European Climate Neutrality Observatory

Framework and methodology for progress measurement

Assessing progress towards climate neutrality

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Summary

The European Climate Neutrality Observatory (ECNO) aims to help the EU achieve climate neutrality by providing scientifically rigorous analysis of economy-wide progress and an impartial check on EU climate policy processes.

As an independent observatory, ECNO seeks to inspire the uptake of better monitoring practices and policy making, as well as greater transparency on the EU's transition to climate neutrality by presenting a unique, comprehensive picture of the whole economy.

ECNO uses an **indicator-based framework** that tracks progress in economic sectors and cross-cutting policy areas, i.e., the '**building blocks**' of a climate neutral future, like lifestyle changes, finance, and governance. These building blocks or some constellation thereof are commonly found in EU Member States' long-term strategies (LTS) and are often referred to in the climate policy literature (EC, 2018b, 2020c; IPCC, 2018; Pestiaux et al., 2018; Tsiropoulos et al., 2020; Velten et al., 2022).

Within each building block we define objectives and enablers. **Objectives** outline what the building block must achieve to support the overall climate neutrality goal, while **enablers** are the supporting conditions needed to meet the objectives in each building block. Enablers reflect on the drivers of and barriers to decarbonisation and, as such, can provide an early sense of progress – or lack thereof.

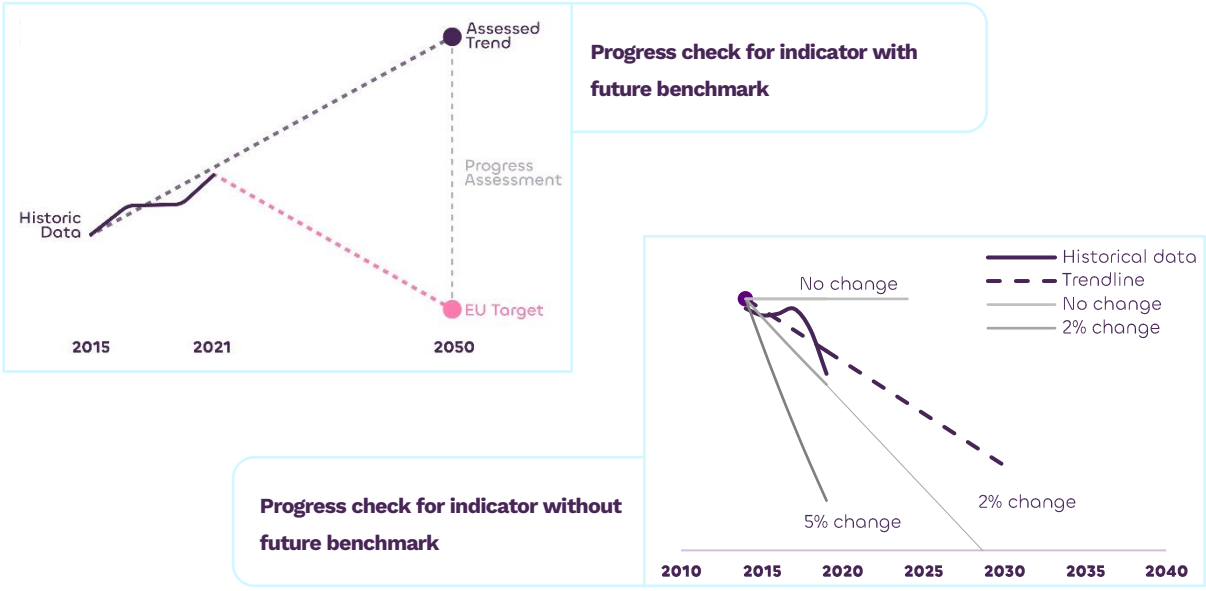
The assessment of progress for each building block towards its objectives and enablers is based on dedicated **indicators**. The selected indicators describe specific aspects of the objectives and enablers and provide a view on past change in the context of the required future changes.

