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EVALUATING GLOBAL CLIMATE POLICY - TAKING STOCK AND CHARTING A NEW WAY FORWARD

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Abstract

The objective of this report is to derive evaluation criteria for global climate policy and to apply this analysis framework to a number of existing proposals for climate policy architectures relying on a global carbon market. In addition, the current policy landscape defined by the Kyoto Protocol and the Copenhagen negotiations will be evaluated to obtain a benchmark where global climate protection efforts currently stand with respect to a set of target criteria.

Based on the insights gained in the analysis of both theoretical frameworks and the current situation, in the last part of the paper I develop a proposal for a new way forward in international climate protection efforts. The cornerstones of the comprehensive architecture proposed are a modular, expandable carbon market whose integrity and time consistency is ensured by a World Climate Bank, to be created by participating countries. Based on regular and comprehensive auctions of emission allowances, the climate rent is shared among countries and distributed to citizens in a way that reflects common but differentiated responsibilities and respective capabilities in addressing climate change.

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Comparing and contrasting classification systems for climate policy

When thinking about global climate policy design, the number of choices and options available to designing a global architecture are staggering and the tradeoffs involved are numerous. In the following, a systematic evaluation system will be developed to classify different approaches for addressing the climate challenge on a global level. The objective is to reduce complexity by offering a set of evaluation criteria that make the pros and cons of various options explicit.

First, a selection of previous scientific proposals to establish classification systems will first be succinctly reviewed and discussed. Based on this analysis, a modified evaluation framework will be derived and discussed in detail.

Before launching into the analysis, it should be pointed out that the different evaluation systems cannot be discussed strictly in terms of normative principles that could help establish a ranking among the different proposals but rather by pointing to the differences in value judgments that underlie each analysis. It can therefore also not be expected that the proposed evaluation framework constitutes a definite answer as to which global climate policy focus is optimal in any case. Rather, it gives policymakers an orientation that also forces them to determine which criteria currently constitute major drivers in climate policy design and which potentially should be given more weight in the negotiation process going forward.

Previous evaluation proposals

The rising interest in climate policy development both on a national and international level has coincided with the formulation of various evaluation systems to assess and compare different policy options. Konidari and Mavrakis (2007) list 16 evaluation systems dating back to 1990. What all evaluation proposals presented have in common is an assessment of climate policy objectives, such as for example environmental aspects and economic criteria. In addition, 13 of the 16 proposals also look at the means of implementing climate policy, for example the role of institutions. However, only 4 proposals explicitly define political acceptability as a criterion for assessment.[1] Climate policy objectives therefore figure front and center in evaluation frameworks but not all proposals deal with the implementation challenges. For a framework to pass the test of reality, however, this component cannot be neglected and it will receive due consideration in this section.

In the following, as a subset of the various evaluation proposals found in the literature, four systems will be succinctly presented and assessed. They differ – at times markedly – in their focus and complexity and thereby allow discerning the main options – and underlying value judgments – associated with defining evaluation criteria. First, four dimensions of analysis suggested by Philibert and Pershing (2001) will be assessed, then an evaluation framework by ECOFYS (2003), followed by an expanded system proposed by Wicke (2005). Finally, main dimensions of analysis as suggested by Stavins (2004) will be discussed.

[1] The evaluation systems targeting all three aspects are from IPCC (2001), Sorrell (2001), Johannsen (2002), and Aldy et al. (2003). The three frameworks only focusing on primary climate policy objectives come from the Governmental departments of the Netherlands (1990), Philibert and Pershing (2001), and Ericsson (2006).

Evaluation criteria as suggested by Philibert and Pershing (2001)

In assessing global architectures for emissions mitigation, Philibert and Pershing (2001) suggest a framework consisting of four criteria with linkages among each other. The factors are:

1. Environmental effectiveness
2. Cost effectiveness
3. Contribution to economic growth and sustainable development
4. Equity

No weighting is given to the factors but all are considered important in the design of a global framework. This is especially true for the criteria three and four that are specifically focused on the burden-sharing dimension of a multilateral and potentially global agreement. In fact, these dimensions take up elements of the United Nations Framework Convention on Climate Change (UNFCCC) that was adopted in 1992 and that has so far been ratified by 194 countries, including for example all EU member states as well as the United States.

With respect to sustainable development, the Convention states that the Parties "should cooperate to promote a supportive and open international economic system that would lead to sustainable economic growth and development in all Parties, particularly developing country Parties, thus enabling them better to address the problems of climate change" (Article 3.5 UNFCCC). A climate policy that responds to these principles would therefore need to take different levels of development into account and contain elements that support structural change toward a sustainable economic system.

The call for an equitable approach is another fundamental component of the UNFCCC – yet it is also one that arguably carries the most potential for conflict since it touches the distribution of costs and benefits of a climate policy head on. The wording in the Convention has been cited numerous times in proposals for global climate architectures but it leaves room for interpretation when it comes to specific instrument design. The Convention states that "The Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities" (Article 3.1 UNFCCC).

Even though not directly stated by Philibert and Pershing (2001), the dimensions of sustainable development and equity define not least the political acceptability of a climate architecture in the developing world. I will come back to this criterion in more detail. Ensuring wide political acceptability has implications on the possible environmental effectiveness of a system. In addition, broader geographic reach can also be linked to improved cost effectiveness. These two examples show that the assessment criteria proposed are indeed interlinked and need to be analyzed in conjunction.

Evaluation criteria as suggested by ECOFYS (2003)

In 2003, ECOFYS put forward an evaluation system equally based on four criteria but with weights assigned to each category. The weights are indicative and the authors state that they may be modified to reflect different priorities. This numerical weighting allows differentiating proposals depending on how they score in each of the categories. In particular, the different evaluation criteria along with their relative importance in the overall ranking (in percent) are:

1. Environmental criteria – 33 percent weight
    a. Environmental effectiveness
    b. Encouragement of early action

2. Political criteria – 33 percent weight
    a. Equity principles
    b. Agreement with fundamental principles of all major constituencies

3. Economic criteria – 22 percent weight
    a. Accounting for structural differences between countries
    b. Minimizing adverse economic effects

4. Technical criteria – 11 percent weight
    a. Compatibility with the structure of the UNFCCC and the Kyoto Protocol
    b. Moderate political and technical requirements of the negotiation process

As has been stated in the introduction to this chapter, analyzing the weighting of categories helps clarify the value judgments underlying the classification system. Here, ECOFYS (2003) assigns environmental and political criteria the highest weight and both together account for 2/3 of the overall score. In fact, political dimensions are further taken into account with respect to the fourth point concerning technical criteria and the compatibility with the current negotiation process. This could be seen as an indicator that the framework considers a realist approach to policymaking, in which the self-interest of states and the distribution of power determine a negotiation outcome. Then, political acceptability by powerful players would need to be an important criterion as without it there would be no agreement, no matter how well a system scored in other areas. In contrast, an idealist perspective would focus more on equity criteria and investigate the question what outcome would be considered just when a number of moral principles would be taken into account. The dichotomy between realist and idealist perspectives will resurface in the discussion of other evaluation systems.

Here, even though the large weight of political criteria may point to a more realist view in terms of which system design should be preferred, the sub-categories indicate that ECOFYS adopts elements from both realist and idealist perspectives: while the technical criteria may be grounded in the current negotiation dynamics, the inclusion of equity principles within political criteria indicates that the analysis goes beyond power dynamics in international relations by also focusing on normative elements. The rather high ranking of environmental criteria also seems to point in this direction.

Interestingly, with 22 percent in the overall evaluation, economic criteria are granted somewhat lower weight. In addition, the sub-categories related to structural differences and minimization of adverse economic effects are rather general. Contrary to several other proposals, cost effectiveness is not mentioned as an evaluation criterion per se, even though global mitigation costs under various climate policy architectures can vary substantially. This point exemplarily highlights the tension between defining criteria that are broad versus a more comprehensive catalogue of sub-categories. In the quest for a more detailed and comprehensive evaluation system, Wicke (2005) proposed a framework along 4 main dimensions with 19 sub-criteria that will be discussed next.

Evaluation criteria as suggested by Wicke (2005)

The evaluation system proposed by Wicke (2005) is inspired by both approaches discussed previously. In addition, it integrates categories proposed by the International Energy Agency and the OECD (2002) as well as additional evaluation metrics. The system also puts forward a weighting (in percent) not only for main categories but also for every sub-category. The dimensions of analysis are:

1. Climate sustainability – 50 percent overall weight
    a. General incentive to reduce the increase in CO_2 in developing countries – 4%
    b. Incentive for fast, substantial reductions in industrialized nations – 10%
    c. Fastest possible involvement of developing countries – 4%
    d. Financing emission reductions in developing countries – 4%
    e. Favoring “early actions” world-wide – 4%
    f. Avoidance of emissions shifting (leakage) effects – 4%
    g. Permanent interest in climate-friendly behavior world-wide – 10%
    h. Quantified climate protection aim of the climate system – 6%
    i. Avoidance of “hot air” world-wide – 4%

2. Economic efficiency – 18 percent overall weight
    a. Cost-effectiveness: minimizing global costs – 6%
    b. Flexibility during national implementation (minimizing national costs) and financial assistance for developing countries – 5%
    c. Considering structural differences in climate-related requirements – 4%
    d. Positive economic (growth) impetus – 3%

3. Technical applicability – 8 percent overall weight
    a. Ability to fit into the international climate protection system and the negotiation process – 4%
    b. Easy applicability and control capability in order to ensure practical functioning – 4%

4. Political acceptance – 24 percent overall weight
    a. Fulfillment of the fairness principles
        i. Promotion/non-prevention if sustainable development – 5%
        ii. Stronger burden on industrialized nations bearing main responsibility and capable of bearing more burdens – 5%
    b. Political acceptability
        i. Acceptance by all key players (groups of players) – 5%
        ii. Acceptance by the largest possible percentage of all contracting states – 9%

Going beyond ECOFYS (2003), environmental criteria, termed in this case climate sustainability, take an even more prominent weight. This indicates that the evaluation system places a particular emphasis on the basic guiding principle of the UNFCCC for climate policy: "The ultimate objective if this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve (…) stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." (Article 2 UNFCCC). As a result, global climate architectures that require participation of a maximum number of countries along with ambitious quantified global emissions targets will be privileged in the evaluation over more incremental schemes, such as the Kyoto Protocol.

While environmental criteria account for the lion's share in the weighting system, elements of economic efficiency along with political acceptability are also considered. The latter appears indeed not only in the fourth category but also under technical applicability, as the criterion of compatibility with the current negotiation process and the climate regime in place is related to the political acceptability of a new framework. Even so, in addition to its environmental focus, the framework by Wicke (2005) is clearly inspired by further principles laid down in the UNFCCC, such as the objective of sustainable development and a call for an equitable distribution of burdens in accordance with common but differentiated responsibilities and respective capabilities. As such, it takes a stance that is grounded more in an idealist perspective of international relations, where normative elements have a much larger weight.

From yet another perspective, however, it can be argued that an evaluation scheme that puts the environmental objective first along with criteria of global equity and responsibility would be advantageous to rich nations even in a purely self-interested, and thus a realist perspective. It can indeed be assumed that a global agreement that effectively prevents the worst consequences of global climate change with benefits for all countries will only be agreed if principles of fairness are duly considered and if developing countries participate (see for example Wicke, 2005 and Klingenfeld, 2006). Of course, the different timing of costs and benefits from climate protection remains a major challenge for any architecture, which has implications for political acceptability.

Evaluation criteria as suggested by Stavins (2004)

In contrast to the detailed quantified framework proposed by Wicke (2005), Stavins (2004) reduces the assessment criteria to three broad dimensions. No weights are assigned. He suggests that an agreement should be:

1. Scientifically sound,
2. Economically rational,
3. Politically pragmatic.

In their brevity, the three categories are appealing but also offer ample room for interpretation. Without further sub-categories providing a more concrete yardstick, an objective evaluation of different proposals appears difficult. For example, exactly what can be considered economically rational is certainly up for debate: a climate policy imposing costs in the immediate future may be considered economically irrational by some since it slows growth in the near term. In contrast, taking long-term climate damages into account, as has been done for example in the Stern Review (2006), points to the rationality of incurring costs now in order to avoid much greater costs in the future. Therefore, climate proposals could be ranked markedly different in Stavins' framework, depending on the frames of reference used in the evaluation.

A similar argument could be made for the other two criteria, in particular for political pragmatism. A policy that focuses on the smallest common denominator in national and international negotiations may well be considered politically pragmatic, as an agreement could be reached while the negotiation process around the difficult questions would be further perpetuated into the future. The structure of the political system with election cycles operating over relatively short periods would also offer an argument pointing in this direction. Burdens in the near term would probably be relatively small in exchange for an equally small climate benefit. What could also be termed pragmatic, however, could be seizing the opportunity of the financial crisis and directing substantial funds necessary for economic stabilization and growth towards a "Green New Deal" (Edenhofer and Stern, 2009). The financing provided could lay the foundations for a deeper transformation of the economic system within an ambitious climate framework. Indeed, what really constitutes political pragmatism is in the eye of the beholder.

Finally, Stavins' (2004) framework avoids putting forward equity criteria along the lines of common but differentiated responsibilities. Given that the discussion about a global approach very much centers around this question, the proposed framework may be more applicable if a national system is considered, such as the proposed economy-wide cap-and-trade scheme for the United States (Stavins, 2008). The truly difficult questions of international burden-sharing and financial transfers are indeed left uncommented.

The presentation of four different evaluation systems for climate architectures has highlighted several tradeoffs. First, establishing weighting factors makes the value judgment on the relative importance of different criteria explicit but may be subject to criticism on what basis the weightings are determined and justified. Second, a tension exists between having many (sub-)criteria versus offering fewer overarching metrics. Ideally, criteria need to be sufficiently well-defined without being artificially detailed in subcategories so as to favor at the outset a specific architecture to be evaluated. Third, all evaluation frameworks need to tread the line between an idealist perspective focusing on normative principles and a realist view that considers the (apparent) limits of political feasibility. Taken all this into account, I will develop in the following an evaluation system that draws on elements of the frameworks presented above and, it is hoped, brings together their respective strengths.

Proposed evaluation metrics for climate policy

The proposed evaluation system is comprised of six basic dimensions of analysis that will be detailed in the following. The categories are:

1. Environmental effectiveness
2. Cost effectiveness and investment implications
3. Equity
4. Institutional complexity and transaction costs
5. Enforcement of compliance
6. Political acceptability

The evaluation criteria follow a systematic order: criteria one, two and three can be classified as broad-based objectives of climate policy architectures. Criteria four and five relate to the means of implementing the frameworks in practice. Here, the role of institutions is of particular importance. Lastly, political acceptability is a critical yardstick for climate protection policy. This criterion relates back to the five preceding categories and considers the possibility for international cooperation along with the consequences for national implementation.

No numerical weights are assigned to the categories. At the same time, this does not imply that all categories are necessarily of equal importance. Since weightings relate to value judgments, policymakers need to be explicit about the relative importance they assign to each category when they decide on a preferred climate framework to be pursued in future negotiations. The following discussion of each factor highlights the tradeoffs involved among the categories as it is not possible to maximize all of them simultaneously – choices will have to be made. After detailing every single factor, an evaluation matrix will be developed in which various proposals can be compared against each other. The classification scale for each factor is in five steps from very positive ("++"), over positive ("+"), neutral ("0"), negative ("-"), to very negative ("--"). Intermediate weightings, for example neutral to positive ("0/+"), are equally possible.

Environmental effectiveness

Strictly speaking, the environmental effectiveness of a climate architecture can be defined as the degree to which a specific emissions target, defined ex ante, will be achieved. However, this narrow definition needs to be broadened. In the case of a cap-and-trade scheme, environmental effectiveness can be analyzed with respect to capped and uncapped emissions: in the first case, the question is asked how binding the cap is for covered entities. Here, the role of certain flexibility mechanisms, such as for example a safety valve, can limit environmental effectiveness in exchange for other benefits. In the second case, environmental effectiveness is assessed in a broader sense beyond the jurisdiction of the cap-and-trade scheme. The question is asked to what degree *global* emissions are covered and how environmental effectiveness fares in a global perspective. This dimension is relevant because carbon dioxide (CO_2) is a global pollutant whose effects are independent of the location of emissions. Relevant criteria for determining environmental effectiveness with respect to uncapped emissions are therefore the geographic extension of the cap-and-trade scheme as well as its sectoral coverage. In addition, regional and global emissions leakage must be considered.

