ELEVATE: Enabling and Leveraging Climate Action Towards Net-Zero Emissions

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# D2.1 – Expanded climate policy database and modelling protocol on NDCs, national policies and transformative policy packages

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|---|---|---|
| Dissemination Level | | |
| PU | Public | √ |

## 1. Changes with respect to the description of work

No changes to deliverable scope.

## 2. Dissemination and uptake

The Climate Policy Database is public and is available at the following website: Home | Climate Policy Database. The modelling protocol will be made available to public on an online repository, together with the research outputs that uses it.

## 3. Short summary of results (<250 words)

This deliverable reports the activities carried out under Task 2.1 of the ELEVATE project. The main outputs of this Task are: (i) update of the Climate Policy Database (CPDB) and an addition of large emitting countries outside the G20, (ii) update of the modelling protocol on current policies and NDCs, (iii) development of a modelling protocol on transformative policy packages.

All of the proposed activities have been completed, except for the modelling protocol for transformative policy packages, for which we present the proof of concept with the renewable energy deployment as an example. The CPDB now contains up-to-date data on policies (cut-off date: February 2023, with selected major policies adopted after the cut-off date) for 42 countries (expanded from 19). The updated modelling protocol on NDCs and current policies reflect the CPDB updates and now covers 25 countries. A full modelling protocol for transformative policy packages will be developed in Q1/Q2 2024, in line with the timeline for the related model runs in WP6.

## 4. Evidence of accomplishment

See report below.

## Version log

| Version | Date | Released by | Nature of Change |
| --- | --- | --- | --- |
| 1 | 18-10-2023 | NewClimate Institute | First draft |
| 2 | 01-11-2023 | NewClimate Institute | Revised version, based on internal review |
| | | | |

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# 1. Introduction

This deliverable reports the activities carried out under Task 2.1 of the ELEVATE project. The task description in the proposal is as follows:

First, a new modelling protocol for implemented national policies, NDCs (including newly submitted NDCs), and selected non-state climate actions (e.g., car companies plans to shift to EVs) will be developed. The protocol describes how current policies and targets can be translated into national model parameters and serves the model runs in Task 2.3. The protocol will employ updated and expanded data on adopted and planned GHG-relevant policies compiled in the climate policy database (CPDB) developed under the H2020 projects ENGAGE and CDLINKS. This task will expand previous work by (i) developing a comprehensive policy dataset beyond G20 members (e.g. Iran, Thailand, Nigeria) validated by national experts; (ii) enhance coverage of mitigation-relevant policies to include policies related to SDGs and biodiversity; and (iii) include feasibility indicators developed under the ENGAGE project and expand them to the national level. We will track the impact of and response measures to COVID-19 on climate policy implementation and collect selected non-state actions and other relevant developments not captured in current national policies. Second, a modelling protocol for transformative policy packages will be developed for large economies, input for WP6. This will (i) identify successful, good practice policy approaches and expand the scope of existing literature; (ii) identify constraints for the global rollout of ambitious climate policies; (iii) analyse how key constraints could be overcome.

All of the proposed activities have been completed, except for the modelling protocol for transformative policy packages, for which we present the proof of concept with the renewable energy deployment as an example. A full modelling protocol for transformative policy packages will be developed in Q1/Q2 2024, in line with the timeline for the related model runs in WP6. Task 2.1 partners are in communication with the modelling teams in WP6, the relevant Tasks of which only started recently, on the format and specifications of the transformative package modelling protocol.

# 2. Climate Policy Database

This task builds on climate policies data collected and analysed in the Climate Policy Database (NewClimate Institute & Wageningen University and Research, 2022).

The Climate Policy Database (CDPB) is an open, collaborative tool to advance the data collection of the implementation status of climate policies. This project is funded by the European Union ENGAGE and CD-Links projects. The database is maintained by NewClimate Institute with support from Wageningen University and Research and PBL Netherlands Environmental Assessment Agency. The CPDB is annually updated to include latest policy developments. These updates include new policies adopted and updates on existing policies, such as changes to the content and implementation status of policies (for example, when a policy is ended, superseded, or goes from being planned to in force).

In ELEVATE, the update of the CPDB is the initial step to prepare the modelling protocol (discussed in detail in Chapter 3). This update includes adding and reviewing data for the G20 countries, which were already comprehensively covered, expanding the coverage of the CPDB and improve several aspects related to documentation and user experience.

As part of this task, we have completed the following outputs:

- CPDB Zenodo entry – published in March 2023
- CPDB Codebook – published in April 2023
- CPDB new methodology page – published in May 2023
- CPDB Python API - published in July 2023
- CPDB 2023 Updated version – published in September 2023

## 2.1. Update of Climate Policy Database data

Under this task, we expanded the coverage of climate policies included in the database. In the CPDB a policy can be a law, strategic document, a target, or any other policy document that results in lasting reduction on the country's emissions intensity. This includes other policies, such as biodiversity- and SDG-related policies that affect greenhouse gas emissions.

In this update round, we expanded the country scope from 19 to 42 countries. The CPDB now covers: Bhutan, Chile, Colombia, Costa Rica, Egypt, Ethiopia, Iran, Kazakhstan, Kenya, Morocco, Nepal, New Zealand, Nigeria, Norway, Peru, Philippines, Singapore, Switzerland, Thailand, The Gambia, Ukraine, United Arab Emirates, and Viet Nam. Together, these countries account for approximately 85% of global GHG emissions (CAT, 2023).

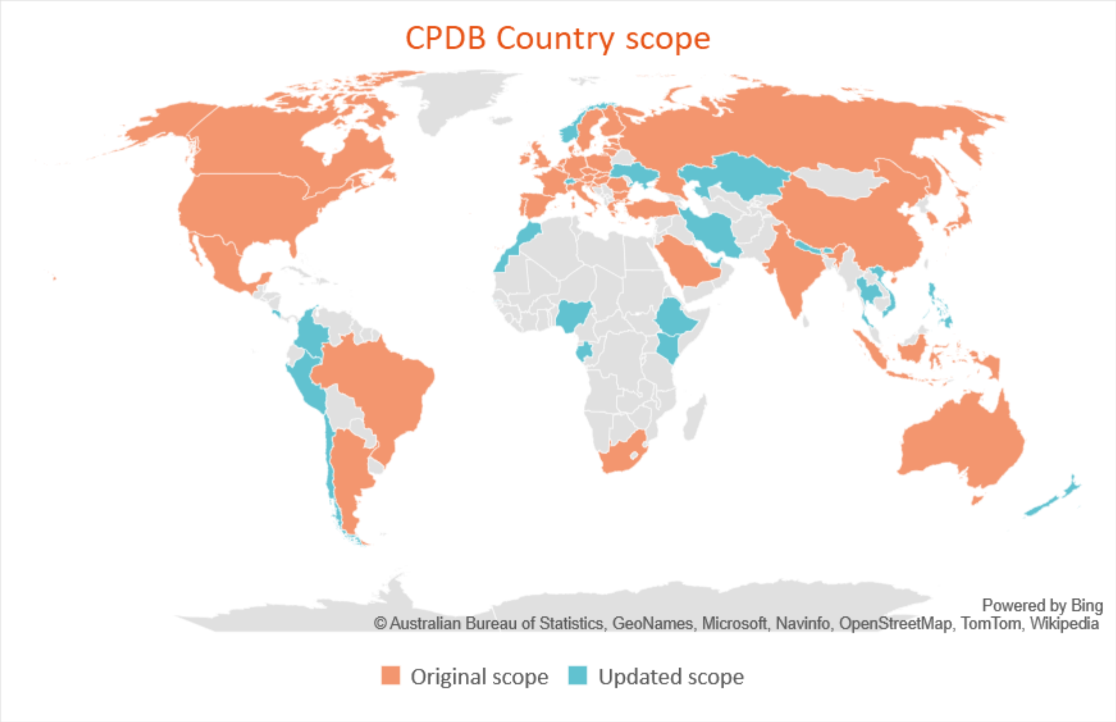


*Figure 1: Overview of country scope of the Climate Policy Database.*

The data was also reviewed and updated to include new policies, update ended, superseded or amended policies and address data gaps. The number of new policies added to the database decreased with each version, because there were fewer gaps in historical policies (before 2021) and only policies from the recent years were added (Table 1). The number of modified policies decreased but remained relatively high, mostly due to improvements in the free text fields such as the title and the description of policies. Erased policies, which are policies resulting from duplicated or incorrect entries, decreased with each update. The status of policies that ended or were superseded in the past few years was also updated.

