

Otto, Felix; Held, Hermann

Working Paper

Targets in International Climate Policy: (Mis)understanding Two Degrees?

WiSo-HH Working Paper Series, No. 64

Provided in Cooperation with:

University of Hamburg, Faculty of Business, Economics and Social Sciences, WISO Research Lab

Suggested Citation: Otto, Felix; Held, Hermann (2022) : Targets in International Climate Policy: (Mis)understanding Two Degrees?, WiSo-HH Working Paper Series, No. 64, Universität Hamburg, Fakultät für Wirtschafts- und Sozialwissenschaften, WiSo-Forschungslabor, Hamburg

This Version is available at:

<https://hdl.handle.net/10419/260467>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

FAKULTÄT
FÜR WIRTSCHAFTS- UND
SOZIALWISSENSCHAFTEN

Targets in International Climate Policy: (Mis)understanding Two Degrees?

Felix Otto
Hermann Held

WiSo-HH Working Paper Series
Working Paper No. 64
January 2022



WiSo-HH Working Paper Series
Working Paper No. 64
January 2022

Targets in International Climate Policy: (Mis)understanding Two Degrees?

Felix Otto, University of Hamburg
Hermann Held, University of Hamburg

ISSN 2196-8128

Font used: „TheSans UHH“ / LucasFonts

Die Working Paper Series bieten Forscherinnen und Forschern, die an Projekten in Federführung oder mit der Beteiligung der Fakultät für Wirtschafts- und Sozialwissenschaften der Universität Hamburg tätig sind, die Möglichkeit zur digitalen Publikation ihrer Forschungsergebnisse. Die Reihe erscheint in unregelmäßiger Reihenfolge.

Jede Nummer erscheint in digitaler Version unter
<https://www.wiso.uni-hamburg.de/de/forschung/working-paper-series/>

Kontakt:

WiSo-Forschungslabor
Von-Melle-Park 5
20146 Hamburg
E-Mail: experiments@wiso.uni-hamburg.de
Web: <http://www.wiso.uni-hamburg.de/forschung/forschungslabor/home/>



1 **Targets in International Climate Policy:**
2 **(Mis)understanding Two Degrees?**
3

4 **Felix Otto (corresponding author):** University of Hamburg, Research Unit Sustainability and
5 Climate Risks, Hamburg, Germany, felix.otto@uni-hamburg.de

6 **Hermann Held:** University of Hamburg, Research Unit Sustainability and Climate Risks, Ham-
7 burg, Germany

8
9 **Keywords:** 2° target; climate policy; Precautionary Principle; international environmental pol-
10 icy;

11 **Funding:** F.O. was partially funded by the German Research Foundation DFG under the con-
12 tract HE 5558/2-2 in the context of SPP 1689 (Climate Engineering: Risks, Challenges, and Op-
13 portunities) by the project CEMICS (“Climate engineering in the context of mitigation: illusion,
14 complement, or substitute?”).

15 **Authors’ contributions:** Hermann Held suggested the research question and the dual role of
16 temperature targets as social planner solutions and policy instruments. The article is based
17 on Felix Otto’s Master’s thesis. Felix Otto wrote the first draft which was edited by Hermann
18 Held. Interviews were designed by Felix Otto and conducted by both. All authors read and
19 approved the final manuscript.

20 **Conflicts of interest:** The authors declare that they have no conflict of interest.
21
22

23 **Abstract**
24

25 This article investigates the genesis and role of the 2° target in international climate policy.
26 We identify a dual role played by temperature targets: (i) a social planner’s option of decision-
27 making under uncertainty that draws on the precautionary principle, and (ii) a policy instru-
28 ment to help the social planners’ position become reality. Accordingly, the recent debate over
29 the 2° target as found in the literature is actually a mutual misunderstanding: while the op-
30 ponents mainly focus on the policy instrument function, the proponents focus on the social

31 planner solution. By publishing this article, we hope to contribute to a more “targeted” dia-
32 logue in the future. In order to achieve this, the article analyses the concept of targets and
33 argues that an environmental target always consists of three elements, namely (a) science or
34 system knowledge, (b) norms and values, and (c) an operational perspective. Further, it in-
35 vestigates how targets were defined in international climate policy and how they have
36 evolved over time. In 1997, emission targets were defined in the Kyoto Protocol. In 2015, the
37 2° target, based on the precautionary principle, was implemented in the Paris Agreement.
38 Learning from the case of sulphur dioxide policy, another example of environmental policy,
39 when considering how the 2° target could be made more effective, one might be tempted to
40 underpin it with impact-related findings that are as concrete as possible – or to replace it with
41 corresponding impact-based targets. However, many actors might contend that the totality
42 of global warming impacts is still hard to judge. Accordingly, the 2° target should also serve
43 as an expression of precaution, as an interim solution of sorts, until we acquired a more com-
44 prehensive grasp of climate impacts.

45

46 **Key Policy insights:**

- 47 1. Differentiating between the 2° target’s role as a policy instrument and a decision op-
48 tion fosters a more nuanced discussion on the target and resolves its validity.
- 49 2. The Precautionary Principle enabled prudent target setting in climate policy when
50 knowledge on impact was still insufficient and CBA unhelpful.
- 51 3. The Precautionary Principle acted as the underlying rationale for the 2° target.
- 52 4. With the 2° target, climate policy shifted from a focus on emissions to a focus on im-
53 pacts that allows for a higher level of ecosystem protection.

