Grantham Research Institute on Climate Change and the Environment

IMPERIAL Grantham Institute

Science in the courtroom: evidentiary needs in climate litigation

Noah Walker-Crawford, Jameela Joy Reyes, Nicholas Petkov and Sofia Palazzo Corner

Grantham Climate Litigation Guide 1

THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

IMPERIAL

The Grantham Research Institute on Climate Change and the Environment was established in 2008 at the London School of Economics and Political Science. The Institute brings together international expertise on economics, as well as finance, geography, the environment, international development and political economy to establish a world-leading centre for policy-relevant research, teaching and training in climate change and the environment. It is hosted by the Global School of Sustainability at LSE.

www.lse.ac.uk/granthaminstitute

The Grantham Institute – Climate Change and the Environment is Imperial College London's hub for climate change and the environment, and one of Imperial's seven Global Institutes established to promote inter-disciplinary working and to meet some of the greatest challenges faced by society. The Institute drives forward discovery, converts innovations into applications, trains future leaders and communicates academic knowledge to businesses, industry and policymakers to help shape their decisions.

www.imperial.ac.uk/grantham

The two institutes are supported by the Grantham Foundation for the Protection of the Environment.

About this guide

This guide is the first in the Grantham Climate Litigation Guides series. These guides are a collaboration between the Grantham Research Institute at LSE and the Grantham Institute at Imperial College London. The series is designed to provide informed guidance on the use of climate science and evidence in legal and policy contexts in concise, non-technical language. Further guides will be published in 2026.

About the authors

Noah Walker-Crawford is a Research Fellow at the Grantham Research Institute on Climate Change and the Environment, LSE and the Grantham Institute at Imperial College London.

Jameela Joy Reyes is a Policy Officer at the Grantham Research Institute, LSE.

Nicholas Petkov is a Research Assistant at the Grantham Research Institute, LSE.

Sofia Palazzo Corner is a visiting researcher at Imperial College London.

Acknowledgements

The authors would like to thank Tiffanie Chan, Catherine Higham, Delta Merner and Rupert Stuart-Smith for reviewing this Guide. They also thank both Grantham Institutes for their support. Noah Walker-Crawford acknowledges funding from the Economic and Social Research Council, Grant ES/Y003314/1.

Georgina Kyriacou edited the guide and it was typeset by Joseph Adjei.

The views in this guide are those of the authors and do not necessarily represent those of the host institutions or funders. Any errors and omissions remain those of the authors. Noah Walker-Crawford has provided advisory support to organisations involved in climate litigation, and was involved as an independent researcher in *Lliuya v. RWE*. Sofia Palazzo Corner is a Science Adviser at the Climate Litigation Network. The authors have sought to maintain analytical independence throughout.

This guide was first published in March 2026 by the Grantham Research Institute on Climate Change and the Environment and Grantham Institute – Climate Change and the Environment.

Suggested citation: Walker-Crawford N, Reyes JJ, Petkov N and Palazzo Corner S (2026) *Science in the courtroom: evidentiary needs in climate litigation.* London: Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science and Grantham Institute – Climate Change and the Environment, Imperial College London.

DOI: 10.21953/researchonline.lse.ac.uk.00137472

Cover photo credit: International Court of Justice

Contents

Summary points

- Climate litigation has emerged as an influential area of climate governance. Scientific evidence plays a key role in helping courts adjudicate cases about government and corporate responsibility for addressing climate change.
- Scientific evidence is used differently across case strategies. This guide focuses on government framework cases (which contest governmental climate policy), corporate framework cases (which challenge companies' climate-related performance), and polluter pays cases (which seek damages for climate-related harm).
- Climate science is evolving rapidly, providing an expanding evidentiary basis for climate litigation. However, there is limited systematic analysis of the evidentiary needs of different climate litigation strategies.
- Courts tend to favour evidence from the Intergovernmental Panel on Climate Change (IPCC) over standalone studies, creating a *de facto* evidentiary hierarchy.
- Scientists can influence litigation both on behalf of parties but also independently of legal teams. They can act not only as expert witnesses but also as advisors, independent researchers, contributors to *amicus curiae* briefs that provide expert knowledge, and facilitators in judicial education.
- Evidentiary discussions vary across case strategies:
  - Government framework cases centre on aligning national targets and actions with global temperature goals, carbon budgets and 'fair share' principles, assessing compliance with targets, and demonstrating the impacts of climate change.
  - Corporate framework cases often seek company-level emissions reductions in line with global or sectoral emissions pathways, analysing transition plans and corporate target setting.
  - Polluter pays cases rely on attribution science to establish a causal chain between large emitters and harm to plaintiffs.
- Tensions between what is regarded as 'best available science' and what is regarded as persuasive by legal audiences create a need for effective scientific communication within legal narratives.

Introduction

This guide explores and reflects on the role of scientific research in climate litigation. It outlines the main types of evidence used across three major case categories and how scientific evidence is utilised by claimants. The guide focuses on strategic climate litigation cases that aim to further climate action, drawing on a range of case studies from around the world.

Climate litigation and the role of evidence

As global warming races towards 1.5° Celsius above pre-industrial levels, climate litigation has emerged as a key tool for influencing climate policy and pursuing accountability. To date, nearly 3,000 cases have been filed in over 60 countries, targeting both state and non-state actors that have made significant contributions to climate change through their greenhouse gas emissions (Setzer and Higham, 2025). According to the *Sixth Assessment Report* (AR6) of the Intergovernmental Panel on Climate Change (IPCC), climate litigation affects the outcome and ambition of climate governance (IPCC, 2022a).

Scientific evidence plays a crucial role in climate litigation. Science provides the tools to understand what climate change is and how it affects us. In courts around the world, litigators and judges draw on scientific research to determine how the climate is changing, who is contributing emissions and what can be done about it. Scientists provide key insights that shape the outcome of climate litigation, whether as expert witnesses, advisors to litigators, or independently publishing litigation-relevant research.

The evidence informing climate litigation is often diverse and complex, involving multiple disciplines in a single case. Litigation strategies often rely on evidence such as attribution studies, greenhouse gas emissions data and expert testimony to establish causation and support legal duties to reduce emissions.

Strategic climate litigation involves using legal tools to drive social, political or economic change. In these cases, litigants are concerned with protecting the rights of the immediate parties but also aim to advance broader agendas related to climate action. The three types of case strategies that form the focus for this guide – government framework cases, corporate framework cases and polluter pays cases – are outlined in Table A below.

Although scientific evidence is central to climate litigation, there is limited systematic analysis of how different types of climate claim rely on different forms of scientific evidence. As evidentiary needs vary across legal strategies and claims, litigators and courts face persistent challenges to identify and account for the best available scientific evidence (Stuart-Smith, Otto et al., 2021). This guide aims to bridge some of this gap and support parties to understand which types of scientific evidence are most relevant to different categories of climate claims, how this evidence can be robustly developed and presented, and how it can be effectively integrated into legal arguments.

Using a retrospective case study approach, this guide provides a structured reflection on some of the arguments and evidence employed in cases to date. Existing cases do not prescribe future approaches. However, given the rapid development of the field and the wide variation in legal systems and factual contexts, they provide a valuable foundation from which future approaches can draw. The guide distils practical lessons and conclusions that may help inform strategic choices, illuminate recurring challenges and clarify the emerging landscape of evidence used in different climate litigation strategies.

Structure of the guide

In the remainder of this Introduction, we outline our methodology and our chosen case strategies. The guide is then divided into two main parts:

- Part 1 outlines how science is understood and perceived in climate litigation. It reviews how courts have evaluated and engaged with scientific evidence, reflecting on the different roles played by scientists in the courtroom and the importance of the IPCC.
- Part 2 distinguishes between the different evidentiary needs present in the three different types of cases. It provides practitioners, non-specialists and those generally interested in the science–law intersection with a clear overview of how different types of scientific evidence have historically been used across climate litigation.

The guide concludes with a reflection on what these findings may mean for future litigation and climate action more broadly.

Box A. Research methods and choice of cases

We conducted an in-depth study of 17 strategic climate lawsuits between July 2024 and September 2025. We carried out a structured textual analysis to look at the kinds of scientific evidence used and considered by the parties and judges. We examined all publicly available documents, including initial pleadings and court resolutions, and used the DeepL translation software for documents not written in the English language.

The cases were chosen based on several factors: their geographical diversity, high-profile nature, public availability of case documents, and the variety (and divergence) in scientific evidence presented.

Some cases may fall under one or more of the case strategies identified. However, for the purpose of this guide, these cases have been paired with the strategy for which they have provided the most novel and helpful insights into the use of evidence in litigation.

Determining whether a case is relevant for this guide and which strategy takes precedence is subjective, and our assessment may differ from that of those directly party to the cases. We have sought to provide an independent overview of key scientific evidence used and required across these diverse cases.

Overview of case strategies

The three case strategies featured in this guide are summarised in Table A, along with a list of the cases identified and analysed for each.

