in the SBTi target-setting process.	Companies shall apply this criterion to all targets set under the SBTi Corporate Net-Zero Standard Version 2.0 and Sector Standards. To apply C29.1 to targets within the scope of the SBTi Automotive Sector Net-Zero Standard, companies shall refer to the Claims chapter of this Standard.
CNZS-C30. Following initial validation, companies shall ensure that target-related "ambition claims" accurately reflect their validation status and the ambition level of their validated targets.	Companies shall apply this criterion to all targets set under the SBTi Corporate Net-Zero Standard Version 2.0 and Sector Standards. For claims related to criteria in the SBTi Automotive Sector Net-Zero Standard, companies shall refer to AMSS-C8 and APSS-C9 instead of the links in C30.1 and C30.2 of the SBTi Corporate Net-Zero Standard Version 2.0.
CNZS-C31. Following assessment of progress and Renewal Validation, companies shall ensure that progress-related claims and renewal claims accurately	Companies shall apply this criterion to all targets set under the SBTi Corporate Net-Zero Standard Version 2.0 and Sector Standards. To apply C31.3 to targets within the scope of the SBTi Automotive Sector Net-Zero Standard, companies shall refer to the Claims chapter of this Standard.

reflect the outcome of the assessment and re-validation process.	
CNZS-C32. Companies addressing ongoing emissions through beyond value chain mitigation (BVCM) measures may make additional claims in line with the criteria outlined in this section.	Companies shall apply this criterion and corresponding sub-criteria at entity level, including all activities (activities covered by the SBTi Corporate Net-Zero Standard Version 2.0 and Sector Standards) and corresponding GHG emissions.

Please note that the SBTi is currently researching the best way to clearly explain the applicability of the SBTi Corporate Net-Zero Standard Version 2.0 criteria within Sector Standards' scopes, which means that the above table might evolve in future versions of SBTi Standards.

6.2. Additional requirements introduced in this Standard

This chapter is divided into two sub-chapters: sub-chapter 1 covers criteria for automakers, and sub-chapter 2 includes criteria for auto parts manufacturers. **Companies that manufacture both vehicles and auto parts shall apply criteria from both sub-chapters**, if they meet the applicability conditions in Section A.4 of this document.

SUB-CHAPTER 1 - CRITERIA APPLICABLE TO AUTOMAKERS

AMSS-C8. Companies shall adhere to the target wording provided

Company segment: *All companies*
Activity type: *Automakers*
Assessment stage: *Initial Validation, Renewal Validation*

C8.1 For AMSS-C5, the following target language shall be used:

<< Company >> commits to reduce the average scope 1, scope 2 and scope 3 category 1, category 11 and category 12 aggregated GHG emission intensity covering vehicles sold in <<category X>> and <<country grouping Y>> by …% by << target year >> relative to << base year >>, for all applicable vehicle category / country grouping combinations.

C8.2 For AMSS-C6, the following target language shall be used:

<< Company >> commits to reduce scope 3 category 1 emissions by …% by << target year >> from a << base year >> base year.

C8.3 For AMSS-C7, the following target language shall be used:

<< Company >> commits to increase the sales share of its low-emission vehicles in <<category X>> across all countries by …% in << target year >> relative to << base year >>, for all applicable vehicle category / country grouping combinations.

SUB-CHAPTER 2 - CRITERIA APPLICABLE TO AUTO PARTS MANUFACTURERS

APSS-C9. Companies shall adhere to the target wording provided

***Company segment:** All companies*
***Activity type:** Auto parts manufacturers*
***Assessment stage:** Initial Validation, Renewal Validation*

C9.1 For APSS-C6, the following target language shall be used:

<< Company >> commits to reduce the average scope 1, scope 2 and scope 3 category 1 and category 12 GHG emission intensity of its products sold for vehicles in <<category X>> and <<country grouping Y>> by …% in << target year >> relative to << base year >>, for all applicable vehicle category / country grouping combinations.

C9.2 For APSS-C7, the following target language shall be used:

<< Company >> commits to reduce scope 3 category 1 emissions by …% by << target year >> from a << base year >> base year.

C9.3 For APSS-C8, the following target language shall be used:

<< Company >> commits to reduce scope 3 category 11 emissions by …% by << target year >> from a << base year >> base year.

ANNEX A: KEY TERMS

A full list of the SBTi terms, definitions, and acronyms is in the SBTi Glossary. Please find here a list of new or updated key terms used in this Standard. Terms marked ‘revised’ differ from the current definitions in the SBTi Glossary.

Term	Definition
Cross-sector company level criteria	These criteria are located in the SBTi Corporate Net-Zero Standard Version 2.0. They apply at the company level and to the full corporate GHG inventory boundaries as defined and calculated per CNZS-C5.
Emerging economy	Amalgamation of the World Bank classifications for low, lower middle and upper middle income countries: World Bank country classifications by income level for 2024-2025. Also designated as ‘emerging markets and developing economies’ (EMDEs)
Emission factor	A coefficient that quantifies the emissions or removals of a gas per unit activity. Emission factors are often based on a sample of measurement data, averaged to develop a representative rate of emission for a given activity level under a defined set of operating conditions (IPCC, 2006)
Emission intensity (EI)	Specific emissions associated with a process, quantified as in g CO_2e per relevant functional unit (e.g. vkm for activity, kg for materials).
Energy Efficiency Ratio (EER)	Ratio of the WTW energy efficiency of a low-emission vehicle compared to a comparable ICE/fuel combination (i.e. taking into account the energy efficiency of vehicle operations, factoring in losses associated with the production of different low-emission energy pathways). The following energy efficiency ratios apply: ● BEVs are subject to an energy efficiency ratio of 1. ● PHEVs, are assessed considering the shares of electricity and fuel consumption[5] and weighted using BEV energy efficiency ratios for the share of equivalent all-electric travel, and HEV energy efficiency ratio for the remaining part. ● FCEVs, HEVs and ICEVs are subject to powertrain-specific energy efficiency ratios, as detailed in Annex F. Further details are included in Appendix N.

[5] As determined based on information provided on the vehicle range, fuel, and electricity consumption in charge depleting mode (CD) and the fuel consumed in the charge sustaining mode (CS), also allowing calculation of equivalent all-electric shares of travel, as further detailed in Annex E. Where possible the automaker can perform the calculation on-board fuel consumption monitoring (OBFCM) data for both electric and liquid fuel use. To do so, it needs to release methodological information and data allowing for third-party verification.

End of Life (EoL)	Dismantling, consisting of processes like the collection and separation of a final product's materials and components, with some parts being landfilled or incinerated, and others being separated and prepared for recycling.
[1] Fuel-cycle emissions (based on GREET Transportation Fuel-Cycle Model - Volume 1: Methodology, Development, Use, and Results)	All greenhouse gas emissions from the production, transportation, storage, and distribution of the fuel/energy used to move the vehicle, the recovery, transportation, and storage of the feedstock needed by the same fuel/energy, and resulting from the use of the fuel/energy for vehicle operations. Synonymous with well-to-wheel (WTW) emissions.
High-income economy:	According to the World Bank definition: [World Bank country classifications by income level for 2024-2025]
Low-emission vehicle:	A vehicle that meets a minimum life-cycle emission intensity (in g CO_2e/km) reduction of 65% with respect to an Internal Combustion Engine Vehicle (ICEV) of the same type using gasoline, diesel, or natural gas fuels of fossil origin.
Powertrain supplier	A company that designs, manufactures, and/or supplies components or complete systems related to the powertrain of a vehicle. This includes technologies and parts responsible for generating and delivering power to the wheels, such as internal combustion engines, electric motors, batteries, transmissions, drivetrains, and related control systems. The following ISIC categories fall within the scope of automotive powertrain suppliers: 2710 (manufacture of electric motors, generators, transformers and electricity distribution and control apparatus), 2720 (manufacture of batteries and accumulators), 273 (manufacture of wiring and wiring devices), 2811 (manufacture of pistons, piston rings and carburetors), 2813 (manufacture of pumps for motor vehicles and engines).
Specified-emissions criteria	These criteria apply only to the portion of GHG emissions included in a specific target scope: - For Sector Standards: they apply to the GHG emissions included in the applicability scope of the standard. - For the SBTi Corporate Net-Zero Standard: they apply to the scope of applicability of the SBTi Corporate Net-Zero Standard, hence on the GHG emissions that are not included in any Sector Standard.
Tank-to-wheel / Tank-to-wake (TTW)	Tank-to-wheel (or tank-to-wake for air and sea transport) refers to the stage of the energy carrier's life cycle where the energy carrier is converted to propulsion energy.
Tank-to-wheel (TTW) emissions:	All greenhouse gas emissions resulting from the TTW phase energy for vehicle operations (mainly combustion emissions from vehicle operations, in the case of internal combustion engine [ICE] vehicles).

Vehicle category	Six vehicle categories (passenger cars, LCVs, buses, medium trucks, heavy trucks and 2&3 wheelers) are used to match the approach taken by different organisations in their scenario definition process.
Vehicle-cycle emissions (as defined by GREET2)	All greenhouses gas emissions of vehicle material recovery and production, vehicle component fabrication, vehicle assembly, and vehicle disposal/recycling.
Vehicle-kilometer	Unit of measurement representing the movement of a vehicle over one kilometer.
Vehicle life-cycle emissions	The sum of the vehicle-cycle and fuel-cycle (WTW) emissions.
Vehicle-to-grid	Technology that enables plug-in electric vehicles (battery electric and plug-in hybrid electric vehicles) to provide services to the electricity grid (including frequency modulation, energy provision, and other services),
Well-to-tank (WTT)	Well-to-tank (WTT) is the portion of transport related fuels and electricity that occur in the value chain before combustion e.g., gasoline, diesel, electricity for electric vehicles, extraction, production, refining, and distribution of the fuel.
Well-to-tank (WTT) emissions:	All greenhouse gas emissions resulting from the WTT phase.
Well-to-wheel / Well-to-wake (WTW)	WTW refers to a specific scope or boundary used for measuring GHG emissions from transportation activities. It encompasses the full life cycle of the energy carrier used by a vehicle, from: ● Well-to-tank (WTT): the extraction, production, refining, and distribution of the fuel (e.g., gasoline, diesel, electricity for electric vehicles). ● Tank-to-wheel or Tank-to-wake (TTW): the combustion of the fuel in the vehicle's engine and the resulting emissions released at the tailpipe.
Well-to-wheel/ Well-to-wake (WTW) emissions	All greenhouse gas emissions from the WTW life-cycle of an energy carrier—i.e., the sum of WTT and TTW emissions. Synonymous with fuel-cycle emissions.
Zero-emission vehicle (ZEV)	ZEVs are vehicles that are capable of operating during some portion of their operations without emitting tailpipe emissions of any air pollutant (or precursor pollutant) or greenhouse gas emissions from the onboard source of power, such as some plug-in hybrid electric vehicles (PHEV), battery-electric vehicles (BEV), and hydrogen fuel cell vehicles.

Abbreviation	Explanation
2/3W	Two- and three-wheeled vehicles
AEs	Advanced Economies (synonymous with high-income economies)
ANL	Argonne National laboratory
APS	Announced Pledges Scenarios (International Energy Agency)
BEV	Battery Electric Vehicle
CCS	Carbon Capture and Storage
CCUS	Carbon Capture, Utilisation and Storage
CNG	Compressed Natural Gas
EER	Energy efficiency ratio
EMDEs	Emerging Market and Developing Economies
EoL	End of Life
FCEV	Fuel Cell Electric Vehicle
GHG	Greenhouse Gas
HDT	Heavy-duty truck
HEV	Hybrid Electric Vehicle
ICAO	International Civil Aviation Organization
ICCT	International Council on Clean Transportation
ICE	Internal Combustion Engine
ICEV	Internal Combustion Engine Vehicle
IEA	International Energy Agency
ILUC	Induced (or Indirect) Land Use Change
IPCC	Intergovernmental Panel on Climate Change

Abbreviation	Explanation
ISIC	International Standard Industrial Classification of All Economic Activities
ITF	International Transport Forum
LCV	Light commercial vehicle (van)
LDV	Light duty vehicle (cars and vans)
LNG	Liquefied Natural Gas
LPG	Liquefied petroleum gas
LULUCF	Land Use, Land Use Change and Forestry
MDT	Medium-duty truck
MJ	Megajoule
NGO	Non-Government Organization
NZE	Net Zero Emissions scenario (International Energy Agency)
OBFCM	On-board fuel consumption monitor
OECD	Organization for Economic Cooperation and Development
OEM	Original Equipment Manufacturer
PLDV	Passenger Light-Duty Vehicle
PHEV	Plug-in Hybrid Electric Vehicle
RCF	Recycled Carbon Fuel
RD	Renewable Diesel
RNG	Renewable Natural Gas
RFNBO	Renewable Fuel of Non-Biological Origin
SDA	Sectoral Decarbonization Approach

Abbreviation	Explanation
SMR	Steam methane reformation
UNECE	United Nations in the Consolidated Resolution on the Construction of Vehicles
V2G	Vehicle-to-grid
vkm	Vehicle-kilometer
ZEV	Zero-emission vehicle (i.e. zero tailpipe pollutant emissions)

Definition of vehicle categories

The choice of vehicles made for the SBTi categories in the Automotive Sector Net-Zero Standard reflects the common approach of the three main global modelling efforts by ICCT, IEA and ITF. It is also consistent – to the extent possible – with the classifications developed at the United Nations in the Consolidated Resolution on the Construction of Vehicles (R.E.3) (UN, 2023) for its part regarding power-driven vehicles, and in the Special Resolution no. 1 concerning the common definitions of vehicle categories (UN, 2023), masses and dimensions as detailed in Table A1.

Table A1. Updated SBTi vehicle categories compared with the UN R.E.3 and the S.R.1

Vehicle categories in this Standard	R.E.3	S.R.1
2- and 3-wheelers	L-category	Category 3
Passenger cars	M_1	Category 1-1
Buses and minibuses	M_3 and M_2	Category 1-2
Light commercial vehicles (LCVs)	N_1 (maximum gross vehicle weight of 3.5 t)	Category 2
Medium duty trucks (MDTs)	N_2 (maximum mass exceeding 3.5 t but not exceeding 12 t)	Category 2
Heavy duty trucks (HDTs)	N_3 (maximum mass exceeding 12 t)	Category 2

Definition of regional groupings

Countries are classified according to the World Bank's categories (World Bank, 2024). "High income" countries are considered to be Advanced Economies (AEs); those in the three other income categories (upper-middle, lower middle, and low income) are considered to be emerging economies (Emerging Markets and Developing Economies (EMDEs) in full). For the purposes of target-setting according to this standard, China Region (including China and Hong Kong) is added as a third, separate regional grouping, reflecting significant differences in that market[6]. Companies will need to take into account their activity at the country level and then aggregate where appropriate.

For consistency and to allow benchmarking with previous years, the definition of high income countries is kept static to the same as the initial year of submissions to the SBTi and revised at recommitment/revision to the automotive standard.

Definition of material groups

The materials shall be mapped into IEA material groups (aluminum, chemicals and steel) as indicated in Table A2, based on the bills of materials, to determine – in combination with IEA NZE scenario carbon intensities by material group – the carbon intensities associated with material production that determine SBTi compliance at future target dates (e.g. 2030, 2035, 2040, etc.).

Table A2. Mapping of GREET-2 materials into IEA material groups

IEA material group	GREET-2 materials
Aluminum	Aluminum (wrought and cast aluminum)
Chemicals	Plastics, rubber
Steel	Cast iron, steel
Other	Copper, zinc, magnesium, glass, nickel Battery materials other than aluminum, fuel cell materials Fluids

[6] Most notably, in light-duty, BEV and PHEV sales shares are substantially higher in China than in any other major automotive market (considering the European market as a single entity). Given the size of China's light-duty vehicle market, this means that over half of the world's EVs are sold in China. (An even higher share was produced in China). Similarly, most of the world's electric buses and trucks are sold in China (and an even higher share are made in China). Most of the big pure-play EV manufacturers are Chinese (with Tesla being the notable exception) and China's lead extends to the battery value chain - the majority of EV critical mineral mines are owned by Chinese companies, and most of the processing of EV critical minerals, and of EV battery cell components and of the cell manufacturing is also done in China. All of these factors together make it worth treating China as a separate region, because benchmarking and trajectory setting on the two main metrics -- emission intensity reductions and low-emission vehicle sales shares -- should account for these considerations so that the SBTi automotive standard can properly incentivize continuing progress in China's market (and to avoid "gaming" of continuing progress in China from replacing progress in other countries and regions).

ANNEX B: INDICATORS, BENCHMARKS AND METHODS

This annex provides indicators, benchmarks, and methods used to set targets. Applicable to companies in the automotive sector, these three elements support assessing performance toward net-zero over time and setting targets. They are used to guide companies in performing a benchmark assessment and to determine whether it is in line with the trajectories that characterize science-based targets and improvement plans.

Indicators and benchmarks

Indicators measure quantitative information about the company's activities that are relevant to setting climate targets and tracking progress against them. The SBTi Automotive Sector Net-Zero Standard covers two categories of SBTi indicator:

- GHG impact and performance, which relate to criteria AMSS-C1 and AMSS-C3, AMSS-C5 and AMSS-C6 for automakers, APSS-C1, APSS-C3, APSS-C4, APSS-C6, APSS-C8 and APSS-C9 for auto parts manufacturers (or powertrain suppliers, i.e. a subset of auto parts manufacturers), where a form of GHG intensity is calculated and tracked against a corresponding trajectory.
- Activity, which relates to criteria AMSS-C2 and APSS-C2, where the company's sales portfolio is compared with requirements related to low-emission vehicles.

Tables B1 and B2 set out the indicators and benchmarks that apply to automakers and auto parts manufacturers respectively under this standard. Entities shall use these tables to select the required indicators to be measured to reach net-zero aligned performance by 2050.

Table B1. Indicators, net-zero aligned benchmarks and target-setting methods for Automakers

Code	Indicator	Unit	Description	Net-zero aligned benchmark value	Reference year	Reference Scenario	Target- setting method
Metric-Auto.1	Vehicle	g CO_2e/	Measures the	Global and (separately)	2050 or	ITF "All Out"	Convergence

	portfolio emission intensity (new vehicles)	vkm	aggregated emission intensity of the manufacturer's annual production portfolio (light-duty vehicles only)	regional emission intensities for AE, EMDEs and the China region, expressed in g CO_2e/vkm according to the values in Tables C1, C3, C5 and C7 in Annex C	earlier	scenario (for WTW emissions); IEA NZE (for vehicle-cycle emissions)	(according to Annex G)
			Measures the aggregated emission intensity of the manufacturer's annual production portfolio (for all non-light-duty vehicle types)	Global and (separately) regional emission intensities for AE, EMDEs and the China region, expressed in g CO_2e/vkm according to the values in Tables C1, C3, C5 and C7 in Annex C	2050 or earlier	ITF “All Out” scenario (for WTW emissions); IEA NZE (for vehicle-cycle emissions)	Percent Improvement Approach (detailed in Annex H)
Metric-Auto.2	Low emission vehicle share	Percentage (%)	Measures the low-emission vehicle share of the annual sales/registration portfolio	100% (as shown in Tables C2, C4, C6 and C8 in Annex C); benchmarks for the emissions intensity, for measurement of meeting the 65% emissions intensity reduction threshold needed to qualify as a low-emission vehicle, shown in Table C19 in Annex C	2050 or earlier	ITF “All Out” scenario (for WTW emissions)	Convergence (according to Annex G)
Metric-Auto.3	Scope 3 category 1	g CO_2e/ vkm	Measures scope 3 category 1 emission intensity of the manufacturer's annual production portfolio	A global emission intensity reduction trajectory for expressed in g CO2e/vkm according to the values in Table C14 in Annex C	2050 or earlier	ITF “All Out” scenario (for WTW emissions); IEA NZE (for vehicle-cycle emissions)	Percent Improvement Approach (detailed in Annex H)

Table B2. Indicators, net-zero aligned benchmarks and target-setting methods for Auto-parts manufacturers

Code	Indicator	Unit	Description	Net-zero aligned benchmark value	Reference year	Reference Scenario	Target- setting method
Metric-Auto.5	Vehicle Parts - Emission Intensity	g CO_2e/ part	Measures the emission intensity of the combined manufacturing and end of life phases of automotive parts for sale to the automotive sector (see Appendix for definition of a part)	Global, and during tool development, regional benchmarks and emission intensity trajectories based on the share of materials in each material grouping (as shown in Figure C4 in Annex C) that make up each specific part	2050 or earlier	IEA NZE (for vehicle-cycle emissions)	Convergence (according to Annex G)
Metric-Auto.6	Scope 3 category 1	g CO2e/ part	Measures the emission intensity of materials supply in automotive parts manufacturing for sale to the automotive sector	Global, and emission trajectories based on projected reductions in intensity for materials production (as shown in Table C14 in Annex C)	2050 or earlier	IEA NZE (for vehicle-cycle emissions)	Percent Improvement Approach (detailed in Annex H)
Metric-Auto.7	Scope 3 category 11	g CO_2e/ vkm	Measures the fuel-cycle emission intensity of powertrains for sale to the automotive sector (light-duty vehicles only)	Global and (separately) regional emission intensities for AE, EMDEs and the China region, expressed in g CO_2e/vkm according to the values in Tables C15, C16, C17 and C18 in Annex C	2050 or earlier	ITF "All Out" scenario (for WTW emissions)	Convergence (according to Annex G)

			Measures the fuel-cycle emission intensity of powertrains for sale to the automotive sector (for all non-light-duty vehicle types)	Global and (separately) regional emission intensities for AE, EMDEs and the China region, expressed in g CO2e/vkm according to the values in Tables C15, C16, C17 and C18 in Annex C	2050 or earlier	ITF “All Out” scenario (for WTW emissions)	Percent Improvement Approach (detailed in Annex H)

Methods for the assessment of aggregated emissions

Assessment methods are mathematical formulae or algorithms used to calculate interim performance values that serve as the reference for entities to set targets and assess performance against them

In formulating this standard a target-setting method is applied to each indicator to determine the required interim performance value, thus guiding the formulation of science-based, measurable, and time-bound targets aligned with pathways that are consistent with limiting warming to 1.5°C with no or limited overshoot. In this way the SDA produces a pathway between base year and target year representing the company’s level of minimum ambition associated with each indicator.

