SCIENCE BASED TARGETS

DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

SYNTHESIS REPORT: POWER SECTOR PATHWAY

Version 1.0 First Consultation Draft

September 2025

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ABOUT SBTi

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

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

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

DISCLAIMER

VERSION HISTORY

Version	Change/update description	Release date
Version 1.0	Synthesis Report: Power Sector Pathway Draft Version 1.0	September 2025

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EXECUTIVE SUMMARY

In 2020, SBTi published the *Quick Start Guide for Electric Utilities* (SBTi, 2020) to support power companies in setting near-term science-based targets. Since then, the energy sector has seen major shifts driven by evolving policy landscape, cost breakthroughs in clean technologies, and structural changes in energy markets. In parallel, updated climate science and new global scenarios, such as the IEA's updated Net Zero scenario and the IPCC's latest scientific assessment, have redefined what constitutes a 1.5°C-aligned transition for electric utilities.

The power sector synthesis report presents an updated methodology, embedding projections for fossil phase-out, renewable deployment, and interim decarbonization milestones. This synthesis report describes the assessments that underpin the power sector standard development, offering a comprehensive review and evaluation of pathways used to define science-based emission reduction targets and sectoral transition milestones.

The methodological framework reviews mitigation scenarios from grey literature, benchmarking them against six guiding principles: ambition, responsibility, scientific rigor, actionability, robustness, and transparency. The selected scenarios—including an ensemble of eight IPCC 1.5°C-consistent pathways and the IEA Net Zero Emissions (NZE) scenario—capture a range of high-ambition decarbonization trajectories that remain within sustainable and technically feasible limits.

The updated power sector pathway yields an 83% reduction in absolute gross CO_2 emissions by 2030 and a net-zero intensity level of 0.001 tCO_2/MWh. The power sector's transformation is driven by the phase-out of unabated fossil fuels and the rapid scale-up of low-carbon sources, with the share of renewables in total electricity generation reaching 83% by 2030 and 96% by mid-century.

The Power standard outlines a transition plan for phasing out unabated fossil fuel assets in line with the pathway. No new unabated coal power plants are approved globally after 2023. Existing unabated coal, oil, and gas capacity is phased out in OECD countries by 2030–2035 and in non-OECD countries by 2040, with 85% of unabated coal and unabated oil and 55% of unabated gas assets in non-OECD regions retired by 2035.

The boundary of the power sector standard extends beyond generation to the full electricity value chain, recognizing the role of grid infrastructure and storage in enabling deep decarbonization. Target setting for these power system segments was benchmarked against World Bank data to reflect regional variation in network efficiency. This approach results in geographically differentiated and ambitious targets, particularly for regions with high transmission and distribution losses.

Building on this assessment, this synthesis report updates the power sector pathway, enabling power-generating companies to set targets validated by the SBTi.

1. INTRODUCTION

1.1 Background

In 2023, global energy-related CO_2 emissions reached 37.4 Gt, with the power sector accounting for 39.4% (IEA, 2024). Emissions from electricity generation grew by 1% in 2023, reaching an all-time high of 14.8 Gt, driven largely by increased coal-fired power generation, even as electricity demand rose by 2.2%. Decarbonising electricity generation is even more critical as electricity demand is expected to rise by 3.4% by 2026 due to economic expansion (IEA, 2024). This trend underpins the case for strengthening the sector's transition in line with the latest scientific findings to drive ambitious and meaningful climate action. Pathways are pivotal in this transformation, providing a solid foundation for defining, measuring, and tracking the climate performance of power-generating companies.

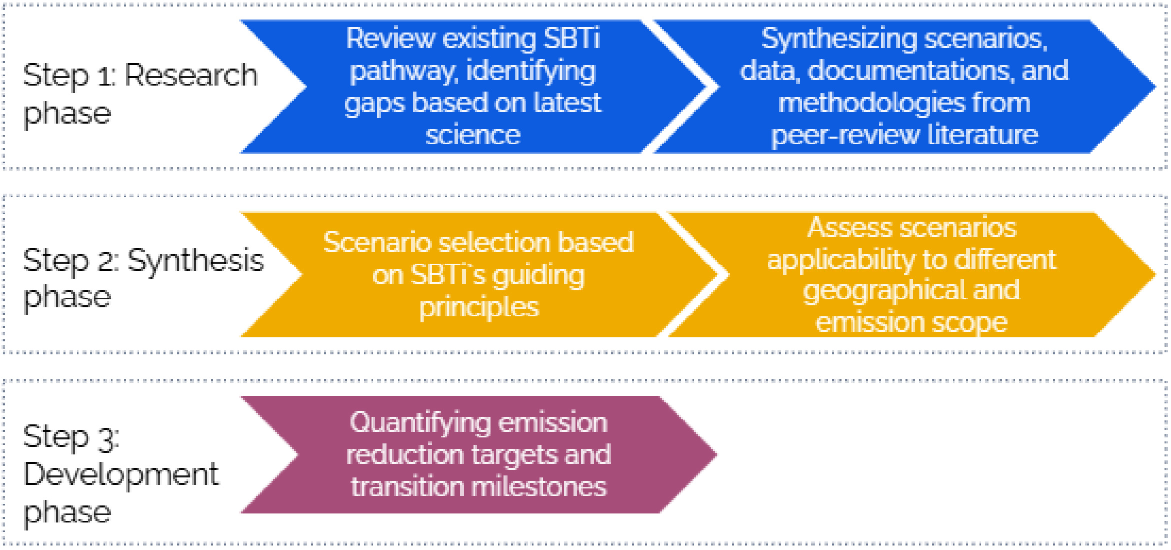
Beyond the established pathways and target-setting methods in the SBTi Power Sector Standard, the scientific community continues to advance knowledge on these frameworks. The SBTi reflects these updated insights in the revisions to its metrics, methods, and pathways.

1.2 Purpose and scope

This synthesis paper is developed in line with the SBTi's Standard Operating Procedures (SOP)[1] and aims to provide an updated pathway underpinning the SBTi's power sector standard. This report discusses the rationale and principles behind scenario selection, offering transparency into the implications of choosing a specific pathway. The report focuses on operational boundaries in the power sector, covering electricity and heat generation, transmission and distribution, and electricity trading activities. Figure 1.1 illustrates the key steps in the updated power sector pathway development process.

[1] Synthesis reports developed as part of the SBTi standard development process are informative documents that summarize research and analysis findings informing a new or updated standard. The inclusion of synthesis report findings related to technical foundations—metrics, methods, and/or pathways—in a standard is subject to the discretion of the standard development project team and the SBTi Technical Department. As such, some content in this synthesis report may not be present in the final published version of a new or updated standard.

Figure 1.1. Steps in updating pathways for sector-specific standards.



Several key research questions have guided the assessment:

- What are the eligible scenarios in the latest scientific literature required to drive 1.5°C-aligned decarbonization in the power sector?
- What global transition milestones in the power sector drive deep, rapid and sustained emissions reductions aligned with the 1.5°C target?
- How should regional pathways be addressed in the power sector?

1.3 Structure

This document first summarises the context in which the global power sector has evolved in terms of historical trends and the main barriers to its net-zero transition. The methodology section details the key guiding principles for scenario selection, global mitigation trajectory, and rationale for regional differentiation in the power sector. The report describes the updated pathway and transition milestones for the power sector. This report concludes with recommendations for future updates of existing pathways to align with the latest science. The paper is structured into four sections:

- Overview of the power sector: This section presents an overview of the current landscape of the power sector, describing the historical trends and sector-specific challenges. It also includes the current state of the operational boundaries covered in the power sector standard.
- Pathway Evaluation: This section provides an overview of the methodology followed to evaluate pathways, as well as the assessment and justifications for scenario selection. This section also explores the geographical scope of the power sector pathway.
- Results: This section quantitatively assesses the updated pathways, including relevant transition milestones.
- Limitations and recommendations: This section provides limitations in the pathway development and recommendations for future updates.

2. OVERVIEW OF CURRENT LANDSCAPE

2.1. Sector-specific trends, status, and challenges

The current trend in the power sector indicates that emissions are not reducing at the pace necessary to meet the net-zero target (IEA 2021). Over the last decade, coal, oil, and natural gas have accounted for 64% of global electricity generation (Ember, 2024). Coal remains a significant fuel in the energy mix of developing economies, where energy security concerns and growing electricity demands continue to drive production. Global oil-fired generation is the only energy source with a stable decline over the past decades, with an average annual reduction of approximately 2% per year (Ember 2024).

The gap between fossil and renewable energy generation has steadily narrowed, driven by the scaling up of clean energy technologies. By 2023, renewables accounted for one-third of global electricity generation, doubling their share compared to 2000. Over the past two decades, solar generation has experienced an average annual increase of 39% per year. Wind energy follows a similar pattern, with an average annual growth rate of about 21%. The growth in renewable generation is driven by declining technology costs and policy support mechanisms (IRENA, 2023).

While the power sector landscape has evolved dramatically with a ramp-up of clean energy technologies, the sector faces some technical and structural challenges that hinder the pace and scalability of the transition. These include inadequate grid infrastructure, supply chain constraints, and regulatory barriers (Table 2.1.1) (IEA 2020).

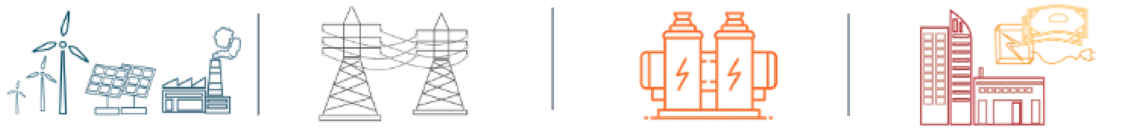
Table 2.1.1. Challenges specific to the power sector transformation.

Sector-specific challenges	Description
Intermittency and system stability	The high penetration of intermittent renewable energy disrupts grid stability and reliability. Technological development in demand response, energy storage performance, and overall system resilience are required to preserve grid operations.
Legacy infrastructure and transition challenges	Many countries, especially in low-income regions, continue to operate aging fossil-fuel power plants, which are difficult to phase out rapidly.
Policy and regulatory uncertainty	Divergent and evolving policy landscapes across regions introduce uncertainties in transition strategies. The lack of uniform regulatory frameworks and frequent policy shifts complicate standardized transformation in the power sector.
Supply chain constraints	Global supply chain disruptions and localized manufacturing bottlenecks delay the procurement of critical components, such as solar panels, energy storage systems, and smart grid equipment. These constraints usually lead to project delays and increased costs.

2.2 Operational boundaries of the power sector

The power sector standard encompasses a range of activities, including electric power generation, transmission and distribution losses, and electricity trading and storage. This operational boundary addresses mitigation strategies and system-wide efficiency across the power sector.

Figure 2.2.1. Activities and emissions in scope of the Power Sector Standard.