Environmental effectiveness is a critical yardstick in the evaluation framework. Even though no numerical weight will be assigned in the evaluation matrix, it should be recalled that the *only* reason for establishing a greenhouse gas control framework is to remedy a negative environmental externality with potentially devastating consequences for ecosystems and human societies around the globe. Averting this threat should be at the heart of any climate strategy and guide the actions of decision makers. This is not a value judgment but a rational consequence in response to the definition of the problem. If a low(er) priority were given to the environmental objective, then political actors should seriously reconsider the bases for their judgment and actions and be explicit what other aims are being pursued.

Underlying the last paragraph is the tension how stringent emissions goals should be against which environmental effectiveness can be measured. At the extreme, would a truly global cap-and-trade scheme with complete coverage but with a lax emissions cap be environmentally effective? The answer is arguably not. Therefore, the level of ambition of the climate policy does matter and needs to be seen in light of the scientific recommendations of the IPCC for global greenhouse gas stabilization pathways. This needs to be kept in mind when assessing the *potential* for environmental effectiveness of various design criteria and the *actual* environmental effectiveness of elaborate proposals, if implemented.

Cost effectiveness and investment implications

Cost effectiveness is a major criterion for analysis that places environmental objectives in an economic context. Cost effectiveness can be defined as achieving any emissions target at least cost. As straightforward as this definition appears, the long-term mitigation challenge requires differentiating between *static* and *dynamic* efficiency that make up the cost effectiveness criterion (see for example Sorrel and Sijm, 2003; Duval, 2008).

Static and dynamic efficiency in context

Static efficiency aims at lowering current marginal abatement cost for a given level of the cap. The focus is on the optimal use of a mix of existing technologies to achieve lowest-cost emissions abatement. However, only relying on the deployment of existing technologies for emissions abatement may not be the most cost-effective way in the long run. This is where dynamic cost effectiveness comes into play.

Dynamic efficiency is achieved if the costs of emissions mitigation *over time* are minimized for a given level of the cap. The focus here is on the development and deployment of new abatement technologies that ultimately have lower costs than what existing technologies could achieve in the future. Certainly, there are tradeoffs involved: incurring higher costs for research and development as well as for targeted diffusion policies in the present would lower static efficiency and raise abatement costs in the near-term. In the long run, however, increasing the portfolio of technologies available at lower cost could prove to be advantageous in a dynamic perspective. Such a strategy would also render the timing of abatement more flexible, since cheaper solutions could be used in the future at a larger scale.

The discussion of static and dynamic efficiency is linked to the question whether a first-best or a second-best world is used as a frame of reference. In a first-best world, static and dynamic efficiency need not be in conflict as economic actors anticipate ongoing and rising carbon constraints and therefore invest in research and development to achieve lowest abatement costs over time. In a second-best world, market imperfections, related to for example intellectual property rights as well as uncertainties about commitment and time inconsistency, lead to underinvestment in R&D of private firms in the near term.

For a given climate policy architecture, the key to achieving cost effectiveness in a broad sense comes down to three points that concern both static and dynamic elements:

- First, static efficiency is enhanced by instruments leading to equal marginal abatement costs across sectors, including targeted policies that address non-market barriers that impede realizing low-cost abatement options.
- Second, dynamic efficiency is fostered by a carbon market that provides a dependable and stable price signal and creates expectations for sustained emissions abatement, thus encouraging long-term investment projects as well as private R&D.
- Third, dynamic efficiency can further be enhanced by additional targeted policies that explicitly focus on driving down abatement costs

of new technologies, for example in the form of public R&D spending or demonstration and early deployment programs.

Investment implications

Since investment decisions require long-term planning horizons and expectations about future carbon prices, the stability of the carbon price signal and the average level of carbon prices over time matter. This is especially the case in a second-best world where actors do not have perfect information and foresight. This argument is closely related to the two last points of the previous paragraph.

In this context, choosing a quantity instrument makes the carbon price the dependent variable, which is subject to potentially large and sudden fluctuations. This volatility is not conducive to strategic planning decisions for long-lived capital assets that need to be depreciated over many years. In contrast, design elements that have a dampening effect on price volatility and that increase the predictability of the carbon price level over time reduce uncertainty. Such design features are assessed positively since they facilitate investment decisions in low-emissions technology.

The average level of the (expected) carbon price signal over time may be an even more important driver for technology investments, especially in a mid- to long-term perspective. Heres, two factors are of particular relevance, namely the stringency of the cap over time and the role of targeted policies in lowering allowance prices. These two dimensions relate to elements of both environmental and cost effectiveness but are considered here particularly with respect to their effects on broad-based investments in low-carbon technologies. In the evaluation, proposals for architectures with ambitious targets in-line with IPCC recommendations that also consider longer time spans are evaluated positively. In contrast, proposals with incomplete geographic coverage with at the same time generous offset provisions are ranked more negatively since the expected carbon price signal is likely to be small.

Likewise, it can be argued that architectures with very technology-specific provisions, e.g. explicit subsidies for near-term deployment, might depress carbon prices and have detrimental effects on investments in *other* technology options. Architectures that make such a crowding out likely, also with respect to longer-term R&D strategies, will be ranked less favorably as compared to more broad-based approaches.

Equity

Equity in a climate framework is the third element in the evaluation system. The equity dimension is a central component particularly for global proposals that need to take into account widely diverging interests and starting positions for climate policy across countries. Equity as a normative principle for an international climate regime was laid down in the United Nations Framework Convention on Climate Change (1992), with currently over 190 states as ratifying parties.

Possibly the most important dimension for analyzing equity (or the lack thereof) is the relationship between anthropogenic causes of climate change and the incidence of harm resulting from these acts. Given the long residence time of carbon dioxide and several other greenhouse gases in the atmosphere, emitting activities of the past have consequences for atmospheric GHG concentrations today while the impacts on the climate reach well into the future. Concurrently, the IPCC (2007) points out that the negative consequences from a destabilized climate system will be disproportionately felt in a number of developing countries. In fact, those who are the least responsible for anthropogenic climate change and who have benefited the least from higher welfare due to increased fossil energy use stand to suffer the most harm. A climate framework that passes the test of equity must therefore take into account the unequal incidence of damages together with the widely varying responsibility for causing anthropogenic climate change and offer design elements that remedy this situation.

Central to the concept of responsibility is the allocation of burdens and benefits resulting from carbon policies. In the case of a global cap-and-trade scheme, the initial allowance allocation is a very important determinant for international wealth transfers that could address this element of equity. There exists a considerable discussion about distributional principles in the scientific literature that draws on elements of moral philosophy. Despite being far from a unanimously shared view (see for example Posner and Sunstein, 2009), several authors argue that allocation principles based on equal-per-capita shares – often combined with further mechanisms to address historical responsibility – come close to fulfilling the equity principle (see for example WBGU (2009); Wicke (2005); a very comprehensive and insightful analysis of the moral questions underlying global climate policy can be found in Vanderheiden, 2008). Whereas such a distributional principle is not endorsed specifically in the evaluation as the best possible alternative, it certainly scores better on equity grounds compared to distributions that are closer to a grandfathering of emissions rights without provisions for substantial side-payments. A similarly positive assessment would also apply for other distributive principles grounded in equity considerations, such as Greenhouse Development Rights (Baer et al., 2008) and a proposal focusing on the highest per-capita emitters within each country (Chakravarty et al., 2009).

Concerning the effects of future emissions, another dimension of equity concerns the capacity for emissions mitigation and adaptation measures. Here again, due to differing capabilities and in accordance with principles laid down in the UNFCCC (1992), differences in the level of development of a country place greater burdens on some nations than on others. For poorer countries in particular, additional burdens through damages from climate change as well as costs to restructure their energy system pose the risk to stall or even reverse development efforts.

In light of these factors, equity in climate regimes cannot be ignored and should be assessed as an integral part of the evaluation system. Indeed, equity does not only have a place in idealist conceptions of climate architectures based on strongly normative principles that may conflict with realist interpretations of international power dynamics. Instead, given the growing political and economic weight of a number of major developing countries as well as the prospect of strong emissions growth outside OECD nations, cooperation across the traditional developing-developed country chasm is essential. Perceived equity of a framework by the largest number of players will be key to its adoption and implementation (see for example Klingenfeld, 2006). Therefore, the equity dimension also presents links to the political acceptability of climate policy that will be discussed as the sixth evaluation criterion.

For practical evaluation purposes, defining a common yardstick to compare different system architectures with respect to equity dimensions remains difficult. Here, the evaluation will be based on formulations adopted in the UNFCCC that call (i) for the protection of the climate system in accordance with the parties' common but differentiated responsibilities and respective capabilities as well as (ii) for a system that would lead to sustainable economic growth and development, particularly also in developing countries, to enable them to better address the problems of climate change.

Institutional complexity and transaction costs

The fourth dimension of analysis, institutional complexity and transaction costs, relates to the administrative feasibility of a climate framework along with its compatibility with the existing institutional landscape. This criterion is especially relevant for global approaches to emissions mitigation, since coordination requirements are greater compared to purely national systems. At the same time, the choice of specific design instruments can also make a big difference in terms of institutional complexity on a national level.

In evaluating various design options, two questions will be explored: first, the need for new institutions on a national and international level and, second, the national and international coordination requirements among institutions for setting up and running the system. Expressed differently, the question is how high the transaction costs are at different stages of policy implementation. The premise in assigning a ranking to different design options is the following: lower institutional complexity is ranked better and is privileged over proposals requiring new institutions or a high degree of coordination, both on a national and international level.

As to the question of new institutions specifically, the argument is made that evolutionary systems that make use of existing structures will be easier and less costly to implement and will very likely also be politically more palatable. They may therefore have higher chances of actually being adopted. The tradeoff that such structures may fare worse in other aspects will be made explicit in the comprehensive evaluation along all criteria.

In terms of coordination requirements, however, certain elements of the existing international framework are relatively complex, thus compensating some institutional advantages of “system incumbency”. As a result, in the evaluation, these different factors need to be weighed against each other to yield a composite score.

Lastly, transaction costs at the end of life of the system are also taken into account: whereas a Kyoto-type policy framework operates within commitment periods requiring recurring negotiations that are source of a high degree of uncertainty, other approaches for global frameworks extend over much longer time spans. While presenting high transaction costs for negotiating and setting up such a system at the outset, future transaction costs compared to the existing Kyoto Protocol approach could be much lower.

Enforcement of compliance

A system that ranks high in other evaluation criteria, such as for example environmental and cost effectiveness, but that lacks credible enforcement mechanisms presents serious drawbacks for practical application. Indeed, enforcement is a critical component to realize the theoretical potential of any climate framework in practice. In addition, enforcement of compliance confers the credibility that is necessary for the sustained operation of a system over several years to decades. In contrast, a lack of credibility would encourage growing defection and free riding on the efforts of others. Ultimately, the system risks collapse.

Evaluating the enforcement of compliance of any system architecture can only be done with respect to the *potential* for enforcement according to the design elements chosen. Whether provisions for enforcement are actually implemented in a consistent way remains speculative and cannot be part of an evaluation system of *proposed* climate architectures. Conversely, it would very well be an important component in evaluating the actual performance of systems in place, such as the Kyoto Protocol.

In the evaluation matrix, enforcement of compliance is ranked by considering two dimensions, namely requirements for measurement, reporting and verification (MRV) as well as the robustness of the cap.

Accurate measurement, reporting, and verification of actual emissions and corresponding emissions reductions are essential to ensuring the credibility of any climate policy. Beyond guaranteeing fairness and a level playing field for all affected parties, MRV has an important information function for the carbon market. For example, accurate emissions data is necessary for carbon pricing and for setting appropriate investment signals. In practice, a lack of reliable emissions data prior to the start of the trading scheme led to a substantial over-allocation of allowances in the first phase of the EU Emissions Trading Scheme (EU ETS) and resulted in a collapse of certificate prices once more accurate data became available (see for example Alberola et al., 2008).

Even with provisions for accurate MRV, enforcement of compliance also depends on the robustness of the cap. Here, the credibility and magnitude of sanctions in case of non-compliance need to be assessed. This question concerns economic actors covered by climate policy but also, and potentially more importantly, nation states committing to a long-term climate policy framework. Incentives and commitment devices that raise the chances for continued participation of countries in a global framework count positively when assessing the prospects for long-term compliance.

Political acceptability

Conceiving a climate framework with design elements that can be justified on scientific grounds is only part of what constitutes optimum system design. Ensuring political acceptability is the acid test for any proposal aimed at having a real-world impact. As Stavins (2008) put it with respect to U.S. climate policy efforts, a system needs to be optimal in Washington D.C., not just seen from the (theoretical) perspective of the academic community. Yet political expediency may well conflict with sound science and a tension exists between what would be scientifically desirable and what appears to be the (current) limits of the politically feasible.

In this sense, political acceptability is not an absolute but a relative concept that evolves over time as the importance of addressing climate change varies in the policy arena but also, and very importantly, in citizens' demands vis-à-vis their governments. Moreover, it appears that this is not a linear process in which climate change can be expected to receive an ever-increasing share of attention. Other political challenges, such as the recent financial crisis, focus the attention temporarily and may slow down policy development elsewhere.

The global dimension of climate change and the need for a global solution to adequately address the challenge add another layer of complexity to the assessment of political acceptability. Depending on the distribution of costs and benefits, a single proposal for a climate architecture may be highly politically acceptable for one group of countries and less so for another. However, if environmental effectiveness is to remain an important objective, then a solution that is acceptable to the largest emitters needs to be found. Yet this group of countries is composed of both developing and developed countries with in part substantial differences in emissions, especially on a per-capita basis.

If yearly emissions are considered on a per-capita basis, then broadly four groups of countries can be distinguished: (i) developed countries with high per-capita CO_2 emissions on the order of 20 tons per year (e.g., United States), (ii) developed countries with an intermediate level of emissions of around 8-10 tons per year (e.g., most EU countries), (iii) developing countries with global-average per-capita CO_2 emissions of around 5 tons (e.g., China), and (iv) developing countries with low per-capita emissions on the order of 1-2 tons (e.g., India). Political acceptability in all four cases needs to be ensured if the largest global emitters are to strike an agreement. This shows that the evaluation of political acceptability cannot be seen as an isolated dimension on a single-country basis. Therefore, the *potential for international cooperation* inherent in various proposals for global climate frameworks needs to be assessed with respect to the question how well diverging interests are considered and brought into balance.

In addition, *national implementation* is the other major evaluation yardstick necessary to come close to an objective assessment of the political acceptability of a climate framework. The ongoing discussion as to GHG regulation in the United States is exemplary as to the factors that are weighed against each other. Three dimensions can be discerned that relate to instrument design:

- First, the impact of climate policy on aggregate economic growth and employment in the near, medium, and long term;
- Second, international competitiveness, the impact on trade-vulnerable industries, and emissions leakage;
- Third, distributional effects, both national and international.

On the third criterion – distributional effects – climate policy-induced price impacts on specific sectors of the economy (e.g. power) can be a barrier to political acceptability. The challenge is compounded if regional differences in burden-sharing are large. Such differences could exist for example if the mix of energy sources in the power sector varied significantly across regions, resulting in uneven cost increases for consumers and industry, depending on their location. The nature of wealth transfers across income groups within a country also has an impact on the political process and the chances for acceptance of climate policy. In this context, system design determines whether GHG regulation will have progressive or rather regressive effects and which income group bears most of the burdens.

A distributional question of even higher controversy are international wealth transfers in accordance with the principles specified in the UNFCCC – chiefly among them equity and differentiated responsibility. Again, it should be pointed out that political acceptability is a dynamic concept that may make such a debate easier if the truly global nature of the problem and the need for broad participation in a framework is fully recognized by a larger number of policymakers. To date, the political reality seems to indicate that larger wealth transfers from developed to developing countries remain a very contentious issue. National participation in a global framework cannot be coerced and the assessment of political acceptability must consider a positivistic view that not only looks at what would be desirable but rather what would be realistic.

Finally, political acceptability is often subject to the relative lobbying power of interest groups. Rarely policy processes seem to be driven by a concern for the welfare of the population as a whole along with due consideration for the welfare of others in the global community. Oftentimes, focused interests appear to capture policy processes and to influence the outcome in their favor at the expense of other less vocal and often dispersed interests. For example, the initial design of the EU ETS has not escaped such a fate (see Markussen and Svendsen, 2005). The following evaluation of various proposals will attempt to consider this aspect in a realist perspective. However, it will also take normative principles into account that may become more politically acceptable over time as the tradeoffs of fragmented global efforts and participation with its consequences on the climate system become more apparent.