The latest CPDB update also includes some policies with GHG mitigation components but with a focus on SDG's or biodiversity, such as the EU's Biodiversity Strategy for 2030, as well as policies implemented as a direct response to the COVID-19 pandemic, such as the Infrastructure Investment and Jobs Act adopted in the United States.

*Table 1: Overview of policies added and modified in each update of the CPDB.*

| Database version | v. 01.2022 | v. 02-2023 | v. 10-2023 |
|---|---|---|---|
| Total modified | 3057 | 2119 | 1819 |
| Total erased | 39 | 22 | 4 |
| Total added | 575 | 79 | 44 |

We track new policies added to the CPDB by sector to understand trends in policy uptake. In 2023 we published two new versions of the CPDB. The first version includes a comprehensive update for all 42 countries covered with policies adopted by February 2023. The second version includes policies adopted between February and September 2023, but does not constitute a comprehensive update for all countries. A full annual update is planned for the beginning of 2024. In the two last update cycles we identified fewer new policies compared to our 2022 update, which includes policies adopted in 2021 (Table 1). This probably results from negotiation efforts leading up to COP26, which took place in Glasgow in 2021 and incentivized governments to adopt additional, more ambitious policies. Although policies are fewer in number, some potentially impactful policies were adopted during 2022, such as the Inflation Reduction Act in the United States and the Fit For 55 and RePowerEU in the European Union (see Table 2).

*Table 2: List of key policies included in CPDB 2023 updates*

| Policy name | Country |
|---|---|
| National Climate Mitigation and Adaptation Plan | Argentina |
| Climate Change Act | Australia |
| PDE 2031 10-year Plan for Energy Expansion | Brazil |
| Energy Transition - National Energy Policy | Chile |
| 2030 Emissions Reduction Plan | Canada |
| 14th Five-Year Plan for New Energy Storage Development Implementation Plan | China |
| National Strategy for Climate Change 2050 | Egypt |
| REPowerEU | European Union |
| Long Term growth trajectory of Renewable Purchase Obligations (RPOs) | India |
| Presidential Regulation No. 112 of 2022 on Accelerated Development of Renewable Energy for Electricity Supply | Indonesia |
| Sectoral roadmaps for Promoting Transition Finance | Japan |
| Program for the development of the national electric system (PRODESEN) | Mexico |
| Aotearoa first Emissions Reduction Plan (ERP) | New Zealand |
| Philippine Development Plan (PDP) 2023-2028 | Philippines |
| Just Transition Framework | South Africa |
| 10th Basic Energy Plan for Electricity Supply and Demand | Republic of Korea |
| National Energy Plan | Thailand |
| Action Plan for Methane Emissions Reduction by 2030 | Viet Nam |
| Inflation Reduction Act | USA |

Since the 2022 update we also monitor the distribution of new policies across sectors to keep track of changing trends in climate policy adoption (see Figure 2: Number of policies adopted and included in the CPDB in the different database updates. This figure shows the number of policies added in each update. The update prepared in 2022 (v. 01.22) contains a substantially higher number of policies due to the increase in the number of countries in the database. Therefore, at this moment, the number of policies in each update cannot be directly compared, but in subsequent updates it will illustrate trends for policy adoption in major emitting economies.

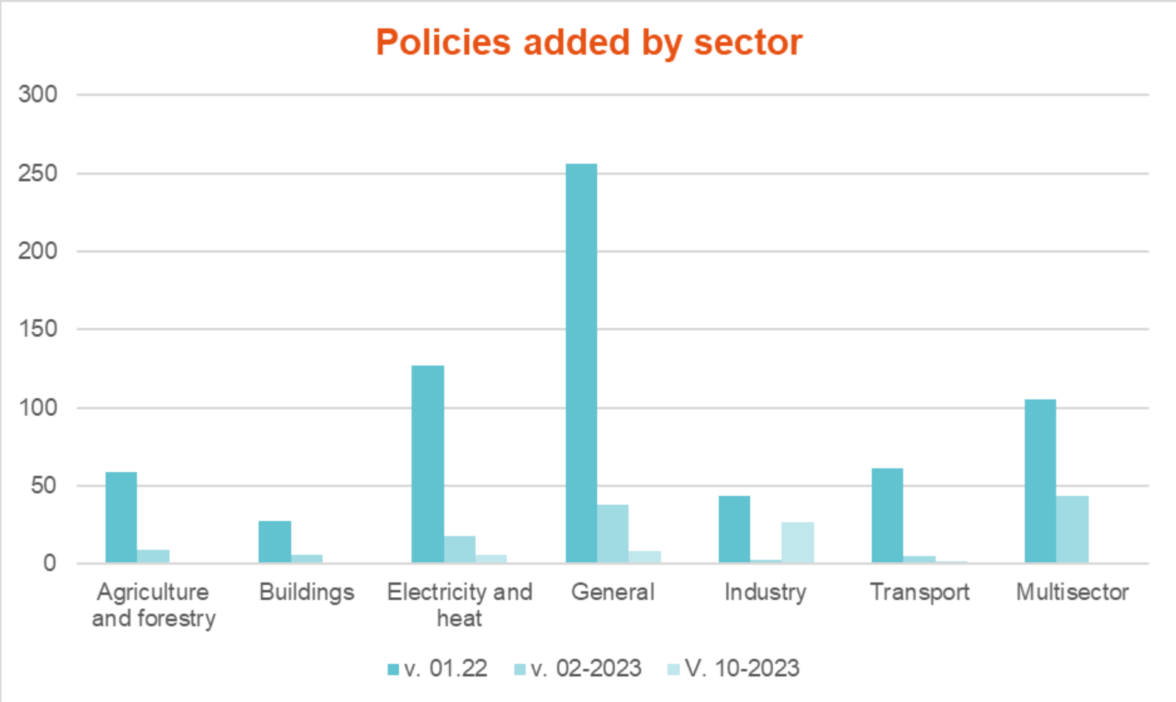


*Figure 2: Number of policies adopted and included in the CPDB in the different database updates. Cross-sectoral policies or policies that apply to any sector and that provide framing for or enable the implementation of other sectoral policies are included in the 'general' sector.*

We track data gaps in the CPDB to improve the free text fields such as the policy description, to address gaps and potential grammar or syntax errors. In the three latest updates to the policy database the gaps in mandatory fields such as policy instrument, sector, policy type, date of decision and policy objective were filled. The gaps in the date of decision field can be explained because some policies are included already in their planning phase due to their importance and therefore do not yet have a decision date. Gaps in the policy description field have been identified and partially filled, but large gaps remain due to the time intensive nature of the task.

## 2.2. Update of Climate Policy Database infrastructure

To increase data transparency and use among stakeholders, we developed new documentation for the Climate Policy Database, including a publicly-available codebook and a Zenodo entry, which is periodically updated. These improvements have been implemented and rolled out in the first quarter of 2023. The codebook includes a description of the data entry conventions adopted by the CPDB, additional explanations on the classification of specific policy types within the CPDB and a description of each type of data field within the CPDB. The Zenodo page for the CPDB includes a description of the database, the general recommended citation for the database as well as for each version and the peer reviewed publication citation.

We have updated several elements of the CPDB website, including adding a new methodology page, and updating user interface elements. The methodology page includes an introduction to the policy and country scopes of the database; an introduction to the data collection and validation process; an overview of the most frequently consulted sources and an introduction to the policy taxonomy used for the classification of policies in the CPDB.

We also implemented a database python Application Programming Interface (API) to improve data access and facilitate tool building. This API is available since July 2023. We also keep annual data versions to ensure version control in our about page.