Power Generation	Transmission & distribution	Storage	Trade and retail
Scope 1 CO_2 emissions	**Scope 1 SF6 emissions** **Scope 2 CO_2 emissions** (losses in the network)	**Scope 2 CO_2 emissions** (losses in storage)	**Scope 3 Cat. 3 CO_2 emissions** (Activity D - generation of purchased electricity that is sold to end users)

- Fossil combustion for power generation constitutes a significant share of the entire power sector's GHG emissions. Increasing electricity demand for end-use purposes in industry, transportation, and buildings drives the rise in power generation, for which unabated fossils currently account for about 60% (IEA, 2023). The upscaling of renewables is a key driver for reducing the carbon intensity of power generation, but achieving deep decarbonization requires a system-wide approach.
- As variable renewable energy (VRE) increases in the power mix, efficient transmission and storage become vital to reduce system losses. Large-scale energy storage also helps balance supply and demand, ensuring grid stability.
- Sufficient storage capacity will be critical for ensuring electricity security as both supply and demand become more weather-dependent. Without adequate storage, temporary drops in renewable output, especially during extreme weather events or fuel disruptions, could severely strain the power system and compromise reliability.
- Energy storage systems incur round-trip efficiency losses, typically between 10% and 30%, meaning that for every 100 kWh charged, only 70–90 kWh are recovered. These losses translate into additional energy demand, and if the grid mix includes fossil fuels, they indirectly increase system-wide greenhouse gas emissions (IEA, 2024).
- GHG emissions from transmission and distribution activities stem from electricity losses in high-voltage lines, transformers, and infrastructure maintenance. According to the U.S. Environmental Protection Agency (EPA), transmission emissions range from 0.1 to 1.5 grams of CO_2 per kilowatt-hour (kWh) transmitted, highlighting the need for greater efficiency.
- Cutting transmission losses remains key to maximizing renewable energy benefits. Investing in modern grid infrastructure, expanding high-voltage interconnections, and

integrating advanced storage solutions can minimize losses and reduce the risk of fossil fuel fallback.

3. OVERVIEW OF MODELLING APPROACHES FOR POWER SECTOR

Mitigation potentials in the power sector can be assessed using three modelling approaches: bottom-up, top-down, and hybrid models (Figure 3.1).

- The bottom-up model follows a detailed technological representation approach. These models cover specific characteristics of energy generation, transmission, and distribution technologies, evaluating how the systems evolve under different policy and market conditions. The bottom-up approach allows for granular analysis of power plant efficiency, fuel switching, carbon capture and storage (CCS), and renewable energy integration (IEA, 2024).
- The top-down approach adopts a broader economic perspective, modelling the power sector as part of the overall economy. These models focus on macroeconomic interactions, including how energy demand responds to price signals, technological changes, and policy interventions. The top-down approach uses production functions to capture the relationship between energy, labour, and capital in driving economic growth.
- The hybrid modelling approach integrates technological detail from bottom-up models with the economic feedback mechanisms of top-down models, providing a comprehensive assessment of mitigation strategies in the power sector. The hybrid modelling framework covers plant-level efficiency improvements and the broader macroeconomic impacts of energy policies.

The IPCC and the IEA's Net Zero Emissions (NZE) scenarios, which inform the power sector pathway, provide distinct modelling frameworks, methodologies, sectoral focus, and policy integration (Table 3.1).

- The IPCC scenarios[2] utilize a top-down approach with bottom-up elements, assessing the impact of global climate policies and carbon budgets across multiple sectors. The scenarios provide moderate to high sectoral detail, offering a global outlook with regional breakdowns. The IPCC scenarios offer a broader, economy-wide perspective with integrated climate policies (IPCC, 2022).
- The IEA NZE pathway follows a more detailed, energy-specific approach to sectoral transitions. The IEA NZE pathway is derived from a bottom-up modelling approach in a top-down policy context, focusing specifically on the energy system transition. With a high level of sectoral and technology-specific detail, the IEA NZE comprehensively models energy policy, offering insights into regional energy dynamics (IEA, 2024).

[2] Scenarios compiled by the IPCC are developed using Integrated Assessment Models (IAMs)—advanced modeling frameworks that simulate the interplay between energy systems, land use, the economy, and the climate system. IAMs such as MESSAGE, REMIND, IMAGE, and GCAM are used to quantify mitigation pathways consistent with long-term temperature goals by integrating assumptions on technology, policy, and socioeconomic trends (IPCC, 2022).

Figure 3.1. Modelling approaches for GHG emissions in the power sector (Adapted from Annex III, IPCC, 2022).

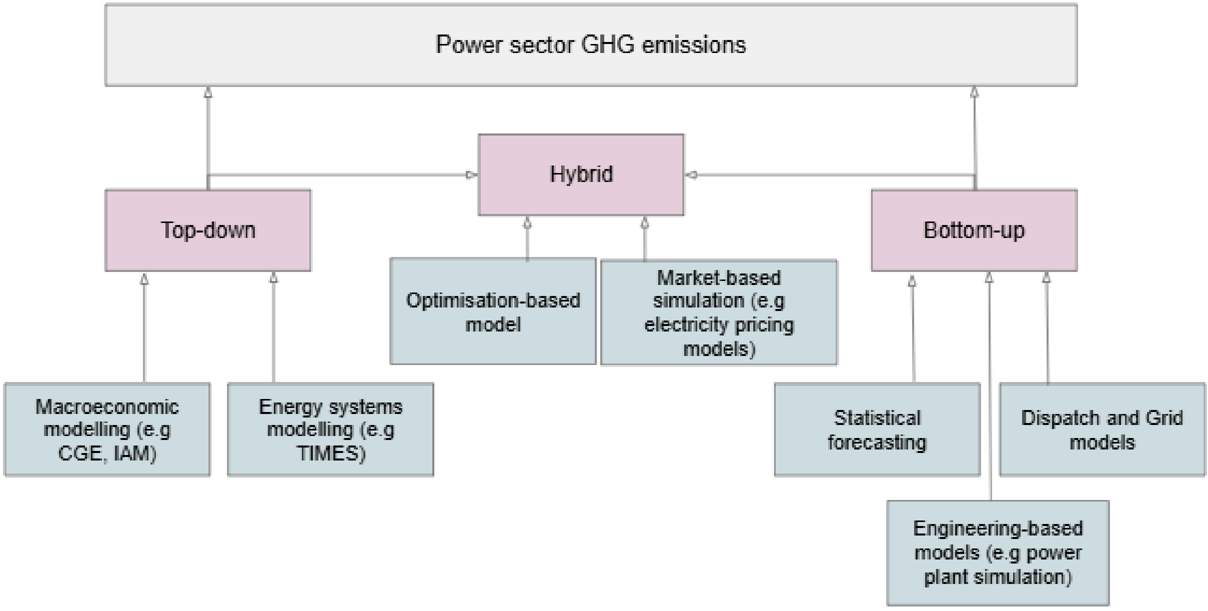


Table 3.1. Modelling approaches informing the power sector pathway.

Aspect	IPCC Scenarios	IEA NZE Pathway
Modelling approach	Top-down with Bottom-Up elements	Bottom-Up with Top-Down context
Sectoral detail	Moderate to High (sector integrated)	High (energy-specific focus)
Regional focus	Global with regional breakdown	Global with regional energy insights
Policy focus	Global climate policies and carbon budgets	Energy policy and investment targets
Technology focus	Integrated across sectors	Detailed, technology-specific
Economic integration	Macro-economic models embedded	Macro-level policy assumptions
Output scope	Global emissions, climate impacts	Energy system transitions

4. PATHWAY EVALUATION

The Paris Agreement establishes a collective goal of limiting global warming temperature to well below 2C while pursuing efforts to stay within 1.5°C above pre-industrial levels by 2100 (IPCC, 2021). Achieving this goal requires deep, sustained, and rapid reductions in global greenhouse gas (GHG) emissions, guided by the finite global carbon budget—the allowable cumulative emissions that stay within a specified temperature threshold.

Pathways translate the global carbon budget into actionable trajectories of mitigation actions over time, forming the basis for science-based target setting for corporate entities. Furthermore, pathways define net-zero-aligned benchmarks at the company level, establishing interim targets and providing sector-specific granular data for various indicators. The mitigation scenarios derived from pathways are developed in single-model and multi-model comparison studies. The research questions of these studies evolve over time, reflecting the changing climate policy debate and the progress in scientific understanding about the physical basis of climate change, its drivers, and available response measures (IPCC, 2022).

The SBTi synthesises pathways from credible grey literature to inform sector-specific standards, based on clearly defined principles. This assessment examines the feasibility of mitigation scenarios in addressing regional disparities, economic viability, technological readiness, and socio-economic considerations. SBTi periodically reviews the latest scenarios, ensuring that emission targets and alignment metrics are up-to-date with the latest climate science while remaining consistent with SBTi's values and mission. These updates often include improved climate models, refined carbon budget estimates, emerging technologies, and an expanded understanding of physical science and socio-economic systems.

4.1 Principles of pathway selection

At the core of the SBTi's scientific foundation is a set of guiding principles that define credible pathways across the scientific literature. These principles—ambitious, responsible, rigorous, actionable, robust, and transparent—form the foundation of the SBTi's pathway development process, such that pathways not only align with the latest advancement in climate science but also drive meaningful and credible corporate climate action. The principles enable consistency in assessing emerging science while maintaining coherence with SBTi's values and mission. Table 4.1.1 outlines how the principles apply to the development of scenario selection in the power sector pathway.

Table 4.1.1. Principles guiding scenario selection.

Principle	Description	Assessment Criteria
Ambitious	Requires that entities decarbonise in line with the ambition to limit warming to 1.5°C with no or limited overshoot.	Pathways should align with 1.5°C scenarios with no or limited overshoot, demonstrating early, deep, rapid, and sustained emissions reductions. **Implementation**: This assessment includes only scenarios from the AR6 database that limit warming to 1.5°C with a 50% or greater likelihood, with low or no overshoot. Scenarios in this category (category C1) are the most ambitious scenarios the IPCC assesses. We also include the IEA NZE pathway, which follows a 1.5°C temperature goal and a global carbon budget consistent with the goal.
Responsible	Requires a transition to net zero that emphasises low risk of adverse outcomes for broader sustainability goals.	Pathways should rest on conservative drivers of climate mitigation, emphasizing the low risk of adverse outcomes for broader sustainability goals, including relevant, sustainable development goals and planetary boundaries **Implementation**: We filtered the scenarios based on several sustainability criteria. Within the compiled scenarios, those that relied on bioenergy use were deemed unsustainable due to their negative impacts on food production, livelihoods, and biodiversity, and were therefore excluded, reflecting the current scientific consensus (Frank et al., 2021). Additionally, scenarios that relied heavily on afforestation for carbon sequestration and exceeded sustainable limits were removed based on estimated thresholds for avoiding significant ecological and socio-economic risks (Fuss et al., 2018).
Rigorous	Use the best available science from authoritative sources, such as the Intergovernmental Panel on Climate Change (IPCC), the International Energy Agency, and similar or related sources, as well as best practices in climate target setting and climate mitigation during pathway development.	Pathways should be based on peer-reviewed literature or compiled by authoritative organisations, such as the IPCC, and utilise internationally recognised models, ensuring scientific integrity. **Implementation**: Our selection of scenarios from the AR6 database directly reflects the principle of scientific rigour, as the scenarios in the AR6 database have undergone rigorous vetting. Our decision to include the Net Zero Emissions by 2050 Scenario is based on the credibility of the International Energy Agency,

		which produced the scenario. The IEA scenario documentation describes rigorous procedures for scenario construction
Transparent	All relevant information is publicly available and transparently documented, including explicit statements of assumptions and calculation procedures.	Pathways should disclose assumptions, data sources, and calculation methodologies, enabling independent verification. **Implementation:** We selected scenarios for inclusion in the pathway only if the underlying scenario data were publicly available. We also document the set of eligible scenarios for the development of the power sector pathway.
Robust	Requires technical foundations to be internally consistent and exhibit coherent logic.	Pathways should be consistent, comparable, and subject to regular updates to reflect evolving science and policy developments. **Implementation**: We implemented this principle by calculating cumulative CO_2e emissions from agriculture, forestry, and other land use (AFOLU) for each C1 category scenario over the 2020-2050 period and comparing this to the land-based emissions in the SBTi FLAG pathway. We eliminated scenarios with smaller cumulative emissions from AFOLU than those in the SBTi FLAG pathway, thereby ensuring that the scenarios included in the pathway did not assume land-based mitigation at amounts higher than those in the SBTi FLAG pathway (SBTi, 2022). We also addressed consistency with sector-specific pathways offered by SBTi by including the IEA Net Zero Emissions by 2050 scenario in our analysis. This scenario currently serves as the basis for SBTi's evaluation of sectoral emissions budgets (SBTi, 2021).
Actionable	Requires all technical foundations to be practical, enabling the design and implementation of effective solutions that lead to measurable action and progress in climate performance.	Pathways should include clear steps, timelines, and measurable milestones to ensure practical implementation and effective tracking. **Implementation**: Scenarios were excluded based on the total amount of CO_2 captured and permanently stored in geological formations (CCS), excluding those with cumulative CCS deployment above the set threshold (van de Ven et al., 2023). Additionally, scenarios relying on novel carbon dioxide removal (CDR) methods, such as BECCS, DAC, and enhanced weathering, beyond their estimated current deployment levels, were excluded, reflecting their limited scale to date (Smith et al., 2023).

