Opportunities for and Alternatives to Global Climate Regimes Post-Kyoto

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Abstract

International policies for mitigation of climate change provide a global public good and thus suffer from "free riding," i.e., inaction of governments. In 25 years of negotiations under the UN Framework Convention on Climate Change (UNFCCC), the regime has changed its character from a top-down approach based on mandatory emissions commitments to a bottom-up system of voluntary government pledges. At the same time, various initiatives by governments at all levels and private companies have been established, but most are limited to emissions reporting and exchange of knowledge on mitigation technologies. None of the alternatives has shown a higher mitigation effectiveness than the Kyoto Protocol. Generally, the transition toward a bottom-up regime risks a reduction of transparency and increases in the transaction costs of mitigation. Although it could give rise to a club of countries engaging in strong mitigation that could expand over time, it is unlikely to be ambitious enough to achieve the target of limiting warming to 2°C. On the one hand, carbon prices will be applied in a larger number of jurisdictions, and mitigation technologies diffuse around the world. On the other hand, carbon price levels will remain relatively low, and their mitigation benefits will be more than outweighed by the growth of infrastructure and consumption. Thus, a temperature increase of at least 3°C by 2100 becomes more and more likely.

Contents

1. THE PRINCIPAL NATURE OF CLIMATE CHANGE MITIGATION AND ADAPTATION

1.1. Mitigation as a Global Public Good

According to Stocker et al. (1) climate change is caused by the increase of greenhouse gas (GHG) concentrations (CO_2, CH_4, N_2O, and certain industrial gases) in Earth's atmosphere. The majority of the increase is the result of CO_2 emissions from the combustion of fossil fuels, which provide the bulk of energy driving the global economy, as well as from deforestation. As emissions of GHGs

mix globally, emissions mitigation—for example, through replacement of fossil fuels by renewable energy, energy-efficiency improvement, destruction of industrial gases, and carbon capture and storage—achieves the same impact regardless of where in the world it happens. Stavins et al. (2) stress that mitigation is a global public good as nobody can be excluded from its benefits, and there is no rivalry among beneficiaries. Although the costs of mitigation accrue to the entity that mitigates, this entity cannot charge for the benefits. Therefore, there is an incentive to wait for mitigation efforts from others in order not to incur costs. Even if this free-riding incentive did not exist, mitigation would be politically unattractive for various reasons. Owing to long lags in the reaction of the climate system to changes in GHG concentrations, mitigation benefits are only generated in the long run, whereas mitigation costs accrue immediately. Given the pervasiveness of GHG emissions in industrial economies, the political weight of interest groups that would have to carry mitigation burdens is higher than that of those groups who benefit from mitigation activities, e.g., by an increased demand for products that are used for mitigation. As the baseline climate change and resulting damages are counterfactuals, the actual mitigation benefits cannot be monitored and verified. Because of these difficult characteristics, Victor (3, 4) suggests that a global mitigation policy regime is impossible. Although some game theorists such as Fuentes-Albero & Rubio (5) and Bréchet & Eyckmans (6) argue that a carefully designed transfer system could lead to a critical mass of participants, Bosetti et al. (7) see no transfer volumes high enough to overcome incentives for defection from the agreement. If the characteristics of climate change mitigation were to change with the availability of cheap methods for reducing the amount of solar radiation reaching Earth's surface (solar radiation management, SRM), the free-riding issue would lose its prohibitive characteristics (8). Kroll & Shogren (9) discuss in a game-theoretical framework how domestic politics influences the provision of mitigation. They find that mitigation contributions are higher if mitigation depends on domestic electoral considerations than if ratification of an international mitigation treaty is the key hurdle.

Experience with management of public goods shows that some societies, such as Swiss alpine farmers as well Japanese peasants, have been able to manage open access resources in a sustainable manner over centuries. They agreed on collective choice rules, including monitoring of the resource status and sanctions commensurate with the level of the damage (10). Elaborate conflict resolution systems as well as a compromise-oriented style of politics emerged, and cultural cohesiveness helped.

On an international level, only few instances of successful management of public goods exist. Transboundary water management has worked in various river basins for over 100 years (11). Epidemics prevention has made great strides under the aegis of the World Health Organization (12). Giddens (13) argues that the framing of mitigation policies to achieve a positive model of a low-carbon future could overcome the public good conundrum. In a similar vein, Eckersley (14) suggests that small groups of countries can engage meaningfully in mitigation.

Brewer (15) argues that mitigation can under certain circumstances become a club good whose benefits can be restricted to the members of the club. He illustrates this with the case of international shipping, where improvements in fuel efficiency are benefits derived from the mitigation agenda of the International Maritime Organization (IMO). International mitigation agreements could then be built on such clubs.

1.2. Mixed Private/Public Good Characteristics of Adaptation and Its Interaction with Mitigation

In contrast to mitigation, adaptation to climate change mostly is a private or club good. Adaptation has two key forms: preventing damages from (more) extreme meteorological events and adjustment

to slow changes in meteorological parameters that cumulatively require changes in human systems. Protection against climate change impacts usually can be done on an individual basis, such as the storm proofing of houses, or regionally, as in the case of use of sea/river walls against floods (16, 17). By contrast, research to produce drought-resistant cultivars or vaccines against vector-based diseases has public good characteristics. Because of the preponderance of the private goods characteristics, Tol (18) suggests that adaptation will politically become more attractive than mitigation. However, this ignores that adaptation needs to be continued over a long period and that initially successful adaptation measures may turn out to be maladaptation if climate change crosses certain thresholds. For example, irrigation systems that have been designed for increased runoffs owing to climate change–induced glacial melt will become obsolete once all glaciers in the catchment have vanished and thus become maladaptations at that point in time.

Theoretically, on the global level, an optimal combination of mitigation and adaptation can be found that minimizes the sum of the costs of mitigation, adaptation, and residual climate impacts (19). Given that the climate impacts cannot be estimated in a robust fashion and that costs accrue to different stakeholders, such an approach is unlikely to be operationalized in a world of sovereign states. Klinsky et al. (20) have found that the public indeed sees mitigation and adaptation as complements and not as substitutes where an increase of mitigation would reduce the need for adaptation, and vice versa. Seo (21) suggests that policy makers should focus on adaptation with mitigation cobenefits because pure mitigation would not be politically palatable.