Table A. Cases included in the study

Case strategy	Description	Examples included in the guide*
Government framework cases	Cases that question the ambition or implementation of a country's climate targets, policies and laws	• *Held v. Montana* (USA) • *Juliana v. United States* (USA) • *KlimaSeniorinnen v. Switzerland* (European Court of Human Rights) • *Neubauer et al. v. Germany* (Germany) • *Notre Affaire à Tous v. France* (France) • *Sharma et al v. Minister for the Environment* (Australia) • *Urgenda v. Netherlands* (Netherlands)
Corporate framework cases	Cases aimed at forcing companies to adopt lower-emission practices by requiring changes to their corporate policies, governance and decision-making processes throughout their value chain	• *Greenpeace Italy v. Eni* (Italy) • *Milieudefensie et al. v. Royal Dutch Shell* (Netherlands) • *Notre Affaire à Tous et al v. Total* (France) • *Smith v. Fonterra* (New Zealand)
Polluter pays cases	Cases where claimants seek financial compensation from defendants for their role in causing harmful climate change impacts through greenhouse gas emissions or other activities contributing to climate change	• *Asmania et al. v. Holcim* (Switzerland) • *City & County of Honolulu v. Sunoco LP* (USA) • *County of Multnomah v. ExxonMobil Corp.* (USA) • *Falys v. TotalEnergies* (Belgium) • *Luciano Lliuya v. RWE* (Germany) • *Native Village of Kivalina v. ExxonMobil Corp.* (USA)

**Note: The links in column 3 lead to descriptions of the cases contained in the Sabin Center for Climate Change Law's climate litigation database, for those wishing to explore their details.*

Part 1. Standards of evidence: similarities across cases

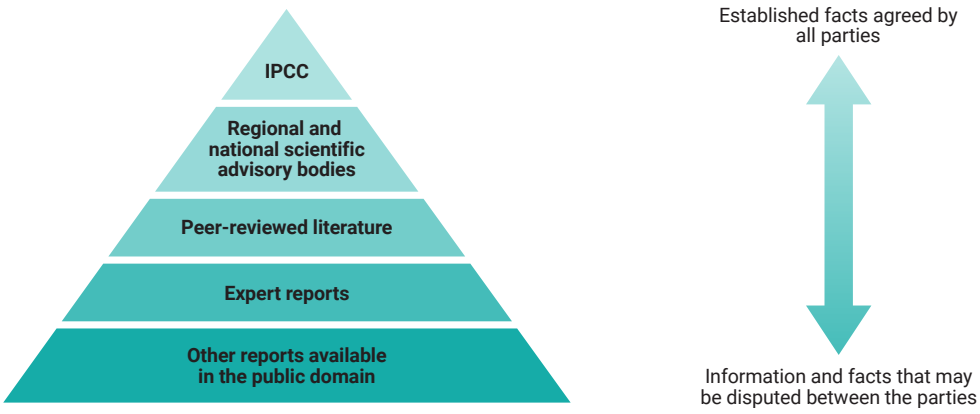
An emerging hierarchy of evidence in climate litigation

The cases considered in this report display a consistent approach to the use of scientific evidence. The most pronounced similarity across all the cases is the use of the Assessment Reports (ARs) released by the Intergovernmental Panel on Climate Change (covered in more detail below). The IPCC is widely understood to be the highest authority on the state of climate science (ICJ, 2025). The Reports synthesise peer-reviewed research and reflect broad scientific consensus, providing judges with a trusted foundation for evaluating climate-related claims.

However, the IPCC is not the only reference point for scientific evidence in climate cases. Courts are faced with a diversity of scientific sources, often needing to assess the quality, and comprehend the relevance, of material presented by parties. Judges and lawyers working in courts are typically non-experts in climate science. If the parties do not agree on the facts in a case, this can make it challenging for them to discern between high- and low-quality scientific research without additional guidance.

To address this, some courts have chosen to appoint their own expert to provide impartial evidence and guidance. In other cases, courts have appeared to assess the evidence that has been submitted by parties based on the writing and review process. Broadly, courts tend to favour evidence that has undergone thorough and transparent peer review, and which they consider to represent scientific consensus. This approach has resulted in an emerging hierarchy of scientific evidence in the courtroom (see Figure 1.1). The IPCC Assessment Reports represent the most extensive assessment and thorough peer review process, delivering the highest quality and most established scientific consensus assessment and thus appearing at the top of the hierarchy.

Figure 1.1. An emerging hierarchy of scientific evidence in the courtroom



Source: Reproduced with permission from Williamson (2025)

Evidence that would ordinarily rank lower in this pyramid may also have stronger value in the eyes of the court if it is based on scientific publications higher up the hierarchy. For example, expert reports may carry more weight if they simply collate and explain the salient findings of the IPCC in the context of the facts of the case being heard.

This preference for evidence that reflects what the court perceives as established scientific consensus, rather than cutting-edge research, can create a gap between the courts and scientists over what constitutes the 'best available science' at a certain point in time. For litigation that relies on more recent scientific findings or methodologies, the best available science may be found in newer publications that are not yet reflected in the latest IPCC reports. This creates a challenge for claimants if courts show reservation in engaging with the most up-to-date literature.

The role of the IPCC and the landmark *Special Report on 1.5 Degrees*

The scientific authority of the IPCC, the United Nations body for assessing the science related to climate change, has become a central pillar in climate litigation, shaping both parties' and courts' reasoning. The IPCC publishes Assessment Reports every seven to nine years on the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation. These also incorporate a Synthesis Report which integrates the contributions and all the Special Reports that were prepared in that assessment cycle. The most recent of these reports is the *Sixth Assessment Report*, which was released in 2022 and 2023 (IPCC, 2023a). The IPCC's landmark *Special Report on 1.5 Degrees* (IPCC, 2022b) supports the international political and legal consensus to limit temperature increase to 1.5°C, as negotiated in the Paris Agreement.[1]

Since publication of the *Special Report on 1.5 Degrees*, climate litigation cases, particularly those challenging the overall ambition of a country's response to climate change, have referred not just to the general IPCC Assessment Reports, but to that report too. Two example cases that both relied on the *Special Report* to strengthen their claims are *Juliana v. US*, where a group of youth claimants sued the US government for its role in contributing to climate change and failing to protect future generations from its impacts, and *KlimaSeniorinnen v. Switzerland*, which was filed by a group of senior women claiming that the Swiss government has not done enough to protect its citizens from the worst consequences of climate change.

Courts have relied on IPCC scientists to inform their decision-making. Prior to the issuance of the Advisory Opinion by the International Court of Justice (ICJ) on states' obligations in the context of climate change in July 2025 (ICJ, 2025), the ICJ convened past and present IPCC scientists (IPCC, 2024) to help enhance the judges' understanding of the key scientific findings of the IPCC, including the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation.

The IPCC is rarely called into question as a legitimate source of evidence; rather, parties often debate how to interpret the IPCC's insights in relation to legal questions. Although the IPCC's authority is widely acknowledged, the perceived reasons for that authority appear to vary between jurisdictions (see Box 1.1).

Box 1.1. Perception of the IPCC in different jurisdictions

While the IPCC is broadly understood to be the principal authoritative international scientific body reviewing the science of climate change, its perception and influence vary depending on jurisdiction.

In Europe (particularly the Netherlands, France and Germany), judges frequently emphasise the intergovernmental characteristics of the IPCC, positioning its reports as consensus-based and agreed upon by all parties. In the US, courts instead prioritise neutrality and the elimination of bias, where it is the rigour of the peer review process and the scientific expertise of contributors that underpins the IPCC's credibility as a source (Zhu and Fan, 2024).

The role of scientists as experts in climate litigation

In addition to the use of the IPCC reports in their pleadings, litigants rely on testimony, reports and other expert evidence produced by scientists to substantiate their claims. Expert evidence can help translate complex scientific findings into forms that courts can meaningfully engage with, strengthening the evidentiary foundations upon which arguments are built.

How expert evidence is presented and how experts are selected vary largely by jurisdiction. In common law jurisdictions parties will often appoint their own experts who present to the judge or jury, whereas in civil law jurisdictions the court itself will often appoint an expert – see Table 1.1.

1. See Box 2.1 below for further explanation of the 1.5ºC target.

Table 1.1. Distinction between common and civil law jurisdictions

	Common law jurisdictions	Civil law jurisdictions
Definition	 Rely primarily on judicial precedent, with law developing through case-by-case decisions.	 Based on comprehensive, codified statutes that set out general principles applied by judges.
Admissibility of expert evidence	 Courts follow an adversarial model. Each party is allowed to present their own experts who will then offer their testimony.	 Experts are often court-appointed, vetted and considered an 'auxiliary of the court' (Verkerk, 2009): the court views their conclusions as highly influential to the ultimate decision.

While these systems differ, both also share similarities in how expert evidence is considered. In common law systems, courts can occasionally appoint experts. For instance, under Rule 706 of the Federal Rules of Evidence, US judges can appoint an expert witness on a party's motion or its own. However, this is an uncommon practice (Verkerk, 2009). In civil law systems, parties will often hire their own experts in an advisory capacity. These experts can help shape the overall case strategy, draft questions to the court-appointed expert, or comment on the findings of the court-appointed expert. However, judges rarely have a duty to address these comments and there are limited opportunities for party experts to directly present their position to the court on specific technical issues.

Other roles scientists can play in climate litigation

Beyond their formal appearance as expert witnesses, scientists may contribute to climate litigation in various other capacities, four of which are described below. Recognising these roles separately helps clarify how scientific expertise intersects with legal processes and where scientists may engage even without directly participating in litigation. Taken together, these roles show that the involvement of scientists in climate litigation is varied and extends well beyond courtroom testimony.