4.2 Scenario selection

Our analysis draws on the C1 scenario ensemble[3], reflecting mitigation pathways that limit temperature rise to 1.5°C with no or low overshoot, as defined in IPCC AR6 (97 scenarios total; IPCC, 2022). We derive a set of eligible scenarios from this ensemble that aligns with the principle-driven criteria outlined in Table 4.1.1. These principles are assessed based on the quantitative criteria presented in Table 4.2.1. However, not all selected scenarios provide the sectoral detail required for target-setting calculations, which includes electricity generation, electricity supply emissions, and bioenergy sequestration (Table 4.2.2). We focused on the variables categorised in the AR6 database as Emissions|CO2|Energy|Supply|Electricity, Secondary Energy|Electricity, and Carbon Sequestration|CCS|Biomass|Energy Supply|Electricity. Table 4.2.3 presents the scenarios that inform the updated power sector pathway.
Importantly, SBTi's target-setting criteria prohibit emission targets from including carbon dioxide (CO_2) removal; therefore, the pathway is based on gross emissions.

Table 4.2.1. Filtering criteria applied to the C1 category scenario of the AR6 and the number and percentage of C1 scenarios satisfying each criterion.

Filtering criterion	Value	Reference	Number (%) of C1 scenarios meeting criterion
Maximum primary energy from bioenergy in any year between 2010-2050	<100 EJ	Frank et al., 2021	30 (31%)
Maximum BECCS deployment between 2010-2050	<3 Gt CO_2	Warszawski et al. 2021	35 (36%)
Maximum CO_2 removed via afforestation in 2050	<3.6 Gt CO_2	Fuss et al., 2018	80 (82%)
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%)

[3] The IPCC's C1 ensemble comprises 97 globally modeled scenarios that limit warming to 1.5°C (>50%) with no or limited overshoot, meaning peak temperature exceedance is typically ≤ 0.1°C before returning by or before 2100 (IPCC, 2023). These scenarios assume immediate, deep GHG reductions, reaching net-zero CO_2 in the early 2050s, declining to net-zero GHG later in the century.

Table 4.2.2. Filtering scenarios based on Key variables for SDA calculation.

Key variables for SDA calculation	Number of scenarios meeting the criteria	(%) of filtered scenarios with power sector variables
Emissions|CO2|Energy|Supply|Electricity	12	63%
Secondary Energy|Electricity	16	84%
Carbon Sequestration|CCS|Biomass|Energy Supply|Electricity	8	42%

Table 4.2.3. Modelling framework and IPCC scenarios that meet the filtering criteria.

Model	Scenarios
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_COV
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
REMIND-MAgPIE 2.1-4.2	EN_NPi2020_600f_COV
MESSAGEix-GLOBIOM_1.1	NGFS2_Net-Zero 2050
REMIND-MAgPIE 2.1-4.2	SusDev_SDP-PkBudg1000

4.2.1 IEA NZE pathway

Mitigation scenarios with sufficient granularity at the power sector level are required to establish the emissions intensity convergence benchmark. Eligible scenarios should include electricity generation projections, emissions, and carbon sequestration from bioenergy with carbon capture and storage (CCS). Based on these requirements and other relevant filtering criteria, the power sector pathway also draws from the IEA Net Zero Emissions by 2050 Scenario.

The Net Zero Emissions by 2050 scenario, originally published by the International Energy Agency in 2021 (IEA, 2021), is a normative, policy-driven roadmap that outlines a pathway to achieve net zero energy-related and industrial process CO2 emissions by 2050. The SBTi includes the IEA NZE in the power sector pathway development based on the following reasons:

- The IEA NZE scenario emphasizes decarbonizing electricity generation as a foundation for broader economy-wide decarbonization. The IEA pathway includes near-term milestones and detailed technology deployment strategies.
- The IEA NZE scenario provides specific and actionable projections for rapidly scaling up renewable energy technologies, which is crucial for the power sector's transformation.

- The IEA NZE scenario includes comprehensive data on technology costs, learning curves, and deployment timelines.
- The IEA NZE ensures that the power sector transition maintains energy security and grid reliability, accounting for the variability of renewables and the need for storage, backup generation, and flexible grids (IEA 2023).

Figure 4.2.1 compares the IEA NZE scenario, the median of 8 selected scenarios from the C1 category, and the interquartile range of AR6 C1 scenarios regarding key mitigation drivers. A key deviation of the IEA NZE scenario from the IPCC scenarios is the high reliance on bioenergy sequestration as a mitigation lever. The IEA NZE scenario projects a rapid phase-out of unabated fossil fuels for power generation by 2050. In contrast, the IPCC scenarios indicate a slower decline, with unabated fossil fuel generation reaching nearly three times the level of the IEA's projections. Figure 4.2.2 shows that global electricity sector emissions rapidly decline across all scenarios, from ~12,000 Mt CO2/yr in 2020 to near-zero or negative levels by 2050, demonstrating a feasible decarbonization pathway for power generation.

Figure 4.2.1. Summary of key characteristics among scenarios included in the power sector pathway. The "filtered_power sector" scenario is the median of the IPCC scenario ensemble that informs the power sector pathway. Dashed lines show the 25th (blue) and 75th (red) percentile values across the 97 C1 scenarios in the AR6 database.

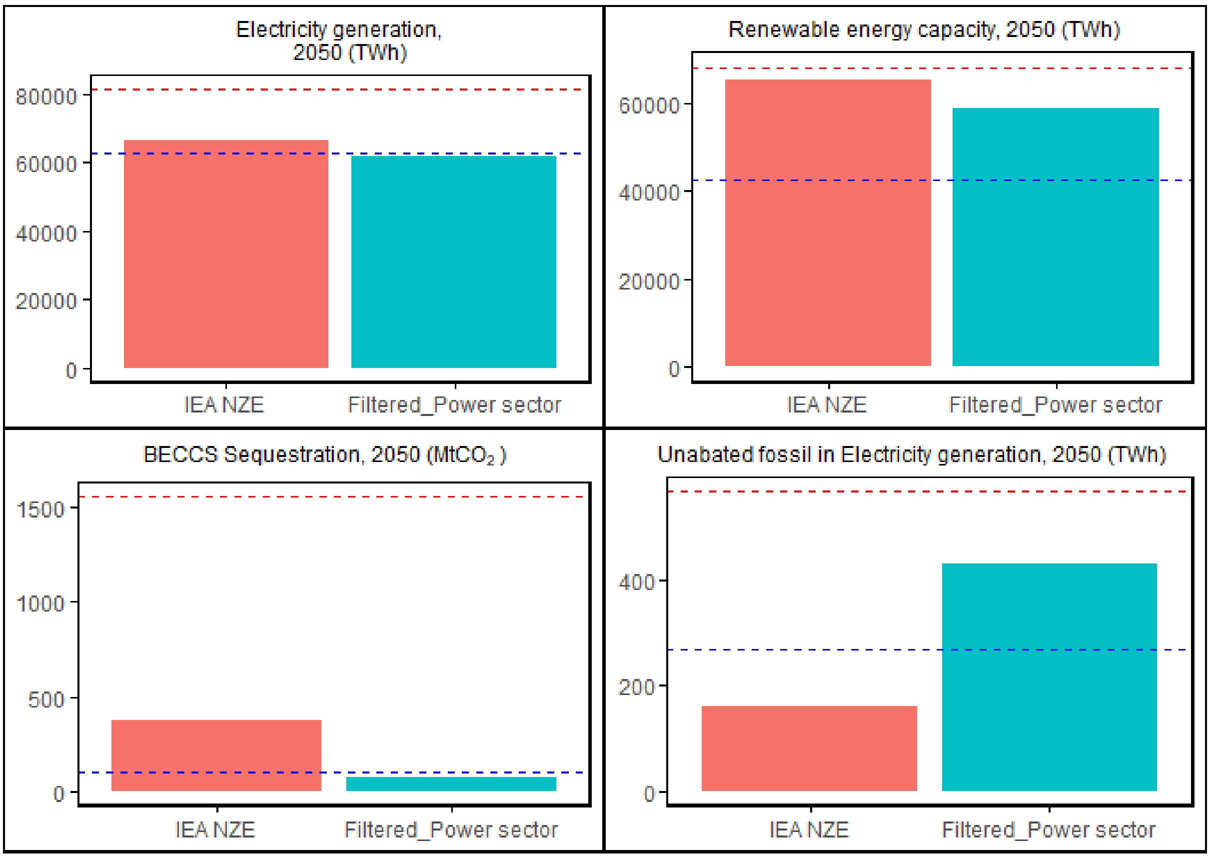


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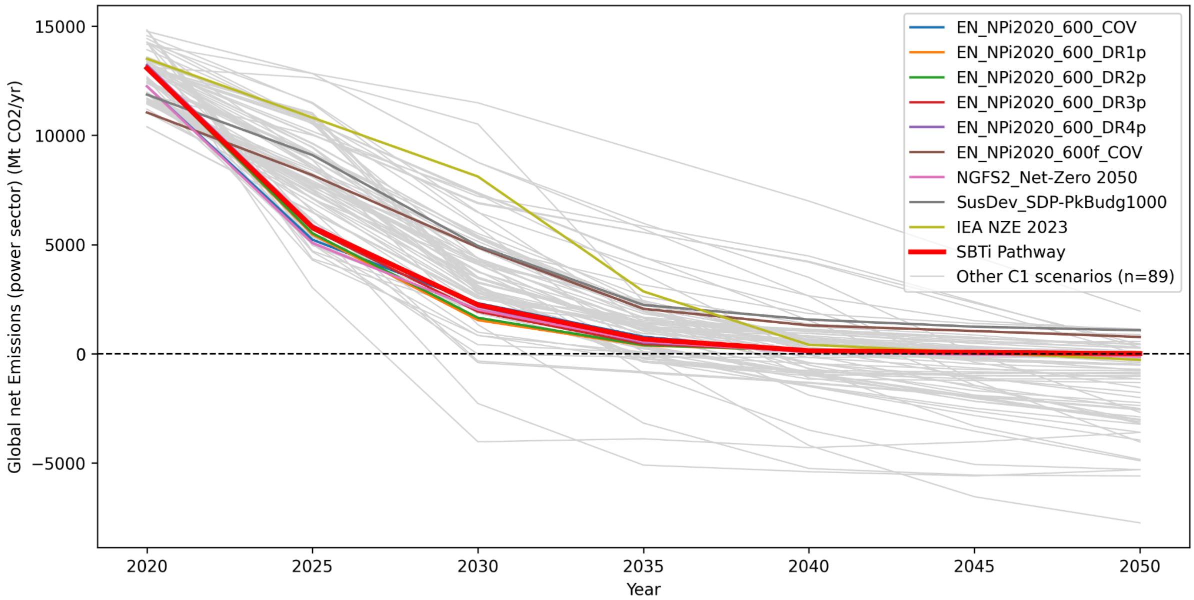
Figure 4.2.2 Net emissions from electricity generation. The scenarios in the legend represent those that meet the filtering criteria and demonstrate sufficient sectoral detail. The SBTi pathway, depicted in red, represents the median trajectory derived from the scenario ensemble for the power sector pathway development.