## 2.3. Recent use cases and publications

Since its first development the Climate Policy Database data has been used in multiple reports and peer-reviewed publications. Here, we present an overview of recent selected use cases:

### Comparing the sequence of climate change mitigation targets and policies in major emitting economies (ELEVATE partner)

Nascimento, L., den Elzen, M., Kuramochi, T., Woollands, S., Dafnomilis, I., Moisio, M., Roelfsema, M., Forsell, N. & Araujo Gutiérrez, Z. (in press). Comparing the sequence of climate change mitigation targets and policies in major emitting economies. Journal of Comparative Policy Analysis: Research and Practice. https://doi.org/10.1080/13876988.2023.2255151

Abstract

The Paris Agreement requires that countries submit and update their Nationally Determined Contributions (NDCs) to mitigate global climate change. This study projected greenhouse gas emissions to evaluate the progress of 25 countries towards their original and updated NDCs. It found that one-fifth of the countries submitted more ambitious, updated NDCs without adopting sufficient policies to meet their original targets. Additionally, in almost half of the countries, updated NDCs lead to emissions above current policies. The findings also suggest that these patterns are influenced by national constraints, especially reliance on fossil fuels. Appropriate sequencing of ambition raising and policy adoption is urgently needed to translate the Paris Agreement into action.

### Reality Check: Lessons from 25 Policies Advancing a Low-Carbon Future

World Bank. 2023. Reality Check: Lessons from 25 Policies Advancing a Low-Carbon Future. Climate Change and Development Series. © Washington, DC: World Bank. http://hdl.handle.net/10986/40262 License: CC BY 3.0 IGO.

Abstract

To address the myriad challenges posed by global climate change, countries at all income levels have put in place a diverse set of policies over the past three decades. Many governments have already made significant progress in their efforts to decarbonize, creating a rich history of implementation experiences that provides important lessons for how to successfully advance climate policy goals in a variety of different economic, cultural, and political contexts. Despite this progress, the transition to a net zero future continues to face significant barriers, including the need for large investment, a lack of institutional capacity, and challenging political economy issues. 'Reality Check: Lessons from 25 Policies Advancing a Low-Carbon Future' identifies key policy approaches that countries are taking to decarbonize their economies. The report classifies policies into five categories: 1. Planning for a future with zero net emissions; 2. Getting the pricing and taxes right; 3. Facilitating and triggering transitions in key systems, such as energy and food; 4. Getting the finance flowing, particularly by incentivizing private sector investment; 5. Ensuring a just transition that protects the poor. 'Reality Check: Lessons from 25 Policies Advancing a Low-Carbon Future' fills a critical research gap by documenting low-carbon policy trends and providing a series of case studies across sectors and geographies. The 25 case studies furnish country contexts and policy details, examine results and impacts, and outline key takeaways and lessons learned for enabling further ambition in achieving emissions reductions. The report contributes to an evolving analytical agenda on how to reduce carbon emissions while achieving economic development and the strategic transition to a greener, more resilient, and more inclusive future.

### Expanding climate policy adoption improves national mitigation efforts (ELEVATE partner)

Nascimento, L., & Höhne, N. (2023). Expanding climate policy adoption improves national mitigation efforts. Npj Climate Action, 2(1), 12. https://doi.org/10.1038/s44168-023-00043-8

Abstract

To identify means to improve mitigation efforts, we investigated whether the number of climate policies is associated with emission projections up to 2030 and compared policies' prevalence across country groups. We find that larger and more comprehensive policy portfolios are conducive to emission reductions, regardless of whether absolute emissions increase or already decline. However, country groups have distinct entry points to expand climate policy. Countries with fast-increasing emissions have significantly fewer policies overall but policies are especially missing in energy-demand sectors, such as buildings and transport. Countries with stalling emissions lack climate strategies and other cross-sectoral policies. This suggests the need for better coordination of mitigation efforts across sectors. In all country groups that fail to reduce emissions, policies to reduce energy and material demand are also substantially fewer. Despite the collective increase of policies in force, countries can still expand climate policy to use the full breadth of mitigation options available.

## Selected list of peer-reviewed publications citing the CPDB or related research since 2022

- 2023

Guy, J., Shears, E., & Meckling, J. (2023). National models of climate governance among major emitters. Nature Climate Change, 13(2), 189–195. https://doi.org/10.1038/s41558-022-01589-x

Scott, W.A., Rhodes, E. and Hoicka, C. (2023) 'Multi-level climate governance: examining impacts and interactions between national and sub-national emissions mitigation policy mixes in Canada', *https://doi.org/10.1080/14693062.2023.2185586*. doi:10.1080/14693062.2023.2185586

Shen, C. and Wang, Y. (2023) 'Concerned or Apathetic? Exploring online public opinions on climate change from 2008 to 2019: A Comparative study between China and other G20 countries', *Journal of Environmental Management*, 332, p. 117376. doi:10.1016/J.JENVMAN.2023.117376

- 2022

Allegretti, G., Montoya, M.A., Bertussi, L.A.S. and Talamini, E. (2022) 'When being renewable may not be enough: Typologies of trends in energy and carbon footprint towards sustainable development', *Renewable and Sustainable Energy Reviews*, 168, p. 112860. doi:10.1016/J.RSER.2022.112860

Best B, Thema J, Zell-Ziegler C, Wiese F, Barth J, Breidenbach S, Nascimento L, Wilke H. Building a database for energy sufficiency policies. F1000Res. 2022 Feb 24;11:229. doi: 10.12688/f1000research.108822.2. PMID: 35474880; PMCID: PMC9010800.

D'Orazio, P. (2022) 'Mapping the emergence and diffusion of climate-related financial policies: Evidence from a cluster analysis on G20 countries', *International Economics*, 169, pp. 135–147. doi:10.1016/J.INTECO.2021.11.005

Eisenkopf, A. and Burgdorf, C. (2022) 'Policy measures and their impact on transport performance, modal split and greenhouse gas emissions in German long-distance passenger transport', *Transportation Research Interdisciplinary Perspectives*, 14, p. 100615. doi:10.1016/J.TRIP.2022.100615

den Elzen, M.G.J., Dafnomilis, I., Forsell, N., *et al.* (2022) 'Updated nationally determined contributions collectively raise ambition levels but need strengthening further to keep Paris goals within reach', *Mitigation and Adaptation Strategies for Global Change*, 27(6), p. 33. doi:10.1007/s11027-022-10008-7

Ghobadi, A., Fallah, M., Tavakkoli-Moghaddam, R. and Kazemipoor, H. (2022) 'A Fuzzy Two-Echelon Model to Optimize Energy Consumption in an Urban Logistics Network with Electric Vehicles', *Sustainability 2022, Vol. 14, Page 14075*, 14(21), p. 14075. doi:10.3390/SU142114075

Kamińska, A.G. (2022) 'Environmental Protection and Italian Constitutional Reform. Some Profiles of Interest and Critical Remarks', *Teka Komisji Prawniczej PAN Oddział w Lublinie*, 15(1), pp. 73–84. doi:10.32084/tkp.4456

Linsenmeier, M., Mohommad, A., & Schwerhoff, G. (2022). Policy sequencing towards carbon pricing among the world's largest emitters. Nature Climate Change. https://doi.org/10.1038/s41558-022-01538-8

Nascimento, L., Kuramochi, T. and Höhne, N. (2022) 'The G20 emission projections to 2030 improved since the Paris Agreement, but only slightly', *Mitigation and Adaptation Strategies for Global Change*, 27(6), p. 39. doi:10.1007/s11027-022-10018-5

Roelfsema, M., van Soest, H.L., den Elzen, M., *et al.* (2022) 'Developing scenarios in the context of the Paris Agreement and application in the integrated assessment model

IMAGE: A framework for bridging the policy-modelling divide', *Environmental Science & Policy*, 135, pp. 104–116. doi:https://doi.org/10.1016/j.envsci.2022.05.001

Schaub, S., Tosun, J., Jordan, A. and Enguer, J. (2022) 'Climate Policy Ambition: Exploring A Policy Density Perspective', *Politics and Governance; Vol 10, No 3 (2022): Exploring Climate Policy Ambition*. doi:10.17645/pag.v10i3.5347

# 3. Modelling protocol on NDC and national policies

The climate policy modelling protocol (CPMP) was originally developed by the PBL international climate policy team under the Horizon 2020 projects ENGAGE and CD-LINKS. Its purpose is to facilitate the quantification of high impact climate policies and their translation into Integrated Assessment Model (IAM) relevant input.

In collaboration with NewClimate Institute, PBL uses the Climate Policy Database (CPDB) as a starting point for the selection of high impact climate policies that are included in the Current Policies scenario. The Current Policies scenario is one of few representations of the current situation relating to climate policy progress and ambition other than SSP storylines[1]. Therefore, it provides a realistic depiction of the actual situation concerning climate progress and national ambitions and serves as a more pragmatic starting point for mitigation scenarios.

