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Chapter 13

International Cooperation: Agreements and Instruments

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Chapter 13: International Cooperation: Agreements & Instruments

Contents

Executive Summary

This chapter surveys and synthesizes the literature on international policies, institutions, and agreements pertaining to climate change. The chapter's scope includes climate policy principles and architectures; lessons from existing climate and non-climate international agreements; linkages between such agreements and regional and national policies; interactions between climate change policy and other policies; and the performance of climate policies and institutions.

Climate Policy Principles and Architectures [13.2, 13.3, 13.4]

Climate change is a global commons problem, because greenhouse gas (GHG) emissions from any source mix globally in the atmosphere and have global impacts. For this reason, broad international cooperation is necessary for significant mitigation of climate change impacts. If one country or sub-national entity were to reduce emissions, the climate benefits provided by those reductions would also be distributed across the globe—in the form of reduced concentration of greenhouse gases, relative to what would have been the case without the abatement in question. No one could be excluded from those benefits, despite their not having shared in the costs of mitigation. On the other hand, the climate benefits accruing to the firm or individual that reduced emissions would be insignificant relative to the mitigation costs incurred. As a result, there is very little incentive from climate benefits alone for firms and individuals (and countries) to reduce emissions in the absence of international cooperation *(High Agreement, Robust Evidence; Very High Confidence)* or local co-benefits of mitigation.

A key challenge is to design international policies or agreements that attract sufficient participation. Conceivable agreements and instruments intended to solve the collective action problem of climate protection exist in the context of several framing concepts and principles and can be evaluated along a number of dimensions, including four assessment criteria: environmental effectiveness, aggregate economic performance, distributional impacts, and institutional feasibility. [13.2]

While substantial attention in international policymaking has been on the United Nations Framework Convention on Climate Change (UNFCCC) processes, a notable change since the Fourth Assessment Report (AR4) is that the landscape of international cooperation on climate has become significantly more complex. Climate change is addressed by an increasingly broad range of policies and institutions, which span all scales of governance *(High Agreement, Robust Evidence; Very High Confidence)*. [13.3]

The literature considers numerous potential approaches to international cooperation that could facilitate progress on climate change mitigation and adaptation. These approaches vary along several dimensions, including the degree to which they are centrally organized and managed. At one end of the spectrum is strong multilateralism, whereby countries and regions agree to a high degree of mutually binding rules or standards to guide their actions--for example, fixed targets and timetables for emission reductions. The Kyoto Protocol is an example of such an approach. A less-centralized approach would structure international cooperation around harmonized national policies, where national or regional policies are made compatible through, for example, harmonized carbon taxes, cap and trade schemes, or standards. Finally, at the other end of the spectrum of international cooperation, decentralized architectures may arise out of heterogeneous regional, national, and sub-national policies, which may vary in the extent to which they are internationally linked. [13.4]

Existing International Agreements [13.5, 13.12, 13.13]

The UNFCCC is currently the only international climate policy institution with both virtually universal membership and the authority to serve as a venue in which governments can negotiate agreements to address climate change. International cooperation has brought about political agreement to recognize the goal of limiting global temperature increase to no more than 2°C, although the overall level of mitigation produced to date by such cooperation appears inadequate for this purpose *(High Agreement, Medium Evidence; High Confidence)*. International cooperation yielded emission-reduction commitments for the period 2008-2012 by industrialized countries through the Kyoto Protocol of the UNFCCC, facilitated by the three flexible mechanisms: the Clean Development Mechanism (CDM), Joint Implementation (JI), and international emissions trading (IET). A second Kyoto commitment period was established in late 2012, for the period 2013-2020, albeit covering a considerably smaller set of countries. UNFCCC parties, in cooperation, established a process in December 2011 in Durban, South Africa, to develop, by 2015, "a [new] protocol, another legal instrument or an agreed outcome with legal force under the Convention applicable to all Parties." This new mode of cooperation would become effective in 2020.

As noted, climate change is also addressed in other plurilateral and multilateral fora, such as the Montreal Protocol, the Major Economies Forum on Energy and Climate, and the G20. A prominent development since AR4 is the emergence of a large number of transnational climate governance initiatives, which are agreements not centred on sovereign states. These include: public-private partnerships, private sector governance initiatives, NGO transnational initiatives, and sub-national transnational initiatives. [13.12]

The multitude of these often fragmented climate fora has been dubbed the "regime complex," or more broadly the "institutional complex." The literature considers the potential advantages of this new complex: greater flexibility and efficiency in the negotiation process in smaller fora, and the ability for agreement to emerge from smaller groups and then expand. But the literature also reflects possible key disadvantages: lower legitimacy due to a lack of universal membership, and lower environmental effectiveness due to insufficient participation and resulting potential emissions leakage to countries outside the agreement *(Medium Agreement, Medium Evidence; Medium Confidence)*. [13.5]

Linkages between Climate Policies [13.6, 13.7]

As a complement to an international agreement on climate change, linkages among existing and nascent regional, national, and sub-national programs are a potentially important form of international cooperation. While policy linkage can take several forms, linkage through carbon markets has been the primary means of regional policy linkage due to the greater opportunities for trade as carbon markets expand. A number of carbon markets have accepted emissions credits from the project-based Kyoto Mechanisms, CDM and JI, and effectively have led to a deeper international market. This has generated substantial demand for carbon market credits, of which nearly 1.5 billion – each equivalent to 1 tonne of avoided CO_2 – had been issued by the end of 2012. On the national and sub-national level, multiple examples exist; a few notable examples are the EU Emissions Trading Scheme (EU ETS), which since 2005 brings together 27 European Union member states and also includes Norway, Liechtenstein, and Iceland; the planned linkage between the EU ETS and the Australian system; and the U.S. state of California, which was set to link with one or more Canadian provinces after California's cap-and-trade system began operating in January 2013.

The benefits of policy linkage may include lower mitigation costs, decreased emission leakage, increased credibility of market signals, and increased liquidity due to expanded market size. Linking national policies with international policies may also provide flexibility by allowing a group of parties to meet emissions reduction obligations in the aggregate. However, policy linkage may also increase transaction costs and raise the concern that the linked policies will be diluted (as enforcement in linked systems is only as stringent as the weakest among them), and that countries may be unwilling to accept an increase in mitigation costs that could result from linking with a more ambitious system *(Medium Agreement, Medium Evidence; Medium Confidence)*.

Interactions Between Climate Change and Other Policies [13.8, 13.9, 13.10, 13.11]

Many interactions exist between climate change and other policies and issues, such as sustainable development, non-climate environmental domains, poverty alleviation, public health, international trade, international security, technology transfer, energy subsidies, human rights, capacity building, and investment and finance.

To elaborate on some of these examples, first, interactions between climate change policy and trade are marked by a diversity of synergies and conflicts. Trade and climate interact at many levels including: World Trade Organization-related issues; regional and bilateral trade agreements; and international agreements governing maritime transportation and aviation. [13.8]

Second, international technology-oriented agreements may also play an important role in the climate regime, particularly where they have the potential to lower mitigation costs. Such agreements could include activities for knowledge sharing, joint collaboration and funding of research and development, technology transfer, and technology deployment. [13.9]

Third, climate change policies can be complemented by capacity building in developing countries to promote effective implementation by creating an enabling environment for mitigation, adaptation, monitoring and evaluation activities. Central to many capacity building activities are institutional development and systemic observation. [13.10]

Fourth, governance of investment and finance for climate change mitigation and adaptation are important foci of international climate negotiations. The last decade has seen new dedicated finance mechanisms created as well as the strengthening of policies to mobilize private investment and finance for climate change mitigation. [13.11]

The Performance of Climate Policies and Institutions [13.13]

Qualitative and quantitative performance assessments of international policies and institutions that have addressed (or could potentially address) climate change have been carried out in terms of four criteria: environmental effectiveness, aggregate economic performance, distributional impacts, and institutional feasibility. In the case of environmental effectiveness, assessments have examined the performance of the Kyoto Protocol and its market mechanisms. Significant emission reductions have taken place in Annex I countries, though relative reductions have been greater in economies in transition, where they were the result of economic factors, as well as the Kyoto Protocol. Overall, the Kyoto mechanisms, particularly the CDM, have demonstrated the institutional feasibility of carbon markets on a large scale, have contributed to reducing aggregate mitigation costs, and started to set a global price signal. Further, agreements inside and outside of the UNFCCC have been assessed, including the Major Economies Forum for Energy and Climate, the G20, and voluntary carbon markets; their performance remains unclear due to a lack of concrete action to date, with the exception of the Montreal Protocol—and the voluntary market to a smaller extent. Performance assessments of proposed architectures have included assessments of examples of strong multilateralism, harmonized national policies, and decentralized architectures and coordinated national policies. [13.13]

13.1 Introduction

Due to global mixing of greenhouse gases (GHGs) in the atmosphere, induced climate change is a global commons problem. For this reason, international cooperation is necessary to achieve significant progress in mitigating climate change. This chapter critically examines and evaluates the ways in which agreements and instruments for international cooperation have been and can be organized and implemented, drawing upon evidence and insights found in the scholarly literature. The retrospective analysis of international cooperation in the chapter discusses and quantifies what has been achieved to date and surveys the literature on explanations of successes and failures.

The topical scope of the chapter is defined by the range of feasible – indeed conceivable – international agreements and other policy instruments for cooperation regarding climate-change mitigation and adaptation, as well as related environmental and economic issues. The disciplinary scope spans the social sciences of economics, political science, international relations, law, public policy, and sociology; relevant humanities, including history and philosophy; and – where relevant to the discussion–the natural sciences. Not all analytic methodologies are appropriate for every topic discussed in the chapter, but where appropriate, the chapter synthesizes literature that utilizes econometric modelling, integrated assessment modelling, comparative case studies, legal analysis, and political analysis.

After the introduction, the chapter continues in section 13.2 with a consideration of useful framing concepts and principles, including the "tragedy of the global commons," and an assessment of conflicts and complementarities among these principles. Next, potential criteria for assessing means of international cooperation are introduced, including aggregate economic performance, distributional and social impacts, and institutional feasibility.

Section 13.3 turns to lessons for climate policy from current and past international agreements, including implications for participation and for compliance. Agreements assessed include not only international climate regimes, but also other international environmental agreements, as well as international agreements on other issues.

Section 13.4 examines alternative climate policy architectures, starting with an examination of the key generic elements of international cooperation: the legal character of an agreement; country participation and burden-sharing methods; and flexible mechanisms. Then, we examine in general terms and with specific examples three categories of approaches to international climate policy cooperation: strong multilateralism; harmonized national policies; and decentralized architectures and coordinated national policies.