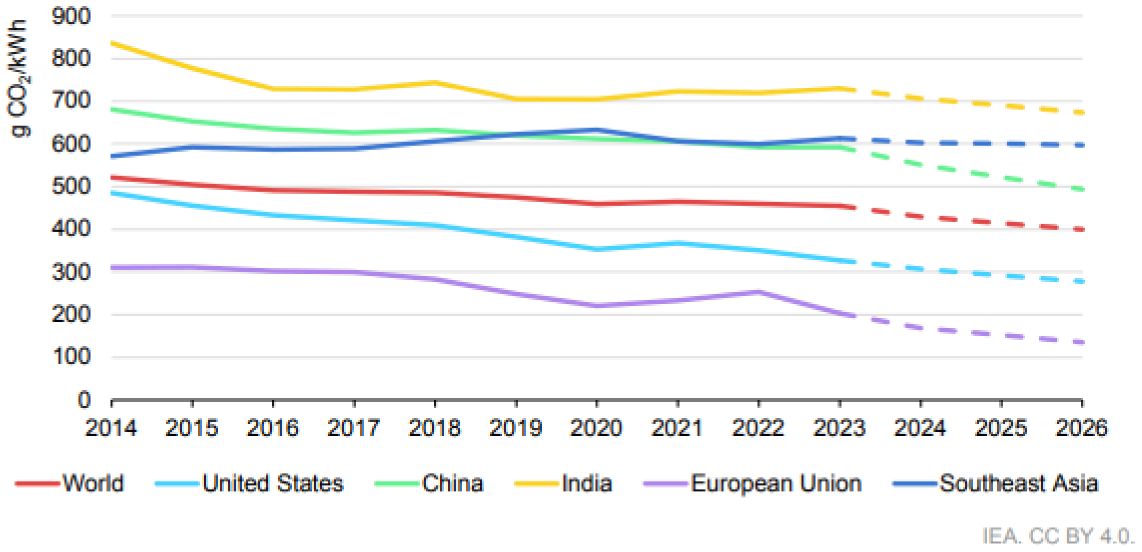
4.3. Exploring regional differentiation in pathway development

The power sector uses a global reference pathway and thus takes a global approach to target-setting for the power sector standard. In a global approach, target setting is consistent across regions, with the same ambition levels and decarbonisation. We explored the option of regional pathways in the development process, particularly on the Scientific Advisory Group (SAG)[4] recommendation. Implementing regional pathways in the power sector could address equity gaps and just transition issues.

The power sector is highly diverse at a global level, and national development of power generation depends on many factors, such as available natural resources, economic strengths, geopolitical views, access to finance, and technological access. Data from the IEA (Figure 4.3.1) indicates the range of emissions intensities across different regions. Despite this, the short-term trend in all regions is for a decrease in emissions intensity for power generation.

[4] The SAG is composed of experts from the scientific community with specialized expertise in climate science and climate change mitigation. They provide advice to ensure the robustness of the pathways and methods that underpin science-based target-setting.

Figure 4.3.1. CO_2 intensity of electricity in selected regions, 2014-2026 (IEA, 2024).



Note: The CO_2 intensity is calculated as total CO_2 emissions divided by total generation.

A significant amount of literature identifies financial capacity and local legislation as barriers to setting net-zero targets in the power sector. Additionally, the fairness of carbon budget allocation at regional and company levels is raised under the "polluter pays" principle, which would draw on historical emissions to place an increasing responsibility for the transition on those who have historically contributed the most emissions.

The collective perception influences the political feasibility of how quickly and extensively decarbonization can occur, which is shaped by geography, available infrastructure, and wealth (James et al. 2018). The political narrative also influences how citizens perceive the value of transition, the likelihood of the private sector adopting initiatives such as the SBTi, and the ease of implementing targets. This way, recognising the importance of social justice becomes highly important.

An IEA forecast on the share of electricity generation from solar PV and wind in different regions by 2030 shows that while the share currently differs greatly across the world, the regions are expected to converge significantly on the share of solar PV and wind by 2030[4].

4.3.1 Allocation mechanisms

To understand the potential for a quantified regional approach for the SBTi Power Sector Standard, it is necessary first to choose the allocation mechanism used to distribute the identified remaining carbon budget for the power sector, as derived at the global level and in compliance with the cross-sector pathway.

The global carbon budget (GCB) could be distributed following EPC (equal per capita) simple or qualified and PCC (per capita convergence) simple or qualified allocation approaches, including qualifications for addressing basic needs (N-qualified), counting historical emissions (H-qualified), benefits of previous emissions (B-qualified), and a combination of all three previous considerations (NHB-qualified) (Keith et al. 2022) (Table 4.3.1.1).

The suitability of these mechanisms and qualifications is open for discussion.

Table 4.3.1.1. Allocation mechanisms summary.

<table>
<tr><th>Mechanisms (Simple)</th><th></th><th>Shortcomings</th><th>NHB-qualification</th></tr>
<tr><td rowspan="3">PCC—per-capita convergence</td><td rowspan="3">Allocates carbon budgets based on current emission levels, converging to equal per capita emissions by 2050</td><td>Legitimises current unequal emission levels</td><td rowspan="6">N-qualified:
● Allocate additional emissions to countries with a human development index (HDI) below a certain threshold.
H-qualified:
● Deduct emissions caused since 1995 from the remaining carbon budget of each country.
B-qualified:
● Deduct emissions embodied in infrastructure available in 1995 from the remaining budget of each country.
NHB-qualified:
● Apply all qualifications together to ensure a comprehensive distribution of the GCB.</td></tr>
<tr><td>Risks frustrating the basic needs of people in developing countries due to unequal per capita shares during transition.</td></tr>
<tr><td>Does not address historical emissions</td></tr>
<tr><td rowspan="3">EPC—equal per capita:</td><td rowspan="3">Distribute the remaining carbon budget equally among all people from 2017 to 2050.</td><td>Does not consider current emission levels</td></tr>
<tr><td>Does not address historical emissions.</td></tr>
<tr><td>It may not be enough for countries with historically low emissions to meet basic needs.</td></tr>
</table>

4.3.2 Regional outlooks

Another means of determining regional sector pathways is to look at feasible outlooks that have been determined, considering how the region can decarbonise from its current state. One example of this is regional analysis from the IEA's Roadmap to Net Zero 2050, which concludes that the electricity sector reaches net zero emissions in advanced economies in aggregate in 2035, in China around 2040, and globally before 2045 in a net zero scenario.

Applications of such analysis would require access to the full IEA Net-Zero Scenario dataset, which is currently being arranged, and careful consideration of how it would interact with the current SBTi power sector pathway, which is built from a selection of scenarios published by the IPCC and IEA.

While the IEA Net-Zero Scenario makes equity considerations, it is unclear if an allocation mechanism was explicitly applied.

To support the development of a regionally differentiated pathway for the power sector, the SBTi is currently consulting on several key questions. These include whether a quantitative, distributive approach to allocating the power sector carbon budget is appropriate, and if so, which allocation mechanism, such as per capita convergence (PCC) or equal per capita (EPC), would be most suitable. Further consideration is being given to whether any adjustments to these mechanisms are needed to account for equity-related concerns, such as addressing basic needs (N-qualified), accounting for historical emissions (H-qualified), or considering the benefits accrued from previous emissions (B-qualified).

In addition, the consultation explores whether alternative allocation mechanisms should be considered beyond the PCC and EPC frameworks. Finally, the process seeks to evaluate whether existing procedural elements within the Power Sector Standard adequately address equity or if modifications are required to ensure a fair and balanced application across regions.

5. POWER SECTOR PATHWAY

This section presents an update on the power sector pathway used by most power generation companies, setting targets validated by SBTi. The previous power sector pathway, published in 2020 (SBTi, 2020), was determined based on a combination of science and principled judgments. The pathway defined the convergence intensity by 2040 from power generation at a global level, consistent with a 50% chance of keeping global warming levels to 1.5°C by the end of this century. Several reasons necessitate updating the power sector pathway.

- Updates in key reference scenarios require alignment with the latest science and policy developments. The previous pathway was informed by a focal scenario from the IPCC SR1.5 report for near-term targets and the IEA 2021 Net Zero Emissions (NZE) scenario for long-term targets (SBTi, 2020). Since then, the IEA has released updated pathways, reflecting accelerated renewable energy deployment, policy shifts, and technological advancements.
- Since the release of SR1.5, numerous studies have expanded the understanding of power sector pathways and associated emissions trajectories. These studies offer deeper insights into sector-specific trends, including the evolving role of renewables, grid flexibility, and low-carbon power sources in achieving net-zero emissions
- Finally, separate pathways for near-term and net-zero target-setting in the previous pathway show applicability challenges, especially for companies with low-intensity baseline emissions.

The updated power sector pathway covers both near-term and net-zero emission trajectories. Tables 5.1 and 5.2 present a summary of the metrics and emission reduction benchmarks.

Table 5.1. Key metrics for Power Sector Pathway development.

Key metrics	Unit	2020	2025	2030	2035	2040	2045	2050
Absolute gross CO_2 emission	MtCO2/yr	13071	5698.57	2165	587	180	123	79
Emission intensity	tCO2/MWh	0.4736	0.1973	0.0645	0.0148	0.003	0.0019	0.0010
Power generation	TWh/yr	27597	29851	37185	45458	5420	64999	76040

Table 5.2 Absolute gross emission reduction in power generation. The 25th and 75th interquartile range is presented in brackets.

	Unit	2020-2025 (%)	2020-2030 (%)	2020-2035 (%)	2020-2040 (%)	2020-2045 (%)	2020-2050 (%)
Gross CO_2 emission	%	56.4 [37.5-55.4]	83.4 [62.7-84.2]	95.5 [84.1-96.1]	98.6 [97.1-98.7]	99.1 [98.2-99.1]	99.4 [99.2-99.4]

5.1 Electricity losses from transmission, distribution and storage activities

The power sector standard expands the list of activities relevant to the sector that are covered by SBTi target-setting guidance. Physical emissions intensity is an appropriate metric for companies engaged in power generation, but to reflect the decarbonization levers available to companies operating in other parts of the value chain, novel activity-specific metrics are proposed.

For transmission and distribution, metrics focus on grid efficiency improvements and reductions in network losses, which directly influence system-wide decarbonization outcomes. For electricity storage, metrics capture efficiency gains and the minimization of storage losses across charging and discharging cycles. The scenario variables used in estimating transmission and storage losses are presented in Tables 5.1.1 and 5.1.2. The resulting benchmark trajectories are presented in Table 5.1.3

Table 5.1.1. Models, scenarios, and variables used to derive electricity transmission and distribution loss metric.

