SCIENCE BASED TARGETS

DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

CONSULTATION DRAFT

CHEMICALS SECTOR TARGET-SETTING CRITERIA SUPPLEMENTAL DATA MEMORANDUM

2nd PUBLIC CONSULTATION DRAFT

November 2024

Introduction

This document provides a summary of how the Science Based Targets initiative (SBTi) and Guidehouse have developed the pathways used for target-setting methods in the Chemicals Sector Target-Setting Criteria. Included in this document is development background on the following pathways and data:

- Emissions scenario selection for setting primary chemical Sectoral Decarbonization Approach (SDA) pathways.
    - Direct emissions, electricity and production values for the total chemicals sector, and for ammonia, methanol and high value chemicals (HVCs). These values have been used to develop the SDA pathways for each primary chemical, which are based on an emissions intensity pathway of combined scope 1 and 2 emissions per unit of production activity from 2020 to 2050. The International Energy Agency (IEA) Net Zero by 2050 (IEA, 2021a) Scenario forms the basis of our calculations, and this has been supplemented by other IEA sources such as the World Energy Outlook Report (IEA, 2023a), the Net Zero Roadmap: A Global Pathway to Keep the 1.5°C Goal in Reach (IEA, 2023b) and the Ammonia Technology Roadmap Report (IEA, 2021b).
- The development of the pathway for N_2O emissions in scope 3 category 11 for the use-phase of sold nitrogen fertilizers.
- The development of the target-setting method for emissions of N_2O from nitric acid production.
- The development of the target-setting method for the sourcing of alternative sources of carbon as feedstocks.

About the SBTi

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

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

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

Note on Consultation Draft

This document has been prepared for the purpose of publication for public consultation. The content, format and/or design of the document may be subject to significant changes due to the outcomes of the public consultation, new data, and potential changes in the SBTi’s format for sector-specific resources.

Disclaimer

These criteria are issued by the SBTi. Any feedback on the SBTi resources can be submitted to info@sciencebasedtargets.org for consideration of the SBTi.

Emissions scenario selection for setting primary chemicals SDA pathways

The SBTi has developed 1.5°C-aligned emissions intensity convergence pathways for ammonia, methanol and HVCs, which together constitute approximately 70% of direct emissions from the chemicals sector. Emissions scenarios that are granular at the chemical product level were needed to establish the chemical-specific emissions intensity convergence pathways. Specifically, projections of emissions, electricity consumption, and product demand to 2050 that are consistent with a 1.5°C emissions budget were needed for each chemical group. The SBTi researched many scenarios that include data for the chemicals sector as a part of the larger model framework or as the primary sectoral focus of the model, to assess the availability and suitability of the data for developing pathways.

Based on this research, the SBTi chose to use data from the IEA's Net Zero by 2050 (NZE) report (IEA, 2021b) and other related publications to develop the chemical-specific pathways. This IEA model was chosen for the following primary reasons:

- The IEA's NZE is a scenario produced by the IEA's Global Energy and Climate model, which includes detailed "technology-rich" modelling for primary chemicals, which includes both emissions, electricity consumption, and demand projections to 2050.
- The IEA has published the data from the 2021 version of the NZE scenario in various topic-specific reports, such as the *Global Hydrogen Review*, which provide transparency into the underlying model results.
- The IEA's NZE scenario has been used as the basis for sector-specific emissions intensity convergence pathways in existing SBTi sectoral guidance, including guidance for the cement and iron and steel sectors. This ensures consistency in the modelling approach across sectoral resources.
- The SBTi has established CO_2 emissions budgets to 2050 at the sectoral level, which were published in the paper *Pathways to Net-Zero: SBTi Technical Summary* (SBTi, 2021). These budgets were developed based on the 2021 IEA NZE Report, therefore using this model for chemical-specific emissions intensity pathways ensures consistency with the upper bound of the sectoral CO_2 budget.
- The SBTi has included the IEA NZE as part of the envelope of scenarios that have been used to develop our cross-sector emissions reduction pathway.
- The IEA is an internationally recognized research organization with a high level of credibility within the chemicals sector and broader climate community.

Summary of data used to develop SDA pathways for each primary chemical

CATEGORY	PARAMETER	BASELINE 2020	2030	2040	2050
Whole sector	Scope 1 emissions (Gt CO_2)	1.296	1.199	0.654	0.066
	Electricity (EJ)	0.66	1.6		
	Production - primary chemicals (Mt)	529	641	686	688
Ammonia	Scope 1 emissions (Gt CO_2)	0.450	0.340	0.145	0.020
	Electricity (EJ)	0.29	0.72	2.52	4.32
	Production (Mt)	185	205	220	230
	Scope 2 emissions (Gt CO_2)	0.033	0.020	0.013	0.001
	Total scope 1 and 2 emissions (Gt CO_2)	0.483	0.360	0.158	0.021
	Emissions intensity (Mt CO_2 / Mt ammonia)	**2.61**	**1.76**	**0.72**	**0.09**
Methanol	Scope 1 emissions (Gt CO_2)	0.222	0.222	0.134	0.012
	Electricity (EJ)	0.29	0.72	1.26	1.80
	Production (Mt)	99	127	136	133
	Scope 2 emissions (Gt CO_2)	0.033	0.020	0.006	0.000
	Total scope 1 and 2 emissions (Gt CO_2)	0.255	0.242	0.140	0.012
	Emissions intensity (Mt CO_2 / Mt methanol)	**2.59**	**1.91**	**1.03**	**0.09**
HVCs	Scope 1 emissions (Gt CO_2)	0.251	0.251	0.151	0.014
	Electricity (EJ)	0.08	0.16	0.30	0.58
	Production (Mt)	245	309	330	325
	Scope 2 emissions (Gt CO_2)	0.010	0.004	0.002	0.000
	Total Scope 1 and 2 emissions (Gt CO_2)	0.261	0.255	0.153	0.014
	Emissions intensity (Mt CO_2 / Mt HVCs)	**1.06**	**0.83**	**0.46**	**0.04**

Table legend:

- **Green** – Values provided by IEA in published reports.
- **Amber** – Values not directly provided, but calculated from IEA values in published reports.
- **Blue** – Values interpolated or estimated from already reported IEA values for other year supplemented with other sources where noted.
- **No color** – Values directly calculated using the above data.