Calculation Methods for aggregated emissions accounting for Criteria AMSS-C1 and AMSS-C5 (Aggregated GHG emission intensity reduction target)

The following sections provide further information about the processes used in the fuel-cycle and vehicle-cycle elements of Criteria AMSS-C5.

Fuel-cycle

For each vehicle category, powertrain and energy combination, the fuel-cycle emission intensity shall be calculated, over the vehicle lifetime, as the ratio of:

a) the energy used (per energy type), multiplied by the related emission factor – at the numerator, and

b) the distance travelled – at the denominator, as follows:

$$Fuel\ cycle\ emission\ intensity\ (\frac{gCO_2\,e}{vkm}) =$$

$$\Sigma_p\ (\frac{\Sigma e_i y\ (Energy\ required\ (MJ)e_i y\ Emission\ factor\ (\frac{gCO_2\,e}{MJ})\ e_i y}{\Sigma y\ (Distance\ travelled\ (vkm)y)})_p$$

Where:
p stands for the WTT and TTW phases,
y for the years of vehicle life, and
e for the types of energy needed by the powertrain (e.g. electricity and oil-based gasoline, for a PHEV).

For vehicles using liquid and gaseous hydrocarbons (ICE, HEV, PHEV), energy use shall be disaggregated from region to country of use[7] (designated by location of registration, then sales location). For FCEVs, or vehicles with thermal engines that use hydrogen, the specific energy pathway for the China region based on local conditions would need to be used.[8]

Default region- and fuel-specific annual GHG emission factors shall be calculated for each year, as indicated in Table B3. They can be based on the emission intensity reductions estimated based on the IEA Announced Pledges Scenario, as outlined in Annex C, in the section titled "Annual default fuel-specific WTW emissions reductions." If available, default IEA APS market shares can also be used to define the portion of biofuels, hydrogen and other renewable fuels of non-biological origin (RFNBOs) and recycled carbon fuels (RCFs) meeting a 65% WTW emission reduction threshold (in terms of g CO2e/vkm). Claims of GHG emission savings paired with biofuel, hydrogen and RFNBO market shares exceeding those reported in the IEA APS need to be thoroughly documented (i.e. by contracts for low-emission fuel provision).

Table B3. GHG emission assessment by fuel group

[7] To determine more accurate biofuel or renewable fuels of non-biological origin (RFNBOs) blend share and associated emission factors. Further details on this subject are outlined in Appendix L.
[8] Hydrogen use in transport is currently limited and almost entirely derived from unbated fossil energies; with specific taxi, bus, or truck fleet deployments that may be using low-emission hydrogen, e.g. electrolytic hydrogen from renewable or nuclear electricity or fossil-derived hydrogen with carbon capture and storage (CCS). Since most hydrogen is currently produced from natural gas steam methane reforming (NG SMR) without CCS, except in China and South Africa, where it is made mostly from coal gasification, these pathways shall be used in the absence of documented evidence that it is derived from low-emission options (as RFNBO), Further details on this subject are outlined in Appendix L.

Energy	GHG emission factor assessment
Biofuels	The WTW emission factor for biofuels shall take into account the CO2 removed from the atmosphere during the growth of the feedstock, the GHGs emitted during the different phases of biofuel production and distribution and their final combustion. Hence, WTW emission factors for biofuels shall be entirely allocated to WTT emissions, while TTW emissions include only non-CO2 (incomplete) combustion products. WTT emission factors for biofuels shall also include direct and indirect land use change (ILUC) emissions. Global default emission factors for biofuels are defined on a feedstock-conversion pathway (henceforth “fuel pathway”) basis, based on work developed by the International Civil Aviation Organization (ICAO) on aviation biofuels and relevant corrections to adapt this to road transport fuels, as detailed in Appendix L. Biofuel feedstocks that are associated with high risks of biodiversity loss, are grown on land with high carbon stocks and that risk to lead to other indirect GHG emission increases shall be excluded, as also detailed in Appendix L.
Electricity	Electricity emission factors shall include emissions from the production phase, transmission and distribution losses and upstream emissions associated with the production, processing, and transport of the primary energy and the embodied emissions in the electricity generation facilities. Emission factors for electricity are shown in Appendix L.
Hydrogen, other RFNBOs and RCFs	WTT emissions intensities for hydrogen, other RFNBOs and RCFs shall be based by default on carbon-intensive production pathways (e.g., steam methane reforming, for hydrogen) or petroleum fuel benchmarks (for synthetic RFNBO or RCF hydrocarbons). Hydrogen, other RFNBOs and RCFs with lower carbon intensities can be accounted for as per IEA APS market shares if they fulfil the 65% WTW emission/MJ reduction vs. the benchmark vehicle and fuel technology and/or if supplies are supported by documentation enabling third-party verification, as further detailed in Appendix L. Additional criteria, based on additionality, temporal and geographical correlation, exclude hydrogen, RFNBOs and RCFs where associated risks may lead to other indirect GHG emission increases, as detailed in Appendix L.

Emission factors shall be multiplied by vehicle category-specific default mileages given in Table D6 in Annex D. In calculating total lifetime vehicle km, the vehicle km per year shall be consistent with values used in other parts of this Standard. Default lifetime and annual distance travelled (km/year) values shall be used (as detailed in Annex D), unless the automaker can justify an alternative value, e.g. based on telematics data regarding lifetime vehicle-km (i.e. annual vehicle-km and vehicle lifetime) and share sufficient details about this alternative data to enable third-party verification. If documented and verifiable, these alternative values may apply to specific vehicle, fuel and powertrain types and location combinations.

Vehicle-cycle

Automakers shall calculate GHG emissions for manufacturing, which comprise part of the vehicle-cycle, for each vehicle category and powertrain combination as follows:

- Calculate emissions due to direct and indirect energy use taking place in their manufacturing (Scope 1 and Scope 2 emissions). If a facility produces multiple vehicle categories, it shall allocate emissions by mass.
- Calculate scope 3, category 1 emissions from the supply chain based on the bill of materials (assuming a global market for materials and components), using model specification data, and track them by material group (chemicals, steel and aluminum) used in vehicle manufacturing, including estimates of the amounts resulting from maintenance and repairs (by accounting for parts replacements) over the vehicle lifetimes.
- Calculate vehicle and component dismantling and EoL emissions (scope 3, category 12) according to the 'cut-off' approach from GREET-2, as further detailed in Appendix M.
- Calculate the mass of materials required to produce the vehicles, including estimated amounts from maintenance and repairs over their lifetimes and the mass of the vehicles.[9]
- Calculate GHG emission intensities for each material group (chemicals, steel and aluminum) used to manufacture the vehicles, dividing GHG emissions by the mass of the materials needed for the production of the parts, by material group.
- Calculate GHG emission intensities (per tonne) for materials and processes unrelated to material production (e.g., assembly and dismantling/EoL) by dividing the emissions associated with these activities by the mass of the vehicles produced.

GHG intensities shall be calculated for all material groups, including assembly and dismantling/EoL, as additive, based on the following equation:

$$GHG\ emission\ intensity\ \left(\frac{g\ CO_2e}{vehicle}\right) = \frac{Total\ mass\ of\ the\ vehicles}{Number\ of\ vehicles}$$

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[9] Automakers should map materials into IEA material groups, for chemicals, aluminum, steel and others.

$$\sum_{m} \left(GHG\ emission\ intensity \left(\frac{g\ CO_2e}{t} \right)_m \frac{Mass\ of\ material\ needed\ for\ the\ vehicles_m}{Total\ mass\ of\ the\ vehicles} \right) +$$

$$+ \left(\frac{GHG\ emissions\ (gCO_2e) assembly}{Number\ of\ vehicles} + \frac{GHG\ emissions (gCO_2e) EoL}{Number\ of\ vehicles} \right)$$

where m represents each material group.

Automakers shall align with each GHG emission intensity reduction trajectory using a percent improvement approach (as outlined in Annex H), based on:

- GHG emission intensities calculated for chemicals, aluminum, steel and other materials, i.e. $GHG\ emission\ intensity \left(\frac{g\ CO_2e}{t} \right)_m$ and the relative mass shares of each of these material groups required for vehicle production. i.e.

  $$\frac{Mass\ of\ material\ needed\ for\ the\ vehicles_m}{Total\ mass\ of\ the\ vehicles}$$

- The GHG emission intensity reduction trajectories for each material group.
- GHG emission intensities calculated for assembly and dismantling/EoL, i.e. $\left(\frac{GHG\ emissions\ (g\ CO_2e)_{assembly}}{Number\ of\ vehicles} + \frac{GHG\ emissions\ (g\ CO_2e)_{EoL}}{Number\ of\ vehicles} \right)$.
- GHG emission intensity reduction trajectories for these industrial activities.

The calculation of the mass of materials in the vehicles and the total mass of the vehicles shall include scrap materials destined for EoL treatment (e.g., total sheet metal mass before stamping, including the stamping scrap mass) and integrate corrections of differences between materials purchased and the scaled weight of the vehicles produced/registered.

To calculate the vehicle-cycle emission intensity, automakers shall divide total GHG emissions per vehicle by the lifetime vehicle-km for each category. In calculating total lifetime vehicle-km, the vehicle-km per year shall align with values used elsewhere in this Standard. Default lifetime and annual distance travelled (km/year) values shall be used (as detailed in Annex D) unless the automaker can justify an alternative based on telematics data regarding lifetime vehicle-km (i.e. annual vehicle-km and vehicle lifetime), including for specific vehicle, fuel and powertrain types and location combinations and share sufficient information about this alternative to enable third-party verification.

Vehicle-cycle compliance trajectories are based on evolving emission intensities of steel, aluminum, chemicals, other materials (for each material group) and of industrial energy use (for assembly and dismantling for disposal and recycling of the vehicles) from the International Energy Agency (IEA) Net Zero (NZE) scenario, as further detailed in Appendix M.

Vehicle-cycle emissions from parts manufacturing can be assessed using data from auto parts manufacturers, including durability-corrected lifetimes and full accounting of material needed for the manufacture of the parts, their assembly and their dismantling for disposal and recycling. For components whose lifetime is lower than the vehicle lifetime, this may also include durability-related correction factors, detailed in Annex I, as outlined in the following section, on auto parts manufacturers. For the purpose of the calculation of vehicle-cycle emissions, replacement parts can be assumed to have equivalent characteristics to parts used for new vehicles.

Target Setting Method for Criterion APSS-C1 and APSS-C6 (GHG emission intensity reduction targets of auto parts manufacturers' activities)

GHG intensities shall be calculated for the total across all material groups, including part assembly and dismantling for disposal and recycling (EoL), using the following equation:

$$GHG\ emission\ intensity\left(\frac{g\ CO_2e}{parts}\right) = \frac{Total\ mass\ of\ the\ parts}{Number\ of\ the\ parts}$$

$$\sum_m \left(GHG\ emission\ intensity\left(\frac{g\ CO_2e}{t}\right)_m \frac{Mass\ of\ material\ needed\ for\ the\ parts_m}{Total\ mass\ of\ the\ parts}\right) +$$

$$+\left(\frac{GHG\ emissions\ (g\ CO_2e)_{assembly}}{Number\ of\ parts} + \frac{GHG\ emissions\ (g\ CO_2e)_{EoL}}{Number\ of\ parts}\right)$$

where m represents each material group.

Auto parts manufacturers shall match each GHG emission intensity reduction trajectory using the percent improvement approach (as outlined in Annex H), based on:

- GHG emission intensities calculated for chemicals, aluminum, steel and other materials – i.e. $GHG\ emission\ intensity\ \left(\frac{g\ CO_2e}{t}\right)_m$ and the relative shares of mass of each of these material groups in what is needed for the production of the parts – i.e. $\frac{Mass\ of\ material\ needed\ for\ the\ parts_m}{Total\ mass\ of\ the\ parts}$.

- The GHG emission intensity reduction trajectories for each material group.

- GHG emission intensities calculated for assembly and dismantling/EoL of the parts – i.e.

$$\left(\frac{GHG\ emissions\ (gCO_2e) assembly}{Number\ of\ parts} + \frac{GHG\ emissions (gCO_2e) EoL}{Number\ of\ parts}\right).$$

- GHG emission intensity reduction trajectories for these industrial activities.

The calculation of the mass of materials in the parts and the total mass of the parts shall include scrap materials destined for EoL treatment (e.g., the total sheet metal mass before stamping, including the stamping scrap mass) and integrate corrections of differences between materials purchased and the scaled weight of the parts produced/registered.

For parts with shorter lifespans than the vehicle, auto parts manufacturers may apply durability-related correction factors if they can demonstrate deviations from default values, as follows:

$$Durability - corrected\ GHG\ emission\ intensity\ \left(\frac{g\ CO_2e}{parts}\right) =$$

$$= GHG\ emission\ intensity\ \left(\frac{g\ CO_2e}{parts}\right) \frac{Default\ part\ lifetime}{Manufacturer - specific\ part\ lifetime}.$$

Where lifetimes are expressed in the same unit (e.g. years). They are determined taking into account the default lifetimes and the other considerations further detailed in Annex B.

In such cases, the GHG emission intensity corrected for durability (see Annex I) is the relevant metric for this criterion.

Calculation Methods for Aggregate Indicators Accounting for Criteria APSS-C4 and APSS-C8 (fuel-cycle GHG emission intensity reduction target for powertrain suppliers)

For powertrains supplied to each vehicle category, the fuel-cycle emission intensity shall be calculated, over the vehicle lifetime, as the ratio of:

a) the energy used by vehicles equipped with the powertrain (by energy type), multiplied by the corresponding emission factor (numerator), and

b) the distance travelled by those vehicles on which the powertrain is installed (denominator), as follows:

$$Fuel\ cycle\ emission\ intensity\left(\frac{g\ CO_2e}{vkm}\right) = \sum_p \left(\frac{\sum_{e,y}\left(Energy\ required\ (MJ)_{e,y}\ Emission\ factor\left(\frac{g\ CO_2e}{MJ}\right)_{e,y}\right)}{\sum_y \left(Distance\ travelled\ (vkm)_y\right)}\right)_p$$

Where:
p stands for the WTT and TTW phases,
y for the years of vehicle life, and
e for the types of energy needed by the engine (e.g. electricity and oil-based gasoline, for a PHEV).

For vehicles using liquid or gaseous hydrocarbons (ICE, HEV, PHEV), energy use shall be disaggregated from region to country of use[10] (designated by location of registration, then sales location). For FCEVs, or vehicles with thermal engines that use hydrogen, the specific energy pathway for the China region based on local conditions would need to be used.[11]

Default region and fuel-specific annual GHG emission factors shall be calculated for each year, as indicated in Table B4. They can be based on the emission intensity reductions estimated based on the IEA Announced Pledges Scenario, as outlined in Annex C, in the section titled "Annual default fuel-specific WTW emissions reductions." If available, default IEA APS market shares can also be used to define the portion of biofuels, hydrogen and other renewable fuels of non-biological origin (RFNBOs) and recycled carbon fuels (RCFs) meeting a 65% WTW emission reduction threshold (in terms of g CO_2e/vkm). Claims of GHG emission savings paired with biofuel, hydrogen and RFNBO market shares exceeding those reported in the IEA APS need to be thoroughly documented (i.e. by contracts for low-emission fuel provision).

Table B4. GHG emission assessment by fuel group

Energy	GHG emission factor assessment
Biofuels	The WTW emission factor for biofuels shall take into account the CO_2 removed from the atmosphere during the growth of the feedstock, the GHGs emitted during the different phases of biofuel production and distribution and their final combustion. Hence, WTW emission factors for biofuels shall be entirely allocated to WTT emissions, while TTW emissions include only non-CO_2 (incomplete) combustion products. WTT emission factors for biofuels shall also include direct and indirect land use change (ILUC) emissions. Global default emission factors for biofuels are defined on a feedstock-conversion pathway (henceforth "fuel pathway") basis, based on work developed by the International Civil Aviation Organization (ICAO) on aviation biofuels and relevant corrections to adapt this to road transport fuels, as detailed in Appendix L. Biofuel feedstocks that are associated with high risks of biodiversity loss, are grown on land with high carbon stocks and that risk to lead to other indirect GHG emission increases shall be excluded, as also detailed in Appendix L.

[10] To determine more accurate biofuel or renewable fuels of non-biological origin (RFNBOs) blend share and associated emission factors. Further details on this subject are outlined in Appendix L.
[11] Hydrogen use in transport is currently limited and almost entirely derived from unbated fossil energies; with specific taxi, bus, or truck fleet deployments that may be using low-emission hydrogen, e.g. electrolytic hydrogen from renewable or nuclear electricity or fossil-derived hydrogen with carbon capture and storage (CCS). Since most hydrogen is currently produced from natural gas steam methane reforming (NG SMR) without CCS, except in China and South Africa, where it is made mostly from coal gasification, these pathways shall be used in the absence of documented evidence that it is derived from low-emission options (as RFNBO), Further details on this subject are outlined in Appendix L.

Electricity	Electricity emission factors shall include emissions from production, transmission and distribution losses, upstream emissions from primary energy production, and embodied emissions in the electricity generation facilities. Emission factors for electricity are shown in Appendix L.
Hydrogen, other RFNBOs and RCFs	WTT emissions intensities for hydrogen, other RFNBOs and RCFs shall be based by default on carbon-intensive production pathways (steam methane reforming, for hydrogen) or petroleum fuel benchmarks (for synthetic RFNBO or RCF hydrocarbons). Hydrogen, other RFNBOs and RCFs with lower carbon intensities can be accounted for as per IEA APS market shares if they fulfil the 65% WTW emission/MJ reduction vs. the benchmark vehicle and fuel technology and/or if supplies are supported by documentation enabling third-party verification, as further detailed in Appendix L. Additional criteria, based on additionality, temporal and geographical correlation, exclude hydrogen, RFNBOs and RCFs where associated risks may lead to other indirect GHG emission increases, as detailed in Appendix L.

Emission factors shall be multiplied by vehicle category-specific default mileages given in Table D6 in Annex D. In calculating total lifetime vkm, the vkm per year shall be consistent with values used in other parts of this Standard, and in particular with the AMSS-C1 and AMSS-C6 criteria. Default lifetime and annual distance travelled (km/year) values shall be used (as detailed in Annex D), unless the automaker can justify an alternative value, e.g., based on telematics data regarding lifetime vkm (i.e., annual vkm and vehicle lifetime) and share sufficient details about this alternative data to enable third-party verification. If documented and verifiable, these alternative values may apply to specific vehicle, fuel and powertrain types and location combinations.