1. **Scientists may serve as advisors to litigators and civil society organisations seeking to file cases.** In this role, scientists do not necessarily appear before a judge but instead support legal teams by helping to inform arguments, interpreting scientific findings, or assessing the strengths and weaknesses of potential claims. This form of engagement evidentiary can influence litigation strategy and strengthen the evidentiary foundation of a case.
2. **Scientists can produce litigation-relevant research independently of case parties.** Such independent work such as this can be submitted as evidence in litigation, even if it was not originally produced for that purpose (e.g. see Stuart-Smith, Roe et al., 2021). For example, a study might show how climate change exacerbated an extreme weather event, inspiring those affected to take legal action. Scientific research shapes the broader evidentiary landscape within which courts operate.
3. **Scientists can submit *amicus curiae* briefs.** These legal submissions, where permitted by the court, provide expert knowledge on matters that lie outside the typical scope of legal arguments. Not tied to any particular party in a case, these briefs offer independent, objective insights that can help clarify complex technical issues for the court. Unlike testimony, which can be subjected to cross-examination, *amicus* briefs serve as an opportunity to contribute relevant scientific information more directly and influence judicial reasoning. For instance, in the Swiss case brought by KlimaSeniorinnen, the group Scientists for Future submitted their brief[2] to explain to the court concepts such as attribution science and causal chains. (See 'Polluter pays cases' in Part 2 for more on these concepts.)
4. **Scientists can participate in judicial engagement.** This process might involve engaging with judges on key scientific principles, methodologies or emerging trends in relevant fields. This serves to enhance judges' understanding of scientific concepts, helping courts assess scientific evidence presented in cases and make well-informed decisions.

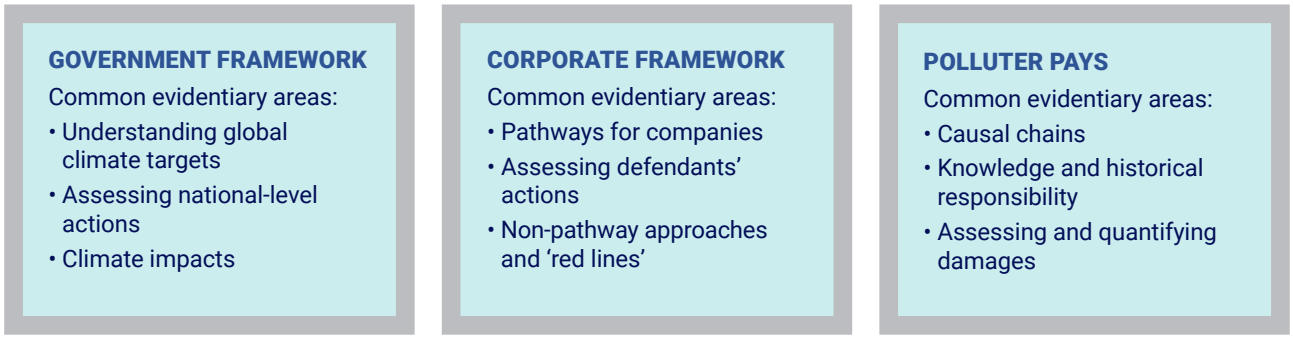
2. See Intervention by Germanwatch, Greenpeace Germany and Scientists for Future: https://cdn.climatepolicyradar.org/navigator/XAB/2020/verein-klimaseniorinnen-schweiz-and-others-v-switzerland_786fd482fab0b3a0c4f2413395e28b1a.pdf

Part 2. Evidence across different climate litigation case types

While general trends in the use of experts and the role of the IPCC are consistent across different types of cases, specific evidentiary needs differ, depending on the type of claim and legal strategy pursued.

This section distinguishes three major types of strategy in climate litigation – government framework, corporate framework and polluter pays – and outlines the areas in each where evidence and scientific input has been most relevant. Figure 2.1 sets out the three case categories, introducing the main areas of evidence relevant to each, which are then discussed in turn below.

Figure 2.1. Common areas of evidence in different case strategies



Government framework cases

Government framework cases challenge a national or subnational government's climate policy by contesting the adequacy of emission-reduction targets, lack of progress towards meeting these targets or carbon budgets, the coherence of climate policies, or failures to implement overarching climate framework laws.

These cases typically seek to compel governments to align their climate action with scientific evidence, legal commitments, or constitutional and human rights obligations.

An important early precedent in this category is the case *Urgenda v. Netherlands*, which involved an action against the Dutch government to require it to do more to prevent climate change. In 2015, the Hague District Court ordered the Dutch state to limit greenhouse gas emissions to 25% below 1990 levels by 2020, finding the government's existing pledges insufficient to meet the state's fair contribution towards global climate goals.[3]

Government framework cases involve the use of multiple, interrelated forms of scientific evidence:

- First, climate science is relied upon to establish global climate goals and temperature thresholds.
- Second, these global benchmarks are used to assess whether national targets are compatible with internationally agreed climate objectives.
- Third, scientific evidence is used to evaluate whether governments are acting consistently with their stated targets and carbon budgets.
- Finally, evidence of climate impacts provides essential context or support for claims, particularly where issues such as standing, causation or specific harm are issues in the case.

Box 2.1 provides definitions of some key terms used in this guide.

3. See judgment: https://cdn.climatepolicyradar.org/navigator/NLD/2015/urgenda-foundation-v-state-of-the-netherlands_fcb4bfb035f824ccd4567dc2a9974d92.pdf

Box 2.1. Key terms in climate litigation

1.5°C goal: the international target set by the Paris Agreement to increase efforts to limit global warming to no more than 1.5°C above pre-industrial levels to avoid the worst impacts of climate change. Achieving this goal requires urgent and significant reductions in greenhouse gas emissions.

Attribution science: a branch of climate science that assesses the relative contributions of different factors to a climate-related change or event. For instance, it might ask how anthropogenic climate change has affected the likelihood or intensity of a particular heatwave, or the contribution of a specific emitter to global warming.

Carbon budget: in its simplest terms, this is the net cumulative amount that can be emitted while still limiting global warming to a specific temperature threshold with a certain probability. The term is most used with reference to the 'remaining carbon budget', which is the amount of CO_2 that can still be emitted from present levels while keeping warming below a target, such as 1.5°C, with a defined probability, e.g. 50%.

Fair share: the amount of emissions reduction or climate action that a country or company should take, considering factors such as its current capabilities, and past and present contributions to global warming. While fair share can be defined in different ways, international climate agreements provide an authoritative framework for sharing this burden fairly.

Overshoot: a temporary exceedance of a temperature threshold. Overshooting the 1.5°C degree target means greater risks of severe impacts, some of which may be irreversible (Phillips, 2025). 'Limited overshoot' refers to temporarily exceeding 1.5°C of global warming by up to about 0.1°C.

Scope 1, 2 and 3 emissions: Scope 1 emissions are direct greenhouse gas emissions from owned or controlled sources, such as a factory's emissions. Scope 2 covers indirect emissions from the generation of purchased electricity consumed by the company. Scope 3 includes all other indirect emissions, such as those from the supply chain or consumer use of a product. Corporate defendants often argue that they should not be held liable for Scope 3 emissions.

Understanding global climate targets

Understanding climate targets and obligations at the global level is a crucial starting point for the formation of government framework cases: it provides essential context for assessing national level target-setting and mitigation measures. While climate science can model and predict the impacts of climate change, the establishment of climate targets is ultimately a legal and political process that balances the feasibility of rapid mitigation against the risk of future climate-induced harm. Scientific research plays two key roles in this context: informing the content of climate targets and identifying pathways to achieve them. These issues have been central to the pleadings in government framework litigation cases launched to date.

Globally, the most widely recognised target is to hold the increase in the global average temperature to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C. This target is enshrined in the Paris Agreement (UNFCCC, 2015), the most authoritative agreement in international law relating to climate action. Recent years have seen the role of the 1.5°C target becoming even more legally significant. In its 2025 Advisory Opinion on the Obligations of States in respect of Climate Change, the International Court of Justice affirmed that state parties bear a legal obligation to pursue the 1.5°C temperature limit (ICJ, 2025).

Of our selected cases, three of the four cases filed post-Paris Agreement cite both the Paris Agreement and the IPCC's *Special Report on 1.5 Degrees* in relation to global climate targets (*Neubauer v. Germany, KlimaSeniorinnen v. Switzerland* and *Notre Affaire à Tous v. France*). In the *KlimaSeniorinnen* application to the European Court of Human Rights, the claimants used the reports to show the global scientific consensus for the 1.5°C target and that "limiting the temperature increase to 1.5°C would reduce the risks and impacts [of climate change] substantially".[4] Beyond these cases, the 1.5°C target (or a lower target) has played a prominent role in 26 of 54 government framework cases filed post-2018 (Higham et al., 2022).

4. See Application: https://cdn.climatepolicyradar.org/navigator/XAB/2020/verein-klimaseniorinnen-schweiz-and-others-v-switzerland_1eb07df12cbd7bf21735fc1a4919197b.pdf

IPCC mitigation pathways are commonly cited to help understand how the 1.5°C target can be achieved. These pathways are "modelled trajectories of global anthropogenic emissions over the 21st century" (IPCC, 2018b) made up of emission scenarios that offer "plausible representations" of future developments.