54

55

56 **1. Introduction**

57 The Paris Agreement (2015) represents a cornerstone in international climate policy. For the
58 first time, the UNFCCC’s calls for avoiding “dangerous anthropogenic interference with the
59 climate system” (1992) were made concrete, in the form of an operational environmental
60 target within an international treaty. Accordingly, global mean temperature rise must be lim-
61 ited to well below two degrees Celsius compared to its pre-industrial value. This “2° target”

62 was the product of twenty years of academic debate and successive national and interna-
63 tional declarations. However, since being introduced, it has been criticized for producing in-
64 efficient policies, i.e., for setting a sub-optimal goal (Tol 2007). Moreover, it has been criti-
65 cized for its lack of effectiveness in mobilizing the necessary global emissions cuts (Geden
66 2016). The latter critique culminated in a proposal to replace the 2° target with a zero-emis-
67 sions target because it is supposed to be more effective (Geden 2016).

68 In this article, our goal is to put this critique into perspective. We think that we can resolve
69 the disagreement on the target: while the opponents mainly focus on the policy instrument
70 function, the proponents focus on the social planner solution. As a result, a misunderstanding
71 arises that unnecessarily hampers the 2° target's acknowledgement. In order to investigate
72 this, we examine the 2° target's dual role as (i) an expression of a particular normative order
73 under deep uncertainty when assuming a social planner perspective, and (ii) a policy instru-
74 ment to help the international community comply with precisely this normative order. With
75 regard to (i), we show that the 2° target resonates with a particular strand of existing inter-
76 pretations of the precautionary principle (PP) in terms of how to address deep uncertainty in
77 decision-making.

78 When conceptually analysing climate regulation, it is crucial that we address the following
79 question: at which point in the complex environmental cause-and-effect chain between hu-
80 man intervention on one end, and impacts on the other, was the environmental target for-
81 mulated? While many in the economics research community regard CBA as the benchmark
82 for environmental decision making, we are going to highlight, that a prudent climate target
83 can in fact be determined with the help of a precautionary perspective, that abstains from
84 addressing the economic damages of a decision.

85 This paper is structured as follows: in the second part we look into the theory of the precau-
86 tionary principle. This is followed by an investigation of the conceptual foundation of environ-
87 mental targets in part 3. Part 4 reviews the history of climate targets and critically analyses
88 the justifications for targets. The analysis of the 2° target is intended to facilitate the inte-
89 grated assessment modelling of climate change and to better differentiate between the tar-
90 get as a policy instrument and a condensation of scientific knowledge on the mechanisms of
91 the climate system. This discussion is further supported by three expert interviews. Hans-
92 Joachim Schellnhuber has been a member of the German Advisory Council on Global Change

93 (WBGU) ever since it was established in 1992. In 1993, he initiated a debate which tried to
94 identify a “tolerable window” for anthropogenic global warming. The 2° target emerged from
95 that debate due to paleoclimatic and evolutionary arguments. Oliver Geden is an outspoken
96 critic of that target. Both he and Niklas Höhne took part in the international climate negotia-
97 tions as policy advisors and have influenced the discourse on the 2° target. The interviewees
98 were selected in order to include different views. The semi-structured interviews on the role
99 of the 2° target lasted for about an hour and were conducted between January and April of
100 2018 by the authors of this paper. They were recorded and later transcribed. We analysed
101 the interviewees’ assertions with regards to our framework of the twofold role of the 2° target
102 as i) a social planner’s decision option under deep uncertainty and ii) a policy instrument.

103

104 **2. The Precautionary Principle**

105 The precautionary principle is one of several possible approaches to decision-making under
106 uncertainty in national and international law. The PP is intended to guide decisions when a
107 full grasp of the cause-and-effect mechanisms and respective impact chains is difficult to ob-
108 tain. In technical terms, it addresses situations in which it is impossible to specify the whole
109 state space at stake in conjunction with probabilistic statements linking causes to effects,
110 hence precluding a full-fledged cost-benefit analysis. This makes it particularly suitable for
111 environmental policy, where problems are often abstract, intangible and complex. As sum-
112 marized by Iverson and Perrings:

113 “The PP offers a guide for regulating novel threats under conditions of severe scientific
114 uncertainty. It is argued to have originated in Germany, in the early 1970s, as the concept
115 of ‘Vorsorgeprinzip’ (Haigh 1993) – ‘foresight planning’ – which emphasizes avoidance of
116 potentially damaging actions even where there is uncertainty about consequences of
117 those actions” (2012, p. 161).

118 Iverson and Perrings emphasize a history of alternative interpretations and present a long list
119 of nation-states and international treaties that have adopted the PP in their regulatory stat-
120 utes for health and the environment. According to Cass Sunstein, the principle was first ap-
121 plied in the 1982 UN World Charter for Nature and then taken up by a number of international
122 declarations und treaties such as the Rio Declaration on Environment and Development or by
123 the European Commission (Sunstein 2005, p. 17).

124 While it is a commonly held opinion that the PP is “notoriously difficult to define” (Steel 2015,
125 p. 1; Townley 2017, p. 603; Goldstein 2012, p. 5), we believe it is not only the definition that
126 is the cause of difficulties but also the principle’s operationalization. Wiener has identified
127 three “archetypal” formulations of the PP, namely: (a) “Uncertainty does not justify inaction”,
128 (b) “Uncertainty justifies action”, and (c) “Uncertainty requires shifting the burden and stand-
129 ard of proof” (Wiener 2011, p. 528). These formulations are in keeping with the way the PP is
130 incorporated in most international agreements. The philosopher Stephen Gardiner has sup-
131 plied a more general analysis of the PP’s structure, and identified three aspects that the PP
132 always contains: (1) “Threat of harm”, (2) “Uncertainty of impact and causality”, and (3) “Pre-
133 cautionary response” (2006, p. 36). According to Gardiner, in order to apply the PP, one needs
134 to identify a threat (1) that has uncertain effects, but which (2) can be minimized through the
135 identification and application of appropriate countermeasures (3). These aspects show that
136 it is difficult to achieve a consensus regarding the application of the PP because it is not always
137 clear what should be considered a threat, or what the appropriate measures are to prevent it
138 (Gardiner 2006).