The discussion of political acceptability concludes the presentation of the evaluation scheme. In the following, it will be put to the test by evaluating comprehensive climate architectures. Here, the Kyoto Protocol will be of particular interest as it constitutes the existing global climate framework and a benchmark for future policy. Building on this assessment, proposals for global architectures for the time when the current framework expires will be evaluated.

Evaluation of global frameworks

Across the different frameworks to be evaluated, the six dimensions of analysis detailed in the previous section will be applied. A summary ranking (ranging from "--" to "++") for each dimension allows comparing all systems in a synthesis format.

The Kyoto Protocol and the current international climate architecture

Environmental effectiveness

The first commitment period of the Kyoto Protocol runs from 2008-2012 but already at this point conclusions as to the environmental effectiveness of the framework can be drawn. On a global scale, the environmental performance of the treaty appears to be poor: global carbon dioxide emissions from fossil fuels in 2008 were 40 percent higher than in 1990 (The Copenhagen Diagnosis, 2009). The global financial crisis that materialized in 2008 and the following recession have temporarily stopped the trend of global emissions growth. However, structurally the Kyoto Protocol is imperfectly designed to manage global emissions increases once economic activity picks up again.

Of course, looking at the global picture may not do full justice to the protocol that relies on an architecture with incomplete emissions coverage. The tension of evaluating environmental effectiveness with respect to capped and uncapped emissions has already been pointed out in the discussion of this evaluation criterion. In the case of the Kyoto Protocol, one reason for the strong increase in global emissions is the categorical distinction between industrialized (Annex I) countries and developing (non-Annex I) countries, as defined in the UNFCCC (1992). Based on this categorization, the Kyoto Protocol established binding emissions targets only for Annex B countries, which are with few exceptions synonymous to the Annex I list defined in 1992. The distinction is grounded in the principle of common but differentiated responsibilities – in this case with an emphasis on *differentiation* through the exemption of developing countries from binding commitments over the time horizon of the first commitment period.

For the group of Annex B countries, the average negotiated emissions reduction was set at 5.2 percent below 1990 levels, which was defined as the base year for most countries. The reduction targets set largely resulted from a political negotiation process without systematic scientific criteria as to overall environmental goals and requirements. In addition, as will be explained in detail in the section on enforcement of compliance, the Kyoto Protocol does not incorporate a credible mechanism that would ensure meeting even the relatively modest environmental goals set. Another point as fundamental as the flaws of the target setting process, the actual implementation of the protocol was hampered by incomplete ratification, most notably by the United States, which had been the largest emitter of greenhouse gases before being overtaken by China in 2007.

As a result of these deficiencies, it is not surprising that the effect of the Kyoto Protocol on global greenhouse gas emissions has not been decisive. This is all the more true given the aforementioned absence of emissions constraints for fast-growing developing countries: in fact, whereas in 1990 developed countries had a share of global emissions of 56 percent, this ratio dropped to 45 percent in 2005 and is set to decline further (IEA, 2009). As a consequence, the integration of developing countries in a global framework is absolutely vital for the achievement of global greenhouse gas emissions targets.

Based on the preceding analysis, the near-term environmental effectiveness of the Kyoto Protocol on a global scale can be assessed negatively, marked by "-" in the evaluation framework. In a long-term perspective, it can even be argued that the environmental effectiveness of the protocol is virtually unnoticeable due to the stock pollutant characteristic of greenhouse gases. As the commitment period of the protocol only encompasses five years with subsequent targets to be negotiated independently and at a later stage, the difference in outcome for the global climate over long timeframes is almost nil. Hence the evaluation "very negative" ("--") could be used if a longer time span is considered.

Cost effectiveness and investment implications

The assessment of cost effectiveness of the Kyoto Protocol presents analogies to the discussion about environmental effectiveness: the structural setup of the protocol with its categorical division of Annex B and non-Annex B countries and a fragmented approach to emissions mitigation is not conducive to a cost-effective attainment of the environmental objective.

Incomplete global emissions coverage prevents realizing all lowest-cost abatement options before more costly abatement is undertaken. The reason for this is that without broader coverage, there are no economic incentives for emissions abatement in large parts of the world – first and foremost the fast growing emerging economies that are not part of Annex B and thereby exempted from emissions reduction commitments. Abatement costs are therefore not equalized and the modest environmental benefit that Annex B countries can achieve by complying with the protocol stands against higher abatement costs than necessary from an economic standpoint. Nevertheless, with the Clean Development Mechanism (CDM), the Kyoto Protocol has a flexibility instrument aimed at overcoming the problem of incomplete coverage. The Clean Development Mechanism allows companies from Annex B countries to finance dedicated emissions reduction projects in non-Annex B countries and to receive corresponding emissions allowances to be used for compliance. In principle, the conditions stipulated for generating so-called Certified Emission Reductions (CER) from CDM projects enable tapping cost-effective mitigation potentials worldwide without compromising the environmental objectives of the protocol. The most important criterion in this context is the additionality of CDM projects that requires mitigation projects to clearly go beyond a business-as-usual development case. In theory, at least, project developers would have an incentive to realize all abatement potentials with lower mitigation costs compared to the market price for emissions allowances in Annex B countries. The price difference allows project developers to make a profit. In practice, however, the CDM has remained a small factor in overall abatement and only a minor fraction of low-cost abatement potentials have been used. The volume of CDM transactions in 2008 accounted for a relatively modest 6.5 billion US dollars, which corresponds to around 5 percent of the size of the global carbon market by value (World Bank, 2009). High transaction costs associated with originating projects and the related cumbersome registration and verification process are main obstacles to the wider use of the mechanism. As a consequence, the major disadvantage of incomplete emissions coverage in terms of cost-effectiveness remains.

Yet even within the group of Annex B countries, cost-effective emissions abatement for covered emissions is by no means a foregone conclusion. The Kyoto Protocol comprises two additional flexibility mechanisms for countries with mitigation commitments destined to increase cost-effectiveness: International Emissions Trading and Joint Implementation. International Emissions Trading as defined by Article 17 of the protocol creates the possibility for Annex B countries to trade part of their Assigned Amount Units (AAU), which correspond to their targeted allowable emissions. Yet since no liquid market for AAUs exists with allowance prices corresponding to marginal abatement costs under the overall cap, trades have been based on bilateral negotiated agreements that had a political rather than an economic basis for determining allowance prices. The problems of bilateral trades with respect to price discovery and cost-effectiveness in global climate architectures have been described by Flachsland et al. (2009), with implications going beyond the Kyoto Protocol.

Joint Implementation allows countries to cooperate on specific mitigation projects and to transfer allowances relative to the project results. Similar to International Emissions Trading, the focus on countries as actors and the lack of a discernable market casts doubt over the workability of the mechanism from an efficiency standpoint.

The previous assessments were primarily focused on the static efficiency of the Kyoto architecture. If dynamic efficiency is concerned, the evaluation of cost-effectiveness presents problems of at least the same magnitude. The protocol is organized along a 5-year commitment period running from 2008-2012. This structure requires a recurring negotiation process about future targets, national commitments, and participation. While such a structure could be justified in light of uncertainty so as to allow new scientific information to be embedded in future periods, it suffers a major drawback by lacking a long-term perspective for abatement. Dynamic inconsistency is a problem that arises if long-term credibility of emissions constraints is not ensured and if future reduction commitments are uncertain. The result is an underinvestment in abatement by companies in the near term for fear of having large sunk costs in the future if carbon policy turned out to be less ambitious. Clearly, the design parameters of the Kyoto Protocol are not conducive to an abatement outcome that is dynamically efficient.

Finally, the implementation of national emissions reduction commitments shows that the opportunity of achieving cost effectiveness at least within Annex B countries has not been seized. The European Union Emissions Trading Scheme (EU ETS) is arguably the broadest effort to equalize abatement costs and to incentivize cost-effective abatement. Yet even in this case, the incomplete coverage through a downstream system covering less than 50 percent of the EU's total carbon dioxide emissions has prevented setting equal abatement incentives across the economy. In addition, a host of targeted policies for specific technology investments within sectors covered by the EU ETS casts doubt as to whether these additional policies can all be justified on grounds of dynamic efficiency and the existence of non-market barriers.

Instead, the question looms large whether indeed other policy objectives are being pursued at the expense of cost-effective emissions abatement.

In conclusion, the Kyoto Protocol contains some elements designed to enhance its cost effectiveness but structural weaknesses render the result very incomplete. In the evaluation matrix, the corresponding overall score would be negative ("-"). A severe drawback of the protocol is the strong focus on national reduction commitments without an appropriate global (or at least Annex B-wide) implementation framework that would create the basis for cost effectiveness, at least in a more static perspective given the problematic limitation of the time horizon to 2012. Here, a broad-based carbon market covering all sectors and effectively allowing an equalization of marginal abatement costs would be essential. In addition, a better integration of countries without reduction commitments under the present scheme would as well be critical for enhanced cost effectiveness. In addition, embedding short-term targets in a pathway of credible long-term emissions reductions would be a precondition for enhancing dynamic efficiency of the policy architecture.

Equity

The discussion of evaluation criteria pointed to two dimensions adopted in the UNFCCC through which equity of climate policy architectures will be assessed: first, the degree to which protection of the climate system is achieved in accordance with the parties' common but differentiated responsibilities and respective capabilities as well as, second, whether a system would lead to sustainable economic growth and development, particularly also in developing countries, and enable them to better address the problems of climate change.

In the Kyoto Protocol, the differentiation between Annex B and non-Annex B countries is a translation of the principle of common but differentiated responsibilities. This structure is very similar to the Annex I/non-Annex I list as defined by the UNFCCC in 1992 that distinguishes between developed and developing countries. As pointed out initially in the discussion of environmental effectiveness, only Annex B countries have quantified emissions reduction commitments under the Kyoto Protocol, which can be justified on grounds of historical responsibility as well as ability to pay. At first glance, such a setup may seem appropriate to address some of the most important aspects of equity.

However, a closer look reveals that, first, the structure chosen incompletely addresses questions of fair burden sharing while, second, sustainable development aspects in the protocol are of very limited scope. The first argument relates to the very modest reduction commitments of on average 5.2 percent below 1990 levels. It has already been stated that this level of emissions reductions was the outcome of a political process without direct links to reaching a specific environmental objective. In view of IPCC (2007) recommendations and with respect to a time horizon to 2020, industrialized countries would need to reduce their emissions in between 25-40 percent below 1990 levels to remain compatible with a global emissions path that avoids the most severe consequences of climate change. A reduction of on average only five percent by 2012 makes it all the more challenging to ramp up abatement over the remaining eight years in order to stay within the target corridor. The insufficient enforcement mechanisms of the Kyoto Protocol (to be detailed later in the evaluation) along with incomplete participation, first and foremost by the United States, make a case where affluent countries do not live up to their responsibilities and respective capabilities in addressing emissions abatement.

When it comes to sustainable development, the Clean Development Mechanism described in the previous section constitutes the main vehicle for economic assistance and financial transfers created by the protocol. Nevertheless, it can be argued that its primary purpose does not lie in fostering sustainable development in a broader sense but to allow tapping low-cost abatement potentials while lowering mitigation costs for countries with reduction commitments. This is laudable from an economic perspective but a look at project types and recipient countries indicates that the mechanism has led to funding primarily for industrial projects, such as highly profitable N_2O reductions, that were concentrated in relatively few countries, most notably China. Due to its design, the CDM follows a logic of economic optimization that would deserve the more fitting name of "global carbon offsets scheme".

Even if some of the CDM projects have benefited development by improving the conditions for local populations, the scope of the mechanism remains far too small in relation to the increasing costs borne by poorer countries for adapting to the effects of climate change, let alone for supporting a larger-scale transition toward a cleaner energy system. Developed countries bear a historical responsibility for the majority of past anthropogenic carbon dioxide emissions and emissions of other greenhouse gases. Concerning carbon dioxide emissions from fossil fuel burning and industrial processes specifically, the developed country share over the timeframe 1751-2004 stands at an estimated 77 percent (Raupach et al., 2007). Even though it may not be practical to establish responsibility for all actions in the past due to incomplete knowledge about the consequences for climate change, the release of the first assessment report of the IPCC in 1990 established a common scientific basis for viewing greenhouse gas emissions as harmful. In the Kyoto Protocol, this concept of responsibility coupled with adequate and concrete mechanisms to assist those countries most vulnerable to and least responsible for climate change is practically not developed. The equity principles laid down in general terms in Article 2 of the UNFCCC have thus not been translated into the framework – a fact that makes the protocol an inadequate blueprint for a truly global solution to climate change that also integrates large emitters from developing countries by addressing burden sharing in an equitable way.

In summary, despite some tentative elements for financial transfers in a development perspective, the Kyoto Protocol lacks an appropriate operationalization of equity principles. The protocol gives no guidance as to how and on which basis the burdens of mitigation and adaptation can be shared on a (more) global scale. The overall evaluation of this criterion therefore closes with the score "negative" ("-").

Institutional complexity and transaction costs

Evaluating the existing structure of an international climate framework presents the risk of assessing the institutional complexity in an overly negative way as compared to design proposals made in the academic literature. A negotiated agreement is the outcome of a complex *political* process in which science is an important input but not the only determinant. In the case of climate change, the result is very likely to deviate from textbook solutions to environmental problems – as is the case for the Kyoto Protocol. This is also due to the complexity of the climate change issue and the multifaceted implications for different regions and sectors in addressing the problem.

Nevertheless, the compromises made in the context of what is termed by some "political reality" should not deter from a scientific appraisal of strengths and weaknesses and of what could be improved to lower institutional complexity and transaction costs in light of the other targets defined.

The Kyoto Protocol creates a complex framework in which nation states pledge to achieve certain emissions targets but where effectively companies and individual consumers make decisions that affect the ultimate emissions outcome. On this basis, countries individually develop a suite of policies aimed at influencing the behavior of economic actors to bring about the desired emissions outcome and to remain in compliance with the protocol. The European Union is somewhat an exception insofar as a group of nations coordinates policies – at least to some degree concerning the sectors covered by the EU ETS and further targeted EU-wide policies, for example labeling of appliances. Still, by largely remaining on the level of reduction targets without specifying a unified institutional framework of *policy instruments*, the Kyoto Protocol effectively creates a very fragmented regulatory landscape with high institutional complexity. The lack of a single price for carbon dioxide emissions that was outlined in the discussion of cost effectiveness is an indicator of this lack of coherence. Of course, the policy fragmentation on a national level is not fully attributable to the protocol itself. Nevertheless it can be argued that the lack of overarching mechanisms that could only be created in the context of an international agreement, such as for example broad-based international emissions trading with common standards and implementing institutions, is at least partially responsible for the patchwork regulation that emerged.

When it comes to institutional structures explicitly created by the protocol, the distinction of Annex B and non-Annex B countries has led to the creation of the Clean Development Mechanism to access additional low-cost mitigation options. Alas, as described in the previous section, the economic (and development) benefits have been quite limited partly because of high transaction costs associated with the mechanism. Proposals have been made to change the verification system from a project-based approach to a program-based system with deemed emissions reductions. But in view of ensuring the environmental integrity of the mechanism, the challenge of monitoring and verification still remains also from an institutional standpoint.

Transaction costs are not only a factor during the operational phase of the Kyoto Protocol. The limitation of the time horizon to the year 2012 is not only problematic from a dynamic efficiency standpoint but also has implications for transaction costs toward the end of life of the agreement. Without a longer-term framework – comprised not only of targets but of policy instruments to implement emissions reductions on a global scale – policymakers have to renegotiate fundamental components of global carbon policy before the current agreement expires. Transaction costs for this (recurring) process on the side of governments having to renegotiate, adapt regulation and potentially create new institutions is greater than for proposals with higher dynamic consistency and predictability over time. Likewise, transaction costs for companies having to comply with fragmented short-term targets while working under high uncertainty over the medium to long term are higher than in alternative architectures.

To summarize, the architecture of the Kyoto Protocol is not conducive to lowering transaction costs for compliance, both for governments and companies. Even though the protocol itself does not feature notable new institutions, it is specifically the *lack* of overarching institutional framework and definition of appropriate policy instruments on a global scale that results in a very high degree of institutional complexity on a national level. Therefore, the overall assessment of this factor is negative (“-“) and the Kyoto Protocol does not fare better in this regard than for its environmental and cost effectiveness aspects.