The pathways are not prescriptive. Instead, they explore a range of possibilities that depend on different assumptions, often created using simplified models known as Integrated Assessment Models (IAMs) (IPCC, 2018b). For example, the IPCC included in a 2023 report that to have more than a 50% chance of limiting warming to 1.5°C (with no or limited overshoot), global greenhouse gas emissions would need to be reduced by 43% by 2030 (compared with 2019 emission levels) (IPCC, 2023a). These pathways are therefore useful in a broad sense, but offer limited guidance for evaluating whether, for instance, national emissions trajectories are compatible with specific goals such as the 1.5°C target. Assessing national compatibility requires more specialised forms of evidence that could include carbon budget allocations and fair share considerations.

Carbon budgets are also used to present 'how much can still be emitted' in more concrete terms. Recent estimates suggest that to have a 50% chance of limiting global warming to below 1.5°C, the remaining carbon budget from the beginning of 2025 is around 130 gigatonnes (Gt) of CO_2 (Forster et al., 2025; see also Box 2.1 for definition). Carbon budgets are important because they clearly define the amount of greenhouse gases that may still be emitted. This enables direct comparison between current emissions and the scale of reductions required. For example, the International Energy Agency reported that global energy-related CO_2 emissions in the year 2024 amounted to almost 40 Gt (IEA, 2025). Emissions at this level would account for around 30% of the remaining carbon budget cited above, clearly demonstrating the need for rapid and ambitious mitigation measures.

Presenting an understanding of politically and legally agreed temperature targets, how they are supported by the best available climate science, and the carbon budgets and pathways required to achieve them forms the basis of how framework cases approach discussions of necessary global-level climate action.

Assessing conformity of national action with global targets

To direct government-level action, global climate targets are localised at the national or regional level. This can involve creating national climate action plans, establishing a national carbon budget, or setting emission-reduction targets that are compatible with climate goals.

When assessing the adequacy of these measures, claimants have asked two distinct but interrelated questions:

a) Are the targets set at the national level reflective of global agreements?

b) Is government action in line with these government-set targets?

A climate case that gave an early mention to national-level target-setting was the *Urgenda v. Netherlands* case. In this case, claimants proposed an emission-reduction target of 25 to 40% by 2020 relative to 1990 levels.[5] Filed prior to the adoption of the Paris Agreement, this target was derived from the IPCC *Fourth Assessment Report*, which indicated that UNFCCC Annex I countries (i.e. developed countries – such as the Netherlands) would need to achieve emissions reductions within this range to limit global warming to near 2°C. In its judgment, the Supreme Court considered the extent of international consensus surrounding this target. Its assessment drew not only on IPCC findings but also on the broader international political context, including the recognition of such targets in UN climate negotiations.[6]

Ultimately, the Court upheld a minimum emissions reduction of 25% by 2020, as previously determined by a lower court.

From an evidentiary perspective, the *Urgenda* judgment was significant for two reasons. First, it confirmed that emissions pathways aligned with the best available science, as reflected in the IPCC's work, could be imposed as legally binding obligations on states. Second (and more crucially), it found

5. See p.12 of Summons: https://www.urgenda.nl/wp-content/uploads/Translation-Summons-in-case-Urgenda-v-Dutch-State-v.25.06.10.pdf
6. See Supreme Court Judgment: https://cdn.climatepolicyradar.org/navigator/NLD/2015/urgenda-foundation-v-state-of-the-netherlands_fcb4bfb035f824ccd4567dc2a9974d92.pdf

that such obligations should be calibrated according to fair share frameworks, by applying emissions pathways consistent with the responsibilities of Annex I countries.

More recent cases have involved a discussion about the translation of global carbon budgets into national climate budgets. These include *Neubauer v. Germany* and *KlimaSeniorinnen v. Switzerland*, cases that followed a broadly similar schematic to *Urgenda* but were filed post-Paris Agreement, meaning that there was a clearer political and legal consensus on the target for global action on climate change.

In *Neubauer v. Germany,* claimants argued that the greenhouse gas reduction target in the German government's Federal Climate Protection Act (KSG) was insufficient, violating human rights under the country's constitution. One of the claimants' arguments was that Germany's national carbon budget was calculated based on an allocation according to population share (i.e. countries with larger populations should be allowed to emit more), but this failed to consider fair share arguments.[7] In fact, claimants argued that if this were to be considered, Germany's carbon budget would already be exhausted, as shown by a cited report (Höhne et al., 2019).

In its judgment on *Neubauer*, the court acknowledged but did not adopt the claimants' fair-share approach, assessing the KSG in terms of Germany's existing carbon budget. However, it still determined that the climate targets in the Act were constitutionally incompatible with fundamental rights because they lacked provisions for emission-reduction targets beyond 2031. The court found that this omission constituted a breach of the government's duty by imposing a disproportionate burden on future generations.[8]

The most pivotal case regarding target-setting and carbon budgets has been *KlimaSeniorinnen v. Switzerland*. The claimants claimed that Switzerland's inadequate climate policies violated the claimants' right to life and health under Articles 2 and 8 of the European Convention on Human Rights (ECHR).[9] They argued that the Swiss government had set inadequate climate targets that were not informed by a national carbon budget and did not reflect the global carbon budget or fair share allocations. The claimants supplemented their arguments by citing the Climate Action Tracker,[10] an independent initiative that tracks government action on climate change, and academic literature, including an interdisciplinary paper from 2021 co-authored by academics with expertise in both science and law (see Rajamani et al., 2021).[11] This shows the range of sources that were used to make arguments.

In its judgment on *KlimaSeniorinnen* the Court found that there were critical gaps in the State's regulatory framework on climate change, noting that "in the absence of any domestic measure attempting to quantify the respondent State's remaining carbon budget", Switzerland could not be regarded as complying with its obligations under Article 8 of the ECHR.[12] The Court's approach implied that states may have to consider the global carbon budget when forming their own domestic climate policy. Analysis of the judgment has gone further to suggest that it has effectively imposed an obligation to quantify fair share, 1.5°C-aligned national carbon budgets (van Berkel et al., 2025). However, this must be understood in the context of the judgment's implementation.

Following the judgment, the Committee of Ministers (the intergovernmental body responsible for supervising the execution of ECHR judgments) evaluated the Swiss government's compliance with the ruling. The Committee noted that Switzerland has quantified future emissions in a manner that corresponds to the general measures and timelines established by the judgment. Yet questions remain as to whether the targets calculated are reflective of carbon budgets. The decision has been characterised by some as taking a "minimalistic understanding of the mitigation obligations" (Heri et al., 2025), but it also reflects the committee's limited competence in the area of climate policy, with the committee instead advising the adoption of a national advisory body to assess compliance with the judgment. While this outcome raises questions about implementation and the longer-term effects of the judgment, the case has nonetheless brought carbon budgets to the forefront of evidence in government framework litigation.

7. See Constitutional Complaint: https://cdn.climatepolicyradar.org/navigator/DEU/2020/neubauer-et-al-v-germany_7801efe8b7ad4fb7fc07deea68b9b6ed.pdf
8. See Order: https://cdn.climatepolicyradar.org/navigator/DEU/2020/neubauer-et-al-v-germany_918d5f39d1cba624f9c683a5292905f5.pdf
9. See Application: https://cdn.climatepolicyradar.org/navigator/XAB/2020/verein-klimaseniorinnen-schweiz-and-others-v-switzerland_1eb07df12cbd7bf21735fc1a4919197b.pdf
10. See https://climateactiontracker.org/
11. Cited in Application: https://cdn.climatepolicyradar.org/navigator/XAB/2020/verein-klimaseniorinnen-schweiz-and-others-v-switzerland_1eb07df12cbd7bf21735fc1a4919197b.pdf
12. See p. 211 in Judgment: https://cdn.climatepolicyradar.org/navigator/XAB/2020/verein-klimaseniorinnen-schweiz-and-others-v-switzerland_f11900a67ad29e6474e007aaf6188991.pdf

To strengthen their arguments, claimants have often referred to the *Emissions Gap Report* of the United Nations Environment Programme (UNEP). This report is published annually and tracks progress in limiting global warming to well below 2ºC. It investigates whether national commitments for reducing emissions are sufficient for the world to stay within the agreed-upon global temperature limits (Alcamo et al., 2025). For example, the 2025 *Emissions Gap Report* states that "collectively, G20 members are not estimated to achieve their 2030 NDC targets" (UNEP, 2025).[13] The claimants in *Urgenda v. Netherlands*, *Juliana v. US*, *KlimaSeniorinnen v. Switzerland*, *Neubauer v. Germany* and *Notre Affaire à Tous v. France* all refer to the report in their initial complaints.

Not all government framework cases have the Paris Agreement as a focal point, however. In *Juliana v. US*, for example, claimants relied on the US constitution as their basis for the claim.[14] The claimants argued that the federal government violated their constitutional rights to life, liberty and property, among other things, by encouraging and enabling the combustion of fossil fuels. In other cases, claimants have also acted relating to specific treaties, projects or government decisions. In *Sharma et al. v. Minister of Environment*, for example, youth claimants sought an injunction to stop the Australian Government from approving the extension of a coal mine, claiming that the project would exacerbate climate change and harm young people in the future.[15] These cases may not directly fit into the categories of evidence identified in this section, but claimants in both relied on scientific consensus and independent experts to establish foreseeability of harm and to clarify state obligations.