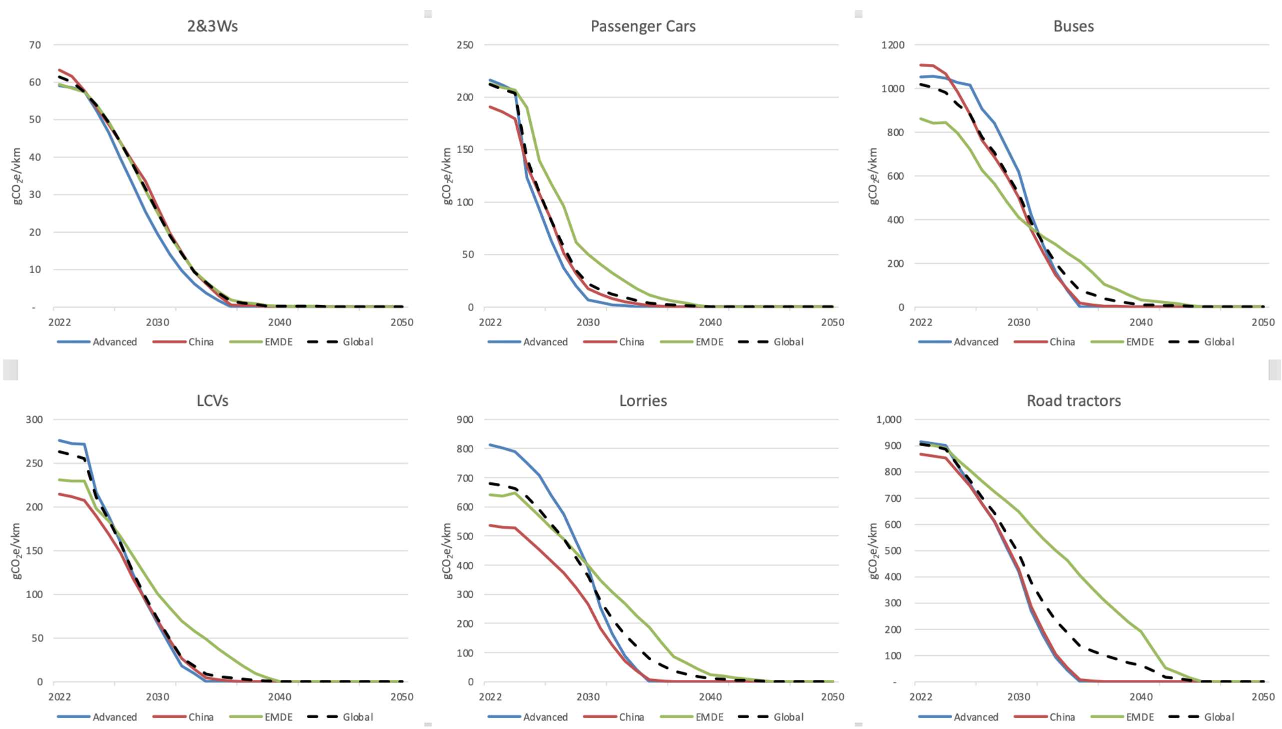
ANNEX C: BASELINE AND PATHWAYS

The pathways and associated benchmarks of WTW emission intensities and low-emission vehicle sales shares are based on an “All-Out” decarbonisation scenario modelled by the International Transport Forum (ITF, forthcoming)[12]. Figures C1 and C2 show the WTW emission intensity trajectories and the low-emission vehicle sales shares (equivalent to the ZEV sales shares, i.e., BEVs and FCEVs) for new vehicles, from 2010 to 2060, across each of the six vehicle categories and for AEs, EMDEs and for the China region, as well as at the global level.[13]

The China region is presented separately, as the specifics of its automotive and energy market make a distinct scenario essential for meaningful results.

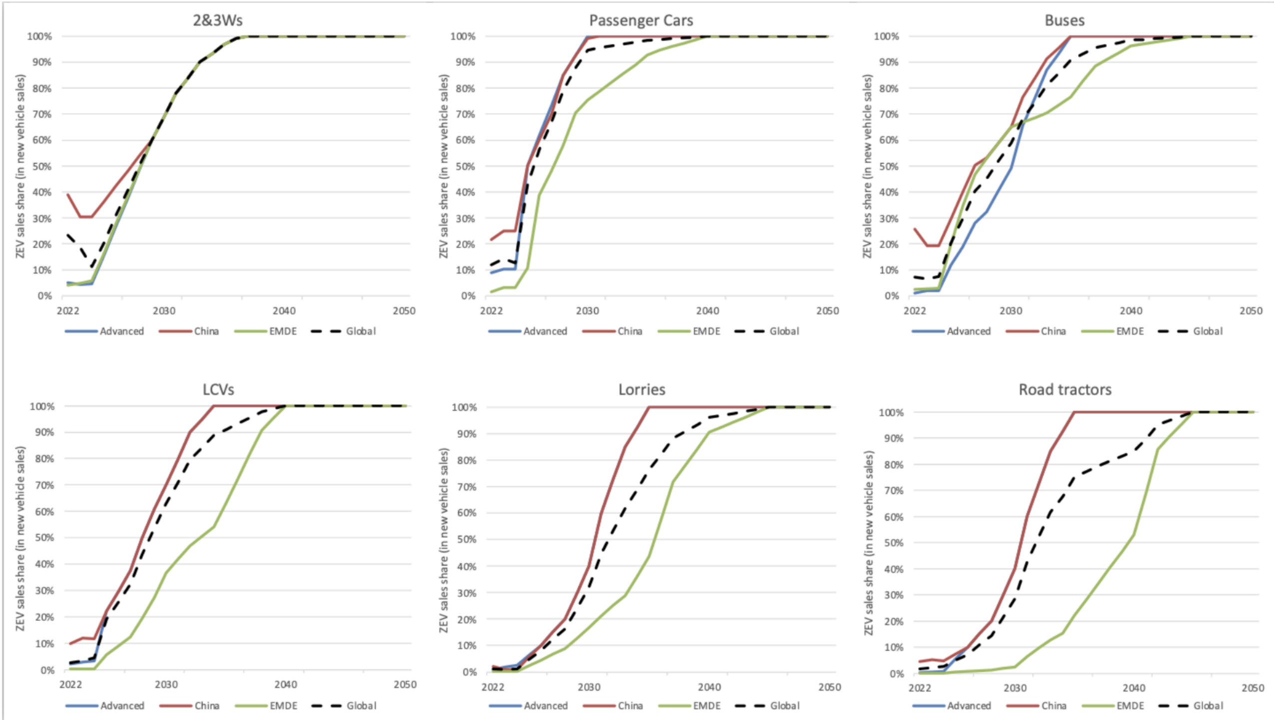
These serve as the basis for the WTW component of the aggregated emission intensity benchmarking for the AMSS-C2 and AMSS-C4 criteria.

Figure C1. Well-to-wheel GHG emission intensity of new vehicle sales in the ITF All-Out scenario



[12] The selection of pathways was made from a wider range of available pathways following SBTi principles. More information can be found in the Synthesis Report.
[13] Note that the WTW emission intensity trajectories shown in Figure C2 were adapted to extend the system boundaries beyond carbon intensity of primary electricity generation (used by ITF) to (i) include GHGs other than CO_2, (ii) include emissions incurred in production, processing, and provision of fuels in thermal plants and embodied GHG emissions in renewables, and (iii) to include T&D losses. The methods adopted to perform this extension are described in further detail below.

Figure C2. Sales shares of vehicles with zero tailpipe emissions in new vehicle sales in the ITF All-Out scenario



The other component needed to benchmark and set the aggregated emission intensity trajectories for the AMSS-C2 criterion is the emission value associated with vehicle manufacturing, maintenance, and EoL.

These aggregated emission benchmarks are based on data on the material composition of vehicles in each category, using information sourced from GREET-2 (for LDVs, buses, and medium- and heavy-duty trucks), and other literature, including life-cycle analyses developed for the European Commission and covering a wide spectrum of vehicle categories (Hill et al. 2020) and targeted analysis (leveraged for 2-3 wheeler estimates) by the ITF (ITF, 2022 and 2024).

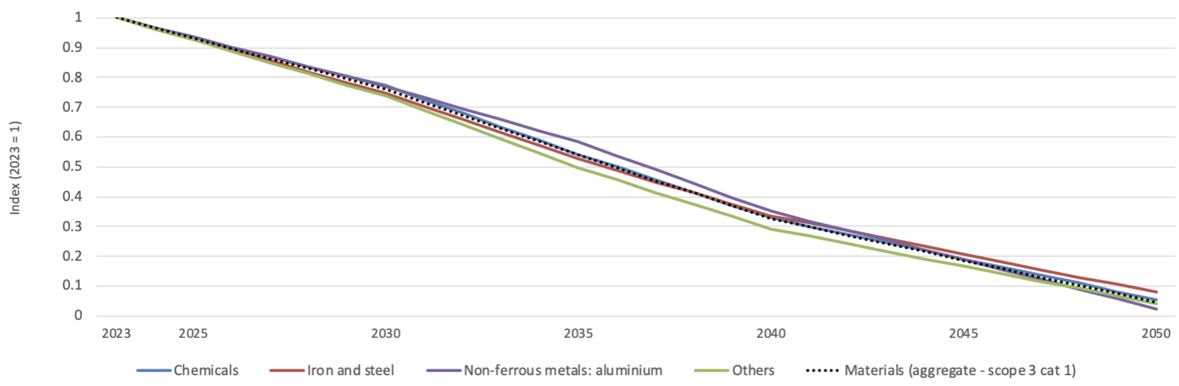
The benchmark emission intensity (in g CO_2e/kg) of each material group is taken from GREET-2 to estimate the global average emissions associated with the vehicle-cycle (in g CO_2e/vehicle), for each major powertrains and vehicle category. The assessment factors in specific inputs on GHG emission intensity of primary (virgin) and secondary (recycled) steel and aluminum, as well as other materials, separating out plastics and rubber to include them in the material group represented by chemicals. The assessment also considers different shares of conventional passenger cars and large passenger cars (SUVs, pick-up trucks), with market shares in major countries within AEs, EMDEs and in the China region being taken into consideration, and variations across ICE, HEV, PHEV, BEV and FCEV powertrains.

Emissions per vehicle in the benchmark years (2022-2024) are also calculated at the regional and global levels, based on the sales share of each powertrain, across each vehicle category and, for cars, also based on the main market segments (then aggregated), by country to the appropriate level of aggregation.

These are then divided over the default lifetime mileage value for each vehicle category (Table D5 in Annex D), to derive benchmark estimates of the vehicle-cycle emission intensity in g CO_2e/vkm.

Emission intensity trajectories for each material grouping are taken from the IEA Net-Zero Emissions by 2050 (NZE) Scenario, based on the publicly available dataset from the latest update of this scenario, in the World Energy Outlook, 2024. Indexed emission intensities for each of the four material groupings (steel, aluminum, chemicals, and other materials) are shown in Figure C3. These apply to steel, aluminum, chemicals, and other materials, respectively. In the case of other materials (for which there is no physical indicator in the IEA dataset), the index used is based on CO_2 emissions from fuel combustion in industry per capita, at the global level. Emission reduction pathways for secondary steel and primary aluminum production follow the carbon intensity trajectories of (primary) electricity generation, due to the major relevance of electricity-related emissions for the technologies needed for these industrial production processes.

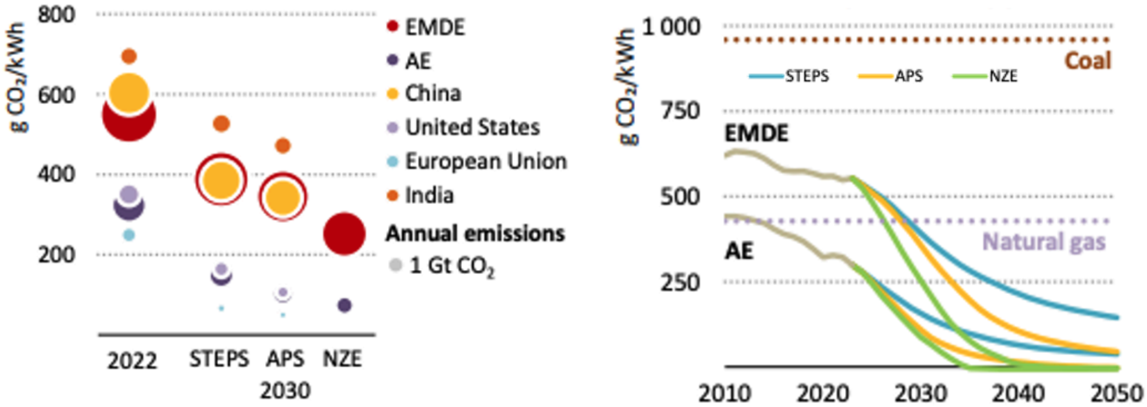
Figure C3. Indexed emission intensity trajectories of steel, aluminum, chemicals (all per tonne), and other materials (per capita) in the IEA NZE scenario



Trajectories of the emission intensity of final electricity (in g CO_2e/vkm) that are both consistent with a 1.5° C-aligned trajectory and consistent with the system boundaries defined for electricity (as summarized in Appendix L) are necessary to project the material emission intensity of specific material sub-groups (i.e., recycled steel, primary wrought and cast aluminum), and to ensure that the WTW emission intensity of vehicles that directly use grid electricity (i.e., BEVs and PHEVs), or indirectly use electricity to produce fuels (i.e., all vehicles using RFNBOs and H2) are estimated to use electricity from grids whose emissions intensity declines in ways consistent with the 1.5° C-aligned trajectory. The steps taken to estimate these trajectories are summarized here.

Trajectories of the carbon intensity of (primary) electricity generation (in g CO_2/vkm) aggregated by country for AEs, EMDEs and the China region, are shown in Figure C4. This figure shows the trajectory of primary electricity for each of the three regional groups as reported in Figure 4.17 of the 2023 edition of the IEA World Energy Outlook, and as reported in the 2024 IEA World Energy Outlook, where the direct carbon intensity of primary electricity the analogous Figure 4.26 shows only the trajectories for AEs and EMDEs (excluding the China region).

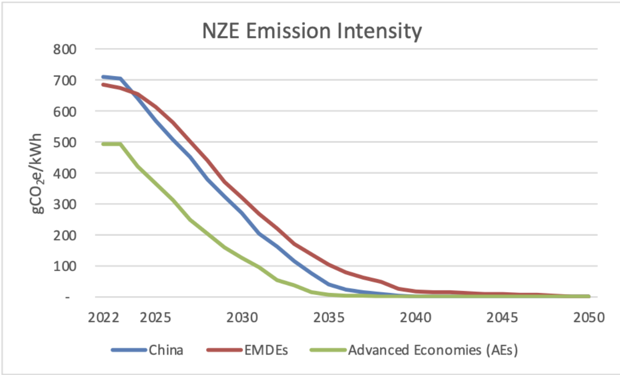
Figure C4. IEA NZE regional trajectories of the carbon intensity of primary electricity generation, in g CO_2/kWh, in the WEO 2023 (left-hand figure), and WEO 2024 (right-hand)

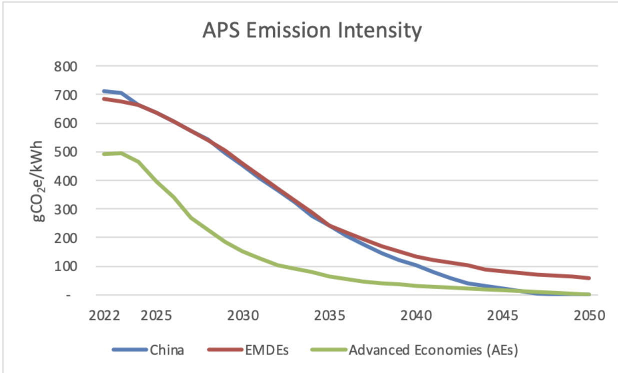


Base year data precision is enhanced using the 2024 edition of the Ember Yearly Electricity Data dataset. These trajectories are adjusted annually by the difference between CO_2 emissions reported in the base year (2023) and GHG emissions in that year, to include GHG emissions beyond CO_2, using data reported in the freely available version of the IEA GHG Emissions from Energy Data Explorer, and to include GHG emissions from fossil fuel extraction, processing, and provision, and embodied emissions of power generation facilities, using the Life Cycle Upstream Emissions Factors 2024 data product, and weighted for countries with data available by the IEA GHG Emissions from Energy Data Explorer. Transmission and distribution (T&D) losses were benchmarked at 5.8% for high-income countries, 14.1% for EMDEs, and 3.7% in the China region (based on the CIA World Factbook). Gaps between primary emission (GHG) and CO_2 intensity and between fuel provision and embodied GHG emissions versus direct CO_2 emissions are projected to decline at region- and scenario-specific rates, reflecting the projected adoption of renewable energy generation resources. T&D losses are assumed to decline, again at region-specific rates informed by historical trajectories, by around 2% (2.5% for the China region, 1.5% for EMDEs) annually in the NZE and around 1% (1.5% for the China region, 0.5% for EMDEs) annually in the APS.

Resulting benchmarks and trajectories, for the IEA NZE (which were also used to inform the WTW emissions trajectories in the ITF modelling, and embedded in the estimates of WTW emissions shown in Figure C1, and for the APS (to benchmark and apply default and region-specific electricity-sector emission intensity reductions), are shown in Figure C5.

Figure C5. Aggregated GHG emission intensity of final electricity demand, derived from the IEA NZE and APS scenarios, in g CO_2e/kWh

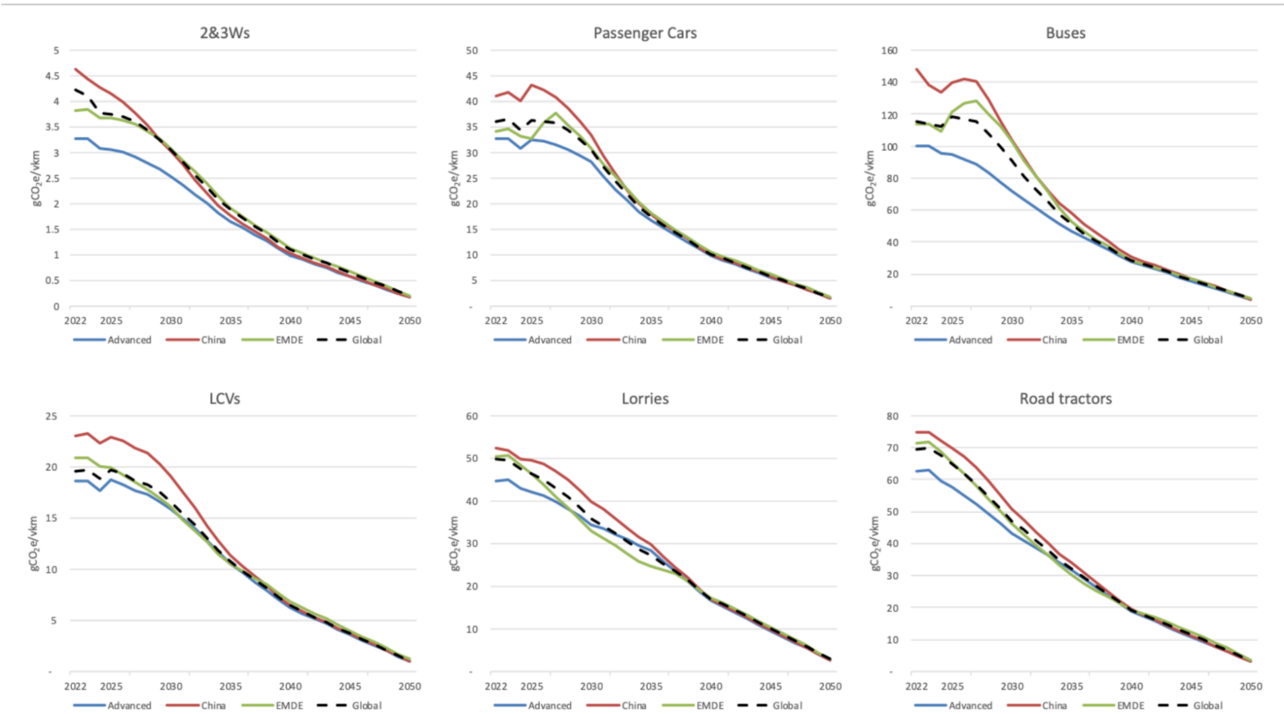




For the vehicle-cycle emissions, trajectories also integrate data on the evolution of shares of scrap steel over time from [Watari et al (2023)](). The same trajectories are also informed by data on the evolution of primary and secondary aluminum production are also informed by [IEA, 2023]().

Resulting vehicle-cycle GHG emission intensities, which contribute to the trajectories of the AMSS-C2 criterion and serve as the basis for the AMSS-C1 sub-criterion, are shown in Figure C6.

Figure C6. Vehicle-cycle (i.e. excluding use-phase) GHG emission intensity of new vehicle sales



Combining vehicle-cycle emission intensity benchmarks and trajectories with the WTW emission intensity trajectories shown in Figure C1 results in the aggregated emission intensity benchmarks and trajectories for each regional group, as well as globally, and for each vehicle category. Resulting values, serving as a basis for the AMSS-C2 criterion, are shown in Figure C7, and are also reported as numerical values, together with the low-emission vehicle sales shares requirements that serve as a basis for the AMSS-C3 criterion and, for auto parts manufacturers, for the APSS-C2, in Table C1.