139 The PP has been applied by various nations and in numerous international agreements over
140 the past several decades. Hence one can see it as an internationally established norm used to
141 apply types of decision-making under deep uncertainty which generally deviate from the pre-
142 scriptions one would have obtained from corresponding cost-benefit analyses.

143 For the purpose of this paper we will examine precautionary action in climate regulation: a
144 case that policymakers have identified as involving both (1) “Threat of harm” and (2) “Uncer-
145 tainty of impact and causality”, in keeping with Gardiner’s conception. Part 4 of this article
146 analyses the countermeasures, namely, the definition of the appropriate targets. In this case,
147 the PP under Wiener’s formulation (a) “Uncertainty does not justify inaction” was invoked. As
148 a conceptual framework for the analysis of action, we will investigate the climate impact chain
149 in both cases; at which point in the chain environmental targets apply; and what this means
150 for the implementation of the PP.

151

152 **3. Setting Environmental Targets**

153 Beat Bächli has argued that the difficulty of finding an exact definition of environmental tar-
154 gets allows the concept to connect various special discourses (Bächli 2012). According to the
155 philosopher Daniel Gruschke, commenting on Bächli, one should consider these targets to be

156 a mix of “scientific insight” and “societal compromise”, which lends them a twofold source of
157 legitimisation through both “scientific objectivity” and “democratic majority decision” (Gru-
158 schke 2012, p. 139). We wish to further clarify this by arguing that targets include three im-
159 portant elements: (a) system knowledge, (b) norms and values, and (c) an operational per-
160 spective.

161 One needs (a) system knowledge to have a general idea of the problem at hand (e.g. that CO₂
162 emissions lead to a higher global mean temperature), i.e., knowledge concerning cause-and-
163 effect relations within the system in question (e.g. how the carbon cycle works). This includes
164 awareness of where in the causal web knowledge ends and deep uncertainty begins. This
165 reflects the system perspective on an environmental target. Though targets substantially de-
166 pend on this kind of knowledge, that alone is not sufficient.

167 Why not? Because targets always also imply (b) norms and values that guide the decision on
168 the extent of change one wants to allow within the environmental system in question. This
169 normative perspective allows the “desired endpoint on a relationship curve”, which is what
170 Bertrand et al. (2008, p. 411) consider a target to represent, to be identified. When clear
171 thresholds between the level of emissions and its effects cannot be identified, a theoretical
172 concept of the desired relationship between society and its environment is called for. Alt-
173 hough science and system knowledge are necessary in order to have an idea of the matter at
174 hand, identifying the “problem” presupposes a normative analysis and a concept of how to
175 deal with the environment. Without these aspects, scientific knowledge remains empty, be-
176 cause it is meant to be normatively neutral and cannot identify “problems”.

177 Finally, targets always include (c) an operational perspective. This implies questions like the
178 following: Should an immission target or an emissions target be set? Should a temperature
179 target be used in climate policy instead of a concentration target? The decision regarding (c)
180 will necessarily depend on both (a) and (b).

181 The consequences of society-environment interactions can be conceptualized as an impact
182 chain from the source (CO₂), to the environmental effects (crop loss, warming etc.), to the
183 economic assessment of the impacts (see Fig. 1 for a generic conceptual model). Environmen-
184 tal targets can be applied at any point in the impact chain in order to define an appropriate
185 level of emissions or impacts. As a necessary condition for selecting the proper point in the
186 chain, the target variable must be linked to the control variable by sufficient causal knowledge
187 (the emission level). Beyond the target, deep uncertainty may arise along the impact chain.

188 For the most part, targets that focus on health and the human body are effects-based; con-
189 sequently, they regulate the immission side of the cause-and-effect relationship, and focus
190 on the amount of a specific substance that a system (e.g. the human body) can tolerate. Set-
191 ting such immission targets requires an advanced level of knowledge on the system in ques-
192 tion and the corresponding impact chain. In the context of environmental policy, targets such
193 as critical loads defining the permitted amount of sulphur intake per hectare per year, or the
194 2° target in climate policy, are examples of impact-oriented targets that address the level of
195 change within a system. In contrast to immission targets, emissions targets focus on the
196 amount of a substance emitted at the source. One example: the CO₂ reduction targets defined
197 in the Kyoto Protocol, which stipulate how much CO₂ every country is allowed to emit over a
198 certain period of time.¹ In Germany, for example, emissions targets have historically followed
199 the precautionary principle and been based on the best available technology (BAT) concept.
200 On the one hand, the PP is said to foster stringent regulation even without complete infor-
201 mation, thus leading to a higher level of protection than other rationales (Wurzel 2002, p. 19).
202 On the other, emissions targets based on BAT largely focus on feasibility, and less on impacts
203 and damages produced within the affected system. But a focus on emissions targets and BAT
204 can facilitate target setting in cases of unknown dose-response relationships and when the
205 system thresholds are difficult to identify.

206 As shown in Fig. 1, applying the PP can be seen as terminating the impact chain at a point that
207 corresponds to the current level of knowledge and avoiding the need to cope with an over-
208 whelming amount of complexity. Thus, the first targets were emissions targets that regulated
209 the permitted amount of CO₂ emissions; subsequent targets shifted from the emission side
210 of the impact chain toward a focus on the consequences within the system. In similar vein,
211 but focusing on chemicals, Martin Scheringer has proposed assessing a given substance's per-
212 sistence and spatial range as a proxy for the effects it produces. By pursuing this approach,
213 one can avoid the complexity of damage research, and can apply the PP in order to define
214 targets (Scheringer 2002, pp. 199–200).