Scope 1 and 2 data calculation process

The primary basis for the primary chemicals scope 1 CO_2 emissions and production data described below is the IEA's 2021 Net Zero by 2050 report (IEA, 2021a), and certain accompanying reports. The IEA has subsequently published data from newer outputs of the NZE scenario in their World Energy Outlook 2023 Report (IEA, 2023a) and Net Zero Roadmap: A Global Pathway to Keep the 1.5°C Goal in Reach Report (IEA, 2023b). The SBTi has chosen to use emissions and production data from the 2021 NZE Report (IEA, 2021a) and not the more recent reports because:

- Some data that was available in the 2021 NZE (IEA, 2021a) and accompanying reports is not available in the 2023 reports (IEA, 2023b), specifically data from the IEA's 2021 Ammonia Technology Roadmap (ATR) (IEA, 2021b) that has been used to inform the pathways for both ammonia and other primary chemicals.

- The SBTi has chosen not to partially update the data based on what is available in the 2023 NZE reports (IEA, 2023b), as this would introduce inconsistencies within pathways and between pathways.

- The chemical sector production data in the 2023 NZE Report (IEA, 2023b) includes production from refineries, which are outside the scope of our pathways.

- Based on differences in the available data, modelled projections for scope 1 CO_2 emissions from primary chemicals between the published 2021 NZE Report (IEA, 2021a) and the 2023 Report (IEA, 2023b) are relatively minor. Published primary chemical emissions data in 2020 and 2030 from the 2023 NZE Report compared to the 2021 data (presented as part of the SDA pathways above) are shown here. 2023 NZE data is from the 2023 NZE Report and the most recent IEA chemicals industry webpage (IEA, 2023c).

CHEMICAL	SCENARIO DATA	2020 SCOPE 1 CO_2 EMISSIONS (GT)	2030 SCOPE 1 CO_2 EMISSIONS (GT)
Whole sector	2021 NZE Reports	1.296	1.199
	2023 NZE Reports	1.329*	1.150
Ammonia	2021 NZE Reports	0.450	0.340
	2023 NZE Reports	0.422	0.311

CHEMICAL	SCENARIO DATA	2020 SCOPE 1 CO_2 EMISSIONS (GT)	2030 SCOPE 1 CO_2 EMISSIONS (GT)
Methanol	2021 NZE Reports	0.222	0.222**
	2023 NZE Reports	0.234	0.209
HVCs	2021 NZE Reports	0.251	0.251**
	2023 NZE Reports	0.244	0.248

*The value shown here is for 2021. 2023 NZE Report does not publish 2020 emissions data for the whole sector.
**As described below, scope 1 emissions from methanol and HVCs production in 2030 have been set equal to 2020, even though the 2021 NZE Scenario projects minor increases in scope 1 emissions for these products.

The differences in cumulative emissions between the 2021 NZE data and the 2023 NZE data from 2020 to 2030 are less than 8% across all chemicals. Differences in the reported baseline emissions for 2020 are noted, but for consistency purposes the SBTi has chosen to use the same 2021 NZE data set for the baseline year as well, as described above. These minor differences in emissions between the NZE scenario versions propose a minor risk of inconsistency between the primary chemical SDA pathways and the current IEA modelling. However, the lack of published primary chemical emissions and production data for 2040 and 2050 in the 2023 NZE Report led us to choose the 2021 NZE as our basis for the development of the pathways, because 2040 and 2050 data for ammonia was available and could be used to inform the pathways for the other chemicals. The SBTi will evaluate new scenario data in the future and will update the SDA pathways if warranted.

For electricity consumption data, the SBTi has based this mainly on IEA's 2023 WEO report for ammonia and methanol production in 2020, 2030 and 2050 (IEA, 2023a) and the current IEA chemicals webpage for total electricity used for the production of primary chemicals in 2020 and 2030 (IEA, 2023c). The IEA had not provided this information in their 2021 publications described above; therefore, the SBTi has chosen to use the more recent reports. Since there is not a significant difference in total production values in the chemical sector between the 2021 and 2023 NZE iterations, the SBTi has assumed electricity consumption in the 2023 NZE Report (IEA, 2023b) to be comparable to those in the 2021 version (IEA, 2021a), and thus compatible with the primary chemical emissions and production values described above.

As described above, data from several reports from the IEA have been used to develop primary chemical emissions intensity pathways. In most cases, these reports were published using data from the NZE scenario in 2021, therefore the SBTi has assumed consistency in data between the reports. Cases where more recent data was used to supplement the 2021 NZE information are described above.

Total chemical sector

This includes primary chemicals and non-primary chemicals, except where noted.

- Scope 1 emissions: **All years** from the 2021 NZE Report, Annex A table A.4 (IEA, 2021a).

- Electricity (only for primary chemicals): **2020** and **2030** values are from the IEA chemicals webpage, the “Energy” graph (IEA, 2023d). 2040 and 2050 values haven’t been calculated as they are not required for our assessment and are not provided by the IEA in the 2023 publications.

- Production (only for primary chemicals): **All years** from the 2021 IEA NZE Report, page 200 (IEA, 2021a).

Ammonia

- Scope 1 emissions: **2020** value is from the IEA ATR report, page 9, and **2030**, **2040** and **2050** values are estimated from the ATR report, Figure 2.1 (IEA, 2021b).[1]

- Electricity: **2020** (assumed to be the same as electricity use in 2022 as little to no change in electrification is assumed), **2022, 2030** and **2050** values are from the WEO 2023 report, Figure 3.6 (IEA, 2023a). **2040** value is calculated as the average of 2030 and 2050 values.

- Production: **2020** and **2050** values are from the IEA ATR report, page 62. **2030** and **2040** are estimated from the ATR report, Figure 2.5 (IEA, 2021b).

Methanol

- Scope 1 emissions: **2020** value is recorded from the IEA’s direct CO_2 emissions from primary chemical production in the Net Zero Scenario, 2015-2030 (IEA, 2021c). **2030** value is assumed to be the same as the 2020 value. Although the 2030 scope 1 CO_2 emissions from methanol in the 2021 NZE Report (IEA, 2021a) showed minor increases from 2020, the SBTi has assumed no emissions increase to prevent backsliding. Note the 2023 NZE Report supports this rationale (IEA, 2023b), with reductions in scope 1 CO_2 emissions from methanol shown.[2] **2040** and **2050** values are assumed to have the same ratio against the total chemical sector emissions (minus ammonia) as 2020 values.