Section 13.5 examines existing multilateral and bilateral agreements and institutions across various scales, starting with international schemes: climate agreements under the United Nations; other climate-focused forums; and international coalitions. Transnational agreements between subnational actors or institutions across state boundaries are also considered, as are relationships with other potentially relevant institutions.

Section 13.6 assesses linkages between international and regional cooperation, with some focus on links among regional and international carbon markets, as well as links with other regional policies. Section 13.7 provides an analogous investigation of the linkages between international and national policies. It also examines collaboration among other international arrangements and various national and sub-national institutions.

Section 13.8 considers the relationship of climate change policy with international trade policy, focusing on: World Trade Organization (WTO)-related issues; regional and bilateral trade agreements; other international venues; public goods, club goods, and trade; and implications for alternative policy options.

Section 13.9 turns to mechanisms for technology development, transfer, and diffusion, starting with the rationale for such mechanisms, followed by an examination of alternative modes of international incentive schemes to encourage investment flows. Also considered are the relationship between intellectual property rights and technology development and transfer, and modes of international collaboration intended to encourage knowledge development and sharing.

Section 13.10 focuses on capacity building in five areas: mitigation and adaptation; monitoring and information sharing; institutional development; mechanisms for technical assistance; and an assessment of the current status of assistance for capacity building. Section 13.11 covers the topic of investment and finance, beginning with modes of governance for public and private financial flows, and then turning to the implications for international cooperation. The respective roles in international cooperation of the public and private sectors and of public-private partnerships are the subject of Section 13.12.

Finally, section 13.13 provides a performance assessment of policies and institutions for international cooperation on climate change, beginning with a performance assessment of existing forms of cooperation: the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol, as well as agreements outside of the UNFCCC. Then, the performance of proposed modes of international cooperation is considered according to criteria developed in section 13.2.

13.2 Framing concepts for an assessment of means for international cooperation

This section introduces the key concepts and criteria for analysing international cooperation on climate change. It builds on earlier IPCC reports. In the Third Assessment Report, Toth et al. (2001, p. 607) list three features of climate change that could well be addressed through international collaboration: the public-good nature of climate protection, the multiplicity of decision makers involved, and the heterogeneity of emission levels and climate change impacts around the world.

13.2.1 Framing concepts and principles

13.2.1.1 The global commons and international climate cooperation

Global climate change is caused by a global commons problem, because GHG emissions from any source mix globally in the atmosphere and have global impacts. As a result, mitigation of climate change through emissions reduction, enhancement of sinks, and climate engineering yields shared global benefits from which it is difficult to exclude any individual or institution. These public good characteristics of climate protection create incentives for actors to "free ride" on other actors' investments in mitigation or carbon dioxide removal (CDR) efforts. Therefore, underinvestment in mitigation and overuse of the atmosphere as a receptor of GHGs are likely. A possible partial exception could be solar radiation management (SRM) (see Sections 13.4.3 and 6.9.2), to the extent that SRM strategies yield heterogeneous regional impacts with benefits to some regions and costs to others (Moreno-Cruz et al., 2012; Robock et al., 2010). As a consequence, SRM might appear attractive to those who perceive resulting local benefits that would not be shared with others. The governance implications of this characteristic of SRM are discussed in Section 13.4.3.

Incentives to free ride on the use of the atmosphere and on climate protection have been analysed extensively and are well-understood (Gordon, 1954; Hardin, 1968; Stavins, 2011). The literature suggests that in some cases effective common property management of local open-access resources can limit or even eliminate overuse (Ostrom, 2001; Wiener, 2009).

Public goods problems may be addressed through policies that incorporate "external" costs and benefits into prices, providing incentives for private actors to more optimally reduce external costs and increase external benefits (Baumol and Oates, 1988). A particular case to avoid underprovision of public goods through pricing is the use of "matching mechanisms". Under such schemes, the contributions of some agents are subsidized by others in such a way as to attain the optimal amount of the public good in a decentralized way (Nordhaus (2006) for applications to climate change, and Boadway et al. (2007) and Bucholtz et al. (2011, 2012) on this type of mechanism in general). Public goods problems may also be addressed through legal remedies, such as seeking injunctive relief (order of prohibition a wrongful action) or compensatory payments (Gupta, Tirpak, et al., 2007; Faure and Peeters, 2011; Haritz, 2011).

Coordinated action has advantages even if the global nature of climate change makes its management particularly challenging (WCED, 1987; Kaul et al., 1999, 2003; Byrne and Glover, 2002; Barrett, 2003; Stewart and Wiener, 2003; Sandler, 2004). It could cope with: actors that are multiple and diverse in their perceptions of the costs and benefits of collective action; emissions sources that are geographically widespread; mitigation costs that vary (are heterogeneous); and the impacts of climate change that are uncertain and distant in space and time (Toth et al., 2001, pp. 607–608).

However, in the absence of universal collective action, smaller groups of individual actors may be able to organize schemes to supply public goods, particularly if the groups are small, know each other well, expect repeated interactions, can exclude non-members, and can monitor and sanction over-consumption (Eckersley, 2012; McGee, 2011; Nairn, 2009; Ostrom, 1990, 2010a; b, 2011; Weischer et al., 2012).

Some authors are optimistic regarding minilateralism (e.g (Keohane and Victor, 2011)) and others are more sceptical (e.g. (Winkler and Beaumont, 2010) or (Depledge and Yamin, 2009)). The global nature of the climate problem makes it difficult to reach a solution only with a small set of countries. Section 13.3 discusses the literature on coalitions, and section 13.4 discusses advantages and disadvantages of alternative degrees of centralization in climate architecture.

Possibilities of decentralization in internalizing external costs could occur both at the national and international level. At the national level, incentives to adopt and implement policies that seek to provide climate protection are weak due to free riding and powerful interest groups preventing collective action (Olson, 1971; Victor, 2011), although local co-benefits may promote some mitigation efforts. These incentives could be strengthened by the creation of coalitions of constituencies or the activities of policy entrepreneurs who introduce and help implement new ideas into policy practice (Wiener and Richman, 2010; Rabe, 2007a; Schreurs and Tiberghien, 2007; Kern and Bulkeley, 2009). At the international level, because there is no world government, and each country must consent to a treaty to be bound by that treaty, policies need to attract participation in international regimes, if they are to be effective (Barrett, 2003, 2007; Stewart and Wiener, 2003; Schmalensee, 2010; Brousseau et al., 2012).

Considering climate benefits alone, there is very little incentive for firms, individuals, or countries to reduce emissions in the absence of international cooperation. However, some emission reductions can occur without cooperation as the positive externality of otherwise self-beneficial actions, such as actions to reduce energy expenditure, enhance the security of energy supply, and reduce local air pollution. These co-benefits of climate protection are receiving increasing attention in the literature (Rayner, 2010; Dubash, 2009; UNEP, 2010a). On the other side, policies designed to address greenhouse gas mitigation may also have adverse side-effects (which are analyzed in Chapter 5 and in each sectoral chapter).

FAQ 13.1. Given that GHG emissions abatement must ultimately be carried out by individuals and firms within countries, whom governments have jurisdiction over, why is international cooperation necessary?

International cooperation is important to achieve significant emissions reductions for a number of reasons. First, climate change is a global commons problem due to the fact that greenhouse gases globally mix in the atmosphere. In the absence of collective action, overuse of the atmosphere as a receptor for greenhouse gas emissions is therefore likely. Climate protection is a global public good and no individuals, firms, or nations can be excluded from the benefits of climate policy actions. These characteristics create incentives for actors to “free ride” on others’ investments in climate protection. Second, international cooperation helps to give every country the same opportunities and ascertain how responsibilities are to be divided among them given principles adopted in international agreements (see 13.3). Third, international cooperation allows for linkages between national and regional policies, which may reduce mitigation costs, increase credibility of price signals, and expand market size and liquidity. Fourth, international cooperation may help to bring international science and knowledge together to craft policy instruments that are most likely to be effective. Finally international cooperation allows parties to take advantage of existing international agreements and coalitions in related areas such as forests, renewable energy, trade, investment, technology transfer and intellectual property rights to enhance effectiveness of climate protection policies.

Though firms and individuals are indeed the actors that ultimately must reduce their emissions, they do not generally have the authority to make commitments to international agreements that form the basis of international cooperation. Thus, negotiations intended to address climate change are among national governments, though firms and groups representing civil society provide significant input to these processes. Section 13.2 and 13.3 go into more detail.

13.2.1.2 Principles

Several principles have been advanced to shape international climate change policies. In the IPCC's Third Assessment Report, Banuri et al. (2001) discuss principles and mention some criteria for evaluation of policies, whereas in the Fourth Assessment Report (Gupta, Tirpak, et al., 2007), principles are clearly differentiated from criteria. Principles serve as guides to design climate policies, while criteria are specific standards to evaluate them.

Several principles are enumerated and explained in international climate change fora, including the Rio Declaration on Environment and Development (UNEP, 1992) and the UN Framework Convention on Climate Change (UNFCCC, 1992). In the latter, the principles listed explicitly include: "equity," "common but differentiated responsibilities and respective capabilities" (Article 3(1)), relative needs, vulnerability, burdens in countries of differing wealth (Article 3(2)), "precaution" and "cost-effectiveness so as to ensure global benefits at the lowest possible cost" (Article 3(3)), and "sustainable development" (Article 3(4)). While the principles themselves may remain similar, policies that apply them will change as economies evolve over time (Stewart and Wiener, 2003; Barrett, 2010; Keohane and Victor, 2011).

Principles can be grouped into five broad categories. First, the principle of maximising global net benefits makes the trade-off between aggregate compliance costs and aggregate performance benefits explicit and also incorporates the notion of seeking efficiency by maximising the difference between aggregate benefits and costs (Stern, 2007; Nordhaus, 2008; Bosetti et al., 2010). A related concept is that of cost-effectiveness, which allows for policies with the same level of performance to be compared on the dimension of aggregate cost (Toth et al., 2001; Gupta, Tirpak, et al., 2007). See chapter 3 for more details.

Second, the precautionary principle emphasizes anticipation and prevention of future risks (Bodansky, 2004; Wiener, 2007; Urueña, 2008). Some see precaution as a strategy for effective action across diverse uncertain scenarios (Barrieu and Sinclair-Desgagné, 2006; World Bank, 2010), pp. 54–55), although the application of precaution varies across risks and countries (Hammit, 2010). A key ongoing debate concerns whether or not this principle implies the need for stringent climate policies as an insurance against catastrophic outcomes, even if they may have very low probability (Weitzman, 2007, 2009, 2011; Pindyck, 2011; Nordhaus, 2011). The link of the precautionary principle to climate risk is further discussed in Chapter 2.