UN Framework Convention on Climate Change (UNFCCC): the basis for international cooperation on climate change, supplemented by agreements defining mitigation and adaptation contributions

Conference of the Parties (COP): the annual UNFCCC meeting with several thousand participants from governments, observers, and media

Measurement, reporting, and verification (MRV): a system that measures mitigation contributions, reports them in a transparent way, and verifies them through independent agencies

2. EXPERIENCES WITH THE UN FRAMEWORK CONVENTION ON CLIMATE CHANGE PROCESS TO DATE

2.1. The Elements of the UN Framework Convention on Climate Change Process

Since the early 1990s, an international climate policy negotiation process has been ongoing. Compared to other international regimes, it has evolved relatively quickly, but its effectiveness is contested (22). The UN Framework Convention on Climate Change (UNFCCC) was agreed upon in 1992 and entered into force in 1994. From 1995, annual Conferences of the Parties (COPs) to the UNFCCC have been held to further develop the regime. The UNFCCC's Kyoto Protocol was signed in 1997, but its entry into force was delayed until 2005 when the necessary number of ratifications had been reached. Since then, negotiations about a new climate policy regime have been ongoing. After the high-profile failure of COP 15 in Copenhagen 2009, the Durban COP in 2011 agreed on a 2015 deadline for an agreement covering all UNFCCC member countries.

Having been ratified by 195 countries, the UNFCCC has almost universal membership. One critical shortcoming of UNFCCC-based negotiations is the need for consensus, as voting procedures have been blocked since the outset. From the start of the negotiations, their complexity has increased. Also, a fragmentation of negotiation groups has occurred, particularly among developing countries. Despite big changes in the economic parameters of these countries in the past 25 years, the dichotomy between industrialized (Annex I) and developing (non-Annex I) countries has so far prevailed but is set to be overcome by the 2015 agreement.

A key success of the UNFCCC to date is transparency regarding GHG emissions. Industrialized countries have to annually report GHG emissions according to common procedures; these reports are reviewed, and sanctions have been issued several times. The relevance of measurement, reporting, and verification (MRV) for a credible international climate change regime cannot be overestimated. Developing countries have published at least one GHG inventory but in varying quality and often for years far in the past.

With respect to common mitigation policy instruments, the UNFCCC has failed to date; it leaves instrument choice to its member states. Except for the Kyoto Protocol, there are no binding requirements for mitigation. The Copenhagen conference of 2009 failed because key governments of emerging economies were unwilling to take up commitments, and governments of industrialized countries saw this as a necessary condition to deepen their commitments (23).

International Emissions Trading (IET): the direct transfer of emissions units between governments

Clean Development Mechanism (CDM): a mechanism that generates emissions credits from mitigation projects in developing countries

2.2. The Kyoto Protocol: Glass Half Full or Half Empty?

The Kyoto Protocol defined binding GHG emissions commitments for the period 2008–2012 for 38 industrialized countries. These commitments took on the characteristic of magic numbers, with a reduction of 6% for Japan, 7% for the United States, and 8% for the European Union compared to 1990. Russia and Ukraine steadfastly refused to go beyond stabilization, and Australia got a bonus linked to a decrease of deforestation in the first half of the 1990s.

From the outset, the Protocol was plagued by the unwillingness of key countries to participate. The United States never ratified it, and Canada withdrew in 2011 because its conservative government wanted to avoid the noncompliance procedures. By contrast, Australia joined after a change in government in 2007. Russia, whose participation was decisive for the Protocol's entry into force, was only convinced in 2004 when the European Union threatened to block its entry into the World Trade Organization (WTO).

After the failure of the Copenhagen conference to replace the Kyoto Protocol with a more far-reaching agreement, progressive states in the negotiations pushed for a second commitment period, which was agreed upon in 2012. However, only a small group of countries continues to participate—those in the European Union and the European Economic Area countries (Norway, Iceland, and Liechtenstein), as well as Australia and Switzerland.

The commitments of the first period have been reached, but only partially owing to dedicated mitigation policies. Especially Eastern Europe, Russia, and the Ukraine witnessed massive emissions decreases as a result of the economic transition away from obsolete heavy industry. This generated a surplus of over 13 billion t CO_2 equivalent (eq.) emissions units compared to the Kyoto Protocol targets, the so-called hot air (24). In Western Europe, the economic and financial crisis since 2008 and the related decrease in industrial production led to a significant emissions reduction. However, it can be shown that renewable energy policies have been accelerated by the Kyoto Protocol (25). An unexpected success of the Kyoto Protocol was the surprising scale and reach of its market mechanisms. This has triggered a lot of academic debate, often following ideological faultlines [see Stephan & Lane (26) for a detailed summary of the anti-neoliberal critique of the mechanisms]. Direct government-government transactions were possible through International Emissions Trading (IET). Researchers had initially expected that IET would dwarf all the other mechanisms (27), but transactions were few owing to the unwillingness of Western governments to buy hot air and corruption risks (28). In the second commitment period, sales of hot air were essentially banned, and thus, Russia and the Ukraine have to date refused to sign up. The Clean Development Mechanism (CDM) generated over 1.5 billion t CO_2 eq. emissions credits through over 7,500 projects in 90 developing countries (29). This was mainly driven by the ability to use CDM credits in the EU emissions-trading system (EU ETS), as well as by governments buying credits to ensure compliance with their commitments. An elaborate regulatory system was created to ensure the credibility of the credits. Its cornerstone was the use of independent auditors to validate the consistency of project documentation with the CDM rules and to verify emissions reductions achieved by the projects. Several hundred methodologies for the calculation of emissions baselines and monitoring of emissions reductions were developed. Although the concept of additionality, i.e., that a CDM project would not happen under a business-as-usual situation, was

initially difficult to operationalize [with a significant share of registered projects being criticized by observers for not being additional (30)], since 2007 regulators have successfully tightened the rules (31). However, contributions to the sustainable development targets of the host countries were only partially reached (32), and complaints arose regarding the high profit margins for industrial gas projects (33). Overall, the CDM has shown that an international market mechanism can flourish if it provides direct monetary incentives to private sector actors and has a limited role for national governments in its administration.