Scientific insights are also used to strengthen claims that assess the conformity of government-level action with given targets. The IPCC in its reports makes a general assessment of national-level climate action. The *Sixth Assessment Report* found that there were gaps between global ambition and the sum of declared national ambition, further compounded by gaps between "declared ambitions and current implementation for all aspects of climate action" (IPCC, 2023a). However, moving beyond a general assessment is essential, and country-specific insights are necessary to make compelling arguments.

In *Neubauer v. Germany*, one complaint analysed Germany's Climate Action Plan 2050 and pointed out the lack of suitability of the measures that had been taken to meet the targets set out in the plan. For instance, it was noted that the plan did not contain any "specific short-term measures for the energy sector", nor did it provide "any measures that are certain to achieve a quantifiable reduction in greenhouse gas emissions in the medium or long term".[16] In *Notre Affaire à Tous v. France*, the claimants argued that given French emissions had increased since 2016, France would clearly not be able to meet the targets in its national emission-reduction strategy. They also cited studies showing that France would not be able to meet European or national targets for reducing energy consumption.[17]

The anticipated sufficiency or insufficiency of specific governmental actions to meet existing targets is often evidenced through official government reports or assessments by scientific advisory bodies. Where governments are relatively untransparent about their compliance with climate targets, it may be more challenging to provide this form of evidence. However, third parties like Climate Action Tracker can fill the gaps in government disclosure, putting pressure on governments to release information (either voluntarily or as evidence or through a court order). Initiatives like this can help improve overall transparency in national-level disclosures.

Climate impacts

Finally, claimants use climate science to explain to the court the impacts of climate change at the national level. This serves several functions, including:

- Demonstrating the urgency and necessity of judicial intervention
- Establishing standing by showing that claimants are already experiencing, or face an imminent risk of, climate-related harm

13. Nationally Determined Contributions, or NDCs, are national climate action plans that countries are required to submit every five years under the Paris Agreement.
14. See Complaint for Declaratory and Injunctive Relief: https://cdn.climatepolicyradar.org/navigator/USA/2015/juliana-v-united-states_feb5345d17b7dfafe1ad6c2ecfe5eb40.pdf
15. See Concise Statement: https://cdn.climatepolicyradar.org/navigator/AUS/2020/sharma-and-others-v-minister-for-the-environment_df5e05ba2e862f35975edd84ef525d98.pdf
16. See p. 43 of the Complaint in *Göppel v. Germany*, decided jointly with Neubauer: https://cdn.climatepolicyradar.org/navigator/DEU/2020/neubauer-et-al-v-germany_e280f70ed020aac63ad68bc794ca4fe2.pdf
17. See Reminder of the Requests: https://cdn.climatepolicyradar.org/navigator/FRA/2018/notre-affaire-a-tous-and-others-v-france_9aff80c8c3015632247cb73337a864e1.pdf

- Supporting findings of damage and liability by linking specific impacts to anthropogenic climate change. In this respect, attribution science may be used to demonstrate that certain forms of harm are significantly more likely or more severe as a result of climate change, while emissions data can be used to situate a defendant's contribution to that harm.

Climate science may also be deployed to link these impacts to the infringement of a constitutional or human right, or simply (as in the *Urgenda* case) to provide the court with "necessary background knowledge".[18] In this sense, climate science can serve an important narrative and evidentiary function in framework cases, supplying the contextual foundation through which courts interpret specific legal claims and assess responsibility.

Studies that discuss climate change impacts at the national or subnational level feature in all the cases showcased in this guide. In the initial complaint of *Notre Affaire à Tous v. France*, claimants use an estimate from the French Ministry of Ecology, Sustainable Development and Energy to show that "62% of the French population is highly or very highly exposed to climatic risks".[19] In *KlimaSeniorinnen*, the claimants claimed that their mortality and morbidity rates were exacerbated by heatwaves that were made worse by climate change. The claimants cited reports that analysed the impacts of climate change in Switzerland as well as specific heatwave-related articles (D'Ippoliti et al., 2010; Watts et al., 2018).

In government framework cases, climate science and evidence can therefore provide essential context for pleadings, support arguments that governmental climate targets should be aligned with legal obligations and best available science, and assist courts in assessing whether governments are complying with their own stated targets and commitments. However, these insights must also be paired with compelling legal arguments and situated within their international or domestic political contexts.

Corporate framework cases

Corporate framework cases strive to hold companies accountable for their climate impacts by challenging their policies, governance and decision-making, arguing that they must address climate risks across their entire value chain. Claimants have brought these cases using legal frameworks such as tort low, human rights law, and other national legislation requiring mandatory due diligence. Much like government framework cases, these types of cases often use global mitigation pathways as a basis to pursue reduction obligations for companies. At least 23 corporate framework cases have been identified to date (building on Setzer and Higham 2025a).

This section focuses principally on the following case studies: *Milieudefensie et al. v. Royal Dutch Shell* (Netherlands), *Notre Affaire à Tous et al v. Total* (France), *Falys v. TotalEnergies* (Belgium) and *Asmania v. Holcim* (Switzerland). The case studies suggest that the most frequently appearing types of evidence for corporate framework cases are those based on emissions pathways and tools to evaluate transition plans. However, given the limited success of cases in this area, the future of most relevant scientific evidence remains to be seen.

Pathways for companies

In corporate framework cases, the dominant approach has been to use a pathway, or emissions reduction target derived from an Integrated Assessment Model, as a proposed reduction solution for companies. Of the 23 framework cases identified by our earlier research, 12 cases requested injunctions with specific emissions reduction obligations. Given the nature of the remedies requested, evidence concerning scenarios and emission-reduction pathways are of crucial importance to these cases. This type of remedy has been highly contested by defendants, not least because they assert that the emissions reductions requested by the claimants are, or may become, unfeasible. Courts have, so far, only engaged with scenarios-based evidence to a limited extent, owing both to perceived scientific challenges and to the small number of cases in which its merits have been assessed.

Some cases take a 'global pathway' approach. These cases simply seek company-level emissions reductions in line with global pathways aligned with 1.5°C. Various claimants cite the IPCC as the main

18. See Summons in the Case: https://www.urgenda.nl/wp-content/uploads/Translation-Summons-in-case-Urgenda-v-Dutch-State-v.25.06.10.pdf
19. See Reminder of the Requests: https://cdn.climatepolicyradar.org/navigator/FRA/2018/notre-affaire-a-tous-and-others-v-france_9aff80c8c3015632247cb73337a864e1.pdf

source for these reduction targets. *Milieudefensie et al. v. Shell* and *Greenpeace Italy v. Eni* cite the target from the *Special Report on 1.5 Degrees*, while *Asmania v. Holcim* and *Smith v. Fonterra* cite the *Sixth Assessment Report*.

Of these cases, perhaps the best-known is *Milieudefensie et al. v. Shell*. Filed in 2019, Milieudefensie [Friends of the Earth Netherlands] claimed that oil company Shell was violating its duty of care under Dutch law and broader human rights obligations. The NGO requested the Hague District Court to compel Shell to reduce its emissions by 45% by 2030 relative to 2019 levels. In 2021, the court granted this request. However, this decision was overturned by the Court of Appeal in 2024. In its judgment, the court confirmed the existence of a reduction obligation and that Shell can be held accountable for its Scope 3 emissions but declined to prescribe a specific reduction target.[20]

Some claimants have also narrowed their use of pathways to a more 'sector-specific' approach. For example, the emission-reduction request in *Falys v. TotalEnergies* includes a requirement for the defendant to reduce its emissions from the production and delivery of fossil fuels by at least 60% by 2030.[21] The claimants drew this figure from a 2023 report by the International Energy Agency (IEA, 2023). Similarly, the claimants in *Notre Affaire à Tous v. Total* relied on reduction targets from the IPCC's Special Report on 1.5 Degrees that are specific to oil and gas production.[22] In cases like these, sectoral emission-reduction percentages are typically derived from scenarios that provide sector-specific information. Sectoral pathways provide a higher resolution approach than global pathways, but they are also based on a smaller range of models, making them less robust (Dietz et al., 2026). It not yet known whether sectoral pathways will command more or less confidence than global pathways in legal contexts going forward.

Most claimants cite IPCC emissions pathways in their pleadings, but not all are suitable for use in framework cases, since the IPCC presents pathways across a wide range of scenarios. The IPCC's *Sixth Assessment Report* creates eight categories of scenarios (C1–C8). Category C1 includes scenarios in which warming is limited to 1.5°C by 2100 (with more than a 50% chance) and involves no or limited overshoot (IPCC, 2023a). Each subsequent category models pathways associated with progressively higher warming outcomes, up to C8, which includes scenarios where warming exceeds 4°C. As noted in *Falys v. TotalEnergies*, "given the scientific-political consensus on the need to remain below 1.5°C at all times, it is clear we must base ourselves on the C1 category of the IPCC scenarios".[23]

In all the case studies, claimants have chosen pathways that are based on limiting warming to 1.5°C. This means that only a small sub-section of the pathways contained in the IPCC's scenario database are relevant.

Assessing defendants' actions

The second core area where evidence is engaged in corporate framework cases involves assessing whether corporate defendants are, firstly, setting targets that align with the need for climate action at a global level and, secondly, taking adequate steps to meet those targets. To show this, company and sustainability reports are commonly cited by claimants, who closely examine what defendants state their actions and commitments to be.