Model	Scenario	Variable
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_COV	Secondary Energy|Electricity|Transmission Losses
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_COV	Secondary Energy|Electricity
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR1p	Secondary Energy|Electricity|Transmission Losses
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR1p	Secondary Energy|Electricity
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR2p	Secondary Energy|Electricity|Transmission Losses
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR2p	Secondary Energy|Electricity
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR3p	Secondary Energy|Electricity|Transmission Losses
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR3p	Secondary Energy|Electricity

Model	Scenario	Variable
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR4p	Secondary Energy|Electricity|Transmission Losses
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR4p	Secondary Energy|Electricity
MESSAGEix-GLOBIOM_1.1	NGFS2_Net-Zero 2050	Secondary Energy|Electricity|Transmission Losses
MESSAGEix-GLOBIOM_1.1	NGFS2_Net-Zero 2050	Secondary Energy|Electricity

Table 5.1.2. Models, scenarios, and variables used to derive electricity storage loss metric.

Model	Scenario	Variable
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_COV	Secondary Energy|Electricity|Storage Losses
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_COV	Secondary Energy|Electricity
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR1p	Secondary Energy|Electricity|Storage Losses
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR1p	Secondary Energy|Electricity
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR2p	Secondary Energy|Electricity|Storage Losses
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR2p	Secondary Energy|Electricity
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR3p	Secondary Energy|Electricity|Storage Losses
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR3p	Secondary Energy|Electricity
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR4p	Secondary Energy|Electricity|Storage Losses
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR4p	Secondary Energy|Electricity
MESSAGEix-GLOBIOM_1.1	NGFS2_Net-Zero 2050	Secondary Energy|Electricity|Storage Losses
MESSAGEix-GLOBIOM_1.1	NGFS2_Net-Zero 2050	Secondary Energy|Electricity

Table 5.1.3 Milestone year benchmark values for electricity transmission and distribution loss target setting and storage loss.

Metrics for activities	Unit	2020	2025	2030	2035	2040	2045	2050
Transmission and distribution loss	%	13.59 %	12.78 %	11.67 %	10.99 %	10.37 %	9.83%	9.23%
Storage loss	%	0.00%	1.58%	4.87%	6.46%	6.47%	6.34%	6.04%

The derived pathway for transmission and distribution activities presents notable methodological limitations. First, the variable *Secondary Energy | Electricity | Transmission Losses* accounts only for high-voltage transmission losses and omits losses associated with low-voltage electricity distribution. As a result, the pathway does not fully represent the total energy losses across the entire transmission and distribution (T&D) system. Furthermore, the scenario ensemble underpinning the power sector pathway does not include a variable that explicitly quantifies electricity distribution losses, making it impossible to construct an aggregate loss metric suitable for robust and comprehensive target setting. Second, the pathway is available only at the global aggregation level, which precludes its direct use in applying the Category A/B company differentiation framework introduced in CNZS v2.0, which relies on regionally or contextually disaggregated benchmarks.

Given the significant regional disparities in the efficiency of transmission and distribution (T&D) networks, particularly between developed and developing economies, the net-zero-aligned benchmarks derived from this metric may be disproportionately stringent for some companies and insufficiently ambitious for others. Moreover, the limited granularity of the power sector pathway prevents differentiation between *technical losses* (e.g., resistive losses in conductors, transformer inefficiencies) and *non-technical losses* (e.g., electricity theft, metering inaccuracies). These categories require distinct mitigation levers: technical losses can be addressed through infrastructure upgrades and grid optimization, whereas non-technical losses are primarily institutional and enforcement-related. It is therefore arguable that interventions to address non-technical losses fall outside the core scope of SBTi's mandate, which is focused on science-based climate action rather than broader governance or anti-corruption efforts.

To enable practical target setting, a 'best practice approach' is proposed based on real-world data on transmission and distribution losses (World Bank Group, 2023). While this method does not generate a modeled pathway with milestone year benchmarks, it offers two key advantages: it incorporates both transmission and distribution losses—addressing the data gap in the scenario-derived pathway—and supports alignment with the Category A/B company framework. Notably, this approach results in more ambitious targets. The minimum loss thresholds for Category A and B companies (2.0% and 5.7%, respectively) are significantly more stringent than the benchmark derived from the power-sector pathway (9.23%).

Table 5.1.2 Alternative approach for transmission and distribution loss metric using World Bank/IEA data.

Metric	Unit	Category	Level	Value
Electricity transmission and distribution loss	%	A	Min	2.0
Electricity transmission and distribution loss	%	A	Mean	10.8
Electricity transmission and distribution loss	%	B	Min	5.7
Electricity transmission and distribution loss	%	B	Mean	20.1

5.2. Global transition milestones

This section presents key global milestones for power sector transformation, focusing on shifts in technology and fuel mix through mid-century. The data reflects the 50th percentile of the combined pathway, aggregated from selected IPCC and IEA scenarios used to construct the SBTi power sector pathway

Multiple levers, including the phase-out of unabated fossils and the ramp-up of renewables, drive system-wide transformation in the power sector. Electricity generation from fossil fuels, which accounts for 70% of total generation in 2020, will reduce to about 17% by 2030. Unabated coal generation is phased out by 2040, while there is a more gradual reduction in abated coal generation (Tables 5.1.1 and 5.1.2). Abated natural gas generation scales up fivefold from 2030 to 2050, supporting system flexibility and firm capacity as variable renewables dominate the electricity mix.

Renewables remain pivotal in driving significant transition in the power sector, with its share of total electricity generation rising from 30% in 2020 to 83% by 2030 and reaching 96% by mid-century (Figure 5.2.1). The contribution of different renewable energy sources reflects a transition in the generation mix. Electricity generation from hydro shows the largest renewable share; however, its relative contribution declines as other renewable technologies scale up. Solar PV rapidly expands in the near term, becoming a major generation source. Wind power steadily increases, reaching the highest share of 42% by mid-century (Figure 5.2.2).

The power sector standard is consulting on the technology share convergence method, which determines interim performance values for key electricity-generating technologies. This method can be applied to technology pathways at various levels of granularity, from a simple binary low-carbon vs. carbon-intensive generation approach to the individual generation asset level. This beta version is consulting on the low-carbon technology share approach as presented in figure 5.2.2.

Bioenergy derived from sustainable feedstocks plays a pivotal role in deep decarbonization, enabling both a zero-carbon energy supply and carbon dioxide removal when coupled with carbon capture and storage (CCS) technologies, known as BECCS. BECCS offers a dual benefit by generating electricity while removing CO_2 from the atmosphere, making it a key technology for negative emissions. The BECCS deployment drives net zero in the power sector by mid-century. Nuclear energy contributes to transforming the power sector, with its generation share relative to total electricity generation reaching 15% by 2030 and 18% by 2050.

Figure 5.2.1 Fuel shares in global electricity generation. Renewables include solar PV, CSP, hydro, wind, and geothermal.

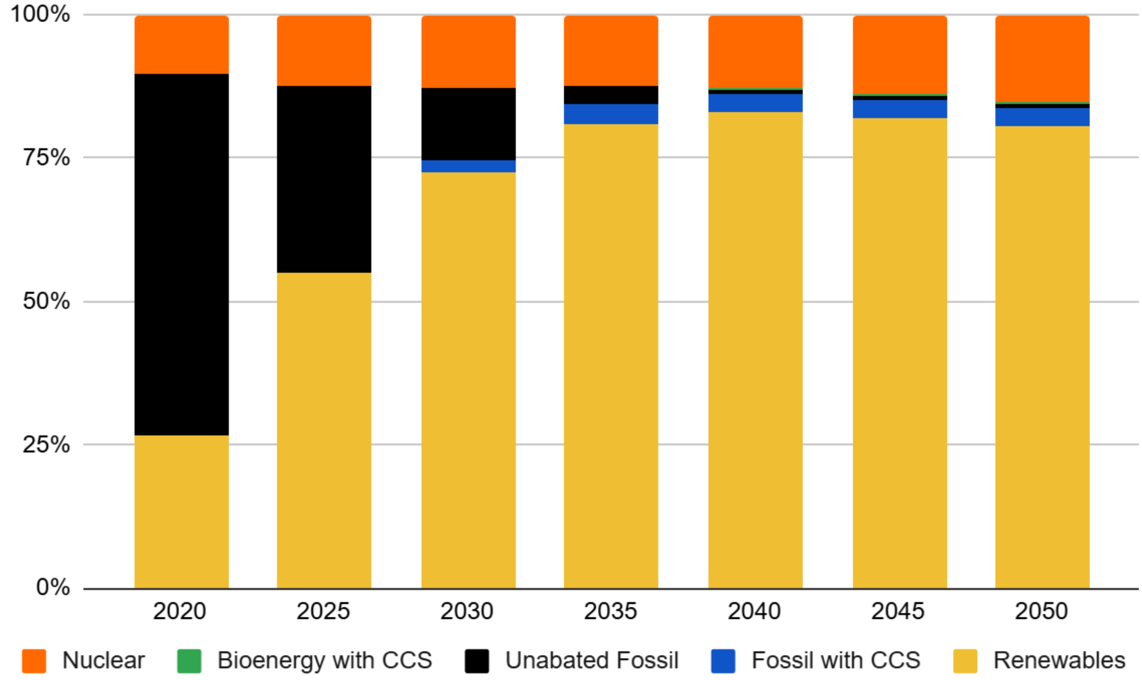


Figure 5.2.2. Technology share of electricity generation. Low carbon includes hydro, nuclear, solar, wind, geothermal, abated gas, abated coal, and bioenergy with CCS. Unabated fossil includes unabated coal, unabated gas, and oil.

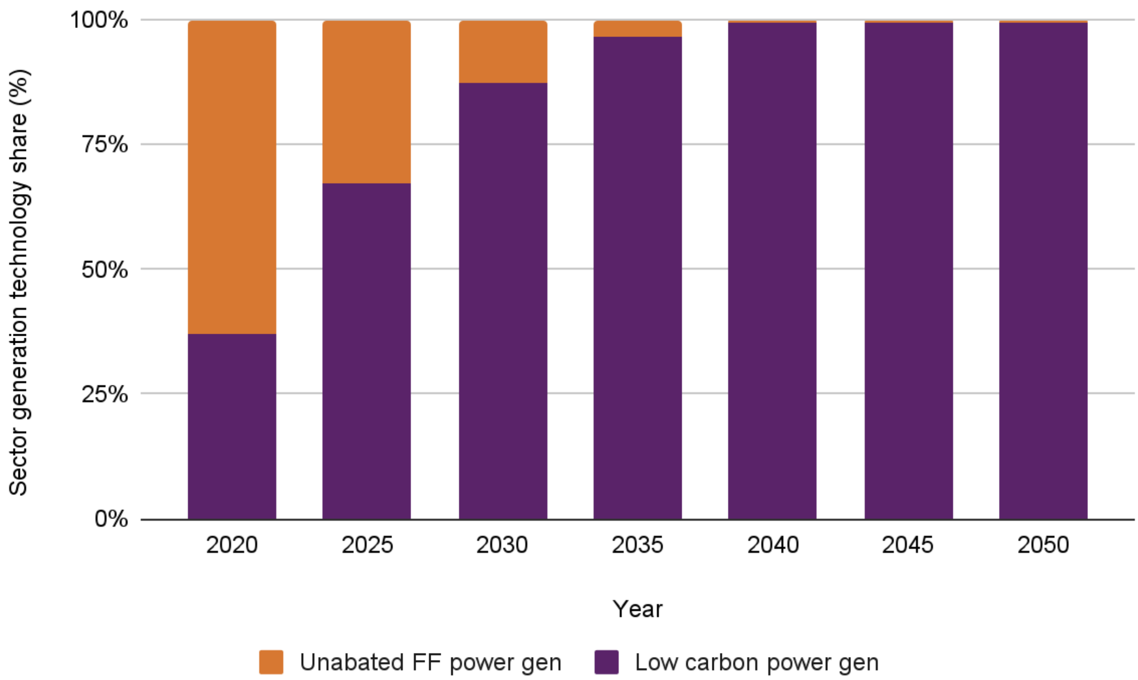


Table 5.2.1 Global Fossil Electricity Generation.