Enforcement of compliance

The Kyoto Protocol is an international treaty that binds nations as signatories. As has been pointed out, the basic nature of the commitments negotiated comes in the form of emissions targets to be achieved over a so-called commitment period, ranging from 2008-2012. The discussion of cost effectiveness has shown that the protocol contains a number of flexibility mechanisms that give governments and – in the case of the CDM – companies various options in meeting the targets set. In a general sense, however, the protocol leaves open the compliance strategy and the policy instruments employed by nations. When thinking about enforcement of compliance, this can be interpreted as a weakness of the scheme as it puts the means of goal achievement *outside* the scope of the treaty. Actual compliance therefore needs to be ensured by appropriate policy design ex post on a national level. If actual emissions of countries deviate substantially from agreed emission limits under the protocol, a sanction mechanism can only take effect *after* the end of the commitment period in 2012 when the treaty expires.

Canada is an example of an Annex B country with agreed emissions reductions of 6 percent below 1990 levels but with quite the opposite evolution in reality. Despite having ratified the protocol, actual greenhouse gas emissions in 2007 were a full 26 percent above 1990 (Environment Canada, 2007). Even though it is certain that Canada will be far from meeting its commitments under the protocol, effective sanctions could only take hold after 2012 – fifteen years after the ratification of the protocol and seven years after its entry into force. Given the long useful life of investments in the energy system and the lead times it takes to influence emissions pathways, lock-in effects are a real problem if enforcement is not linked to the actual operational phase of the agreement. Here again, the lack of policy instruments specified within the protocol that could support compliance during the commitment period appears to be a structural drawback. Indeed, virtually everything rests on the faith that national self-commitments will lead to the implementation of appropriate policies. The Kyoto Protocol is not self-enforcing and has little to offer to guard against shifting political coalitions in ratifying states that could call into question the further development and implementation of national policies.

In fairness, the protocol does contain elements for enforcement of compliance that are delineated in Article 18 and that were later defined more specifically at the meeting of the parties in Bonn in 2001. The binding consequences called for by Article 18 were agreed to be additional reduction commitments in the following commitment period after 2012 equivalent to the previous shortfall together with an additional 30 percent penalty. However, as pointed out by Aldy et al. (2003), this mechanism is not likely to alter behavior out of two reasons: first, a country would have to agree voluntarily on the penalty in a future commitment period and, second, since future reduction targets would need to be negotiated at a later stage, non-compliant nations could simply push for a laxer target to compensate for the compliance penalty. Effectively, the enforcement mechanism in the Kyoto Protocol is a self-punishment device without any self-enforcing characteristics that would be required for it to be credible. Its structure is a testimony to a worldview of nation states unwilling to yield sovereignty for enforcement of previously agreed-upon goals. Different structures for enforcement are possible, as the example of the European

Union and its supranational institutions indicates, so does on the global level, albeit imperfectly, the International Court of Justice.

To sum up, enforcement of compliance under the Kyoto Protocol presents severe structural weaknesses that make goal achievement almost exclusively a function of favorable political conditions in different countries for the establishment of mitigation policies. Some countries and groups of countries have effectively established legal frameworks with binding consequences. The EU ETS serves such a function for certain industrial sectors. This outcome, however, cannot be attributed to specific features of the Kyoto Protocol with respect to compliance. For these reasons and in light of the previous arguments, enforcement of compliance can only be given the most negative assessment, marked by "--".

Political acceptability

While the previous evaluation criteria have highlighted the drawbacks of the Kyoto Protocol, its political acceptability at least by a larger number of nations is a demonstrated fact. Passing the "reality test" gives the Kyoto architecture an advantage over other proposals for global climate schemes made in the academic literature. Such theoretical ideas would first need to prove that a large enough coalition of states would support and agree on their working principles.

In addition, by creating a framework of institutions and a formalized and ongoing negotiation process through conferences of the parties, the Kyoto Protocol establishes a frame of reference that could be called "system incumbency". In turn, as this structure evolves, it becomes harder for new proposals that may require a departure from the Kyoto-type structure to be implemented. The de facto political acceptability of the Kyoto Protocol therefore has an influence on alternative architectures and explains why the academic literature has dealt extensively with evolutionary schemes to the protocol. This is despite deeper structural shortcomings inherent in the protocol – the most important of which were highlighted in the previous discussion – that may be incompatible with the target criteria and institutional requirements specified in the evaluation framework.

Nevertheless, the fact that the Kyoto Protocol is a political reality also goes together with the observation that often the least common denominator formed the basis for agreement. Otherwise, it would be hard to explain why the protocol presents such severe drawbacks with respect to all other evaluation criteria analyzed: environmental effectiveness, cost effectiveness, equity, institutional complexity, and enforcement of compliance. Indeed, the long-term, all-encompassing nature of the climate problem coupled with its global dimension present a new and unprecedented challenge for policy development. The incentive structure of the political system with election cycles running over a few years is at first sight incompatible with rising to this challenge. Based on relatively modest environmental targets and weak enforcement, the Kyoto Protocol delivered a compromise that fitted into this structure.

The tension between national implementation and the potential for international cooperation may be another factor able to explain the structure of the protocol and why it was accepted politically. As detailed throughout the evaluation, the protocol contains some mechanisms, among the CDM as well as the possibility for emissions trading between nations, which give it a more global dimension. However, in terms if national sovereignty with respect to policy design the protocol leaves everything up to national formulation and implementation – a fact that may have been beneficial to political acceptability but in practice also detrimental in terms of other aspects, such as environmental and cost effectiveness.

Beside these arguments that may cast a pessimistic light on the chances for acceptance of architectures that require a much deeper level of international cooperation, political acceptability is also a dynamic concept that evolves over time. The framework structure of the Kyoto Protocol that was agreed on in 1997 may not be a politically acceptable outcome in 2010 and beyond. Already in the years following its adoption, the non-ratification of the protocol by the United States as a key player indicated the limits of political acceptability even of the compromise-laden Kyoto Protocol. It can be argued that the choice made by the then-government of the United States was partly influenced by specific interest groups negatively impacted by prospective carbon regulation. Yet the arguments brought forward officially, for example the lacking integration of fast-growing emitters in the developing world and the small environmental benefit of the protocol, remain accurate and have not lost their power. Rather, they have increased in importance in the search for a solution to the problem.

In addition, the critical analysis of the Kyoto Protocol in the scientific literature (see for example Aldy et al., 2003) similar to the preceding evaluation as well as the better understanding of climate change risks has helped inform policy discussions since 1997. Today, the Kyoto Protocol would not be as politically acceptable as in 1997 and a future agreement will look different than the blueprint agreed on over a decade ago. Overall, the fact that the protocol has entered into force still warrants a positive ("+") score in this assessment category. Finally then, among all six criteria evaluated, political acceptability is the only dimension, where the Kyoto Protocol is convincing – at least partially.

Summary evaluation of the Kyoto Protocol

Evaluating the Kyoto Protocol along the six dimensions of analysis has led to the following scores:

Evaluation criterion	**Evaluation**	**Summary score**
Environmental effectiveness	Negative/Very negative	-/--
Cost effectiveness	Negative	-
Equity	Negative	-
Institutional complexity and transaction cost	Negative	-
Enforcement of compliance	Very negative	--
Political acceptability	Positive	+

The Global Climate Certificate System

The Global Climate Certificate System (GCCS) was proposed by Wicke in 2005 based on an evaluation of existing proposals for international climate architectures and the identification of their deficiencies. In contrast to the Kyoto Protocol, GCCS is a comprehensive, top-down framework aimed at creating a global carbon market with full emissions coverage. Developing country participation is an integral part of the scheme and is brought about by monetary incentives through the allowance allocation formula. Throughout the evaluation, specific elements of GCCS will be discussed in the context of the six assessment criteria (for a comprehensive overview of the system and its working principles, see Wicke 2005).

Environmental effectiveness

The Global Climate Certificate System puts environmental objectives front and center. In its first version (Wicke, 2005), GCCS is based on a concentration target of 550 ppm CO_{2e}, which was considered compatible with limiting the global mean temperature increase to 2°C above pre-industrial levels. As new findings from climate science indicated that a 450 ppm CO_{2e} would be more appropriate to remain within the temperature boundary of 2°C, another version of GCCS proposed an emissions pathway compatible with this concentration target (Wicke, 2006). Indeed, scientific recommendations as to tolerable global emissions to avert the worst consequences of climate change are a defining input into the overall system. Starting from this environmental objective, GCCS derives a global emissions profile that is broken down into yearly global emission quantities which define global emissions ex ante, with allowance prices as the dependent variable.

The setup of GCCS with *quantified* global environmental objectives stands in stark contrast to the Kyoto Protocol, where, as has been discussed, emissions coverage is incomplete and where the countries with reduction commitments negotiated their respective efforts in a political process with few scientific benchmarks. In contrast, as the first step in crafting a comprehensive climate architecture, the top-down setting of a global emissions pathway and derived yearly emissions budgets within GCCS define the "size of the pie" that in a second step has to be divided up among nations.

With this quantified environmental objective as a foundation coupled with global emissions coverage and institutional provisions to assure that actual emissions need to be covered by allowances, GCCS would deserve the highest mark under this evaluation criterion. Yet in order to prevent price spikes on the allowance market, for example in times of strong economic expansion, the system establishes a so-called safety valve mechanism. This mechanism empowers the principal implementing agencies, defined in the framework as a Global Climate Certificate Bank together with National Climate Certificate Banks, to issue an unlimited number of allowances should allowance prices reach a certain threshold until the price drops below the predetermined level. This threshold is to be negotiated but the initial framework suggests prices of $30 per ton of CO_2 initially, which would be raised to $60 per ton and $90 per ton in time steps of ten years. Yet it is not clear whether prices above the safety valve level would constitute temporary "price spikes" or whether they would be required in order to remain within the cap over the long run. Through this mechanism, GCCS becomes a hybrid scheme that combines elements of a quantity-based regulation (cap-and-trade) with a price-based mechanism (tax). While economic reasons as well as enhanced political acceptability can justify this setup, fulfillment of the environmental objective is hampered to some degree.

In conclusion, the overall assessment of environmental effectiveness of GCCS is positive ("+"). The system misses the best possible evaluation due to the compromise in environmental terms given by its hybrid structure.

Cost effectiveness and investment implications

The global carbon market that forms the basis of the framework is a key element in fostering cost effectiveness: by design, GCCS combines broad emissions coverage through the participation of a maximum number of countries and an upstream point of regulation. As a result, the cost of emitting carbon dioxide and other covered greenhouse gases is equalized both across regions and across sectors. Due to equal mitigation incentives, the lowest-cost emissions abatement options are realized first irrespective of their geographic or sectoral incidence. Contrary to the Kyoto

Protocol that was based on national reduction commitments without specifying a set of policy instruments to achieve them, GCCS *constitutes* a policy instrument that is designed at the outset for enhanced cost effectiveness.

Nevertheless, despite relying on the fundamental element of a global carbon market, GCCS also presents a number of drawbacks in efficiency terms. This is particularly true when viewed in a dynamic perspective: the framework stipulates that emission allowances are given out on a yearly basis with validity for only that one year. Intertemporal optimization, which would be possible by means of carbon budgets for longer time spans or by banking and borrowing provisions, is thereby rendered impossible. Faced by hard emission constraints, companies may have to retire productive capital stock earlier than would be optimal under a dynamically optimized emissions trajectory. This points to an important insight with more general implications: carbon markets that do not rely on long-term budgets but on an exogenously given emissions pathway benefit from additional flexibility mechanisms to increase cost effectiveness over time.

Even though potentially detrimental to cost effectiveness, the fixed yearly carbon budget gives a strong investment signal right from the start of the system. By design, global carbon abatement decisions cannot be delayed which also means that carbon-intensive lock-ins are avoided. This is especially important when economic actors have imperfect foresight and underestimate the long-term effects of climate policy on the relative competitiveness of carbon-emitting assets. This also helps guard against dynamic inconsistency. In addition, given other market imperfections of a second-best world, an initial overinvestment in low-carbon capital stock may mobilize additional investment in research and development that may otherwise be inhibited. In summary, some of the efficiency drawbacks of the GCCS structure are likely to be compensated in the presence of real-world market imperfections.

Next to the absence of flexibility mechanisms to manage the occurrence of emissions over time, GCCS presents another attribute that may be problematic from an efficiency standpoint: the system features an initial equal-per-capita allocation of emission rights but at the same time puts in place mechanisms to limit the redistribution of rents among countries. This is done by effectively creating two carbon markets – one among states and one within states on the company level. Prices are only allowed to fluctuate freely (below the safety valve) on the carbon market for companies. In order to manage the large initial imbalance of available allowances in developing countries and the allowance shortfall in industrialized countries, the World Climate Certificate Bank has the function to coordinate this exchange among countries. In order for this to happen without major distortions, Wicke (2005) proposes a low, politically negotiated fixed price, for example $2 per metric ton of CO_2 equivalent. Under this scheme, inefficiencies could result from a misallocation of allowances among countries, due to artificially distorted prices that do not reflect the opportunity cost of abatement relative to the level of the cap (see also Flachsland et al., 2009). In practice, developed countries would have the incentive to keep their allowances domestically by artificially raising their "business-as-usual" emissions baseline rather than selling them at a low price.

In conclusion, despite the absence of flexibility mechanisms, the fundamental design of a global carbon market would warrant a positive evaluation of the cost effectiveness of the framework. However, the splitting of carbon markets to equilibrate national carbon budgets at artificially low prices is a problematic element that may not work well in practice. Overall, a neutral cost effectiveness score ("0") seems to be warranted.

Equity

The Global Climate Certificate System addresses equity principles directly through the allowance allocation in the global cap-and-trade system. Here, GCCS relies on an initial equal-per-capita allocation of the yearly global emissions budget. The population key is determined with respect to a year in the immediate past (for example the year 2000 as suggested by Wicke, 2005) so as not to reward future population increases with higher emission allowances. As a consequence, this allocation principle attempts to distribute equal property rights for atmospheric pollution with greenhouse gases for *future* emissions and does not account for historical responsibility. This is why equal-per-capita distribution proposals have been criticized on equity grounds for not taking the highly unequal historical pattern of greenhouse gas emissions into account (see for example, Kartha et al., 2009). Other proposals have been made to explicitly consider the historical contribution to anthropogenic climate change, with redistributive consequences going substantially beyond equal-per-capita designs (for example Baer et al., 2008).

As has been stated in the initial discussion of equity as a design criterion, this analysis cannot give an exhaustive and conclusive assessment of which allocation principle best addresses equity concerns (for a comprehensive assessment, see for example Vanderheiden, 2008). Nevertheless, an equal-per-capita allocation of future emissions leads to a distributional outcome that at least in part responds to the requirement of common but differentiated responsibilities in emissions abatement stipulated in the UNFCCC in accordance with different levels of development and differing respective capabilities.

Yet equal-per-capita allocation of emission allowances – even in a future-oriented perspective – entails very extensive redistribution of rents among countries and may lead to major economic distortions, for example higher current account imbalances. The political acceptability of this scheme from a developed country perspective is also far from assured. These are among the reasons why GCCS effectively limits rent transfers by stipulating a low-cost, fixed-price allowance transfer market among countries, as described in the previous section. As a consequence, in practice the initial allocation principle comes closer to a grandfathering scheme as monetary transfers are limited significantly. From an equity standpoint, this compromise is not grounded in normative principles and dilutes the initial approach taken with respect to burden sharing of mitigation and adaptation financing.

Yet GCCS maintains a number of important elements that fulfill the second dimension of equity: supporting sustainable development in the largest number of countries possible. Indeed one important role of the Global Climate Certificate Bank is to oversee the financial transfers from developed to developing countries and to ensure that funds are spent on projects supporting sustainable development and elimination of poverty (abbreviated with the acronym SDEP in the proposal). Even with a low fixed transfer price for allowances, the system is estimated to mobilize initially around $22 billion per year for developing countries and the architecture allows setting higher transfer prices, depending on the outcome of political negotiations.

In conclusion, the framework starts out with bold allocation principles based on fundamental norms for equity. Constraints beyond this design objective lead to a modification of the distribution outcome that goes against the basic principles defined at the outset. Nevertheless, GCCS still benefits those countries least responsible for climate change and potentially the most affected. Its comprehensive coverage supports this endeavor and verification mechanisms foster sustainable development projects. The overall assessment in this category remains positive, marked by "+".