Many companies are engaging with what are known as 'target-setting initiatives': frameworks designed to help establish specific goals for reducing greenhouse gas emissions. The leading initiative of this kind is the Science Based Targets Initiative (SBTi), a voluntary corporate climate initiative initially founded as a collaboration between Carbon Disclosure Project (now CDP), the UN's We Mean Business Coalition and others. SBTi helps companies set greenhouse gas emissions targets in line with climate science; however, claimants often argue that just because a company adopts SBTi targets, this does not mean these targets are aligned with climate objectives.

20. See Judgment: https://cdn.climatepolicyradar.org/navigator/NLD/2019/milieudefensie-et-al-v-royal-dutch-shell-plc_7906be91211b629326988390015e6701.pdf
21. See Petition: https://cdn.climatepolicyradar.org/navigator/XAA/2024/hugues-falys-fian-greenpeace-ligue-des-droits-humains-v-totalenergies-the-farmer-case_4348c2b644e89092bebe641026e5649e.pdf
22. See Summons: https://cdn.climatepolicyradar.org/navigator/FRA/2019/notre-affaire-a-tous-and-others-v-total_5964ec5deb68f0584775a1739b9d8ae8.pdf
23. See Petition: https://cdn.climatepolicyradar.org/navigator/XAA/2024/hugues-falys-fian-greenpeace-ligue-des-droits-humains-v-totalenergies-the-farmer-case_4348c2b644e89092bebe641026e5649e.pdf

A common issue raised with the SBTi, and with corporate target-setting more broadly, is that companies often choose to adopt *relative* rather than *absolute* emissions reduction targets. Relative (or intensity-based) reductions refer to decreases in emissions *per unit of activity or production,* while absolute emissions reduction involves a decrease in the *total volume* of greenhouse gases produced. As a result, a company may reduce its relative emissions – e.g. by increasing the energy efficiency of its production – while still increasing its overall emissions by expanding its operations.

In *Asmania v. Holcim* the claimants submitted a report analysing the SBTi-based climate strategy of Swiss-based buildings materials company Holcim, arguing that the SBTi has many methodological and governance shortcomings and its climate targets are incompatible with global climate objectives. The claimants raised the concern about the targets being based on a relative reduction target.

This concern was also part of the case presented by Milieudefensie against Shell, with the claimants arguing that such an approach would allow "Shell [to] realize this climate ambition by, for example, simply buying up companies that are involved in the production or trade of renewable energy".[24]

These arguments, and the other ways in which defendants' actions are assessed, will be discussed further in the fourth guide in this series.

Non-pathway approaches and 'red lines'

Although many of the cases filed to date have used emissions pathways in their claims, these pathways are not the only way to establish standards for corporate actors. Where in force, environmental due diligence legal frameworks may create procedural obligations for companies rather than mandating specific targets.

For instance, under the French Duty of Vigilance Law (passed in 2017), certain companies must establish, publish and implement a vigilance plan (European Coalition for Corporate Justice, 2021). This plan must include appropriate measures to identify and prevent risks of serious infringements to human rights and fundamental freedoms that result from a company's activities. In *Notre Affaire à Tous v. Total*, the claimants relied on this legislation to argue that fossil fuel giant Total's 'vigilance plan' should include other types of measures. One of the measures requested was that Total publish a new plan considering the risks associated with global warming beyond the 1.5°C threshold, as well as the company's contribution to global greenhouse gas emissions and the global carbon budget.[25] While this argument is limited to jurisdictions with relevant due diligence legislation, it may become more relevant following the EU's introduction of its corporate sustainability due diligence directive in 2024 (European Commission, n.d.).

Beyond due diligence legislation, claimants can also advocate for specific measures or 'red lines' that companies must follow. These are requests that do not necessarily rely on complex pathways and target-setting but instead focus on clear principles or simpler objectives. One example is the call for 'no new fossil fuel projects'. In the case brought by Falys, the claimants argued that, at a minimum, TotalEnergies must immediately halt new fossil fuel projects.[26] In *Milieudefensie et al. v. Shell*, the court noted that Shell's planned investments in new oil and gas fields may be at odds with the energy transition.[27] In May 2025, Milieudefensie built on this in a new case against Shell, calling specifically for no new oil and gas fields (Milieudefensie, 2025). The NGO highlighted a recent analysis that found "existing fossil fuel capital stock is sufficient to meet energy demands implied by representative 1.5°C scenarios" (Green et al., 2024) to support the claim that "in a world committed to adequate climate action, no investments in new oil and gas fields are needed to meet the demand for oil and gas".[28] These 'red line' arguments offer a potential alternative to arguments focused on pathways, demonstrating a diversity in approaches to corporate framework cases.

24. See p. 193 of Summons: https://cdn.climatepolicyradar.org/navigator/NLD/2019/milieudefensie-et-al-v-royal-dutch-shell-plc_8e611f046b2e29d3e930e2c2439d2245.pdf
25. See p. 48 of Summons: https://cdn.climatepolicyradar.org/navigator/FRA/2019/notre-affaire-a-tous-and-others-v-total_5964ec5deb68f0584775a1739b9d8ae8.pdf
26. See Petition: https://cdn.climatepolicyradar.org/navigator/XAA/2024/hugues-falys-fian-greenpeace-ligue-des-droits-humains-v-totalenergies-the-farmer-case_4348c2b644e89092bebe641026e5649e.pdf
27. See Judgment: https://cdn.climatepolicyradar.org/navigator/NLD/2019/milieudefensie-et-al-v-royal-dutch-shell-plc_7906be91211b629326988390015e6701.pdf
28. Letter from Milieudefensie to Shell plc, 13 May 2025: https://en.milieudefensie.nl/news/this-is-our-letter-to-shell/@@download/file/Brief%20aan%20Shell%20EN%20(in%20huisstijl)%20DPWO.pdf

Polluter pays cases

Polluter pays cases[29] involve claimants seeking damages from defendants for their contribution to the harmful impacts of climate change. Many of these cases have been filed by US states, cities and municipalities against major fossil fuel companies. Further claims have been brought in the US and Europe by individuals and groups facing harm from climate change, many of them from the Global South (Setzer and Higham, 2025).

Polluter pays claims rely on scientific research that links defendants' actions to climate-induced harm affecting claimants:

- **First, they usually set out a causal chain linking the defendants' activities to the harm suffered:** this chain runs from the emissions attributable to the defendants' products or operations to the resulting physical hazards such as extreme weather or slow-onset events, and ultimately to the specific injuries or losses experienced by the claimants. By articulating this chain, litigants seek to establish that the defendants' contribution to climate change and its impacts is both scientifically traceable and legally actionable.
- **Another layer of evidence concerns the defendants' knowledge and historical responsibility,** where claimants argue that climate-induced harm was foreseeable. Claims often involve arguments about fossil fuel companies' historical knowledge about climate change.
- **Finally, many of these cases conduct a preliminary quantification of damage,** using methodologies to calculate the proportion of harm attributable to defendants' activities.

These aspects are discussed below.

Causal chains

A causal chain is an evidentiary model of cause and effect, comprised of a set of relationships (causal links) that can link greenhouse gas emitters to those experiencing climate-induced harm. Claimants will often use a branch of climate science called 'attribution science' to construct this causal chain, factually linking the impacts on the claimant and the defendant's actions. The IPCC defines attribution as "the process of evaluating the relative contributions of multiple causal factors to a change or event with an assessment of confidence" (IPCC, 2023b).

Attribution science then evaluates these contributions across different aspects of the global climate system and has evolved significantly to become a "cornerstone of climate research, legal accountability, and policy development" (Union of Concerned Scientists, n.d.).

The causal chains presented by claimants can be summarised using a three-pronged approach, aligned with three distinct branches of attribution science:

1. ***Source* attribution** traces an emitter's historical emissions, supporting claims about the defendant's contribution to global warming.
2. ***Physical hazard* attribution** involves studies that consider the role of climate change in specific weather events, connecting global warming to a specific physical hazard in a specific locality at a specific point in time.
3. ***Impact* attribution** is focused on the consequences of climate events, including social and economic impacts, and can show how the physical hazard leads to specific damage and harm to the claimant.

Table 2.1 illustrates how this three-pronged approach exists in practice by referring to some of the case study examples reviewed for this study.

29. A more detailed discussion about the different types of attribution science and how they have been used in polluter pays litigation will be provided in the forthcoming third guide in this series.

Table 2.1. Example attribution-science-based arguments used in polluter pays cases

	Case names		
Causal link	***Asmania v. Holcim***	***Lliuya v. RWE***	***Falys v. TotalEnergies***
Source attribution	Defendant Holcim's cement production leads to increased greenhouse gas emissions in the atmosphere, leading to global warming.	Defendant RWE's emissions from electricity production lead to increased greenhouse gas concentration in the atmosphere, leading to global warming.	Defendant TotalEnergies' oil and gas production leads to increased greenhouse gas emissions in the atmosphere, leading to global warming.
Physical hazard attribution	Global warming leads to extreme and slow-onset events on Pari Island, Indonesia.	Global warming leads to glacial retreat at Lake Palcacocha in the Peruvian Andes.	Global warming leads to increased instances of heatwaves, floods and droughts in Europe.
Impact attribution	Extreme weather events and slow-onset events lead to harm and increased risk of loss and damage to claimants on Pari.	Glacial retreat causes flood risk affecting the house of the claimant, farmer Saúl Luciano Lliuya.	Heatwaves, floods and droughts cause agricultural losses for the claimant, farmer Hugues Falys, in Wallonia, Belgium.