	Unit	2020	2025	2030	2035	2040	2045	2050
Abated coal	TWh/yr	0	0	268	393	172	62	42
Unabated coal	TWh/yr	9426	3328	751	73	0	0	0
Abated natural gas	TWh/yr	0	3	487	1044	1511	1988	2283
Unabated natural gas	TWh/yr	6632	5596	3467	1301	281	329	396
Unabated oil	TWh/yr	567	235	92	57	36	24	12

Table 5.2.2 Fossil Share in Global Electricity Generation.

	Unit	2020	2025	2030	2035	2040	2045	2050
Abated coal	%	0.00%	0.00%	1.02%	1.07%	0.38%	0.15%	0.07%

	Unit	2020	2025	2030	2035	2040	2045	2050
Unabated coal	%	39.94%	13.51%	2.51%	0.19%	0.00%	0.00%	0.00%
Abated natural gas	%	0.00%	0.01%	1.63%	2.74%	3.30%	3.70%	3.76%
Unabated natural gas	%	28.10%	22.71%	11.59%	3.41%	0.61%	0.61%	0.65%
Unabated oil	%	2.40%	0.96%	0.31%	0.15%	0.08%	0.04%	0.02%

5.3. Unabated fossil fuel phaseout

The power sector standard requires power generation utilities to disclose and implement asset-level phase-out plans for unabated fossil fuel capacity. This criterion is designed to drive structural transformation by mandating transparency on the timing and strategy for retiring unabated fossil-based generation assets.

Recognizing regional differences in technological maturity, financial resources, and policy readiness, the standard sets differentiated phase-out milestones for Organization for OECD and non-OECD countries[5] (see the list in the Supplementary, Table S2), aligning timelines with each region's ability to implement the transition

Phase-out trajectories are drawn from the IEA NZE Scenario, which offers region-specific projections absent in the global-level IPCC scenarios, making it better suited for differentiated timelines. Phase-out milestones can be derived either from the net installed capacity pathway or from the average annual retirement benchmarks provided by the IEA.

5.3.1 Net installed capacity

Net installed capacity data reflects the total stock of installed unabated fossil fuel capacity at a given point in time, representing the combined outcome of retirements of existing plants, additions of new unabated capacity, and the reclassification of retrofitted plants (e.g., those equipped with carbon capture), which are no longer counted as unabated. As such, net capacity reductions do not directly indicate how much capacity was retired, making it difficult to isolate the actual phase-out of fossil assets without supplemental data on annual retirements.

The IEA Net Zero Emissions by 2050 Scenario (NZE) projects a rapid decline in unabated fossil fuel capacity used for power generation. The scenario shows a steep reduction in unabated coal and oil capacity throughout the period, while natural gas capacity sees a modest increase up to 2030, followed by a sharp decline thereafter.

By 2040, at least 74% of unabated coal capacity and 82% of unabated oil capacity must

[5] The OECD stands for the Organisation for Economic Co-operation and Development, an international organization that works to promote policies that improve the economic and social well-being of people around the world. The OECD acts as a forum for governments to collaborate on economic, social, and environmental issues.

have been either decommissioned or abated. By 2050, these rates increase to 89% for unabated coal, 91% for unabated oil, and 67% for unabated gas. Despite some remaining installed capacity, the share of generation from these assets declines to near zero by mid-century, indicating that any residual fossil capacity is retained solely for non-routine operations, such as maintaining grid reliability, providing contingency reserves, or addressing peak demand periods. This interpretation is confirmed by the observed decline in average capacity factors for all asset types, achieving capacity factors of less than 10% from 2040 onwards.

Figure 5.3.1. Projected unabated fossil fuel capacity (GW) under the IEA Net Zero Emissions by 2050 Scenario (NZE).

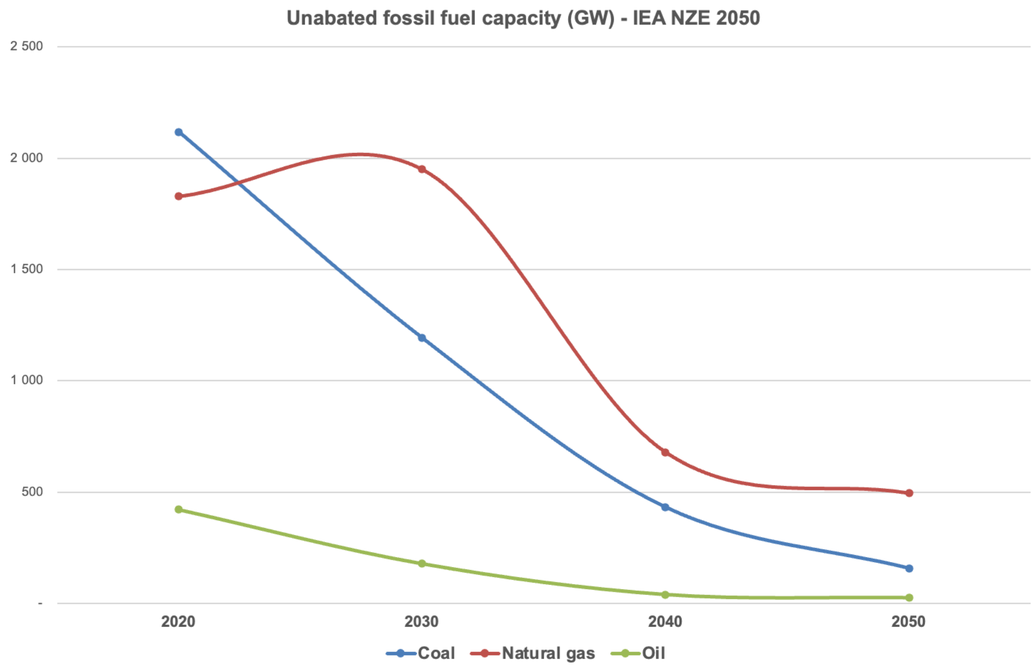


Table 5.3.1 Projected capacity decline of unabated fossil capacity.

	Capacity decline				
Unabated fossil fuel capacity (GW)	**2020-2030**	**2030-2040**	**2040-2050**	**2020-2050**	
Coal	31%	62%	55%	89%	
Natural gas	5%	38%	44%	67%	
Oil	48%	66%	48%	91%	
	2020-2030	2020-2035	2020-2040	2020-2045	2020-2050
Coal	31%	57%	74%	81%	89%

Natural gas	5%	23%	41%	54%	67%
Oil	48%	67%	82%	85%	91%

5.3.2 Average annual capacity retirements

Anchoring the phase-out of unabated fossil fuel assets on the average annual retirement rates, as reported in the IEA NZE, represents the actual capacity decommissioned per year, independent of new builds or technology retrofits, and offers a more direct measure of structural change in the power sector.

The assessment reveals a steep and front-loaded phase-out of coal, with 94% of capacity retired by 2050. Natural gas capacity declines more gradually, with a 67% reduction by 2050, reflecting its transitional role in supporting system flexibility through mid-century. Unabated coal capacity is retired rapidly in the near term—73% by 2040—while gas retirement is less abrupt.

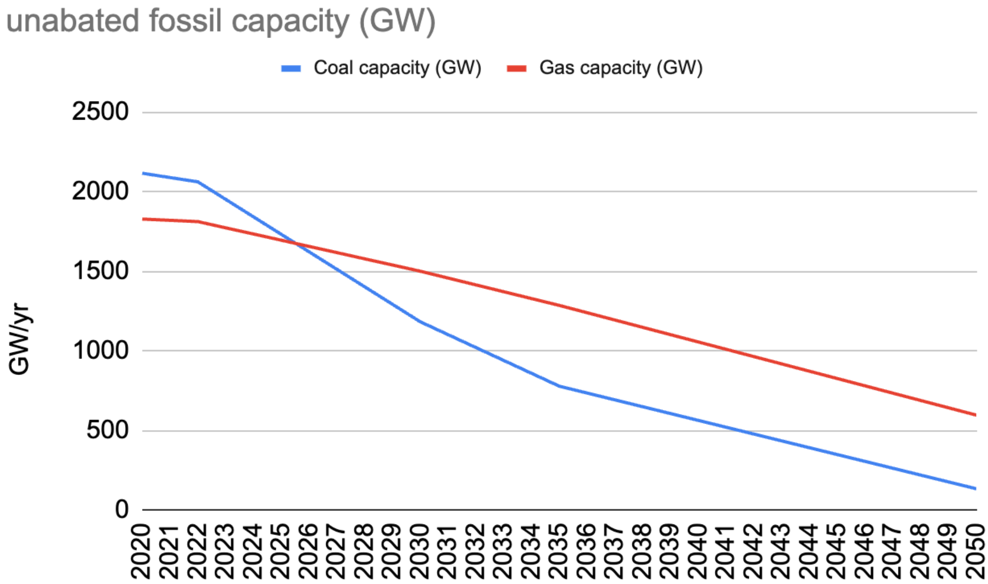
Table 5.3.2. Average annual capacity retirements (GW).

Average annual retirement rate (GW)	2017-2022	2023-2030	2031-2035	2036-2050
Coal	27	110	81	43
Natural gas	8	39	43	46

Table 5.3.3. Projected capacity decline of unabated fossil capacity.

	Capacity decline				
Unabated fossil fuel capacity (GW)	**2020-2030**	**2030-2040**	**2040-2050**	**2020-2050**	
Coal	44%	52%	76%	94%	
Natural gas	18%	30%	44%	67%	
	2020-2030	**2020-2035**	**2020-2040**	**2020-2045**	**2020-2050**
Coal	44%	63%	73%	85%	94%
Natural gas	18%	30%	42%	55%	67%

Figure 5.3.2. Projected unabated fossil fuel capacity (GW) based on the annual retirement capacity under the IEA Net Zero Emissions by 2050 Scenario (NZE). The retirement decline was calculated from the 2020 capacity level. The global unabated coal and gas capacity in 2020 was 2117 GW and 1829 GW, respectively (IEA, NZE).



The global average annual retirement rate for unabated fossil capacity is used to estimate the overall reduction trajectory (Figure 5.2.2). This approach forms the basis for deriving the interim benchmark in the power sector standard. The assessment indicates that:

- No new unabated coal power plants are approved for development globally after 2023.
- Power utility companies in OECD countries should retire all existing unabated coal capacity by 2030, while non-OECD countries are projected to complete their coal phase-out by 2040. By 2035, 85% of the unabated coal assets in the non-OECD should be retired.
- Oil-fired power is expected to be phased out in the OECD region by 2035, while non-OECD countries are projected to complete their oil phase-out by 2040. By 2035, 85% of the unabated oil assets in the non-OECD should be retired.
- Unabated gas power is expected to be phased out in the OECD region by 2035, while non-OECD countries are projected to complete their gas phase-out by 2040. By 2035, 55% of the unabated gas assets in the non-OECD should be retired.

Table 5.3.4. Proposed unabated fossil capacity retirement, differentiated by OECD and non-OECD regions.

