Cartography of policy paths: A model for solution-oriented environmental assessments

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NOTICE: This is the authors' version of a work that was accepted for publication in "Environmental Science & Policy." Changes have been made to this work since it was submitted for publication, and changes resulting from the publishing process, such as peer review, editing, corrections, structural formatting, and other quality control mechanisms, are not reflected in this document. For the published version, see:

Edenhofer, O. and Kowarsch, M. (equal contributions) (2015): Cartography of pathways: A new model for environmental policy assessments. Environmental Science and Policy 51, pp. 56–64. Online: http://dx.doi.org/10.1016/j.envsci.2015.03.017

Abstract

How can solution-oriented assessments of environmental policy issues be policy-relevant without being policy-prescriptive? The predominant technocratic and decisionist responses to this question mistakenly assume that value-neutral scientific recommendations for public policy means, or even objectives, are possible. On the other end of the spectrum, the literature on democratic and pragmatic models of expertise in policy often does not satisfactorily explain what researchers can contribute to public discourses surrounding disputed policy objectives and means. Building on John Dewey's philosophy, this article develops the "pragmatic-enlightened model" (PEM) of assessment making, which refines the existing pragmatic models. It is used to some extent by Working Group III of the Intergovernmental Panel on Climate Change. According to the PEM's policy assessment methodology, policy objectives and their means can only be evaluated in light of the practical consequences of the means. Learning about the secondary effects, side effects and synergies of the best means may require a revaluation of the policy objectives, for instance, regarding the use of bioenergy for climate mitigation. Following the PEM, assessments would—based on a thorough problem analysis—explore alternative policy pathways, including their diverse practical consequences, overlaps and trade-offs, in cooperation with stakeholders. Such an arduous interdisciplinary cartography of multiple objectives, multi-functional policy means and the broad range of their quantitative and qualitative practical consequences may face considerable practical challenges and uncertainty. Yet, it could make assessments more policy-relevant and less prescriptive, and could effectively support a learning process about the political solution space.

Keywords: *Environmental assessment • Public policy analysis • Ends-means relationship •Side-effect • Objective • Value judgment*

Highlights

- **Environmental assessments require refined guidance for value-laden policy analysis.**
- **Different disciplines may jointly identify practical consequences of policy means.**
- **They should map alternative policy pathways, potential overlaps and trade-offs.**
- **Policy objectives are to be revised if policy means have severe side-effects.**
- **Assessments could foster learning processes about viable policy paths.**

1 Introduction: Environmental assessments require a refined orientation

The international community has demanded and supported a number of large-scale assessments of complex environmental issues in recent years (see IPBES, 2013, for an overview), such as the assessments by the Intergovernmental Panel on Climate Change (IPCC), the United Nations Environment Programme's (UNEP) Global Environment Outlook (GEO) series, the Millennium Ecosystem Assessment (MA), and the assessments of agricultural issues (IAASTD) and biodiversity (IPBES). According to Mitchell et al. (2006, p. 3), such assessments can be understood as formal efforts by a number of experts and stakeholders to assemble and synthesize the knowledge in a particular research field with a view toward making it publicly available in a form that is intended to be useful for policy-making. Hundreds of academic researchers from the natural and social sciences, as well as experts from non-academic institutions (both hereafter referred to as "researchers"), and several years of research and significant financial resources, were needed to conduct these large-scale, interdisciplinary assessments.

Large-scale assessments can be worth the immense effort and costs required, particularly if they promote better-informed public policy on multiple governance levels. Assessments can achieve this by (1) identifying the socially relevant practical consequences (externalities, etc.) of human actions and (2) helping to better understand the possible response options and their implications (Dewey, 1927). The degree to which at least one of these two valuable goals is achieved constitutes an assessment's level of policy relevance (compare the more formal and perceptual understanding of policy relevance in Cash et al., 2003). Large-scale assessments have specific strengths when dealing with long-term, complex environmental issues where different stakeholders and objectives, as well as high uncertainty, are involved. First, because they can provide an in-depth, systematic analysis of complex issues and a relatively comprehensive, authoritative knowledge synthesis; and second, because they usually require political mandates, relatively high transparency and formal procedures involving policymakers, which can facilitate acceptance of the assessment results among policymakers.

Yet, as many case studies reveal (e.g., Jasanoff, 1990; Sarewitz, 2004; Pielke, 2007; Robert and Zeckhauser, 2011), a crucial precondition for the wide public acceptance of assessments is that assessments avoid policy prescription, i.e., that they avoid taking an explicit or implicit stance on disputed value-laden policy issues when there is no public consensus on these issues. In the presence of such a bias in assessments—for instance, when the ethical values underlying a specific environmental problem framing of a natural science assessment are disputed—policymakers and other stakeholders who do not share this explicit or implicit standpoint are likely to reject the assessment as a whole. Therefore, in order to realize their full potential for public decision-making and society, large-scale environmental assessments have to be scientifically sound and policy-relevant (in the sense described above), without being policy-prescriptive. Though slightly different concepts and definitions exist in this regard (e.g., "salience," "legitimacy" and "credibility" in the seminal work by Cash et al., 2003), these fundamental preconditions are now widely shared in the literature as relatively obvious criteria for successful assessments.

However, in the practice of assessment making, it turns out that these criteria are hard to achieve, at least simultaneously, due to the many significant trade-offs and challenges (see Cash et al., 2003) that hamper successful assessment making in the above sense. For instance, in some cases, a relatively wide acceptance of environmental assessments among different policymakers is achieved by watering down or even avoiding certain controversial, yet socially highly relevant, aspects of the problems or possible solutions (Siebenhüner, 2003). This can considerably reduce the policy-relevance of assessments. On the other hand, some highly policy-relevant studies or reports are criticized for being strongly biased from a social and political perspective. A wave of criticism of the IPCC in recent years (both in the media and academic debates, e.g., in *Nature 463*, 2010, pp. 730–32; many articles in *Nature 463* and *464*) show how real these challenges are. Some critics argue that the IPCC assessments are biased, unsound and policy-irrelevant. However, a comprehensive, independent review of the IPCC by the InterAcademy Council concluded, "the IPCC assessment process has been successful overall and has served society well" (IAC, 2010, p. 51), and convincingly exonerated the IPCC from most of the reproaches. Nonetheless, the many criticisms and lack of trust in the IPCC's work and other assessment bodies point to the major pitfalls of the role of researchers in public policy and to the challenge of ensuring that the criteria for successful assessments are met.