215 One can analytically conceptualize the PP as terminating the impact chain at a point that is
216 appropriate to the level of system knowledge. Regulation according to best available technol-
217 ogy focused on the first step of the impact chain (see Fig. 1) and ignores the rest. In contrast,

¹ SRU (1996) and Reinhardt (2008) provide historical perspectives on the development of targets for health and the environment.

218 cost-benefit analysis (CBA) considers the whole impact chain from emission to an analysis of
219 the lost economic value and seeks to derive an optimal target. In the following, we will exam-
220 ine climate regulation and investigate how regulation has dealt with the impact chain and
221 applied the PP. Once the appropriate extent of the impact chain is identified, the problem of
222 how to set the environmental target arises. We argue, that in climate policy, the 2° target was
223 based on historical information on temperature extremes and thus, as an application of the
224 PP instead of an analysis of the economic damages of climate change.



225

226 *Figure 1 Conceptual model of impact chain in the climate context based on (Hertwich et al.*
227 *2000).*

228

229 **4. Climate Change**

230 The first legally binding international agreement addressing the climate problem was the UN-
231 FCCC from 1992, which prescribes to stabilize “greenhouse gas concentrations in the atmos-
232 phere at a level that would prevent dangerous anthropogenic interference with the climate
233 system” (UNFCCC 1992), Article 2). The problem of how to operationalize “dangerous anthro-
234 pogenic interference” had to be solved in subsequent international agreements. The first at-
235 tempt was the Kyoto Protocol (UNFCCC 1997), which defines emission reduction targets for
236 the countries listed in Annex 1 of the UNFCCC (which mainly includes industrialised nations).
237 The emission cuts defined in the Kyoto Protocol are generally not considered to reflect a sci-
238 entific view on what is required to stabilize the global climate (in fact, it was clear at the time
239 that the defined cuts could not stabilize the climate); rather, they were the result of political
240 negotiations and diplomatic haggling (Liverman 2009; Liberatore 2001).

241 The 2015 Paris Agreement changed the approach from emissions targets to an impact-fo-
242 cused target on temperature stabilization. Article 2a of the Paris Agreement states that the
243 participating countries agree to hold “the increase in the global average temperature to well
244 below 2 °C above pre-industrial levels” (UNFCCC 2015). In response to pressure from the Small
245 Island States, the article also includes a reference to pursuing “efforts to limit the temperature
246 increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce

247 the risks and impacts of climate change” (Art. 2a). Furthermore, Article 4 calls for achieving
248 “a balance between anthropogenic emissions by sources and removals by sinks of greenhouse
249 gases in the second half of this century” (UNFCCC 2015). While the 2° target had already been
250 adopted by the Council of the European Union in 1996 and gained further international trac-
251 tion in 2009 when it was mentioned in the Copenhagen Accord of COP 15, the formulation in
252 the Paris Agreement was the first within a treaty at the at the UN level². Yet, apart from its
253 legal recognition, the idea of the target dates much earlier. In the following, we want to high-
254 light a number of waypoints of the target’s genesis.

255 A very early but less explicit argument for keeping global mean temperature below historic
256 extremes was provided by William Nordhaus, who maintained that: “If there were global tem-
257 peratures more than 2 or 3°C above the current average temperature, this would take the
258 climate outside of the range of observations which have been made over the last several hun-
259 dred thousand years” ((Nordhaus 1975, p. 23)). However, he would later argue that doubling
260 the carbon dioxide concentration represented a more fundamental target and became best
261 known for endorsing CBA as the most apt method for decision making in climate policy. In
262 1987 members of the German Physical Society and the German Meteorological Societies have
263 argued that since the last ice age, variations in GMT have not been higher than 1.5 – 2 °C.
264 Based on this interval, they call for measures to limit warming at no more than 1.5° C
265 (Physikalische Blätter 1987). Both proposals highlighted the role of a historical perspective on
266 temperatures instead of a detailed look into damages. A prominent argument in favour of the
267 2° target and employing the same rationale was made by the German Advisory Council on
268 Global Change (WBGU) in 1995. They argue that global mean temperature rise should be lim-
269 ited to 2 °C compared to pre-industrial levels. According to the WBGU, the geologic period of
270 the younger Quaternary is what “has shaped our present-day environment” (1995, p. 7) and
271 included global mean temperatures as low as 10.4 °C during the last ice age (which ended ca.
272 10,000 years ago) and as high as 16.1 °C during the last interglacial period (which ended ca.
273 115,000 years ago). Adding a margin of 0.5 °C at either end³ results in a “tolerable climate
274 window” (p. 8) of global mean temperatures between 9.9 °C and 16.6 °C, which human activ-
275 ity should not exceed, according to the WBGU. Taken together with a pre-industrial GMT of

² According to Bodansky (2016) the Copenhagen Account was a political agreement while the Paris Agreement is a treaty.

³ WBGU does not justify the choice of a 0.5 °C margin.

276 14.6 °C, this corresponds to a maximum allowable warming of 2 °C.