Joint Implementation: a mechanism that generates emissions credits from mitigation projects in countries with emissions commitments under the Kyoto Protocol

Joint Implementation, which was limited to projects in industrialized countries, lagged behind, mostly due to institutional challenges in countries in transition (34). However, in late 2012, over 300 million credits were generated in a few weeks, but this was because the Ukraine and Russia wanted to launder hot air that could no longer be sold through IET. The attempts to ensure a high quality of mitigation through reinvestment of Joint Implementation revenues in Green Investment Schemes could not prevent that (35).

Owing to the lack of demand for emissions credits in the period 2013–2020, which was caused by both low emissions targets and increasing barriers to the import of emissions credits, the price for emissions credits collapsed. Therefore, a lot of the human capacity built up was lost, and trust in the long-term stability of market mechanisms and their incentives for mitigation has been severely shaken (36, 37).

The Kyoto Protocol has an elaborate noncompliance mechanism, which has been successful in ensuring compliance with MRV rules (38, 39). However, sanctions are expressed in terms of units of future commitment periods and thus do not really serve as deterrents. Enforcement powers are largely absent (40). Moreover, countries can withdraw with one year notice, as Canada did. Game theorists see it as almost impossible to develop sanctions for enforcement of mitigation commitments that are credible and can be sustained over time (41).

2.3. Increasingly Dysfunctional Conditions Since Copenhagen

The Bali conference in 2007 decided that by 2009 a new international climate policy regime should be specified. The Danish government was able to mobilize over 100 heads of state to participate in the Copenhagen conference of 2009 but could not overcome gridlock. When the United States, China, and India, the COP heavyweights, tried to salvage the conference by drafting a short bare bones decision text, in the final conference plenary, the powerless countries, such as the small island state Tuvalu and the socialist countries of Latin America, revolted. Therefore, the Copenhagen Accord could not be decided under the UNFCCC (22), and it took several years of painstaking work to bring its key elements back on the UNFCCC track through agreements in Cancun 2010 and Durban 2011.

The key reason for the failure of the Copenhagen COP was a reduction of salience of mitigation policies in key industrialized countries, which had just been rocked by the financial crisis (42). Moreover, the increasing differentiation of the group of non-Annex I countries led to growing uncertainty in the negotiations. Emissions of emerging economies have multiplied several times since 1990, especially in the case of China. These countries have realized that, in order to reach the Copenhagen Accord's target to limit global warming to less than 2°C, they would have to severely reduce emissions by 2050 even if the industrialized countries reduced their emissions by 80% (see **Figure 1**). Therefore, they set up the new negotiation group, BASIC, to call for the continued ability to increase emissions, with a peak to be reached decades into the future. Subsequently, China supported the emergence of the group of like-minded developing countries, which promotes persistence of the differentiation into Annex I versus non-Annex I countries (43). Although more and more researchers argue [Winkler & Rajamani (44) and de Coninck et al.

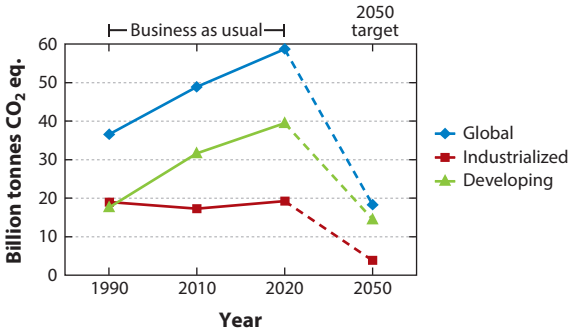

Figure 1

The mitigation challenge for developing countries in the Copenhagen negotiations. The value for developing countries is the difference between the global and industrialized country values. Data sources: global level (52). Industrialized countries in 1990 and 2010: UNFCCC inventories, in 2020 (52). Abbreviations: CO_2 eq., carbon dioxide equivalent; UNFCCC, UN Framework Convention on Climate Change.

(45)] that the dichotomy between these country groups is obsolete, the negotiation positions have hardened.

The Copenhagen Accord asked industrialized countries to submit quantified economy-wide emissions targets for 2020, and these were submitted by 42 countries. Developing countries were asked to submit a list of mitigation actions; these were received from 45 countries. Dellink et al. (46) estimate that fulfilling these pledges would lead to a gross domestic product loss of 0.3%, whereas den Elzen et al. (47) see costs between 0.1 and 0.15% of gross domestic product. Peterson et al. (48) see a cost range between 0.1 and 0.7%. Since Copenhagen, the UNFCCC has brought the pledges under its purview through the decision of the Cancun conference (49), and they are likely to form the basis of the post-2020 agreement scheduled for the Paris conference in late 2015 (50, 51). The United Nations Environment Programme (UNEP) has annually analyzed the mitigation gap between these pledges and an emissions path that would be consistent with the 2°C target. It has found that the gap is significant and has not been declining over time (52), a conclusion that is confirmed by a meta-study by Höhne et al. (53). **Figure 2** provides an overview of the development of climate policy regimes between Copenhagen and Paris.

3. EXPERIENCES WITH ALTERNATIVES TO THE UN FRAMEWORK CONVENTION ON CLIMATE CHANGE TO DATE

The slow progress of the UNFCCC negotiations since 2009 has led to an intense discussion about whether other approaches could achieve mitigation in a more effective manner (54, 55). Such approaches could theoretically take various forms—from international agreements outside the UNFCCC to coordinated approaches on the national and subnational level (56). Only a limited number of them have become operational; the majority remains on a theoretical level. The term transnational initiatives has recently been coined for the alternatives that involve subnational and private actors (57, 58).