Ideas are, therefore, needed to reduce or even overcome these trade-offs between the basic criteria for successful environmental assessments. In the end, specific proposals for the institutional arrangements of assessment bodies are required. However, and this is the starting point of this article, there is a current lack of adequate guidance for large-scale environmental assessments even on a fundamental, strategic level. There are at least two reasons for this: First, the predominant general models of the roles and responsibilities of scientific expertise in policy are flawed; and the critics, apologists and practitioners of solution-oriented environmental assessment institutions usually work with such models. Often, these models are neither made explicit, nor are they necessarily comprehensive and consistent. Such general, normative models *inter alia* guide the institutional arrangements and procedures of environmental assessments, as well as the concrete practices within those arrangements. In this action-guiding function, the (implicit or explicit) models contribute considerably to the quality and impact of the assessments (Hulme, 2009; Pielke, 2007); therefore, more appropriate models are needed to address the trade-offs between policy-relevance, sound science, and avoiding policy-prescription. The lack of an appropriate general model of this kind has been observed by many scholars (Pielke, 2007; Brown, 2009; Hulme, 2009, pp. 102–10; Kitcher, 2011, pp. 25f; Sarewitz, 2011, p. 54). This is partly due to the underestimated philosophical challenges regarding implied value judgments and objectivity (Putnam, 2004; Douglas, 2009).

Second, there seems to be a recent trend in environmental assessments that worsens the above-mentioned challenges regarding the assessment criteria. Environmental assessments increasingly focus also on more specific policy solutions, i.e., specific response options, in addition to the traditional, still indispensable problem analyses that mainly address biophysical systems. We call these assessments “solution-oriented.” In our experience, policymakers increasingly demand these kinds of assessments because global awareness of environmental problems has increased, yet it is often unclear for them what to do because of the complexity, uncertainty, risks and multiple objectives at stake. For instance, in climate policy debates, the focus seems to have shifted away from the question of whether or not anthropogenic climate change exists, to the question of what can be done on different governance levels. Another example is UNEP’s recent GEO assessment (UNEP, 2012) that aims to identify regional best-policy practices in order to speed up the attainment of internationally agreed-upon environmental goals. As a result, solution-oriented environmental assessments must increasingly deal with highly value-laden, disputed policy issues as well as the challenge of truly interdisciplinary cooperation (natural and social sciences) when dealing with complex and highly uncertain public policy analyses—on multiple scales and governance levels.

Consequently, this article aims to provide a refined model, i.e., a framework and strategic orientation, specifically aimed at large-scale assessments of long-term environmental problems *and* specific policy response options in light of the complexity, uncertainty and multiple policy objectives associated with them. This model may help these solution-oriented assessments to better deal with disputed, value-laden environmental policy issues in a scientifically sound and policy-relevant, but non-policy-prescriptive, manner. Yet, this model also acknowledges the strengths of some existing approaches in the literature and practices of assessment making and, therefore, refines them; It builds on previous works in public policy analysis and other research fields (e.g., Hulme, 2009; Robert and Zeckhauser, 2011; Sluijs et al., 2010; Dunn, 2012). This article mainly goes beyond the literature by discussing more clearly—and in a philosophically systematic and consistent manner—the decisive role of the practical consequences for the assessment of the objectives and means of environmental policy, resulting in a proposal for how to constructively deal with the inevitable fact/value entanglement in assessments.

2 Predominant science-policy models and disputed climate policy narratives

To make the discussion of a fundamental guidance for environmental assessments more vivid, we chose the example of long-term, global climate change mitigation goals and how these highly disputed goals are to be assessed by institutions, such as the IPCC. A popular mitigation goal is limiting the global mean temperature rise to a maximum of two degrees Celsius (2°C goal) in order to reduce the risk of severe climate impacts. However, high uncertainty is related to such temperature goals; Guivarch and Hallegatte (2013) provide an overview of these uncertainties and the feasibility of the 2°C goal. There is an ongoing debate over whether international climate policy should envisage even more ambitious mitigation goals (1.5°C goal) or if the assumed economic costs and risks of very ambitious mitigation goals should lead to less ambitious climate policies (e.g., 3.5°C goal), or to completely different types of goals (for an overview, see Knopf et al., 2012). In addition to the need for balancing (1) climate change mitigation, (2) adaptation and (3) economic development in light of uncertainty and risks, various unresolved intra- and intergenerational distributional issues make international agreements very difficult (Edenhofer et al., 2012). To complicate matters further, climate policy may have negative or positive interdependencies with additional policy objectives related to health, energy policy, food security, biodiversity, trade, migration, public finance, the role of the state and individual liberties, etc. Consequently, climate policy affects multiple interests, values and policy objectives on multiple governance levels, including a large number of stakeholders and institutions, all while facing many risks and uncertainties (for a taxonomy of the disagreements in climate policy see Robert and Zeckhauser, 2011).

To provide a simplified orientation of such complex value-laden issues, policy narratives are often developed and widely used in public policy debates (Shanahan et al., 2011). These policy narratives provide rough hypotheses of the problems at stake, as well as the appropriate response strategies. For instance, they demand high economic growth and individual liberties (resulting in less ambitious climate policy), green growth, or even de-growth in light of "planetary boundaries," such as climate change (for these and further examples see Urhammer and Røpke, 2013; IISD, 2013). How should assessment bodies successfully carry out public policy analyses given these climate policy controversies and policy narratives? Can the predominant models of scientific expertise in policy successfully guide solution-oriented environmental assessments?

Jürgen Habermas (1971) provided a seminal description of three still predominant, general models of scientific expertise in policy. These are the technocratic, decisionist and pragmatic models. While many other models are conceivable, most of them would prove to be variations or mixtures of these models (e.g., the four models in Pielke, 2007). These three stylized models are widely discussed in the science and technology studies literature (e.g., Hulme, 2009, pp. 102–110; Millstone, 2005) and are reconstructed from practice at the science-policy interface, which includes large-scale scientific assessments. More precisely, in their normative function, such models typically suggest, among other things, different divisions of power and responsibilities on a fundamental level, such as: Who should be tasked to infer (1) the policy objectives and (2) the policy means to achieve the policy objectives—researchers only, policymakers only, or other stakeholders and civil society? The term "policy objectives," as used here, can refer to (a) general goals, ethical values, interests, priorities and constraints related to a particular framing of the problem or risk assessments, such as assumed planetary boundaries (Rockström et al., 2009); or (b) their translation into more specific, possibly subordinate, policy targets, such as specific greenhouse gas concentration targets. Policy means are courses of action decided on by governments or state institutions that include a broad range of public policy instruments, for example, an emissions-trading scheme or education funding that are intended to result in specific measures (i.e., technologies, behaviour, etc.). Policy means can be decided through legislative acts, executive orders or court decisions at different governance levels. To determine the divisions of power, the models always imply assumptions regarding what kinds of knowledge researchers can provide and what role this knowledge can and should play in the political process.