Under the ELEVATE project, two main tasks regarding the protocol took place until now: updating the Climate Policy Modelling Protocol content and updating the Climate Policy Modelling Protocol framework.

## 3.1 Update of Climate Policy Modelling Protocol content

The update of the CPMP content occurs on an annual basis. Under a DG CLIMA service contract and ELEVATE, the protocol was updated this year to include policies up to October 2023 (following the CPDB v.10-2023 as presented in Section 2.1) for 25 major emitters covering 80% of global GHG emissions, as well as all respective updated NDC targets. The selection of countries to be included in the CPMP is performed under consultation with DG CLIMA, based on countries' emission levels, policy information availability and other country-related characteristics (location, LULUCF emissions etc.). This selection may change each year and is frequently expanded. As mentioned above, PBL policy experts select high impact climate policies to be included in the protocol. The selection of high impact policies is crucial for the functioning of the protocol, as it is impossible to quantify and implement all climate policies adopted by a government.

This draft selection of policies and NDC targets was reviewed at the first stage by the policy experts in PBL and NewClimate, to ensure that no important climate policy in the CPDB was left out of the protocol. Afterwards, quantifiable policies were translated into model targets and implemented in the Current Policies scenario. The quantification of policies directly relates to the policy definition, content and target.

[1] In the context of this work, the current policy scenario reflects all relevant adopted climate policies, which are defined as legislative decisions, executive orders, or their equivalent. This excludes publicly announced plans or strategies (e.g. NDCs) but policy instruments to implement such plans or strategies do qualify. NDC targets or goals are, however, included in the Climate Policy Modelling protocol, as an indicator of policy progress.

Examples of easily quantifiable policies include, e.g., renewable capacity targets (GW of installed capacity) or vehicle emission standards ($gCO_2$/km travelled); conversely, policies that cannot be quantified include, e.g., monetary support schemes with no clear, discernible target or investment tax credits for (sustainability related) projects.

Subsequently, the protocol was sent out to national experts, which are partners from national institutes or research organizations that are participating in the ELEVATE project or external experts who have been collaborating with the PBL policy team on other projects. The contribution of national experts in this stage is critical, as they have intimate knowledge of national policies and provide input on whether a policy is still valid, if it has been replaced by a recent one that might not have been included in the CPDB, or if the quantification targets are interpreted correctly and are up to date[2].

After this step, the protocol update was completed, and the implementation phase began. The goal of the implementation is to use as many of the quantified policies as input for the Current Policies scenario modelling. It is usually impossible to implement all quantified policies, due to overlapping or clashing targets, or the inability of IAMs to implement the policy target. It is important to note that while the protocol includes all NDC targets for the countries that we are looking into, the NDC targets themselves were not implemented in the model. Per definition, the Current Policy scenario that the protocol serves as a base for, includes only policies which are defined as legislative decisions, executive orders, or their equivalent. NDC related targets are included only if a specific policy, that serves as an instrument to implement said target, has been passed into law.

After this update, the protocol included 533 policies (including all NDC targets), out of which 227 were able to be quantified and implemented in IAMs. Major new policies included with this update include:

- The Fit-for-55 and REPowerEU packages for the EU. The individual policies implemented from the European packages include the increased renewables share in the electricity mix, the updated ETS scheme, the electric vehicle target, $CO_2$ standards for cars and vans, and the energy performance standards in buildings.
- The Inflation Reduction Act (IRA) for the USA. The IRA is primarily a financial support mechanism, so quantification and implementation followed the work of Bistline et al. (2023): we implemented the mean value of the multi-model range presented by Bistline et al. in the areas of increased non-fossil capacity, emission reductions from unabated coal power generation and the updated new light duty vehicle share by 2030.

[2] For this year's CPMP update, we received feedback from national partners from: Brazil, Canada, India, Indonesia, Japan, Korea, Saudi Arabia, Thailand, Viet Nam and the USA.

- The Kigali Amendment to the Montreal Protocol which calls for a gradual reduction in the consumption and production of hydrofluorocarbons (HFCs) was implemented for all countries under consideration that have signed it.

## 3.2 Update of Climate Policy Modelling Protocol framework

Under this task, a major update of the protocol framework took place this year. After several meetings and detailed discussion with the modelling teams of ELEVATE partners, the protocol was overhauled to facilitate the implementation by all project partners.

A brief list of all updates includes:

- Inclusion of NDC and Long-Term Strategy (LTS) targets. While these targets are not implemented as such in the modelling of policies for each country, they are very useful to check whether climate policy implementation is able to achieve said targets, or more ambition from certain countries is required.
- Separation of 'Original Target Indicator' from 'Model Target Indicator' in the protocol, by creating two different versions of policy quantifications. Where the former one serves mostly as an explanatory field for modellers, the latter one is a specific and concise translation of the original target and relates directly to model input of variables.
- Standardization of policy and target variable names – all policies across the protocol that describe the same type of target (e.g. renewable capacity target at a certain year) have the exact same nomenclature following the Integrated Assessment Model Consortium (IAMC) conventions where possible. This facilitates not only the communication of policies to all other partners, but also the implementation of policies in each IAM since input variables are using standard names that correspond to IAM input variables.
- Standardization of variable units – currencies, energy content, capacities, intensities etc. all follow the IAMC conventions where possible.
- Alternative interpretation of policy targets to facilitate implementation in IAMs. In certain cases, policies are originally expressed or quantified in units that are not compatible with IAM implementation – e.g., tonnes of oil equivalent (toe) for energy variables, litres per kilometre (L/km) for fuel efficiency in vehicles etc. These variables are now also provided with an alternative quantification that complies with IAMC standards to harmonize implementation between models.

The modelling protocol will be undergoing more updates during the ELEVATE project, with input from all IAM modelling teams. The result will be a more flexible, simplified, and standardized version of the protocol, making climate policy implementation straightforward for all modellers. Additionally, during ELEVATE efforts will be made to harmonize the extension of policies beyond their target year between all IAMs involved in the project, reducing the uncertainty range of climate policy impact (and thus total emission and temperature implications) by the end of the century. While for the time being, the protocol is used internally by PBL, NewClimate and ELEVATE partners, the future vision includes a version that can be disseminated to all types of decision makers in the field of climate policy – policy makers, climate negotiators, extended national modelling teams, etc. This outreach aims to gain a better understanding of national policy representation, and, more importantly, bridge the gap between policy makers and modellers in terms of policy implementation and the impact of policy decisions on policy emission projections.

# 4. Modelling protocol on transformative policy packages: A proof of concept

This section relates to the preparation of 'good practice policies' / 'transformative policies' modelling protocol. To identify good-performer countries and their performance levels across sectors, NewClimate proposes a different approach than that applied in previous Horizon projects (e.g., CD-LINKS and ENGAGE). We present a proof of concept for one sector indicator: renewable electricity deployment. NewClimate Institute will now, in combination with processes under T2.3 and WP6, receive comments from modelling teams on the proof of concept and agree on the set of sector-level indicators for which NewClimate would expand the analysis required to develop a full modelling protocol.

## 4.1. Introduction

### Background

Reducing global greenhouse gas emissions is imperative to limit the worse impacts of climate change (IPCC, 2023). Most countries in the world now have committed to reduce their own emissions and pledged targets that constitute their self-determined contribution to the goal of reducing global emissions (den Elzen et al., 2022). Several countries also adopt policies that help reducing projected greenhouse gas emissions (Nascimento & Höhne, 2023). However, global emissions remain on an upwards trend (UNEP, 2022). Identifying means to reduce national and global greenhouse gas emissions remain critical to realise global climate change mitigation goals.

Since 2018, many distinct studies have explored the potential effect that expanding 'good practice' climate policies have on greenhouse gas emissions (Baptista et al., 2022; Roelfsema et al., 2018; van Soest et al., 2021). Good practice policies are those that were successfully adopted in a certain jurisdiction, can be associated with a clear impact indicator and are expected to or led to substantial effect on emissions or other related indicators, such as share of renewable electricity (Fekete et al., 2021).