3.1. Other UN Treaties

The Montreal Protocol on Substances that Deplete the Ozone Layer has 197 member states and has been universally acclaimed for its effectiveness in the reduction of ozone-depleting substances,

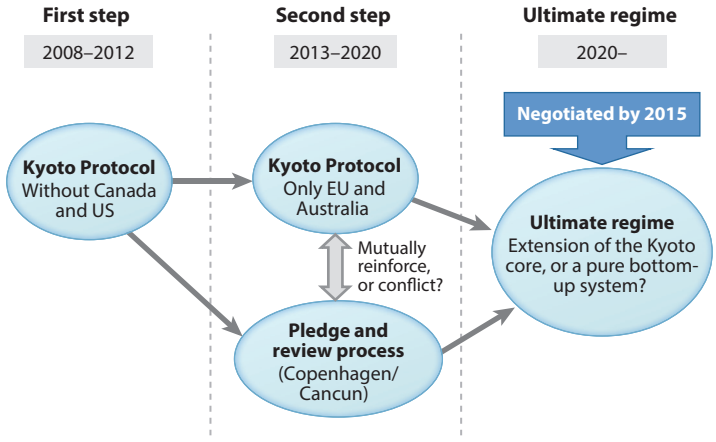

Figure 2

The shifts in the international climate policy regime between 2008 and 2020. Whereas before 2009, international climate policy was characterized by a top-down regime with centrally defined rules under the Kyoto Protocol, since then, a coexistence of a top-down (Kyoto Protocol) with a bottom-up regime (Copenhagen pledges) has emerged. It remains to be seen whether the future regime after 2020 will become exclusively bottom up or whether it retains some centrally determined rules. Abbreviations: EU, European Union; US, United States.

which are also strong GHGs (59, 60). Currently, its member countries are discussing whether hydrofluorocarbons, which were introduced as replacements for ozone-depleting substances, should be subject to a mandatory phase-down schedule. However, for several years no progress has been made, as especially India and China argue that this issue is covered by the UNFCCC. These initiatives may contribute on the order of one to a few hundred million tonnes of CO_2 eq. to reduce the 2020 mitigation gap (52, 61, 62).

The WTO plays a potentially significant role when it comes to mitigation measures that have an impact on trade. So far, the UNFCCC has tried to avoid potential conflicts with the WTO, such as the introduction of border adjustments to reduce the competitive impacts of domestic mitigation policies. Also, the increasing protectionism with regard to the trade of emissions credits from market mechanisms has not yet been challenged at the WTO. A WTO dispute settlement procedure that would give the green light for border adjustment measures to bolster domestic mitigation policies and/or to reduce protectionism with regard to emissions credit transactions could be a crucial trigger for more ambitious mitigation policies. Branger & Quirion (63) see a significant reduction of carbon leakage, i.e. the shift of emissions-intensive activities outside of jurisdictions that have introduced mitigation policy instruments through border adjustment.

3.2. Sectoral UN Organizations

Emissions from international transport that reach about 2% each of global emissions for shipping (64) and aviation (65) are not covered under the Kyoto Protocol. Therefore, UNFCCC negotiations have tried to engage the sector organizations International Civil Aviation Organization (ICAO) and International Maritime Organization (IMO) in mitigation (15). As ICAO was not able to come up with a stringent mitigation approach, the European Union included international flights in the EU ETS from 2012. Owing to strong diplomatic pressure, the

European Union put this on hold in 2013 to allow ICAO to promote more serious measures. ICAO agreed to design a market-based mechanism for reduction of air traffic emissions by 2016 and to implement it by 2020. In 2011, the IMO despite opposition by Brazil, China, India, South Africa, and Saudi Arabia adopted an energy-efficiency index for new ships that entered into use in 2013. Ships built between 2015 and 2019 are to improve efficiency by 10% compared to business as usual; those built between 2020 and 2024 should improve by 15 to 20%, depending on the ship type; and after 2024, 30% efficiency improvement is required. Haites (66) suggests distinct trading schemes for ICAO and IMO that could eventually be linked.

3.3. Country Clubs

Over time, various initiatives have been developed among small groups of countries, covering large shares of global GHG emissions. Many of these initiatives have significant participation by the private sector.

Among the government-only initiatives, the Major Economies Forum on Energy and Climate convened by the United States and covering 80% of global emissions primarily acts as a discussion club (67). The almost identically set-up Group of Twenty (G20) involving governments and central bank governors from major economies has repeatedly discussed removal of fossil-fuel subsidies and is seen as a valuable negotiation forum by Hurrell & Sengupta (68) but has not achieved anything on the ground. In contrast, the Group of Eight (G8) highly industrialized nations was the first country grouping that—in 2009—formally endorsed the target that warming should not exceed 2°C from preindustrial levels (69).

Initiatives that involve both government and private companies have expanded considerably over time. The Asia-Pacific Partnership for Clean Development and Climate was launched by the United States and Australia as an explicit alternative to the Kyoto Protocol. Karlsson-Vinkhuyzen & van Asselt (70) and McGee & Taplin (71) found a modest impact on governance, e.g., by working groups involving major companies but no impact on emissions. It fizzled out after Australia ratified the Kyoto Protocol. The Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (CCAC) focuses on black carbon (which is not covered by the UNFCCC inventory guidelines and Kyoto Protocol rules), methane, and hydrofluorocarbons. Emissions reduction potential from the initiative is an estimated 0.4 million tonnes black carbon in 2030 compared to a business-as-usual path and an absolute reduction of 80 million tonnes by 2050 (72). CCAC has a solid architecture and could serve as a role model. The Methane to Markets Initiative tries to mobilize reductions of methane emissions from various sources. Despite the hitherto unconvincing results, Weischer et al. (73) and Garibaldi & Arias (74) see the future of international climate policy in self-selecting clubs with differing rules for mitigation. Winkler & Beaumont (75) are more skeptical; they view fora outside the UNFCCC as "useful for airing different points of view, achieving better understanding, and brainstorming possible solutions" (p. 650), whereas decisions should continue to be made by the UNFCCC.

3.4. Subnational Jurisdiction Clubs

In countries whose governments have been reluctant to participate in the Kyoto Protocol, subnational entities have joined forces to engage in proactive mitigation policies. The most prominent example is the Western Climate Initiative, which initially covers a significant number of US states and Canadian provinces. This initiative has led to the emergence of emissions trading in California

and Quebec but has lost a number of members after it became clear that the United States and Canadian federal governments would not introduce emissions trading (76).