The technocratic model claims that researchers should address both policy objectives and means, because many policy problems are assumed to be too complex for policymakers. It is assumed that modern science and technology can resolve these problems without implying ethical judgments. Variations of this model admit that ethical judgments are involved in determining policy objectives, but refer to a consensus in society in these specific cases, or to hardly disputable ethical values, in order to avoid illegitimate policy prescription. The task of policymakers—aside from generic agenda-setting—is reduced to formal decision-making and the implementation of scientific proposals as laws. In our example of climate policy, the technocratic model implies that researchers alone can identify the best policy objectives. For instance, an economic cost-benefit analysis could result in the researchers recommending a hypothetical 1.5°C goal. At the same time, the researchers may also propose a suitable set of means that could possibly include riskier options such as solar radiation management and the massive use of bioenergy and nuclear energy. According to the technocratic model, researchers can propose an appropriate policy narrative and even specific public policy blueprints based on state-of-the-art science and technology. The uncertainties in climate-related science are interpreted as temporary and surmountable. The following figure depicts the core structure of the technocratic model, which promises to provide highly policy-relevant and sound expert recommendations.

Fig. 1 The technocratic model suggests that researchers propose policy objectives and means, while policymakers implement these means as laws

In contrast, the decisionist model assumes that only policymakers should make decisions about policy objectives and overarching policy narratives, because they are always value-laden and therefore regarded as purely subjective and disputable. According to this model, researchers only explore—aside from some facts underlying the public problems at stake—the means to given policy objectives without making any value judgments. Thus, to avoid policy prescription by researchers, only policymakers should decide the climate policy objectives—such as a 2°C goal to avoid certain climate change impacts—to be achieved in an economically efficient manner. Researchers should then explore the suitable means, such as carbon taxes and R&D investments, to achieve the future energy mix and land use that will likely result in a 2°C world. These means, determined by consensus among the researchers, should then be implemented by the policymakers. This model promises to avoid policy prescription by researchers and to provide scientific proposals for policy means. It can be illustrated with the following diagram.

Fig. 2 The decisionist model suggests that policymakers should decide on policy objectives, researchers should propose policy means based on those objectives, and policymakers should implement those means as laws

Finally, the pragmatic model has many variants, such as the "democratic," "co-production," "deliberative" or "co-evolutionary" models. Similar to the decisionist model, the pragmatic model rejects the technocratic, unambiguous recommendation of policy objectives by researchers in order to avoid policy prescription. However, it also rejects the decisionist standpoint that researchers could identify the appropriate policy means on their own. In contrast to the previous models, the pragmatic model argues that climate policy objectives and means, and the related policy narratives, should only be determined through a discourse between researchers, policymakers and the public, provided that certain formal and fair rules are followed. Researchers are called on for their input, but not to determine the climate policy objectives or means. The following simplified scheme is typical for most versions of the pragmatic model, which promises to lead to more pluralism and democratic governance.

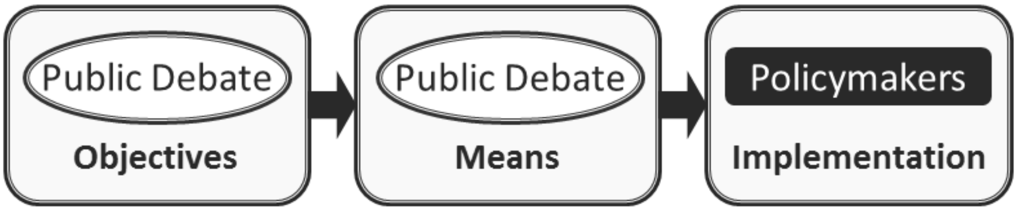

Fig. 3 The pragmatic model suggests that the policy objectives and means should be discussed democratically before being implemented by policymakers

All three of these models prevail in the debate and practice surrounding scientific expertise in environmental policy (Hulme, 2009, pp. 102–110; Pielke, 2007). The different variants of the technocratic model remain the predominant choice at least regarding scientific policy advice in general (e.g., Jasanoff, 1990, p. 229; Pielke, 2007, p. 34; Beck, 2011), although there are significant cultural differences (Hulme, 2009, p. 105; Maasen and Weingart, 2005). In the following, we evaluate these models by identifying and evaluating their practical results if they guide solution-oriented assessments.

Of the three models, the technocratic model has been most scrutinized in the literature. One of the critiques is that the technocratic (and, furthermore, decisionist) optimism concerning the linear, "clean" transfer of scientific knowledge into policy-making (i.e., the instrumental function of expertise in policy) is empirically and theoretically flawed—not only due to underestimated communication problems (particularly in global assessments) between researchers and target audiences, but also due to intentional distortion and other dynamics in political processes that limit the impact of assessments in general (see Sabatier and Jenkins-Smith, 1999, for a theory on the possible role of expertise in public policy). A further critique states that reducing scientific uncertainty does not necessarily lead to the resolution of political conflict, as technocrats assume, particularly in heated environmental debates (Jasanoff, 1990, pp. 7f; Sarewitz, 2004).

However, the main critique in the literature points out that, in practice, the technocratic model with its clear-cut policy recommendations is often turned into a symbolic legitimation model (Jasanoff, 1990; Sarewitz, 2004). This means that certain political standpoints in scientific studies (i.e., the proposed objectives and means) are allegedly justified by referring to a consensus; however, these are in fact strongly biased toward certain disputed political or ethical standpoints in a non-transparent manner (e.g., by concealing their value judgments or uncertainties). If one-sided value assumptions in assessments are not sufficiently made transparent, researchers can become, deliberately or unintentionally, “stealth issue advocates” through their reports (Pielke, 2007). There is also some demand by policymakers for this kind of report in order to create legitimacy for their policy narratives by making use of scientific authority (e.g., the case studies in Jasanoff, 1990; Pielke, 2007). This risk of the technocratic model and the lack of a consensus regarding environmental policy may be among the reasons why many large-scale environmental assessments, such as the IPCC (2007; not recommending any mitigation goals, but rather exploring mitigation means) and UNEP (2012; exploring policy means to speed up given internationally agreed-upon environmental goals) seem to primarily follow the decisionist model.

But also assessments that follow the decisionist model can become value-laden and policy-prescriptive because their assumption that researchers can provide sound science without implying disputed value judgments in their scientific justifications is misleading (Putnam, 2004; Hands, 2001; Caldwell, 1994; Douglas, 2009). There are no “facts” without values; facts and values are always entangled (Dewey, 1986), though one can distinguish between the positive and normative purposes of statements. All scientific statements at least imply cognitive values (such as consistency, coherence or objectivity, see Douglas, 2009) that have, however, the same fundamental characteristics as ethical value judgments (Putnam, 2004). Furthermore, some predominant cognitive values in scientific research are built on ethical values (Douglas, 2009, pp. 90f). Additionally, value-laden “thick ethical concepts” (i.e., descriptive concepts with strong normative-ethical connotations) are often used in assessments, including those for framing the problems (Putnam, 2004). Examples include “efficiency,” “vulnerability,” “risk” and “development.” The widespread, mistaken belief in value-free science opens the door wide for the deliberate misuse or unintentionally misguided use of expertise in policy—notably for policy-prescriptive assessments through implied ethical judgments already at the level of problem framing (Skodvin, 2000, p. 9; Douglas, 2009; Hulme, 2009). Advocacy for certain controversial policies (be it objectives or means) in assessments makes environmental controversies even worse in the long run (Sarewitz, 2004) and undermines scientific authority and credibility even further. Furthermore, contradictory opinions usually turn up quickly, which reduces the political impact of specific technocratic policy recommendations (Sarewitz, 2004). Moreover, assessments that follow the decisionist model are often significantly less policy-relevant (in the above substantial sense of this term), as there is no role for research regarding the critical discussion of policy objectives, such as the 2°C goal. The epistemic and ethical value-ladenness of scientific knowledge casts doubt on the soundness and objectivity of scientific assessments that claim to present value-neutral knowledge (Hands, 2001; Douglas, 2009).