Figure C7. Aggregated life-cycle GHG emission intensity of new vehicle sales

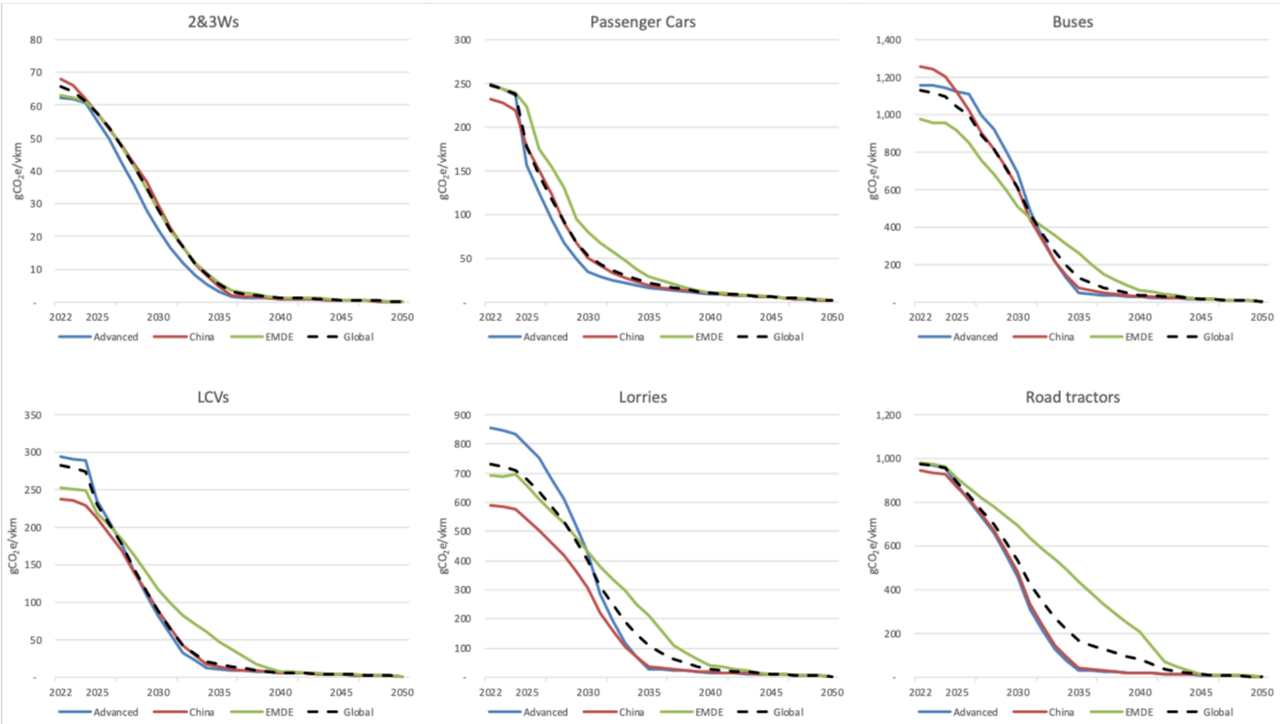


Table C1. Global aggregated GHG emission intensity of new vehicle sales (g CO2e/vkm)

	2&3Ws	Passenger Cars	Buses	LCVs	Lorries	Road Tractors
2022	65.6	248.2	1132.3	282.4	729.0	975.4
2023	64.1	243.9	1118.2	279.2	722.8	968.6
2025	57.6	178.3	1044.6	230.2	680.4	890.8
2030	28.5	52.8	608.1	88.9	398.1	535.7
2035	5.7	21.4	126.0	16.9	108.2	168.8
2040	1.3	10.2	39.2	6.5	27.6	81.1
2045	0.7	5.9	16.5	3.7	10.0	11.5
2050	0.2	1.7	4.6	1.1	2.8	3.4

Table C2. ***Global*** *low-emission vehicle sales shares (percent of new vehicle sales)*

	2&3Ws	Passenger Cars	Buses	LCVs	Lorries	Road Tractors
2022	23.3%	11.9%	7.1%	2.5%	1.1%	1.7%
2023	18.6%	14.2%	6.4%	3.2%	0.9%	2.1%
2025	20.5%	42.6%	20.4%	19.1%	4.7%	4.9%
2030	69.0%	94.6%	58.9%	63.0%	32.0%	28.4%
2035	96.7%	98.4%	90.9%	91.0%	76.3%	75.0%
2040	100%	100%	98.5%	100.0%	96.0%	85.0%
2045	100%	100%	100%	100%	100%	100%
2050	100%	100%	100%	100%	100%	100%

Table C3. ***AEs*** *Aggregated emission intensity of new vehicle sales (g CO_2e/vkm)*

	2&3Ws	Passenger Cars	Buses	LCVs	Lorries	Road Tractors
2022	62.4	248.6	1152.5	294.4	856.4	976.7
2023	61.8	244.0	1156.2	291.1	845.9	969.2
2025	55.6	156.0	1121.9	235.4	792.7	882.5
2030	22.1	34.9	691.1	83.0	427.2	461.6
2035	3.4	16.7	47.6	10.6	28.3	31.9
2040	1.0	9.9	27.6	6.2	16.7	18.8
2045	0.6	5.7	15.9	3.6	9.6	10.9
2050	0.2	1.6	4.3	1.0	2.7	3.1

Table C4. ***AEs*** *low-emission vehicle sales shares (percent of new vehicle sales)*

	2&3Ws	Passenger Cars	Buses	LCVs	Lorries	Road Tractors
2022	5.0%	8.9%	1.1%	2.0%	0.9%	0.2%
2023	4.4%	10.3%	2.0%	2.8%	1.9%	0.6%
2025	15.8%	50.0%	12.0%	22.2%	6.2%	5.3%

2030	69.0%	100.0%	49.1%	70.0%	40.0%	40.0%
2035	96.7%	100%	100%	100%	100%	100%
2040	100%	100%	100%	100%	100%	100%
2045	100%	100%	100%	100%	100%	100%
2050	100%	100%	100%	100%	100%	100%

Table C5. ***China region*** *aggregated GHG emission intensity of new vehicle sales (g CO_2e/vkm)*

	2&3Ws	Passenger Cars	Buses	LCVs	Lorries	Road Tractors
2022	67.8	232.0	1253.3	237.2	588.2	942.4
2023	66.0	227.5	1240.6	235.0	582.6	935.3
2025	57.5	177.7	1122.3	212.2	541.3	870.1
2030	29.8	51.0	606.1	89.4	306.6	479.7
2035	4.9	19.2	75.8	13.5	36.6	41.1
2040	1.0	10.1	30.5	6.4	17.1	19.4
2045	0.6	5.8	17.4	3.7	9.8	11.2
2050	0.2	1.6	4.4	1.0	2.7	3.2

Table C6. ***China region*** *low-emission vehicle sales shares (percent of new vehicle sales)*

	2&3Ws	Passenger Cars	Buses	LCVs	Lorries	Road Tractors
2022	38.9%	21.6%	25.7%	9.9%	2.2%	4.5%
2023	30.4%	25.0%	19.3%	11.8%	1.0%	5.1%
2025	36.4%	50.0%	29.7%	22.2%	5.5%	7.3%
2030	69.0%	99.0%	64.9%	70.0%	40.0%	40.0%
2035	96.7%	100%	100%	100%	100%	100%
2040	100%	100%	100%	100%	100%	100%
2045	100%	100%	100%	100%	100%	100%
2050	100%	100%	100%	100%	100%	100%

Table C7. ***EMDE*** *aggregated GHG emission intensity of new vehicle sales (g CO_2e/vkm)*

	2&3Ws	Passenger Cars	Buses	LCVs	Lorries	Road Tractors
2022	63.2	247.0	973.0	252.0	691.1	976.8
2023	62.3	243.8	954.6	250.2	688.3	972.5
2025	57.7	222.7	917.2	218.3	656.1	911.0
2030	28.3	80.7	511.2	116.8	431.0	693.5
2035	6.0	29.4	262.0	48.1	210.7	435.2
2040	1.4	10.9	61.5	7.2	42.2	210.3
2045	0.7	6.2	16.8	4.0	10.5	12.4
2050	0.2	1.9	4.9	1.2	3.0	3.8

*Table C8. **EMDE** low-emission vehicle sales shares (percent of new vehicle sales)*

	2&3Ws	Passenger Cars	Buses	LCVs	Lorries	Road Tractors
2022	4.0%	1.6%	2.5%	0.1%	0.1%	0.0%
2023	4.9%	3.1%	2.6%	0.2%	0.2%	0.1%
2025	16.5%	10.8%	20.1%	5.6%	2.4%	0.5%
2030	69.0%	75.5%	65.0%	36.6%	16.7%	2.4%
2035	96.7%	92.6%	76.6%	63.2%	43.7%	22.1%
2040	100%	100%	96.2%	100.0%	90.6%	52.9%
2045	100%	100%	100%	100%	100%	100%
2050	100%	100%	100%	100%	100%	100%

Annual default fuel-specific WTW emissions reductions, derived from the IEA APS

Reporting and target-setting for the criterion AMSS-C2 requires the calculation of the WTW emission intensity (in gCO_2e/MJ) of all fuels used by vehicles. Minimum reporting of the emission intensity for each vehicle category and in each regional grouping, and for each fuel category outlined below. In cases of blended fuels (i.e., automotive gasoline, diesel, and natural gas) where a fuel pool contains blended shares of fossil-derived fuels, biofuels, and RFNBOs and/or RCFs, default shares based on the IEA APS scenario are provided below.

In this context, the choice of the IEA APS, and not NZE scenario, is grounded on the desire to acknowledge progress, based on policy and collective industry action, while still requiring the specific demonstration of efforts capable to align action in the automotive sector to a trajectory that is aligned with SBTi requirements. This avoids taking for granted that other parts of the economy (and the energy industry in particular) will take sufficient action, and at the same time allows, should this action actually materialize in a way that can be documented, to consider it, beyond the default.

Electricity

Annual percentage reductions in emission intensity (in gCO_2e/kWh) is derived for each regional grouping based on the methods described above and as is shown in the right-hand side of Figure C5. Table C2 shows the default percent reduction emission intensity to be applied to the direct use of grid electricity in BEVs and PHEVs. These percentage reduction factors are to be applied at the country level to the final aggregated emissions intensity of final electricity (in g CO_2e/kWh) for all countries where BEVs and/or PHEVs are sold in each region grouping.

Table C9. Default GHG emissions intensity of final electricity APS scenarios, by region grouping, indexed to 2022 within each region grouping

Year	AEs	EMDEs	China region
2022	100%	100%	100%
2023	103%	94%	99%
2024	94%	97%	93%
2025	80%	93%	90%
2026	69%	88%	85%
2027	54%	84%	81%
2028	46%	79%	76%
2029	37%	73%	69%
2030	31%	67%	63%
2031	26%	61%	57%
2032	21%	54%	52%
2033	19%	48%	46%
2034	16%	42%	39%
2035	13%	35%	34%
2036	11%	32%	29%
2037	10%	28%	25%
2038	8%	25%	21%
2039	8%	22%	17%
2040	6%	20%	14%
2041	6%	18%	11%
2042	5%	17%	8%
2043	5%	15%	6%
2044	4%	13%	5%
2045	3%	12%	3%
2046	3%	11%	2%
2047	2%	10%	1%
2048	1%	10%	0%
2049	1%	9%	0%
2050	0%	9%	0%

Oil and gas

Default emission intensity reductions for reporting purposes over ICE vehicle lifetimes for oil- and gas-based fuels are derived from the IEA APS trajectories outlined in the 2023 IEA publication The Oil and Gas Industry in Net Zero Transitions. Key levers to reduce emission intensity in oil supply chains, including production and refining, are: (i) preventing methane leaks, capturing vented methane, and flaring; (ii) implementing electrification and efficiency measures; (iii) shifting to low-emission hydrogen; (iv) CCUS; and (v) improving the efficiency and reducing the emission intensity of liquids transport. The figures in that report that provide benchmarking and trajectory data, by reporting on the efficiency and/or emission intensity improvements achieved by the above five levers, are:

- Figure 1.6: Reductions in oil demand in the APS and NZE Scenarios (paired with Figure 2.6 to calculate scope 1 and 2 emission intensity trajectories for oil)
- Figure 1.8: Natural gas demand by scenario, 2000-2050 (paired with Figure 2.6 to calculate scope 1 and 2 emission intensity trajectories for natural gas)
- Figure 2.6: Scope 1 and 2 oil and gas emissions in the APS and NZE Scenario

From these three figures, trends in the APS in the WTT emissions intensity of oil and gas production, processing/refining, and transport can be derived, as shown in Table C10.

Table C10. WTT GHG emission intensity of oil and gas production and refining, processing, and transport, as derived from the IEA APS

Parameter	Year				Unit	Source
	2022	2030	2040	2050		
Oil demand	96.5	93	74*	55	mb/d	Figure 1.6
Oil - Emissions	3.4	2.27	1.34	0.848	Gt CO_2e	Figure 2.6
NG demand	4156	3861	3004	2421	Bcm	Figure 1.8
NG - Emissions	1.653	1.07	0.635	0.449	Gt CO_2e	Figure 2.6
Oil – EI	35.23	24.54	18.19	15.47	Gt CO_2e / kb/d	Derived
NG – EI	398	277	211	185	Gt CO_2e / m3	Derived
Oil and Gas - EI	88.4	60.8	47	39.4	kt CO_2-eq/boe	Figure 2.5

Source: The Oil and Gas Industry in Net Zero Transitions (IEA, 2023).
Note: EI = emissions intensity. *Oil demand in 2040 is interpolated.
The above scope 1 and 2 GHG emission reductions from oil and gas translate to reductions in the WTT emission factor for fossil-derived automotive oil-derived (gasoline, diesel, LPG) and natural gas-derived (CNG, LNG) fuels. Assuming linear improvements in years not reported in the above table, and applying the emissions intensity reductions to the WTT emissions of these fuels, results in annual WTW emission factors reported in Table C11.

Table C11. WTW GHG emission intensity of fossil-derived automotive gasoline, diesel, natural gas (CNG/LNG), and LPG, as derived from the IEA APS, in g CO_2e/MJ

Year	Petroleum (oil-based)		Fossil-natural gas-based		Fossil-derived LPG
	Gasoline	Diesel	CNG	LNG	
2022	90.20	91.30	70.80	74.80	73.50
2023	90.20	91.30	70.80	74.80	73.50
2024	90.20	91.30	70.80	74.80	73.50
2025	89.34	90.45	70.09	73.90	73.08
2026	88.48	89.60	69.38	73.00	72.65
2027	87.62	88.75	68.68	72.10	72.23
2028	86.76	87.90	67.97	71.20	71.80
2029	85.90	87.05	67.26	70.30	71.38
2030	85.04	86.20	66.55	69.40	70.95
2031	84.73	85.90	66.32	69.11	70.80
2032	84.43	85.60	66.09	68.81	70.65
2033	84.12	85.29	65.86	68.52	70.50
2034	83.82	84.99	65.63	68.22	70.35
2035	83.51	84.69	65.40	67.93	70.19
2036	83.20	84.39	65.17	67.64	70.04
2037	82.90	84.08	64.93	67.34	69.89
2038	82.59	83.78	64.70	67.05	69.74
2039	82.28	83.48	64.47	66.75	69.59
2040	81.98	83.18	64.24	66.46	69.44
2041	81.85	83.05	64.15	66.34	69.37
2042	81.72	82.92	64.06	66.23	69.31
2043	81.59	82.79	63.97	66.11	69.24
2044	81.45	82.66	63.87	65.99	69.18
2045	81.32	82.53	63.78	65.88	69.11
2046	81.19	82.40	63.69	65.76	69.05
2047	81.06	82.27	63.60	65.65	68.98
2048	80.93	82.14	63.51	65.53	68.92
2049	80.80	82.01	63.42	65.41	68.85
2050	80.67	81.88	63.33	65.30	68.79

Biofuels

The IEA publication [Renewables 2024: Analysis and Forecast to 2030] outlines development for biofuels serving road transport in the "accelerated case", which is used to benchmark APS developments. Relevant figures that can be used to estimate global and regional developments in WTW emission intensity and blend rates for ethanol in the gasoline fuel pool and biodiesel (including RD) in the diesel fuel pool, are:

- Road biofuel consumption by country and fuel, main and accelerated cases, 2010-2030 (page 139 – from which can be derived ethanol and biodiesel blend shares in the APS at the global level, for road transport)
- Road biofuel consumption by country and fuel, main and accelerated cases, 2023-2030 (page 144 – from which can be derived blend shares for ethanol, biodiesel, and RD in road can be allocated to AEs [United States and Europe], EMDEs [Brazil, Indonesia, and RoW].
- Road biofuel feedstock demand, main and accelerated cases, 2023-2030 (page 148 – from which can be derived feedstock allocations of sugars, starches, and other feedstocks for ethanol, and vegetable oils, residual oils, and other feedstocks allocations for biodiesel.
- In addition, the "Policies and assumptions, main and accelerated cases" outlines the policy frameworks and blend shares at the country or regional level for AEs (United States, Europe, Canada, United Arab Emirates), EMDEs (Brazil, India, Indonesia, Malaysia, Colombia, Egypt, Ghana, Kenya, Nigeria, Mozambique, South Africa, Uganda, Zambia and Zimbabwe), and the China region.

Figures used to estimate regional WTW GHG emission intensity projections for biomethane in the same publication include:

- Global historical and forecast production of biogases, and Net Zero Scenario target (page 159 – from which shares of biomethane in total NG demand in the main case – STEPS – and the accelerated cases – APS – can be derived)
- Demand for biogases by country/region and sector, main case, 2023 and 2030 (page 160 – from which regional shares of biomethane can be allocated to road transport for high-income countries [United States and EU], the China region, and EMDEs [India and other countries])
- The region-specific text in the biogases section summarizes growth in biomethane consumption in transport from 2023 to 2030.

Based on the above sources, and assuming linear improvements in the intervening years (2024-2029 and 2031-2049) estimates of the percent reduction in baseline emission intensity for ethanol, biodiesel, and biomethane, across each of the three regional groupings are derived. These are shown in Table C12, and serve as the basis for default regional reductions in WTW GHG emission intensity for each biofuel type. The percentage reductions are to be applied to the benchmark value of the WTW GHG emission intensity (in g CO_2e/MJ) for liquid fuels of each type in each region or country.

Table C12. Annual WTW GHG emission intensity of biofuels: ethanol, biodiesel, and biomethane, indexed to 2022-2024 regional values, as derived from the IEA APS.

Year	Ethanol			Biodiesel			Biomethane		
	AEs	EMDEs	China region	AEs	EMDEs	China region	AEs	EMDEs	China region

2022	100%	100%	100%	100%	100%	100%	100%	100%	100%
2023	100%	100%	100%	100%	100%	100%	100%	100%	100%
2024	100%	100%	100%	100%	100%	100%	100%	100%	100%
2025	98%	99%	98%	97%	99%	99%	98%	97%	97%
2026	97%	97%	97%	94%	99%	99%	95%	93%	93%
2027	95%	96%	95%	90%	98%	98%	93%	90%	90%
2028	93%	95%	93%	87%	98%	98%	90%	87%	87%
2029	92%	94%	92%	84%	97%	97%	88%	83%	83%
2030	89%	91%	89%	77%	96%	96%	83%	77%	77%
2031	86%	89%	86%	75%	92%	92%	81%	74%	74%
2032	84%	87%	84%	73%	89%	89%	78%	71%	71%
2033	82%	85%	82%	71%	86%	86%	75%	69%	69%
2034	80%	82%	80%	69%	82%	82%	72%	66%	66%
2035	78%	80%	78%	67%	79%	79%	69%	64%	64%
2036	76%	78%	76%	65%	75%	75%	67%	61%	61%
2037	74%	76%	74%	63%	72%	72%	64%	59%	59%
2038	71%	74%	71%	61%	68%	68%	61%	56%	56%
2039	69%	72%	69%	59%	65%	65%	58%	54%	54%
2040	67%	70%	67%	58%	61%	61%	56%	51%	51%
2041	65%	68%	65%	56%	58%	58%	53%	48%	48%
2042	63%	66%	63%	54%	55%	55%	50%	46%	46%
2043	61%	63%	61%	52%	51%	51%	47%	43%	43%
2044	59%	61%	59%	50%	48%	48%	44%	41%	41%
2045	56%	59%	56%	48%	44%	44%	42%	38%	38%
2046	54%	57%	54%	46%	41%	41%	39%	36%	36%
2047	52%	55%	52%	44%	37%	37%	36%	33%	33%
2048	50%	53%	50%	42%	34%	34%	33%	31%	31%
2049	48%	51%	48%	40%	30%	30%	31%	28%	28%
2050	46%	49%	46%	38%	27%	27%	28%	26%	26%

RFNBOs, RCFs, and Hydrogen

There is no publicly available data on projections for RFNBO or RCF ("e-fuel") consumption in the IEA APS modeling. If dedicated production of such fuels does materialize, it can be assumed that the GHG emission intensity will be documented so that such fuels can be sold at a premium and be eligible for policy support. Therefore, no default annual percentage WTW GHG emission intensity reduction factors are provided for such fuels.

Very small volumes of hydrogen are projected to be allocated to road transport in the IEA APS scenario. Figure 3.2 in the Global Hydrogen Review 2024 provides a basis for estimating a global trajectory for WTW GHG emission intensity reductions for hydrogen supplied to road transport vehicles in the APS. This figure shows a total of 7.5 Mt of low-emission H_2 production in 2030.

This compares with 97 Mt of hydrogen produced in 2023, nearly all via unabated NG SMR or, in China, from coal gasification. Assuming that road transport is allocated an equal proportion of low-emissions H_2 as all other potential demand sectors, and assuming that around 70% of the hydrogen production is produced via electrolysis using primarily low-emissions electricity, and 30% via SMR with CCS (and accounting for efficiency losses associated with hydrogen compression or liquefaction, transport, and dispensing) leads to an estimated global trajectory for low-emission hydrogen as shown in Table C13.