Institutional complexity and transaction costs

GCCS does not benefit from what I termed "system incumbency" with respect to the Kyoto Protocol. Creating a global carbon market with comprehensive participation requires setting up a new institutional framework. Central in this context is the creation of a World Climate Certificate Bank (WCCB) to manage allowance transfers among countries as well as issuing new allowances should prices reach the safety valve level. Nation states would need to yield some degree of sovereignty to empower this institution with managing the global carbon market while shielding it to some extent from political interference, much like a Central Bank for a currency. Negotiating and setting up such a system would be a complex process. Concurrently, a system of National Climate Certificate Banks is proposed to oversee the national carbon markets among upstream fuel and resource providers.

Next to establishing the institutional structures of this system, monitoring all fossil fuel inputs into every economy worldwide is associated with transaction costs, particularly in the early years of the program when registries need to be created and their integrity verified. One countervailing factor in this context is the upstream point of regulation of GCCS which lowers the number of regulated entities relative to hybrid or downstream systems. This design feature effectively reduces transaction costs in running the scheme.

While the institutional complexity and transaction costs for establishing a global climate framework like GCCS are important, a fundamental advantage relative to a structure given by the Kyoto Protocol remains: by creating a set of policy instruments on the international level, first and foremost a global cap-and-trade system, cumbersome patchwork regulation on the national level can largely be avoided.[2] This argument was already made in the opposite direction when evaluating the current international climate protection structure: as has been shown, it is defined by few overarching policy instruments with limited institutional complexity but which in turn has led to a thicket of diverging national regulations with much greater complexity and associated transaction costs.

Furthermore, creating a framework with a long-term quantified environmental objective and a predefined emissions pathway running over decades avoids having to renegotiate international commitments in regular intervals, as is currently the case. In the long run, this can be an important advantage from a transaction cost perspective, both for governments and their implementing agencies as well as for regulated companies.

In summary, in the short run the demands of GCCS for new institutions on a global scale is important but still more moderate than for fragmented national implementation of climate policies. In the long run, the framework has important advantages especially with respect to transaction costs. The score in this assessment category is therefore split between neutral ("0"; short run) and positive ("+"; long run).

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[2] However, creating a global carbon market does not take away the justification for additional national policies focusing on non-market barriers and market failures with respect to R&D investments.

Enforcement of compliance

Setting yearly annual emissions budgets within the framework of a global carbon market is a defining feature of GCCS. The system is not based on national self-commitments with weak enforcement mechanisms, as can be found under the current Kyoto structure. Instead, by virtue of the institutional setup, which caps carbon emissions globally and moves enforcement onto a supranational level, GCCS becomes to a certain degree self-enforcing. This is mainly because the price of emitting greenhouse gases becomes the dependent variable and is allowed to fluctuate relative to a fixed yearly global carbon budget.

Therefore, whether the cap will be achieved is less a question of formulating appropriate policy instruments rather than of implementing the policy instruments already inherent in the GCCS structure. It is at this implementation level that it will be decided whether the system actually achieves stabilization and reduction of GHG emissions targeted at the global level. This is the difference between the potential for enforcement of compliance and actual enforcement observed in reality that was already discussed in the description of the evaluation system.

If one considers the potential for enforcement of compliance, a lot depends on the specific powers of the World Climate Certificate Bank and its independence relative to shifting political constellations in various countries. Another fundamental component is the creation of complete registries for upstream fossil fuel inputs into each country's economy. The role of National Climate Certificate Banks is central in this respect. Only complete carbon and other greenhouse gas accounting will ensure the integrity of the trading scheme and create confidence for market participants. What seems problematic for GCCS in this context is the full integration of all countries right at the start of the scheme. It seems improbable that many of the least developed countries will have adequate institutional capacities for ensuring measurement, reporting, and verification – which are all fundamental for its operation.

Beyond the factors determining the potential for enforcement, actual enforcement of compliance will chiefly be determined by the transactions among upstream fuel and resource providers and the system of climate certificate banks. Wicke's (2005) proposal contains a rather complex modus operandi of allowance distribution with in part grandfathered emissions and in part purchase requirements on the free certificate market that is complicated by the short commitment period of only one year, defined by the validity of emissions allowances. These aspects may need to be refined if a system similar to GCCS were to be implemented.

On an even more fundamental level, even self-enforcing systems, such as GCCS, cannot fully surmount the current limits of international agency and the predominance of nation states in international affairs. If a (powerful) nation decides not to be bound any longer by an international treaty it signed previously, there are few levers to ensure enforcement. Only the future will tell whether nations will decide to limit their sovereignty voluntarily in order to achieve global public purpose by means of deeper international cooperation.

Assigning a score for enforcement of compliance for GCCS is not easy because a lot depends on its implementation in detail. Nevertheless, when comparing the scheme to the Kyoto structure, its self-enforcing characteristics due to its design as a set of policy instruments are very appealing. However, the global nature of the proposed system, integrating all countries right from the start, may present drawbacks as to its operation in practice – particularly in the early learning phase. With this caveat in mind, the overall picture remains positive ("+").

Political acceptability

A global emissions trading scheme needs to take into account widely diverging national circumstances with respect to per-capita emissions and the setup of the energy system. To some degree, these differences result from varying levels of economic development and a formula for burden sharing of abatement costs needs to be applied that is both equitable and politically acceptable for the largest number of states possible. Furthermore, in order to ensure the environmental integrity of the framework, it is essential for the largest emitters to participate.

As has been pointed out in the description of the evaluation framework, China, the United States, the European Union, and India are all among the largest global emitters, yet display considerable differences in their emissions profiles and levels of development. GCCS attempts to take these differences into account through its allocation formula that starts out with an equal-per-capita distribution of allowances but introduces elements to effectively limit the redistribution of rents. This "compromise formula" is designed to still present incentives for developing countries to join the framework while making the distributional outcome more palatable for industrialized countries. Together, all countries share in the vast benefits of limiting the worst consequences of climate change by applying policy instruments designed to reach a predetermined environmental objective.

A major question concerning the political acceptability of GCCS is whether countries are capable of acting rationally and in a long-term perspective for the benefit of their populations and future generations or whether focused interest groups impacted by climate legislation prevail. With respect to the United States in particular, the question of political acceptability of GCCS has been studied previously by Klingenfeld (2006). One conclusion of the assessment was that maximum demands by one group of countries for allowance allocation will make reaching a global deal very difficult and likely impossible. Rather, a politically negotiated compromise on burden sharing, which translates to a compromise in the allocation formula, is a likely way forward in order to equilibrate opposing interests for the sake of a common, shared environmental benefit.

GCCS presents such a compromise and allows for a political negotiation of the allowance transfer price among countries in order to fine-tune allocation. The framework has political acceptability as a central design objective, *subject to* an environmental objective that defines the overall maneuvering space. In this context, the basic principle of any global cap-and-trade architecture with a fixed cap, however, is that allowance allocation constitutes a zero sum game, which makes negotiating national shares a delicate undertaking. Yet introducing other negotiation elements outside climate policy – so-called issue linking (see for example Carraro, 1999) – could provide the additional flexibility needed to finally agree on a distributional principle.

Ultimately, the question of political acceptability of GCCS goes beyond the careful choice of design criteria and touches fundamental priorities in policy making. As political acceptability is indeed a dynamic concept with different possible outcomes at different points in time, the question that can be answered here is whether GCCS could be acceptable if world leaders were effectively serious about devising a framework to prevent dangerous climate change – and to accept the consequences from a substantial deviation from "business-as-usual" that this would entail. If the answer is yes, then GCCS would stand good chances for political acceptability. If the world is not capable of making a step large enough to adequately address the climate change problem in time, then a system can be designed as well as can be without standing a chance for implementation. As a compromise score, I propose a neutral to positive ("0/+") evaluation for GCCS' chances for political acceptability.

Summary evaluation of the Global Climate Certificate System

Evaluating GCCS along the six dimensions of analysis has led to the following scores:

Evaluation criterion	**Evaluation**	**Summary score**
Environmental effectiveness	Positive	+
Cost effectiveness	Neutral	0
Equity	Positive	+
Institutional complexity and transaction cost	Neutral/Positive	0/+
Enforcement of compliance	Positive	+
Political acceptability	Neutral/Positive	0/+

The WBGU Budget Approach

Ahead of the climate negotiations in Copenhagen, the German Advisory Council on Global Change (WBGU) proposed a global climate protection framework termed budget approach (WBGU, 2009). Similar to GCCS, the budget approach relies on a global carbon market with an allowance allocation based on fundamental principles of equity. Yet the budget approach also differs in some important aspects, such as intertemporal flexibility of emissions (for a full presentation of the budget approach, see WBGU, 2009). In the following, the proposal by WBGU will be put to the test in the evaluation framework.

Environmental effectiveness

The budget approach draws on the latest findings in climate science (e.g., Meinshausen et al., 2009) which indicate that, over the long run, increases in global average surface temperatures can be approximated by future carbon dioxide emissions. Against these results, the WBGU proposal aims at capping global CO_2 emissions in order to limit global warming to a still tolerable level. More specifically, the focus is on emissions from fossil fuels. In a first step, the scheme calls for the establishment of a global emissions budget for these sources up to the year 2050. This global budget is then apportioned among countries according to a specific allocation key, supported by a global carbon market to enable trading of emissions allowances.

At the same time, beyond emissions from fossil fuels, land-use change also constitutes a substantial portion of overall emissions (Le Queré, 2008). Here, WBGU recommends the negotiation of a comprehensive, separate agreement out of the following reasons: measurability, reversibility, long-term controllability as well as interannual fluctuations of terrestrial carbon dynamics are all factors that suggest restricting reciprocal offset possibilities with fossil energy use (WBGU, 2009).

As its name indicates, the budget approach derives a long-term maximum emissions quantity that can still be emitted by mankind in the decades to come. This emissions budget is set according to a predefined environmental objective. All other distributional and further design aspects derive from this quantitative limitation of future carbon dioxide emissions. The principal environmental objective of the WBGU proposal is to limit the average global temperature increase to a maximum of 2°C over preindustrial times. However, climate science can only give probabilistic estimates as to the likelihood with which certain temperature thresholds will be crossed. This is why the budget approach requires setting a probability level for achieving the 2°C target. The approach is essentially flexible as to which level of ambition is pursued but at a minimum a 67 percent probability is proposed, which yields a remaining global emissions budget of 750 gigatons (Gt) CO_2 from 2010 until 2050.

Even a global carbon dioxide budget of 750 Gt until mid-century cannot prevent significant perturbations of the climate system with final certainty but it can avoid dangerous anthropogenic interference, as stipulated in the UNFCCC (1992). Moreover, by allowing full intertemporal flexibility, the budget approach does not rely on a safety valve to guard against short-term price spikes. Thereby, over the long run, the budget constitutes a "hard" cap which in turn leads to fulfillment of the environmental objective as long as the system is implemented and enforced properly. In conclusion, pending appropriate implementation, the budget approach has positive ("+") to very positive ("++") environmental effectiveness if probability levels for the 2°C target as suggested by WBGU are used. Of course, this assessment would need to be adapted if the probability level were to be reduced in the political negotiation process leading up to an agreement.

Cost effectiveness and investment implications

A global carbon market is the main vehicle for achieving the environmental objective in the proposal put forward by WBGU (2009). As with other proposals calling for a comprehensive, market-based approach, such as the previously discussed Global Climate Certificate System, marginal abatement costs are equalized across sectors and regions. This is a major element for realizing cost-effective emissions abatement.

Furthermore, the budget approach has a distinctive feature that enhances its dynamic efficiency: the global budget that is apportioned to the countries of the world is intertemporally flexible. This means that no fixed schedule for emissions reductions is defined ex ante, in contrast to for example GCCS. Such flexibility is conducive to optimizing the abatement profile over time. For example, if economic actors anticipate major cost decreases in abatement technologies due to successful research and development, it may be advantageous to postpone some abatement and to undertake more ambitious efforts in the future.

Nevertheless, full intertemporal flexibility should not lead to a mere continuation of "business-as-usual" by attempting to rely on very severe and most likely unrealistic emissions reductions in a more distant future. Such an evolution would not be consistent with the objective of dynamic efficiency. Rather, it would contain elements of dynamic inconsistency as well as free riding by relying on mitigation efforts of others. In order to counter this risk, the budget approach requires states to submit so-called "national decarbonization roadmaps" to a newly created international authority, termed World Climate Bank. This new institution has, among other tasks, the function to verify national climate strategies as to their plausibility and to require modifications if needed.

Even though dynamic efficiency could be enhanced by this structure, the question remains whether nation states should be the principal actors in managing national carbon budgets. Given a global carbon market, all national decarbonization roadmaps would need to be coordinated to some extent in order to avoid strategic behavior by individual players. In light of the mixed experience with National Allocation Plans in the European Union, this may not be a very promising way forward. Intertemporal management of a global emissions budget could instead directly be undertaken by a World Climate Bank. The ensuing carbon price would lead to least-cost emissions abatement worldwide, irrespective of national boundaries. What remains very valuable in the budget approach, however, is the recognition of abatement flexibility over time as an important component in cost effectiveness.

In terms of other specific design aspects, the proposal is rather limited. Non-market barriers to enhanced cost effectiveness as well as market imperfections leading to private underinvestment in research and development are not addressed in particular. Such refinements would be beneficial if the proposal were to be further adapted for actual implementation.

But even in its current form, the budget approach contains critical elements that foster efficient emissions abatement – in both a static and dynamic perspective. This is why a positive assessment ("+") in this category seems justified.

Equity

The main vehicle for addressing equity in the budget approach is the allocation formula for dividing up the global carbon budget among countries. Here, the fundamental distributional principle is an equal-per-capita allocation that confers equal rights to the atmosphere to every citizen of the world, irrespective of nationality.

Starting from this first principle, the budget approach introduces a variable to be determined in an international negotiation process: the year from which to calculate the global budget as well as corresponding national shares. This decision is of high relevance for the distributional outcome on a national level as it determines to what degree historical responsibility for past emissions by developed countries is taken into account. The further the start year for calculating national budgets based on population shares is set in the past, the more allowances are allocated to developing countries.

The WBGU proposal presents two allocation examples, one starting from 1990, and the other from the year 2010. Both dates lead to substantial redistribution of rents going forward. Taking 1990 – or earlier years – as starting point for the allocation makes most industrialized countries "carbon-bankrupt" already today, which means that they would need to purchase emissions allowances for all future emissions. The authors (WBGU, 2009) recognize the political challenges of such a strict interpretation of equity principles and suggest 2010 as a more realistic alternative. In addition, in order to compensate for historical responsibility that is not taken into account through this allowance allocation principle, a climate change adaptation fund is proposed to help those countries most affected by anthropogenic climate change and least responsible for its causes.

At the same time, the proposal goes beyond a mere dividing-up of rents through allocation and redistribution via a global carbon market. Instead, the proposed World Climate Bank is to assume a major role in coordinating a new development partnership among industrialized and developing countries. This new partnership is characterized by common interests in view of successive decarbonization of the energy system and sustainable development. By making emission allowances available to developed countries, developing nations generate funds that enable them to invest in low carbon technologies. By the same token, developed countries benefit from additional maneuvering space in order to manage their decarbonization process without the need for disruptive change. Both groups of countries have the incentive to emit carbon dioxide as scarcely as possible in order to either save funds by not having to purchase additional allowances or to generate additional income through allowance sales on the global carbon market.

What is more, the proposal goes beyond the traditional distinction of developing and developed countries and thereby overcomes the in some ways anachronistic and artificial differentiation under the UNFCCC (1992). Instead, the budget approach focuses on per-capita emissions as the sole allocation criterion. This means that some countries, considered as developing nations, such as for example Venezuela or Malaysia, would soon be significantly constrained in their emissions trajectory. China, as the largest global emitter with high absolute growth rates, would also have to assume increased responsibility. Together, all countries are called to action with one clear environmental objective and based on a transparent burden sharing formula. While in detail an equal-per-capita allocation key may not capture all the various national circumstances, it remains a valid principle to address global equity in emissions abatement. Even with 2010 as a start year, combining the budget approach with additional provisions for adaptation assistance warrants a very positive ("++") assessment when it comes to the equity dimensions of the proposal.

Institutional complexity and transaction costs

Evaluating the budget approach with respect to institutional complexity and transaction costs presents several analogies to the assessment of GCCS. The biggest institutional challenge for setting up the system is to enable the proper functioning of the global carbon market. Here, WBGU calls for full participation, which, from an institutional standpoint, may particularly be a challenge for least developed countries. Let us recall that for a global carbon market to work in a robust way, confidence in measurement, reporting, and verification of emissions is essential. It is not entirely clear how the actual implementation of these requirements worldwide would work in practice.