The pragmatic model is much more promising than the linear technocratic and decisionist models (see Cash et al., 2003, who argue for more boundary work). It envisages cooperative knowledge production and a learning function for scientific expertise in environmental policy. It accepts the value-ladenness of scientific knowledge production, yet allows for a scientific contribution to the discussion of disputed, value-laden environmental policy issues. The major challenge of the pragmatic model is to specify this potential contribution and to show how value-laden research can still be sound and reliable. Yet, many existing variants of the pragmatic model that generally highlights the procedural and institutional aspects fail to respond to this philosophical challenge in a satisfactory manner. Often, like the technocratic and decisionist models, these model variants fail to take the key interdependency of policy objectives and means fully into account.

3 Theory: The interdependency of objectives and means

Understanding the interdependency of objectives, means and consequences is key for the development of a refined pragmatic model as more appropriate guidance for solution-oriented, large-scale environmental assessments. It helps develop a compelling methodological idea for how environmental policy objectives and means—given the inevitably implied ethical values—can actually be assessed by researchers in a scientifically sound and reliable manner. Furthermore, the value-ladenness of even proposed policy means, as well as the diversity of the objectives at stake, become particularly obvious in light of this interdependency. The analysis of the interdependency in this section builds on the theory of philosophical pragmatism in the tradition of John Dewey and Hilary Putnam. It is a philosophy of science and furthermore a meta-ethical theory. The Deweyan-Putnamian variant of pragmatism is explained in Dewey (1986; 1988) and Putnam (1999; 2004). Although Putnam does not call himself a pragmatist, he has contributed significantly to pragmatist theory.

The core idea of pragmatism is to trace and evaluate the practical consequences of hypotheses, be they scientific, ethical or just verbalized gut feelings in ordinary life. Hypotheses are possible means to solve any kind of practical problems; the “rightness” of hypotheses (of any kind) depends on their potential to solve problematic situations, as experienced by us. Though this may sound disturbing for some natural scientists, the pragmatist method builds on the successful principle of experimentation that is fundamental to natural science. Basically, Dewey’s abstract idea of inquiry consists of five main steps (Dewey, 1986, pp. 105–122; see a detailed analysis in Brown, 2012):

1) Noticing a problematic situation.

2) A precise and thorough analysis of the problem and its causes, constituents and contexts. This includes identifying objectives as desired consequences (similar to the definition provided by Dunn, 2012) and as specific, comprehensive problem-solving conditions.

3) Developing tentative hypotheses for (a set of) means to attain the objectives.

4) Evaluation of these proposals for means, and possibly a revaluation of the initial objectives, by critically considering the potential, practical consequences of the means. These practical consequences refer to (a) the sum of direct effects of the objectives in step two; and (b) the unwanted side effects as negative and synergies as positive co-effects on additional objectives. Direct effects also comprise potential secondary, later effects in causality chains that diminish or increase the direct effects in total.

5) Evaluation after the actual implementation: Do the hypotheses for means and objectives need to be revised in light of the real practical consequences of the implemented means?

These five steps form a pattern of inquiry (a meta-theory) that could guide the colorful plurality of the many specific research methods. For Dewey, a successful scientific inquiry transforms an indeterminate problematic situation into a determined one with the help of adequate hypotheses (means); this usually requires a “transaction” of the people involved, which includes learning processes about valuable objectives and their means (Kuruvilla and Dorstewitz, 2010, p. 267). A crucial precondition for a successful Deweyan inquiry into more complex social issues is some kind of dialogue between researchers and the public. This essential co-operative aspect of knowledge production is mainly because researchers alone can hardly be aware of all socially and politically relevant objectives and means-consequences, or of all possible means. Moreover, since a pragmatist inquiry is so much about human action and, inevitably, value-laden objectives, a fact/value conflation is constitutive for pragmatist thinking. Moreover, there is a continuum of objectives and means: objectives in one specific context can become the means of another case, and vice versa (Dewey, 1986).

The crucial implication of this Deweyan pattern of inquiry for a framework of environmental public policy analysis is, in our view, that researchers should not simply explore possible policy means to given policy objectives because objectives alone do not justify their means. Rather, both the means and the objectives should be critically reflected on in light of the diverse practical consequences of the means, according to step four in Dewey’s inquiry. Pragmatism suggests that a critical inquiry into the means-consequences could possibly change previous evaluations of the policy means, and even policy objectives, dramatically. And “changing one’s values is […] frequently the only way of solving a problem” (Putnam, 2004, p. 98). Consequently, the policy objectives and the means are interdependent and cannot be evaluated separately.

The low-hanging fruit of the evaluation of practical means-consequences can be that the meaning of the frequently ambiguous policy objectives is clarified and possibly corrected, for example, in terms of more precise evaluative criteria (i.e., specific indicators, metrics, etc.), as these evaluative criteria are always directly related to the policy objectives at stake. Additionally, the initial appraisal of the means can change in light of their actual or potential consequences—possibly requiring a search for better or additional means. Because of the complex biophysical and socio-economic system dynamics, the practical consequences of the climate policy means may include economic costs, risks, externalities, etc., but also consequences related to the many objectives from other policy fields discussed above (Sect. 2). Moreover, a given set of objectives often has to be completed with additional objectives after the exploration of the means-consequences if it turns out that the identified side effects and synergies of the means correspond to the objectives that were missed by the initial list of objectives at stake. However, as these objectives are obviously interrelated through side effects and synergies, the weights of given policy objectives may have to be revised and relativized, or the objectives may have to be completely abandoned, for instance, if even the best available means have severe side effects. Competing sets of objectives can be compared in a similar manner, i.e., via their practical means-consequences. Even in the rare case that there is no initial disagreement over a specific set of objectives regarding a policy problem, the actual practical consequences of the best means to realize these objectives can surprisingly lead to a world that is, in fact, not desirable and necessitates a completion and revision of the initial objectives. The sheer existence of co-effects due to multi-functional policy instruments does not yet tell us what to do; the weighing of different public policy objectives in order to find an acceptable compromise between them is an exercise that requires a social welfare function and fair democratic procedures. Figure 4 summarizes these thoughts on the role of practical consequences in the (r)evaluation of policy objectives and means.