Third, sustainable development is a principle that, broadly defined, emphasizes the need to consider the resource needs of future generations in making decisions about current resource use (IPCC, 2007, chap. 12; World Bank, 2010, pp. 39–48). For a detailed discussion on the vast literature on sustainable development, see Chapter 4.

Fourth, the principle of "common but differentiated responsibilities and respective capabilities" (CBDRRC) has been central in international climate negotiations (Rajamani, 2006, 2011a). The literature refers to the varied historic responsibility—and current capability and capacity—of countries with regard to climate change (Jacoby et al., 2010; Rajamani, 2006, 2012b; Höhne et al., 2008; Dellink et al., 2009). Some literature assesses how the principle might be applied to actors' diverse needs (Jonas, 1984; Dellink et al., 2009). The literature reveals competing views regarding the meaning of this principle, regarding its legal status, operational significance, and the obligations it may entail (Höhne et al., 2006; Halvorssen, 2007; O'Brien, 2009; Winkler et al., 2009; Winkler, 2010; Hertel, 2011). CBDRRC is further analyzed in Chapters 3 and 4.

Fifth, fairness is a principle that emphasizes distributive justice across and within countries and across and within generations (Vanderheiden, 2008; Baer et al., 2009; Okereke, 2010; Posner and Sunstein, 2010; Posner and Weisbach, 2010; Somanathan, 2010; Cao, 2010c). The principle of fairness includes evaluating the procedures used to reach an agreement as well as the achieved outcome. This principle may also apply in a broader assessment of well-being (Sen, 2009; Cao, 2010a). For detailed discussion of such ethical concepts, see Chapter 3.

13.2.2 Potential criteria for assessing means of international cooperation

The principles elaborated above may inform the identification of criteria for choosing among agreements and instruments that are intended to solve the collective action problem of climate protection. Criteria may be traded off against each other (Barrett and Stavins, 2003) and the set of possible instruments displays a considerable variety of interactions (Aldy and Stavins, 2007, 2010a; Barrett, 2007; Gupta, Tirpak, et al., 2007). Gupta et al. (2007, p. 751)have also put forth one set of criteria: environmental effectiveness, cost-effectiveness, distributional considerations, and institutional feasibility. Table 13.1 shows the relationship of these criteria, with cost-effectiveness replaced by "aggregate economic performance" in order to also capture the principle of economic efficiency, to the principles elaborated above.

Table 13.1: Principles and criteria

Criteria (13.2.2)	Principles it draws on (13.2.1.2)
Environmental effectiveness	Precaution Sustainable development
Aggregate economic performance	Maximising global net benefits (economic efficiency) Cost-effectiveness
Distributional impacts	Sustainable development Common but differentiated responsibilities and respective capabilities Fairness
Institutional feasibility	Precaution Common but differentiated responsibilities and respective capabilities Fairness

The selection of "metrics of success" influences both ex-ante assessments of alternative policies, and ex-post evaluations of actual performance (Hammitt, 1999; Fischer and Morgenstern, 2010). In addition to the selection of evaluation criteria, policy evaluation can be considered in the context of four caveats: First, an ex-ante evaluation of a policy may overestimate the costs and/or the benefits of that policy, by overestimating the extent of its implementation (Harrington et al., 2000; Harrington, 2006). Second, ex-ante evaluation may favour a policy, because interactions between proposed policies and other existing policies may be difficult to predict. These interactions can be benign, counterproductive, or beneficial (Goulder and Stavins, 2011; Levinson, 2012).

Third, while evaluation of proposed policies can be informed by lessons learned from regime complexes in other contexts (see section 13.5), such lessons may come with extrapolation bias, since the generalizability of findings in other contexts applied to the climate context is unknown. Finally, in comparing existing policies using these criteria, it can be helpful to keep in mind that as institutions evolve, the performance of particular policies may also change, limiting the ability to evaluate policies ex-ante. These caveats hold in Section 13.13, where assessment criteria are applied to evaluate instruments and policy measures.

13.2.2.1 Environmental effectiveness

A primary environmental objective of international cooperation has been to stabilise GHG concentrations at levels sufficient to "prevent dangerous anthropogenic interference" with the climate system. Presumably, this would require action within a time-frame sufficient to "allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner" ((UNFCCC, 1992), Article 2). The Kyoto Protocol established specific emission reductions for developed countries, while the Copenhagen Accord, recognized a goal of limiting increases in average global temperature to 2° C above pre-industrial levels (UNFCCC, 2009a, 2010, 2011a), and so expressed environmental effectiveness in terms of global average temperature increase. There are three distinct categories of actions around each of which metrics to measure environmental effectiveness can be developed (Section 6.3.2). First, GHG emissions from anthropogenic sources can be reduced, for example by switching from high-emission technologies to low-emitting ones. Second, atmospheric GHG concentrations can be reduced, in addition to emissions reductions, by methods of sequestration that remove these gases from the atmosphere by enhancing sinks (biological sequestration, e.g. in forests), as well as other geo-engineering forms of carbon dioxide removal (CDR) (e.g. ocean iron fertilization or capturing gases directly from the atmosphere and storing those underground). Third, global temperatures can be directly reduced through solar radiation management (SRM) projects that change the earth's surface albedo, or reflectivity, to intercept sunlight before it reaches the Earth or reflect more heat back out into space. (See Sections 13.4.3 and 6.9.2) The impacts of climate change can be reduced through increasing resilience and adaptability in the face of damages from climate change. (See also the report of Working Group 2, particularly Chapters 14-17).

13.2.2.2 Aggregate economic performance

Economic efficiency refers to the maximization of net benefits, that is, the difference between social benefits and social costs (Stern, 2007; Nordhaus, 2008; Bosetti et al., 2010). Calculation of a policy's net benefits involves the summation of monetized benefits of environmental performance and the full measure of social cost.

Cost effectiveness refers to the ability of a policy to attain a given level of environmental performance at least cost, taking into account impacts on dynamic efficiency, notably technological innovation (Jaffe and Stavins, 1995). Unlike net benefit assessment, cost effectiveness analysis takes the environmental performance of a policy as given and seeks the least-cost strategy to attain it (Hammitt, 1999). While analysis of a policy in terms of its cost effectiveness still requires environmental performance of the policy to be quantified, it does not require environmental performance benefit to be monetized.

13.2.2.3 Distributional and social impacts

As noted above, distributional equity and fairness may be considered important attributes of climate policy – for their own sake, for their impact on measures of well-being (Posner and Weisbach, 2010), and for their impact on political feasibility (Jacoby et al., 2010). Different policies may have different impacts on distributional equity (Fischer and Morgenstern, 2010), assessed along two dimensions: intra-generational equity (which includes geographic, income or wealth, and demographic equity), and inter-generational equity. Inter and intra-generational comparisons are studied in more depth in Chapters 3 and 4.

These criteria relate to options in international agreements for burden (and benefit) sharing across countries, and across time (e.g. through differentiated targets, allowance allocations, prices, and funding or technology transfers). Although, in theory, all social impacts can be assessed as part of aggregate net benefits, some social impacts may be more difficult to monetize, such as international or national security, energy security, food security, and water security.

13.2.2.4 Institutional feasibility

The institutional feasibility of international climate policy may depend upon agreement among national governments and by governments and intergovernmental bodies (Wiener, 2009; Schmalensee, 2010). Institutional feasibility is closely linked to political domestic feasibility, because domestic conditions affect the achievability of international climate policies. This has been reflected in the literature on “two-level” games (Kroll and Shogren, 2009; Hafner-Burton et al., 2012).

Four sub-criteria of institutional feasibility are assessed here: participation, compliance, legitimacy, and flexibility. Participation in an international climate agreement might refer to the number of parties, geographical coverage, or the share of global GHG emissions covered. Participating parties might vary with regard to the nature (e.g., actions versus quantitative emissions-reduction targets) and specificity of their commitments. Sovereign states are not bound by an international treaty or other arrangement unless they consent to participate. The literature has examined a broad array of incentives to promote breadth of participation in international agreements (Barrett, 2003; Barrett and Stavins, 2003; Stewart and Wiener, 2003; Hall et al., 2010; Victor, 2010; World Bank, 2010, pp. 55–58; Olmstead and Stavins, 2012). Those incentives can be positive (e.g. funds or technology transfers) or negative (e.g. trade sanctions). Some authors have suggested that participation limited to countries with the highest emissions enhances institutional feasibility (Leal-Arcas, 2011). Finally, the drivers of participation stability have also been studied (Dellink et al., 2008; Dellink, 2011).

Compliance can challenge institutional feasibility because participation is only effective if countries adhere to an agreement’s provisions. Mechanisms to ensure compliance are important both for long-term performance and for incentives to participate ex ante (Barrett, 2003). Incentives for encouraging compliance can be built into flexible mechanisms, such as tradable permit systems (Wiener, 2009; Ismer and Neuhoff, 2009; Keohane and Raustiala, 2010). Compliance is fundamentally problematic in international agreements, as it is hard to establish an authority that can legitimately impose direct sanctions upon sovereign national governments. Despite that, indirect consequences of non-compliance can arise within the same agreement or in other ones. For example, the form those sanctions can take is that of negative voting by other countries in international forums, or reduction in foreign aid (Heitzig et al., 2011).

Legitimacy is a challenge for institutional feasibility because to attract participation and compliance, cooperative regimes need a justification to exercise authority over the parties to that regime. So, legitimacy depends on the shared understanding both that the substantive rules (outputs) and decision-making procedures (inputs) are legitimate (Scharpf, 1999), and thus that other regime members will continue to cooperate (Ostrom, 1990, 2011). In practice, the legitimacy of substantive rules is typically based on acceptance of the authority ruling legitimacy (this happens when parties evaluate positively the authority policies' results), while procedural legitimacy is typically based on the existence of proper input mechanisms of participation and consultation for the parties participating in the agreement (Stevenson and Dryzek, 2012). Both ideas of legitimacy are discussed in Chapters 2 and 4.