City governments have set up various GHG reduction initiatives (77). A Climate Alliance of European cities was set up in 1990 and now has 1,700 members, many of which have introduced a local emissions target. The International Council for Local Environmental Initiatives' Cities for Climate Protection program started in 1993. More recently, large metropolises have become engaged, for example, in the C40 Cities Climate Leadership Group (78) or the Covenant of Mayors. Although their performance in reaching targets was decidedly lackluster (79), the initiatives have led to participation of many local governments in monitoring and reporting their emissions (80).

3.5. Private Sector Clubs

The private sector has repeatedly teamed up with think tanks and nongovernmental organizations to launch initiatives related to GHG emissions. Among the proliferating initiatives (81), three stand out. The World Resources Institute has collaborated with a number of companies to develop a common standard for emissions reporting, the Greehouse Gas Protocol. More than 90% of Fortune 500 companies are reporting emissions under the Carbon Disclosure Project, and some researchers (82) see this as a basis for future regulation. The Cement Sustainability Initiative has developed emissions benchmarks for cement companies. However, Kolk et al. (83) do not find that these initiatives change investment toward low-carbon options. Lovell & MacKenzie (84) stress that the private sector has developed various accounting systems for GHG emissions. Pattberg (85) sees an important role for public-private partnerships.

A comparison of the alternatives to the UNFCCC is shown in **Figure 3**, where dark blue shapes denote international treaties, light blue ones indicate sectoral UN organizations, orange ones represent mixed initiatives by governments of various levels, and red ones indicate private sector initiatives.

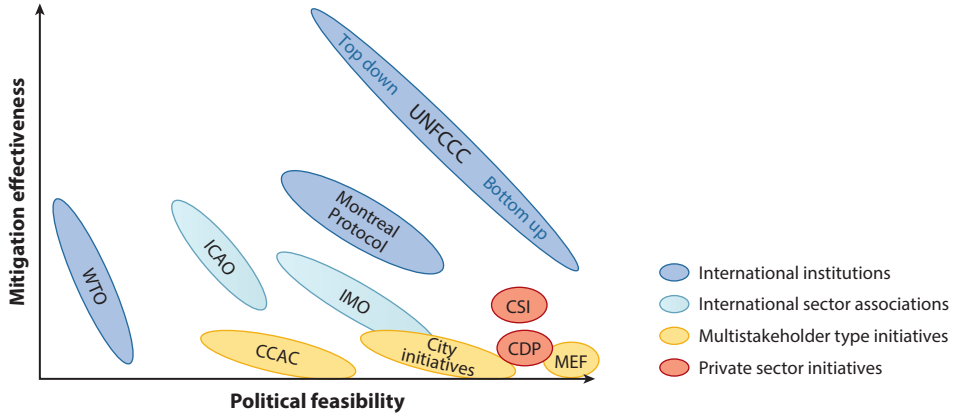

Figure 3

Mitigation effectiveness and political feasibility of the UN Framework Convention on Climate Change (UNFCCC) and alternatives to it. The length of the shape shows the trade-off between stringency and political feasibility that is inherent in each alternative, with some alternatives having more scope for change than others. Abbreviations: CCAC, Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants; CDP, Carbon Disclosure Project; CSI, Cement Sustainability Initiative; ICAO, International Civil Aviation Organization; IMO, International Maritime Organization; MEF, Major Emitters Forum; WTO, World Trade Organization.

4. TOP-DOWN APPROACHES BASED ON MANDATORY EMISSIONS COMMITMENTS

Principally, a global climate policy agreement can take the form of country-wide mandatory emissions commitments for specific commitment periods and include policy instruments that allow achievement of an efficient mitigation outcome. Hare et al. (86) stress that such a regime is required to successfully address the climate change problem. In a system with national commitments, mitigation efficiency depends on the mobilization of the options with the lowest mitigation costs, while sustaining incentives for mitigation technology development. A particularly far-reaching form of agreement would also harmonize the domestic policy instruments. Bodansky (87) sees huge difficulties in getting agreement on commitments, and Hoffmann (88) sees the complexity of the issue as the key reason why top-down approaches would fail.

4.1. Indicators for Burden Sharing

The key challenge is now to define the principles and indicators that specify the stringency of commitments, honoring the principles of common but differentiated responsibility and respective capacity enshrined in the UNFCCC (89–93). Responsibility can be linked to the GHG emissions levels. Key questions relate to the historical responsibility and whether emissions should be indexed to population levels or economic activity (see, e.g., 94, 95). Capacity can be expressed in the form of development parameters, such as income or aggregated indicators, e.g., the Human Development Index. Eventually, a system of concentric circles of commitments could be developed, where countries graduate from one circle to the next as their development progresses (96).

Briner et al. (97) stress the importance of periodic consultations on mitigation contributions, and the existence of safety valves to accommodate unexpected shocks, such as economic crises and natural disasters.

4.2. International Market Mechanisms

In a system where every country has a national emissions commitment, efficiency can theoretically be achieved by an international emissions trading system (98). This requires universal application of a robust MRV system. As long as there are countries or economic sectors not covered by the commitment, emissions reductions in these countries can be harnessed by project-based offset credits that can be used for fulfillment of the commitments.

4.3. Harmonization of Domestic Mitigation Policy Instruments

Given the experience with the first commitment period of the Kyoto Protocol, Cooper (99) proposed a harmonization of mitigation policy instruments among countries. In a similar vein, Bradley et al. (100) proposed sectoral agreements where mitigation commitments would be agreed among international industry associations, not governments. The introduction of emissions trading would be most appropriate for economic sectors with large point sources, whereas emissions taxes are most effective for sectors with distributed emissions. Emissions trading systems suffer from the political challenge to use allocation mechanisms that burden powerful emitter interests; the ideal mechanism would be auctioning. Experiences with emissions trading have shown that overallocation is endemic [Branger et al. (101) for the European Union, Jotzo & Löschel (102) for China]. Price volatility has limited investment in mitigation under emissions trading schemes. A key challenge for harmonizing taxes is the variation of exchange rates over time. Owing to the

drawbacks of pure systems, hybrid systems that allow trading in a range between a floor price and a price cap have gained popularity.