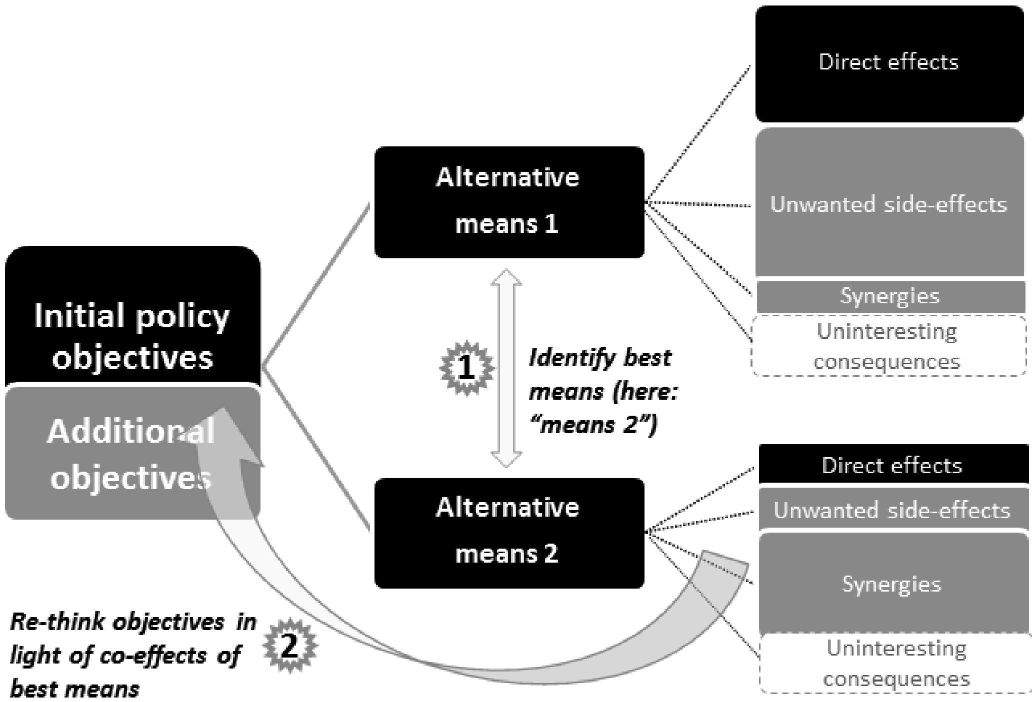

Fig. 4 The interdependency of objectives and means via their practical consequences. Both means and the initial objectives are to be evaluated and possibly revised in light of the direct effects and co-effects of the means

Let us illustrate this pragmatist policy analysis methodology with a *hypothetical* example of mitigation goals by assuming the dual initial policy objective to stay below 2°C global warming in order to avoid severe climate impacts, but in an economically efficient manner. Further assume that carbon taxes and subsidies for renewables are the major policy means; these means will likely result in specific measures in the energy and transport sector. Given the complexity of natural and socio-economic and biophysical systems, the direct effects could be the least-cost attainment of the 2°C goal at first, inter alia due to a high share of bioenergy in the global energy mix. The secondary direct effects of large-scale bioenergy production could cause increasing greenhouse gas emissions due to direct and indirect land-use changes of the large-scale biomass production. Moreover, the suggested means may have synergies, for instance, with the additional objectives of energy security or health improvement due to reduced air pollution from fossil fuel combustion. However, there could also be severe side effects in terms of risks, for instance, regarding food production prices and land-use changes (Creutzig et al., 2012). Food security, for instance, might then have to be added to the context-specific list of relevant policy objectives (and to the interrelated list of evaluative criteria), and the policy objectives may have to be weighed differently against each other in light of the identified co-effects, possibly leading to a revision of the 2°C goal as such.

Consequently, according to pragmatism, researchers can contribute to value-laden policy debates about policy objectives by exploring and evaluating also the practical consequences of the means. But, how can such a highly value-laden public policy analysis, following the pragmatist pattern, still generate objective, reliable results to ensure sound science in solution-oriented environmental assessments? Actually, we can never have direct access to things in the real world that are free of any particular value-laden perspective or concepts (Putnam, 1999, Part I; Douglas, 2009). For pragmatists, there is no possibility to come to infallible, everlasting, absolutely certain knowledge. But, this does not necessarily have to lead to epistemological relativism that can at best refer to an actual consensus among scholars or coherence among theories. The point is that the problematic situations and their resolutions through scientific inquiry are not so unique that the successful results of a pragmatist inquiry could not also be applied to other situations or accepted by other people. Hypotheses that have repeatedly turned out to be sound and reliable in terms of their practical consequences for the solution of the problematic situation at stake can serve as the premises for further inquiries, such as for certain laws of nature. It is the reality out there in the world, and the assumed causalities, that make our best scientific theories so extraordinarily successful in terms of their problem-solving abilities in similar situations, despite always being value-laden (Putnam, 1999; 2004). This can also be valid for social science and even normative-ethical hypotheses.

4 Result: The pragmatic-enlightened model of assessment making

Building on this pragmatist theory of how policy objectives and means can be scientifically evaluated, let us now refine the promising pragmatic model of scientific expertise in policy to adapt it to the specific characteristics of solution-oriented, large-scale environmental assessments, as explained in the introduction. This will result in the pragmatic-enlightened model (PEM). In the following, we sketch the structure of a PEM-guided assessment that comprises several stages; the structure is an echo of standard policy process models (e.g., Dunn, 2012, Chap. 1).

The first stage is the comprehensive analysis and definition of the policy problem at stake, which corresponds with step two of the Deweyan pattern of inquiry. The participation of stakeholders and civil society representatives affected by a given problem is useful to adequately identify and address the problem and related objectives in assessments. The importance of adequate and thorough problem framing can hardly be overestimated. According to an old proverb, a problem well put is half-solved. However, in spite of several decades of discussions on this topic, framing the problem of climate change is still disputed (Hulme, 2009), which closely corresponds with the competing policy narratives mentioned above. In these cases, assessments should explore alternative, disputed problem-framings and related policy objectives, and discuss their pros and cons, respectively.