277 Jaeger and Jaeger have provided an overview of justifications in favour of the target and iden-
278 tified three main perspectives: the catastrophe view, the cost-benefit view and the focal point
279 view (Jaeger and Jaeger 2011). Essentially, the catastrophe view argues that global tempera-
280 ture rise should be capped at 2 °C because a further temperature increase would potentially
281 have catastrophic consequences. Jaeger and Jaeger consider the WBGU's justification to be
282 an example of the catastrophe view. In turn, the cost-benefit view regards the 2° target as the
283 outcome of a cost-benefit analysis. Jaeger and Jaeger quote statements made by the Euro-
284 pean Commission as examples of the cost-benefit view; however, they claim that it remains
285 quite controversial to what extent the target can be seen as the outcome of cost-benefit anal-
286 ysis (Jaeger and Jaeger 2011). Because of this stance and the lack of consensus regarding the
287 threshold for catastrophic consequences of climate change, Jaeger and Jaeger consider the
288 focal point view to be the best argument for the 2° target. They “propose to use it as a focal
289 point in a coordination game, where a multitude of actors need to find a new coordination
290 equilibrium in the face of climate risks” (Jaeger and Jaeger 2011, p. 25). The focal point per-
291 spective on the 2° target has since gained a number of supporters: Knopf et al. refer to the
292 target as a focal point (2012) and Cointe et al., using similar reasoning, refer to it as a “bound-
293 ary object” (2011, p. 20). Knopf et al. set the limit for temperature rise at 2 °C because of the
294 trade-off between high mitigation costs (which they consider to be a problematic aspect of a
295 1.5° target) and avoiding tipping points, which can be expected with high probability in a
296 world that is 3 °C warmer. But they also stress that high precision was not their priority, be-
297 cause they do not differentiate between an increase of 1.9 °C and of 2.1 °C (Knopf et al. 2012).
298 Lastly, in a comment on the 2° target, Schellnhuber points out that it “relies on a set of ethical
299 and operational principles (like the precautionary one), and reflects a strategic compromise
300 between desirability and feasibility” (Schellnhuber 2010, p. 231).

301 That being said, though accepted at the international level, the 2° target has been widely
302 criticized. With regard to its function from a social planner's perspective, Tol (2007) makes it
303 clear that he considers the 2° target to be too costly, and that it might have been a position
304 “too strong for other countries to engage in a dialogue over” (Tol 2007, p. 429). Furthermore,
305 he criticizes the EU for justifying its acceptance of the target by referring to CBA without hav-
306 ing actually conducted any CBAs that support the 2° target. In our interview, Schellnhuber
307 objects to applying CBA to the climate problem: “We will not be able to work out a global

308 utility function that can be optimized in a Ramsey model or any other model. Nobody can
309 work out this function.” For him, the PP was important at the beginning of the idea of a 2°
310 target. But he argues that the goal of the PP is to guide decisions for situations with low prob-
311 ability impacts, and that this is not the case in climate policy: “Here, it is different. Here, I can
312 say with high probability that something drastic is going to happen and I want to avoid it. [...]”
313 We constantly talk about probabilities that lie in the range of 50% or 60% and then shrug our
314 shoulders. This is completely absurd.” Further, he argues that the above reconstruction of the
315 original justification along the WBGU’s line of reasoning is a rather abstract version of precau-
316 tion. Instead, given recent advances in impact research, he stresses the above mentioned ca-
317 tastrophe view: the target’s role in helping to avoid a series of tipping elements. This rationale
318 is expanded on by Lenton et al. (2019). Yet Schellnhuber concedes that, for those actors for
319 whom “the [natural science-based] data do not speak for themselves”, the target could still
320 perform an important precautionary function.

321 With regard to the target’s function as a policy instrument, Shaw finds it poorly suited to
322 conveying the uncertainties and ambiguities of climate change and its impacts, because it
323 implies more accuracy than it can actually provide (Shaw 2013). In our interview with him,
324 Oliver Geden expressed similar issues with the target: “Do people know what the 2° target
325 implies? I don’t think so. I would say that this is the price for such a target to work and to be
326 supported by everyone. If only those who truly understood all the implications supported the
327 target, we might only have 5,000 supporters.” In the interview, Geden acknowledges that the
328 2° target has been acting as a focal point for international climate policy and a benchmark to
329 help structure the debate. His critique focuses less on the policy in its social planner function,
330 and more on policymakers and the political debate concerning the target, i.e., on its problem-
331 atic function as a policy instrument. He argues that the target has successfully structured the
332 debate and political decisions but has not been sufficiently action-guiding due to its inherent
333 ambiguity. According to Geden, a domain like climate policy with its transformative potential
334 runs the risk of an inconsistency between political decisions in favour of a target and subse-
335 quent long-term actions that do not support its realization (Geden 2016). Both Geden and
336 Niklas Höhne argue that a zero-emissions target would be preferable. As Höhne argues in our
337 interview: “I prefer it [the zero-emissions target] because the 2° target is not very specific. It
338 was good at the time when it was passed, but it doesn’t actually help anyone, because no-
339 one has any idea what they need to do in order to comply with the 2° target. The net-zero

340 target, phasing out GHG emissions, or whatever you prefer to call it, is a lot more tangible for
341 everyone: I need to get the emissions to zero. And then it doesn't actually matter so much
342 anymore when this happens; the most important thing is that we reach zero. It's not enough
343 to reduce 10% here and 20% there; it has to be zero. And this has an entirely different effect.
344 In my opinion, this is an important and significant step forward." Schellnhuber concedes that
345 today, the 2° target's function as a policy instrument might indeed be performed more effec-
346 tively by alternatives, e.g. a net-zero target. But he also stresses the risk of inducing underde-
347 termined levels of policy ambition in the process, as the target year might be set rather arbi-
348 trarily. He highlights Yamin's "zero emissions for all sectors by 2050" as a potential candidate
349 (Haites et al. 2013), but emphasizes that the systemic justification of any new target must be
350 traced back to the 2° target in its social planner function. Further, he stresses the importance
351 of the 2° target as a policy instrument due to its highly symbolic function. This includes the
352 number "2" as the simplest-possible number, and furthermore, the coincidence with human
353 body temperature, where +2°C corresponds to a serious infection and +4°C signals a life-
354 threatening illness. More generally, he points out the importance of a temperature target
355 which is further underpinned by the IPCC special report on 1.5°C warming (IPCC 2018).