Institutional feasibility to develop policies that are flexible or adjustable may be important to adapt to new information or to changes in initial economic and political circumstances. The institutionalization of learning among actors (the so called: “social learning” in the literature of environmental governance: (Pahl-Wostl et al., 2007)) is an important aspect of success, to enable them to adapt to changing circumstances. While institutional arrangements to craft policies that incorporate a purposive process of experimentation, evaluation, learning, and revision may be costly, policies that do not incorporate these steps may be overly rigid in the face of change and potentially even more costly (Greenstone, 2009; Libecap, 2011). Another area of current debate and research is the question of whether increased flexibility in designing obligations for states helps them align their international obligations more readily with domestic political constraints (Hafner-Burton et al., 2012). Simultaneously, excessive flexibility may undermine incentives to invest in long-term solutions. All of this suggests the efficacy of designing international climate policies to balance benefits of flexibility with costs of regulatory uncertainty (Brunner et al., 2012). A more in depth discussion on problems related to regulatory uncertainty can be found in Chapter 2.

13.2.2.5 Conflicts and complementarities

Criteria may be mutually reinforcing (Cao, 2010a; c), but there may also be conflicts or tradeoffs among them. For example, a cost-effective allocation of environmental targets could fulfil some of the key criteria for the evaluation of an IEA (e.g. environmental effectiveness and aggregate economic performance). However, given the need for consent to participate in an international treaty, if the allocation leads to an unduly asymmetric distribution of the net gains from cooperation, without local co-benefits or compensatory transfers (or with a distribution that is perceived as unfair), then such an agreement may lead to low participation and poor compliance, or to a "lowest-common denominator" agreement (Ward et al., 2001). Maximizing global net benefits or attaining cost-effectiveness may lead to actions that decrease distributive fairness (Van Asselt and Gupta, 2009). Posner & Weisbach (2010) and Baer (2009) argue that the efficiency and distribution concepts can be reconciled by either normatively adjusting the net benefit or cost calculations to account for changes in relative utility, or by adopting redistributive policy in addition to cost-effective climate policy.

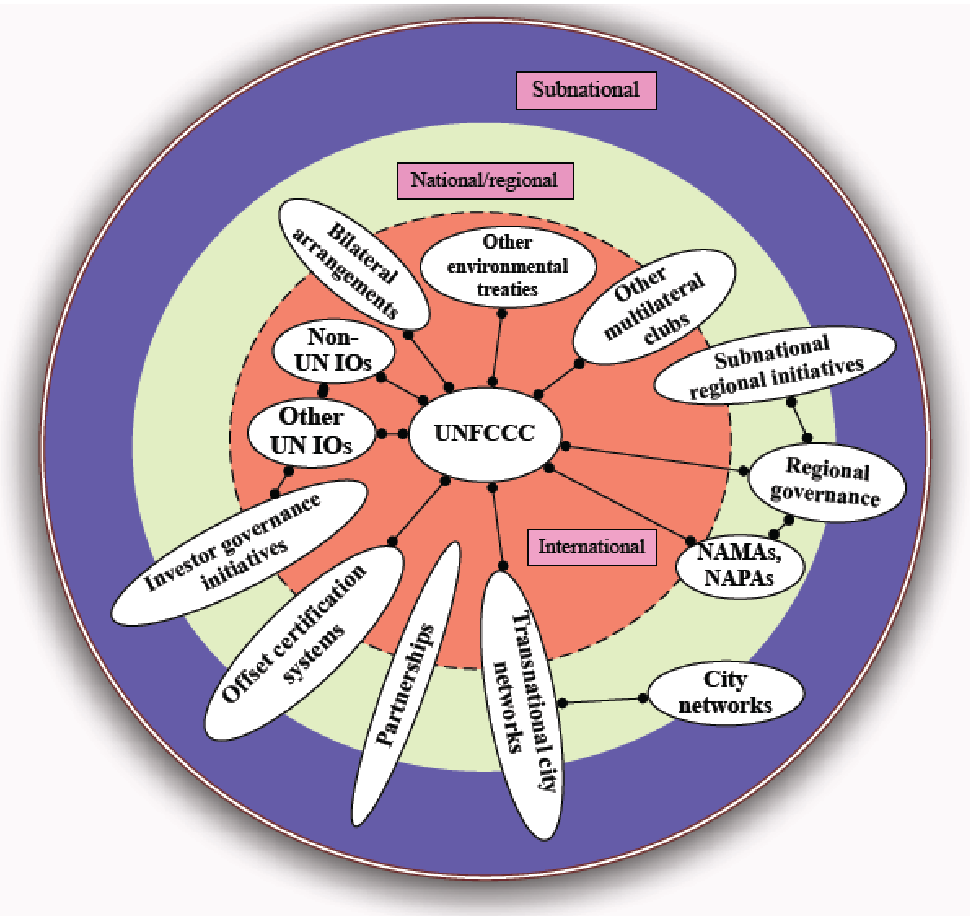
Different approaches within the same criteria (for example, fairness) may also conflict with each other when operationalized (Fischer and Morgenstern, 2010) or lead to different results (Dellink et al., 2009). Simultaneously, there are relations among sub-criteria: excessive flexibility may undermine incentives to invest in long-term solutions, and may also increase the likelihood of participation. Compromises to enable institutional feasibility of an agreement may weaken performance along other dimensions of performance. More broadly, the performance of an international agreement is a function of at least three factors that interact – ambition, participation, and compliance – and there can be significant trade-offs among them (Barrett, 2003; Bodansky, 2011a; Rajamani, 2012a).

13.3 International agreements: lessons for climate policy

Several lessons for climate change institutions and policy can be drawn from research on the range of existing international agreements, and on formal game-theoretical models of possible agreements. This section briefly summarizes some of the key lessons, which are then addressed in more detail in subsequent sections of this chapter.

13.3.1 The landscape of climate agreements

While most attention to date has been given to the UNFCCC processes, a notable change has occurred since the publication of IPCC AR4 in 2007: the landscape of international agreements on climate has become significantly more complex. Climate change is increasingly addressed in a range of other fora and institutions, and across a wider range of scales (Keohane and Victor, 2011; Bulkeley et al., 2012; Biermann et al., 2009, 2010; Barrett, 2010; Abbott, 2011; Hoffmann, 2011; Zelli, 2011; Rayfuse and Scott, 2012). As illustrated in Figure 13.1, this includes a variety of international, transnational, regional, national, sub-national and non-state agreements and other forms of cooperation, many of which have emerged since the mid-2000s. Many of the regimes now addressing climate change have previously focused on other issues, e.g. trade (see section 13.8), energy (see Chapter 7), biodiversity, and human rights, among other topics.



Legend: (Note: these are not necessarily exhaustive lists of the examples, but either a representative set of examples or the principal ones)

UNFCCC	Kyoto Protocol, Clean Development Mechanism, International Emissions Trading
Other UN Intergovernmental organizations	Intergovernmental Panel on Climate Change, UN Development Programme, UN Environment Programme, UN Global Compact, International Civil Aviation Organization, International Marine Organization, UN Fund for International Partnerships
Non-UN IOs	World Bank, World Trade Organization
Other environmental treaties	Montreal Protocol, UN Conference on the Law of the Sea, Environmental Modification Treaty, Convention on Biological Diversity
Other multilateral "clubs"	Major Economies Forum on Energy and Climate, G20, Asia Pacific Partnerships on Climate and Energy, REDD+ Partnerships
Bilateral arrangements	e.g. US-India, Norway-Indonesia
Partnerships	Methane to Markets, Renewable Energy and Energy Efficiency Partnership, Climate Group
Offset certification systems	e.g. Gold Standard, Voluntary Carbon Standard, Climate Change and Biodiversity Alliance standard
Investor governance initiatives	Carbon Disclosure Project, Investor Network on Climate Risk
Subnational regional initiatives	Regional Greenhouse Gas Initiative, Western Climate Initiative, Midwestern Greenhouse Gas Reduction Accord
City networks	US Mayors' Agreement, Transition Towns
Transnational city networks	C40, Cities for Climate Protection, Climate Alliance, Asian Cities Climate Change Resilience Network

Figure 13.1. The landscape of agreements and institutions on climate change

Figure 13.1 shows the landscape of international cooperation on climate change, with some linkages to regional, national and sub-national scales (addressed in Chapters 14 and 15 of this report). For a more detailed discussion of these initiatives, see Sections 13.3 and 13.5.

As a consequence of this change, the design of future agreements (both climate agreements and those addressing other issues) needs to take account of the actual and potential linkages among institutions across different scales and issues. It is no longer simply a question of choices between different types of single agreements, but how to manage the interaction across a wide variety of agreements. Careful design of linkages and cooperative arrangements will be needed to manage the increasingly fragmented regime complex to prevent conflicts among institutions (Biermann et al., 2010; Keohane and Victor, 2011; Zelli, 2011), avoid gaps or loopholes (Downs, 2007), and maximise potential institutional synergies (Hoffmann, 2011; Rayfuse and Scott, 2012).

13.3.2 Lessons from game theory

Lessons may be learned from the game-theoretic approach developed both in environmental economics (Finus, 2001, 2003; Wagner, 2001; Ward, 1993; Barrett, 2003, 2007) and in the rationalist school of political science (Sjostedt, 1992; Downs et al., 1996; Underdal, 1998; Koremenos et al., 2001; Avenhaus and Zartman, 2007; Hafner-Burton et al., 2012). These analyse the incentives and motivations of actors to join and comply with international environmental agreements (IEAs).

The game-theoretic literature on climate change agreements has grown substantially in the last two decades (Barrett, 2007; Bosetti, Carraro, Duval, et al., 2009; Bréchet et al., 2011; Bréchet and Eyckmans, 2012; Chambers, 2008; Muñoz et al., 2009; Dutta and Radner, 2009; Rubio and Ulph, 2007; Asheim and Holtsmark, 2009; Froyn and Hovi, 2008; Weikard et al., 2010; Heitzig et al., 2011; Dietz and Zhao, 2011; Wood, 2011; Pittel and Rübbelke, 2012). While the literature's assumptions or models are easily identified, they have also been criticized for their simplicity and sometimes high specificity. Therefore it is important to treat with caution any general conclusions from these studies. In this section, we refrain from listing assumptions in detail (Finus, 2001, 2003), and restrict attention to the most general and policy-relevant discussions. Some issues covered in past IPCC ARs by Toth et al. (2001) and Gupta et al. (2007) are reiterated if they appear particularly important or if new evidence has emerged.