4.4. Technology Development and Diffusion

Pure, politically realistic carbon-pricing instruments are unable to promote technology development, as technologies in an embryonic stage are never competitive with mature technologies (103), and the political willingness to increase carbon pricing to a level that is sufficient to mobilize new technologies is generally lacking. Therefore, specific instruments are required to finance new technologies. There is no silver bullet instrument for that purpose (104). Technology agreements such as those proposed by de Coninck et al. (105) so far have not received significant results.

4.5. Direct Transfers (Climate Finance)

Given the incentive to free ride on an international climate policy agreement, transfer payments have been suggested to provide an incentive for participation. Hourcade et al. (106) propose a climate finance system linked to an agreed social cost of carbon. Such payments can be earmarked for mitigation or adaptation. The challenge is that under budget constraints the willingness of governments to provide climate finance is rather limited. Moreover, the ability to frame climate finance in many ways obfuscates the real transfer levels.

5. BOTTOM-UP APPROACHES: EACH GOVERNMENT DOES WHAT IT LIKES

In the post-Copenhagen climate policy discussions, bottom-up systems have gained in prominence (56), and there is an increasing consensus that the COP 21 Paris agreement (in late 2015) will essentially be a pledge and review system (107, 108). Governments will communicate emissions reduction pledges [which in UNFCCC jargon are intended nationally determined contributions (INDCs)], and these will be assessed according to a set of centralized rules overseen by the UNFCCC. Under such a system, the stringency of the commitment to reducing emissions is likely to be relatively low, so the assessment procedure and its ability to lead to an increase of stringency in pledges are crucial.

Höhne et al. (109) discuss the various forms pledges can take. Briner & Prag (110) discuss the common rules used to guide the establishment of country pledges, e.g., by defining the types of emissions target definitions that are eligible. For example, emissions targets could be limited to those defined in absolute terms, excluding intensity-based ones. Moreover, base years and target years or periods could be predefined. The Lima COP 20 in 2014 did not follow this route but essentially allowed governments to define their pledges as they liked. It specified only that fairness and ambition of pledges should guide establishment of the INDCs and that adaptation could also be covered.

A second field for common rules would be the review of pledges to assess whether they are sufficiently ambitious (111). Originally, it had been expected that INDCs would be published by early 2015 to allow implementation of a review before the Paris COP in late 2015, which would then see a revision of the pledges to become nationally determined contributions. However, the Lima COP was unable to agree on any firm deadline. Thus, a review will only be possible after Paris.

A centralized review through UNFCCC institutions could follow the precedent of the review of national GHG inventories, where expert review teams assessed rule conformity. In case of noncompliance, eligibility to use flexible mechanisms could be withdrawn.

Key aspects of centralization also relate to the questions of whether emissions units can be freely transferred between governments and whether certain minimum quality parameters would have to apply to the pledge to allow transfers of units. This relates to the issues of whether MRV of emissions levels would also be centralized and whether minimum requirements could be defined (112, 113).

Under a bottom-up system, policy instruments such as emissions-trading schemes in various jurisdictions could be linked (114). Direct linkage increases liquidity, increases access to mitigation options, and smooths price variability (115, 116). However, given experiences with linking in the past, it requires a high degree of similarity to prevent contamination of an ambitious system by a less ambitious one (117). Linking of other policy instruments as proposed by Metcalf & Weisbach (118), such as multicountry emissions taxes or linking of emissions taxes with project-based offsets, will even be more difficult. Despite 25 years of carbon taxation, no harmonization between countries has been achieved to date, and governments have been increasingly unwilling to accept foreign emissions credits (119) because they fear pushing prices down to levels where domestic mitigation is no longer attractive. The reaction of the EU ETS prices to the massive imports of CDM credits is an illustration of this effect (120). Therefore, it seems rather unlikely that linking could play a strong role in a world of widely varying pledge types.

A bottom-up regime requires linkages and careful interaction between the involved institutions to minimize conflict (121). By contrast, Ostrom (122) stresses the potential of polycentric governance to mobilize mitigation, i.e., the interplay of a plethora of institutions on various levels of aggregation.

6. ADVANTAGES AND DISADVANTAGES OF BOTTOM-UP APPROACHES

Given the ongoing shift from a top-down to a bottom-up international climate policy regime, it is imperative to understand how the former and the latter perform with regard to environmental effectiveness, cost-effectiveness, and distributional and institutional feasibility (123).

6.1. Advantages

Barrett & Stavins (124) and Victor (3) argue that given the global public good nature of climate change mitigation bottom-up approaches are the only realistic way to achieve mitigation contributions. The history of international climate negotiations since 2009 is seen as an indicator that the top-down approach has failed. Even the Kyoto Protocol is evaluated by some as just following a business-as-usual path and thus being devoid of environmental effectiveness (125). The majority of researchers, however, finds the Protocol cost-effective for mitigation but insufficiently stringent (126). Briner et al. (97) stress that flexibility with regard to the type of contributions as well as the structure of the 2015 agreement is required to make the agreement durable and to achieve widespread participation. Cole (127) stresses that bottom-up approaches allow experimentation and learning to improve policies over time and that they increase communications and interactions on multiple levels. This would help to build the trust needed that would eventually lead to increased cooperation. Morgan et al. (128) propose a predictable commitment cycle to achieve increasing emissions goals over time.

If governments are unwilling to contribute to mitigation as such, the level of cobenefits of mitigation would determine the degree of commitment to reducing emissions. Of course, theoretically such cobenefits should have already been harnessed under an optimal policy course, and thus, mitigation would be zero. Given a second-best situation where policy makers act according to the short-term interests of powerful groups, an increase of the salience of mitigation might lead to the discovery of cobenefits (129) and a nonzero mitigation outcome. Edenhofer et al. (130) hope that carbon prices can emerge in various ways owing to differentiated reasoning—air pollution cobenefits in emerging economies and revenue generation in industrialized countries.