356 Building on these analyses of the target, we want to highlight two of its functions in particular:
357 firstly, as an expression of a value system, and, as a codification of that, a preference order
358 the "social planner" might assume. Such a social planner position represents one of many
359 academically consolidated options that society may assume with regard to a pending deci-
360 sion. Multiple social planner positions (such as a 2°C target, a 1.5°C target, or no target) rep-
361 resent a prerequisite for society to discursively define its own position when faced with mul-
362 tiple, yet conflicting goals (such as preserving nature or economic growth) it might wish to
363 pursue. Secondly, a target can serve as a policy instrument to make that very social planner's
364 position (e.g. keeping the global mean temperature rise below 2°C) become a reality (by act-
365 ing as a "focal point").

366 In the course of reconstructing the foundation of the 2° target as well as the critiques of the
367 target, we found that there are two main lines of argument, tackling the two distinct functions
368 outlined above. One line of criticism, emanating from an economic perspective, argues that
369 the 2° target is not in line with the results of CBAs, making it sub-optimal (and therefore irra-
370 tional). This critique questions the 2° target as an option for a rational social planner. While
371 this statement holds true for the majority of CBAs published to date, more recent work

372 demonstrates CBAs as a highly sensitive instrument of analysis with respect to abstract as-
373 sumptions that are hard to specify for stakeholders (Dennig 2018). Whether PP-based strains
374 can be consistently accommodated in more formalized economic assessment is the subject
375 of on-going research in the area of environmental economics (Held 2019). In that sense, the
376 critique addressing the 2° target's social planner function likewise applies to any PP-based
377 approach as departing from an alternative set of principles. One may or may not subscribe to
378 the latter – this is a fundamental meta-decision on the normative level. Schellnhuber sug-
379 gested that today, given our advanced understanding of the natural science basis of global
380 warming impacts, the target's PP character should be replaced with a directly impact-based
381 one. For a particular version of decision-making under tipping point position uncertainty, we
382 can follow this argument. However, he also conceded that from an economic point of view, a
383 PP component might still be needed in order to justify the target.

384 The other line of argument addresses the focal point function of temperature targets. Both in
385 the literature as well as among our interviewees, emission-based targets are preferred over
386 temperature targets, because they are considered to be more actionable. Schellnhuber con-
387 ceded that this might indeed be the case, while insisting that the authority of emission-based
388 targets must rest on temperature targets as their systemic basis and hence, on the social
389 planner solution. Accordingly, the recent debate over the 2° target as found in the literature
390 is actually a mutual misunderstanding: while the opponents mainly focus on the policy instru-
391 ment function, the proponents focus on the social planner solution. By publishing this article,
392 we hope to contribute to a more “targeted” dialogue in the future that acknowledges the
393 bridging role of the precautionary principle towards a more nuanced cost-benefit-approach.

394

395 **6. Summary and Conclusions**

396 In this paper, we have analysed the historical genesis and different arguments in favour of the
397 2° target. Policies started out as emission targets which were considered a first step toward
398 regulation in a situation characterised by uncertainty and political opposition to stringent reg-
399 ulation. This first step meant reducing CO₂ emission for industrialized countries in the Kyoto
400 Protocol of 1997. In succeeding policies, a larger extent of the impact chain was considered
401 in order to define the targets. The idea behind the 2° target was to guide prudent decisions
402 in the absence of sufficient information on expected impacts of climate change. That is why
403 the argument relied on the historical variability of temperatures as a theoretical construct for

404 decision-making and policy makers refrained from making an economic analysis of the dam-
405 ages.

406 By tackling these questions, we have sought to further clarify the structure and role of targets.
407 We have determined that environmental targets necessarily consist of three elements: a min-
408 imum level of system knowledge linking human causes to the target variable; norms for deci-
409 sion-making under deep uncertainty; and, building on the first two, an operational compo-
410 nent in terms of the exact target formulation, also factoring in the target's potential role in
411 the political discourse. Our review of the relevant literature, as well as the interviews we con-
412 ducted, reveals that this "2+1"-type structure may allow targets to play the following dual
413 role in society: (i) as an expression of a particular normative order under deep uncertainty
414 when assuming a social planner's perspective, and (ii) as a policy instrument to help the in-
415 ternational community comply with said normative order.

416 We want to highlight an important comparison for climate policy: the case of the international
417 sulphur dioxide policy regulated by the Convention on Long Range Transboundary Air Pollu-
418 tion (CLRTAP) - widely considered to be one of the major successful examples of international
419 environmental regulation – starting in the 1980. Here, the precautionary principle helped to
420 shape early policies, such as a 30% national emissions target, where emission reductions were
421 prescribed, even though full information on their impacts was not yet available. This was soon
422 replaced by intensive research on impacts, which led to the adoption of the critical loads ap-
423 proach still in use today. While pollution below the critical load is assumed to have no nega-
424 tive impacts on the environment, exceeding the critical load is assumed to harm the ecosys-
425 tem.⁴ A similar trend from emission targets towards a target that is set according to ecosys-
426 tem requirements can be seen in climate policy; however, it began only recently, which can
427 be explained by the higher complexity of the climate system. The analysis illustrates the bridg-
428 ing function of the precautionary principle. In contexts characterised by deep uncertainty,
429 and for decision-makers who are sceptical about using CBA, it might serve as a substitute,
430 starting with the emissions level as the target variable. As more system-based knowledge be-
431 comes available, targets can be formulated further down the impact chain, toward impacts.
432 It was possible up to temperature, and current efforts are seeking to replace the PP by listing
433 more concrete impacts – which is perceived as convincing more stakeholders of the need for

⁴ Nilsson and Grennfelt (1988) provide a technical definition of the concept. Patt (1998) and Levy (1993) pro-
vide analyses of the political discussions that led to the agreements.