The second stage builds on the interdependency of objectives and means. It comprises (1) the identification of possible means and (2) the critical exploration of the possible practical consequences of these means, using multiple criteria in quantitative and qualitative terms. This is the core stage of a solution-oriented environmental assessment. As in the first stage, researchers may play a strong role because their elaborated methods come to bear fully here. But, without learning from the people affected by the policy problem and potential solutions, and without taking into account their interests, preferences and fears, researchers are at risk of overlooking relevant objectives and, consequently, specific means-consequences. Moreover, Dewey rightly states that “to participate in the making of knowledge is the highest prerogative of man and the only warrant of his freedom” (Dewey, quoted in Brown, 2009, p. 135), which points to the ideal of a deliberative and participatory, democratic process of assessing policy objectives and means as a society. Though there is much literature on the need for and limitations of public participation at the science-policy interface (e.g., Dewey, 1927; Durant, 1999; Callon, 1999; Goodin, 2008; Scoones, 2009; Brown, 2009; Renn, 2009), there are still research gaps regarding the options for stakeholder engagement within large-scale, global assessments that face a huge number of stakeholders.

A decisive feature of the PEM is that several *alternative* policy pathways (i.e., objectives and means) as well as their practical consequences are explored in a large-scale environmental assessment process and presented to the target audiences at the end. For the PEM, scientific consensus can at best relate to the consistency and scientific quality of the statements on a particular policy alternative. A proponent of the technocratic model could possibly object that there is no need to present alternatives because it is theoretically possible to come to objective scientific statements, even when considering highly value-laden policy evaluations, which was argued when pragmatism was explained above. There are, nonetheless, several reasons to present alternatives. First, the pragmatist methodology presupposes the thorough exploration of alternative pathways before the best pathways can be identified in terms of their practical consequences. There is no *a priori* method that can help decide what the best policy pathway is, because such an approach would always mistakenly presuppose fixed objectives and criteria instead of interdependency with the practical consequences. Second, due to the many uncertainties and complexities regarding large-scale environmental policy issues, the objective identification of the best policy pathways is virtually impossible, and presenting alternatives and their uncertainties may at least allow for a constructive public discourse; although, for pragmatism, insights can already be useful and valuable if they are mere estimates or opinions instead of fully objective and certain knowledge. Third, independent from methodological thoughts, presenting alternative policy pathways and their consequences may help avoid the misguided use of expertise in policy, as policymakers can no longer legitimate policy pathways by referring to an alleged "inherent necessity" of a certain policy pathway based on a (pseudo) scientific consensus, nor can they refer to scientific uncertainties and disagreements.

Yet, the scope of possible future pathway analyses has to be narrowed down because of the vast range of environmental policy pathways and related consequences (Sect. 2) and the limited resources available for assessment processes. However, there is a danger of being biased in this selection of pathways because the "definition of the alternatives is the supreme instrument of power" (Schattschneider, 1960, p. 66). Moreover, a meta-narrative is unavoidable to structure the variety of policy narratives (Roe, 1994). To avoid severe bias in assessments, policymakers and other stakeholders should be involved in the selection process also because the chosen pathways have to be relevant to them. In addition, these scenarios ought to reflect several politically important and disputed objectives, ethical values and prevalent policy narratives, respectively.

Once the assessment results are published, there should be an extensive public discourse about the selected, thoroughly explored, alternative policy pathways throughout society at large. This public discourse is no longer part of the scientific assessment process itself, but is informed by the assessment results and presupposes transparency of important assumptions, value judgments and uncertainty in the assessment report. However, researchers may have to answer questions, make corrections and join the political discussions in order to learn about further neglected aspects of the problem at stake. If the PEM is used for global assessments, this public discourse may take place on a national level. Following the public discourse, a decision has to be made by policymakers (at the international, national or sub-national level), and the chosen policy pathway has to be implemented as law. The implemented policies are rarely identical to any of the pathways analyzed in the assessment.

After the policy is implemented, there is a third and final stage of the assessment. Analogous to step five in Dewey's pattern of inquiry, the *actual* means-consequences need to be explored ex-post. The goal is learning for future policy problems and the next assessment cycle (for example, the periodic IPCC assessments). This third stage can lead to a refinement of earlier problem analyses, objectives and means-hypotheses, as well as a revision of the "meta-narrative," i.e., the selection of competing policy narratives to be explored in-depth. Figure 5 summarizes the basic structure of a PEM-guided assessment:

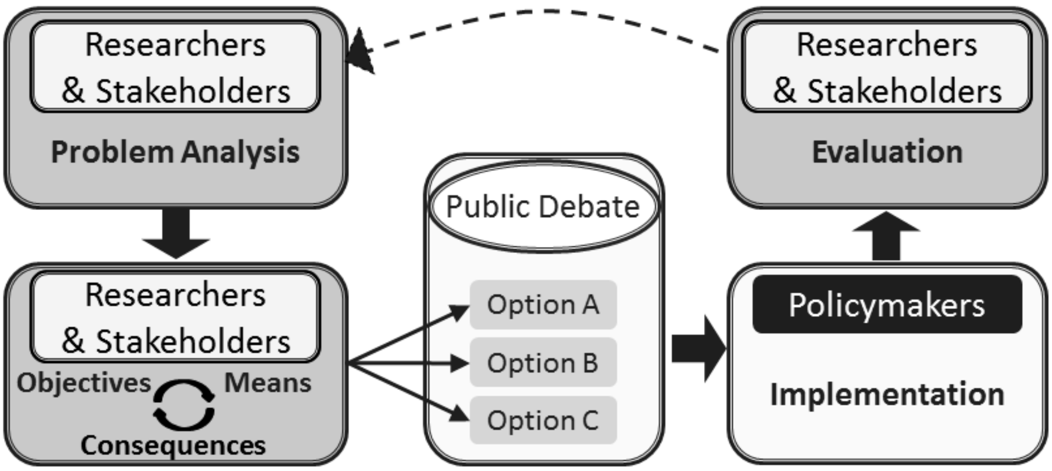

Fig. 5 The PEM as a model for solution-oriented assessments suggests that after researchers and stakeholders have jointly framed the problem, they explore the objectives, means and consequences. The two white boxes indicate steps in the policy process that are outside the assessment-process *per se*, such as public debate on alternative policy pathways, as well as policy decisions and implementation by policymakers. Next, there is a scientific ex-post evaluation of the actual means-consequences, which is also the starting point for a new assessment cycle

The PEM is strongly based on the pragmatist idea that objectives and means are interdependent via their practical consequences. The PEM has three core characteristics: (1) the thorough exploration of diverse practical means-consequences, including co-effects; (2) stakeholder engagement and public discourse; and (3) the mapping of alternative viable policy pathways, with transparency of important assumptions, value judgments and uncertainties. As a refinement of the pragmatic model, the PEM is "enlightened" in that it considers the interdependency of objectives and means and the conditions under which a certain policy pathway can be attractive. In the predominant models of expertise in policy, no one feels responsible for the practical consequences of a public policy decision.