One institution has a fundamental role to play in the setup of the budget approach: the proposal puts a newly created World Climate Bank (WCB) at the center for managing the global carbon market. The functions of this bank, as suggested in the framework, go well beyond being a clearing house and registry for global allowance transactions. In fact, the World Climate Bank is pivotal in overseeing the intertemporal use of the global carbon budget: while in principle individual countries can choose the timing of emissions abatement, they have to document their respective strategies in national decarbonization roadmaps. These roadmaps are then reviewed by the WCB. The bank can mandate changes in order to ensure that the overall budget will not be exceeded, especially if abatement efforts are pushed far into the future. This review and verification role creates high administrative complexity and is associated with significant transaction costs. Such problems arise in part because the proposal focuses on nation states as the main actors in managing national budgets.

Alternatively, banking and borrowing provisions for allowances on a company level along with an active role of the World Climate Bank in open-market interventions on the global carbon market could also foster dynamic efficiency with arguably far less administrative complexity – yet this is not a road chosen by the proposal.

On the positive side, the budget approach creates a long-term framework that has to overcome the most important institutional and administrative challenges in its early operational phase. Once measurement, reporting, and verification channels are established and the carbon market proven to operate as designed, future transaction costs are likely to be lower, especially when compared to the Kyoto Protocol with its short timeframe for commitments and recurring negotiation process. With the budget approach, expectations of economic actors as to future carbon constraints can be stabilized, which also helps mitigate against dynamic inconsistency.

In addition, the focus of complete (upstream) coverage of carbon dioxide emissions also lowers the need for additional policy instruments targeting specific sectors. This helps guard against an institutionally complex regulatory landscape, as seen for example with the patchwork implementation of the Kyoto Protocol.

Summing up, the comprehensive coverage of carbon dioxide emission sources by means of a single carbon market is an important advantage of the structure, so is its long-term focus. However, integrating all countries into a global carbon market right from the start and allowing nation states to manage national carbon budgets subject to a complex review process are factors not conducive to lowering institutional complexity and transaction costs. This is why the overall assessment of the budget approach in this category is negative ("-") in the short run and neutral ("0") in a longer-term perspective.

Enforcement of compliance

Enforcement of compliance in the budget approach will chiefly be determined by the relationship and relative powers of the World Climate Bank vis-à-vis participating countries. Interestingly, a major challenge for enforcing compliance stems from one of the biggest advantages of the approach: its intertemporal flexibility. Since countries can freely manage their assigned carbon budgets, a great deal of trust and cooperation – as well as enforcement devices – on an international level is needed to ensure the integrity of the global carbon budget.

Specifically, compliance with the global budget in the long run will depend on the degree to which sovereign nation states transfer authority to the World Climate Bank and abide by the rules set for this worldwide scheme. As in the previous assessment category, an area of concern is the concept of national decarbonization roadmaps, which leaves the primary authority for the timing of emission cuts in the hands of states – subject to political pressures and shifting coalitions.

Equipping the World Climate Bank with adequate institutional powers to review and to modify these strategies, if necessary, would be central to raising the prospects for long-term compliance. Without it, the system could all too easily revert to a Kyoto-type reliance on national self-commitments that, if not backed up by adequate policy instruments, could jeopardize goal achievement. In order to mitigate this threat, the proposal suggests sanction mechanisms that the World Climate Bank could use against non-compliant states but it leaves open how these measures could look like in order to be effective.

Furthermore, the global reach of the carbon market coupled with comprehensive country participation is not only challenging from an administrative point of view but also when it comes to ensuring compliance. Reporting, measurement, and verification have already been pointed out as factors that contribute to considerable transaction costs. But it is not even clear that such a suite of rules and regulations can successfully be implemented in a timely way in all 190+ countries that the budget approach attempts to put under the umbrella of the global carbon market. Major questions remain as to how so-called "failing states" and other institutionally weak countries would be part of a market that depends on the comprehensive enforcement of rules to ensure its integrity.

The previous arguments indicate that the budget approach requires further refinements and potentially modifications to enhance its robustness. In particular, the scheme needs to demonstrate that national decarbonization strategies are compatible with a global carbon market subject to a hard cap over the long term. Since global emissions quantities can only be controlled indirectly via monitoring progress of these national plans, the World Climate Bank cannot act as directly as for example its institutional counterpart in GCCS. In its design, the budget approach thus appears to be less “self-enforcing”.

Taken together, there are a number of issues surrounding enforcement of compliance that would need to be improved and developed further if the proposal were to be considered for implementation. Currently, a final assessment score of in between the negative (“-”) and neutral (“0”) categories appears justified.

Political acceptability

Many of the conclusions regarding political acceptability that were drawn for GCCS also apply to the budget approach. A basic, yet profound question to be asked is whether world leaders are ready to engage the global community in a comprehensive transformation process that would be required from now onwards to counter the long-term threats from climate change faced by ecosystems and mankind. Political agency – and its limits – will be put to the test, as a solution to the climate challenge requires unprecedented sustained global cooperation as well as a marked shift from “business-as-usual” development paths, where only minor adjustments will be vastly insufficient.

The properties of the earth system are subject to the laws of physics. Over time, climate science has not ceased to progress to give policymakers better data to support their decisions. The budget approach draws on this body of science, assembled by leading research institutes around the world. Over time, the 2°C guard rail for global temperature increase has received widespread scientific endorsement as an upper limit of still tolerable anthropogenic interference (see for example Schellnhuber et al., 2006; Richardson et al., 2009). Policymakers have equally adopted this goal, for example at the G8 summit in L’Aquila and most recently through the Copenhagen Accord. If policies to achieve the 2°C guard rail are to be implemented, setting this upper temperature limit with a certain probability level equates to agreeing on a global carbon budget. This is the starting point of the budget approach and the resulting substantial constraints on global greenhouse gas emissions are the “inconvenient truth” that is associated with responding to the environmental imperative. Therefore, *if* the temperature threshold formulated by science and adopted in various policy circles is indeed to serve as a firm guiding principle, *then* formulating a global emissions budget stands good chances for acceptance.

The critical question, much like for GCCS, becomes how to apportion this budget among individuals or nations. The equal-per-capita principle is, as stated before, a good approximation for addressing equity. However, the distributional effects as compared to the status quo are very significant – even if 2010 is taken as the reference year for calculating national shares in the budget approach. In contrast to GCCS, the budget approach does not establish limits on wealth transfers among nations. Their magnitude is driven primarily by the allowance allocation and prevailing carbon market prices. In light of the current political discourse, finding an agreement among exemplarily China, the United States, the European Union, and India on how to divide the global emissions budget is far from being a done deal. In fact, this is all the more true after the sobering outcome of the Copenhagen summit that may have moved the world further away from the possibility for effective global cooperation.

However, political acceptability is a dynamic concept that can evolve over time but climate physics remain anchored in the laws of nature. Thus, the question to be answered is not so much whether the budget approach is politically acceptable but rather whether taking appropriate measures on a global scale to avert the worst consequences of climate change is politically acceptable. Today, one can be skeptical but the jury is still out for the years to come. Currently, the budget approach is ranked negative ("-") to neutral ("0") as to its political acceptability.

Summary evaluation of the Budget Approach

The evaluation has led to the following overall assessment of the WBGU proposal:

Evaluation criterion	Evaluation	Summary score
Environmental effectiveness	Positive/Very Positive	+/++
Cost effectiveness	Positive	+
Equity	Very Positive	++
Institutional complexity and transaction cost	Negative/Neutral	-/0
Enforcement of compliance	Negative/Neutral	-/0
Political acceptability	Negative/Neutral	-/0

Taking stock and looking ahead: a new proposal for an international climate architecture

The preceding evaluation of the Kyoto architecture as well as two proposals for a new global climate regime has highlighted a number of tradeoffs that exist when designing a response to the climate change challenge. It is therefore essential to make explicit the priorities that should guide policy development. Here, the evaluation system proposed is an important tool not only in an ex-post evaluation but also in forming the basis for crafting future policy architectures. In the following, I am going to delineate the main elements of a new proposal that attempts to find a delicate balance in maximizing the evaluation criteria outlined above. In doing so, the framework draws on a number of elements of previously published work, such as for example GCCS (Wicke, 2005) or the budget approach (WBGU, 2009) but attempts to overcome some of their limitations. Following the description of the main working elements, first in summary format and then in more detail, the system will be scored in the evaluation framework.

Summary description of the main working principles

1. National self-commitments are not a promising way forward in designing an international climate protection architecture. The overall level of ambition of individually-proposed targets following the "collection plate principle" (Schellnhuber) risks falling far short of preventing dangerous climate change. In addition, such targets suffer from ex post enforcement problems, as seen with the Kyoto architecture. Relatively short commitment periods also have the potential for time inconsistency and recurring negotiation deadlocks. Finally, a globally (and potentially even nationally) uncoordinated policy instruments mix is likely to lead to inefficiencies and higher abatement costs than necessary.

2. Instead, the starting point of the proposed climate protection scheme is a global carbon budget compatible with keeping global temperature increase below 2°C. A probability level for meeting this threshold needs to be defined in political negotiations in order to obtain a quantified carbon budget for the next decades, for example from 2010 to 2050.
3. The global carbon budget is broken down into smaller three-year budgets based on modeling results of optimum intertemporal emissions abatement. Commitment periods also have a length of three years, after which companies need to surrender emissions allowances proportional to carbon dioxide emissions. The point of regulation is upstream on the first trading level of fuel and resource providers in order to keep the number of regulated entities manageable. In addition, the system is based on full emissions coverage in order to enhance cost-effective emissions abatement across the economy.
4. Regular auctions of emissions allowances (e.g., every three months) supervised by a newly created World Climate Bank in conjunction with national institutions are a central component of the scheme in order to limit company windfall profits and to generate funds to be used for public purposes.
5. Countries do not negotiate individual emissions reduction targets but their share in global auction proceeds over time. This constitutes a major innovation over previous proposals. This feature ensures that efficiency gains of a global carbon market are realized irrespective of the location of the abatement opportunity. No single approach to burden and opportunity sharing is advocated in the proposal but if an equity-based allocation were chosen by policymakers, funds from auction proceeds could be apportioned accordingly without the need to tap into existing national financial budgets to finance transfer payments.
6. The role of the World Climate Bank is critical in the scheme proposed: beyond overseeing global allowance auctions together with national partners the World Climate Bank manages the global carbon budget as an independent institution with statutory powers. This includes active open-market transactions in order to smooth out price fluctuations linked for example to economic cycles – with certain parallels to the tasks of central banks for currencies. The World Climate Bank also coordinates the global auction revenue-sharing among nations according to the previously negotiated distribution key.
7. The scheme relies on a flexible and expandable global structure with increasing global emissions coverage over time: right from the start, the architecture attempts to integrate the largest number of developed countries possible as well as a number of key emitters from developing and transition economies. A greater number of developing countries are joining the scheme over time. In general, countries need to pass a qualification and audit process for measurement, reporting, and verification in order to ensure the integrity of the carbon market.
8. Since the carbon market becomes increasingly global only over time, the carbon budget allocated through auctions needs to be reduced in the initial years of operation to reflect emissions outside the cap.

Additional provisions to prevent emissions leakage into uncapped areas are also required. Selective border tax adjustments are one possibility, whose importance would diminish over time as the scope of the global carbon market increases.

The new proposal for a global climate regime in detail

Following the summary of the main working principles for a proposed comprehensive international climate architecture, the various elements are going to be described in more detail.

A broad carbon market with increasing global participation

The advantages of a truly global carbon market in terms of enhanced efficiency and prevention of leakage effects are important. Yet in practice establishing a scheme with comprehensive geographic coverage requires accurate measurement, reporting, and verification in *all* regions to safeguard the integrity of the trading system. Political acceptability across the globe is a further precondition for creating a truly global carbon market. These requirements present high hurdles for any proposal relying on such a universal scheme. In contrast, fragmented markets with small geographic coverage, as have developed following the adoption of the Kyoto Protocol, present major deficiencies not only with respect to efficiency but primarily also concerning environmental integrity.

I therefore suggest a modular approach to establishing a global carbon market that is compatible with geopolitical realities and technical requirements – while still putting the global environmental objective of preventing dangerous climate change first. Limiting global average temperature increase to 2°C is the starting point for defining the quantitative global emissions budget over time. The method is analogous to the one described in the budget approach (WBGU, 2009) and involves setting a probability level for goal achievement in order to derive the emissions constraint. Ultimately, this probability level, and thus the level of ambition of climate policy, needs to be determined in political negotiations. Drawing on WBGU (2009), a guiding figure for the timeframe 2010-2050 could be a global carbon dioxide budget of 750 gigatons, which would correspond to a probability level of around 67 percent for respecting the 2°C guard rail (see WBGU 1995, 2006, 2008).

The focus of the scheme is on carbon dioxide from the combustion of fossil fuels only and excludes other emissions, notably from land use change. Convincing arguments have been made as to why emissions associated with the natural carbon cycle should be dealt with in a separate agreement and not be made available as potential offsets in a broad carbon trading scheme (WBGU, 2009, p.39). Similarly, fluorinated greenhouse gases regulated by the Kyoto Protocol could be reduced rapidly under a different scheme modeled on the Montreal Protocol (ibid.). However, anthropogenic emissions of other long-lived greenhouse gases regulated under the Kyoto Protocol – methane and nitrous oxide – could be integrated into the trading scheme. In the following, the working principles will be detailed for fossil CO_2 only but could be expanded for other greenhouse gases accordingly.

Apportioning the global carbon budget over time

While recognizing the benefits of full intertemporal flexibility of a global carbon budget, I nevertheless suggest breaking down the overall budget into smaller parts for shorter commitment periods with a length of three years. Determining the quantities available for each three-year period should be based on an ensemble of modeling results as to optimum intertemporal emissions management. Even though this can only be an approximation given the large uncertainties in terms of future low-carbon technology development, breaking down the available carbon budget into smaller periods generates immediate incentives for emissions mitigation. It also sends a signal for companies that research and development in lower-cost abatement options has the potential for near-term payoffs. By relying on shorter commitment periods, strategic behavior of postponing abatement far into the future can be avoided. Dynamic inconsistency, whereby actors anticipate less ambitious emissions constraints in the future than initially announced, can also be countered by creating emissions scarcity right from the beginning of the scheme.

As will be explained in more detail later in this section, the scheme does not presuppose complete global participation right from the start. Therefore, it has incomplete emissions coverage at least in the initial years of the program, while a growing number of countries are joining the scheme over time. For the carbon budget available in any three year commitment period, this means that emissions outside the cap need to be deducted from the global budget so as to match the degree of coverage attained.

The proposal places the point of regulation upstream at the level of fuel and resource providers. Here, all fossil carbon inputs into an economy can be monitored with relative ease as compared to other options targeting the individual emitter level. The number of regulated companies on this first trading level is also relatively small, which is an important factor in conceiving a carbon market with global reach. After the end of each commitment period, regulated entities would need to surrender emissions allowances proportional to the embedded emissions in their product sales. In order to avoid “carbon-bankruptcy” of individual companies due to insufficient allowance purchases at the end of the trading period, a possible additional requirement is to require companies to surrender allowances equal to 90 percent of emissions on a yearly basis before having to fully true up their emissions account in period three.

Regular auctions and the pivotal role of a World Climate Bank

As a mode of allowance allocation on a company level, I suggest relying on regular auctions of emissions allowances, preferably with a relatively short periodicity of three months. Additional detailed auction rules need to be specified and previous scientific work in this area (for an overview and specific recommendations, see Klingenfeld, 2007) should serve as an input for shaping the auction details.

Relying on a full auctioning of emissions allowances prevents windfall profits on a company level from occurring while the price increase for products and services associated with carbon dioxide emissions is independent of the mode of allocation. The biggest upside for this company-level allocation model lies in the generation of substantial funds that can for example be redistributed directly to citizens, used for targeted R&D in energy technologies, or in part as transfer payments to finance climate-compatible low-carbon development around the globe.

Organizing large-scale auctions in regular intervals on an increasingly global scale is a novel task that requires new institutional structures. A World Climate Bank (for similar concepts, see Wicke, 2005 and WBGU, 2009) should be established to manage the global carbon budget and to coordinate the auctions for emissions allowances. National implementing agencies are required to complement the work of the World Climate Bank and to assist in areas relevant for the integrity of the trading scheme, such as reporting, measurement, and verification.