It is essential to compare the assumptions, models and conclusions of the game-theoretic literature to the reality of actual experience with institutions. This comparison helps in interpreting the relevance and validity of the game-theoretic models, and in adding more realistic elements to future game-theoretic research. This Chapter assesses actual institutional experience in more detail below (throughout the Chapter, and especially in Sections 13.4, 13.5, and 13.13), notably regarding international climate treaties (chiefly the UNFCCC and the Kyoto Protocol) and other IEAs (such as the Montreal Protocol on Substances that Deplete the Stratospheric Ozone Layer). A key lesson from both the game-theoretic literature and actual institutional experience is that it is difficult to engage broad participation by all countries, or even by major emitting countries, in an environmentally effective climate change treaty (Barrett, 2007). The game-theoretic models indicate that this difficulty could potentially be reduced, and participation attracted and maintained, through mechanisms such as local co-benefits, international transfers and stable coalitions of countries (Carraro et al., 2006; Bosetti, Carraro, Duval, et al., 2009; Asheim and Holtsmark, 2009; Bréchet et al., 2011; Bréchet and Eyckmans, 2012). The merits of transfers and coalitions are discussed below in section 13.3, and further in Section 13.5.

Given that there is currently no supranational institution that can impose an IEA on governments and subsequently enforce it (see 13.2.2.1), countries are only bound by the treaties they consent to join. Thus, IEAs must be self-enforcing to engage and maintain participation (Finus, 2001; Barrett, 2007; Dutta and Radner, 2009; Rubio and Casino, 2005; Heitzig et al., 2011). Nevertheless, in practice, international institutions can help to promote, negotiate and administer an IEA. They can do so in their roles as coordinator and moderator, i.e. via reductions in transaction costs of cooperation and the generation of trust (Keohane, 1984, 1989; Finus and Rundshagen, 2006), via changing the interests of actors by providing new information or building capacity (Haas et al., 1993), via enlisting actors in domestic politics within and across states (Abbott and Snidal, 2010; Hafner-Burton et al., 2012), via inculcating norms (Bodansky, 2010a), and in other ways.

More generally, in contrast to the rationalist focus on incentives and payoffs, alternative perspectives in political science, law, sociology and other fields emphasize the roles of legitimacy, norms and acculturation in shaping behaviour under international law and institutions (Hafner-Burton et al., 2012, pp. 54–60); (Brunnée and Toope, 2010; Goodman and Jinks, 2004). These factors may relate to both attracting participation and ensuring compliance, and to both hard and soft forms of international law (Bodansky, 2010a). Moreover, states' reputations, which are shaped by acculturated norms, may in turn be relevant to realist approaches as an incentive for states to comply (Chayes and Chayes, 1998).

The game-theoretic literature and actual experience both illustrate that the difficulty in engaging countries in a broad climate change treaty arises in significant part from problems in arranging incentives. These incentives relate both to the aggregate shared benefits and to the costs of climate protection (with the familiar difficulties of public goods and the consequent free-riding), and to the distribution of those benefits and costs among the relevant actors. If states seek to maximise domestic political gains and competitive advantage over other countries rather than absolute gains in environmental outcomes for all, then unduly asymmetric outcomes can make cooperation even more difficult (Ward, 1993; Grundig, 2006). Hence, questions of relative status, fairness and reciprocity (Saran, 2010) may also influence incentives to participate.

13.3.3 Participation in climate agreements

Participation in climate change agreements is valuable for criteria including environmental effectiveness (by covering a larger share of global emissions, and avoiding leakage to non-participating areas) and aggregate economic performance (by enabling lower-cost emissions abatement). An international regime might achieve depth (ambition of emissions reduction) and breadth (of participation) in different sequence. Schmalensee (1998) argues for breadth first, in large part to give time to develop "…institutions to ensure broad international participation in emissions abatement, which is essential to any serious effort." (See also (Schelling, 1992; Barrett, 2003); but see (Chander and Tulkens, 2009).) Others have suggested that depth should come before breadth because of the urgency of the climate-change problem. Yet depth without breadth of participation could induce emissions leakage, undermining effectiveness (Babiker, 2005).

The trade-off between the level of abatement by a sub-set of actors and participation in an IEA has been described as a comparison between an "ambitious versus a modest treaty" (Finus and Maus, 2008; Courtois and Haeringer, 2011) or between an incomplete (deep and narrow) versus a consensus (broad but shallow) treaty (Barrett, 2002); (Hafner-Burton et al., 2012, p. 78). Very broad but shallow architectures, involving only weakly or implicitly coordinated decentralized national actions, may reflect an absence of international cooperation; very narrow but deep architectures, involving ambitious or unilateral first-movers, may also ironically reflect the absence of international cooperation. These and intermediate architectures are discussed in section 13.4. On the other hand, tradeoffs between breadth and depth might be overcome, if broad participation increases environmental effectiveness (by covering more emissions and reducing leakage), and reduces costs (by encompassing more low-cost abatement options in a larger market), so that breadth also enables greater ambition (subject to the costs of attracting participants) (Battaglini and Harstad, 2012).

The procedures for joining (or acceding to) international treaties are typically specified in membership rules, which can be open or exclusive (the latter limiting the parties or requiring existing parties to a treaty to decide whether to accept a new member). One finding in the theoretical literature is that even in the context of a public good such as climate protection, exclusive membership can help to stabilize IEAs and avoid defection (Carraro and Marchiori, 2003; Eyckmans and Finus, 2006; Finus, 2008; Finus and Rundshagen, 2009). Yet for a global public good, exclusive membership may reduce coverage of global emissions, may risk emissions leakage (unless non-members are covered by their own coalition in a system of multiple agreements), and may conflict with norms of institutional legitimacy. It is not clear how these factors work out in practice. The UNFCCC is in principle open to all countries. The European Union Emissions Trading Scheme (ETS), which has exclusive coalition membership, has succeeded in engaging participation through cross-member transfers via the allocation of tradable emission allowances (Ellerman, 2012). Other more or less exclusive (sometimes dubbed "minilateral") climate coalitions have included the Major

Economies Forum on Energy and Climate (MEF), the Asia-Pacific Partnership on Clean Development and Climate (APP), and the Association of Small Island States (AOSIS). Moreover, even in an open membership treaty, there can be various types of participation commitments by various parties. For example, under the Kyoto Protocol, accession is ostensibly open to all countries, but quantified emissions-reduction commitments were exclusively provided for Annex I (Annex B) countries, and efforts by some non-Annex I countries to join such quantified commitments were not accepted (though this distinction may be relaxed or superseded in subsequent agreements pursuant to the 2011 Durban Platform). That distinction has contributed to the non-participation of some major emitters in Annex I, rendering the remaining coalition less effective (Bréchet and Eyckmans, 2012). In fact, as of the end of 2012, all major emitting countries have put forward voluntary emission limitations or actions for 2020, which have been acknowledged in the Cancun Agreements (2010).

As mentioned above, participation can be difficult to attract and maintain because the shared global benefits and the local costs of climate protection may yield incentives to defect. But mechanisms such as the formation of different coalitions of countries, the development of norms, international transfers, trade sanctions or linkages with other policies can foster participation.

Conceptually, multiple agreements of various coalitions may be a strategy for stable agreements if a universal treaty binding for all countries to limit emissions is not stable or attainable (e.g. (Asheim et al., 2006; Bosetti, Carraro, Duval, et al., 2009; Bréchet and Eyckmans, 2012; Stewart and Wiener, 2003). Multiple coalition agreements involving all major emitters could potentially achieve better environmental effectiveness than a partial coalition acting while other countries do not act at all; and they could potentially be more stable than a single universal grand coalition (Bréchet and Eyckmans, 2012). But, as noted above, for protecting a global public good, multiple coalitions could forego some of the cost-effectiveness gains of a broader regime (a larger trading market), and they could face questions of legitimacy. In IPCC AR3, Toth et al. (2001), addressed the question of single versus multiple agreements. Since that time, the landscape of actual climate agreements has evolved considerably, including both the proliferation of fora and institutions as shown in Figure 13.1, and also the advance of the Durban Platform to build on the universal design of the UNFCCC through emissions limits by all major emitters, moving beyond the Kyoto Protocol's discrete Annex I/non-Annex I distinction (Aldy and Stavins, 2012).

It remains unclear whether partial coalitions for climate policy will accelerate momentum for a more universal global agreement, or may undermine such momentum (Brewster, 2010). In actual practice, the question now is not to choose between the universal design of the UNFCCC and its Durban Platform versus an alternative path of only partial coalitions, but to assess how they can interact with each other when evolving at the same time. Other international regimes also illustrate the historical evolution of multiple coalition agreements. For instance, in the context of international trade policy, after slow progress within the WTO after the Doha round, bilateral and multilateral (or "plurilateral") agreements among smaller groups of countries have emerged (though perhaps they might have emerged in any case). Whether these bilateral and plurilateral agreements will evolve into an effective global agreement—or perhaps render such evolution less likely—cannot yet be assessed.

Meanwhile, some argue that the array of multilateral institutions and transnational organisations are developing a system of "global administrative law," which may inform and influence governance across multilateral agreements, networks of agreements, transnational executive accords, norms, and implementation in executive and judicial systems (Kingsbury et al., 2005). In the climate regime, for example, some aspects of such administrative law are being developed through recommendations by the subsidiary bodies to the Conference of the Parties to the UNFCCC (Churchill and Ulfstein, 2000; Hey, 2001; Brunnée, 2002; Gupta, 2011).

International transfers (either directly through monetary or in-kind transfers, or indirectly through the initial allocation of tradable emission permits) can be essential to attract broad participation in a climate change agreement (Carraro et al., 2006; Barrett, 2007; Bosetti, Carraro, De Cian, et al., 2009; Fuentes-Albero and Rubio, 2010; Bréchet and Eyckmans, 2012; Stewart and Wiener, 2003). Historically, transfers have been important to engaging participation in past international agreements ((Hafner-Burton et al., 2012, p. 91). The experience of the Montreal Protocol illustrates the importance of transfers in engaging participation by major developing countries (Sandler, 2010; Kaniaru, 2007; Zhao, 2005, 2002; Andersen et al., 2007). Transfers via the allocation of tradable emission permits have been important to engaging participation in international and regional climate policies (Stein, 2008; Wiener and Richman, 2010; Ellerman, 2012), and this experience indicates that such indirect transfers via allocation and decentralized trades may be more feasible than direct transfers via government tax revenues (Ellerman, 2012). Hence, transfers will likely be key to engaging participation by major emitters in future climate agreements (Tian and Whalley, 2010; Walsh et al., 2011; Zhao, 2013). However, the efficacy of transfers may depend on the type of overall burden-sharing scheme (Weikard et al., 2006; Eyckmans and Finus, 2006; den Elzen et al., 2007; Höhne et al., 2007; Nagashima et al., 2009; Bosetti, Carraro, Duval, et al., 2009). Recent research on optimal transfer schemes (Carraro et al., 2006; McGinty, 2007, 2011; Eyckmans and Finus, 2009; Weikard, 2009; Fuentes-Albero and Rubio, 2010) stresses that it is not sufficient to consider only plausible and widely accepted equity criteria for the redistribution of the gains from cooperation (Ringius et al., 2002), because if the distribution of net burdens (or sharing of net benefits) violates the fundamental interests of some parties, those parties may not participate, despite the distribution satisfying others' equity criteria. Thus this literature suggests that issues of equitable burden sharing and transfer need to be addressed at the same time (e.g. (Sandler, 2010)).