- Electricity: **2020** (assumed to be the same as electricity used in 2022 as little to no change in electrification is assumed), **2022, 2030** and **2050** values are from the WEO 2023 Report, Figure 3.6 (IEA, 2023a). 2040 value is calculated as the average of 2030 and 2050 values.

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[1] The IEA modelling approach for ammonia doesn't consider CO_2 generated during ammonia production but converted to urea to be emitted under scope 1.
[2] https://www.iea.org/energy-system/industry/chemicals.

- Production: **2020** value is calculated by dividing the 2020 emissions (see above) by the methanol production emission intensity value provided in Figure 1.7 in the ATR (2.2 tCO2 / t) (IEA, 2021b). **2030** value is based on the indexed values provided in IEA's Expansion in primary chemical production in the Net Zero Scenario, 2000-2030 graphic, published in 2021 (IEA, 2021d). This value is calculated as an index against the calculated 2020 value. **2040** and **2050** values are calculated by assuming the same ratio against the total primary chemical production values (minus ammonia) as 2030 values in the 2021 NZE Report (IEA, 2021a). The SBTi notes that 2020 and 2030 ratios are similar in the NZE Report. The SBTi also notes that this ratio between methanol and total primary chemical production remains the same in 2030 and 2050 in the CTS scenario provided in the IEA Future of Petrochemical Report – Methodological Annex report in Table A8 (IEA, 2018).

HVCs

- Scope 1 emissions: **2020** value is recorded from the IEA's direct CO_2 emissions from primary chemical production in the Net Zero Scenario, 2015-2030 (IEA, 2021c). **2030** value is assumed to be the same as the 2020 value. Although the 2030 scope 1 CO_2 emissions from HVCs in the 2021 NZE Report showed minor increases from 2020, the SBTi has assumed no emissions increase to prevent backsliding. Note the 2023 NZE (IEA, 2023b) Report supports this rationale, with scope 1 CO_2 emissions from HVCs increasing only 1.7% from 2020 to 2030.[3] **2040** and **2050** values are assumed to have the same ratio against the total chemical sector emissions (minus ammonia) as 2020 values.

- Electricity: **2020** and **2030** values are calculated by subtracting the total electricity required to produce ammonia and methanol from the total electricity from primary chemical production in those years. Minimal electrification is assumed for the production of HVCs, therefore the same rate of increase in electricity between 2020 and 2030 is maintained for **2040** and **2050**.

- Production: **2020** value is calculated by dividing the 2020 emissions (see above) by the HVCs production emission intensity value provided in Figure 1.7 in the Ammonia Technology Roadmap (1 tCO_2 / t) (IEA, 2021b). **2030** value is based on the indexed values provided in IEA's Expansion in primary chemical production in the Net Zero Scenario, 2000-2030 graphic, published in 2021 (IEA, 2021d). This value is calculated as an index against the calculated 2020 value. **2040** and **2050** values are calculated by assuming the same ratio against the total primary chemical production values (minus ammonia) as 2030 values in the 2021 NZE Report (IEA, 2021a). The SBTi notes that 2020 and 2030 ratios are similar in the NZE Report. The SBTi also notes that this ratio between HVCs and total primary chemical production remains the same across 2030, 2040, and 2050 in the CTS scenario provided in the IEA Future of Petrochemical Report – Methodological Annex report in Table A8 (IEA, 2018).

[3] https://www.iea.org/energy-system/industry/chemicals.

Pathway development for N_2O emissions in scope 3 category 11 from the use-phase of sold nitrogen fertilizers

The SBTi, with input from members of the project's EAG, explored source-specific emissions scenarios to develop a science-based trajectory that could be used by fertilizer manufacturers to set 1.5°C-aligned emissions reduction targets on emissions of N_2O in the use-phase (scope 3 category 11).

The SBTi used the following qualitative criteria to guide assessment of studies that specifically address emissions of N_2O from the use of synthetic N-fertilizers:[4]

- Provide a realistic representation of the potential reduction in emissions until 2050 resulting from different measures that fertilizer companies can take.
- Be compliant with a scenario that limits global warming to a maximum of 1.5 °C.
- Be based on recent and credible scientific research.
- Provide transparent underlying data and calculations.

The SBTi identified three studies which focused on the key levers to reduce N_2O emissions from fertilizers from the field (Gao & Serrenho, 2023), Systemiq (Systemiq, 2022), and McKinsey & Co (McKinsey & Co, 2020). The key mitigation levers relevant for N_2O considered in these studies include minimizing the demand and use of N-fertilizers while maintaining crop production sufficient to meet global food demand, and thus ensuring food security. Maximizing the nitrogen use efficiency (NUE) of N-fertilizers[5] is a key strategy to achieve optimized fertilizer application while maintaining adequate and equitable food supply. Increasing NUE can be achieved by:

- Applying the "4R" N management principle (i.e. applying right N source at the right rate, time and place); and
- Use of Enhanced Efficiency Fertilizers (EEFs).

The use of nitrification inhibitors (NIs) is another lever to mitigate N_2O emissions from the field. NIs are chemicals that prevent bacteria from performing the nitrification and denitrification reactions that generate N_2O.

The three studies each include consideration in their model that meeting future food demand is a necessity that cannot be compromised by reductions in N_2O emissions from N-fertilizers. Gao & Serrenho (2023) rely on projected crop demand and N-fertilizer demand from the Food and Agriculture Organization of the United Nations (FAO) against which their mitigation levers are measured. McKinsey & Co rely on mitigation scenarios from the IPCC's 2018 report, *Global Warming of 1.5°C* which considers trade-offs and synergies with the sustainable development goals (SDGs). Gao & Serrenho (Gao & Serrenho, 2023) separately

[4] These criteria were established for the specific purpose of evaluating scenarios dealing with emissions of N_2O from fertilizer use in the field. They are not representative of the evaluation of scenarios for other SBTi work, for which more general principles are currently in development.
[5] Nitrogen use efficiency is the fraction of N input that is harvested as product in the crop.

modeled 2020-2030, while the annual emission reduction from Systemiq and McKinsey & Co was derived based on their 2020-2050 modeling.