In managing the carbon budget, the World Climate Bank does not only auction off predetermined quantities of emissions allowances every three months but has a more active role in carbon budget management, similar in some aspects to a currency central bank. Through open-market operations, the World Climate Bank can smooth out price fluctuations on the carbon market. For example, adapting its interventions to cycles of economic expansion can prevent sudden price spikes and price drops and thereby stabilize investor expectations as to short and medium-term allowance prices. Such an active management role would require clearly-defined statutory powers along with guaranteed independence from political interference. By the same token, nation states would need to surrender some of their sovereignty in exchange for a time-consistent scheme with strong self-enforcement characteristics through the carbon market and more effective deterrence from free riding as compared to a purely national approach. In practice, quantity – and price – management could be done by adapting the quantity of allowances available at the regular auctions up or down. In addition, but not necessarily required, the World Climate Bank could be allowed to keep some of the auction proceeds in a dedicated account to be used for true open-market purchases of allowances in order to boost market prices. Conversely, new allowances could be issued as needed to temporarily relieve upward pressure on certificate prices.

In the context of this management function, the overall carbon budget set for longer timeframes constitutes the maneuvering space for the bank so that in the long run the overall emissions path remains compatible with the goals set. This objective should be part of the bank's statute, which gives greater environmental certainty than for example a pre-announced safety valve. A potential problem with such a static solution could be that if the safety valve level is set too low, emissions could consistently exceed the cap, thereby undermining its environmental effectiveness.

Introducing flexibility mechanisms to enhance dynamic efficiency

On a company level, the three year commitment period proposed for the carbon market with reductions of the available global budget over time managed by the World Climate Bank may not always be in-line with managing emissions in a dynamically efficient way. Previous research has identified the benefits of enhanced flexibility for companies due to banking and borrowing of emissions allowances (see Ellerman et al., 2003). In particular, dynamic efficiency in emissions abatement on a company level can be improved since abatement can be better attuned to investment cycles of long-lived capital assets without being constrained by the duration of specific commitment periods. Therefore, in practice banking of allowances on a company level should be allowed without restrictions. Indeed, since the global carbon budget is being managed with a fixed quantity available over the long run, the environmental integrity of the scheme is not affected.

In order to enhance flexibility, borrowing of allowances from future commitment periods should also be allowed. However, more restrictions are needed as compared to banking of allowances. To recall, the overall global carbon budget defined over several decades is broken down in the first place and divided into three year commitment periods in order to guard against time inconsistency. Absent an immediate need for abatement, mitigation actions could be postponed not on grounds of an intertemporal optimization strategy but in anticipation of much laxer climate policy requirements in the future, as then-required annual reduction rates would become too ambitious. Unrestricted borrowing would increase this risk and render meaningless shorter commitment periods. What should be possible, however, is to borrow allowances from a future commitment period against some form of interest payment in order to allow for flexibility while limiting speculative deferment of abatement. The World Climate Bank could manage interest rates depending on overall demand for postponing emissions abatement into future commitment periods.

As a consequence of these additional mechanisms for market participants, the carbon budget becomes flexible on two levels. The first level of macro management by the World Climate Bank through managing auction volumes and potentially additional open market operations is complemented by a finer-grained decentralized component on the company level.

Away from national self-commitments and toward a global revenue-sharing from climate policy

Agreeing on a science-based global environmental target should be the starting point for international climate negotiations. By removing the question of burden and opportunity sharing from the initial stages of the negotiation process, it is hoped to facilitate consensus building with respect to defining an overarching global target first. However – and in contrast to most existing proposals for global climate architectures – no national reduction commitments are derived from the global emissions constraint (this feature is also central for Wicke, 2005). In fact, the proposal targets least-cost global emissions abatement, which means that the geographic location of the emissions abatement opportunity should not be a determining factor. Instead, a global carbon price signal would incentivize *all* emissions reductions with marginal costs lower than the current market clearing price.

The true innovation of the architecture proposed lies in the concept for burden and opportunity sharing on a national level: nation states negotiate their share of global auction proceeds, defined in percentage terms from the grand total. Depending on the negotiation outcome, the respective country share could evolve over time without affecting the overall environmental integrity and economic efficiency of the carbon market. By removing emissions abatement from national policymaking and by placing it in a global structure overseen by a World Climate Bank, the system is intended to be more robust over time and to be less affected by changes in political constellations in nation states. With enhanced confidence that free riding of others can be prevented more effectively, the overall level of ambition of global climate policy with its transformative implications for nation states can be raised.

Certainly, determining in a negotiation process the national shares from global auction proceeds – or in other words dividing up the climate rent – is the one fundamental challenge whose resolution would be akin to cutting the “Gordian Knot of climate policy” (WBGU, 2009, p.8). It should be highlighted that finding and agreeing on this distribution key is a precondition for making the system work as described. Following from the overall constraint given by the carbon budget, the recognition that a limited pie of remaining atmospheric space needs to be distributed worldwide is the “inconvenient truth” that international climate negotiations have tended to avoid so far. At the same time, negotiating directly about the distribution of the climate rent is also a means to focus the international negotiations that so far have tended to get encroached in ever more complex matters as to specific details of an incoherent global climate policy architecture. If it turns out that additional flexibility is needed to reach an agreement, the apparent zero-sum game of dividing the climate rent can be complemented by so-called issue linking (see for example Carraro, 1999), thereby expanding the negotiation space beyond the domain of climate policy.

However, care should be taken so as not to dilute the negotiation process with ever more issues, which could lead to inhibiting progress towards an agreement.

When it comes to a specific distributional principle, no single approach is advocated here as this question should be left to the outcome of an international negotiation process. What is required in this context is a normative discussion as to what constitutes an equitable concept for burden and opportunity sharing on the global level that also takes a number of constraints into account. Examples of consequences to be studied include possible distortions of current account balances through large-scale climate rent transfers as well as the potentially detrimental effects of high rent incomes on nations, as the example of Nigeria and the social consequences of the oil boom indicates. However, beyond these rather broad suggestions, the officially-adopted principles of the UNFCCC (1992) should guide finding a consensus. To recall, the Convention stipulates that "The Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities" (Article 3.1 UNFCCC).

Science has made a number of proposals on global burden and opportunity sharing. The most prominent examples include contraction and convergence (Meyer, 2000), common but differentiated convergence (Höhne et al., 2005) or recent work on country-specific emissions targets (Frankel, 2008). But instead of forcing countries to take on individual reduction commitments, as most existing proposals have advocated, the new approach to global revenue-sharing from climate policy described here does not have this constraint. As has been highlighted, global emissions abatement is optimized in a cost-effective way, irrespective of geographic location. Within the global cap, no country would be forced to abate if it turned out that economic actors and citizens had a higher willingness to pay for emissions than elsewhere, where fewer barriers for a transition to a low carbon economy exist. What is still fully possible in the architecture proposed is to distribute the auction proceeds according to an allocation key oriented along previous proposals, such as the ones mentioned above. For example, if contraction and convergence were chosen as a burden-sharing principle, then converging per-capita emissions allocations over time could easily be expressed in terms of a dynamic climate rent sharing in the framework proposed here without affecting any of the underlying benefits in terms of environmental and cost effectiveness.

Even as the distribution of the climate rent is to be left to an international negotiation process, one promising way forward that has not been widely discussed could be to start out from a responsibility-based principle for current (and to some degree past) anthropogenic greenhouse gas emissions. However, rather than deriving an equal-per-capita distribution based on a reference period as proposed for example by WBGU (2009), actual costs for transforming the energy system could be taken into account: more specifically, transfers of climate rents from high to low per-capita emissions countries could be based on estimates for the cost *differential* to transform their energy systems from a carbon-intensive to a low-carbon pathway. In addition, compensation for specific adaptation measures could be taken into account when determining the share of specific low-emissions countries in overall auction proceeds. This way, the principle of common but differentiated responsibilities and respective capabilities could be given a concrete distributional translation. In addition, as the cost differential of low-carbon technologies to conventional alternatives narrows over time and as low-emission developing countries become wealthier, absolute transfers of climate rents could decrease over the long run. Moreover, given the link to actual investments in the energy system, pure rent transfers to countries with very low per-capita emissions and a small energy system could be avoided. In fact, instead of benefiting development, such rent transfers could have a destabilizing effect due to rent seeking of subgroups of the population. Thinking of transfer payments in terms of cost differentials would also allow these generally poorer countries to keep up with their "business-as-usual" pace of development while ensuring a positive lock-in effect into a low-carbon economy. In order for the scheme to work as proposed, all countries with net positive receipts of auction proceeds would agree to earmark these transfer payments specifically for investments in the energy system and for adaptation projects.

For countries with higher emissions and a net negative share of the global climate rent, domestic use of auction proceeds would be unconditional. However, science has highlighted several productive uses for these funds, including spending part of the receipts on targeted R&D in order to correct for market failures as well as returning the bulk of the funds to every country's citizens. This can be done on an equal-per-capita basis to foster progressive effects of climate policy or potentially be combined with lowering income taxes to reap a "double dividend" by also supporting accelerated economic growth. A direct redistribution of the lion's share of the climate rent to citizens is particularly important in developing and transition economies where on average people spend a higher percentage of their disposable income on energy. This point will be taken up separately later in the discussion.

Implementing a global carbon market through a modular, expandable system

Previously proposed schemes for comprehensive climate architectures relying on a global carbon market, such as the aforementioned proposals by Wicke (2005) and WBGU (2009), assume complete participation by all countries right from the start of the system. However, making a global carbon market work requires accurate measurement, reporting, and verification (MRV) of emissions. Choosing an upstream point of regulation is an architectural feature that facilitates this endeavor as compared to more complex downstream or hybrid systems. Nevertheless, the institutional requirements for making such a system work on a global scale are substantial and it is questionable whether adequate MRV capabilities can be established and tested in time on such a large scale.

Moreover, if the operation of a carbon market were to be conditional upon universal accession of all countries, veto players could jeopardize the entire process by declining to join the global scheme. Given the substantial impacts from an effective limit on future emissions from fossil fuels and the decline in resource rents for resource-exporting countries, the risk for incomplete participation is very real. In addition, political acceptability, as has been highlighted in the discussion of this criterion in the evaluation framework, is a dynamic concept. Several countries are further advanced in the public debate on taking substantial action on climate change than others. This would facilitate the implementation of a scheme based on the working principles outlined above.

Therefore, questions surrounding measurement, reporting, and verification as well as the general acceptability of a broad-based climate architecture point to the benefits of a modular, expandable approach to building a global carbon market. To be clear, the ultimate goal for global emissions coverage is to be as complete as possible with broad participation but what is fundamental in the first place is to integrate all large emitters into the scheme in a very timely manner. The way forward described here is not the route of linking previously established heterogeneous trading schemes (for a discussion of linking versus a global top-down carbon market, see Flachsland et al., 2009) but a conscious construction of an expandable global scheme based on a set of *common* design principles. If, however, in anticipation of the conclusion of international climate negotiations, countries or groups of countries decide to go ahead to establish regional trading schemes or to modify existing ones to make them compatible with the design criteria suggested, then linking would also be a viable option for making progress towards a globally integrated scheme. Specifically, the European Union could underscore its leadership role in helping bring about a global carbon market in the near term by reforming the working principles of the EU ETS in view of full upstream coverage and comprehensive auctioning of emissions allowances.

In practice, what is required for the system to succeed is a founding coalition of a group of countries that together make up a sizeable portion of global emissions. The United Nations Framework Convention on Climate Change from 1992 remains the basis for international action on climate change and stipulates that industrialized countries should take the lead in addressing climate change, both on grounds of historic responsibility and capacity. Their initial participation in the climate architecture proposed would be essential in order to demonstrate the institutional feasibility of the approach as well as to create incentives for developing countries to join. Indeed, through the climate rent revenue sharing mechanism, high-emitting developed countries would become net contributors as compared to other countries, first and foremost in the developing world. These countries, in return, would benefit from joining the global climate architecture by receiving financial assistance for their transformation process toward a low-carbon economy. Developing countries with low per-capita emissions would also receive adaptation assistance through climate rent transfers.

Thus, the incentives for countries with lower emissions to join the scheme are important as compared to a situation where they did not participate, in which case no revenue sharing would take place. It can therefore be expected that a large number of low-emitting countries would be willing to join the climate framework. This would be a desirable outcome in order to contribute to advancing the environmental integrity of the scheme by increasing global emissions coverage. In addition, overall cost effectiveness would increase due to larger geographic scope of the carbon market with access to a greater number of lower-cost mitigation options. This is why the participation of large emitters from developing countries and transition economies is so important. China and India are absolutely vital but other countries, such as for example Brazil, Mexico, South Africa, and Indonesia also have sizeable global emissions and would need to be integrated into the scheme as soon as possible.

An audit scheme to ensure the integrity of the global carbon market

While broad global participation beyond the large national emitters is desirable and constitutes an explicit goal of the architecture described, it has also been highlighted that accurate measurement, reporting, and verification are equally important – and in fact a precondition for making the system work. This is why I propose an audit and graduation system through which countries need to qualify themselves before joining the expanding, global scheme. Establishing adequate and dependable protocols for measurement, reporting, and verification requires in a first step administrative capacity and capability building. The financial benefits that countries acceding to the climate scheme derive from climate rent transfers also constitute an incentive for improving governance: indeed, the requirement for earmarking the net receipts of climate rents for mitigation and adaptation projects requires transparent processes, in which governments can be held accountable for using the receipts in a previously-agreed way.

The audit process outlined above has to be conducted before countries can link to the global carbon market. Reviews in regular intervals would also be beneficial to ensure the integrity of the global trading scheme. In case of major violations of commonly-agreed principles, such as fraud of emissions statistics, there should also be a provision for suspending the participation of individual nation states so as to safeguard the continued operation of the overall framework and the trust of market participants. It remains up to the international negotiation process to determine through which administrative structure this audit process should be conducted. One possibility is the specification of detailed provisions for MRV as well as rules for the carbon market in the statutes of the World Climate Bank. There, a department with a taskforce of experts could be located who, in cooperation with country officials and national institutions, would conduct the review process sketched above. This role would have certain parallels to UN inspectors within the International Atomic Energy Agency, who are tasked with supervising how individual countries abide by a set of rules defined on the international level.

The mandatory audit and graduation process may sound like a complicated extra layer of bureaucracy but the practical constraints for implementing a global carbon market are not trivial. In practice, it is hard to see how a fully global carbon market would emerge almost instantaneously, as suggested by other proposals for global architectures. What is needed indeed is a realistic pathway that combines pragmatism with fundamental objectives of climate policy embedded in the architecture, such as environmental and cost effectiveness as well as equitable burden sharing.

Addressing leakage on the way to the global carbon market

The initially only partial – but growing – emissions coverage of the architecture proposed has consequences with respect to emissions leakage, which is linked to both environmental and cost effectiveness. Since a stringent cap in-line with scientific recommendations results in a significant carbon price signal for countries being part of the trading scheme, the price differential for fossil fuels and energy more broadly in non-participating countries will be widening. At the extreme, without additional measures investment decisions of companies would lead to a mere shifting of carbon emissions from capped to uncapped regions with no – or even detrimental – effects in environmental terms. Granted, the degree to which carbon leakage will emerge is not solely conditional on energy price differentials, as a host of other factors, such as infrastructure conditions and availability of human resources, are equally critical components in investment decisions. However, the environmental effectiveness of the climate architecture in the presence of incomplete geographic emissions coverage would be impacted at least to some degree.

Therefore, mechanisms need to be defined to prevent leakage effects as much as possible particularly during the transition period of the early years of the program, where emissions coverage is expanding. Simultaneously, since institutional capacity building in many developing countries will allow them to join the architecture only at a later stage, care needs to be applied so as not to penalize entire countries for not immediately being part of the emerging global carbon market. In this context, comprehensive border tax adjustments would be problematic for this transition period. An – admittedly more complex – option suggested here would be to assess selective border tax adjustments for variations in output resulting in higher exports into capped regions. Care needs to be taken to make such measures compatible with WTO rules that so far have tended to exclude the nature of the production process as a criterion that would allow a differential treatment of identical goods. The literature on this question is still evolving. In a recent report experts from the World Bank evaluate different options for border tax adjustments and conclude that such measures are in principle WTO-compatible (for a more detailed discussion, see Mattoo et al., 2009).

The specifics of the border tax adjustment rules to be created are not going to be developed here in detail and the implementation details would need to be determined on an expert level following the international negotiation process on the contours of the path toward a global carbon market. Making the measures selective to be determined on a case-by-case basis certainly creates a tension as to their objective implementation and administrative feasibility. Still, what is important is to have a policy instrument that *could* be applied. The existence of a mechanism and implementing rules could already help shape expectations of companies that shifting investment patterns on grounds of avoiding carbon charges would not be a viable long-term strategy.