434 climate action, while completely abandoning the PP does not yet seem feasible. On the policy
435 instrument side, more actionable targets for climate policy are currently being discussed. Fu-
436 ture research might reveal how a learning-based phase-out of the PP from decision-making
437 could be formalized, and what actionable targets might be optimally suited for climate policy.
438 What lessons can be learned for climate policy from the effective implementation of sulphur
439 policy? Acquiring more complete information on global warming impacts as soon as possible
440 might accelerate opinion formation and enhance the willingness to act in society, while the
441 PP will likely retain its bridging role for some time to come.

442

443

444

445

446

447

448

449

450

451 [Publication bibliography](#)

452 Bächli, Beat (2012): Zur Geschichte, Epistemologie und sozialen Robustheit des Regulierungs-
453 wissens: Grenzwerte für gefährliche Arbeitsstoffe als produktive Missverständnisse (1955-
454 1980). In Geert Keil, Ralf Poscher (Eds.): *Unscharfe Grenzen im Umwelt- und Technikrecht*.
455 Baden-Baden: Nomos (Umweltrechtliche Studien /Studies on Environmental Law, 44).

456 Bertrand, Nathalie; Jones, Laurence; Hasler, Berit; Omodei-Zorini, Luigi; Petit, Sandrine; Con-
457 tini, Caterina (2008): Limits and targets for a regional sustainability assessment. An interdis-
458 ciplinary exploration of the threshold concept. In Katharina Helming, Marta Pérez-Soba, P.
459 M. Tabbush (Eds.): *Sustainability impact assessment of land use changes*. Berlin, New York:
460 Springer, pp. 405–424.

461 Bodansky, Daniel (2016): The legal character of the Paris Agreement. In *Review of European,*
462 *Comparative & International Environmental Law* 25 (2), pp. 142–150.

463 Cointe, Béatrice; Ravon, Paul-Alain; Guérin, Emmanuel (2011): 2°C: The history of a policy-
464 science nexus. IDDRI Working Paper.

465 Dennig, Francis (2018): Climate change and the re-evaluation of cost-benefit analysis. In *Cli-*
466 *matic Change* 151 (1), pp. 43–54. DOI: 10.1007/s10584-017-2047-4.

467 European Union (1992): Treaty on European Union (Consolidated Version), Treaty of Maas-
468 tricht.

469 Gardiner, Stephen M. (2006): A core precautionary principle. In *Journal of Political Philoso-*
470 *phy* 14 (1), pp. 33–60.

471 Geden, Oliver (2016): The Paris Agreement and the inherent inconsistency of climate policy-
472 making. In *WIREs Clim Change* 7 (6), pp. 790–797. DOI: 10.1002/wcc.427.

473 Goldstein, Bernard D. (2012): John Snow, the broad street pump and the precautionary prin-
474 ciple. In *Environmental Development* 1 (1), pp. 3–9.

475 Gruschke, Daniel (2012): Grenzwerte als produktive Missverständnisse? Kommentar zu Beat
476 Bächli. In Geert Keil, Ralf Poscher (Eds.): *Unscharfe Grenzen im Umwelt- und Technikrecht*.
477 Baden-Baden: Nomos (Umweltrechtliche Studien /Studies on Environmental Law, 44).

478 Haigh, Nigel (1993): The precautionary principle in British environmental policy. In *Institute*
479 *for European Environmental Policy, London*.

480 Haites, Erik; Yamin, Farhana; Höhne, Niklas (2013): Possible elements of a 2015 legal agree-
481 ment on climate change. In *IDDRI Working Paper* (N°16/13).

482 Held, Hermann (2019): Cost risk analysis: dynamically consistent decision-making under cli-
483 mate targets. In *Environ Resource Econ* 72 (1), pp. 247–261.

484 Hertwich, Edgar G.; Hammitt, James K.; Pease, William S. (2000): A theoretical foundation
485 for life-cycle assessment. Recognizing the role of values in environmental decision making.
486 In *Journal of industrial ecology* 4 (1), pp. 13–28.

487 IPCC (2018): Global warming of 1.5°C. An IPCC Special Report on the impacts of global
488 warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission
489 pathways, in the context of strengthening the global response to the threat of climate

490 change, sustainable development, and efforts to eradicate poverty. Edited by Valérie Mas-
491 son-Delmotte, Panmao Zhai, Hans-Otto Pörtner, Debra Roberts, Jim Skea, Priyadarshi R.
492 Shukla et al.

493 Iverson, Terrence; Perrings, Charles (2012): Precaution and proportionality in the manage-
494 ment of global environmental change. In *Global Environmental Change* 22 (1), pp. 161–177.

495 Jaeger, Carlo C.; Jaeger, Julia (2011): Three views of two degrees. In *Reg Environ Change* 11
496 (S1), pp. 15–26. DOI: 10.1007/s10113-010-0190-9.

497 Knopf, Brigitte; Kowarsch, Martin; Flachsland, Christian; Edenhofer, Ottmar (2012): The 2° C
498 target reconsidered. In Ottmar Edenhofer, Johannes Wallacher, Hermann Lotze-Campen,
499 Michael Reder, Brigitte Knopf, Johannes Müller (Eds.): *Climate change, justice and sustaina-*
500 *bility. Linking climate and development policy: Springer Science & Business Media*, pp. 121–
501 137.

502 Lenton, Timothy M.; Rockström, Johan; Gaffney, Owen; Rahmstorf, Stefan; Richardson,
503 Katherine; Steffen, Will; Schellnhuber, Hans Joachim (2019): Climate tipping points - too
504 risky to bet against. In *nature* 575 (7784), pp. 592–595. DOI: 10.1038/d41586-019-03595-0.