Knowledge and historical responsibility

In many legal systems, questions of knowledge and foreseeability are relevant to assessing responsibility for harm, although the precise legal requirements and thresholds vary. 'Foreseeability' concerns whether a defendant could reasonably have anticipated that their conduct would contribute to harm. In the climate context and polluter pays cases, evidence is often presented for the court to assess whether defendants could reasonably have foreseen that their greenhouse gas emissions would contribute to climate change and related harm. This demands analysis of how scientific knowledge links greenhouse gas emissions to global warming and its impacts.

The decision of the Hamm Regional Court in Germany in the case of *Lliuya v. RWE* engages with this issue. The court held that RWE could reasonably have foreseen that its emissions would contribute to global warming and associated risks since at least 1965.[30] The court indicated that the warming effect of carbon dioxide emissions was scientifically established as far back as the late 1950s, referring to the Keeling Curve, which was one of the first substantial pieces of research on this process. This finding relied on publicly available scientific knowledge which, according to the court, would have been accessible to the defendant at the time.

Some polluter pays cases examine not only general scientific foreseeability, but also what defendants specifically know about climate risks. In these cases, claimants seek to show that companies had access to detailed or early knowledge of climate impacts, which may be relevant to assessing standards of care, fault or remedies. Evidence used for this purpose often includes internal research reports, commissioned studies and internal communications.

In a subset of cases, claimants also allege that fossil fuel companies have engaged in misinformation or deception about climate change; this argument has been used particularly in cases brought by US states, cities and communities, such as *Native Village of Kivalina v. ExxonMobil*. Such claims argue that defendants publicly downplayed or misrepresented climate risks despite internal knowledge to the contrary, thereby delaying regulatory action and exacerbating harm. Misinformation claims rely on a distinct evidentiary record, including internal communications, marketing materials, investigative journalism and expert analysis of corporate communications strategies.

In the US case *Multnomah County v. ExxonMobil Corp.*, the County sought to hold a set of defendants, including the oil and gas giant, liable for harm caused by anthropogenic climate change to which they

30. See Verdict: https://cdn.climatepolicyradar.org/navigator/DEU/2015/luciano-lliuya-v-rwe-ag_e585fec2553b5e2374b8a576e43d07ce.pdf

claimed the defendants had contributed. In its complaint, the County noted that the defendants had known about climate change and in fact had discussed it internally through the release of inter-office memoranda but did not advise the public of the impact of the use of fossil fuels on the climate.[31] In addition to ExxonMobil, the claimant named other institutions involved in allegedly facilitating such misinformation as defendants. These included the Oregon Institute of Science and Medicine, which the claimant alleged to be a 'front' group "engaged in a climate deception/misinformation campaign in Oregon to further the business objectives of its carbon polluting funders"[32] (the referred-to 'funders' including ExxonMobil). They also included the consulting company McKinsey and Company, Inc., which the claimant alleged to have been working with fossil fuel entities including Chevron (one of McKinsey's biggest clients), ExxonMobil, BP and Royal Dutch Shell, despite McKinsey's self-promotion as being committed to protecting the planet. Claimants noted that McKinsey had coordinated and participated in a deliberate misinformation campaign to downplay the causal relationship between the use of its clients' products and climate impacts.

The claimants in *City and County of Honolulu v. Sunoco LP* provided similar arguments, alleging that the defendants, major corporate members of the fossil fuel industry, concealed the dangers of climate change and promoted false and misleading information about the use of its fossil fuel products.[33]

The cases cited above are mostly US cases because of the existence of respective states' law on fraud, negligence and nuisance. These provide pathways for holding companies liable for deceptive statements and failure to warn about climate-related risks.

Assessing and quantifying damage

Assessing and quantifying damage is another consideration in polluter pays cases, generally raising two distinct but related issues: how to calculate the amount of harm and how to allocate responsibility. The first includes how to assess and calculate losses, damage and adaptation costs. The second concerns how responsibility for those costs is allocated to defendants. Both questions are shaped by the legal theory underpinning the claim and influence how scientific evidence is framed and relied upon.

Different types of evidence are engaged to support claims involving different types of harm. As shown in Table 2.1 above, impact attribution can help provide insights into the social and economic impacts of a climate-related event. However, in practice this is a complex process. Often, calculating harm will involve specialised forms of evidence not necessarily related to climate change. For example, in *Falys v. TotalEnergies,* the claimant presented purchase invoices, selling prices and reports on the average crop yield to establish the damage to his strawberry and potato crops caused by a 2016 storm.[34] Furthermore, harm may not be tangible or clearly quantifiable: in the cases brought by Falys[35] and Asmania (Call for Climate Justice, 2022) the claimants discussed non-material damage such as the impacts of increased workload, stress and eco-anxiety.

Once the overall scale of harm is established, courts must determine how costs may be allocated to defendants. This process may differ greatly between legal grounds and case jurisdiction:

- **A proportional liability approach is taken in some cases,** linking responsibility for harm to historical emission contributions. In *Lliuya v. RWE* and *Asmania v. Holcim*, the claimants relied on source attribution research (Heede, 2014) to argue broadly that defendants should bear a share of adaptation costs or damages arising from climate-induced harm. This equated to 0.38% in *Lliuya* and 0.42% in *Asmania*.

31. See Complaint: https://cdn.climatepolicyradar.org/navigator/USA/2023/county-of-multnomah-v-exxon-mobil-corp_a2dffb4b620383325e84ca7c9333b775.pdf
32. See Second Amended Complaint: https://cdn.climatepolicyradar.org/navigator/USA/2023/county-of-multnomah-v-exxon-mobil-corp_ab22b128141386d3ffa6cd0fe86c3bd3.pdf
33. See Complaint: https://cdn.climatepolicyradar.org/navigator/USA/2020/city-county-of-honolulu-v-sunoco-lp_d5cdb9d20bbc4a983bebab49175eea61.pdf
34. See Conclusions Principales: https://cdn.climatepolicyradar.org/navigator/AUT/2024/hugues-falys-fian-greenpeace-ligue-des-droits-humains-v-totalenergies-the-farmer-case_134cce0f52cc968b56948aa1df8d21f0.pdf
35. See p. 117 of Petition: https://cdn.climatepolicyradar.org/navigator/XAA/2024/hugues-falys-fian-greenpeace-ligue-des-droits-humains-v-totalenergies-the-farmer-case_4348c2b644e89092bebe641026e5649e.pdf

- **Full responsibility is pursued in other cases.** *Falys v. TotalEnergies* took this approach, arguing that according to the legal basis for the case, if the damage has been caused by several factors, each actor responsible is liable for the entire damage.[36] While this is a very case-specific point, if the claim demands apportioning liability, the discussion of how this may be divided is important from an evidentiary perspective.

The landscape of polluter pays cases is developing. Despite a relatively small number of cases filed in this category, recent filings including the *Odette* case (Greenpeace, 2025) and the *Pakistan Climate Cost* case (ECCHR, 2025) represent an expansion of polluter pays cases into new jurisdictions and legal grounds. These new cases generally fit within the wider trends already observed in this category, yet they also open space for new procedural, legal and evidentiary developments. As the field moves towards greater maturity, variation across cases is likely to increase, and new approaches may contribute to more effective and potentially more impactful outcomes for claimants.

36. See p. 41 of Petition: https://cdn.climatepolicyradar.org/navigator/XAA/2024/hugues-falys-fian-greenpeace-ligue-des-droits-humains-v-totalenergies-the-farmer-case_4348c2b644e89092bebe641026e5649e.pdf

Conclusion and outlook: science in new settings

Given limited political action to curb global warming and address impacts – despite 2025 being the third-warmest year on record (ECMWF/C3S, 2025) – climate change is increasingly being brought to the courts. As people around the world face ever more devastating climate change impacts, governments and companies face claims over their climate responsibilities, both in terms of past emissions and future mitigation efforts.

As we have shown in this guide, scientific research, in providing the evidence base for understanding the processes of climate change, helps litigators and courts understand the causal link between emissions and climate impacts, which actors contributed to emissions, and what actions may be effective for addressing climate change at various scales.

While scientific evidence is central to climate litigation, the type, level of detail and function of evidence will vary depending on the nature of the claim. Academic knowledge must be translated to fit the conceptual framework of law. Scientific research is typically broader, while legal settings require detailed information regarding the specific parties involved in a case. Scientific and legal standards of proof often differ in practice. Legal practitioners must carefully examine scientific evidence to determine its suitability for informing legal decision-making. Science provides crucial input for answering legal questions about who is responsible for climate change and what should be done to alleviate its impacts.

As scientific research continues to develop, it may set the stage for new types of legal arguments. Climate research is evolving rapidly; climate liability cases such as *Lliuya v. RWE* would not have been possible two decades ago because the necessary causal evidence did not then exist. The recent global wave of climate litigation can be linked to both the increasing legal recognition that climate change affects people's rights and the improved evidentiary basis. For example, end-to-end attribution approaches directly quantify the real-world harm caused by specific actors' emissions, simplifying the construction of causal chains (Callahan and Mankin, 2025). Another area of research examines from a social science perspective how climate change can lead to the loss of cultural heritage and Indigenous knowledge that may be lost if the focus is purely on monetary losses (Pearson et al., 2023). Temperature overshoot, particularly in the context of national targets, will also be a critical point of contention in the future (Reisinger et al., 2025).