While selecting indicators for tracking progress towards objectives and enablers, a **significant challenge is the availability of data**. Despite the crucial importance of having a robust and reliable database, data limitations *do not* restrict the selection of indicators. This means that we also incorporate indicators with the knowledge that they lack a comprehensive dataset. Although this limits the interpretation of results, especially when there are no second-best indicators or proxies available, it also highlights critical information gaps.

ECNO investigates past progress using **historical data** from a range of sources. Using a trendline calculated over a **past period of five years** for which data is available focuses the assessment on the latest developments and attenuates the influence of outliers.

ECNO checks, where possible, past progress against **the EU's vision of climate neutrality** that is formed from official EU targets and benchmarks derived from EU strategic planning documents. The progress check compares the absolute annual change of the past development with the required annual change to meet the future benchmark starting with the last data point of the trendline and drawing a straight line to the benchmark. The ratio between these two values indicates the required change in the pace of development (a similar method is used by Schumer et al., 2022). If no quantified future benchmark can be derived from EU sources, the analysis relies on qualitative insights from official EU documents as well as on external scientific literature outlining the desired direction and speed of change.

Figure 1: Progress check for indicators with and without a benchmark



Source: own representation

Progress for each indicator is classified along a four-degree scale: 'on track', too slow', 'far too slow', and 'wrong direction'; while 'insufficient data' indicates data availability limitations. The same classification is used to describe the **overall progress for each climate neutrality building block**. Here the assessment is based on the progress of the underlying indicators. The assessment is based on expert judgement informed by a nuanced reflection on the indicator values, their respective importance, and other developments in the policy area in the context of historic trends (similar to the approach taken by e.g., IEA, 2023).

Overview: ECNO methodology and glossary of key terms	
Progress measurement	For each indicator separately, its past development is compared against the required change in a desired direction or to reach a future benchmark.
Trendline	A line of best fit is calculated from all data points in a specified past time period.
Time coverage	We look at the change over five years requiring six data points (e.g., 2016 to 2021).
Benchmark	A benchmark is an official EU target or value from an official EU source that provides a future reference point against which we assess the required change. If there are two official sources for a benchmark, the more ambitious one is selected.
Past change	ECNO observes absolute and relative annual changes in a specified past timeframe, e.g., from 2016 to 2021.
Required change	The required change is the absolute and relative annual change that is needed to meet a future benchmark or reach a desired direction and magnitude of change.
Acceleration factor	The ratio between the absolute past change and required change indicates the necessary change in the speed of progress. This only applies for indicators with a benchmark.
Classification of indicator progress	Indicators are classified into four categories depending on the adequacy of the rate of progress. Where data are insufficient, a 'Insufficient data' category is assigned to highlight data gaps.
Classification of building block progress	Building blocks are classified into four categories (the same as for indicators) depending on their rate of progress.

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1. Introduction

The European Climate Neutrality Observatory (ECNO) aims to help the EU achieve climate neutrality by providing scientifically rigorous analysis of economy-wide progress and an independent check on EU climate policy processes.

ECNO's leading experts analyse the data underlying a comprehensive set of progress indicators to present a unique, up-to-date picture of the whole economy, and identify any gaps in data collection, benchmarking, and monitoring that need to be addressed. Crucially, ECNO's analysis focuses on the underlying enablers of climate neutrality, not just the observed outcomes.

ECNO is a trusted one-stop shop for monitoring progress on climate neutrality that will enable policy makers, businesses, and civil society to hold the EU accountable for the delivery of climate neutrality. As an independent observatory, ECNO further seeks to inspire the uptake of better monitoring practices and policy making, as well as greater transparency on the EU's transition to climate neutrality.