Because these three studies examine only a single source of emissions within the broader land sector, it is difficult to definitively conclude their alignment with the 1.5°C level of ambition that the SBTi has recognized for the land sector (SBTi, 2022). The McKinsey study claims alignment with the upper end of required reductions and is higher than the top of the interquartile range for emissions reductions from agriculture in the low-overshoot scenarios from the Integrated Assessment Modeling (IAM) Consortium that underpins IPCC's 2018 report Global Warming of 1.5°C (IPCC, 2018). For this reason, the SBTi considers the McKinsey pathway and other, more ambitious pathways, to be consistent with a 1.5°C level of ambition.

Many other emissions scenarios for the land sector model N_2O emissions from fertilizer use, such as those summarized by Roe et al. (Roe, et al., 2019); however, these models typically lack the resolution on mitigation options for individual emission source types such as N_2O emissions from synthetic fertilizer. However, these models can provide additional insight into the role of land sector N_2O emissions mitigation in global models; therefore, in addition to the studies described above, the SBTi also evaluated the envelope of scenarios assessed in the sixth Assessment Report (AR6) of the IPCC in order to broaden our dataset and ensure our methods are informed by a more diverse range of scenarios.

The AR6 database contains 1,202 scenarios selected from multi-model and individual modeling studies. Together, these scenarios represent an ensemble of possible futures defined, among other factors, by a range of technological and socio-economic conditions. To navigate this complexity, to restrict the scenario space, and to ensure internal consistency in scenario assessment, the SBTi adopted six broad principles to guide the selection of scenarios. Here, the SBTi used the principles to derive strict criteria for scenario selection. The principles are outlined below, while the precise criteria applied to scenario selection are given in Table D.1.

Ambitious: SBTi standards should drive action and transformative decarbonization in line with the ambition required to limit warming to 1.5°C. In this analysis, the SBTi began our scenario selection by including only scenarios in the AR6 database that limit warming to 1.5°C with a 50% or greater likelihood, with low or no overshoot of the 1.5°C temperature goal. Scenarios in this category (category C1) are the most ambitious scenarios assessed by the IPCC.

Responsible: SBTi standards should incentivize a transition to net zero that emphasizes low risk of adverse outcomes for broader sustainability goals. For pathways specifically, the principle of responsibility dictates that pathways should rest on drivers of climate mitigation that are conservative, emphasizing low risk of adverse outcomes for broader sustainability goals, including relevant Sustainable Development Goals (SDGs) and planetary boundaries. The SBTi addressed this principle through several criteria related to sustainability. First, within the C1 category, scenarios were excluded that exceeded the sustainability limits of bioenergy in primary energy consumption in any year before and by 2050. The current scientific consensus estimates that sustainable bioenergy production ranges between 75-110 EJ (Kalt et al., 2020; Creutzig et al., 2021; Gidden et al., 2024; Frank et al., 2021), balancing the need to mitigate adverse impacts on food security, livelihoods, and biodiversity conservation. Additionally, a constraint on novel CDR capacity by 2050 was applied to as a proxy for sustainable limit on biomass consumption in the scenarios, ensuring alignment with sustainability thresholds and resource availability. An upper limit of 1 $GtCO_2$ on novel CDRs by 2050 (Smith, S. et al., 2023) constrained biomass consumption to <= 90 EJ. With a similar rationale, scenarios that included more than 3.6 $GtCO_2$ sequestration per year via afforestation in 2050 were removed, reflecting the estimated upper limit of sustainable sequestration by this lever (Fuss et al., 2018).

Rigorous: SBTi standards should be informed by the best available science, as defined by international consensus bodies like the IPCC, and best practices in climate target setting and climate mitigation at the time of standard development. The selection of scenarios from the AR6 database reflects the principle of scientific rigor, as only scenarios that successfully passed the IPCC's rigorous vetting assessments were considered.

Actionable: SBTi standards should offer an actionable framework that provides organizations with clear, measurable, and achievable steps towards meeting their targets, thereby facilitating effective and immediate reductions in emissions. For pathways specifically, this principle dictates that pathways should be supported by climate mitigation scenarios that rest on credible narratives on how key socio-economic factors, such as population, economic growth, and rate of technological development, may evolve over time. The SBTi applied this principle primarily according to the deployment of key carbon storage technologies. The SBTi restricted scenarios according to the total amount of CO_2 captured and permanently stored in geological formations (CCS), eliminating 14 scenarios that featured a cumulative CCS capacity deployment higher than 214 $GtCO_2$ between 2010 and 2050. This restriction reflects broad concern over the plausibility and feasibility of large-scale CCS deployment along biophysical, infrastructural, and market-related lines (van de Ven et al., 2023).[6] The SBTi also ruled out scenarios exhibiting deployment of novel CDR (i.e. removal of CO_2 via BECCS, DAC, and enhanced weathering) greater than 2.3 Mt in the year 2020, representing their current yearly deployment level based on most recent estimates (Smith et al., 2023).

Robust: SBTi standards should be rigorous and impartial, safeguarding the independence of the standard-setting process, and enabling credible and evidence-based claims throughout the target-setting and implementation journey. For pathways, this principle necessitates that pathways should be internally consistent and exhibit coherent logic. The SBTi applied the principle of robustness in two ways: first, scenarios were examined that include mitigation through land sinks according to their compatibility with existing SBTi guidance for the land sector[7] (Anderson et al., 2022). This restriction was implemented by calculating cumulative CO_2e emissions from agriculture, forestry, and other land use (AFOLU) for each scenario over the 2020-2050 time period and comparing this to the land-based emissions in the SBTi FLAG pathway. No constraint was applied on the upper limit of land-based emissions.

[6] This reflects a simplified assumption that 75% of the volume of oil and gas basins, and 25% of the volume of saline aquifers, could be deployed for CO_2 storage. For more details about how this heuristic was derived, see supplementary material of Van de Ven et al. (2023).
[7] The SBTi forestry, land and agriculture (FLAG) pathway is based on the summary of land-based mitigation potential in 1.5°C scenarios described by (Roe, et al. 2019).

Transparent: SBTi standards should make all relevant information publicly available, and be documented in a way that supports balanced, multi-stakeholder involvement in their construction and use. This principle implies that SBTi standards must rest on methods, scenarios, and positions that are transparently documented, including explicit statements of assumptions. As such, the SBTi selected scenarios for inclusion only if the underlying scenario data were publicly available.