From a marketing perspective, bottom-up approaches can be flexibly aligned to national circumstances. For example, a rapidly growing economy can choose an intensity target, whereas a stagnating one would prefer an absolute contribution (131). Marschinski & Edenhofer (132) stress that intensity targets are more appropriate for developing country circumstances than absolute targets. Base years and target periods can be chosen according to the national emissions profile. Sectoral approaches can exclude those sectors where mitigation is difficult to mobilize (133). So purely voluntary national contributions under a bottom-up regime do not have negative distributional consequences but obviously also do not generate significant mitigation.

Given these characteristics of a bottom-up approach, agreement would be much easier than on a top-down approach that generates significant burdens for specific parties. Thus, institutional feasibility is high.

6.2. Disadvantages

A bottom-up approach, especially if not underpinned by common rules regarding parameters for target setting and MRV, leads to a loss of transparency and a significant level of transaction costs (134). This can be shown empirically in the case of the fragmentation of market mechanisms (see **Figure 4**), which has led to the emergence of a variety of prices for emissions credits and emergence of the need to make a project charismatic in order to attract buyers (135, 136).

If one takes into account that policy makers are receptive to pressure by international nongovernmental organizations and media, a bottom-up approach would lead to a lower level of stringency than a top-down approach. Environmental effectiveness of the agreement is thus likely to be low.

7. CAN SIGNIFICANT EMISSIONS MITIGATION BE ACHIEVED?

International climate policy is currently facing serious challenges. The top-down regime developed during the 1990s is now dismantled in favor of a bottom-up regime. But neither the top-down regime in its current form nor the emerging bottom-up regime is likely to achieve a global emissions path that would be consistent with the 2°C target (52). Nevertheless, it should be acknowledged that the top-down regime has clearly led to a deviation from a business-as-usual emissions path and that a bottom-up regime with a sufficient degree of transparency would enable such a deviation in the future, particularly if carbon prices are introduced in key countries (2).

7.1. International Climate Policy: A Victim of the Tragedy of the Commons?

In recent years, the persistence of economic crises and emergence of geopolitical tensions not seen since the end of the Cold War have led to a loss of salience of policies addressing long-term issues such as climate change (137). Policy makers do not hesitate to openly dismiss relevance of mitigation, especially those of conservative and right wing parties, such as the Republicans in

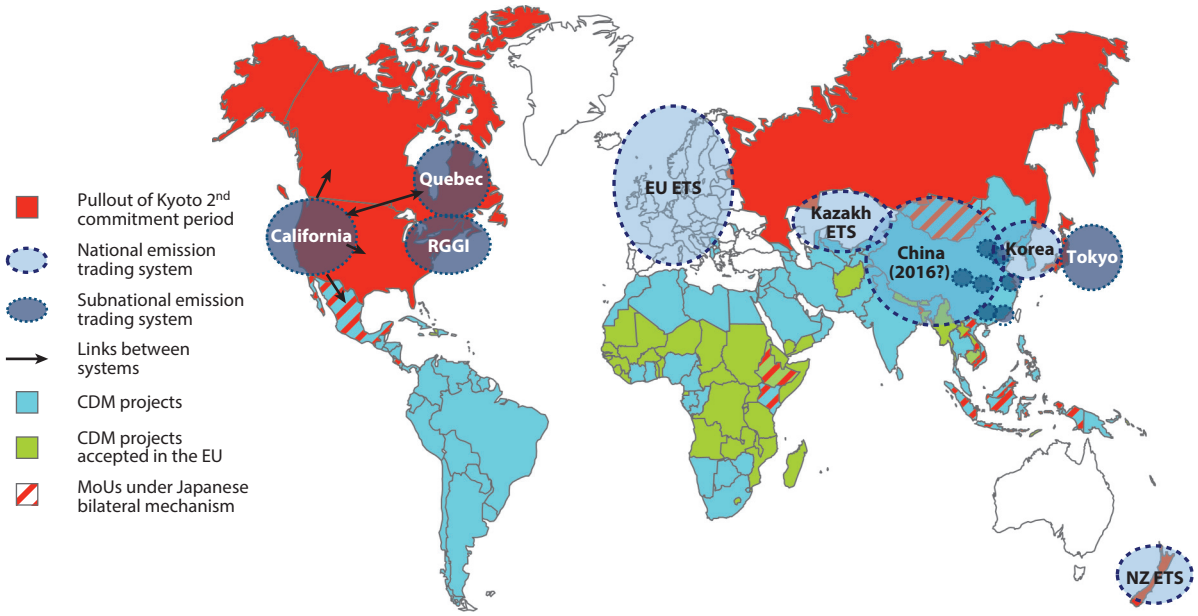

Figure 4

Fragmentation of market mechanisms. Abbreviations: CDM, Clean Development Mechanism; ETS, emission-trading system; EU, European Union; MoU, memorandum of understanding; NZ, New Zealand; RGGI, Regional Greenhouse Gas Initiative.

the United States, the Conservatives in Canada, and the Liberals in Australia (138). Although introduction of carbon pricing is slowly advancing throughout the world, an implicit political acceptance ceiling is reached at a level of US$20–30/tonne CO_2 (104), a level that would not be sufficient to reach the 2°C target (47).

Although extreme meteorological events, such as hurricanes Katrina and Sandy, have led to a short boost in public interest (139), none of them has been strong enough to trigger significant strengthening of mitigation policies in industrialized countries or the willingness to shoulder burdens in the international negotiations. Recurrent impacts of extreme events in developing countries are likewise unable to trigger anything other than short-term disaster relief. How strong would events have to become to overcome free riding?

The political response to forest dieback in Europe in the 1980s (140) could give an indication of what is required to trigger a significant policy response. An ecosystem or activity that is seen as crucial for the national identity needs to be threatened to mobilize public opinion. Once climate change impacts destroy iconic national parks or prevent people from engaging in national sports, such as skiing in Norway and Switzerland, pressure from the population to seriously engage in mitigation will rise. However, the latter can be deferred by technical measures, such as artificial snowmaking (141) or the change of habits.