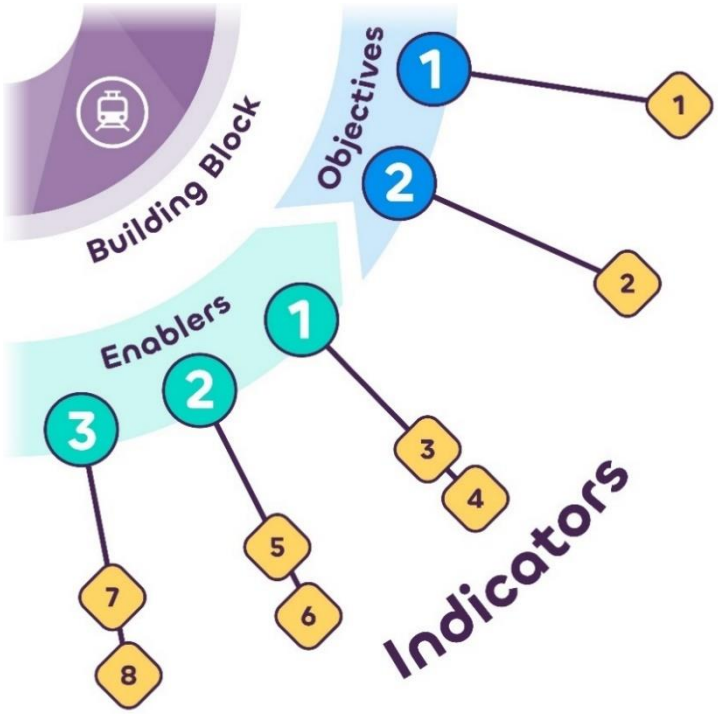
This document outlines a framework and methodology for checking progress towards climate neutrality in the EU with a set of indicators. It provides insights on the selection of indicators to address the structural, sectoral, and cross-sectoral changes of the transition, covering economic, social, and technical dimensions. It outlines how ECNO calculates and classifies progress on the indicators and their overarching building blocks. A full analysis based on this underlying methodology is presented in an annual ECNO flagship report.

Other initiatives measuring the progress towards climate goals or emission reductions in different contexts are the UK Climate Change Committee's progress monitoring (UKCCC, 2022), the International Energy Agency's Tracking of Clean Energy (IEA, 2023), the EU Buildings Tracker of the Building Performance Institute Europe (BPIE, 2022) or the indicator monitoring as part of the French national low-carbon strategy (Ministère de la transition énergétique, 2021).

2. The indicator framework

To unpack the complexity of a transition to climate neutrality in the EU, one must consider more than headline emission reduction trends and investigate the systemic changes already underway or required in EU society. For this purpose, ECNO uses an indicator-based framework that tracks progress in policy sectors and cross-cutting policy areas, i.e., the 'building blocks' of a climate neutral future. Within each building block we account for key objectives and the underlying enabling conditions, i.e., 'enablers', needed to drive change. The selected indicators for both the objectives and enablers describe past progress and point to required future changes. This analytical framework illustrated in Figure 2 aims at both the breadth and depth of the transition.

Figure 2: Selection of indicators based on building blocks, objectives, and enablers



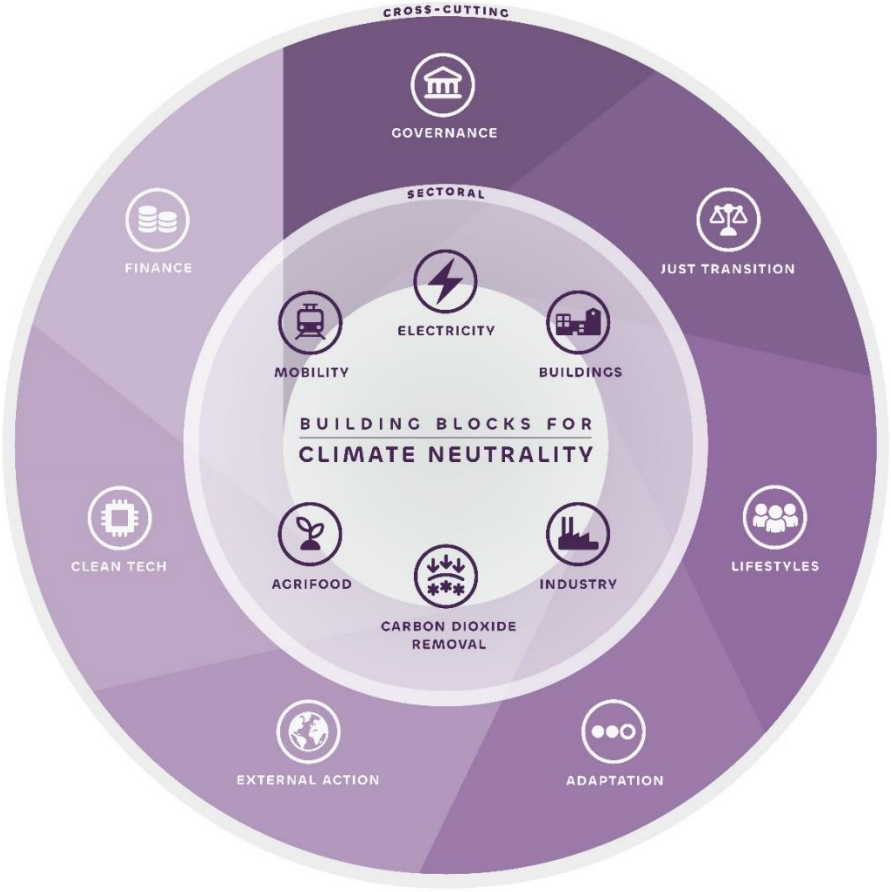
Source: ©ECNO based on previous work (Velten et al., 2021)