To analyze the remaining emissions pathways for N_2O emissions from the use of N-fertilizers in the AR6 scenarios, the SBTi focused on the variable for N_2O emissions from soil management practices in the agriculture sector, classified in the AR6 dataset as *Emissions|N2O|AFOLU|Agriculture|Managed Soils.*

Upon applying the principles-driven filtering criteria to the C1 scenarios category of the AR6, and limiting to scenarios that report the emissions of N_2O from managed soils in the agriculture sector, 7 scenarios were found to meet all criteria, originating from two main model families. The number of scenarios satisfying each filter is shown in Table D.1.

Table D.1. Filtering criteria applied to the AR6 scenario database, and the number and percentage of C1 scenarios satisfying each individual criterion. When applied together, 7 scenarios satisfied all criteria. Scenarios in the C1 category are the most ambitious scenarios assessed by the IPCC and exhibit low or no overshoot of the 1.5°C temperature goal.

FILTERING CRITERION	VALUE	REFERENCE	NUM. (%) OF C1 SCENARIOS MEETING CRITERION
Maximum primary energy from bioenergy in any year between 2010-2050	<90 EJ	Frank et al., 2021	20 (21%)
Maximum CO_2 removed via afforestation in 2050	<3.6 Gt CO_2	Fuss et al., 2018	79 (81%)
Total cumulative CO_2 permanently stored in geological deposits, 2010-2050	<214 Gt CO_2	van de Ven et al., 2023	83 (86%)
Maximum CO_2 removed via novel CDR in 2020	<2.3 Mt CO_2	Smith et al., 2023	92 (95%)
Total cumulative AFOLU emissions, 2020-2050	>-99.54 Gt CO_2e	SBTi, 2022	95 (98%)

The 7 scenarios remaining from this analysis are listed in Table D.2.

Table D.2. Scenarios meeting all filtering criteria

MODEL	SCENARIO NAME
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR1p
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR2p
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR3p
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR4p
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_COV
REMIND-MAgPIE 2.1-4.2	EN_NPi2020_600f_COV
REMIND-MAgPIE 2.1-4.2	SusDev_SDP-PkBudg1000

The MESSAGEix-GLOBIOM integrated assessment model (IAM) consists of the energy model MESSAGEix and the land use model GLOBIOM. GLOBIOM provides a detailed representation of the agricultural, forestry and bio-energy sectors, including modeled emissions from these sectors. Emissions from crop sources in GLOBIOM include N_2O from both synthetic and organic fertilizers (IBF-IIASA, 2023). Relevant mitigation options referenced in the GLOBIOM model include improved fertilization practices and the use of nitrification inhibitors (Frank et al., 2018).

The REMIND-MAgPIE 2.1-4.2 framework is a coupling of the energy-economy model REMIND and the agricultural production model MAgPIE. MAgPIE includes a nitrogen module that estimates N_2O emissions from managed soils, among other sources (Dietrich et al., 2019). Relevant mitigation options referenced in the MAgPIE model also include improved fertilization practices and the use of nitrification inhibitors (Lucas et al., 2007).

In order to determine the suitability of these 2 modeling frameworks to the pathway development, the SBTi compared the reported values in the base year for both N_2O emissions from managed soils and the total use of nitrogen as fertilizer from the scenarios listed in Table D.2. For both variables, the REMIND-MAgPIE 2.1-4.2 framework reported values that were significantly higher than the median values from the rest of the C1 scenario dataset, and from the values reported in FAOSTAT (FAO, 2024). A comparison of these values is shown in Table D.3.

Table D.3. Reported fertilizer use by source

MODEL/SOURCE	SCENARIO	VARIABLE	2020 REPORTED VALUE
REMIND-MAgPIE 2.1-4.2	EN_NPi2020_600f_COV	Fertilizer Use, Nitrogen (Inorganic + organic)	254.7 Tg N
		N_2O Emissions from Managed Soils	7,411.5 kt N_2O

MODEL/SOURCE	SCENARIO	VARIABLE	2020 REPORTED VALUE
REMIND-MAgPIE 2.1-4.2	SusDev_SDP-PkBudg1000	Fertilizer Use, Nitrogen (Inorganic + organic)	257.9 Tg N
		N_2O Emissions from Managed Soils	7,406.7 kt N_2O
C1 scenario dataset, excluding REMIND-MAgPIE scenarios (Median)	–	Fertilizer Use, Nitrogen (Inorganic + organic)	124.7 Tg N
		N_2O Emissions from Managed Soils	4,127.1 kt N_2O
FAOSTAT (World Total)	–	Fertilizer Use, Nitrogen (Inorganic only)	114.7 Tg N
		N_2O Emissions from Synthetic Fertilizers + Manure applied to Soils	2,913.3 kt N_2O

To ensure consistency among the included scenarios, the SBTi eliminated the remaining scenarios from the REMIND-MAgPIE model family from the pathway development.

To determine near-term pathways for setting targets on emissions of N_2O in scope 3 category 11 from the use of sold N-fertilizers, the SBTi calculated the percent reduction in the relevant N_2O emissions in each of the 3 independent studies described above (Gao & Serrenho, McKinsey, and Systemiq), and the percent reduction in N_2O emissions from managed soils in the agriculture sector in the 5 MESSAGEix-GLOBIOM scenarios shown in Table D.2 for the period of 2020 - 2030. To determine a long-term target-setting pathway, the same calculations were performed on the period 2020 - 2050.

The near and long-term target-setting pathways have been set based on the median of the percent reductions from the included studies and scenarios. The calculated percent reduction values and the resulting median reduction percentage are shown in Table D.4.

Table D.4. Calculated absolute emissions reduction percentage in N_2O emissions from the fertilizer use-phase

MODEL / STUDY	SCENARIO NAME	% REDUCTION IN N_2O EMISSIONS *2020 - 2030*	% REDUCTION IN N_2O EMISSIONS *2020 - 2050*
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR1p	11.0%	13.4%
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR2p	12.5%	15.3%
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR3p	12.7%	16.0%
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR4p	12.7%	16.7%

MODEL / STUDY	SCENARIO NAME	% REDUCTION IN N_2O EMISSIONS *2020 - 2030*	% REDUCTION IN N_2O EMISSIONS *2020 - 2050*
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_COV	11.1%	15.4%
Gao & Serrenho	–	46.3%	76.0%
McKinsey	–	9.0%	27.0%
Systemiq	–	23.3%	69.9%
	Median	**13%***	**17%***

*Values conservatively rounded up to 2 digits.