Litigation is, at its core, an exercise of narration, and this applies as much to climate cases as to any others. The most compelling cases are not those that cite all relevant studies, but that present the relevant evidence in a powerful manner that closely aligns with the legal questions at stake. Therefore, both litigators and courts must be open to engaging with an evolving scientific field, ensuring sound case-building and accurate judicial decision-making.

References

Alcamo J, Olhoff A and Höhne N (2025) Impact of scientific research on the international climate regime: the strategic niche of the emissions gap reports. *Frontiers in Climate*, 7. https://doi.org/10.3389/fclim.2025.1534267.

Call for Climate Justice (2022) *Struggling not to go under.* https://callforclimatejustice.org/en/webreport/

Callahan CW and Mankin JS (2025) Carbon majors and the scientific case for climate liability. *Nature*, 640(8060): 893–901. https://doi.org/10.1038/s41586-025-08751-3

Climate Action Tracker (n.d.) Website: https://climateactiontracker.org/

Dietz S, Setzer J, Higham C, Chan T, Walker-Crawford N and Venmans F (2026) Translating climate science into legal standards: Lessons from the Milieudefensie v. Shell case. *Science*, 391(6780): 26–29. https://doi.org/10.1126/science.adz4857

D'Ippoliti D, Michelozzi P, Marino C, de'Donato F, Menne B, Katsouyanni K (2010) The impact of heat waves on mortality in 9 European cities: results from the EuroHEAT project. *Environmental Health*, 9(1): 37. https://doi.org/10.1186/1476-069X-9-37

ECMWF/Copernicus Climate Change Service [C3S] (2025) *2025 Global Climate Highlights*. https://climate.copernicus.eu/sites/default/files/custom-uploads/GCH-2025/GCH2025-full-report.pdf

European Center for Constitutional and Human Rights [ECCHR] (2025) *Pakistan Climate Cost Case: Pakistani farmers demand compensation from RWE and Heidelberg Materials*. https://www.ecchr.eu/en/case/pakistan-climate-cost-case/

European Commission (n.d.) *Corporate sustainability due diligence.* Web page. https://commission.europa.eu/business-economy-euro/doing-business-eu/sustainability-due-diligence-responsible-business/corporate-sustainability-due-diligence_en

Forster PM, Smith C, Walsh T, Lamb WF, Lamboll R, Cassou C et al. (2025) Indicators of Global Climate Change 2024: annual update of key indicators of the state of the climate system and human influence. *Earth System Science Data*, 17(6): 2641–2680. https://doi.org/10.5194/essd-17-2641-2025

Green F, Bois von Kursk O, Muttitt G and Pye S (2024) No new fossil fuel projects: The norm we need. *Science,* 384(6699): 954–957. https://doi.org/10.1126/science.adn6533

Greenpeace (2025) *The Odette Case.* https://www.greenpeace.org/static/planet4-philippines-stateless/2025/12/dc127e3f-factsheet-_-the-odette-case-external.pdf

Heede R (2014) Tracing anthropogenic carbon dioxide and methane emissions to fossil fuel and cement producers, 1854–2010. *Climatic Change*, 122(1–2), 229–241. https://doi.org/10.1007/s10584-013-0986-y

Heri C, Blattner CE and Cadalbert T (2025) Another Brick in the Wall of KlimaSeniorinnen: The Committee of Ministers' September 2025 Monitoring Decision. *EJIL: Talk!* 6 October. https://www.ejiltalk.org/another-brick-in-the-wall-of-klimaseniorinnen-the-committee-of-ministers-september-2025-monitoring-decision/

Higham C, Setzer J and Bradeen E (2022) *Challenging government responses to climate change through framework litigation.* https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2022/09/Challenging-government-responses-to-climate-change-through-framework-litigation-final.pdf

Höhne N, Emmrich J, Fekete H and Kuramochi T (2019) *1,5°C: Was Deutschland tun muss.* NewClimate Institute. https://newclimate.org/sites/default/files/2019/03/Deutschland_1.5_Web.pdf

International Court of Justice [ICJ] (2025) *Obligations of States in Respect of Climate Change.* https://www.icj-cij.org/sites/default/files/case-related/187/187-20250723-adv-01-00-en.pdf

International Energy Agenca (IEA) (2023) *World Energy Outlook 2023*. https://iea.blob.core.windows.net/assets/86ede39e-4436-42d7-ba2a-edf61467e070/WorldEnergyOutlook2023.pdf

International Energy Agency [IEA] (2025) *Global Energy Review 2025.* https://iea.blob.core.windows.net/assets/5b169aa1-bc88-4c96-b828-aaa50406ba80/GlobalEnergyReview2025.pdf

Intergovernmental Panel on Climate Change [IPCC] (2022a) *Climate Change 2022: Mitigation of Climate Change Summary for Policymakers.* https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_SPM.pdf

IPCC (2022b) *Global Warming of 1.5°C.* Cambridge University Press. https://doi.org/10.1017/9781009157940

IPCC (2023a) *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 35-115, doi: 10.59327/IPCC/AR6-9789291691647

IPCC (2023b) Glossary. In *Climate Change 2022 – Impacts, Adaptation and Vulnerability* (pp. 2897–2930). Cambridge University Press. https://doi.org/10.1017/9781009325844.029

IPCC (2024) IPCC announcement. https://www.ipcc.ch/2024/11/25/ipcc-icj/

Pearson J, Jackson G and McNamara KE (2023) Climate-driven losses to knowledge systems and cultural heritage: A literature review exploring the impacts on Indigenous and local cultures. *The Anthropocene Review,* 10(2): 343–366. https://doi.org/10.1177/20530196211005482

Phillips C (2025) *We're on Track to Overshoot 1.5°C of Global Warming: Why Does That Matter?* Union of Concerned Scientists, 24 November. https://blog.ucs.org/carly-phillips/were-on-track-to-overshoot-1-5c-of-global-warming-why-does-that-matter

Rajamani L, Jeffery L, Höhne N, Hans F, Glass A, Ganti G and Geiges A (2021) National 'fair shares' in reducing greenhouse gas emissions within the principled framework of international environmental law. *Climate Policy,* 21(8): 983–1004. https://doi.org/10.1080/14693062.2021.1970504

Reisinger A, Fuglestvedt JS, Pirani A, Geden O, Jones CD, Maharaj S et al. (2025) Overshoot: A Conceptual Review of Exceeding and Returning to Global Warming of 1.5°C. *Annual Review of Environment and Resources*, 50(1), 185–217. https://doi.org/10.1146/annurev-environ-111523-102029

Setzer J and Higham C (2025) *Global trends in climate change litigation: 2025 snapshot.* https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2025/06/Global-Trends-in-Climate-Change-Litigation-2025-Snapshot.pdf

Stuart-Smith RF, Otto FEL, Saad AI, Lisi G, Minnerop P, Lauta KC (2021) Filling the evidentiary gap in climate litigation. *Nature Climate Change,* 11(8), 651–655. https://doi.org/10.1038/s41558-021-01086-7

Stuart-Smith RF, Roe GH, Li S and Allen MR (2021) Increased outburst flood hazard from Lake Palcacocha due to human-induced glacier retreat. *Nature Geoscience*, 14(2), 85–90. https://doi.org/10.1038/s41561-021-00686-4

United Nations Environment Programme [UNEP] (2025) *Emissions Gap Report 2025: Off Target.* https://www.unep.org/resources/emissions-gap-report-2025

Union of Concerned Scientists (n.d.) *What is attribution science?* https://www.ucs.org/resources/attribution-science

United Nations Framework Convention on Climate Change [UNFCCC] (2015) *Paris Agreement on Climate Change.* https://unfccc.int/sites/default/files/english_paris_agreement.pdf

van Berkel D, Tan F, Udell J, and Williamson A (2025) *Quantifying a 1.5C fair share carbon budget: Human rights obligations on climate change after KlimaSeniorinnen.* Amsterdam Law School Research Paper No. 2025-11. http://dx.doi.org/10.2139/ssrn.5265958

Verkerk R (2009) Comparative Aspects of Expert Evidence in Civil Litigation. *The International Journal of Evidence & Proof*, 13(3): 167–197. https://doi.org/10.1350/ijep.2009.13.3.321

Watts N, Amann M, Arnell N, Ayeb-Karlsson S, Belesova K, Berry H et al. (2018) The 2018 report of the Lancet Countdown on health and climate change: shaping the health of nations for centuries to come. *The Lancet,* 392(10163), 2479–2514. https://doi.org/10.1016/S0140-6736(18)32594-7

Williamson A (2025) *Science and evidence for framework climate litigation.* EGU General Assembly 2025, Abstract EGU25-381. https://doi.org/10.5194/egusphere-egu25-3811

Zhu M and Fan L (2024) A comparative study of the judicial construction of scientific credibility in climate litigation. *Review of European, Comparative & International Environmental Law*, 33(2): 250–264. https://doi.org/10.1111/reel.12542