The selective measures outlined above are designed to avoid strategic behavior of companies especially in the early years of the program, where global coverage of the carbon market is increasing. However, for outspoken veto players who make no effort of taking measures to prepare joining the global scheme and who try to block further advances in international climate policy, comprehensive and permanent border tax adjustments should be considered. This way, carbon leakage into these areas that stands to counteract mitigation efforts in capped regions could permanently be avoided.

Addressing energy price increases in developing countries

Increasing global coverage of the carbon market goes in hand with improving the environmental and cost effectiveness of the architecture proposed. These are very important benefits and constitute critical design criteria for global climate protection proposals. At the same time, reaping these benefits comes with consequences that also need to be addressed: establishing a broad carbon market results in a carbon price level that is uniform across the entire market. The carbon price differential for fossil fuels is thus the same in developed as well as in developing countries. In light of the severe quantitative emissions constraints in the decades to come compared to a business-as-usual case, substantial carbon prices will result. What is more, currently energy prices – and thus mostly fossil fuel use – in many developing countries are subsidized to make them even cheaper than their current market price absent any carbon pricing would be.

These facts need to be taken into account when designing an architecture that relies on a set of common principles with broad applicability. In the negotiation process ahead, it may turn out that additional tailor-made rules are required in certain areas to reflect the widely varying circumstances around the world. But even based on the set of universal principles described above, welfare effects on a consumer level due to higher energy prices could be largely compensated also in developing countries. Distributing auction receipts back to the population is fundamental in this context. Indeed, carbon pricing has the objective to change *relative* prices while redistributing auction proceeds restores overall purchasing power. Since developing countries receive net positive transfer payments by being part of the global carbon market, overall welfare is even set to increase.

In this context, it is essential for individual citizens to share in the climate rent in order not to be made worse off by climate policy. Parenthetically, this applies to both developed and developing countries. What needs to be implemented alongside the auction mechanism therefore is a system of returning the largest part of the climate rent directly to the population to compensate for higher energy prices, with the remaining funds available for strategic investments for mitigation and adaptation projects. While respecting national sovereignty remains crucially important in order to win support for the scheme proposed, the audit and graduation process could also ensure verifiable structures for distributing the climate rent to large parts of the population in view of supporting broad *public* acceptance for the carbon market also in a medium to long-term perspective. Such a requirement would be an additional incentive for improving governance structures, which could have benefits going beyond the domain of climate policy.

The discussion of these specific implementation aspects of the new global climate architecture proposed concludes the presentation of the main working elements. On the basis of this description, the architecture will be evaluated and scored in the framework used previously for other scientific proposals as well as the existing international climate policy landscape. The format will be more succinct given the comprehensive outline of key features in the preceding section.

Evaluation of the new framework proposed

Environmental effectiveness

Defining a global carbon budget compatible with science-based targets is the starting point of the architecture and a global quantity of 750 gigatons of fossil carbon dioxide emissions for the timeframe 2010-2050 is suggested. However, only partial global coverage is realistic for the early years of the program that is expanding over time as more countries are joining the carbon market. What is assumed, however, is widespread initial participation of industrialized countries along with a number of key transition economies to reach a critical mass early on, which goes well beyond the present-day patchwork carbon regulation. In the transition period to an even more global and comprehensive carbon market, the environmental effectiveness of the scheme is enhanced by measures targeting emissions leakage and strategic behavior of companies attempting to avoid carbon charges by shifting production into uncapped areas. Over the long run, veto players to global climate policy can be kept in check with permanent border tax adjustments.

In terms of environmental effectiveness, over the short to medium term, establishing a structure along the criteria proposed would have positive (“+”) effects: the majority of global CO_2 emissions would effectively be capped and set on an ambitious mitigation trajectory, while leakage effects would be minimized. As the carbon market expands, the question whether environmental effectiveness can become very positive depends on the degree of coverage ultimately achieved and by the same token whether remaining within the global carbon budget defined ex ante will be possible over the long run. If the coalition inside the carbon market consists of large and powerful players resulting in large enough disincentives for a blockade of global climate policy, then a dynamic evolution could be set in motion leading to practically complete global coverage over time. Therefore, the architecture described has the potential for very positive environmental effectiveness, with a split score ("+/++") reflecting the evolution of the scheme as its scope expands.

Cost effectiveness and investment implications

There are a number of similarities to the environmental effectiveness of the scheme when looking at aspects related to cost effectiveness. In fact, the degree to which *global* cost effectiveness in emissions abatement can be realized is strongly linked to the degree of coverage achieved through the global carbon market over time. Indeed, the effect of a uniform carbon price signal required for least-cost global emissions abatement would be limited if emissions coverage were significantly constrained. However, the assumption for the gradual build-up of a global carbon market is a starting coalition of a limited number of countries with large individual carbon dioxide emissions that together make up significantly more than half of global emissions. In addition, the combination of developed and developing countries initially under the cap would increase the pool of available abatement options and lead to optimized mitigation, since no country-specific reduction targets are defined at the outset. So even in a static, short-term perspective, the degree of cost effectiveness achieved by the framework proposed is considerable.

In a dynamic context, the flexible instruments for managing the timing of abatement on the level of the World Climate Bank as well as on a company level enhance intertemporal flexibility, while their specific design still guards against the risks arising from time inconsistency. It can be argued that with increasing global emissions coverage, the design elements proposed contribute to a maximum degree of cost effectiveness in emissions abatement also in a dynamic perspective, so that in the long run a very positive score ("++") seems appropriate.

The assessment for the transition period towards a global carbon market in cost effectiveness terms is less straightforward. The proposal outlined above does not include offset provisions for abatement measures undertaken outside the capped area along the lines of the existing Clean Development Mechanism. The problems of ensuring true additionality as well as the cumbersome registration process constitute a problematic practical experience with this approach. Yet a reformed CDM-like mechanism could well be integrated in the modular approach toward a global carbon market. This way, additional low-cost abatement options outside the cap could be accessed, thus lowering abatement costs in the short run.

However, even without this provision, the potential for cost-effective emissions abatement in the transition phase towards increasing global coverage is substantial, given the scope of the carbon market if major emitters were part of the scheme right from the start. In conclusion, a score of positive to very positive ("+/++"), depending on the time horizon, seems warranted. The scoring with respect to cost effectiveness thereby mirrors the assessment in terms of environmental objectives.

Equity

The distribution key for sharing the climate rent determined on a country-by-country basis is a direct translation of the degree of equity achieved within the climate architecture. It has been pointed out that the ultimate distributional principle needs to be determined in a – difficult – international negotiation process. Potentially, no one universal distributional principle will be agreed on but a compromise solution depending on political acceptability in different regions of the world will be found. This would mirror the current international negotiation dynamics, where some regions of the world display higher public acceptance for more ambitious climate policy (e.g., European Union) as compared to laggards at the current stage, such as the United States or Canada. This in turn would have implications as to the equity of the framework in exchange for enhanced political acceptability by some players.

Indeed, the fully flexible nature of the architecture proposed in terms of revenue sharing along with its potential for a dynamic adaptation of individual country shares over time can be adapted to any distribution that is acceptable by participating countries. Remember that any previous proposal for international burden sharing (e.g., contraction and convergence, etc.) can easily be translated into this architecture. Therefore, the equity dimension of the framework can only be judged ex ante with respect to an exemplary allocation of climate rents – the more fundamental evaluation will need to take place ex post after an agreement is reached and an actual distribution determined.

The distributional principle favored in the description of the framework in order to address the cost differential for transforming the energy system of countries least responsible for climate change together with transfers for adaptation funding is a concrete translation of the principle of common but differentiated responsibilities. On equity grounds, this burden-sharing formula can be justified as it specifically addresses additional burdens arising from climate change (polluter pays principle) without being an all-out redistributive scheme, such as the one proposed by WBGU (2009), which would over-compensate detrimental climate change effects especially in countries with very low per-capita emissions.

The remaining issue to be addressed is how to deal with countries that are not initially part of the emerging global carbon market. To recall, transfer payments are meant as an incentive to join the global framework and to accept overall quantitative limits on emissions. However, since it may take time to establish the necessary governance structures, the scheme may need to be complemented by additional provisions for interim adaptation funding without taking away the incentives for joining the emerging carbon market. Yet even as it stands now, the design proposed contains elements for a positive ("+") evaluation of equity aspects on a global basis – pending political acceptance of distributional principles that truly take common but differentiated responsibility and respective capabilities into account.

Institutional complexity and transaction cost

The framework proposed specifically focuses on the political and administrative requirements for making a global, integrated carbon market a reality. This is why a gradually expanding scheme is suggested and specific recommendations are made on how to ensure adequate measurement, reporting, and verification across the carbon market. The audit and graduation requirements for countries wanting to join the global framework are therefore a specific recommendation for implementing the scheme under real-world conditions.

Establishing a new global institution in the form of a World Climate Bank is a prerequisite for enabling emissions management within a global budget in a time-consistent way along with the enforcement benefits described previously in detail. It is true that defining the statutes and setting up this new institution is linked to transaction costs, so are the gradual build-up of a global carbon registry and the establishment of regular emissions allowance auctions on a global scale. The initial changes to the existing structure are therefore not negligible. However, similar to the arguments brought forward in the assessments of GCCS (Wicke, 2005) and the budget approach (WBGU, 2009), long-run institutional complexity and transaction costs for achieving the environmental objective in a cost-effective way are lower as compared to piecemeal patchwork solutions that fall short in terms of environmental and cost effectiveness.

Given the modular approach to building the carbon market that also takes veto players into account, the specifications for possible border tax adjustments indeed increase the transaction costs for running the scheme, so does the requirement for an audit and graduation process before linking up to the emerging carbon market. Again, these features become necessary as compared to first-best solutions, where full participation in a global carbon market is assumed from the outset and where no market imperfections exist. Clearly, the proposal developed here tries to take into account existing circumstances while showing a path towards realizing an outcome over the medium-term that more closely resembles a first-best solution to the climate change problem. In conclusion, the institutional complexity of the architecture proposed receives a neutral ("0") evaluation, with potentials for simplification over time.

Enforcement of compliance

Designing a system with robust mechanisms for enforcement was an important objective in defining the various architectural features of the proposal for a new international climate architecture. In particular, the role of the World Climate Bank is critical in ensuring the integrity of the global carbon market. This happens on two levels: first, with respect to ensuring that only countries with adequate MRV capabilities join the market. The audit and graduation scheme proposed is critical in this context. Second, by managing the global carbon budget centrally, political interference on a national level as to emissions quantities available can be prevented. This feature mitigates free riding once countries have become part of the global trading structure. It also guards against time inconsistency that ultimately would also present a barrier to enforcing compliance over the long run. Indeed, the fundamental principle of defining a global emissions limit and appropriate policy instruments for implementation instead of relying on national self-commitments is central to ensuring compliance in "real time" (see in contrast the evaluation of the Kyoto Protocol architecture).

In addition, further specific features of the architecture, such as three-year commitment periods and the reliance on auctions with a short periodicity, generate mitigation incentives for companies early on. Placing the point of regulation upstream reduces the number of regulated entities and makes this structure manageable from an administrative viewpoint despite its global reach. This practical advantage also enhances the enforcement of compliance, as unaccounted emissions can be more easily detected than under a much more complex downstream system.

Finally, relying on a flexible, expandable structure for the global carbon market that takes potential veto players into account and establishes mechanisms for preventing leakage into uncapped regions contributes to strengthening the stability of the coalition of countries cooperating in international climate policy. In turn, the long-term potential for enforcing the environmental objectives embedded in the architecture is much enhanced.

In light of the various elements designed to ensuring enforcement of compliance, the proposal merits the highest possible evaluation ("++") in this assessment category.

Political acceptability

The environmental objective – and *raison d'être* for the architecture proposed – is to keep global average temperature increase within 2°C above pre-industrial times. The broad political acceptability of this policy goal on the highest and broadest international level has been underscored most recently through the Copenhagen Accord. The observation made in the evaluation of the budget approach (WBGU, 2009) still holds that a quantified temperature threshold not to be crossed with a certain probability corresponds qua the laws of physics to a global greenhouse gas budget, particularly with respect to anthropogenic carbon dioxide emissions.

Beyond agreeing on a global carbon budget, the question of political acceptability principally revolves around two questions: first, whether it is possible for participating countries in the global carbon market to reach a mutually acceptable agreement on how to share the climate rent; and second, whether the requirements for international cooperation and new institutions to make goal achievement possible will lead to a corresponding transfer of national sovereignty.

In the structure proposed, the first question is addressed through a fully flexible revenue-sharing mechanism, which can easily accommodate adjustment components over time. The modular structure of the carbon market is a further component that enables countries where the political acceptability for a broad-based approach to climate protection exists to go ahead, while support for such a scheme is still emerging elsewhere. This is in contrast to other proposals discussed previously that require complete participation and initial agreement by all parties before operation can commence.

The second question relating to transfer of sovereignty to a new international institution is harder to evaluate. From a European perspective, it has been possible to reap the benefits of transnational cooperation and integration against bitter historical experiences. The historical context of great powers like the United States and China is very different, yet their participation is fundamental to solving the climate challenge. The Copenhagen negotiations have shown the difficulties in going beyond "pledge and review"-type policies towards more integrated approaches. Only time will tell whether a broader understanding for the need for globally integrated climate policy will emerge to reach an outcome, especially in environmental terms, that uncoordinated strategies cannot deliver.

Further design features of the architecture proposed, such as the flexibility mechanisms for intertemporal optimization of abatement, contribute to preventing price shocks on the carbon market and are conducive to a managed transition to a low-carbon global energy system. The provisions for border tax adjustments guard against emissions leakage and competitive disadvantages in the transition phase where global coverage is expanding.

The sum of individual design aspects enhances the political acceptability of the scheme without compromising basic target criteria, such as environmental and cost effectiveness. This is why a positive score ("+") in this category is given.

Summary evaluation of the proposal for a new climate architecture

The following scores were assigned in the different evaluation categories:

Evaluation criterion	Evaluation	Summary score
Environmental effectiveness	Positive/Very Positive	+/++
Cost effectiveness	Positive/Very Positive	+/++
Equity	Positive	+
Institutional complexity and transaction cost	Neutral	0
Enforcement of compliance	Very Positive	++
Political acceptability	Positive	+

Bringing it all together – choices and tradeoffs in global climate policy

The detailed assessment and evaluation of four climate policy architectures – the Kyoto Protocol and three academic proposals for global cooperative solutions – has led to the following summary scores:

Evaluation criterion	Kyoto Protocol	GCCS	Budget Approach	New climate architecture
Environmental effectiveness	-/--	+	+/++	+/++
Cost effectiveness	-	0	+	+/++
Equity	-	+	++	+
Institutional complexity and transaction cost	-	0/+	-/0	0
Enforcement of compliance	--	+	-/0	++
Political acceptability	+	0/+	-/0	+

The summary table indicates that no proposal is unequivocally superior in all six dimensions studied. Instead, tradeoffs become apparent that policymakers need to be aware of when negotiating global climate policy. At the same time, this observation does not imply that it becomes impossible to differentiate between the options studied and to give recommendations. A look at the currently operational architecture of the Kyoto Protocol indicates that this approach falls short on all three target criteria for climate policy (environmental, cost effectiveness, equity) as well on aspects of transaction cost and enforcement. Aside from current limits to political acceptability, the two existing proposals for global climate architectures studied – GCCS and the budget approach – fare better in all other five evaluation criteria. Relative to each other, GCCS has advantages in terms of transaction cost, enforcement of compliance, and political acceptability, whereas the budget approach puts environmental and equity principles even more at the forefront of system design.

The proposal for a new climate architecture developed in this paper takes one step closer to reality and puts forward a set of design principles consistent with the target criteria, which at the same time is applicable in a fragmented global policy landscape. This conscious choice enhances the chances for acceptance of the architecture while building a bridge to a more comprehensive scheme that will be necessary to contain climate change over the medium to long run. Limited initial tradeoffs in environmental and cost effectiveness are accepted, while even the outcome during the early operational phase remains far superior to the status quo given by the Kyoto Protocol. Enforcement of compliance is a point of particular emphasis in the system proposed, and this particularly also in a dynamic perspective to ensure time consistency.

Based on the evaluation results, I argue that the architecture presented here constitutes a major improvement over the current status of international climate policy. Moreover, in a number of aspects it also presents improvements over existing academic proposals. It is my hope that the design elements presented here will further contribute to advancing the discussion on how to shape future global climate policy – and ultimately contribute to enlightened policy choices.

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