The SBTi recognizes the importance of establishing a specific pathway for setting targets on N_2O emissions from the use of fertilizers in the field. Additional research on mitigation measures for these emissions in the context of equitable food demand scenarios would provide further insight into source-specific climate-aligned pathways. Additionally, improving the availability of primary data from farming practices up the value chain could provide fertilizer manufacturers more visibility and influence on how their products are being used. This could increase the uptake of optimized fertilizer application methods in all regions and thus reduce the N_2O emissions associated with the use of fertilizers and improve quantification of these reductions. In future work, the SBTi may revisit this target-setting method as part of the review and revision process for this document to incorporate future research.

Development of target-setting metrics for nitric acid production

The SBTi has established the target emissions intensity metric of 0.5 kg N_2O / t Nitric Acid based on an assumed unabated emissions intensity of 9.0 kg N_2O / t Nitric Acid [(NACAG, 2023), (Joerss, 2023), (WRI, 2015)] and an assumed annual average abatement percentage of around 95% from the use of tail-gas abatement technologies [(NACAG, 2023), (IPCC, 2007)].

The SBTi has chosen to set a requirement to reach this threshold value to ensure that companies who have not taken abatement measures yet will be incentivized to do so, without creating an obligation for companies who have already implemented abatement measures to invest further, while still ensuring that these emissions are covered by a companies' overall emission reduction target.

Development of target-setting metrics for the sourcing of alternative sources of feedstock carbon.

Scenarios and roadmaps for the chemicals sector's transition towards net-zero consistently include a reduction in reliance on virgin fossil feedstocks, and an increase in the usage of alternative feedstocks. Different literature sources provide different projections for the future feedstock mix as well as the dominance of the various alternative feedstocks (bio-based, recycling and CCU), as is illustrated in Table 4.3 of (Kloo, 2023).

To determine the increase in share of alternative feedstocks for this target, the SBTi used the scenarios described in the reports *Planet-compatible pathways for transitioning the chemical industry* (Meng, et al. 2023), and *Planet Positive Chemicals: Pathways for the chemical industry to enable a sustainable global economy* (Kremer, et al. 2022).

These studies present planet-compatible pathways toward 2050 employing demand-side and supply-side interventions. These pathways were chosen due to the detailed modeling of feedstock types, scope 3 emissions, and availability of data between 2020 and 2050.

The low- and high-circularity demand scenarios (LC and HC), and the most economic (ME) and no fossil new build after 2030 (NFAX) supply scenarios were jointly analyzed to model the rate of increase in alternative feedstock consumption by the chemical sector from 2020 to 2050.

Ultimately, the SBTi has decided to use the LC demand scenario as the basis for the minimum target thresholds to be conservative regarding re-use and substitution rates.[8] The values for the alternative feedstock target thresholds were determined as described below. Unless otherwise noted, the scenarios analyzed are the LC-ME and LC-NFAX scenarios.

STEP 1: Determine overall use of different feedstocks for production of the chemicals included in the scenarios for each year.

STEP 2: Determine a representative end-of-life emission factor in 2050 based on the modeled end-of-life fates for each hydrocarbon chemical (e.g. incineration with and without CCS, recycling, landfilling, etc.).

STEP 3: Determine the end-of-life emissions and the share of C that is emitted end-of-life in 2050 for all the produced hydrocarbon chemicals (including urea) in each scenario.

STEP 4: Determine the ratio between the LC-ME and the LC-NFAX scenarios that balances the share of feedstock C of atmospheric origin in 2050 with the share of C that is emitted end-of-life in 2050 from step 3. This results in shares of alternative feedstocks for the modeled chemicals that are between the modeled shares from the LC-ME and LC-NFAX scenarios.

STEP 5: Add 8% to the obtained alternative feedstock numbers to reflect the additional potential of direct bio-based routes that are not included in the modeled feedstocks in the Systemiq scenarios, and current use of bio-based feedstocks.

A detailed explanation of the method used to determine the alternative feedstock threshold values using these steps is provided below.

STEP 1: The yearly overall use of the various types of feedstocks was determined from:

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[8] As a comparison exercise, a combination of the HC-ME and HC-NFAX scenarios was also analyzed, which resulted in comparable values to the LC scenarios for the alternative feedstock target in 2030, 2040 and 2050.

1. Feedstock use (in Mt feedstock) to produce ethylene, propylene, butadiene, benzene, toluene, xylene, methanol, and urea was taken from Systemiq's global dashboard file:[9]
    - HVCs produced in refineries are not accounted for in the feedstock share. As IEA projects for their NZE scenario that by 2050 around 32% of total fuels will be alternative fuels (based on energy content, rather than C-content) (IEA, 2023d), chemicals originating from refineries were not deemed to present a major deviation for the downstream chemical companies purchasing HVCs for the minimum target. Thus, production of primary chemicals in Systemiq's modeling using the following refinery processes is excluded:
        - Gasoline catalytic reformer.
        - LPG catalytic reformer.
        - Off-gas catalytic reformer.[10]
    - Production of "Ammonium Nitrate" and production of "Ammonia (excl. Derivatives)" are excluded; production of ammonia for the conversion to urea (including its subsequent conversion to urea) are included.

2. The feedstock consumption in Mt feedstock from #1 was converted to feedstock consumption in Mt-C by multiplying #1 with the carbon content for each feedstock, which was taken from the global dashboard file as well. A value of 0.65 was used for pyrolysis oil.

3. Total feedstock use was determined for each of following feedstock categories:
    - Virgin fossil feedstock.
    - Bio-based feedstock.
    - Direct Air Capture CO_2 (considered part of CCU-based feedstock).
    - Point Source CO_2 (considered part of CCU-based feedstock).
        - The SBTi's definition of alternative feedstock excludes traditionally produced urea[11] from the CCU feedstock category. Therefore, to consider point source CO_2 used to produce urea:
            - CO_2 from fossil and municipal solid waste (MSW)[12] feedstocks to produce urea doesn't qualify as CCU and thus doesn't contribute to the alternative feedstock target.
            - CO_2 from bio-based feedstocks to produce urea doesn't qualify as CCU but does qualify as bio-based and thus counts towards the alternative feedstock target.
            - Double counting of CO_2 from fossil- or bio-based feedstocks is corrected.