2.1 Building blocks for the transition to climate neutrality

The **building blocks** of a climate neutral society include the sectors and cross-sectoral themes, which are also referred to as the key fields of action. These are outlined in long-term strategies (LTS) and are often referred to in the climate policy literature (EC, 2018b; IPCC, 2018; Pestiaux et al., 2018; Tsiropoulos et al., 2020; Velten et al., 2022). Consultations with topical experts further refined the list and helped to identify additional relevant elements.

Building blocks can be categorised into two groups: (1) sectoral building blocks, which represent the key GHG emission categories, and (2) cross-cutting building blocks, which drive GHG emission reductions across the sectors (see Figure 3).

Figure 3: Building blocks for the transition to climate neutrality



Source: ©ECNO based on previous work of Velten et al. (2021)

The six sectoral building blocks are commonly used, systematic, and well-understood: Electricity, Buildings, Industry, Mobility, Agrifood, and Carbon Dioxide Removal. Still, there are some methodological variations in how these are treated when checked against the UNFCCC inventory on GHG emissions. For example, for the purposes of ECNO, the building block on 'Buildings' covers households and the services sector as both sub-sectors have in common that their GHG emissions come from energy consumption for heating and electric appliances and processes, while in the GHG inventories, these are two distinct categories. Similarly, the ECNO building block on 'Carbon Dioxide Removal' includes natural carbon sinks (from land use (change) and forestry) and GHG removal technologies whereby natural and technical removals are referred to separately in national GHG inventories. In other documents, they are, however, also targeted together by, e.g., the new EC proposal for a certification framework for carbon removals (EC, 2022).

The cross-cutting building blocks provide supporting conditions for emission reductions and associated change in more than one sector. Going beyond the sectors puts emphasis on the cross-sectoral dimensions increasingly considered central to achieving climate neutrality. These include Lifestyles, Clean Technologies, Finance, Just and Inclusive Transition, Adaptation, Governance, and External Action. All feature at least to some extent in existing national LTSs and the National Energy and Climate Plans (NECPs) but often only with a qualitative description and without any clearly defined policy target (EC, 2020a; Velten et al., 2022).

Table 1: Descriptions of building blocks for the transition to climate neutrality

Sectoral building blocks	**Electricity**	Electricity supply plays a central role in decarbonising energy supply and its importance will only increase over time through sector coupling, i.e., the electrification of demand sectors. Emission reductions are mainly realised through the phase-out of fossil fuels and the build-up of renewables
	Mobility	Mobility is essential for connecting people and sustaining economies. For a transformative shift in the transport sector, reducing motorised transportation, promoting clean modes, and decarbonising remaining transport are key.
	Industry	Industry is an indispensable element of the EU's economy. However, the sector is facing complex decarbonisation challenges requiring a shift in the mix of energy and applied feedstocks, partly deep modifications to technological processes and efforts in terms of circular economy.
	Buildings	The buildings element covers the main stages of the buildings cycle, from materials production to energy demand for various end-uses: heating, cooling, cooking, lighting, ventilation, and appliances. They decarbonisation depend on reducing the demand for heating and