The quantification of impact indicators in these studies was often identified using two main approaches. First, the impact of good practice policies was quantified based on an ex-post assessment. Researchers identified successful national climate policies, analysed their formulation to identify quantifiable policy outcomes and assessed the actual effect of the policies towards those outcomes. Second, the impact of the good practice policies was based on an ex-ante assessment. Good practice policies were identified based on the principle that their expected policy outcomes are sufficient for them to be classified as good practice, even though their actual implementation may in some cases remain in the future.

While these studies provide a good overview of impact indicators that can be used to measure policies' effect, estimating the level of these impact indicators is research intensive and the results are context dependent. For example, the level of a good practice impact indicator is often identified based on a single case, or country, for each indicator. One country reaching a certain level of progress is a poor indicator of how plausible such outcomes are. Additionally, interactions among polices likely affect policy outcomes and the attribution of observed effects to one single policy is challenging.

### Objectives

Instead of quantifying the effect of good practice policies, we identify a range of good historical performance. In this analysis concept, we propose a more statistical, data-based approach to identifying the impact indicator levels associated with good practice. Instead of analysing the effect of specific policies in force, we estimate the value for the impact indicator based on top historical performers (e.g., $90^{th}$ percentile over a selected period). This analysis is not based on an ex-post assessment of the effect of individual policies but on the ex-post effect of the whole policy mix, national context and other national actions on a specific impact indicator.

This approach also allows for more flexibility. Calculating the top performers can be done at the global or regional level. This enables calculating differentiated good performance indicator levels that account for country differences such as income levels, climate policy constraints, among others.

Although a full ex-post analysis of the effect of the policy mix is out of the scope of our concept. Other researchers are invited to develop different attribution analysis to explore the relationship between policies and impact indicators. For example, assessing the prevalence of specific policy options among top performing countries enables identifying similarities in their approach to climate policy making.

In our analysis concept, we present a test case of how the approach can be operationalised. This analysis clarifies which level of change in a certain indicator can be considered historical good performance. It does not aim to constrain future levels of good performance or indicate what is considered feasible in certain sectors (Cherp et al., 2021). In fact, we show that the range of good performance changes over time. This analysis can be used to expand indicators to assess progress in implementing the Paris Agreement (Peters et al., 2017), benchmark country efforts to historical best practice and compare historical efforts to necessary change to meet the collective mitigation goals of the Paris Agreement (Brutschin et al., 2021).

## 4.2. Defining good historical performance

Our statistical approach to identify good historical performance relies on analyses of the distribution of impact indicators. Instead of relying on data for one or a few countries, we use a dataset with information for a large number of countries to calculate the historical change in certain impact indicators per country. This country-level information is aggregated and communicated using distributions (Figure 3), which help identifying patterns in the data (Nascimento et al., 2023).

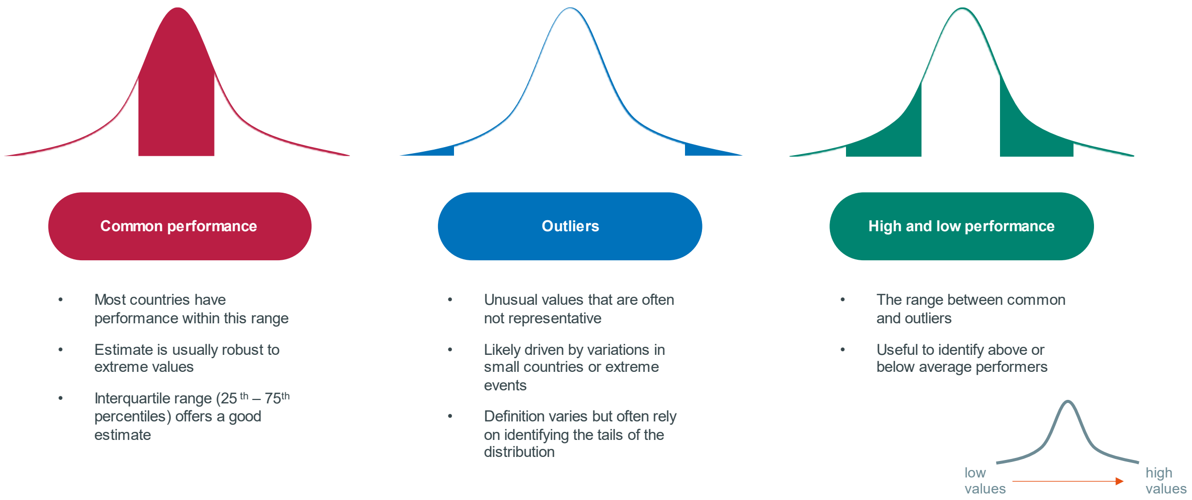


*Figure 3: Stylised impact indicator distributions showing the relationship between distinct ranges and performance.*

Distributions show the range of actual values of a certain indicator and simultaneously indicate how often a value occurs within that range. In other words, they show the count of countries within certain intervals and which intervals contain more countries than others (Jeffery et al., 2021). In the examples above, the centre of the distribution contains most countries (Figure 3 – left). The number of countries drops the further away one moves from the centre of the distribution (Figure 3 – right). These ranges can indicate values that are above or below common performance. In this stylised distribution, very few countries have values at both ends of the distribution (Figure 3 – middle). This indicates that these values, often named outliers, are less probable or common in this distribution.

In the context of identifying good historical performance, we focus on high performance percentiles, namely the upper quartile – higher 25% of the values.

The border between good performance and an outlier performance is not uniquely defined. We raise caution to the use of high percentiles (above 90th) as good performance. In our analysis concept, we focus on the values between 75th and 80th percentile because they are prevalent in a substantial share of countries (20% to 25%) and constitute above average or high performance.

## Defining good historical performance

In addition to identifying the right percentile range to be considered good performance, there are distinct approaches to calculate the value of the indicator for a fixed percentile. Although calculating the percentile of a distribution per year is straightforward, annual values can fluctuate substantially. Using a moving average helps to smooth the trends and obtain more robust values over time. Here, we use two approaches to estimate the percentile in a certain year based on the moving averages. The first one is based on the recent trend and the second relies on estimating the long-term trend.

1. Recent trend

This approach consists of using the latest available five-year moving average. This means that the 75$^{th}$ percentile in, for example, 2021 is the average of the values for the 75$^{th}$ percentile of the distribution between 2017 and 2021. The results of this approach focus on most recent years. Therefore, it is better suited for sector or indicators substantially affected by recent developments.

2. Long-term trend

This approach consists of using at least two decades of information to model the moving average over time. In this approach, the five-year moving average of each percentile is independently modelled using a linear regression. For example, the 2021 75$^{th}$ percentile is calculated based on a linear regression of the annual five-year moving averages of the 75$^{th}$ percentile between 2001 and 2021. This approach is the least subject to annual fluctuations and captures the long-term trend of the percentile. However, the results may also over- or underestimate recent developments.

## The proposed approach is applicable to a vast set of indicators

To identify good historical performance, we first identify an impact indicator that is often associated with the effect of good practice policies (Annex I). Second, we identify a dataset that allows for calculating this indicator over many countries. Third, we calculate main statistics associated with the distribution of the indicator over time. Evaluating the indicator over time enables identifying variations in the main statistics that may affect the good performance indicator.

After this preliminary analysis, we move towards identifying the level of good historical performance. First, we select the percentile range to be used in the analysis (here we use 75th – 80th). This choice depends on how the indicator changes over time, sample size and outlier behaviour. Second, we choose which method is most suitable to the analysis at hand to estimate one single range of good performance. In this analysis we use both 'latest trend' and 'long-term trend' methods described above. Finally, informed by the results of these analyses, we disaggregate the global statistics based on distinct country groups to identify the level of good performance for each group.