Table C13. WTW GHG emission intensity hydrogen for use in road vehicles in g CO_2e/MJ

Year	WTW emission intensity (g CO_2e/MJ)
2022	96.3
2023	96.3
2024	96.3
2025	95.3
2026	94.3
2027	93.3
2028	92.1
2029	91.0
2030	88.6
2031	87.1
2032	85.7
2033	84.3
2034	82.8
2035	81.4
2036	79.9
2037	78.5
2038	77.0
2039	75.6
2040	74.1
2041	71.2
2042	68.3
2043	65.4
2044	62.5
2045	59.6
2046	56.7
2047	53.8
2048	50.9
2049	48.0
2050	45.1

Scope 3 category 1 emissions intensity reductions for automotive manufacturers (AMSS-C3) and auto parts manufacturers (APSS-C3)

The indexed emissions intensity trajectories of steel, aluminum, chemicals, and “other” materials in the IEA NZE scenario, shown in Figure C3, are averaged to derive an aggregate emissions intensity trajectory for scope 3 category 1 emissions (associated with material production). Given the wide variability and high uncertainty of the global benchmark emissions intensity (let alone regional benchmark intensities), AMSS-C3 requires automotive manufacturers, and APSS-C3 requires parts manufacturers, to meet the schedule of emissions intensity reductions shown in Table C14 on a percent reduction basis.

Table C14. Composite indexed emissions intensity trajectory of materials manufacturing in the IEA NZE scenario

Year	Indexed emission intensity (g CO_2e/vkm - AMSS-C3) (g CO_2e/part - APSS-C3)
2023	100%
2024	97%
2025	93%
2026	90%
2027	86%
2028	83%
2029	79%
2030	76%
2031	72%
2032	67%
2033	63%
2034	58%
2035	54%
2036	50%
2037	45%
2038	41%
2039	37%
2040	33%
2041	30%
2042	27%
2043	24%
2044	21%
2045	19%
2046	16%
2047	13%
2048	10%
2049	7%
2050	5%

Scope 3, category 11 emissions intensity reductions for powertrain manufacturers

Criterion APSS-C4 requires powertrain providers to meet scope 3, category 11 (fuel-cycle) emission intensity reduction trajectories on both a global and regional basis, based on a convergence approach (according to Annex G). These reduction trajectories are based on the ITF "All-Out" scenario, and target values are shown in Tables C15–C18.

Table C15. Global fuel-cycle GHG emission intensity of new vehicle sales (g CO_2e/vkm)

	2&3Ws	Passenger Cars	Buses	LCVs	Lorries	Road Tractors
2022	61.3	212.3	1016.9	262.8	679.2	905.8
2023	60.0	207.5	1004.2	259.5	673.2	898.8
2025	53.8	142.1	925.9	210.6	633.9	825.8
2030	25.5	22.2	516.8	72.3	362.2	488.6
2035	3.8	3.9	75.0	6.2	81.0	136.5
2040	0.2	0.1	10.8	0.1	10.5	61.9
2045	0.0	0.0	0.0	0.0	0.0	0.0
2050	0.0	0.0	0.0	0.0	0.0	0.0

*Table C16. **AEs** fuel-cycle emission intensity of new vehicle sales (g CO_2e/vkm)*

	2&3Ws	Passenger Cars	Buses	LCVs	Lorries	Road Tractors
2022	59.1	215.9	1052.4	275.8	811.6	913.9
2023	58.6	211.2	1055.8	272.4	800.9	906.4
2025	52.5	123.5	1027.0	216.7	750.5	825.0
2030	19.6	6.8	619.1	67.1	392.8	418.5
2035	1.7	0.0	0.7	0.0	0.0	0.0
2040	0.0	0.0	0.0	0.0	0.0	0.0
2045	0.0	0.0	0.0	0.0	0.0	0.0
2050	0.0	0.0	0.0	0.0	0.0	0.0

*Table C17. **China region** Fuel-cycle GHG emission intensity of new vehicle sales (g CO_2e/vkm)*

	2&3Ws	Passenger Cars	Buses	LCVs	Lorries	Road Tractors
2022	63.2	190.9	1105.5	214.3	535.7	867.5
2023	61.6	185.6	1102.7	211.7	530.8	860.4
2025	53.4	134.5	982.5	189.3	491.7	800.1
2030	26.7	17.5	502.1	70.4	266.9	428.9
2035	3.1	1.4	18.0	2.1	6.7	7.0
2040	0.0	0.0	0.0	0.0	0.0	0.0
2045	0.0	0.0	0.0	0.0	0.0	0.0
2050	0.0	0.0	0.0	0.0	0.0	0.0

*Table C18. **EMDE** Fuel-cycle GHG emission intensity of new vehicle sales (g CO_2e/vkm)*

	2&3Ws	Passenger Cars	Buses	LCVs	Lorries	Road Tractors
2022	59.3	212.8	859.5	231.1	640.6	905.2
2023	58.4	209.1	840.8	229.2	637.8	900.7
2025	54.1	190.0	795.8	198.4	609.9	845.6
2030	25.2	49.9	408.1	100.7	398.1	647.4
2035	4.1	11.3	209.5	37.6	186.0	405.1
2040	0.3	0.3	33.1	0.4	24.9	191.0
2045	0.0	0.0	0.0	0.0	0.0	0.0
2050	0.0	0.0	0.0	0.0	0.0	0.0

Benchmarks for comparison with the 65% emissions intensity reduction threshold for the low-emission vehicle sales share criterion (AMSS-C2)

Criterion AMSS-C2 requires that a vehicle meet a 65% emissions intensity reduction threshold to qualify as a low-emission vehicle. The regional and global WTW emissions intensities of conventional ICE vehicles (sales-weighted averages across gasoline, diesel, and natural gas ICEs) from the ITF "All-Out" scenario are adopted as the benchmark values. Table C19 shows these benchmark values across each of the six vehicle categories and three regional groupings (as well as at a global level), and for benchmark years from 2023 to 2030. The benchmark applied shall correspond to the year in which a vehicle is sold or registered.

Table C19. Fuel-cycle GHG emission intensity of new ICE vehicle sales (g CO_2e/vkm)

Vehicle category	Region	2023	2024	2025	2026	2027	2028	2029	2030
2&3Ws	Advanced	59.1	58.6	57.5	56.5	55.5	54.5	53.6	52.7
	China region	60.2	59.9	59.6	59.3	59	58.7	58.5	58.1
	EMDE	59	58.3	57.4	56.6	55.7	55	54.5	54
	Global	59.5	58.6	57.8	57	56.3	55.7	55.4	55
Passenger Cars	Advanced	235.9	232.2	216.1	207.6	197.7	188.2	163.9	152.2
	China region	210.9	209.9	199.7	190.2	181.1	172.4	129.8	0
	EMDE	213.5	211.4	201.4	190.1	181.8	174.3	140	133.1
	Global	225	224.3	208.6	197.8	187.4	176.6	142.6	133.1
Buses	Advanced	1066.4	1060.3	1107.9	1170.9	1162.6	1151.1	1139.7	1128.4
	China region	1138.5	1132.6	1129.4	1129.6	1124.1	1113	1102	1091.1
	EMDE	842.9	849.8	848.5	849.7	853.2	876.1	876.6	881
	Global	1013.5	1002	1014.3	1060.7	1062.2	1062.9	1054.8	1049
LCVs	Advanced	280.6	280.5	269.9	259.4	248.2	236.2	225.7	216.6
	China region	216.7	215.7	210.2	202.2	195.3	186.9	179.4	172.9
	EMDE	229.5	229.5	212.8	203.1	192.8	183.3	174.6	166.4
	Global	265.8	262.7	253.4	241.8	230.3	217	206.2	197.3
Medium-duty trucks	Advanced	815.7	809.4	790.9	772.1	735.8	700.7	666.7	633.9
	China region	530.5	527.9	499.8	472.7	450.2	428.8	408.4	388.9
	EMDE	639.7	647.6	618.5	585.6	556.5	528.9	501.5	475.4
	Global	678.5	668.6	653.9	625.8	596.5	567.5	538	508.7
Heavy-duty trucks	Advanced	909.8	903.5	861	821.8	782.6	745.3	709.8	675.9
	China region	876.7	872.4	834.4	798.4	760.4	724.2	689.7	656.9
	EMDE	901.1	891.4	848.9	809.6	771	734	698.6	664.9
	Global	903.3	893.2	852.4	814.5	775.5	738.3	702.6	668.6

ANNEX D: REFERENCE DATA

For the purpose of accounting for WTT and TTW emissions for fossil fuels, representative emission factors are shown in Tables D1 (fossil-derived fuels), D2 (biofuels), D3 and D4 (hydrogen, carbon-bearing RFNBOs and RCFs). Further details on the origin and the use of these factors are included in Appendix L.

Table D1. WTT and TTW emissions factor of fossil-derived fuels

Fuel	gCO_2e/MJ		Source
	WTT	TTW	
Petroleum (oil-based) gasoline	17	73.2	Simple average
	17	73	GREET-2023
	17	73.4	JEC v5
Petroleum (oil-based) diesel	16.8	74.5	Simple average
	15.3	75.7	GREET-2023
	18.9	73.2	JEC v5
Compressed natural gas (CNG)	14	56.8	Simple average
	16.7	57.4	GREET-2023
	11.9	56.2	JEC v5
Liquefied natural gas (LNG)	17.8	57	Simple average
	19	57.6	GREET-2023
	16.6	56.4	JEC v5
Liquefied petroleum gas	8.4	65.1	Simple average
	8.9	64.5	GREET-2023
	7.8	65.7	JEC v5

Sources: Cai et al., 2022, Tables S17, S18, and S19; R&D GREET1, 2023 version.

Table D2. Default emission factor for biofuels (2024), in g CO_2e/MJ

Pathway - feedstock(s)	Fuel pool	WTW	ILUC
Ethanol - corn	Gasoline	53.7	28.5
Ethanol - sugarcane	Gasoline	26.1	9.2
Cellulosic Ethanol	Gasoline	14.9 (excluding land with high biodiversity value and land with high-carbon stock)	-
FAME – soybean	Diesel	45.3	28.9
FAME - canola/rape	Diesel	41.25	22.6
FAME – tallow	Diesel	18.85	-
RD/HVO - soybean	Diesel	40.7	26.0
RD/HVO - canola/rape	Diesel	40.95	22.4
RD/HVO – Used Cooking Oil	Diesel	16.35 (50 beyond a 2% cap)	- (capped)
FT diesel - forest residue	Diesel	7.45	-
Fast pyrolysis of forest residue	Diesel	24.05	-

Pathway - feedstock(s)	Fuel pool	WTW	ILUC
Manure anaerobic digestion	CNG	-96.6 (13 beyond a 3% cap)	- (capped)
MSW AD RNG	CNG	-45.5 (13 beyond a 3% cap)	- (capped)
Sewage sludge AD RNG	CNG	-34.55 (13 beyond a 3% cap)	- (capped)

Notes: AD = Anaerobic digestion; FT = Fischer Tropsch; HVO = Hydrotreated vegetable oil; RD = Renewable diesel; RNG = Renewable natural gas.
Biofuels from feedstock produced on land with high biodiversity value or high-carbon stock shall be excluded.
The ILUC value for used cooking oil is only applicable within limits set by a cap corresponding to 2% of the fuel used by road vehicles. Beyond this percentage, a default indirect emission value of 50 g CO_2e/MJ applies, unless lower indirect impacts are demonstrated and disclosed in a way that enables third-party verification. Other waste oils and fats are subject to the same default values and limitations as used cooking oil.
Negative emission factors for biogas, biomethane, and RNG apply within a cap set at 2% of the fuel used by road vehicles. Beyond this percentage, a default indirect emission value of 13 g CO_2e/MJ applies, unless lower indirect impacts are demonstrated and disclosed in a way that enables third-party verification.

Sources: Cai et al., 2022, Tables S17, S18, and S19; R&D GREET1, 2023 version; ILUC from CORSIA global defaults (ICAO, 2024), adapted based on direct WTW emission ratios (as the CORSIA values are for aviation fuels); European Union, 2018 and European Union, 2023; biofuel emission factor values are not exhaustive of pathway-feedstock combinations.

Table D3. Default global emission factors for hydrogen, carbon-bearing RFNBOs and RCF benchmarks

Pathway	WTT emissions (g CO_2e/MJ)	WTW emissions (g CO_2e/MJ)
Hydrogen from steam methane reforming of natural gas	96.3	Same as WTT
Gasoline benchmark	17	73.2
Diesel fuel benchmark	16.8	74.5

Sources: Hydrogen based on Cai et al., 2022 (simple average of GREET and JEC) and consistent with 35% losses in SMR and stoichiometric ratios of water and methane: 0.5 kg methane and 1.125 kg of water per kg of hydrogen. Gasoline and diesel benchmarks are based on petroleum gasoline and petroleum diesel for gasoline and diesel fuel, also from Cai et al., 2022 (simple average of GREET and JEC).

Table D4. Default estimates of the carbon intensity of hydrogen, carbon-bearing RFNBOs, and RCFs (before and after 2040) for varying carbon intensities of electricity generation

Pathway	Emission intensity of electricity (g CO_2e/kWh)	WTW emissions (g CO_2e/MJ)
Electrolytic hydrogen	25	[1] 11.1
	50	[2] 22.2

	100	[3] 44.4
	150	[4] 66.7
	200	[5] 88.9
Synthetic gasoline or diesel (RFNBO, e-fuel)	25	17.8
	50	35.6
	75	53.4
	100	71.2
	125	89.0
Synthetic gasoline or diesel (RCF, e-fuel, before 2040)	25	14.9
	50	29.9
	75	44.8
	100	59.8
	125	74.7
	150	89.7
Synthetic gasoline or diesel (RCF, e-fuel, after 2040)	25	52.8
	50	60.3
	75	67.8
	100	75.3
	125	82.7
	150	90.2

Sources: Based on information retrieved from Soler et al., 2022, Bothe et al. (2021), Deutz and Bardow (2021), and IEA (2020), assuming 1.6 MJ of electricity requirements for the production of 1 MJ of hydrogen, 2.13 MJ/MJ of RCFs and 2.56 MJ/MJ of RFNBOs.

Default mileages by vehicle type are listed in Table D5 for the purpose of accounting for emissions occurring during vehicle manufacturing, from the vehicle-cycle and expressed in g CO_2e/vehicle, alongside emissions from the fuel-cycle (energy production and use), in g CO_2e/km. Further details on the origin and the use of these factors are included in Appendix M.

Table D5. Lifetime mileage defaults by vehicle category

Vehicle category	Lifetime km (thousands)
2- and 3-wheelers (2-3Ws)	100
Passenger light duty vehicles (PLDVs)	220
Buses	500
Light commercial vehicles (LCVs)	400
Medium duty trucks (MDTs)	550
Heavy duty trucks (HDTs)	900

Sources: Odyssee-Mure, 2025; U.S. DOE Alternative Fuels Data Center, 2024; Girardi et al., 2019; Weymar and Finkbeiner, 2016; Mao et al., 2021; Krishnamoorthy, Kelly and Elgowainy, 2023; ITF, 2020; Bieker, 2021; O'Connell, 2023; Rebouças and Cieplinski, 2023; Yadav et al., 2024; Mera and Bieker, 2023; Anup and Deo, 2021.

Default lifetimes by vehicle type, shown in Table D6 are used to set specific delays for low-emission vehicle shares related to replacement parts.

Table D6. Default lifetimes by vehicle category

Vehicle category	Lifetime (years)
2- and 3-wheelers (2-3Ws)	12
Passenger light duty vehicles (PLDVs)	18
Buses	12
Light commercial vehicles (LCVs)	16
Medium duty trucks (MDTs)	14
Heavy duty trucks (HDTs)	12

Sources: Hunt et al., 2021; Greene and Leard, 2024; US DOT, 2017; Weymar and Finkbeiner, 2016; Mao et al., 2021; Krishnamoorthy, Kelly and Elgowainy, 2023; ITF, 2020; Bieker, 2021; O'Connell, 2023; Rebouças and Cieplinski, 2023.

Default mileage decay values (i.e., the reduction in annual mileage over vehicle's lifetime), shown in Table D7, are necessary to align projected fuel-specific WTW emission intensity with vehicle operations over its lifetime in the initial market of use.

Table D7. Default mileage decay functions, in percent reduction from the initial year and in absolute annual mileage, by vehicle category

Vehicle category	*Age (yrs)*	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
2-3Ws	km/year	10,792	10,345	9,898	9,451	9,004	8,557	8,110	7,663	7,216	6,769	6,322	5,875								
	% decay	100%	95.9%	91.7%	87.6%	83.4%	79.3%	75.1%	71.0%	66.9%	62.7%	58.6%	54.4%								
PLDVs	km/year	14,188	13,795	13,403	13,011	12,228	11,794	11,382	11,157	10,941	10,855	10,707	10,609	10,372	10,232	10,092	9,650	9,349	9,047	8,746	8,444
	% decay	100%	97.2%	94.5%	91.7%	86.2%	83.1%	80.2%	78.6%	77.1%	76.5%	75.5%	74.8%	73.1%	72.1%	71.1%	68.0%	65.9%	63.8%	61.6%	59.5%
Buses	km/year	77,042	65,999	57,781	49,050	42,630	37,494	33,898	30,817	27,992	26,708	25,681	24,910								
	% decay	100%	85.7%	75.0%	63.7%	55.3%	48.7%	44.0%	40.0%	36.3%	34.7%	33.3%	32.3%	31.4%	30.4%	29.5%					
LCVs	km/year	40,527	39,716	38,501	37,690	36,474	34,448	32,421	27,153	21,074	18,237	16,211	14,995	14,184	14,184	14,184					
	% decay	100%	98.0%	95.0%	93.0%	90.0%	85.0%	80.0%	67.0%	52.0%	45.0%	40.0%	37.0%	35.0%	35.0%	35.0%					
MDTs	km/year	78,625	68,404	58,969	51,106	44,030	38,526	34,595	31,065	27,895	25,049	22,493	20,197	18,136	16,286	14,624					
	% decay	100%	87.0%	75.0%	65.0%	56.0%	49.0%	44.0%	39.5%	35.5%	31.9%	28.6%	25.7%	23.1%	20.7%	18.6%					
HDTs	km/year	128,127	117,209	106,136	95,120	85,115	75,806	66,768	58,628	50,907	44,777	38,610	32,796								
	% decay	100%	91.5%	82.8%	74.2%	66.4%	59.2%	52.1%	45.8%	39.7%	34.9%	30.1%	25.6%								

ANNEX E: VEHICLE ENERGY INTENSITY CALCULATIONS

Specific energy consumption values, measured in MJ/vkm, shall be assessed based on internationally agreed, or in the absence of these, country-specific test procedures. On-road corrections shall also be applied to light-duty vehicles.

In the absence of testing obligations, estimates of fuel and/or electricity consumption of the vehicle's sales shall be supported by published methodologies and sufficient evidence to allow for third-party verification.

This information can be based on:

- Dedicated tests conducted voluntarily in unregulated markets
- Assessments based on tests already available in regulated markets in cases where the same technologies are used in vehicles sold in unregulated markets
- It can also rely on telematics data, based on onboard diagnostics and monitoring (while still requiring the release of sufficient information to enable transparent third-party verifications).

Relevant test procedures are summarised in Table E1, for each vehicle category.

Table E1. Cycles, simulation tools and procedures for energy consumption and g CO_2e/km measurements

Vehicle category	Test procedures
2- and 3-wheelers	Worldwide Harmonized Motorcycle Emissions Certification Procedure (WMTC)
Passenger cars and LCVs	Worldwide Harmonized Light Vehicles Test Cycle (WLTC) and Test Procedure (WLTP) Japanese JC08 Cycle (superseded by WLTP) New European Driving Cycle (superseded by WLTP) US Corporate Average Fuel Economy (CAFE), reliant on the Federal Test Procedure (FTP)-75 and Highway Fuel Economy Test (HWFET) cycles
Buses, minibuses and trucks	China GB/T 27840-2021, fuel consumption test methods for heavy-duty commercial vehicles EU Vehicle Energy Consumption calculation TOol (VECTO) Japanese Hardware in the Loop Simulator US Greenhouse Gas Emissions Model (GEM)

In the case of cars and light commercial vehicles, it is possible to convert to MJ/vkm calculated based on country- or region-specific test procedures in the internationally agreed

Worldwide harmonized Light vehicles Test Procedure (WLTP), using conversions across country- or region-specific test cycles.

Test cycle conversions are based on analysis conducted by UC Davis and FIA Foundation (Trends in the Global Vehicle Fleet 2023, Global Fuel Economy Initiative [GFEI, 2023]), ICCT (ICCT, 2014, 2014a, and 2021), and are consistent with the JRC for the WLTP/NEDC ratio (Joint Research Centre, 2023), as embedded in the Automotive Standard reporting tool. Conversions from NEDC to WLTP for battery electric vehicles (for PLDVs and LCVs separately) are based on (JRC, 2017).

Test cycle conversions shall be carried out as outlined below, and based on the multipliers listed in Table E2. These scalars should be multiplied by initial specific energy consumption values (in MJ/vkm) to convert from the specific energy consumption in a given test cycle to WLTP.

- **NEDC to WLTP**: For all data reported in NEDC, separate powertrain-fuel specific scalars based on GFEI 2023 for PLDVs (passenger cars) and for light commercial vehicles, as determined by zero-intercept regression methods based on EEA type approval data for new cars and vans, shall be adopted to convert to WLTP. These scalars shall also be applied for regional variants of NEDCs testing (e.g. India, China, Japan), separately for PLDVs and LCVs.