		2023	2030	2035	2040
Unabated coal	**OECD**	No new capacity	Full retirement		
	non-OECD	No new capacity		Retirement of 85% capacity	Full retirement

Unabated oil	**OECD**	No new capacity		Full retirement	
	non-OECD	No new capacity		Retirement of 85% capacity	Full retirement
Unabated gas	**OECD**	No new capacity*		Full retirement*	
	non-OECD		No new capacity*	Retirement of 55% capacity	Full retirement

To maintain alignment with the full retirement deadline, the interim benchmark for non-OECD countries anchored on the global pathway of unabated fossil capacity retirement is brought forward by 10 years—for example, advancing the coal retirement milestone originally set for 2045 to 2035.

6. LIMITATION AND RECOMMENDATIONS

Despite the robust framework followed in the pathway development process, we acknowledge that a lack of more granular details in geographical scopes has certain applicability implications. These gaps should trigger future updates following the recommendations presented in Table 6.1.

Pathways revisions should be based on aligning with the latest advances in technological innovation, sectoral budget, or model updates. Pathway revision can also be triggered by new mitigation scenarios that pass the SBTi's principle-driven criteria, ensuring methodologies, assumptions, and baseline parameters align with the evolving sectoral landscape.

Table 6.1. Recommendation for pathway development.

Criteria	Status	Recommendations
Geographical scope	Optional	Scenario assessment should include regional nuance, accounting for local emission profiles, resource availabilities, and socio-economic conditions. A strong case for distributive equity should be presented for mitigation and adaptation actions, including, but not limited to: ● Resource transfer to power-generating companies in less developed regions is recommended in the distributive ambit actions. ● mobilisation of finance, technological transfer, and capacity building ● Equitable mitigation responsibilities, accounting for countries` historical emissions, Complementary to distributive dimensions, other procedural equity frameworks should be considered. ● Participation of Indigenous or vulnerable groups in climate negotiations. ● Inclusive decision-making processes in global policy formulation

S. SUPPLEMENTARY

S.1 Scenario ensemble

Table S1 presents the scenarios that inform the power sector pathway drawn from the IPCC C1 category and the IEA NZE.

Table S1. Scenarios that inform the power sector pathway.

Model	Scenario	Literature reference
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_COV	Riahi, K., Bertram, C., Huppmann, D., Rogelj, J., Bosetti, V., Cabardos, A. M., ... & Zakeri, B. (2021). Cost and attainability of meeting stringent climate targets without overshoot. Nature Climate Change, 11(12), 1063-1069. https://doi.org/10.1038/s41558-021-01215-2; Bertram, C., Riahi, K., Hilaire, J., Bosetti, V., Drouet, L., Fricko, O., ... & Luderer, G. (2021). Energy system developments and investments in the decisive decade for the Paris Agreement goals. Environmental Research Letters, 16(7), 074020. https://doi.org/10.1088/1748-9326/ac09ae; Hasegawa, T., Fujimori, S., Frank, S., Humpenöder, F., Bertram, C., Després, J., ... & Riahi, K. (2021). Land-based implications of early climate actions without global net-negative emissions. Nature Sustainability, 4(12), 1052-1059. https://doi.org/10.1038/s41893-021-00772-w
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR1p	(as above)
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR2p	(as above)

MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR3p	(as above)
MESSAGEix-GLOBIOM_1.1	EN_NPi2020_600_DR4p	(as above)
MESSAGEix-GLOBIOM_1.1	NGFS2_Net-Zero 2050	NGFS Climate Scenarios for central banks and supervisors, NGFS June 2021. https://www.ngfs.net/sites/default/files/media/2021/08/27/ngfs_climate_scenarios_phase2_june2021.pdf
REMIND-MAgPIE 2.1-4.2	EN_NPi2020_600f_COV	(as above)
REMIND-MAgPIE 2.1-4.2	SusDev_SDP-PkBudg1000	Soergel, B., Kriegler, E., Weindl, I., Rauner, S., Dirnaichner, A., Ruhe, C., ... & Popp, A. (2021). A sustainable development pathway for climate action within the UN 2030 Agenda. Nature Climate Change, 11(8), 656-664.https://doi.org/10.1038/s41558-021-01098-3
IEA	IEA NZE Net Zero Roadmap	IEA (2023). https://www.iea.org/reports/net-zero-roadmap-a-global-pathway-to-keep-the-15-0c-goal-in-reach

S.2 OECD and Non-OECD countries

Table S2. List of countries under the OECD and non-OECD regions (IEA, 2023).

Region	Countries
Organisation for Economic Co-operation and Development (OECD)	Australia, Austria, Belgium, Canada, Chile, Colombia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States.
Non-OECD	All other countries

S.3 Power sector transition in IEA NZE and IPCC scenarios

This section compares the decarbonization dynamics of the power sector in the IEA NZE 2023 scenario with those in IPCC-aligned pathways. Although all scenarios show transformation toward low-carbon power systems, they differ in technology deployment, emissions profiles, and pace of transition. For the development of the SBTi power sector pathway, we use the median of selected IPCC and IEA scenarios. This reflects a robust central estimate across a range of modelled outcomes, capturing the most representative emissions trajectory while reducing sensitivity to outlier assumptions. The following analysis examines how IEA NZE 2023 deviates from these IPCC scenarios, particularly in terms of slower near-term reductions.

- While many IPCC scenarios show a significant decline in gross emissions by 2030, reflecting deep early decarbonisation in the power sector, the IEA NZE 2023 scenario remains substantially higher (Figure S1). Specifically, gross emissions in 2030 reach over 8,000 $MtCO_2$ in IEA NZE 2023, compared to a median of approximately 2,100 $MtCO_2$ in the IPCC scenario ensemble. Even the 75th percentile among IPCC scenarios remains well below the IEA level.
- This divergence becomes even more apparent when examining net emissions. IEA NZE 2023 reports net emissions of 8,113 $MtCO_2$ in 2030, again, vastly higher than the IPCC median of approximately 2,240 $MtCO_2$ (Figure S2). This suggests that negative emissions technologies, primarily BECCS, is not yet playing a significant role by that year. In fact, IEA NZE 2023 shows net-positive BECCS deployment in 2030 (−41 $MtCO_2$). By contrast, IPCC pathways typically exhibit a modest yet increasing role for BECCS by 2030, with a median sequestration of about 6 $MtCO_2$.
- The IEA's slower trajectory appears to result from two structural frameworks. First, the IEA NZE 2023 scenario is designed around near-term feasibility and technological readiness, prioritising a slow ramp-up of BECCS, scaling up significantly only after 2035.
- The IEA pathway allows for a more gradual transition in the power sector compared to many IPCC scenarios. Rather than enforcing a rapid decline in fossil fuel-based electricity generation by 2030, the IEA NZE 2023 scenario permits continued use of fossil fuels, particularly natural gas, over a longer period.
- This delayed decarbonisation reflects the IEA's emphasis on near-term feasibility, infrastructure readiness, and realistic deployment timelines, especially in emerging markets. It contrasts with many IPCC pathways that assume more idealised or cost-optimised transitions.
- Overall, the high net emissions in IEA NZE 2023 by 2030 reflect a deliberate modelling choice to prioritise gradual transformation and delayed reliance on BECCS. While the IEA NZE scenario reaches net-zero by 2050, its path differs substantially from IPCC scenarios that assume earlier and more aggressive decarbonization across the energy system, particularly in the power sector.

Figure S1. Absolute gross emissions in eligible scenarios and updated power sector pathway. The SBTi pathway is the median of all eligible scenarios.

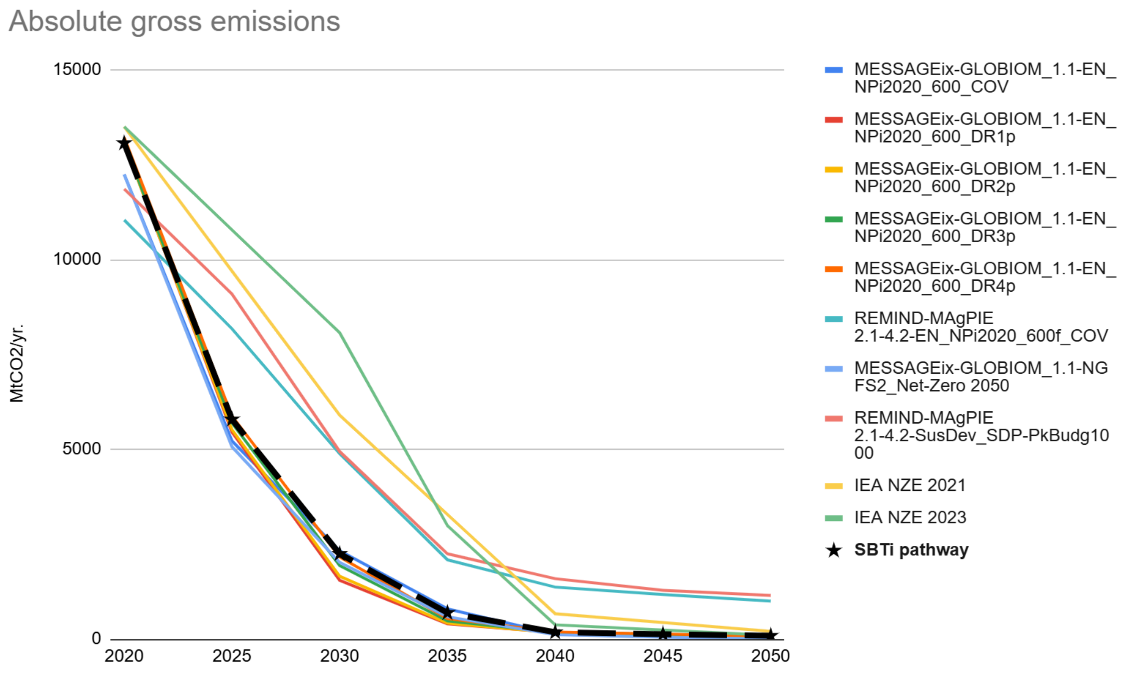


Figure S2. Absolute net emissions in eligible scenarios and updated power sector pathway. The SBTi pathway is the median of all eligible scenarios.

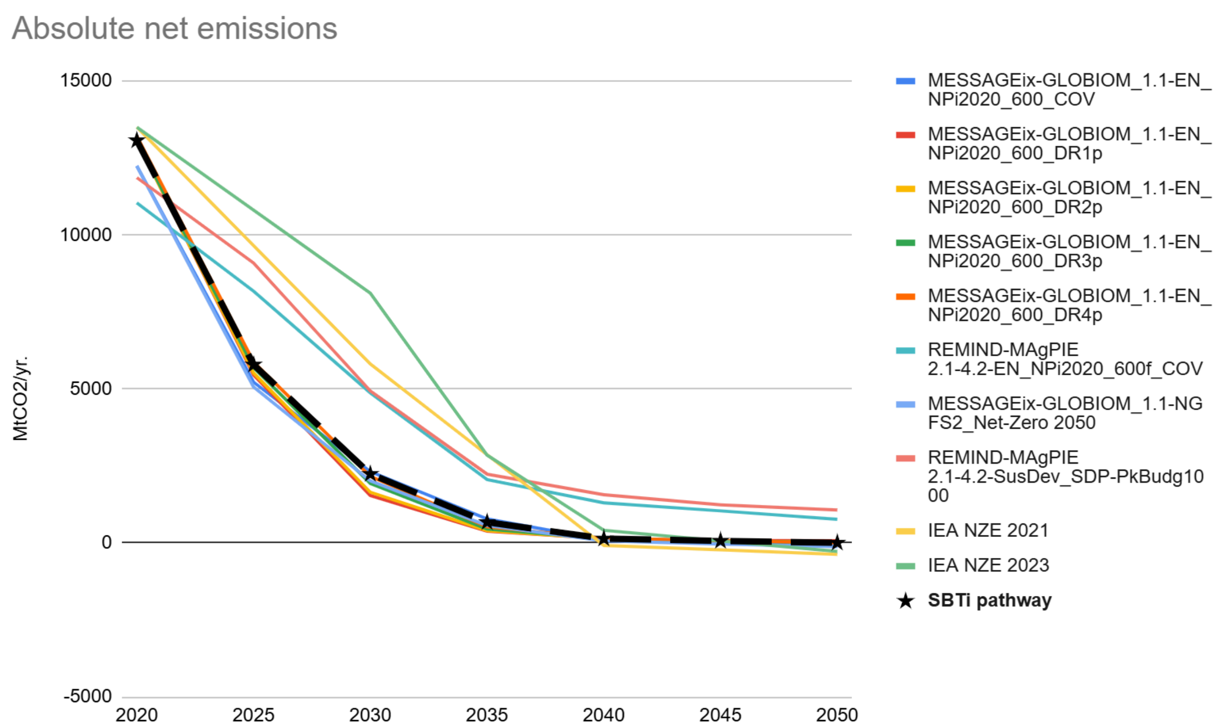


Figure S3. Emissions intensity in eligible scenarios and updated power sector pathway. The SBTi pathway is the median of all eligible scenarios.