		cooling services, improving energy performance, and shifting the remaining energy demand to renewable heating or cooling systems.
	Agrifood	The agrifood building block refers to all stages of the agricultural supply chain from food production to consumption, including food processing, retail, and associated waste. It also considers aspects of land use and the production of agricultural inputs.
	Carbon dioxide removals	Carbon dioxide removal (CDR) will be crucial to achieve climate neutrality by compensating for minimal residual emissions that cannot be avoided. Currently, CDR comprises only natural sinks but is anticipated to include technical solutions in the future
Cross-cutting building blocks	**Lifestyles**	The transition of collective and individual lifestyles towards more sustainable behaviour patterns and social practices is a meaningful driver of decarbonisation. These are dependent on policies to promote options that are accessible, affordable, and desirable.
	Clean technologies	Developing new and improving existing technologies while ensuring manufacturing capacity to deploy them at scale is critical to enable the transition to climate neutrality across the economy.
	Finance	Redirecting financial flows towards clean products and services is essential to put the EU on track to achieve climate neutrality by 2050. It includes both public and private investment flows.
	Just and inclusive transition	A just and inclusive transition means that the timely shift towards climate neutral economy will not come at the cost of vulnerable regions and social groups.
	Governance	Governance refers to the tools used by governments to align short-term actions with a climate neutral future, ensure a sound evidence-base for decisions, coordinate across sectors, enhance transparency and accountability, and foster public and political buy-in.
	Adaptation	Adapting to climate impacts will require a wide range of adaptation responses across sectors, both at the European level, but also from individual Member States. To track progress, the element assesses the implementation of adaptation measures and actions, specifically nature-based solutions in the urban context, land use sectors, and the aquatic environment.
	External action	To support global climate neutrality, the EU must consider the extraterritorial impacts of its actions, engage in climate diplomacy, and support other countries in decarbonisation

2.2 Objectives and enablers

Each sectoral and cross-cutting building block has its own objectives and enabling conditions on the path to climate neutrality. The **objectives** outline what the building block must achieve to support the overall climate neutrality goal. For instance, all sectoral building blocks include the respective GHG emission reductions as one of the objectives. The **enablers** are the supporting

conditions needed to meet the objectives in each building block. Enablers reflect on the drivers of and barriers to decarbonisation and, as such, can provide an early sense of progress that will later change the emission curve.

2.3 Indicators to measure progress

The assessment of progress for each building block towards its objectives and enablers is based on underlying **indicators** (see Figure 2). These indicators show the historical development and present status of the objectives and enablers and allow for a comparison of the past trend with the required development. Defining what is meant by 'required development', however, depends on a vision of each indicator's contribution to climate neutrality. Thereby ECNO checks past progress against the **EU's own goals** using official EU targets and benchmarks derived from EU strategic planning documents (see also section 3.2). Where no quantified value is available, qualitative insights from official EU documents as well as from literature on the desired direction and speed of change serve as a basis to measure an indicator's progress and contribution to climate neutrality.

The ECNO indicator set includes both commonly used indicators as well as ones that go beyond the standard approaches to produce new insights. This is particularly the case for the cross-cutting building blocks where quantitative analysis is limited and policy goals are either non-existent or qualitative in nature. For some indicators, data availability is a significant challenge, and in a few cases, there is no data readily available. Although having a good data basis is crucial, this limitation did not restrict indicator selection, especially in those cases where there was no second-best indicator or proxy found. These cases point to areas where new data gathering and indicator creation activities, as well as new monitoring and reporting obligations, may be recommended to inform policy making.

3. How ECNO measures progress

3.1 Past developments

ECNO investigates past developments to check how the EU has progressed in each of the building blocks based on trends for the underlying indicators. Past developments build on **historical data** from a range of sources, including statistics reported by EU Member States and then harmonised and provided by Eurostat or the European Environment Agency (EEA), as well as from international organisations, such as the OECD and FAO. Historical data is also sourced from recurring studies that rank or classify specific aspects of EU climate policy, often with a more qualitative angle.