A different instrument to prod participation is trade sanctions against non-parties to an international environmental agreement. These include what are sometimes referred to in the literature as "offsetting border measures" to address leakage issues (see Chapter 5). The threat of such trade sanctions can motivate participation (Barrett, 2003) and deter free-riding (Victor, 2011), as it may have done in the Montreal Protocol. The possibility of imposing such trade measures has been on the agenda of the EU ETS. But the actual imposition of trade sanctions may not be highly effective at changing states' behaviour ((Hafner-Burton et al., 2012, p. 91), because trade sanctions against non-parties may violate WTO/GATT trade law (see discussion in 13.3.2 and section 13.8 below), may impair the capacity and resources of targeted countries to participate in the treaty regime, may burden low-income populations in the targeted country while leaving its elites less affected and hence even more insulated from outside pressure, may exacerbate inequality and strife within the targeted country (Peksen, 2009), and may also be costly to consumers in the imposing country (McKibbin and Wilcoxen, 2009) (and that in turn undermines the credibility of threats to impose trade sanctions) (Kemfert et al., 2003). Further, even if effective at prodding participation by targeted countries, trade sanctions – especially for an economy-wide factor such as carbon (unlike the more narrow CFCs industry in the Montreal Protocol) – may trigger retaliation and trade wars with wider adverse effects. In the absence to date of any instances of the actual imposition of such measures, there is an absence of empirical evidence about their effects.

Linkages across issues may help encourage participation. Many linkages exist between climate change and other issues, such as sustainable development, poverty alleviation, public health, international trade, foreign direct investment, human rights, biodiversity, and national security. These and other linkages may create opportunities, co-benefits, or adverse side-effects, not all of which have been thoroughly examined. Further, intentionally linking climate agreements with agreements that cover other policy issues (see (Toth et al., 2001)), and the literature cited there) has been proposed as a way to encourage participation as an alternative to direct transfers. By redistributing the net benefits from cooperation, as through transfers, such issue-linkage deals may change incentives for participation (Finus, 2003; Carraro and Marchiori, 2004). The issue with which climate change is linked may provide an exclusive advantage to climate treaty members, or it may impose a cost or harm to outsiders, or both; these can help pull outsiders into the linked climate agreement.

For example, linking emissions limitation agreements with agreements to promote research and development (R&D) may produce benefits for participants in the collaborative effort (Barrett, 2003; de Coninck et al., 2008). Such linking will be more effective at encouraging participation, the more that the benefits of the joint R&D efforts accrue to the club members of the linked collaborative effort (as opposed to those R&D benefits spreading to non-members) (Lessmann et al., 2009; Lessmann and Edenhofer, 2011). Some recent studies (Barrett, 2006; de Coninck et al., 2008; Hoel and de Zeeuw, 2010; Pittel and Rübbelke, 2012) consider the opportunities of pure R&D cooperation to develop environmental "breakthrough technologies" to produce low- or even zero-carbon energy. Barrett (2009) suggests that inducing technological change may create greater momentum for participation in a climate agreement than market-based instruments alone.

However, the advantage of issue linkage diminishes if the transaction costs of linkage negotiations are high. With increasing numbers of negotiating parties and numbers of linked issues, diseconomies of scale may arise. This may be one of the reasons that some scholars,e.g., (Barrett, 2010; Barrett and Toman, 2010; Falkner et al., 2010; Keohane and Victor, 2011) have proposed that some issues – such as mitigation, financing of adaptation and mitigation in developing countries, and technology transfer – could be negotiated separately, instead of in one climate agreement (and maybe among a smaller group of key countries), if needed to overcome a stalemate in multilateral climate negotiations. Yet such separate negotiations may forego the advantages of linkage, transfers and comprehensiveness in attracting broader participation, as discussed above.

Whether adding adaptation to mitigation measures in the policy portfolio will encourage or discourage participation remains an open issue (Barrett, 2008c). Adaptation is crucial for particularly vulnerable countries, and these countries are more likely to participate in agreements that address adaptation and its funding (Huq et al., 2004; Mace, 2005; Ayers and Huq, 2009; Denton, 2010; Smith et al., 2011). Both theoretical analysis and empirical evidence are needed to evaluate whether, where, and which types of adaptation and mitigation measures are substitutes or complements. Some studies indicate that adaptation reduces the marginal benefits from mitigation measures, and vice versa (Ingham et al., 2005; Buob and Stephan, 2011; Ebert and Welsch, 2011). Other studies find that the joint provision of mitigation and adaptation is welfare improving, especially in the shorter term (with higher discount rates and lower long-run damages), and that developing countries will need international financing to assist their adaptation (Bosello et al., 2010; de Bruin et al., 2009; Eisenack and Kähler, 2012; Ebert and Welsch, 2012). If the benefits of important types of adaptation are local and private (while other benefits of adaptation are shared regionally or even globally), those local benefits may be more effective incentives for treaty participation by vulnerable countries than are the less-excludable benefits of GHG mitigation or technology R&D (which may also be of less value to countries that are not large emitters). At the same time, financing for locally-important adaptation may offer fewer reciprocal benefits to the funding country than would financing for mitigation. The incentives for international participation in adaptation efforts may thus depend on the particular settings and types of measures being considered.

Finally, another key issue related to participation is the role played by uncertainty. Earlier research suggested that reducing uncertainty about the benefits and costs of mitigation can render IEAs less effective, showing that as parties learn of the actual costs of mitigation, so their incentive to participate may shrink (Kolstad, 2005, 2007; Kolstad and Ulph, 2008). However, more recent work (Dellink and Finus, 2009; Finus and Pintassilgo, 2011) has qualified this conclusion by showing that transfers increase incentives to participate, and that removing uncertainty about such transfers can have a significant positive impact on participation. Asymmetry may increase participation (Finus and Pintassilgo, 2011), and exceptionally large but uncertain damages may lower discount rates and hence encourage cooperation on abatement (Weitzman, 2007), but recent experimental evidence suggests that uncertainty about the tipping point of disastrous climate change impacts reduces the success of cooperation (Dannenberg et al., 2011).

13.3.4 Compliance

Closely related to participation is the issue of compliance. As noted in Sections 13.2.2.4 and 13.3.3, in the absence of a supranational authority, compliance with international agreements cannot be imposed but must be engaged. Barrett (2003) sees compliance as a dimension of participation, in the sense that incentives to comply are incentives to continue participating in the agreement. Put another way, if a country can withdraw from a treaty at low cost – because sanctions for withdrawal are not significant or applicable, and continued cooperation offers little net benefit – then the country also may have few incentives to comply. In that case, participation and compliance go hand in hand. Perhaps these choices might diverge if the reputational costs of being a noncompliant party differed from the reputational costs of withdrawing altogether. Yet the direction of this effect is not clear: a party violating might be seen as cheating, while a party withdrawing altogether was seen as more forthright. But alternatively, a party violating might be seen as struggling earnestly to comply, while a party withdrawing was seen as betraying the shared effort (Brewster, 2009, p. 265). There is only one case of withdrawal from the Kyoto Protocol, that of Canada in December 2011. It is not clear which dynamic is dominant in this case (Chalecki and Ferrari, 2012).

Compliance alone is not necessarily success: because countries choose whether to consent to join a treaty, compliance with a treaty may only reflect what countries would have done anyway without the treaty (Downs et al., 1996). The more important issue is effectiveness: has the treaty changed countries' behaviour, compared to what they would have done in the absence of the treaty (the counterfactual baseline scenario), and thereby changed actual outcomes in a way that promotes the goals of the treaty? (Hafner-Burton et al., 2012, pp. 88–90). (Note that a treaty might change behaviour and outcomes, yet in a manner that is different from the goals of the treaty – producing a co-benefit or risk trade-off.) Evaluating a treaty's actual effectiveness is difficult because the counterfactual is not observed (Simmons and Hopkins, 2005); this evaluation is especially difficult in fields like international environmental policy where so many complex factors are involved (Mitchell, 2008); (Hafner-Burton et al., 2012, p. 90).

Where compliance promotes effectiveness, it remains important to ensure compliance. Ensuring compliance, as is also the case for participation, can be enhanced by positive inducements such as international transfers, financing, capacity-building, technology transfer, or credible threats of sanctions for violating emissions commitments or reporting requirements. From a rationalist perspective, compliance will occur if the discounted net benefits from cooperation (including direct climate benefits, co-benefits, reputation, transfers, and other elements) exceed the discounted net benefits of defection (including avoided mitigation costs, avoided adverse side effects, and expected sanctions). The institutional and behavioural reality of ensuring compliance can be more complicated.

One instrument for successful compliance strategies is an independent and high-quality regime of "measurement (or monitoring), reporting and verification" (MRV) with a high frequency of reporting (as documented in the IPCC AR3, see (Toth et al., 2001)). Provisions for greater transparency in MRV are being developed (Winkler, 2008; Breidenich and Bodansky, 2009; Ellis and Larsen, 2008; Ellis and Moarif, 2009). Lessons on MRV from other multilateral regimes – such as International Monetary Fund (IMF) consultations, OECD economic policy reviews, WTO trade policy reviews, and arms control agreements – include attention to accuracy, evolution over time, combining self-reporting with third-party verification, including independent technical assessment as well as some form of political or peer review, the potential use of remote sensing or other technical means, and public domain outputs (Cecys, 2010; Pew Center, 2010; Greenspan Bell et al., 2012)).