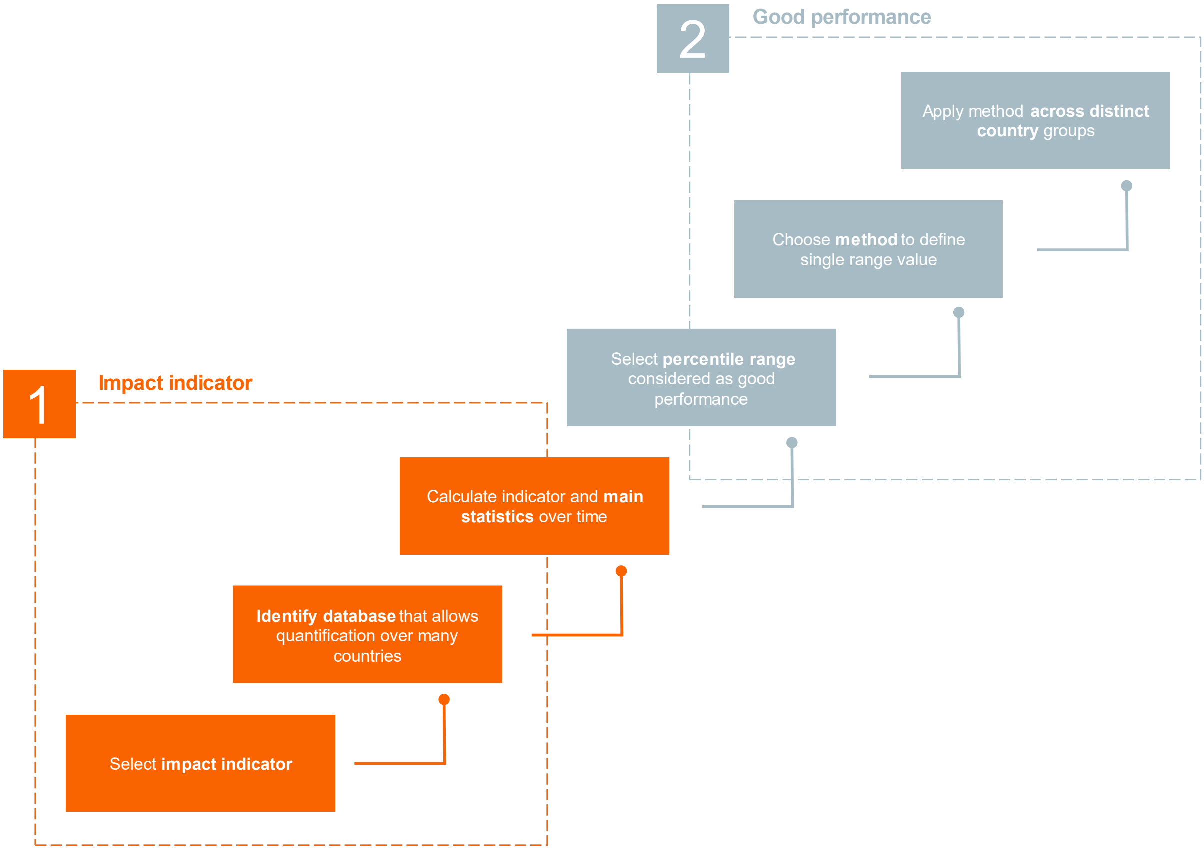


*Figure 4: Method to replicate good performance calculation across indicators and sectors.*

## 4.3. Good performance in renewable electricity

Renewable electricity is a core element of any strategy to reduce national and global emissions. Most countries have adopted renewable electricity targets (Iacobuta et al., 2018). These targets are now also often followed by policies to support their implementation (Nascimento et al., 2022; Schmidt & Fleig, 2018). The effect of these policies and other actions to improve renewable electricity uptake is measurable in the increase in renewable share in countries' electricity generation mix (Jones, 2022). A good practice policy package to reduce emissions therefore results in a substantial annual increase in the share of renewable electricity.

The percentage-point increase in the share of renewable electricity generation is often used in analyses that investigate good practice policies (Table 3). The average increase in renewable electricity used in these analyses is 1.38 p.p. per year, with a min of 1.25 p.p. and a max of 1.45p.p. per year. These results are a combination of ex-post and ex-ante analyses of the effect of policies in force. Others have also found that percentage-point change for any fuel rarely goes above 2 p.p. per year (Brutschin et al., 2021).

*Table 3: Overview of best practice renewable electricity %-point increase in existing literature.*

| Indicator | Value | Source |
|---|---|---|
| Renewable electricity increase per year | 1.35 p.p. | (Roelfsema et al., 2018) |
| Renewable electricity increase per year | 1.25 – 1.45 p.p. | (Kriegler et al., 2018) |
| Renewable electricity increase per year across income groups | 1.40 p.p. | (van Soest et al., 2021) |
| Renewable electricity increase per year, excluding hydro | 1.35 p.p. | (Fekete et al., 2021) |
| Renewable electricity increase per year | 1.40 p.p. | (Baptista et al., 2022) |

### Historical performance of renewable electricity increase

We present a distinct approach to answer the same question. We calculate the percentage-point change in the share of renewable electricity in 150 countries based on the International Energy Agency World Energy Balances (IEA, 2022). We then calculate main statistics associated with this change over time (Figure 5). Our analysis includes all renewable electricity sources, including hydropower. Due to high year-to-year fluctuations, our results are always based on the five-year moving average of all metrics.

Our analysis shows that renewable electricity growth accelerated over time across countries.

Before 2009, the share of renewables was on average declining globally. In some countries like Rwanda, Sri Lanka and Kenya, the reduction in the share of renewable electricity is substantial and partly caused by the increase of fossil electricity, especially oil, which reduced the already existing hydropower electricity. In other countries, like Spain, Argentina, and Tanzania the decrease in renewables is caused by an increase in the role of fossil gas.

Since 2009, the share of renewables has been on average increasing at an accelerated pace globally. The mean global %-point annual increase in renewables reached 0.86 p.p. in 2021, compared to 0.05 p.p. in 2009. This is largely driven by a global increase in electricity generation from solar and wind, which together represent approximately one-tenth of global electricity generation in 2021 (IEA, 2021).

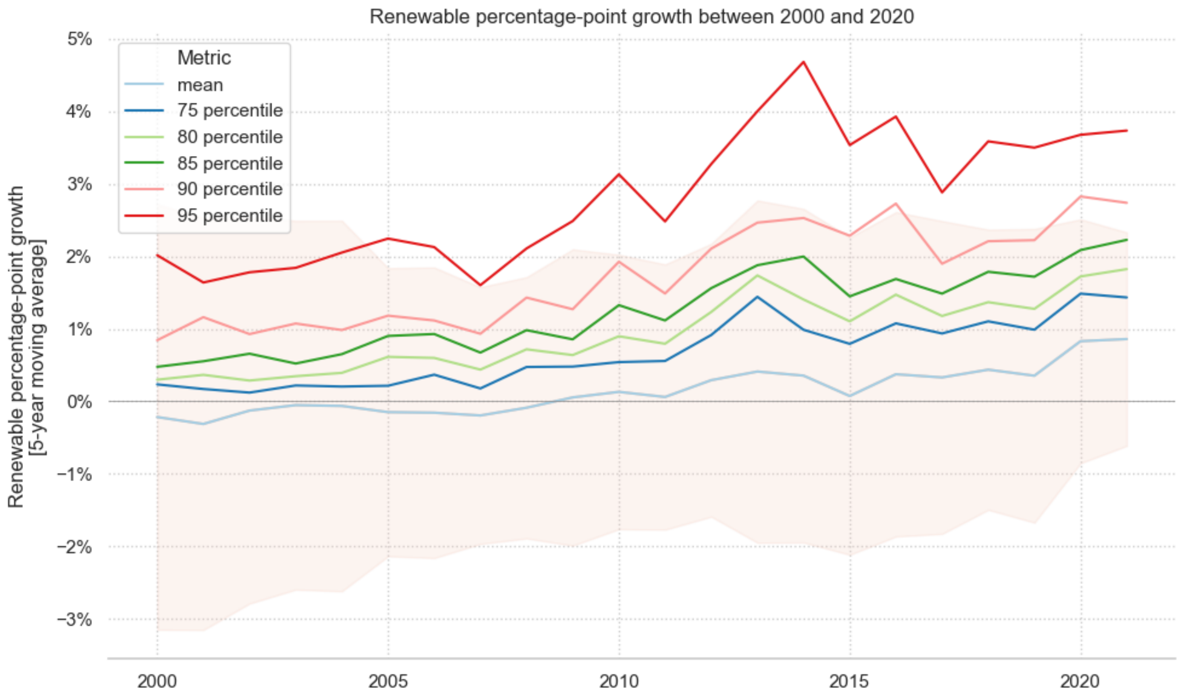


*Figure 5: Five-year moving average of distinct statistics related to the national %-point change in renewable electricity. Lines represent distinct statistics and the shaded area shows the standard deviation.*

One-quarter of the countries (75th percentile) had an increase in renewable electricity of above 1.43 p.p. in 2021. This value is slightly above what is considered good practice in recent studies (Baptista et al., 2022; van Soest et al., 2021) and falls within the range of a previous study (Kriegler et al., 2018). Considering that renewable electricity %-point increase accelerates, including most up-to-date information using similar methods to these studies would likely increase the level of 'good practice' over time.