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[9] The Global Dashboard file is provided as part of the supplementary modeling documentation data for the Systemiq study. It is available at https://github.com/systemiqofficial/Pathways-Chemical-Industry.
[10] This also means the impact of a shift from production of High Value Chemicals in refineries to the chemical sector has not been explored.
[11] Traditionally produced urea involves the production of ammonia from fossil-based sources, in which the ammonia and the CO_2 from this ammonia production is captured explicitly to be used as feedstocks to produce urea.
[12] MSW feedstocks do qualify as chemical recycling. Note the origin of the MSW (bio-based or fossil) would only have been relevant for 2050, in which no MSW feedstock is used to produce urea in any of the assessed 4 scenarios.

        - Remaining CO_2 feedstock to produce urea is all assumed to originate from another point source (e.g. the cement sector) and thus counts towards the alternative feedstock target as CCU-based feedstock (but doesn't qualify as CO_2 of atmospheric origin – see below).
    - For Point Source CO_2 for methanol:
        - CO_2 feedstock is all assumed to originate from another point source and thus contributes to the alternative feedstock target as CCU-based feedstock (but doesn't qualify as CO_2 of atmospheric origin – see below).
- MSW refuse derived fuel (RDF) and pyrolysis oil together form the 'chemical recycling' feedstocks.
- In line with Systemiq's approach to treat depolymerization- and dissolution-recycling as demand reduction and in view of the expected limited availability of mainly dissolution-recycling options for chemical products, these volumes have been added to the volumes of mechanical recycling.[13]
- Mechanical recycled volumes are:
    - Neither included in the alternative feedstock scope, nor in the calculation of the total amount of feedstocks for table F.2 (target thresholds that exclude mechanically recycled materials).
    - Included in the alternative feedstock scope, as well as in the calculation of the total amount of feedstocks for table F.3 (target thresholds that include mechanically recycled materials).
- Methanol is used as one of the feedstocks to produce HVCs in Systemiq's modeling. However, this methanol-as-feedstock is excluded when determining the share of alternative feedstock in Systemiq's model outcomes, because the share of alternative feedstock has already been included in the feedstocks to produce this methanol. Towards later years, the feedstocks going into methanol production seem too high to meet the methanol demand, while the amount of feedstocks is too low for the propylene demand and especially for the xylene demand. The SBTi interprets that a relevant share of the methanol in the model is used for the production of mainly xylene in these years.[14]

STEP 2: The end-of-life emission factor (t CO_2 / t C) was determined for 2050 for each of the hydrocarbon chemicals considered by Systemiq (ethylene, propylene, butadiene, benzene, xylene, toluene and methanol) as follows:

1. Determining the total amount of each of these chemicals that end up in waste after increasing re-use and substitution, after mechanical recycling and after dissolution- and depolymerization-recycling.[15]

[13] Note that SystemIQ labels these as 'chemical recycling'
[14] While this is not shown in the numbers for feedstock use for propylene and xylene used, the SBTi is relatively confident about this assumption as we can approximately replicate the Mt Carbon feedstock from figure 2 in (Meng, Wagner, Kremer, & Kanazawa, 2023).
[15] Based on the distribution of waste processing technologies as Systemiq provides for LC-scenarios, specifically in worksheets "Ethylene Recycling LC", "Propylene Recycling LC", "Methanol Recycling LC", "BTX Recycling LC", and "Butadiene Recycling LC".

2. Converting these into end-of-life emissions using the following emission factors:[16]

   - Landfilling / Dumpsite: 0 t CO_2 / t C (from the "Scope 3 Yearly" worksheet in the demand model supplemental data file. This is a simplification, assuming neglibile emissions from landfilling of durable plastics and ignoring emissions of methane from non-durable waste.

   - Leakage to the environment and to oceans: 0 t CO_2 / t C (from the "Scope 3 Yearly" worksheet in the demand model supplemental data file. This is a simplification which may require further work in the future.

   - Incineration with or without energy recovery without CCS: Stoichiometric conversion (all C becomes CO_2). While this value is higher than assumed by Systemiq, this assumes by 2050 emissions will not be attributed to the energy consumer.

   - Incineration with CCS: 5% of the emissions without CCS, in line with the "Scope 3 Yearly" worksheet in the demand model supplemental data file.
   - Open burning: Stoichiometric conversion (all C becomes CO_2). This value is higher than assumed by Systemiq.

STEP 3: The overall end-of-life emissions (ton CO_2) for the hydrocarbon chemicals and urea were determined for each scenario (LC-ME and LC-NFAX) based on their production in 2050[17] by adding:

1. The product of the production of each of the hydrocarbons with their end-of-life carbon emission factor determined as described in step 2 above (including urea, amounts are based on numbers in the worksheet Yearly Summary in the demand model supplemental data file).

2. End-of-life carbon emissions from urea, obtained by multiplying its production[18] with the stoichiometric emission factor (44/12) based on the assumption that all urea would be applied as fertilizer and thus emit the embodied CO_2.

STEP 4: The minimum threshold for the alternative feedstock target in each year in these target-setting criteria was based on a combination of the LC-ME and the LC-NFAX scenarios that would ensure the percentage of overall end-of-life carbon (as CO_2) emitted was equal to the percentage of carbon of atmospheric origin in the feedstock[19], by:

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[16] The SBTi is unsure whether the distribution of end-of-life treatment routes is just based on plastics, or also on other products. In the absence of other data, the SBTi has applied the distribution between these routes to all production of the hydrocarbons, adding uncertainty to the approach taken.
[17] This assumes ultimately each produced hydrocarbon reaches – at some point – end-of-life status; its timing was not considered. In line with our understanding of Systemiq's approach total (fossil+biobased) CO_2 emissions are included.
[18] As simplification: To weigh the emission factors of the different feedstocks and products, 100% conversion of C in all feedstocks to product has been assumed; this assumption is not conservative for urea (as the C-conversion efficiency in urea production is likely significantly higher than the C-conversion efficiency in HVC production from naphtha even when considering by-products).
[19] This carbon balancing method is described by Systemiq in (Meng, Wagner, Kremer, & Kanazawa, 2023), although the SBTi is unsure whether Systemiq applied this rationale of balanced carbon flows to all scenarios. The SBTi has chosen to apply the end-of-life percentages based on *products* to *feedstocks*, thus including the share of feedstock that end up as loss, fuel or by-product would have a similar emission factor as the share of

1. Determining the percentage of carbon of atmospheric origin in the feedstock as the amount of bio-based carbon + CCU-based carbon from direct air capture[20] for the LC-ME and the LC-NFAX scenarios separately.