- **JC08 to WLTP**: For all data reported in JC08, scalars shown in Table E2 shall be used. These were derived by correcting zero-intercept formulas converting from JC08 to NEDC based on (ICCT, 2014), Table 5.2, single regression with zero intercept (Formula 4.2), to account for the gap between NEDC and WLTP, following the methods described in (GFEI, 2023).

- **CAFE (EPA) (also known as U.S.-combined or FTP75 + HWFET) to WLTP**: For all data reported in CAFE, i.e. for cars and light-trucks tested on the CAFE cycle and sold in North America, Brazil, South Korea, and Mexico, scalars shown in Table E2 shall be used. These were derived by correcting zero-intercept formulas converting from CAFE to NEDC based on (ICCT, 2014), Table 5.2, single regression with zero intercept (Formula 4.2), to account for the gap between NEDC and WLTP, following the methods described in (GFEI, 2023).

While applying zero-intercept equations introduces uncertainty (reflected in the standard error of the regressions used to develop these estimates), the simple multiplier reduces ambiguity and increases clarity in the test cycle conversions. Future development of the standards could explore adopting non-zero intercept formulas. If this approach were to be adopted, care should be taken to ensure that test cycle conversions are consistent among one another and reflect current gaps, for instance between NEDC and WLTP, as reflected in recent EEA data for cars and vans (EEA, 2024a; 2024b).

Table E2. Test cycle conversions for light-duty vehicles

Vehicle category	From cycle	To cycle	Powertrain-Fuel	Multiplier	Source
PLDV*	NEDC	WLTP	ICEV/HEV-Gasoline	1.185	GFEI, 2023, Table A5 (and supporting analysis)
PLDV*	NEDC	WLTP	ICEV/HEV-Diesel	1.234	GFEI, 2023, Table A5 (and supporting analysis)
PLDV*	NEDC	WLTP	BEV	1.283	JRC, 2017
PLDV*	NEDC	WLTP	FCEV	1.283	JRC, 2017
LCV	NEDC	WLTP	ICEV/HEV-Gasoline	1.166	GFEI, 2023, Table A5 (and supporting analysis)
LCV	NEDC	WLTP	ICEV/HEV-Diesel	1.284	GFEI, 2023, Table A5 (and supporting analysis)
LCV	NEDC	WLTP	BEV	1.21	JRC, 2017
PLDV*	JC08	WLTP	ICEV/HEV-Gasoline	1.246	ICCT, 2014; GFEI, 2023 (NEDC to WLTP update)
PLDV*	JC08	WLTP	ICEV/HEV-Diesel	1.208	ICCT, 2014; GFEI, 2023 (NEDC to WLTP update)
LCV	JC08	WLTP	ICEV/HEV-Gasoline	1.225	ICCT, 2014; GFEI, 2023 (NEDC to WLTP update)
LCV	JC08	WLTP	ICEV/HEV-Diesel	1.256	ICCT, 2014; GFEI, 2023 (NEDC to WLTP update)
PLDV*	CAFE	WLTP	ICEV/HEV-Gasoline	1.211	ICCT, 2014; GFEI, 2023 (NEDC to WLTP update)
PLDV*	CAFE	WLTP	ICEV/HEV-Diesel	1.306	ICCT, 2014; GFEI, 2023 (NEDC to WLTP update)
LCV	CAFE	WLTP	ICEV/HEV-Gasoline	1.19	ICCT, 2014; GFEI, 2023 (NEDC to WLTP update)
LCV	CAFE	WLTP	ICEV/HEV-Diesel	1.358	ICCT, 2014; GFEI, 2023 (NEDC to WLTP update)

*Note: PLDV = Passenger cars (PCs) in the European Union context.

For PHEVs, it is especially important to assess the shares of fuel and electricity consumption that reflect actual, real-world usage. In order to accurately calculate utility factors, for the purposes of estimating the specific (i.e. per vehicle-km) electricity and fuel consumption of new PHEV models, automakers will be required to disclose model-level information on the fuel consumption, electricity consumption, and range in the charge-depleting (CD) mode, and on fuel consumption in charge-sustaining (CS) mode.[14]

For passenger cars and LCVs, specific fuel consumption, GHG emissions, and/or electricity consumption shall be calculated using test procedures normalized to the WLTP. Fuel consumption/TTW GHG emissions and electricity consumption estimates will then be adjusted upwards using data available from the European Environment Agency (EEA, 2024), based on on-board fuel consumption monitoring (OBFCM) devices, of real-world energy consumption.

Multipliers to adjust for real-world performance that shall be adopted for the purposes of estimating specific energy consumption (in MJ/vkm) are shown in Table E3.

Table E3. Multipliers to estimate real-world specific fuel consumption based on WLTP performance

Vehicle category	Powertrain-Fuel	Multiplier
PLDV*	ICEV/HEV-Gasoline	1.168
PLDV*	ICEV/HEV-Diesel	1.1566
PLDV*	PHEV-Gasoline	4.1905
PLDV*	PHEV-Diesel	4.5238
LCV	ICEV/HEV-Gasoline	1.2938
LCV	ICEV/HEV-Diesel	1.1127
LCV	PHEV-Gasoline	3.3205
LCV	PHEV-Diesel	6.86

Values are derived from the vkm-weighted fuel-powertrain specific gaps for vehicles registered in 2022, as reported in (EEA, 2024).
*Note: PLDV = Passenger cars (PCs) in the European Union context.

These adjustments include corrections for PHEVs, accounting for differences between utility factors (i.e., equivalent shares of driving in all-electric modes) deriving from WLTP tests and real-world records, reflecting actual PHEV usage.

Automakers that provide documented evidence showing their sold PHEVs outperform the EEA or publicly available defaults may use specific fuel and energy consumption values based on annual, model-level aggregations of their own OBFCM data, by region and globally.

[14] WTW emission factors related to the fuel and electricity use can then be calculated by either adopting regional / country-level defaults, or by providing verifiable documentation of contracts showing that some subset of the vehicles sold are operating on lower-emission electricity and/or fuels.

ANNEX F: ENERGY EFFICIENCY RATIOS

Weighting factors based on energy efficiency shall be applied to assess the sales shares of low-emission vehicles in criteria AMSS-C3. Energy efficiency ratios (EERs) applicable for this purpose are detailed in Table F1. Appendix N contains further information on how these factors have been determined.

Table F1. EERs by powertrain technology, for all vehicle categories

Powertrain technology	Energy efficiency ratio (EER)
Battery electric vehicles (BEVs)	1
Fuel cell electric vehicles (FCEVs)	0.45
Hybrid electric vehicles (HEVs)	0.3
Internal combustion engine vehicles (ICEVs)	0.2

PHEVs can be assessed based on the energy efficiency ratios included in Table E1 in Annex E, using the BEV value for the equivalent share of driving purely on electricity ($a_{electricity}$) and the HEV value for the remaining share. The factor $a_{electricity}$ can be calculated from the average fuel consumption ($FC_{average\ usage}$) and the fuel consumption in charge sustaining (CS) mode ($FC_{CS\ mode}$), as follows:

$$FC_{average usage} = \alpha_{fuel} FC_{CS\ mode} = \left(1 - \alpha_{electricity}\right) FC_{CS\ mode}$$

$$\alpha_{electricity} = \frac{\left(FC_{CS\ mode} - FC_{average\ usage}\right)}{FC_{CS\ mode}}$$

also considering that

$$FC_{average usage} = \alpha_{CD\ mode} FC_{CD\ mode} + \alpha_{CS\ mode} FC_{CS\ mode}$$

where $FC_{CD\ mode}$ is the fuel consumption in charge depleting (CD) mode, $a_{CD\ mode}$ is the share of travel in CD mode, and $a_{CS\ mode}$ is the share of driving SC mode, and considering that all these values are available at the model level for PHEV from energy consumption and CO_2 emission tests.

ANNEX G: CONVERGENCE APPROACH

Companies selling passenger light-duty vehicles and light commercial vehicles shall meet both the global and each regional trajectory. Regional and global convergence criteria apply to both the emission intensity criterion (AMSS-C1) for light-duty vehicles. They are also applied for low-emission vehicle sales share criterion, including the one that applies to automakers (AMSS-C2).

In the case of the emission intensity criterion (AMSS-C1), this double compliance based on a convergence approach is possible thanks to the fact that emission intensities can be brought under a single metric, based on the WLTP, and integrating conversions from other test cycles where needed and an on-road correction. In the case of the low-emission vehicle sales share criterion (AMSS-C2), the common metric is the sales share.

Benchmarking of energy and emissions intensity in LDVs relies on established conversion methods across regional test cycles, as well as real-world measurements of the gap between rated (in WLTP) and on-road fuel consumption. Benchmarking of estimated on-road fuel consumption is far more accurate for light-duty vehicles than for all other vehicle types. As a result, as long as LDV manufacturers calculate their on-road emissions by applying the methodology detailed in the standard, the overall weighted-average on-road energy intensity (in MJ/vkm) and WTW emissions intensity (in gCO_2e/vkm), across each of the regional markets is likely to be reasonably accurately reflected by the ITF modelled values in historical and benchmark years (2020-2024).

This is not the case for other vehicle categories, where there is far more uncertainty and regional variability, both in the testing procedures and in the actual on-road vehicle performance. Taking medium- and heavy-duty vehicles (MHDVs) as an example, while testing procedures provide a strong basis for incentivizing fuel efficiency technologies in each regulated segment, they tend to provide biased (upwards or downwards) estimates when compared with real-world data (e.g. telematics and tracking by bus and truck OEMs). These biases vary across vehicle segments and differ by testing procedure (listed in Table E.1).

Adopting a convergence approach (according to Annex G) for each non-LDV vehicle category, within each regional test cycle, is likely to introduce two undesired impacts:

- Since global modelling adopts energy intensity estimates that are internally consistent but disconnected from regional test cycles, regional benchmarks will be higher or lower than tested energy intensities, in ways that cannot be estimated and evaluated across all global regions. This means that for certain regional trajectories and vehicle category combinations, automotive manufacturers could face a systematically less or more stringent baseline.
- The mismatch within and across regions would result in a further disconnect in terms of implied slopes of the emission intensity reduction pathways, effectively introducing a major inconsistency in the stringency of emission intensity trajectories, across non-LDV segments and regions.

Note: These issues also exist with the proposed approach (absolute percentage reduction), especially for MHDTs together with the heterogeneity of vehicle duty cycles and operations (especially for trucks) also exist, although they are mitigated by a consistency in assumptions and methodology for estimating energy intensity in global modelling efforts.

This is the rationale for adopting a percent improvement approach (detailed in [Annex H]), rather than a convergence approach, for all non-light-duty vehicle categories. The percent improvement approach reduces the margin for introducing bias across regions with different test cycles (and the gaps between test-cycles and on-road emissions intensity).

Compliance with both regional and global metrics shall be based on the weighted average of their sales—considering different powertrains and associated life-cycle CIs—in AE, EMDEs and the China region:

In the case of the low-emission vehicle sales criteria (AMSS-C2), the single metric is the share of sales, by vehicle category. Compliance with the regional and the global metric shall be based on the weighted average of vehicle sales, by type, and it shall be integrating energy efficiency-related factors.

A convergence approach is implemented to ensure all automakers align with regional pathways by 2035.[15] It is implemented using linear convergence between each company's initial aggregated emission intensity (expressed in g CO_2e/km) or the low-emission vehicle sales share and the 2035 aggregated emission intensity or low-emission vehicle sales share trajectory defined for the SBTi Automotive Sector Net-Zero Standard, as detailed in the formulas below.

$$X_{Company}(t) = X_{Trajectory}(t) + \left(X_{Company}(t_0) - X_{Trajectory}(t_0)\right)\frac{(t_1 - t)}{(t_1 - t_0)}$$

Applicable until; 2035, and where:

t_0 is the initial year, for which historical data are available

t_1 is the year 2035

t is any year between the initial one and 2035

$X_{Company}(t)$ is the value of the relevant parameter (carbon intensity or low-emission vehicle sales shares, by vehicle category) for a given company at a time t

$X_{Company}(t_0)$ is the value of the same company-specific parameter at the initial time t_0

$X_{Trajectory}(t)$ is the value of the relevant parameter in the trajectory at the time t

$X_{Trajectory}(t_0)$ is the value of the same trajectory parameter at the initial time t_0

$$X_{Company}(t) = X_{Trajectory}(t)$$

Applicable after 2035.

[15] This recognizes the need and the demonstrated capacity for industry laggards to catch-up with industry leaders, both within regionalized country groupings, and at a global level.

ANNEX H: PERCENT IMPROVEMENT APPROACH

Original Equipment Manufacturers (OEMs) that produce 2-3 wheelers, buses, or medium- and heavy-duty trucks in any of these regional markets shall be subject to regional and global aggregated GHG emission requirements (criteria AMSS-C3) in each market where they operate, given the lack of any methodology to harmonise rated fuel consumption across regional test cycles for these vehicle categories.

This is implemented as detailed in the formula below.

$$X_{Company}(t) = \frac{X_{Company}(t_o)}{X_{Trajectory}(t_0)} X_{Trajectory}(t)$$

Where

t_0 is the initial year, for which historical data are available

t is any year

$X_{Company}(t)$ is the value of the relevant parameter (carbon intensity or low-emission vehicle shares, by vehicle category) for a given company at a time t

$X_{Company}(t_0)$ is the value of the same company-specific parameter at the initial time t_0

$X_{Trajectory}(t)$ is the value of the relevant parameter in the trajectory at the time t

$X_{Trajectory}(t_0)$ is the value of the same trajectory parameter at the initial time t_0

ANNEX I: DURABILITY CORRECTION FOR PART LIFETIMES

A correction related with part durability has the aim to ensure that this Standard effectively rewards quality and durability as part of decarbonization strategies for auto parts manufacturers. It only applies to parts with a default lifetime lower than the lifetime of the vehicle, in order to avoid inducing lifetime extensions that may have detrimental effects for decarbonization by locking-in life-cycle emissions of GHG-intensive vehicles by extending their lifetimes.

The durability correction needs to be carried out at the level of the components covered in GREET-2. Components whose lifetime cannot be considered lower than the vehicle lifetime (based on their treatment in GREET-2) include: powertrain system (including balance of plant), transmission system, chassis (without battery), traction motor, generator, electronic controller, fuel cell onboard storage (where relevant), body (including “body-in-white”, interior, exterior, and glass) and fuel tanks. Components with lower lifetime than the vehicle include tires, battery systems (for ICEVs, HEVs, PHEV and BEV) and fluids (engine oils, powertrain coolant, windshield fluid). They may also include power steering fluid, brake fluid, transmission fluid, and adhesives).

The durability correction factor:

$$\left(\frac{Default\ part\ lifetime}{Manufacturer{-}specific\ part\ lifetime}\right)$$

The durability correction factor shall consider default values for part lifetimes from GREET-2 assumptions. Manufacturers may use alternative lifetimes if they can transparently and verifiably demonstrate part durability.Durabilities that differ from default values can rely on lifetimes that manufacturers recommend to their customers and require the disclosure of sufficient details regarding methodologies and supporting data, allowing third-party verification.

Durability corrections can be indirectly integrated in the APSS-C1 criteria if the revised parts are part of the original vehicle equipment.

ANNEX J. ASSIGNMENT OF PARTS TO VEHICLE POWERTRAINS

In the absence of documentation demonstrating the vehicle powertrain to which a given part is supplied, the part is assigned the default low-emission vehicle share sale (for a given vehicle category and within each region) to the least performant powertrain, in terms of WTW energy efficiency, as follows:

1. For powertrain-specific components:

    - **Battery electric powertrains*:*** Parts that are unambiguously produced for battery electric powertrains (e.g., large-capacity lithium-ion batteries) are assigned to BEVs and receive a low-emission vehicle sales share credit of 1.
    - **Fuel cell electric vehicle (FCEV) powertrains**: Parts that are unambiguously produced for fuel cell electric powertrains (e.g., fuel cell stacks and systems), are assigned to FCEVs. Hydrogen storage tanks that could be used in either hydrogen ICEs or FCEVs require documentation to be assigned to FCEVs.
    - **Internal combustion engine powertrains***:* Components for ICE powertrains are assigned to ICEVs, in the absence of documentation that they are being supplied to more energy-efficient powertrains (i.e., HEVs or PHEVs)
    - **Hybrid powertrains***:* Components (e.g., electric motors) that could be designed for hybrid or plug-in hybrid vehicles are assigned to HEVs in the absence of documentation.

2. For non-powertrain-specific components:

    - **Components designed for hybrid or electric vehicles**: in the absence of further documentation, components that are clearly designed for hybrid or electric vehicles (e.g., low-RR high-performance tires, regenerative brakes), will be assigned to HEVs.
    - **Components that can be used by any vehicle powertrain**: in the absence of further documentation, the default assignment will be to ICEVs.

APPENDIX K: LIFE-CYCLE ASSESSMENT COMPONENTS

The [SBTi's land transport science-based target-setting guidance v1.1]() takes a WTW emissions approach, without sufficient guidance on how to calculate this, as it notes that "As companies make assumptions for the type of fuels plugged into the fuel tanks, original equipment manufacturers can also make assumptions of the average grid electricity factors for their sales across markets."

The SBTi Automotive Sector Net-Zero Standard expands this scope to include use-phase or "fuel-cycle" (i.e., TTW and WTT emissions - both of which fall under Scope 3 category 11 emissions for both automakers and auto parts manufacturers) and "vehicle-cycle" emissions (i.e., emissions resulting from vehicle manufacturing, including the production of the materials needed, the assembly of the parts, and the end-of-life dismantling of vehicles and their parts/components).[16]

A key reason for the extension to an aggregated approach lies in the observation that battery electric vehicles are the most promising technology to drive cost-effective and substantial reductions in the aggregated emissions of road transport vehicles, despite higher upfront manufacturing-related emissions.

Ensuring that these and other ZEVs, which are in-fact only zero tailpipe emissions, can deliver on their full long-term potential to cut aggregated GHG emissions, also requires consideration of the energy efficiency implications of different pathways, including energy production, to achieve the timely decarbonization of the automotive sector.

Extending the analysis beyond the areas under direct OEM control presents a key limitation: OEMs cannot directly influence the GHG emission intensity of these fuel supply pathways.

However, to ensure that OEM decisions reflect the broader energy transition, including its emissions, operational, and economic constraints, a fair comparison of powertrain technologies must assess fuel supply chain emissions.

This Standard updates the Land Transport guidance adding vehicle-cycle emissions to the scope of the aggregated emission intensity reduction criterion (AMSS-C2).

To support simplicity, accessibility, and transparency, calculations of vehicle-cycle and fuel-cycle emissions are generally aligned with GREET defaults, system boundaries, and methodologies.

[16] Vehicle-cycle emissions fall into multiple categories of the GHG Protocol: (i) direct and indirect energy use for vehicle and component manufacturing (Scopes 1 and 2, and scope 3, category 3), (ii) metals and materials used in vehicle manufacturing, (Scope 3, category 1), and (iii) End-of-Life (Scope 3, category 12).

Exceptions are made where system boundaries must be expanded, such as for WTW accounting of electricity, RFNBOs, RCFs, and biofuels, with each exception clearly noted and justified.

Various other methodologies for automotive aggregated accounting are being developed, including:

- Under the UN Economic and Social Council's World Forum for Harmonization of Vehicle Regulations (WP.29) under the Working Party on Pollution and Energy (GRPE)'s Automotive Life-Cycle Assessment (A-LCA) working group (UNECE, 2023)
- The European Commission has commissioned several studies on vehicle life-cycle emissions, including comparative studies of conventional and alternatively fuelled vehicles (Ricardo, 2020); on-going Horizon-funded projects on zero-emission road transport (TranSensus LCA, 2024) and on biomass, including biofuels for all transport modes (Clever, 2023), as well as the carbon footprint of EV batteries (CFB) (JRC, 2023), in support of the EU Batteries Regulation (Regulation (EU), 2023/1542).

We recommend remaining open to updates and revisions to the SBTi Automotive Sector Net-Zero Standard once the above standards are published, to ensure alignment and reduce administrative reporting burdens for companies committing to the Standard.

For reporting and compliance purposes, the Standard also refines the WTW emission accounting to define fuel-specific defaults and trajectories based on the IEA Announced Pledges Scenario (APS).

Finally, it enables automakers to receive credit for lower-emission intensity fuels used in vehicles that achieve at least a 65% reduction in WTW GHG emissions (g CO_2e/MJ), compared to a fossil fuel benchmark (petroleum gasoline for 2- and 3-wheelers and cars, and diesel fuel for other vehicle categories).[17]

As further detailed in Box 1, the selection of the IEA APS represents a pragmatic compromise between the IEA Stated Policies Scenario (STEPS), which risks underrepresenting contributions from low-emission technology deployment (especially for technologies like wind and solar photovoltaic, and hence also for the emission factor of electricity and the availability of low-emission RFNBOs), and the IEA Net-Zero (NZE) scenario, which integrates significant actions to decarbonise incumbent technologies (e.g., oil-based transport fuels) but, given the track record of action to date, risks to offer disproportionate advantages to these same technologies, with the risk of significantly weakening the effectiveness of the Standard, if used as a default assumption.

[17] Additional details on the use of APS values for fuel-specific WTW emission intensity trajectories factor going forward are provided in the WTT emission Section below.