The difficulty of monitoring compliance, and the implications for actual effectiveness, may differ among the regulatory policy instruments used in a climate change treaty. Under either an international cap-and-trade system or an international emissions tax, noncompliance through underreporting actual emissions (i.e., emitting more than the permits held, or more than reported on one's tax form) would undermine the environmental effectiveness of the cap or the tax. But these two instruments may differ on other aspects of compliance. First, whereas all taxpaying emitters would have incentives to resist paying the tax and to resist monitoring of emissions, under a cap-and-trade system, those who hold permits would have incentives to support stringent monitoring and enforcement, in order to maintain the market price (scarcity value) of their permits (Wiener, 2009). Second, the environmental effectiveness of internationally harmonized emission taxes (but not of quantity caps) would be vulnerable to “fiscal cushioning” – a country’s formal compliance with the emissions tax, coupled with its adjustment of complex domestic fiscal policies through exemptions, loopholes, subsidies, or otherwise, to shield domestic industries from the impact of the emission tax – in ways that are difficult for others to monitor and detect (Wiener, 1999; Rohling and Ohndorf, 2012).

Some research suggests that the Kyoto Protocol and its follow-on accords are unusual among IEAs in having established an “elaborate and multifaceted” compliance system, which has been successful in assuring compliance with reporting (MRV) requirements (Oberthür and Lefeber, 2010; Brunnée et al., 2012), while many other IEAs rely on self-reporting of domestic actions. Compliance with MRV can in turn improve detection of other forms of noncompliance. Even if the Kyoto Protocol compliance regime has been imperfect, it can offer learning for future regimes, in particular with regard to MRV. The design of sanction mechanisms currently in place under the Kyoto Protocol, however, has also been criticized for not being fully credible (Halvorssen and Hovi, 2006; Barrett, 2009; Vezirgiannidou, 2009). Others have used game theory to try to identify more credible sanctioning mechanisms for the Kyoto Protocol, involving financial penalties for noncompliance that countries would theoretically find it rational to adopt (Heitzig – no year, Lessmann and Zou, 2011 – no ref). Monetary penalties as part of the European monetary institutions have proven largely ineffective, as no second-order punishment is available if penalties are not paid (Feldstein, 2011). In the Kyoto Protocol system, one possible sanction for noncompliance is the suspension of eligibility to take part in the flexible mechanisms (in particular, in trading of AAUs), which may be a more credible provision.

Trade sanctions, such as those employed under the Montreal Protocol, are put forward as one principal alternative compliance mechanism. As discussed above in 13.3.1, and further in 13.8 below, the threat of trade sanctions may be successful in promoting participation (Barrett, 2003). Yet Barrett (2009) and Victor (2010) argue that trade sanctions are neither a feasible nor a desirable option for enforcing compliance with a climate treaty, because trade sanctions may not be compatible with WTO rules (absent reforms to WTO rules). Victor (2011) addresses the dilemma that trade sanctions may have undesirable effects, but may also sometimes be needed – or may need to be threatened – to deter the undesirable effects of free riding. Others argue that a WTO-compatible design is feasible in the case of border adjustments with obligations to buy allowances (Ismer and Neuhoff, 2007; Monjon and Quirion, 2011). Meanwhile, imposition of trade sanctions would pose some risks of reducing cooperation by undermining capacity for compliance in targeted countries (see discussion above in 13.3.1) and could be burdensome to low-income populations in targeted countries (Murase, 2011a). If applied to embedded carbon (see Section 13.8), the number of goods affected by the sanctions could be large, potentially fuelling a trade war that may negatively affect even those countries that intend to be the punishers (McKibbin and Wilcoxen, 2009).

Finally, there is a considerable literature on the potential use of legal remedies (such as civil liability) to address climate damages (Penalver, 1998; Grossman, 2003; Allen, 2003; Gillespie, 2004; Hancock, 2004; Burns, 2004; Verheyen, 2005; Jacobs, 2005; Smith and Shearman, 2006; Lord et al., 2011; Farber, 2011; Faure and Peeters, 2011). There has been little suggestion that such liability remedies be formally incorporated into climate agreements as compliance mechanisms, and there would be significant obstacles to doing so (including the lack of a robust international civil liability system), but this is nonetheless a potential avenue for encouraging compliance, perhaps indirectly. The IPCC AR4 (Gupta et al., 2007) reported on evidence from various legal actions and potential actions that have been considered in the theoretical literature. Haritz (2011) has argued, based on an analysis of the literature and court cases, that it is theoretically possible to link the IPCC scale of likelihood with a scale based on legal standards of proof required for various kinds of legal action. Liability for climate change damage at the supranational level (De Larragán, 2011; Gouritin, 2011; Peeters, 2011), and at the national level in the United Kingdom (Kaminskaite-Slaters, 2011), the United States (Kosolapova, 2011), and the Netherlands (Van Dijk, 2011), has been explored. The United States Supreme Court held in 2011 that a major climate liability case (Connecticut v. American Electric Power) could not be heard because the US Congress had directed climate change policy to be made by the federal administrative agency (the US Environmental Protection Agency, EPA) rather than by federal judges. Still, some climate liability cases based on other legal theories remain pending in US courts. Climate litigation and legal liability may put additional pressure on corporations and governments to be more accountable (Smith and Shearman, 2006; Faure and Peeters, 2011). However, there are key analytical hurdles to establishing important legal facts, such as causation and who is to be held liable.

13.4 Climate policy architectures

"Policy architecture" for global climate change refers to "the basic nature and structure of an international agreement or other multilateral (or bilateral) climate regime." (Aldy and Stavins, 2010b, pp. 1–2) The term includes the sense of durability, with regard to both policy structure and the institutions to implement and support that structure (Schmalensee, 1998, 2010), which is appropriate to the long-term nature of the climate-change problem.

13.4.1 Degrees of centralized authority

Absent a shift to globally centralized allocation of emissions rights, as advocated by (Tickell, 2008), approaches to international cooperation all arise out of the negotiated agreements among independent participants. However, they vary in the degree to which they confer authority on multilateral institutions to manage the rules and processes agreed to. On one end of the spectrum of possible approaches, referred to by some as "top-down" (Dubash and Rajamani, 2010), actors agree to a high degree of mutual coordination of their actions, with, for example, fixed targets and a common set of rules for elements, such as emissions trading. On the other end of the spectrum, sometimes known as "bottom-up" (Victor et al., 2005; Dubash and Rajamani, 2010), national policies are established that may or may not be linked with one another. Figure 13.2 illustrates how existing and proposed international agreements can be placed on this spectrum (see (Gupta, Tirpak, et al., 2007, pp. 770–773) for a detailed list of many proposals that could be placed in this grid).

The level of centralization refers to the authority an agreement confers on an international institution, not the process of negotiating the agreement. It shows that many proposals can be more or less centralized depending on the specific design. It also shows that the three ideal types discussed in the following sections have more blurred boundaries than their titles suggest. The figure also divides them into agreements focused on specific ends (emissions targets, for example) – and those that focus on means (specific policies, or technologies, for example). Finally, it should be understood that these are ideal types and in practice there will be considerable additional complexity in how the basic design of agreements connect the actions of the various actors that make them up, with distinct limits to what can be gleaned from the "top-down vs bottom-up" metaphor or the degrees of centralization notion deployed here (Dai, 2010) as for example emphasized in Ostrom's accounts of "polycentric governance" (Ostrom, 2012).

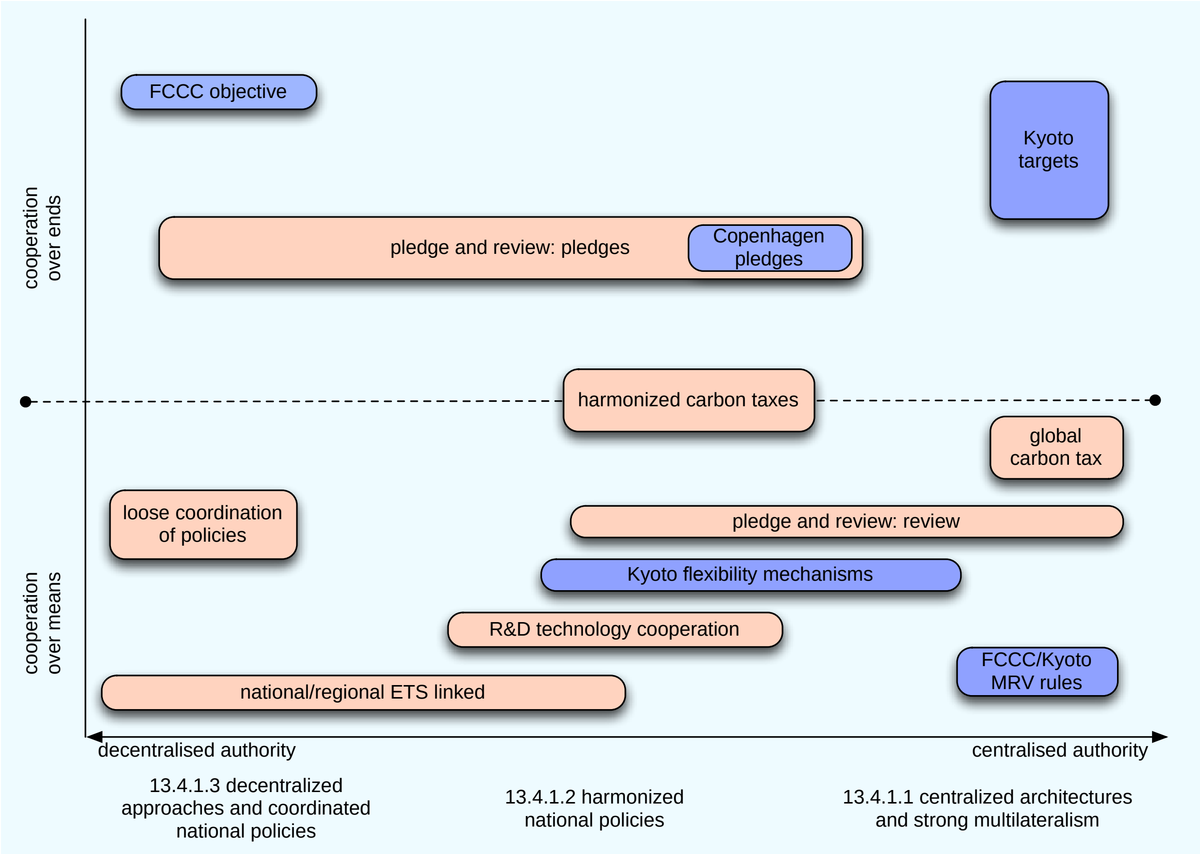


Figure 13.2. Degrees of centralized authority. Examples in blue are existing agreements. Examples in pale pink are proposed structures for agreements.