2. Establishing a percentage of alternative feedstocks in each year using a weighted average of the alternative feedstocks in each of the two scenarios to achieve a balance between CO_2 emissions at the end-of-life and feedstock carbon of atmospheric origin. In this balanced state, the amount of feedstock C of atmospheric origin = the amount of emitted C at the end-of-life. This was done using the following data and method.

Table F.1. Parameters used to determine combined alternative feedstock target values

PARAMETER	VALUE	NOTES
Percentage of C emitted at the end-of-life from total produced hydrocarbon chemicals in the LC-ME scenario in 2050	22 wt.% C	Represents the total C to be balanced by feedstocks of atmospheric origin in the SBTi target threshold calculations
Percentage of feedstocks of atmospheric origin in the LC-ME scenario in 2050	8 wt.% C	Implies there are remaining emissions at the end-of-life in this scenario that are not balanced by feedstocks from atmospheric origin.
Percentage of feedstocks of atmospheric origin in the LC-NFAX scenario in 2050	59 wt.% C	Implies there are greater amounts of feedstocks from atmospheric origin than end-of-life emissions in this scenario.

The SBTi combined the LC-ME and LC-NFAX scenarios by assigning a relative weight to each scenario based on how close each scenario's share of feedstocks of atmospheric origin, as summarized in Table F.1, is to the 22% of end-of-life CO_2 emissions in the LC-ME scenario. In this case, closer values result in a higher weight:[21]

Weighting for LC-ME scenario = 1- [(22 wt.% C – 7 wt. % C) / (57 wt. % C – 7 wt. % C)] = 72%

Weighting for LC-NFAX scenario = 1- [(57 wt.% C – 22 wt. % C) / (57 wt. % C – 7 wt. % C)] = 28%

The weighted average of the alternative feedstock share from each scenario, using the weighting factors above, was used to determine the minimum alternative feedstock share thresholds in each year, prior to the adjustment described below in step 5.

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feedstock that ends up as product; this assumption has been made for simplicity and is not based on either an assessment or expert judgement.

[20] This approach just accounts for removal of CO_2 from the atmosphere into bio-based feedstock and through direct air capture into products. It ignores any upstream emissions for the production of biobased feedstock / DAC. It also doesn't account for any upstream emissions savings by replacing the virgin fossil feedstock. It thus is a highly simplified approach that should not be used for Life Cycle Analyses or GHG emissions accounting. MSW is assumed to be of fossil origin only; volumes are < 1% of total C in LC-ME and LC-NFAX.

[21] This calculation method includes a simplifying assumption of equivalent volume of production between the LC-ME and LC-NFAX scenarios, as both scenarios use the same demand model. In the actual Systemiq modeling there are minor differences in total production between the scenarios.

STEP 5: 8% is added to the total feedstock values calculated as above,[22] now and in future years, to account for bio-based feedstocks currently used in the sector, mainly to make specific chemicals often with molecule structures resembling the molecule structure of biomass. This percentage is based on the currently estimated percentage (Kaehler, 2023) and is assumed to stay constant in time. The minimum and recommended targets in the table below include the 8% bio-based feedstocks values.

The higher alternative feedstock share target values based on the LC-NFAX scenario remain as an inspirational alternative feedstock target because:

1. The minimum target threshold is based on a highly simplified approach, for example ignoring emissions from non-durable waste from landfilling and upstream emissions from the production of biomass (including indirect land-use change emissions).

2. This approach relies to a high extent on application of CCS on waste incineration and on landfilling, and assumes zero emissions from leakage and landfilling. Thus, higher alternative feedstock shares may be needed.

3. As our understanding of Systemiq's modeling suggests a rather limited potential for chemical recycling, therefore the potential for chemical recycling as a feedstock option may be higher.

4. The current targets ignore the upward potential for growth of direct routes towards bio-based or CCU-based chemicals (without methanol or High Value Chemicals as intermediates).

5. As Systemiq modeled the scenario with a relatively low[23] carbon price,[24] the share of alternative feedstocks by 2050 may be higher for scenarios based on a carbon price similar to the carbon price in IEA's NZE scenario.

Table F.2. Target alternative feedstock shares by 2030, 2040 and 2050 ***excluding*** *mechanically recycled materials*

SCENARIO	2030	2040	2050
Minimum target (based on the combination of Systemiq's LC-ME and LC-NFAX scenarios)	14 wt.% C	26 wt.% C	42 wt.% C
Recommended target (based on Systemiq's LC-NFAX scenario)	16 wt.% C	37 wt.% C	83 wt.% C

[22] 0% in 2020; 1.6% in 2021, 3.2% in 2022; 4.8% in 2023; 6.4% in 2024; 8% in 2025 and later; this 8% is assumed to be additional production (*not* involving the production of primary chemicals), and the total % of alternative feedstocks is thus divided by 1.08.
[23] Carbon price used by Systemiq (132 USD/ton CO_2) is likely lower than the carbon price applied by IEA in their NZE scenario, ranging from 55 to mostly 180-250 USD/ton CO_2 (IEA, 2023c). This infers that the percentages of alternative feedstock projected from Systemiq's Most Economic scenarios would be higher if a higher carbon price was utilized.
[24] Carbon price for Systemiq can be found in the "Prices and Availability" tab in the "Master Template" file in (Systemiq, GitHub repository).

Table F.3. Target alternative feedstock shares by 2030, 2040 and 2050 ***including*** *mechanically recycled materials*

SCENARIO	2030	2040	2050
Minimum target (based on the combination of Systemiq's LC-ME and LC-NFAX scenarios)	19 wt.% C	34 wt.% C	55 wt.% C
Recommended target (based on Systemiq's LC-NFAX scenario)	21 wt.% C	45 wt.% C	87 wt.% C

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