5 Discussion

Compared to the predominant technocratic and decisionist models, the PEM promises to more successfully avoid policy-prescription in value-laden policy analyses carried out by researchers. This is mainly achieved through (1) the presentation of policy alternatives based on opposing political standpoints and policy narratives, and (2) transparency of disputed assumptions. The scientific explorations of specific policy pathways can be a valuable input for the public discourse and provide highly policy-relevant information on policy objectives, means and their consequences. Negotiating a consensus or acting as a broker of policy options to achieve a compromise within a scientific assessment process should not be the task of researchers in assessments, but of policymakers only (see also Sluijs et al., 2010). Moreover, the serious engagement of researchers with stakeholders and the public could significantly improve the quality of assessment outreach and public discourses. The pragmatist methodology could also promote more reliable and scientifically sound expertise, since researchers are free to acknowledge the limitations and value-ladenness of their knowledge production.

Superficially, the PEM claims may seem to be widely shared, thus combining the strengths of the prevalent approaches: (1) evaluating even policy objectives in scientific assessments and analyzing their costs and benefits (technocratic model); (2) avoiding policy-prescription (decisionist model); (3) and including stakeholders (pragmatic model). This implies that at least some PEM elements seem robust and are not confined to the proponents of pragmatist philosophy. The major difference from most existing approaches—including the concept of regulatory impact assessment in the tradition of cost-benefit analysis (see Kirkpatrick and Parker, 2007, for an introduction and evaluation)—is the systematic idea of a feedback loop between the objectives and means, which has far-reaching implications for any science-policy model and practice (exceptions include, for instance, Lasswell, 1951; Habermas, 1971; Dunn, 2012; Douglas, 2009; and Robert and Zeckhauser, 2011, who at least mention this interdependency). The PEM goes beyond making (partly well known) value conflicts transparent, as suggested by Robert and Zeckhauser (2011) with their useful taxonomy of disagreements. Though transparency is indeed necessary, it is not sufficient for assessments, nor does it make research value-neutral. Instead, the exploration of the full range of practical means-consequences promises to address value-laden policy issues in a more constructive and scientific manner. Among the reasons why many large-scale assessments do not explore policy alternatives thoroughly (Hulme, 2009; Siebenhüner, 2003; Pielke, 2007), let alone a broad range of practical means-consequences, seems to be a misguided conception of values. Either they are regarded as subjective and irrational and to be avoided whenever possible, or researchers, to some extent depending on their discipline, have very strong opinions about them and regard them as fixed criteria, i.e., as ends in themselves (Dewey, 1986, p. 169). Certain conceptions of utility or costs and a single discount rate in economic analyses of environmental policy pathways could fall into the latter category. With Dewey, the PEM offers a methodology that allows for a constructive discussion and learning process about values and objectives, which may change or be completed when the means-consequences are thoroughly explored in an assessment.

Though the PEM only provides a general framework for environmental assessment making, it can make a significant difference in terms of the specific practices of assessments, including the objectives and methods for policy analyses in assessments and the type of key messages. The PEM is already being tested in practice, and further testing will be required to evaluate its practical consequences. As a prominent example, the PEM already guides the IPCC WG III to some extent (Edenhofer, 2012). For instance, in a Special Report (IPCC, 2011, p. 59, Fig. TS.2.9), the IPCC provided an overview of alternative and highly disputed narratives regarding future bioenergy use and explored some of the practical consequences of each pathway. Moreover, instead of recommending a specific climate mitigation goal or avoiding these disputed political issues, the recent IPCC WG III report (AR5) explored the implications of alternative ambition levels for climate mitigation, adopting a multi-metric perspective (Edenhofer and Seyboth, 2013). Sophisticated multi-scenario analyses were conducted for this purpose that explore the implications of alternative policies, timings, delays and metrics, as well as technological and other assumptions for climate policy in general and specific sectors. Examples include the LIMITs model comparison project (http://www.feem-project.net/limits/) and the AMPERE project (http://ampere-project.eu). Some of the potential co-benefits of ambitious climate policy (see West et al., 2013) that had been neglected in previous assessments were analyzed in more detail by the IPCC AR5; they can potentially make ambitious climate policy more attractive for different interest groups. This type of finding helps to better understand the political solution space. IPCC WG III AR5 furthermore included a chapter on ethical issues to make this crucial dimension of the climate policy debate more transparent and explicit. The treatment and transparency of uncertainties have also been improved (Mastrandrea et al., 2011), and the IPCC WG III conducted a multi-stakeholder meeting in Washington D.C. in August, 2012 (see http://www.ipcc-wg3.de/meetings).

However, many gaps in knowledge still have to be filled by future IPCC assessments if they are to be guided by the PEM. For instance, the policy pathways to be explored by the IPCC should be more directly linked to the existing, disputed policy narratives and more general value beliefs. Future IPCC WG III assessments could explore more systematically how the world would look in the event of a 1.5°C, 2°C or 3.5°C global temperature rise. Researchers cannot settle the issue of disputed mitigation goals, as this is not a technical or "scientific" question, but is rather, a highly political question. By exploring the practical consequences of each goal, they can however contribute a great deal to this debate.

This, however, would inter alia require more literature on ex-post analyses of climate policies. The various practical consequences of policy instruments that are already implemented are poorly understood, also because there are complex interdependencies between governance levels. Moreover, to achieve a more comprehensive understanding of the pros and cons of certain policy options, research on the socio-economic impacts of climate change, adaptation measures and the socio-economic and technological aspects of climate policies must be combined. This would require merging the current WG III with WG II of the IPCC. A picture as complete as possible of the climate political solution space must be achieved, in order to reveal differential impacts and mitigation costs in the event of various climate scenarios. Furthermore, to explore the political leeway, it may also be useful to explore extreme scenarios, including worst-case scenarios, due to the ambiguity that often makes probability-density functions impossible (Kunreuther et al., 2013). The following figure summarizes some of the PEM-guided thoughts on possible key dimensions of future IPCC assessments:

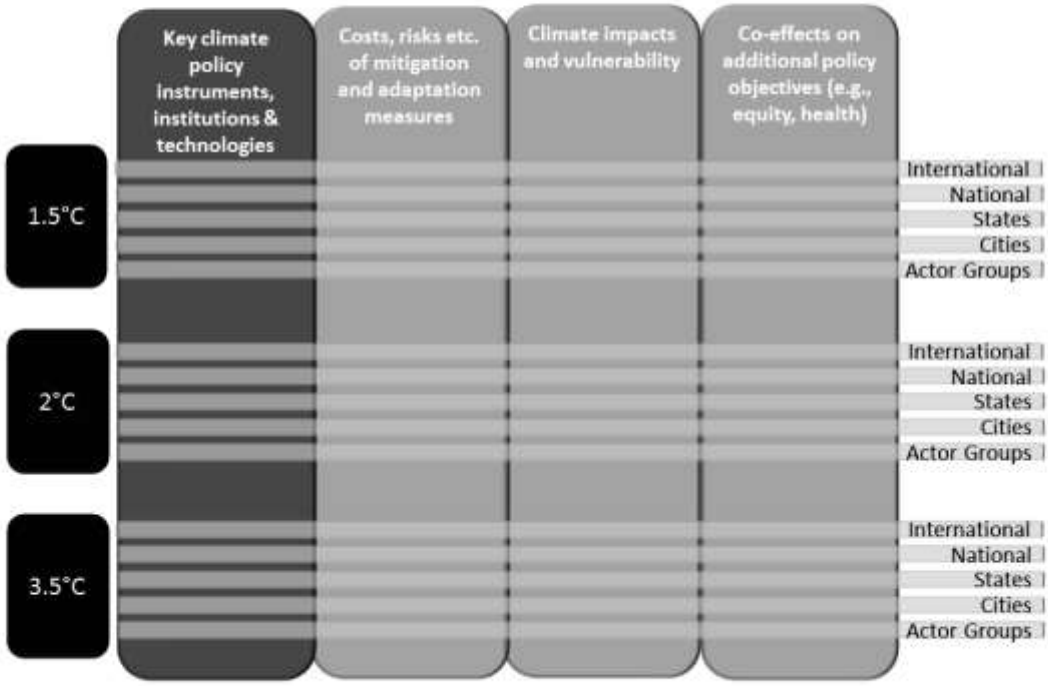

Fig. 6 Simplified overview of assessment dimensions regarding climate policy pathways. Given the major climate policy objectives of mitigation, adaptation and economic development, future IPCC assessments could perhaps explore the differential costs, risks, climate impacts as well as co-effects related to additional policy objectives in the event of a 1.5°C, 2°C or 3.5°C global temperature rise, for instance

The PEM-guided cartography of the political solution space is clearly an immense and time-consuming effort. Pre-studies and "pre-assessments" are required to provide the knowledge needed to fill at least some of the fields about means-consequences in Fig. 6. It is hardly surprising that not all researchers want to engage in such a laborious, interdisciplinary PEM-mapping exercise of highly uncertain means-consequences. Rather, research is often method-driven instead of problem-driven and organized around scientific "tribes," in contrast to the often highly interdisciplinary nature of large-scale environmental assessments. Incentives like academic credits are required to make the cartography exercise and the production of pre-assessments more attractive for academics. Moreover, an effective research organization is required to ensure the provision of policy-relevant research to help fill the gaps in Fig. 6. For example, assessment bodies may play a key role as coordinators, without telling the scientific community what to do.

Other reservations about PEM-style assessments can be due to the observations (1) that some policymakers and researchers might have very clear opinions about the "right" policy option, which they do not want challenged during a PEM assessment (Sarewitz, 2004) and (2) many governments presumably do not want their policies to be critically evaluated by assessment bodies (Siebenhüner, 2003). The reason why we regard such arduous assessments as nonetheless worthwhile is our assumption that policymakers and the public are not yet well informed about the specific options and practical consequences of environmental policy, and at least some researchers and stakeholders are willing to learn in this regard. Moreover, without such large-scale assessments and their consistent metrics and definitions, the alternative proposals for policy pathways in different studies cannot be compared adequately.

6 Conclusion

This article developed the PEM as a model for solution-oriented, large-scale environmental assessments. The basic principles underlying the PEM, such as the exploration of alternative pathways, including their practical consequences based on the interdependency of objectives and means, may also be interesting for other formats of scientific expertise in policy, to some extent.

According to the PEM, researchers, along with stakeholders, act as the “cartographers” of different, viable policy pathways by acting as the “mapmakers” of the political solution space. They provide a guidebook with alternative options for policymakers (i.e., the “navigators”) and the public. Such maps cannot replace travelling (i.e., decision-making), nor can they resolve all environmental policy conflicts, yet they can provide an important orientation in otherwise uncharted territory.

The PEM provides a framework for the application of the valuable plurality of research methods and approaches. Mapping possible future means-consequences implies innovatively exploring terra incognita, as the original strength of researchers. Detecting non-trivial practical consequences of very different kinds and in quantitative and qualitative terms requires a broad range of methods, including, for example, econometrics, sociology and political sciences, and even going beyond standard methods, metrics and approaches in a creative and highly interdisciplinary manner. Already rough estimates and mere plausible assumptions can sometimes help to understand policy pathways better—as we can learn from Africa’s cartography (Krugman, 1995, pp. 1f)—though many gaps in knowledge and uncertainty will still block our view into the future. Sometimes, researchers can also substantially contribute to the environmental policy debate by creatively developing new ideas for scenarios and specific policy options (or detours). Even new policy narratives may stem from scientific discourses (Hulme, 2009).

Mapping policy pathways in assessments is an iterative exercise that frequently requires adjustment if new forks in the road, alternative destinations, pitfalls and uncharted territories turn up. Due to the high uncertainties, long-term issues, such as global environmental change, require trial-and-error policy-making. Assessments can strongly support this through ex-post policy analyses providing information about their consequences to decision makers. In the light of these consequences, objectives might be revised and means can be adjusted. Mistakes in policy-making can occur, and from them, society as a whole can learn for the future.

The cartography of policy alternatives and their consequences possibly allows for the identification of potential overlaps and trade-offs between different, disputed policy narratives at the level of specific courses of action in a given context, even if more fundamental value conflicts remain unresolved. A trade-off is a special type of side effect, and an overlap denotes a special type of synergy. There is an overlap (respectively, trade-off) between two objectives if one cannot be pursued without simultaneously having a strong positive (respectively, negative) effect on the other, perhaps because the same means are involved. The identification of such an overlap and possibly a clarification of the real trade-offs, could help to overcome the environmental political stalemate. Juxtaposing general, vague policy narratives and values with the diverse practical consequences of specific policy options could contribute, at least on a long-term basis, to the resolution of social, ideological value conflicts and the often-deadlocked political debates. However, in many cases, conflicts and disagreements over policy options remain. The cartography of policy pathways helps to clarify what the controversies and trade-offs are really about in more specific terms, and to allow for a more direct and constructive discussion. This may also reveal the mere strategic rhetoric of some policymakers. Environmental assessments should, therefore, increasingly analyze issues of political economy and conflicting interests in a differentiated manner, as well as identify the winners and losers of policy options (see also IISD, 2013); this seems to be a crucial matter of policy-relevance.

PEM-guided assessments envisage learning processes and a reflective equilibrium for alternative policy options and may, in that sense, contribute to the development of a deliberative democracy and to the re-establishment of trust in scientific assessments. However, this presupposes a new culture in academia that provides the kind of studies needed for this cartography exercise, and that accepts the arduous cartography of the political solution space as a fully respectable and serious scientific task on its own.

Acknowledgements: The authors are grateful to Christian Flachsland, Michael Pahle, Eva Schmid, Jan Minx, Marcel Dorsch, Pauline Riousset and Jennifer Garard for their helpful comments on earlier versions of this article, and Ashley Renders for editing.

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