We also observe a narrowing of the standard deviation over time (Figure 5). This suggests that the performance of countries has converged in the past two decades. The standard deviation is a good metric to evaluate the spread of the distribution and the trend in percentiles, but alone remains insufficient to identify and remove outliers. Identifying the good performance range of percentiles should not rely exclusively on analyses of the distribution main statistics. It must be combined with specific knowledge on the impact indicator analysed and potential underlying drivers.

The 95$^{th}$ percentile is subject to much higher year-to-year fluctuation, even when smoothed using a five-year moving average. It is also markedly outside the distribution standard deviation over most of the period analysed (Figure 5). Considering this as historical good practice would likely result in a substantial overestimation of the uptake of renewable electricity across countries.

The 90th percentile is mostly within the standard deviation over time. However, in 2021 it results in values almost twice the 1.4 p.p. identified in previous literature as good practice for this indicator (Table 3). This percentile is also based on data for only fifteen countries, which together are responsible for 2.4% of global total electricity generation. The share of renewable electricity can change fast in small systems.

In our analysis, we consider the 75$^{th}$ and 80$^{th}$ percentile as good historical performers. These values are prevalent in a substantial share of countries, constitute above average performance and provide a reasonable range (Figure 5). They are also clearly not outliers as they fall well within the standard deviation for the whole period.

### Disaggregating historical good performance levels

Disaggregating historical good practice indicators means defining the level of the indicator at a more granular level. This disaggregation allows for a better understanding of potential differences among country groups. Two of existing publications account for countries' income level to define the level of good practice indicators (Baptista et al., 2022; van Soest et al., 2021). However, in most indicators, the level of the good practice indicator does not vary by country group. This is partly a result of the research-intensive method to identify good practice and the lack of available information to successfully desegregate the values when evaluating effects at the policy level.

Our statistical approach simplifies this process. To disaggregate historical good practice levels, we simply divide the sample into country groups based on distinct criteria and re-calculate the main statistics within these groups. In this process, analysts need to be mindful of the sample size to ensure that statistics are calculated based on a minimum number of countries.

In our analysis, we divide countries based on three main characteristics:

- Income group: We divide the country sample based on the income categorisation of the World Bank in 2022. The four categories are High income, Upper middle income, Lower middle income and Low income.

- Geographical region: We divide the country sample based on the R5 regions geographical categorisation. The seven regions are R5REF, Asia, Latin America, Middle East and Africa, R5OECD90+EU, and Other, which are countries not included in the R5 regional categorisation.
- Architectures of climate policy constraint: We divide the country sample based on the five architectures of climate policy constraint proposed in Lamb et. al. (2020). These architectures constitute clusters in which distinct constraints to climate policy progress converge. The five architectures are Oil and gas states, Fragile states, Coal-development, Fracture democracies and Wealthy OECD. In this categorisation we also have a group for countries that were not clustered in the original analysis.

Renewable %-point increase in electricity has accelerated in the past decade (Figure 6). Across almost all clusters, the median %-point change increased between 2011 and 2021. This shows that the global pattern (Figure 5) is maintained at different country group levels. The only group that shows a decrease in %-point increase are countries that were previously a part of the Soviet Union.

Countries with fewer constraints to climate policy increase the share of renewable approximately four time faster than countries with the highest level of constraint. The disaggregation based on architectures of constraint shows that the %-point increase in renewable electricity is higher in countries with fewer constraints to climate policy (Figure 6). Historical good performance range ($75^{th}$ – $80^{th}$ percentile) is between 0.50 – 0.66 p.p. in 2021 for Oil & gas states, which are countries with the highest levels of climate policy constraints. The good performance range for Wealthy OECD countries, the ones with the lowest constraints to climate policy, is 2.04 – 2.38 p.p. in 2021.

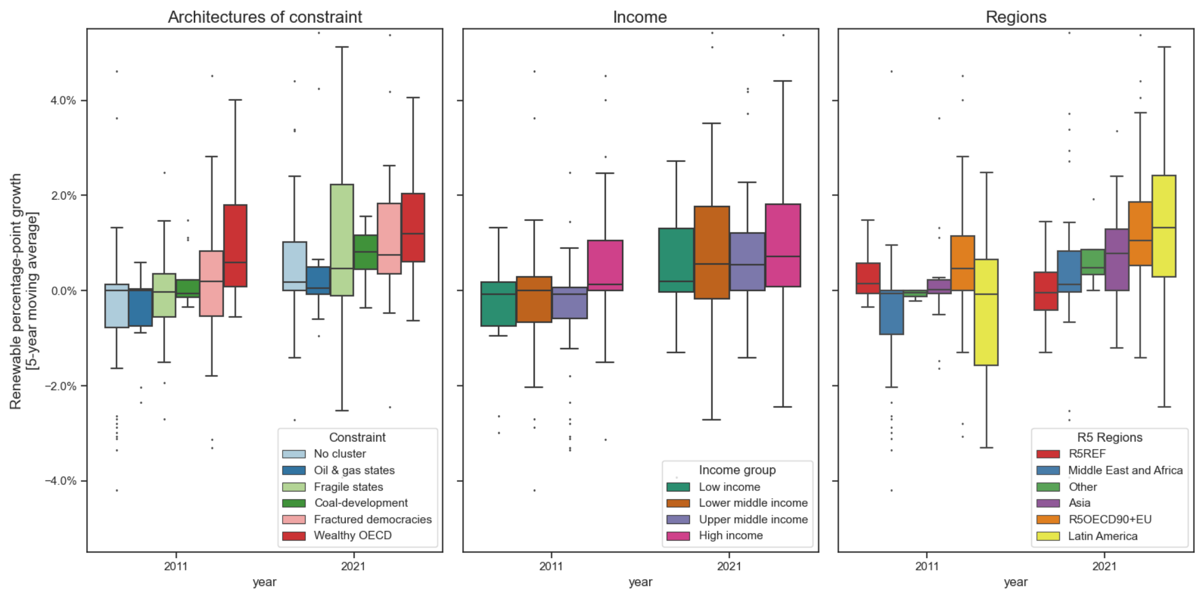


*Figure 6: Distribution of historical %-point increase in renewable electricity per income group, geographical region and architectures of climate policy constraint. Figure based on the 'latest trend' approach in the respective years.*

The disaggregation based on income shows that the %-point increase in renewable electricity is higher in countries in higher income (Figure 6). Middle income countries (both higher and lower) have similar median %-point increase and high-income countries have slightly higher. In general, the differentiation between these groups is not as significant as that observed when disaggregating based on architectures of constraint. Historical good practice range (75th – 80th percentiles) is 1.31 p.p. for low-income countries and 1.82 – 1.97 p.p. for high-income countries in 2021.

Disaggregation based on geographical regions is particularly useful in the context of global modelling exercises without national resolution. Our results indicate that substantial differences exist across regions. Countries that were part of the Soviet Union have the worse historical performance among the regions analysed, with a range (75th – 80th percentile) of 0.38 – 0.39 p.p. in 2021. Middle Eastern and African countries performed better at a range of 0.83 – 0.99 p.p. in 2021. Asian countries also performed better at 1.29 – 1.35 p.p. in 2021 but still below the global historical performance (1.35 – 1.70 p.p. in 2021). In our analysis, OECD (at 1.87 – 2.05 p.p. in 2021) and Latin American (2.42 – 2.95 p.p. in 2021) countries are the best performing regions.

## Exploring differences in the methods to define good historical performance

Although differences between the latest trend and long-term trend methods are minimal across all countries, results vary substantially when country groups are considered (Figure 7). In most cases, the latest trend results in an increase the good performance range value compared to the long-term method.

This difference is influenced by many factors. For example, countries where renewable electricity growth has slowed down in the recent years have a higher good performance range based on the 'long-term trend' approach. This is the case for many OECD countries. This is observed in the high-income country group, Wealthy OECD architecture of constraint and in the R5OECD+EU region. All these groups have similar country membership. Fractured democracies also observe higher long-term renewable growth compared to recent years — although the difference is smaller compared to OECD countries. In many of these countries, such as Brazil, Argentina, and Greece, recent economic recession partly explains a slowdown in renewable growth compared to the long-term trend.