Based on the historical data, we calculate the **trendline** (line of best fit) over a specified timeframe. The trendline calculation takes into consideration all data points in the specified timeframe. Apart from a few exceptions where data is available at different intervals, data points refer to annual values. By taking the average of all years' values, the trendline smooths out outliers and variations between years and does not put an emphasis on specific years.

The trendline for ECNO is calculated using a least square method:

$$m = \frac{\sum(x - \bar{x}) \times (y - \bar{y})}{\sum(x - \bar{x})^2}$$

$$\bar{y} = m\bar{x} + b$$

With: m = slope of the trendline
b = y-axis intercept
x = given value on the x-axis (*here: years*)
$\bar{x}$ = mean value of the covered x-axis values
y = given value on the y-axis (*here: indicator value for the given year*)
$\bar{y}$ = mean value of the covered y-axis values

The ECNO methodology uses **the change over each of the past five years** whereby this requires six data points (e.g., 2016 to 2021). This timeframe is long enough to partly smooth out outliers and short enough to focus on the latest developments most relevant for the transition now, leaving out earlier developments driven by previous global events and policy decisions. The timeframe always ends with the last available datapoint (year) from a dataset. This means that the covered timeframe varies for each indicator. Any **missing datapoint within the given timeframe** is left as a gap. Data are not interpolated and the trendline is calculated only with existing values.

Past development can be framed in terms of absolute and relative annual change. The absolute annual change (given, e.g., in Mt CO_2e per year) can be compared to the future required change, while the relative annual change (given in % per year) indicates the direction and speed of change.

3.2 Required change for indicators with a benchmark

Measuring progress requires an understanding of how indicators must develop to contribute to the transition to climate neutrality. For progress checking, it is best to have a specified future benchmark for each indicator.

ECNO measures progress against the EU's own goals. Thus, the benchmarks used under ECNO come from official EU sources. They can come in the form of **targets**, or a quantified political goal adopted by the EU. Important targets in this context are, for example, the 2030 climate and energy targets. However, benchmarks can also be derived from scenario outcomes or other values mentioned in a strategy document, impact assessment, or Action Plan of the EU Commission. Two key sources are the EU 2030 Climate Target Plan (EC, 2020b) as well as the EU long-term strategy (EU LTS) ('Clean Energy for All') (EC, 2018a) and their underlying impact assessments (EC, 2018b, 2020c).

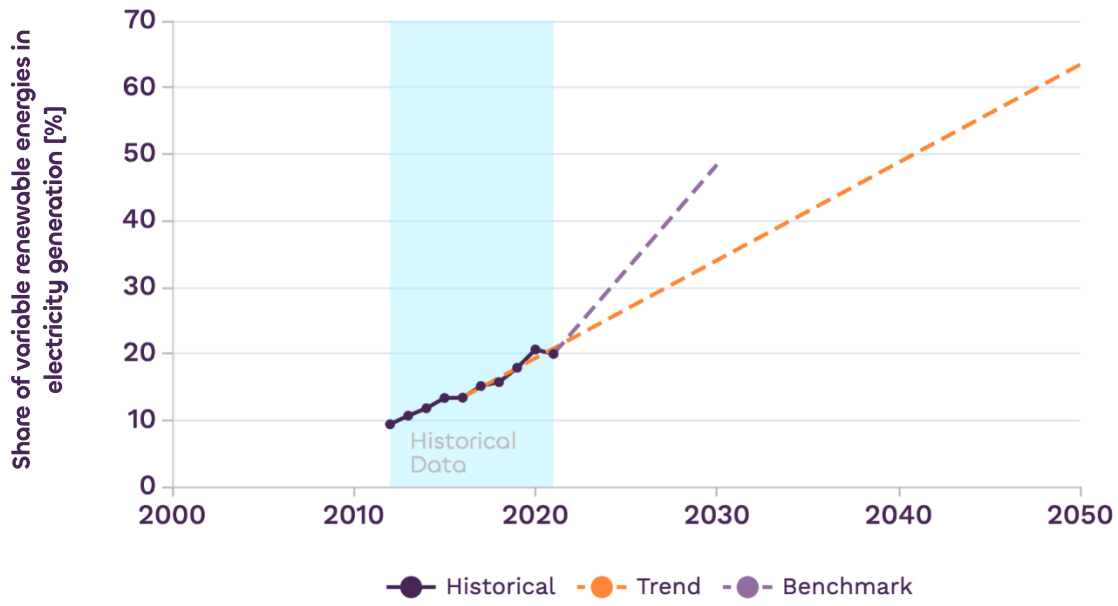
In some cases, official EU sources outline several different future benchmarks for a single indicator – either for the same or different years. In this situation, ECNO uses the **benchmark that requires a faster transition**. This is generally also the most recently established benchmark. Focusing on the benchmark that requires faster advancement will ensure that the progress check is not underestimating the changes required for achieving climate neutrality.