505 Levy, M. A. (1993): *European Acid Rain. The Power of Tote-Board Diplomacy*. In Peter M.
506 Haas, Robert Owen Keohane, Marc A. Levy (Eds.): *Institutions for the earth. Sources of effec-*
507 *tive international environmental protection*. Cambridge: Mit Press.

508 Liberatore, Angela (2001): From Arrhenius to the Kyoto Protocol: Climate change and the
509 interplay between science and policy. In M. Hisschemöller (Ed.): *Knowledge, power, and*
510 *participation in environmental policy analysis*. New Brunswick, N.J., London: Transaction
511 (Policy studies review annual, 0163-108X, v. 12), pp. 175–197.

512 Liverman, Diana M. (2009): Conventions of climate change. Constructions of danger and the
513 dispossession of the atmosphere. In *Journal of Historical Geography* 35 (2), pp. 279–296.

514 Nilsson, Jan; Grennfelt, Peringe (1988): Critical loads for sulphur and nitrogen. Workshop :
515 Papers. Copenhagen: Nordic Council of Ministers.

516 Nordhaus, William D. (1975): Can we control carbon dioxide? Working Paper 75-63. IIASA.
517 Laxenburg.

518 Patt, Anthony (1998): Analytic frameworks and politics. The case of acid rain in Europe.
519 ENRP Discussion Paper E-98-20: Kennedy School of Government.

520 Physikalische Blätter (1987): Gemeinsamer Aufruf der DPG und der DMG: Warnung vor dro-
521 henden weltweiten Klimaänderungen durch den Menschen. In *Physikalische Blätter* 43 (8),
522 pp. 347–349. DOI: 10.1002/phbl.19870430811.

523 Reinhardt, Carsten (2008): Boundary Values. In Viola Balz, Alexander von Schwerin, Heiko
524 Stoff (Eds.): *Precarious Matters/Prekäre Stoffe. The History of Dangerous and Endangered*
525 *Substances in the 19th and 20th Centuries.*

526 Schellnhuber, Hans Joachim (2010): Tragic triumph. In *Climatic Change* 100 (1), pp. 229–238.
527 DOI: 10.1007/s10584-010-9838-1.

528 Scheringer, Martin (2002): Persistence and Spatial Range of Environmental Chemicals. *New*
529 *Ethical and Scientific Concepts for Risk Assessment.* Weinheim, Cambridge: Wiley-VCH.

530 Shaw, Christopher (2013): Choosing a dangerous limit for climate change. Public representa-
531 tions of the decision making process. In *Global Environmental Change* 23 (2), pp. 563–571.
532 DOI: 10.1016/j.gloenvcha.2012.12.012.

533 SRU (1983): Waldschäden und Luftverunreinigungen. Sondergutachten März 1983 des Rates
534 von Sachverständigen für Umweltfragen. Drucksache 10/113. Available online at
535 <http://dipbt.bundestag.de/doc/btd/10/001/1000113.pdf>, checked on 4/18/2018.

536 SRU (1996): Zur Umsetzung einer dauerhaft-umweltgerechten Entwicklung. Drucksache
537 13/4108. Available online at [https://www.umweltrat.de/SharedDocs/Down-](https://www.umweltrat.de/SharedDocs/Downloads/DE/01_Umweltgutachten/1994_2000/1996_Umweltgutachten_Bundestagsdrucksache.pdf?__blob=publicationFile&v=4)
538 [loads/DE/01_Umweltgutachten/1994_2000/1996_Umweltgutachten_Bundestagsdruck-](https://www.umweltrat.de/SharedDocs/Downloads/DE/01_Umweltgutachten/1994_2000/1996_Umweltgutachten_Bundestagsdrucksache.pdf?__blob=publicationFile&v=4)
539 [sache.pdf?__blob=publicationFile&v=4](https://www.umweltrat.de/SharedDocs/Downloads/DE/01_Umweltgutachten/1994_2000/1996_Umweltgutachten_Bundestagsdrucksache.pdf?__blob=publicationFile&v=4), checked on 1/24/2018.

540 Steel, Daniel (2015): *Philosophy and the Precautionary Principle. Science, evidence, and en-*
541 *vironmental policy.* Cambridge: Cambridge University Press.

542 Sunstein, Cass R. (2005): *Laws of fear. Beyond the Precautionary Principle.* Cambridge: Cam-
543 *bridge University Press.*

544 Tol, Richard S.J. (2007): Europe's long-term climate target. A critical evaluation. In *Energy*
545 *Policy* 35 (1), pp. 424–432. DOI: 10.1016/j.enpol.2005.12.003.

546 Townley, Stephen (2017): The Rise and Risk in International Law. In *Chi. J. Int'l L.* 18,
547 pp. 594–614.

548 UNECE (1985): Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution
549 on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent.

550 UNFCCC (1992): United Nations Framework Convention on Climate Change.

551 UNFCCC (1997): Kyoto Protocol to the United Nations Framework Convention on Climate
552 Change adopted at COP3 in Kyoto, Japan, on 11 December 1997.

553 UNFCCC (2015): Adoption of the Paris Agreement. FCCC/CP/2015/L.9/Rev.1.

554 United Nations (1992): Rio Declaration on Environment and Development.

555 WBGU (1995): Scenario for the derivation of global CO₂ reduction targets and implementa-
556 tion strategies. Bremerhaven.

557 Wiener, Jonathan B. (2011): The Real Pattern of Precaution. In Jonathan B. Wiener, D. Rog-
558 ers Michael, K. Hammitt James, H. Sand Peter (Eds.): *The Reality of Precaution. Comparing*
559 *Risk Regulation in the United States and Europe.* Washington, D.C.: RFF, pp. 519–565.

560 Wurzel, Rüdiger (2002): *Environmental policy-making in Britain, Germany and the European*
561 *Union. The Europeanisation of air and water pollution control: Manchester University Press.*

562