Box 1. Assumptions on fuel-specific WTT emission trajectories and guidance on the use of IEA APS scenario values for reporting/compliance purposes

The automakers' life-cycle EI reduction criterion (AMSS-C2) requires estimates of g CO_2e/vkm of the portfolio of new vehicles sold each year. The SBTi Automotive Sector Net-Zero Standard also requires estimating EI reductions over the vehicle lifetime. Assumptions are therefore needed on plausible trajectories of the WTW emission factor for each form of energy used by road vehicles in the years following the initial benchmark.

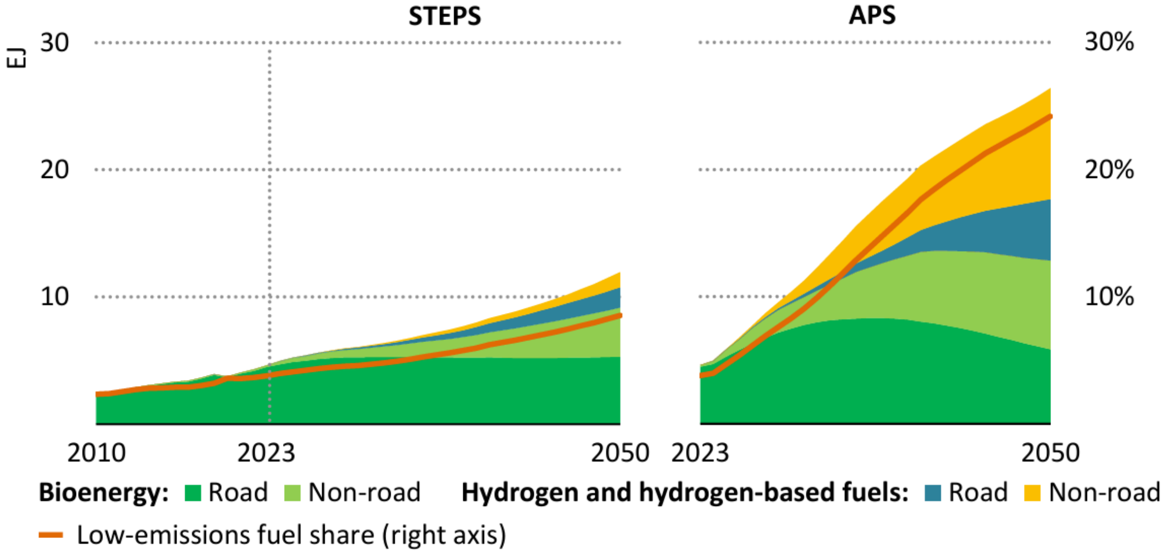
The IEA STEPS and APS provide regularly updated assessments under current policies and announced policy ambitions, respectively. Both scenarios, illustrated in Figure K1. for what concerns low-emission energy used in transport (excluding electricity), are regularly updated in major IEA publications, particularly in its World Energy Outlook (IEA, 2024).

If companies use fuel production technologies with emission intensities that differ from those in the IEA Announced Pledges Scenario (APS) in their assessments for a subset of vehicles sold (e.g. based on validated long-term supply contracts between fleets that purchase the vehicles and fuels providers), they should provide documentation and justification enabling third-party verification of how they ensure availability of less emission-intense energy to their customers. This is also necessary if the IEA APS market developments cannot be associated with relevant fuel production pathways.

Each scenario includes data on projected changes in fuel production, transport, and processing technologies and in the shares of energy used in road transport (e.g., of ethanol in the gasoline fuel pool, biodiesel and renewable diesel in the diesel pool, and biomethane in natural gas), enabling, in combination with targeted complementary analyses[18] and assumptions (e.g., on emission factors of specific subsets of biofuels), where the available data is limited, to estimate trends in emission factors. Sufficient data on electricity and hydrogen emission factors also exist in other IEA resources, including its Global Hydrogen Review (IEA, 2024) and its Electricity Market Reports (IEA, 2024).

[18] E.g., the Renewables market report, for biofuels (IEA, 2024), or the OECD/FAO outlook (OECD/FAO, 2024).

Figure K1. Low-emission fuels in transport in the Stated Policies (STEPS) and Announced Pledges scenarios (APS), 2010–2050



Source: (IEA, 2024)

Since the IEA first introduced these scenarios, STEPS has been closest to how the energy system has evolved, despite overestimations (e.g., in the cases of capture and sale of vented or flared methane; and scale-up of low-emission hydrogen production), and underestimations (e.g., in the case of BEVs, solar and wind electricity deployment) of specific technology options. APS projected trajectories have been far more rapid than historical progress, to date, aiming to reflect the impacts of policies oriented towards an acceleration of decarbonization, but they also tended to fall short (for technologies that are genuinely paired with low GHG emissions) of the changes that are included in the IEA NZE scenario.

The need to demonstrate that the emission intensity of a given fuel meets the 65% threshold versus its conventional fossil-based fuel alternative is based on the following considerations:

- The need to ensure that the SBTi effectively incentivizes transformative changes in the energy mix, towards pathways capable of delivering significant reductions in emissions.
- The use of the 65% threshold for advanced biofuels that is already applied in the Renewable Energy Directive (RED II and RED III) in the European Union and in the draft rules for tax credits (section 45V) regarding hydrogen production introduced by the U.S. Inflation Reduction Act.[19]
- For oil- and gas-based fuels, the share of TTW emissions in total WTW emissions makes it impossible to meet the 65% threshold without blending in low-emission biofuels and/or e-fuels.
- Electricity offers unmatched energy efficiency and diversification benefits, especially in light of the rapid deployment of new low-emission electricity generation capacity.[20]

[19] Regarding hydrogen, it is relevant to recall that the Renewable Energy Directive applies a 70% threshold for RFNBOs, with a WTW approach.
[20] If prospects for increased shares of low-emission electricity change over time, future updates of the SBTi Automotive Sector Net-Zero Standard may revisit the exclusion of vehicles using electricity directly from the 65% threshold.

Clear guidance on default values and on methodological choices adopted for calculating life-cycle emissions is essential to ensure a harmonized and fair approach and to reduce scope for misrepresenting different technologies.

Default values have been developed in the SBTi Automotive Sector Net-Zero Standard, together with tools and methodologies for calculating each TTW, WTW and vehicle manufacturing emissions. These tools also incorporate efforts to leverage existing tools and align with established methodologies.

Life-cycle GHG emissions are intended to reflect estimates of climate forcing across all GHGs, based on 100-year global warming potentials (GWPs) aligned with either the IPCC AR5 or AR6 (depending on the vintage of the source of WTT, TTW, and WTW emission calculations) (GHG Protocol, 2024). Additionally, hydrogen has been assigned a GWP_{100} value of 11.6, (based on Sand et al., 2023).[21]

Supporting Evidence on how Automakers will Reduce Emissions from Components

In support of submissions under sub-criterion AMSS-C4.3, automakers should include specific details on how they intend to source materials (including those resulting from parts and components supplied by third parties) with emission intensity below historical benchmarks for steel, aluminum and chemicals. For components supplied by third parties, they should also include information on the way they intend to secure manufacturing emission reductions (e.g. through contracts with auto parts manufacturers that are also SBTi compliant).

[21] Hydrogen's GWP is not direct, rather, chemical reactions induced by atmospheric hydrogen change the abundance of the GHGs methane, ozone, and stratospheric water vapor, as well as aerosols. The atmospheric science attributing a 100-year GWP to molecular hydrogen is relatively new, and not yet been integrated in the GHG Protocol documentation listing GWPs for other climate forcing gases.

APPENDIX L: WELL-TO-TANK EMISSIONS

The WTT methodology and default values outlined below aim to incorporate the most relevant elements for the effective decarbonization of the value chain and beyond value chain mitigation considerations.

Fuel-specific defaults and emission calculations are required to ensure that the operational emissions of vehicles are properly estimated and that reductions in fuel emission intensity are incentivized.

Fuel-specific emission factors over vehicle lifetimes shall also be estimated, under the SBTi Automotive Sector Net-Zero Standard, at the level of global macro-regions, to align with compliance requirements.

WTT emission factors shall be assessed for energy production pathways, differentiating between:

- Oil- and gas-based fuels, for which the assessment considers fuel types, and takes a conservative approach.
- Biofuels, which can be based on representative pathways and related market penetration data, for reasons due to both data availability and practical feasibility.
- Electricity, at the country level, as disaggregated data exist and are regularly updated, due to the potential for rapid improvements in emission intensity as the share of renewables and nuclear increases.
- Hydrogen, other RFNBOs and RCFs, at the fuel pathway level, since there are still very limited volumes of low-emission hydrogen, and of other RFNBO and RCF production, meaning that making further differentiation risks to be unnecessarily cumbersome. Further differentiation may become necessary if greater volumes of low-emission hydrogen, RFNBOs or RCFs become available in the road fuel pool.

Methodological approaches and system boundaries shall align with those of the WTT emission assessment used in GREET and the JEC analyses, for oil-based and biofuels, and with the EU delegated act on a methodology for renewable fuels of non-biological origin for hydrogen, other RFNBOs and RCFs (European Union, 2023), with two exceptions:

1. *The emission intensity of electricity* used to produce hydrogen, RFNBOs and RCFs will use an expanded system boundary, consistent with electricity accounting as described in greater detail below. Electricity emissions calculations are to include emissions associated with fuel provision (e.g., coal and natural gas production and processing) and embodied in electricity generation infrastructures (including PV solar, wind, and hydropower). These emissions are included due to materiality (i.e., these emissions contribute substantially to the emission factor of hydrogen, RFNBOs and RCFs), and consistency with emissions accounting for the direct use of electricity.
2. Emissions calculations account for *atmospheric leakage of hydrogen* across all stages of the supply chain (i.e., production, liquefaction/compression, transport, and dispensing). Default values are provided in the section on hydrogen, and automakers can use lower values if they provide sufficient disclosure/documentation of lower leakage rates.

Previously developed tools may be used for reporting and compliance regarding direct emissions, if the methodological approach and the system boundaries are aligned and enable transparency through sufficient disclosure for third-party verification.

Default WTT emission profiles of different fuels can be combined with IEA APS market developments. The use of alternative (lower) WTT emission factors for fuel supplies is possible, including for a subset of vehicle sales/registrations, as long as automakers and/or their energy suppliers provide transparent information to back them, with sufficient documentation to enable third-party verification of their claims, including compliance with the methodological requirements outlined in the Standard.[22]

The following sections outline the methodologies for assessing WTT emission factors for each major automotive fuel technologies covered by the SBTi Automotive Sector Net-Zero Standard, aligned with the energy production pathways listed above.

Oil- and gas-derived fuels

There is significant regional variability in the emission intensity of oil extraction and refining, leading to a high degree of variability in the emission factors of oil- and gas-derived transport fuels (see, for example, Science, 2018, Nature Climate Change, 2020). There are also different methodologies to estimate and attribute emissions across the oil product slate (e.g., PRELIM, OPGEE).

Several IEA reports outline the ways that the oil and gas industry could reduce the emission intensity of its operations. The report The Oil and Gas Industry in Net-Zero Transitions shows how ceasing investments in exploration and exploitation of new oil and gas resources and shifting investments to capturing and monetizing currently leaked or flared methane resources, together with investments in electrification and efficiency of extraction and refining operations, shifting to low-emission hydrogen production, and CCUS, could reduce the emission intensity of oil and gas, thereby lowering the WTT emission factor of oil- and gas-derived road transport fuels. IEA analysis suggests that approximately 40% of current upstream emissions (i.e., about 7-8% of WTW emissions) could be cut at no net cost, primarily by capturing and selling leaked or flared methane.

However, IEA and others' efforts to track methane show a wide and growing disconnect between trends in methane emissions and capture rates that would be required for the sector to contribute to a Paris-aligned pathway, let alone to take advantage of methane capture opportunities with a net negative cost.

It is challenging to account for these complexities in globally differentiated modelling:

- Benchmarking a regional representative emission factor for each transport fuel is subject to significant uncertainty, due to shifting weights of country-level consumption in a global market for crude oil and refined automotive fuels and the difficulties in benchmarking and then accounting for potential changes in oil and oil products trade.

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[22] Note that the methodology used in this Standard strives for maximum alignment with existing tools, established practices and adopted regulations. However, emissions profiles and sustainability considerations are unique to each fuel/energy vector, so it is important to manage trade-offs between fuel-specific methods and resolution and fair treatment across all fuels.

- Projecting how the emission factor of oil products might change over time in global scenario modeling is subject to a high degree of uncertainty.

For simplicity, and to focus company reporting and investment on the need to rapidly diversify the road transport fuel mix away from fossil fuels, this Standard adopts representative emission factors for fossil-based automotive fuels. These are shown in Table D1 in Annex D, and are derived as the simple average between assessments by the GREET team in the US and the JEC team in the EU. They are benchmarked in the base year (2023) on a global point estimate, based primarily on (Cai et al., 2022).

This is in line with the choice not to include oil- and gas-based fuels among the options whose life-cycle emissions can be assessed using IEA APS low-emission technology projections. If merited by notable improvements in the emission intensity of producing and refining or processing these fuels, the point values may be revisited in a future update of the SBTi Automotive Sector Net-Zero Standard (e.g., in the 2030s). In this context, it is important to flag that WTW emissions from fossil energy pathways meeting the 65% reduction threshold (in terms of WTW g CO_2e/km) adopted for biofuels and RFNBOs in this Standard would be extremely hard to meet except through blending higher shares of low-emission, sustainably produced, biofuels and/or e-fuels (RFNBOs or RCFs), as most of the WTW emissions result from combustion (i.e., the TTW phase).

As upstream emission reductions vary across regions, based on trade, and may vary even more (e.g., based on regulatory requirements) in the future, and as this same topic is covered in the Oil & Gas Standard, the SBTi Automotive Sector Net-Zero Standard also leaves open an option to increase regional granularity in future developments. Regional differentiations would also need safeguards to prevent using changes in their market shares across regions, as there are regional differences in technology adoption, as an SBTi compliance strategy.

Future refinements may also be based on better representation of different pathways, using inputs from the SBTi Oil & Gas Standard or using data on actual emission intensities of fuels (including regional differences), if these data are publicly available.

Biofuels

As for fossil-derived fuels, global biofuel emission factor defaults excluding ILUC are based primarily on (Cai et al., 2022), which builds on assessments by the GREET team in the US and the JEC team in the EU. In cases of pathways not included in both assessments, the default adopts values directly from GREET or JEC. In all other instances, this Standard adopts default values from the ICCT Roadmap model (ICCT, forthcoming).

For global point emission factor values attributable to direct and ILUC, WTT emissions defaults are adapted from CORSIA (CORSIA 2022a, 2022b). This is the only available international approach capable of bringing together different perspectives by the US and the EU. Global feedstock-conversion pathway (henceforth “fuel pathway”) default ILUC values are adjusted based on differences in emission factors between fuel pathway specific biojet kerosene production and automotive-grade ethanol and biodiesel, with the aim to reflect differences in terms of energy efficiency of the conversion of the primary feedstocks[23].

For pathways based on waste oils and or fats, indirect emissions are highly sensitive to what would occur if the waste oils and or fats are already in use as feedstocks for other purposes (e.g. animal feed, pet food, other uses in the oleochemicals industry, for animal fats), (i.e., which product would substitute them). This is especially relevant in cases of rapid changes of demand, leading to supply imbalances. Existing estimates of impacts of indirect emissions from the use of waste oils and or fats span across a wide range of results, from 13 g CO_2e/MJ to more than 140 g CO_2e/MJ (O'Malley et al., 2021, Malins, 2023), with more frequent values between 20 and 80 g CO_2e/MJ, in the case of animal fats (Malins, 2023) and result that depend significantly on sourcing approaches.

To prevent undesired indirect effects, as well as the risk of fraud (e.g., from downgrading other oils and fats to waste categories), the European Renewable Energy Directive caps used cooking oil and animal fats at 1.7% of the energy content of transport fuels supplied for consumption or use on the market (European Union, 2018, European Union, 2023). Considering that these precautions are well grounded, and also that the CORSIA ILUC emission defaults do not provide sufficient tools to manage risks associated with strong increases of demand of biofuels from waste oils and animal fats, this Standard considers the CORSIA ILUC value for used cooking oil only applicable for up to 2% of the fuel used by road vehicles. Beyond this percentage, a default indirect emission value of 50 g CO_2e/MJ (informed by Malins, 2023) applies, unless lower indirect impacts can be demonstrated and disclosed in a way that enables third-party verification. This Standard also considers that other waste oils and fats are subject to the same default values and limitations as used cooking oil.

A similar approach is followed for the negative emissions credited by (Cai et al., 2022) to biomethane, only considered applicable to shares of energy use up to 3% of the fuel used by road vehicles. This is based on shares of biomethane use between 20% and 33% (in IEA, 2020), a total demand of 13 EJ in ambitious IEA scenarios (APS, NZE), (from IEA, 2024), leading to biomethane consumption ranging from 2.5 to 4.3 EJ, which corresponds to 2% to 3.5% of the total energy demand in transport of 2023. This is also aligned with the following considerations: a current focus of use in electricity generation next to agricultural facilities where it is produced, competing demand for biomethane in industry and buildings (where the IEA APS and NZE scenarios anyway focus its use) and infrastructure-related challenges to enable large-scale deliveries of biomethane to road transport vehicles. Beyond the 3%, a default emission value of 13 g CO_2e/MJ, corresponding to the value excluding credits and land use change effects for compressed methane in a medium scenario, including new biomethane plants, (based on Noussan et al., 2024).

The European Renewable Energy Directive also excludes the possibility to rely on feedstocks produced from land with high biodiversity value and land with high carbon stock (including wetlands, continuously forested land and peatlands), as their inclusion would not enable the achievement of low ILUC values (European Union, 2018, European Union, 2023).

[23] The approach to ILUC factors will be assessed after the first public consultation and may be revised to adopt a risk-based approach (which would result in the exclusion of the feedstocks that are also excluded in the RED III).

Considering that these precautions are well grounded, this Standard also considers these restrictions, for woody biomass, as well as food and feed crops, excluding any feedstock sourced from land with high biodiversity value and land with high-carbon stock from what can qualify for the use of CORSIA-based ILUC defaults.

The choice of ILUC values from CORSIA is combined with additional limitations for pathways based on waste oils and the exclusion of feedstocks from land with high biodiversity value and land with high-carbon stock (including wetlands, continuously forested land, and peatlands). The inclusion of these latter sustainability criteria enables this Standard to effectively adopt a risk-based approach,[24] based on available international agreements and evidence, while at the same time limiting the exclusion of specific feedstocks.[25]

This Standard is therefore primarily based on global benchmarks for the emission factor of biofuels at the resolution of pathway-feedstock combinations (as summarized in Table D2 in Annex D). Notwithstanding this consideration, automakers can claim different emission factors for biofuel supplies than the defaults when assessing life-cycle emissions of their vehicle sales. To do so, they still need to provide transparent information, sufficiently detailed to enable third-party verification of their claims.

Carbon intensities of different biofuel production pathways should be paired with national or regional consumption-based data (in Brazil, South America, North America, Europe, China, India, Indonesia, and other countries) by pathway-feedstock combination, and accounting for blend shares in the gasoline, diesel, and natural gas automotive fuel pools. Key data sources allowing this assessment include the annual (OECD/FAO Agricultural Outlooks, 2024), the (USDA GAIN / Biofuels Annual country/region reports, 2024) and the (IEA Renewable energy market reports, 2024).

As this Standard requires a minimum abatement capacity of 65% in terms of WTW g CO_2e/km for any powertrain-energy technology to be effectively accounted using IEA APS energy technology shares, biofuel options that qualify are likely to be restricted to those with the lowest WTW emissions when used in ICE powertrains. Use in hybrids and plug-in hybrids can enable the qualification of biofuels with lower WTW abatement capacity.

In the absence of a clear case showing the alignment with the 65% g CO_2e/km abatement requirement for fuel and powertrain pathways (including due to limited data availability in the IEA APS regarding the emission profiles of different biofuels), companies need to provide demonstrated evidence (with sufficient details to enable third-party verification) of which volumes of biofuel supplies can meet, in combination with the relevant powertrain configurations, the 65% WTW g CO_2e/km threshold.

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[24] A risk-based approach is what has been indicated as the preferred solution in the context of the IMO negotiations (IMO, 2024). This approach has also been flagged by the IEA as recommended practice (IEA, 2024a and 2024b).

[25] In this regard, it is important to recall that the approach adopted by the EU Renewable Directive (European Union, 2018, European Union, 2023) also introduces specific feedstock-related restrictions, excluding food and feed crops, intermediate crops, palm fatty acid distillate, palm and soy-derived materials, soap stock and its derivatives.

Similar to the case of O&G based fuels, if merited by notable improvements in the EI of producing and refining or processing biofuels, the point values can be revisited in a future update of the SBTi Automotive Sector Net-Zero Standard (e.g., in the 2030s).

Electricity

A fair and harmonized comparison across all energy vectors, including electricity, requires accounting for likely energy efficiency advantages of EVs (and BEVs in particular), on one hand, and for all emissions and energetic efficiency losses incurred in EV manufacture, electricity production, transport, distribution and use on the other. Similar considerations apply also to RFNBOs derived from electrolysis. Consideration of these aspects is done, for instance, in the ICCT's authoritative assessment of life-cycle emissions across powertrain-fuel combinations for passenger cars (Bieker, 2021).