Our good historical performance approach (Figure 7) results in higher renewable %-point increase for some groups, such as Latin American and OECD countries, and lower levels for others, such as Asian, previous Soviet and Middle Eastern and African countries, compared to previous literature on good practice (Figure 7). Our approach adds nuance to the quantification of good performance and improves the representation of good practice policy effects globally. Globally, good performance levels are slightly above previous literature investigating good practice policies.

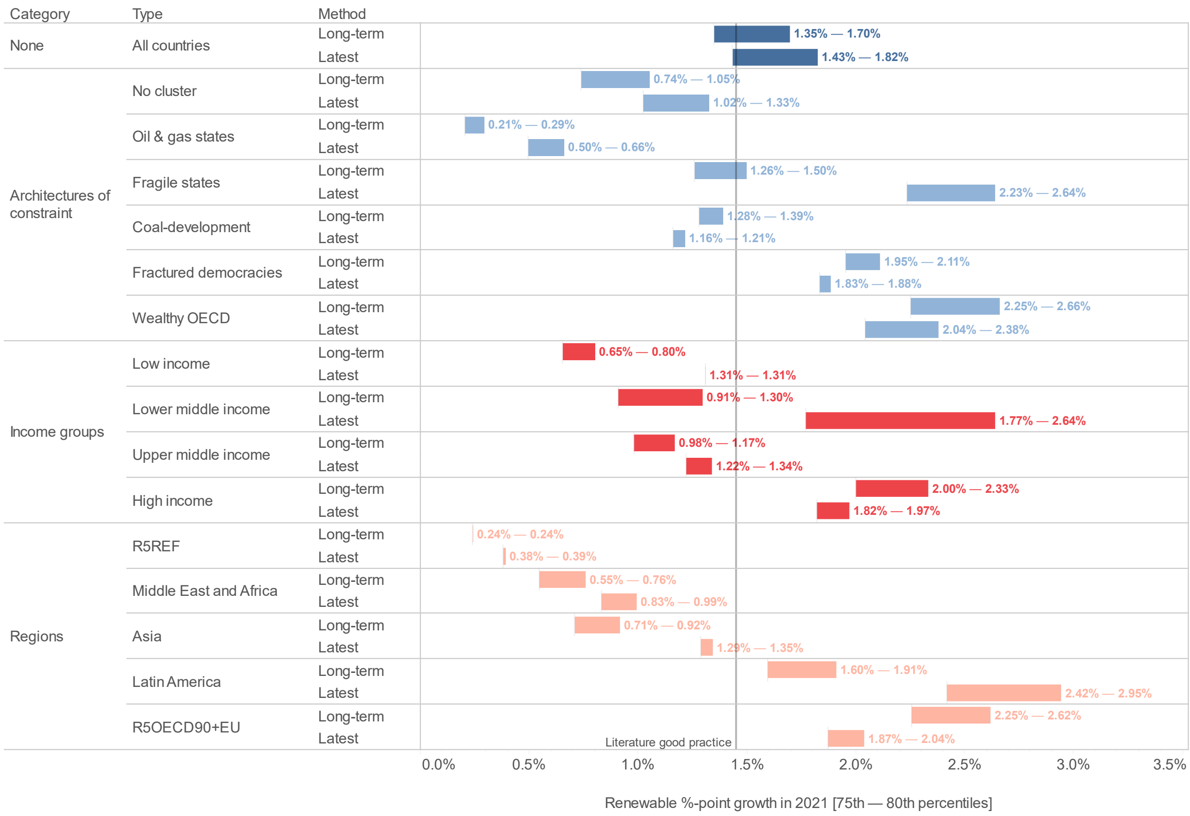


*Figure 7: Good performance range (75th — 80th) for renewable %-point increase across country groups. Range calculated using both latest and long-term methods.*

### Considerations when selecting method to calculate good performance

We suggest that researchers investigating historical developments, especially in recent years, apply the latest trend approach. While researchers interested in developing future scenarios use the long-term trend approach. However, the long-term approach may lead to overestimating the growth of renewables in some countries. This is especially the case for early movers that have higher shares of renewable electricity and now face a new set of barriers, such as land availability or integration challenges.

## 4.4. Conclusions and further research

In this analysis concept, we propose a new method to estimate the value of policy outcome indicators based on top historical performers. Specifically, we estimated the change in renewable electricity share.

Our estimated good performance levels are aligned with existing literature for good practice policies for renewable electricity. The results were also easier to disaggregate, which allow for a more differentiated quantification across countries.

We also discussed different methods to calculate good performance, outlined some of their implications and presented a step-by-step procedure to replicate the analysis.

In the context of ELEVATE, we will expand this analysis to additional indicators, after consultation with the project consortium. This consultation includes the definition of priority indicators and categories for disaggregation and preference regarding output formats. Additionally, we will explore potential determinants of good historical performance by identifying common top performers across sectors and indicators and mapping climate policy approaches, focusing on the prevalence and timing of distinct policy instrument types across sectors. Future analyses will depart from the table presented in Annex I and policies presented in Climate Policy Database (Chapter 2).

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# Annex

This annex contains an overview of indicators associated with good practice policies. This list is not comprehensive but offers a good set of indicators to explore good historical performance. Although this list provides an overview of the intended focus of forthcoming analysis, in some cases calculations may not be possible due data limitations.

*Table A1: Overview of potential impact indicators to measure good historical performance. List adapted from van Soest et al. (2021).*

| Sector | Measure | Potential impact indicators | Database |
|---|---|---|---|
| Agriculture and Forestry | Treat manure from livestock with anaerobic digesters | Reduction of $CH_4$ emissions from manure management relative to 2015 | (Minx et al., 2022) |
| | Increase nitrogen use efficiency | Reduction of N2O emissions related to synthetic fertilizer application relative to 2015 | (Minx et al., 2022) |
| | Selective breeding to reduce $CH_4$ emissions from enteric fermentation | Reduction of $CH_4$ emissions from enteric fermentation relative to 2015 | (Minx et al., 2022) |
| | Increase natural forest afforestation and reforestation | %-point annual change in forest area per year | (FAO, 2022) |
| | Halt natural forest deforestation | Not applicable | Not applicable |
| Energy supply | No new installations of unabated coal power plants | Not applicable | Not applicable |
| | Increase of the share of renewables in total electricity generation per year | %-point annual change in share of renewable electricity | (IEA, 2022) |
| | Coal mine $CH_4$ emissions recovery | Reduction of $CH_4$ emissions from coal mining fugitive emissions relative to 2015 | (Minx et al., 2022) |
| | Reduce venting and flaring | Reduction of oil and gas fugitive emissions relative to 2015 | (Minx et al., 2022) |
| Buildings | Improve final energy efficiency of appliances | TBD | TBD |
| | Improve final energy intensity of new residential and commercial buildings | %-point annual change in energy use in buildings | (IEA, 2022) |
| | No new installations of oil boiler capacity in new and existing residential and commercial buildings | Not applicable | Not applicable |
| | Improve efficiency of existing buildings | TBD | TBD |
| Industry | Apply CCS—Carbon captured and stored as share of industry's total $CO_2$ emissions (model-dependent) | TBD | TBD |
| | Improve final energy efficiency | %-point annual change in energy use in industry | (IEA, 2022) |
| | Reduce $N_2O$ emissions from adipic/acid production | Reduction of $N_2O$ emissions in industry relative to 2015 | (Minx et al., 2022) |
| Transport | Improve energy efficiency of aviation | %-point annual change in energy use in world and domestic aviation | (IEA, 2022) |
| | Improve average fuel efficiency of new passenger cars | TBD | TBD |
| | Increase the share of non-fossil in new vehicle sales | TBD | TBD |
| Waste | Reduce $CH_4$ emissions | Reduction of waste $CH_4$ emissions relative to 2015 | (Minx et al., 2022) |
| Economy-wide | Carbon pricing | TBD | TBD |

| Sector | Measure | Potential impact indicators | Database |
|---|---|---|---|
| | Reduce F-gas emissions, induced by policies | Reduction of economy-wide F-gases emissions relative to 2015 | (Minx et al., 2022) |