7.2. Outlook for the 2015 Agreement

The Paris agreement is expected to become a hybrid between top-down and bottom-up regimes (142, 143), with latest tendencies reducing top-down elements. Oberthür (144) discusses what a compliance mechanism should look like. Whether a bottom-up agreement can generate robust mitigation remains to be seen. *The Emissions Gap Report 2014: A UNEP Synthesis Report* (52) stresses

the growing distance from a 2°C emissions path since the Copenhagen Accord was signed and thus is skeptical that bottom-up mitigation will be sufficient in the long run. But if a critical mass of countries develops a climate club (15, 73) that introduces strong mitigation policy instruments, positive dynamics could be generated that would lead to a significant emissions reduction. Which of these futures is realistic may become clear around 2030.

7.3. Long-Term Scenarios for International Climate Policy for 2030 and 2050

Two extreme scenarios of international mitigation are sketched in the literature. A logical continuation of a pure bottom-up approach would lead to anarchy (145, 146). Each government would limit mitigation to no-regrets measures that are either directly profitable or generate sufficient cobenefits to justify the costs. International cooperation would dwindle to minimal levels, such as the exchange of emissions inventory data. According to Stocker et al. (1), following the present baseline emissions path will lead toward 4°C and more warming by 2100.

If extreme hydrometeorological events trigger political pressure in a critical number of countries, a coordinated mitigation policy with significant top-down elements might become feasible, anchored in a long-term mitigation path consistent with the 2°C target. Emissions budgets would be allocated to countries according to an indicator set agreed on in the UNFCCC process (86). Market mechanisms and direct climate finance would mobilize mitigation in emerging economies and contribute to development in the poorest countries. Adaptation transfers would focus on highly performing activities in the poorest and most vulnerable countries (147).

The most likely scenario would lead to a slow accretion of governments to a core of governments supporting strong mitigation action. In this scenario, carbon prices would cover a significant share of global emissions (130) but would rise only slowly, and temporary setbacks for mitigation policies would occur. Mitigation technologies would mainly be developed in these core countries and diffuse in emerging economies, but the growth of infrastructure and consumer middle classes would outpace this improvement and lead to overall emissions increases. By the end of the century, the temperature increase might exceed 3°C (148).

7.4. Climate Engineering: A White Knight or Pandora's Box?

In case the impacts of hydrometeorological extreme events rise rapidly, political pressure to solve the climate change problem may become so strong that policy makers would be unable to engage in mitigation strategies except those that would require many years to show visible effects. In such a situation, they may turn to climate engineering technologies that promise a rapid solution at insignificant costs. Although knowledge of such technologies remains scanty, a detailed assessment of the literature by the National Research Council (149) finds that SRM by putting sulfate aerosol into the stratosphere is the most attractive candidate. If the optimistic assumptions are confirmed, the costs of this option may be so low that small states or even rich individuals could stop temperature increase unilaterally (8). Use of SRM might lead to a tug of war between different states about the ideal temperature level (150) and show that the governance of SRM may be as contested as the governance of weapons of mass destruction. SRM technologies can have the character of club goods that allow exclusion of geographical areas from their benefits.

The most problematic aspect of climate engineering is the possibility of indirect impacts on meteorological variables, such as wind systems and precipitation. Even though the often portrayed risk of disruption of the South Asian monsoon is probably rather small, a decrease in precipitation would be likely. Attribution of changes to an SRM intervention would be very difficult (149).

SUMMARY POINTS

1. The global public good characteristics of climate change mitigation make it a wicked problem and lead to free riding by governments. Adaptation is less of a public good but has characteristics that have limited its role in international climate policy.
2. The UNFCCC started as a top-down process, culminating in the Kyoto Protocol, but since 2009 has developed toward a bottom-up regime owing to the reduced political salience of climate change issues.
3. The Kyoto Protocol's market mechanisms have been utilized intensively and unexpectedly harnessed a wide range of mitigation technologies in many developing countries.
4. None of the government-only alternatives to the UNFCCC has achieved significant mitigation contributions, but they may have contributed to the transparency of emissions by various levels of government and the private sector.
5. A top-down regime has the advantage of high transparency and common rules for implementing mechanisms for the minimization of mitigation costs, but it is currently not politically feasible.
6. A bottom-up regime is politically feasible but unlikely to go beyond business-as-usual approaches in a significant manner, unless a club of countries forms that pushes mitigation. Moreover, it reduces transparency and increases transaction costs.
7. Because a stringent top-down regime is not feasible and because of the ineffective goals set by bottom-up regimes, the 2°C target is very likely out of reach. A temperature increase of 3°C or more by the end of this century becomes more and more likely.
8. If impacts of hydrometeorological extreme events become politically unbearable, policy makers will be tempted to engage in SRM, with the risk of significant side effects and strong challenges to international governance.

FUTURE ISSUES

1. What mitigation policy instruments can a climate club implement without suffering significant competitive disadvantages? What role would the WTO play?
2. How can carbon markets be designed in a bottom-up regime?
3. How can transparency of mitigation contributions be assured in a bottom-up regime?
4. Under what conditions could government- and private-sector-driven alternatives to the UNFCCC provide significant contributions to mitigation?
5. How can governance of climate engineering be designed to limit negative side effects?
6. Under what conditions could a top-down climate policy system become realistic?
7. What combination of policy instruments can drive implementation of innovative mitigation technologies?
8. How can the performance of adaptation actions be compared to channel adaptation financing to the most effective uses?

DISCLOSURE STATEMENT

The author is founder of and shareholder in the consultancy firm Perspectives, which supports governments and other stakeholders on climate policy instrument design, particularly market mechanisms. Beyond that, the author is not aware of any affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

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RELATED RESOURCES

The UN Framework Convention on Climate Change website provides all the documents of the negotiation process. It also includes a wealth of material presented by observer organizations at side events to the negotiation sessions: **http://unfccc.int/2860.php**

The Climate Action Tracker website assesses the pledges of 30 countries regarding their consistency with the 2°C target: **http://climateactiontracker.org/**

The Greenhouse Development Rights website allows one to calculate country commitments according to Baer et al. (94): **http://calculator.climateequityreference.org/**

The UNEP Danish Technical University website provides extremely detailed databases on the Clean Development Mechanism and Joint Implementation: **http://cdmpipeline.org/**