Estimates of the annual average direct operational CO_2e/kWh of primary electricity generation are readily available at a country level (e.g., from EMBER). However, these data do not account for the following emissions:

- Upstream "fuel cycle" GHG emissions, incurred in extracting, processing, and transporting fossil fuels or radioactive elements used to fuel in fossil- or nuclear-thermal plants, respectively). These emissions are available from a data product assessing electricity lifecycle emissions factors (IEA, 2024).
- Embodied GHG emissions, incurred when constructing, maintaining, decommissioning all electricity generation technologies (and spread across the average assumed operational lifetime of the facility). These emissions are available from a data product assessing electricity lifecycle emissions factors (IEA, 2024) and are sourced from the central tendency values of the (US National Renewable Energy Laboratory (NREL) harmonization project, 2021).
- Transmission and distribution losses, which shall be accounted for in the case of EVs (as most assumed losses between the charging point and the EV).

Facility electricity own-use is also accounted for, either based on assumed averages or country-level data.

The SBTi Automotive Sector Net-Zero Standard considers benchmark values for WTT emission factors of electricity based on EMBER data, with inclusion of the above three aspects. It also considers the same approach for the way electricity-related emission factors shall be accounted for, in compliance. Automakers can claim different emission factors for electricity supplies than the defaults when assessing life-cycle emissions of their vehicle sales. To do so, they still need to provide transparent information, sufficiently detailed to enable third-party verification of their claims.

Hydrogen, carbon-bearing RFNBOs, RCFs and other synthetic fuels

WTT emissions from RFNBOs and RCFs (including hydrogen and its derivatives) shall be considered, in the absence of demonstrated evidence, based on incumbent fossil-based production. The SBTi Automotive Sector Net-Zero Standard therefore requires the use of the default values shown in Table D3 in Annex D. These are based on unabated steam methane reforming for hydrogen, and they are set as the same as those used for fossil fuels for carbon-bearing RFNBOs and RCFs.

Automakers can use IEA APS energy technology developments to account for future emission intensity by powertrain-energy pairs (e.g., fuel cell and hydrogen, ICEs and hydrogen, HEVs and hydrogen, PHEVs and hydrogen and electricity, ICE and synthetic e-fuels, either as carbon-bearing RFNBOs or as RCFs, HEVs and synthetic e-fuels, PHEVs and synthetic e-fuels), as in the case of biofuels. This is feasible in the presence of sufficiently clear data availability in the IEA APS regarding the emission profiles of different hydrogen, RFNBO and RCF pathways.

In cases where automakers have contracts, e.g., through PPAs for low-emission hydrogen, and are able to demonstrate that some of their vehicles are operating on RFNBO and or RCF supplies that have a lower emission intensity than the benchmark value in a given year, automakers can provide demonstrated evidence (with sufficient details to enable third-party verification) of the volumes and or shares of RFNBO and RCF being used, as well as its emission intensity in WTW g CO_2e/MJ.

Additional conditions require the fulfilment of additionality and temporal correlation (including through power purchase agreements) and the disclosure of sufficient information about them to enable third-party verification. This is in line with the provisions considered in the European Union for the consideration of RFNBOs in the context of the Renewable Energy Directive (European Union, 2023).

For RCFs, this Standard allows the full accounting of life-cycle emission savings on the fuel side, before 2040. After 2040, it requires allocating savings between fuels and the upstream source of carbon (e.g. the industrial complex supplying it). This is again in line with the provisions considered in the European Union, based on the consideration that the origin of carbon used for the production of RFNBOs and RCFs is not relevant for determining emission savings of such fuels in the short term, as currently many carbon sources are available and can be captured while making progress on decarbonization (European Union, 2023).

Table L1 provides selected estimates of the carbon intensity of electricity that could be compatible with these conditions, for hydrogen, carbon-bearing RFNBOs produced through the synthesis of hydrogen and carbon from direct air capture, RCFs (these are labeled as “before 2040” and “after 2040”, in this last case the table shows that RCFs do not meet the 65% WTW requirement).

Table L1. Carbon intensity of electricity that could enable (or not) compatibility with the 65% WTW g CO_2e/km minimum emission reduction threshold to use IEA APS technology shares

Pathway	Carbon intensity of electricity (g CO_2/kWh)
Threshold for hydrogen and ICE	70
Threshold for hydrogen and HEV	90
Threshold for hydrogen and FCEV	130
Threshold for carbon-bearing RFNBOs (from DAC) and ICE	43
Threshold for carbon-bearing RFNBOs (from DAC) and HEV	55
Threshold for RCFs (before 2040) and ICE	52

Threshold RCFs before 2040 and HEV	66
Threshold for RCFs, after 2040	Not feasible

Sources: Based on information retrieved from Soler et al., (2022), Bothe et al., (2021), Deutz and Bardow (2021) and IEA (2020), assuming 1.6 MJ of electricity requirements for the production of 1 MJ of hydrogen, 2.13 MJ/MJ of RCFs and 2.56 MJ/MJ of RFNBOs.

Table D4 in Annex D provides estimates of the carbon intensity of hydrogen, RFNBOs and RCFs (before and after 2040), for different carbon intensities of electricity generation.

The tables reflect a simplification that considers 1.6 MJ of electricity requirements for the production of 1 MJ of hydrogen, 2.13 MJ/MJ for RCFs and 2.56 MJ/MJ of RFNBOs, based on information retrieved from Soler et al., (2022), Bothe et al., (2021), Deutz and Bardow (2021) and IEA (2020), with electricity covering all energy input needs. They also exclude fugitive emissions of hydrogen and other GHGs.

Automakers may claim different emission factors for hydrogen, carbon-bearing RFNBO and RCF supplies than the defaults when assessing life-cycle emissions of their vehicle sales. To do so, they still need to provide transparent information with sufficient detail to enable third-party verification of their claims.

This may take place thanks to contractual arrangements with low-emission fuel suppliers, provided the latter disclose information regarding the carbon intensity of their fuels, in line with the methodological approach outlined in this Standard and with sufficient detail to enable third-party verification.

The 65% reduction in WTW g CO_2e/km is also applicable to hydrogen and synthetic fuels derived from fossil energy resources, provided this aligns with GHG emission abatement thresholds. To this end, it is crucial to ensure that hydrogen and synthetic fuel production are obtained from best practices, especially for ICE vehicles.

For example, only values for specific production pathways, at the low-end of the range outlined in Romano et al., (2022) (and well below the range outlined in Howarth and Jacobson, (2021) would qualify, in the case of hydrogen ICEVs, for the 65% WTW g CO_2e/km threshold considered in this Standard.

APPENDIX M: VEHICLE MANUFACTURING AND EOL EMISSIONS

Assessing manufacturing emissions and EoL emissions

The recommended approach to vehicle manufacturing emissions is based on accounting approaches compatible with the methodology adopted by the GREET-2 model.

The GREET-2 approach includes the following steps, also described in Burnham et al., 2006:

1. Estimation of the mass of vehicle components.
2. Assessment of the material composition (i.e., breakdown into steel, aluminum, iron, plastic, rubber, and any other materials) of the component mass.
3. For components that are subject to replacement during a vehicle's lifetime (e.g., batteries, tires, and various vehicle fluids), assessment of replacement schedules.
4. Assessment of the energy used from raw material recovery to vehicle assembly and related GHG emissions and assessment of the energy required and GHG emissions generated during recycling of scrap materials back into original materials for reuse.
5. Assessment of the energy use and emissions associated with component (and—where relevant—vehicle) assembly from the energy efficiency of assembly plants and life-cycle analyses of paint manufacturing and the painting process.
6. Assessment of the energy required for dismantling components (and—where relevant—vehicles) for disposal or recycling

The energy use of materials that are recycled and later used in a vehicle is part of what is listed under points 2 (for recycled materials used as inputs) and 4 (for the energy used during the processes from raw material recovery to vehicle assembly).

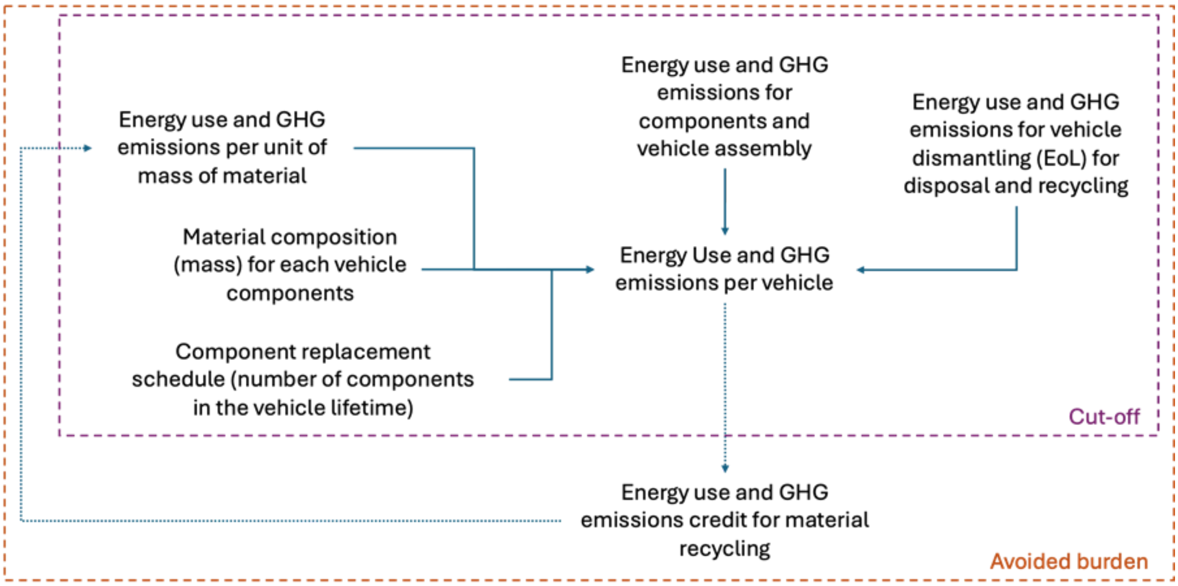
This is consistent with a system boundary characterized by the so-called "cut-off" approach, which does not account for impacts (or avoided impacts) beyond those directly related with the vehicle life. In the context of decarbonization, it comes with incentives to secure supplies of recycled materials (e.g. scrap steel, aluminum or plastics), irrespective of the sector supplying them, due to lower embedded carbon in their manufacturing processes

There are currently significant efforts ongoing in the European Union and at the United Nations, in the framework of the World forum for the harmonisation of vehicle regulations, to develop an internationally agreed methodology for the calculation of aggregate indicator emissions for road vehicles. Alternatives being considered share the same fundamental basis of vehicle-cycle emission accounting but differ from the cut-off approach, as outlined in Box 2. Considering the relevance of these efforts, this Standard remains open, in further developments, to the alignment with this multilaterally agreed approach.

Box 2. Differences between cut-off, avoided burden and Circular Footprint Formula (CFF) in life-cycle assessments

The cut-off life-cycle assessment approach excludes the attribution of lower GHG emissions for EoL management approaches that enable recycling of materials, in the form of credits, under the assumption that they replace the same quantity of virgin materials. This crediting system, instead, is what is integrated into the so-called “avoided burden” approach. In doing so, the avoided burden approach incentivises material recycling within the specific sector for which the life-cycle assessment is performed. Both approaches are illustrated in Figure M1.

Figure M1. Graphical representation of energy and GHG emission tracking in the vehicle-cycle, with the cut-off and avoided-burden approaches

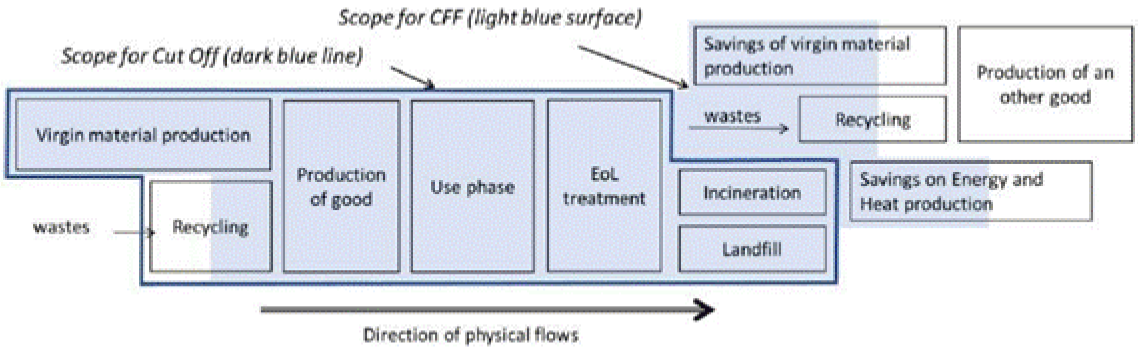


A third approach, based on the CFF, combines the cut-off and the avoided burden approaches, giving greater weight to the cutoff approach in cases where there is high supply of recyclable materials and a low demand, and to the avoided burden in cases where there is a low supply of recyclable materials and a high demand (Ardente et al., 2023), as illustrated graphically in in Figure M2.

Currently there is no consensus on the definitive approach to recycled content allocation, and life-cycle assessment calculation tools tend to enable all of these, since they are all grounded on the same fundamental basis of vehicle-cycle emission accounting (i.e., the sum of emissions embedded in the materials, also accounting for recycling, and emissions resulting from assembly and EoL dismantling and disposal phases).

A graphical representation of the cut-off approach, as opposed to the CFF approach, considering a 50/50 split between cut-off and avoided-burden, is shown in Figure M2.

Figure M2. Graphical representation of energy and GHG emission tracking in the vehicle-cycle, with the cut-off and CFF approaches



Source: (PFA, 2022)

Components covered in GREET-2 include vehicle body (including primary vehicle structure, closure panels, impact bars, energy absorbers, sealers, door modules), powertrain, transmission, chassis (incuding wheels, tires, steering modules, electrical signals), electric-drive and battery systems and fluids (including engine oils, power steering fluid, brake fluid, transmission fluid, powertrain coolant, windshield fluid, and adhesives) (Burnham et al., 2006).

Materials whose production processes are part of the scope of GREET-2 include steel, cast iron, aluminum (divided in wrought and cast aluminum), copper, zinc, magnesium, glass, plastics, rubber, fluids, battery materials (e.g., cathode materials, precursors, electrolytes, anode materials), fuel cell materials (including membrane, hardware materials, platinum group metals) and other materials (Burnham et al., 2006, Dunn et al., 2015 and Dai et al., 2018).

The aggregated assessment of GHG emissions shall consider the bill of materials needed for the components (and—where relevant—the vehicles) sold at different points in time,[26] as well as the GHG emission intensities by material and those imputable to assembly and dismantling for disposal and recycling (EoL) of the same components (and—where relevant—the same vehicles).[27] GREET-2 also integrates default assumptions on part durability, for parts whose lifetime is lower than the lifetime of the vehicle. These lifetimes shall also be considered by default for the application of this Standard, except for cases in which specific corrections are applicable, as detailed in Annex I.

[26] The GREET-2 model (U.S. DOE, 2025; ANL, n.d.) and an EU-specific study (European Commission, 2020) provide bills of materials and GHG emissions intensities for different vehicle categories, including passenger cars of different sizes, LCVs, buses, medium and heavy duty trucks. An assessment published by ITF in 2020 (ITF, 2020) and updated in 2024 (ITF, 2024) covers a wide range of passenger transport modes, including bikes, e-bikes, scooters/mopeds (ICE, EV), cars, large cars, and buses. The ICCT also carried out a global assessment comparing cars (ICCT, 2021), and regional assessments for other vehicle categories: buses and trucks in the EU (ICCT, 2023); buses in Latin America (ICCT, 2024), and, trucks in India (ICCT, 2024), 2-wheelers in India (ICCT, 2021) and Indonesia (ICCT, 2023).
[27] As this Standard requires forward-looking assessments and it targets GHG emission intensities, this requires information relative to expected vehicle weight developments.

The materials shall be mapped into IEA material groups (aluminum, chemicals and steel) as indicated in Table M1, based on the bills of materials, to determine, in combination with IEA NZE scenario carbon intensities by material group, the carbon intensities associated with material production that define SBTi compliance at different points in time (e.g., 2030, 2035, 2040).

Reductions in emissions attributable to assembly and dismantling for disposal and recycling (EoL) shall follow absolute trends in carbon intensity reductions of the industrial energy use per capita in the IEA NZE scenario, as in the case of materials other than aluminum, chemicals and steel.[28]

Table M1. Mapping of GREET-2 materials into IEA material groups

IEA material group	GREET-2 materials
Aluminum	Aluminum (wrought and cast aluminum)
Chemicals	Plastics, rubber
Steel	Cast iron, steel
Other	Copper, zinc, magnesium, glass, nickel Battery materials other than aluminum, fuel cell materials Fluids

Life-cycle assessment tools may be used to assess vehicle-cycle GHG emissions if the methodology and system boundaries are consistent with those of GREET-2 and if they enable transparency through the disclosure of sufficient details to enable third-party verification. Similar considerations apply for systems of tools enabling the pass-through of life-cycle assessment-related information (such as mass by vehicle categories, energy and GHG emissions for assembly and dismantling) relative to components, for vehicle aggregated GHG emission assessment.

Switching to a g CO_2/vkm metric

Vehicle-cycle GHG emissions shall be assessed based on the same functional unit used for fuel-cycle emissions, lifetime vkm. To do so, it is necessary to divide GHG emission intensities per vehicle, assessed as detailed above, by the relevant lifetime vkm.

Table D5 in Annex D details values to be used for different vehicle categories to perform this conversion. These values are considered globally applicable, based on the following considerations:

- There is no robust and reliable publicly accessible global dataset that reports reliable mileages globally (let alone by vehicle category).
- Reliable/robust estimates are available for some advanced economies, but even here, there could be inconsistencies or issues.
- In practice, there is important heterogeneity in lifetime mileages within the vehicle categories used in the pathways. For example, between taxis and private cars, urban

[28] While these are not carbon intensity emissions, but absolute values, they have been considered as the best available driver to be considered, due to the absence of corresponding functional units representing the relevant activity parameter (the denominator) in a ratio defining a carbon intensity.

buses and coaches, and trucks used for regional deliveries or long haul deliveries. There are also differences across powertrains.

- Second-hand vehicle trade also affects lifetime-km estimates.
- Here are matching indications related with average travel speed and the travel time budget theory, suggesting that it there are reasons to expect greater annual mileages in advanced economies, which tend to be characterized by higher average travel speed (see IMF, 2022), but it is possible that lifetime mileages are still higher in these regions, due to longer lifetimes in EMDEs (and despite lower annual mileages in EMDEs).

APPENDIX N: METHODOLOGICAL CONSIDERATIONS ON THE ACCOUNTING OF ENERGY EFFICIENCY RATIOS FOR LOW-EMISSION VEHICLES

Annex F sets out how companies shall calculate their low-emission vehicle (or components/parts) sales share for each vehicle category, according to the methodology outlined for aggregated emission intensity reduction (AMSS-C2). This condition applies to all fuel and powertrain technologies, using sales-weighted averages across gasoline, diesel, and natural gas ICEs, to derive region- and vehicle-category specific emissions, as detailed in Table C19 of Annex C for ICEVs.

The 65% reduction is informed by life-cycle emission assessments from (Bieker, 2021, 2022) for cars, (Mera and Bieker, 2023) for two wheelers, (O'Connel et al., 2023) for trucks and buses and by the consideration that both BEV and FCEV cars can achieve a level of life-cycle GHG emission abatement of 70%, in comparison with ICEVs using petroleum fuels.

Savings are greater for BEVs and FCEVs using primary low-emission renewable energy in cases characterized by lower relative shares of "vehicle-cycle" emissions, due to low material requirements (2-3 wheelers) and high relevance, in the ICEV with oil-based fuel benchmark, of GHG emissions from the "fuel-cycle".

A vehicle's contribution to the low-emission vehicle sales share (or that of its components or parts) shall depend on its relative WTW low-emission energy efficiency of the vehicle (i.e., its operational efficiency, also factoring in energy production), in comparison to a reference BEV of the same type using primary renewable electricity of the same type, giving lower weight to vehicles with poorer energy efficiency.

Table F1 in Annex F contains details on vehicle powertrains and related energy efficiency ratios. The values are informed by energy efficiency assessments for RFNBOs and electricity from (Malins, 2022), (T&E, 2022), (Bieker, 2021, 2022), and (Trinomics, 2023).

Energy efficiency ratios are not differentiated by vehicle category in Table F1 in Annex F and they also consider losses occurring for the production of advanced low-emission biofuels and diesel/gasoline RFNBO substitutes as having similar magnitudes. Future updates of the SBTi Automotive Sector Net-Zero Standard may include further differentiations. These updates may also consider updates to the values in Table F1 in Annex F resulting from a switch to life-cycle energy efficiency accounting rather than based on WTW/operational energy efficiency.

The accounting for PHEVs in Annex F is informed by (Bieker et al., 2022).

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