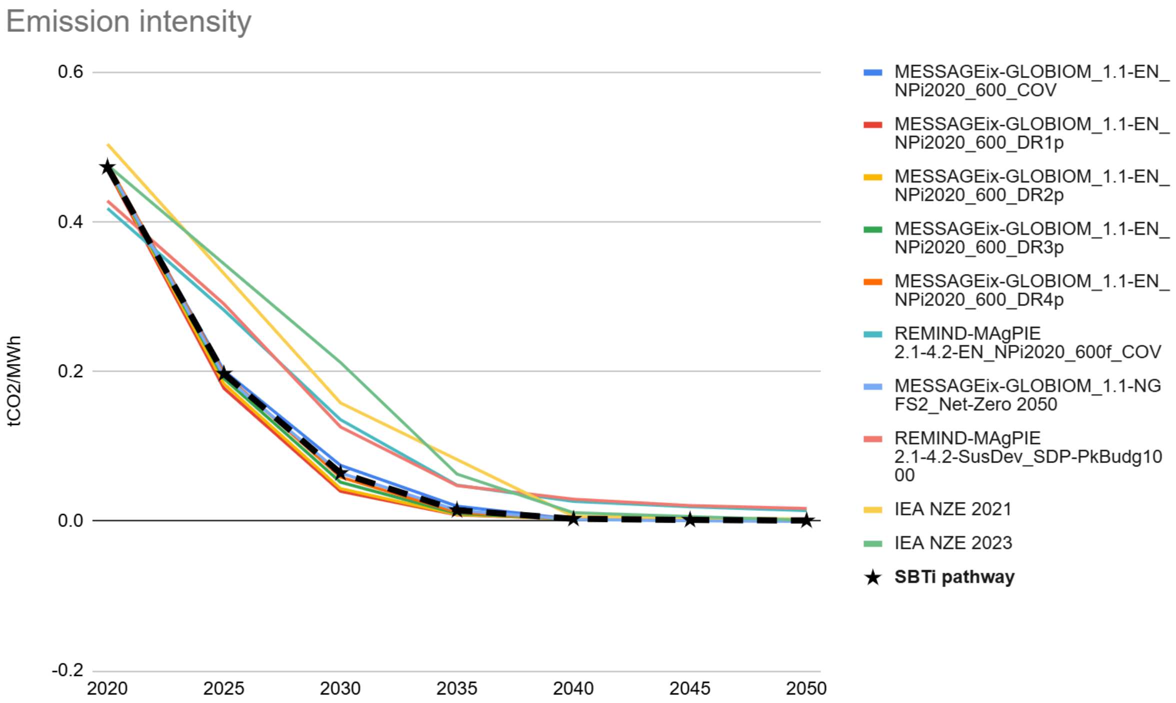


Figure S4. Bioenergy sequestration in eligible scenarios and updated power sector pathway. The SBTi pathway is the median of all eligible scenarios. The positive values represent net-negative emissions (removals), while the negative values represent net positive emissions to the atmosphere.

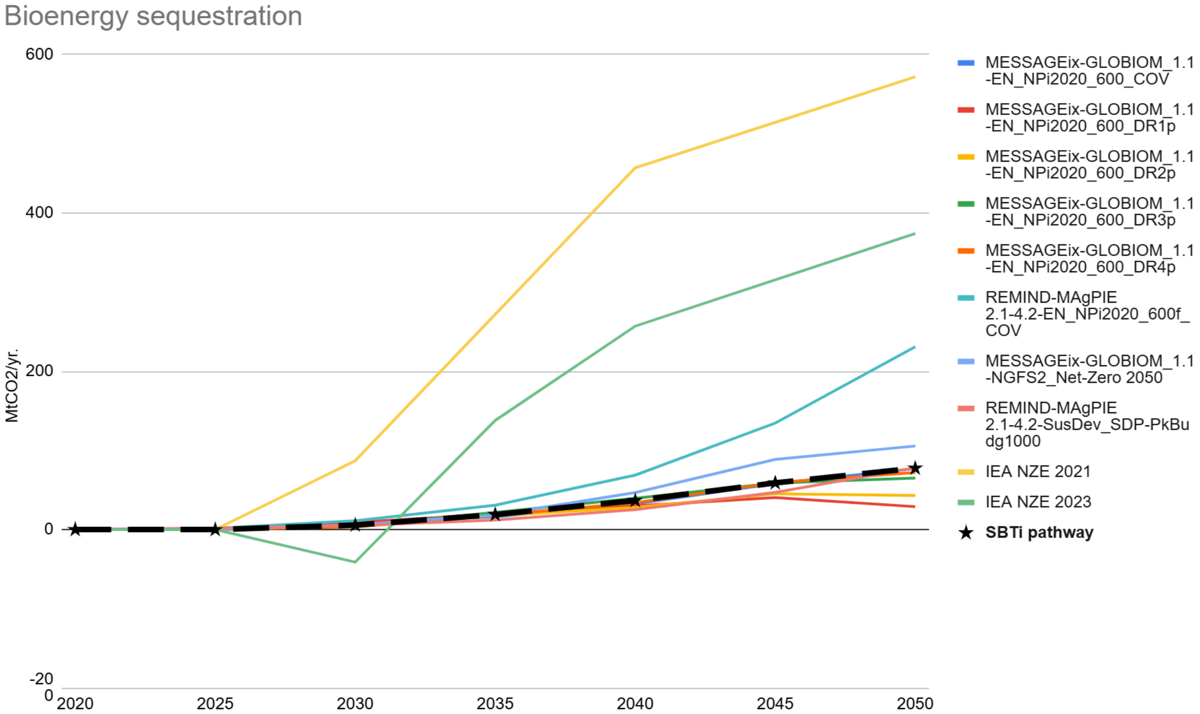
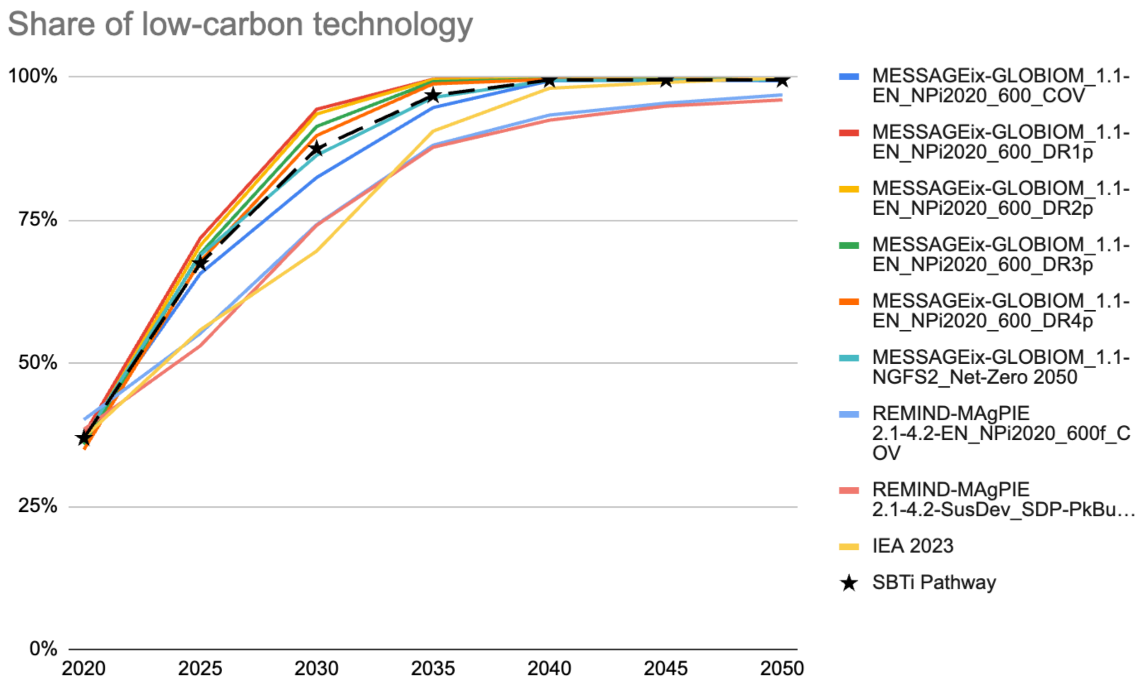


Figure S5. Share of low-carbon technologies in eligible scenarios and updated power sector pathway. The SBTi pathway is the median of all eligible scenarios.



GLOSSARY

Benchmarks: Target-setting benchmarks indicate a desirable level of performance, in terms of a target-setting metric, and serve as a point of reference against which ambition and performance of a target-setting entity is compared.

Metric: A metric is a quantifiable metric to assess, manage, compare, and communicate the past, current, or intended climate-related performance of an organization. Metrics can be expressed in terms of impact (e.g. greenhouse gas emissions released into the atmosphere), outcome (e.g. percentage of electricity sourced from zero-carbon sources), or process (e.g. establishment of a portfolio company engagement strategy).

Scenarios and pathways: A scenario is a plausible description of how the future may develop, based on a coherent and internally consistent set of assumptions about key driving forces (e.g. rate of technological change, prices) and relationships. Scenarios yield pathways, which represent a quantitative trajectory of a climate-relevant metric over time, such as greenhouse gas (GHG) emissions.

Science-based target: A science-based target is a specific greenhouse gas reduction goal whose ambition is consistent with the latest peer-reviewed climate science to limit global warming to temperature goals as set by the Paris Agreement.

Target: A target is a quantity that indicates the rate of change of a metric, in terms of percentage change over time, from benchmark to benchmark to reach long-term net-zero performance.

Target setting: Target setting refers to the process of establishing a target on a given metric that represents the total percentage change that the entity wishes to achieve.

Target-setting method: A target-setting method is a mathematical formula or algorithm that can be used to determine the benchmark, threshold, or desired performance of a counterparty using a relevant metric. These benchmarks serve as a reference for defining criteria and setting targets in SBTi Standards.

Technical foundations: Technical foundations refer to target-setting metrics, target-setting methods, and pathways. They are the foundation of SBTi Standards.

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SCIENCE BASED TARGETS

DRIVING AMBITIOUS CORPORATE CLIMATE ACTION