The required change starts with the last data point of the trendline and draws a straight line to the future benchmark. The annual change equals the slope (m) and is calculated as:

$$m = (y_2 - y_1)/(x_2 - x_1)$$

With: m = slope of the required change
x_1 = given value on the x-axis for the last data point of the trendline
x_2 = given value on the x-axis for the benchmark (*here: the benchmark year*)
y_1 = given value on the y-axis for the last data point of the trendline
y_2 = given value on the y-axis for the benchmark

Figure 4: Progress check of indicators with a benchmark



Source: own representation

The **progress check for indicators with a benchmark** compares the absolute annual change of the past development with the required annual change to meet the future benchmark. The ratio between these two values indicates the required change in the pace of development (see also Schumer et al., 2022) and is calculated as:

$$Acceleration\ factor = m_{RC}/m_{TL}$$

With: m_{RC} = slope or annual absolute change of the required change
m_{TL} = slope or annual absolute change of the trendline

Consequently, the outcome of the progress check for the example depicted in Figure 4 shows: *The share of renewable energies increased by 1.5 %-points per year between 2016 and 2021. This was far too slow to be on track towards the 2030 target of 32%. The share must increase to at least 3.2 %-points per year, which is 2 times faster when compared to the past change.*

3.3 Required change for indicators without a quantifiable benchmark

For some indicators relevant to the EU's transition to climate neutrality there is **no benchmark available**. In this case, the required change cannot be defined based on a quantified future value. As such, the second-best approach is to compare past development to a desired direction and magnitude of change (see Eurostat, 2014). This means the **progress check for indicators without a benchmark** compares the relative annual change of the past development with pre-defined ranges (see section 4.1). However, such an approach has its limitations due to the characteristics of different indicators. For example, indicators measuring new activities with low values often require a high relative change to achieve meaningful absolute changes. For better assessing such indicators, the analysis builds also on non-official EU benchmarks and expert judgement to put the past development into perspective.

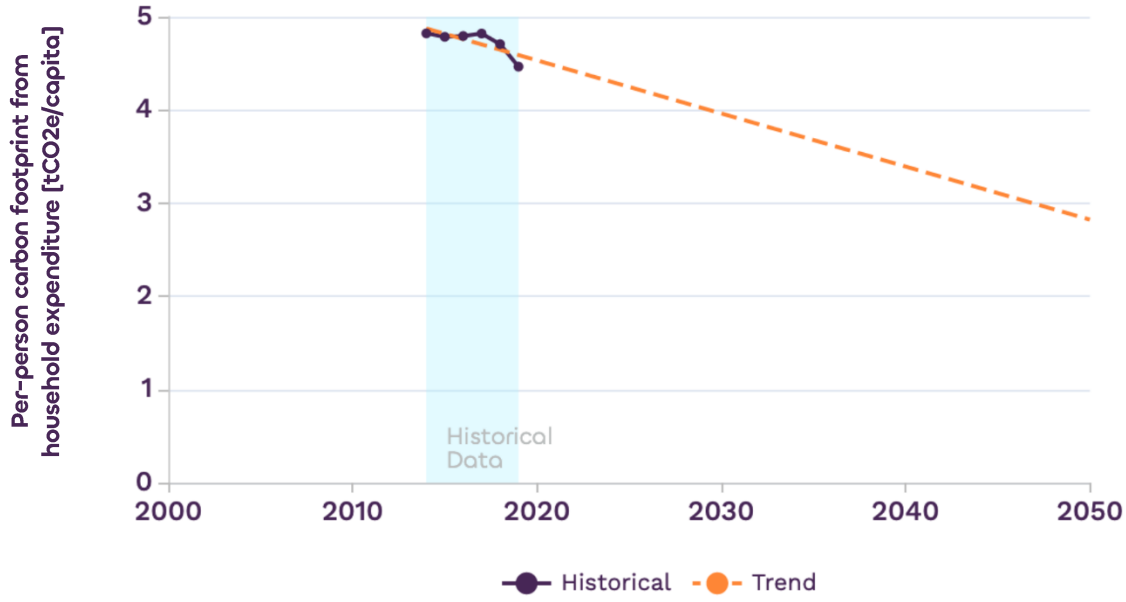
The relative annual change is also known as the compound annual growth rate (CAGR) and is calculated as:

$$Relative\ annual\ change = (y_2/y_1)^{1/(x_2-x_1)} - 1$$

With:
- x_1 = given value on the x-axis of the first data point of the trendline
- x_2 = given value on the x-axis of the last data point of the trendline
- y_1 = given value on the y-axis of the first data point of the trendline
- y_2 = given value on the y-axis of the last data point of the trendline

The outcome of the progress check for the example displayed in Figure 4 Figure 5 can be described as follows: *The carbon footprint fell by 1.2% per year between 2014 and 2019. This is far too slow under the consideration that the IPCC found that global net emissions have to fall to zero by 2055 to remain below a 1.5°C temperature increase.*

Figure 5: Progress check of indicators without benchmark



Source: own representation

In some cases, the relative annual change between the years changes from a negative to a positive value throughout the years, or the other way around. Then, the CAGR cannot be computed. If this is the case, ECNO calculates a trendline either of only positive or only negative values, depending on which values are in the majority.

4. Classification of indicators and elements

Indicators and elements are classified into descriptive groups to provide a quick and easy overview of progress. In total, the ECNO methodology employs five classes. Four classes refer to the degree or lack of progress, ranging from 'on track' to 'wrong direction'. A fifth class is used for indicators with missing data where no progress check can be carried out.

4.1 Classification of indicators

There are four classes for showing if an indicator is on or off track. The allocation differs for indicators with and without a benchmark due to the differences in how required change is defined. For indicators with a benchmark, the classification is based on the ratio of past development to required change (i.e., the 'acceleration factor', see also section 3.2). For indicators without a benchmark, classification is based on the desired direction of and magnitude of change (i.e., the relative annual change, see also section 3.3).

4.2 Classification of elements

The same classification is used to describe the **overall progress for each climate neutrality building block**. Here the assessment is based on the progress of the underlying indicators. The assessment is based on expert judgement informed by a nuanced reflection on the indicator values, their respective importance, and other developments in the policy area in the context of historical trends (similar to the approach taken by e.g., IEA, 2023)

Table 2: Classification of progress for indicators with and without benchmark

Class #	Description		Indicators with benchmark	Indicators without benchmark
Class 0 	Insufficient data	Data were insufficient to assess progress	/	/
Class 1 	Wrong direction	Change has been in the wrong direction; a U-turn is needed	Ratio of required change to past change is < 0	Average annual percentage change is < 0%
Class 2 	Far too slow	Change has been in the right direction but well below the required pace	Ratio of required change to past change is > 2	Average annual percentage change is ≥ 0% to < 2%
Class 3 	Too slow	Change has been in the right direction at a promising but insufficient pace	Ratio of required change to past change is > 1 to 2	Average annual percentage change is ≥ 2% to < 5%
Class 4 	On track	Change has been at or above the required pace	Ratio of required change to past change is ≤ 1	Average annual percentage change is ≥ 5%

Source: own representation; note that classification for indicators without a benchmark can deviate from the given ranges to reflect on the characteristics of an indicator (see also section 3.3)

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