13.4.1.1 Centralized architectures and strong multilateralism

A centralized architecture, such as that generated by strong commitments to multilateral processes and institutions, establishes goals, targets, or both, that are generally binding, for participating countries, for a set of future years, and establishes collective processes for monitoring progress towards meeting those goals. The Kyoto Protocol adopted targets and timetables for participating Annex I countries, one realisation of strong multilateralism (Bodansky, 2007). Other centralized approaches to international cooperation could expand on targets-and-timetables by also specifying the mechanism for implementation of the goals and/or targets of the agreement; such an approach could establish, for example, a global cap-and-trade system or global emission tax.

In the literature, targets-and-timetables have been coupled with specific notions of fairness and/or prospective conditions for political acceptance to establish quantitative targets and timetables for all countries and all years in a potential international agreement (Agarwala, 2010; Frankel, 2010; Höhne et al., 2008; Bosetti and Frankel, 2011; Gupta, Tirpak, et al., 2007; Cao, 2010c).

13.4.1.2 Harmonized national policies

A less-centralized approach would be to structure international cooperation around policies that would be harmonized but where relatively little collective monitoring or other forms of authority is generated. In this class of approaches, national policies are made similar or even equivalent to one another in some key dimension. Examples of these include the G20 and APEC agreement in 2009 to phase out fossil fuel subsidies (Barbier, 2010), the EU's use of private certification schemes regarding biofuels to link to its import policies for such fuels, or ongoing efforts to harmonize carbon accounting systems such as in the Carbon Disclosure Standards Board (Lovell and MacKenzie, 2011), or through an equivalent national carbon tax (Cooper, 2010), similar cap and trade schemes, or implementation of similar technology or performance standards. Many of these also differ from more multilateral approaches in involving relatively limited numbers of actors compared to the UNFCCC agreements, thereby reflecting "minilateralism" (Eckersley, 2012).

The so-called "pledge and review" approach, exemplified to some degree by the Copenhagen Accord and the Cancún Agreements, is an architecture in which a participating nation or region voluntarily registers to abide by its stated domestic reduction targets or actions (pledges). If a pledge and review system, such as that represented by the Copenhagen Accord, involved cooperation to come to an agreement (as opposed only to voluntary, unilateral announcement of pledges), it could—depending on the precise arrangement—be considered an example of strong multilateralism, although perhaps with less centralised authority than the Kyoto Protocol, or of coordinated national policies (section 13.4.3.3, see also Figure 13.2).

13.4.1.3 Decentralized approaches and coordinated policies

Finally, even more decentralized architectures may arise out of different regional, national, and sub-national policies, and subsequently vary in the extent to which they are connected internationally (Victor et al., 2005; Hoffmann, 2011).

One form of decentralized architecture is directly- or indirectly-linked regional, national, or sub-national tradable permit systems (Jaffe et al., 2009; Ranson and Stavins, 2012; Mehling and Haites, 2009). In such a system, smaller-scale tradable permit systems can be linked directly (e.g. through mutual recognition of the permits from other systems) or indirectly (e.g. through mutual recognition of an emission-reduction credit system such as the CDM). In practice, this is already emerging. However, the question of linking such systems is not as simple as might be thought, principally because of varying: emissions reductions requirements; proportions of target emissions that may be covered by offset credits; use of ceiling or floor prices; and accounting units (Jaffe et al., 2009; Bernstein et al., 2010). As a consequence, it may involve more harmonization around these sorts of issues (see Figure 13.2).

Similarly, heterogeneous regional, national, or sub-national policies could be linked either directly or indirectly (e.g., cap and trade in one jurisdiction linked with a tax in another) (Metcalf and Weisbach, 2012). Linkage of heterogeneous policies can occur through trade mechanisms (e.g., import allowance requirements or border adjustments) or via access to a common emission reduction credit system (e.g., CDM, as with indirectly linked tradable permit systems).

These approaches have emerged more in recent years, in part as ETS have developed and have started to explore linkage (for example between the EU ETS and Australia), and as a range of transnational or private agreements have emerged (see 13.5.2 and 13.12, respectively) that have this sort of loose, decentralized, and often multilevel governance.

13.4.1.4 Advantages and disadvantages of different degrees of centralization

Some authors conclude, particularly post-Copenhagen, that attempts to develop a comprehensive, integrated climate regime have failed, due to resistance to costly policies in both developed and developing countries and lack of political will (Michonski and Levi, 2010; Keohane and Victor, 2011), or alternatively because of the nature of the problem with its complexity and fundamental need for costly collective action (Hoffmann, 2011). Other analyses emphasise the legitimacy of the UN, particularly citing its universal membership (Hare et al., 2010; Winkler and Beaumont, 2010; Müller, 2010; La Viña, 2010) and noting that fragmentation of the climate regime could create opportunities for forum shopping, a loss of transparency, and reduced ambition (Biermann et al., 2009; Hare et al., 2010; Biermann, 2010). Other studies have examined the evolution of multilateralism (Bodansky and Diringer, 2010) and possible transitional arrangements from fragmentation to a comprehensive agreement (Winkler and Vorster, 2007), and how to manage fragmentation so that it may become synergistic rather than prone to conflict (Biermann et al., 2009; Oberthür, 2009).

13.4.2 Current features, issues, and elements of international cooperation

Policy architecture for climate change raises a number of specific questions about the structure of international cooperation. Four specific elements or issues are raised here as of particular contemporary relevance: legal bindingness; goals, actions and metrics; flexibility mechanisms; and participation, equity and effort-sharing methods.

13.4.2.1 Legal bindingness

International agreements among states, including especially the commitments that these agreements include, may be legally binding or non-legally binding upon the parties. Legal bindingness involves four related dimensions: (1) legal form (e.g., treaty, protocol to a treaty, decision of the UNFCCC Conference of the Parties, political agreement), which reflects whether the instrument is governed by international law; (2) whether a provision is "expressed in obligatory language" ("shall" vs. "should" or "aim", for example) (Werksman, 2010); (3) "…whether [commitments] are expressed in sufficient detail to accurately assess compliance"; and (4) the institutions, procedures, and mechanisms designed to implement an agreement by monitoring, reviewing, and encouraging compliance with commitments (Werksman, 2010).

Agreements may be regarded by parties as binding even if they do not generate international legal rules. The "bindingness" of the agreement may be expressed in moral or political terms instead, and the obligations thus regarded as "pledges" instead of "contracts" (Raustiala, 2005). Much literature in this field has focused on the development of norms in the climate change regime, with the underlying argument being that such norms "bind" actors without necessarily having the force of law, e.g. (Hoffmann, 2005, 2011; MacLeod, 2010).

Table 13.2 provides a taxonomy of options with regard to the nature of the commitments in international agreements (Bodansky, 2003, 2009). The usage of "mandatory" in the table refers to the second aspect of bindingness introduced above: the nature of the obligations undertaken, not an actor's choice of whether to participate or not. An obligation can also be mandatory and at the same time contain flexibility, whether via some sort of market mechanism, as in the Kyoto Protocol, or other means, such as the sort of "bottom-up" target-setting as proposed, for example, by (Murase, 2011b).

Table 13.2: Typology of commitment in international agreements for climate change

Type of Commitment and dimensions of legal bindingness (See above in this sub-section)	Description	Example
Mandatory provision in a legally-binding agreement with enforcement mechanisms (1)-(4)	A legally-binding commitment can be subject to a mandatory compliance system, with authority to respond to violations. Enforcement can also come in the form of reciprocity for non-compliant actions.	The targets and timetables in the Kyoto Protocol and the Marrakech Accords, which set forth detailed rules to operationalize Kyoto and established a compliance procedure, including consequences for non-compliance. (Note that the World Trade Organization is the most prominent example of this type, though not in the climate realm).
Mandatory provision in a legally-binding agreement (1)-(2)	"Legally binding," but subject only to self-enforcement.	Article 4.1 of the UNFCCC, mandating, *inter alia*, national emissions inventories.

Mandatory provision in a non-legally-binding ("political") agreement (2)	Such a provision binds the party, though in principle less so than if the agreement were legally-binding.	The targets and actions submitted by signatories of the Copenhagen Accord (other than LDCs and small island developing states).
Non-mandatory provision in a legally-binding agreement (1)	Such a provision still does not bind the parties, but carries somewhat more weight than a political agreement, given the nature of the document in which it is embedded.	The UNFCCC target for developed countries to return their emissions to earlier levels by the year 2000 was stated as an "aim" rather than a legal requirement (UNFCCC, 1992); Article 4.2 (a) and (b).
One-way ("no-lose") commitments (2)-(3)	A commitment can be designed with legal consequences that bestow benefits to parties exceeding a baseline level of compliance. Since such a commitment has no legal consequences for falling short of the baseline, it is non-binding.	No-lose targets under some sectoral crediting mechanisms are "one-way commitments," since a country (or sector association) faces no penalty if its emissions exceed a baseline, but receives emission reduction credits if the emissions are reduced below the baseline.
Non-mandatory provision in a non-legally-binding ("political") agreement	An aim or aspiration, expressed in hortatory, non-binding language. This type of provision typically includes one or more statements of principles or norms.	Targets set in the 1989 Noordwijk Declaration, at a ministerial conference on climate change held prior to the 1992 Rio summit.

There are various perspectives within the scholarly literature regarding whether a (binding) agreement is necessary to stimulate greater national and local action, or not. Absent an international authority that can impose obligations on states—that is, in an "anarchic" international states system (Waltz, 1979; Thompson, 2006)—execution of legally-binding international agreements depends on states' consent to limit their future freedom of action. In general, accepting a commitment in legally-binding form has symbolic value (Rajamani, 2009): it signals a high level of seriousness by states, increases the costs of violation (either through an explicit enforcement mechanism, the lost benefits associated with compliance, or loss of reputation and credibility in future negotiations), and sets in motion domestic legal-implementation mechanisms, including ratification in those states that require it (Bodansky, 2003). Domestic law may be enforced more effectively than international law, and the domestic enforcement of international law is more effective in some countries than in others.

There may nevertheless be situations where there is a trade-off between stringency of commitments and legal bindingness. States may not be prepared to be legally-bound to an action even if they agree in practice to undertake it, and may indeed accept more ambitious targets if they are not legally binding (Rajamani, 2009; Raustiala, 2005). The central question here is one of the perceived legitimacy of the agreement by the participants. In an "anarchic" international system of states, legitimacy principally derives from the consent of parties and typically relies on the perceived fairness of procedures leading to the agreement (e.g., democratic voting rules: (Albin, 2001; Grasso and Sacchi, 2011) and the desirability of the outcomes of the agreement (Bodansky, 1999; Bernstein, 2005).

However, the distinctions between binding agreements (e.g., treaties), and political agreements that lack a formal legal foundation, often referred to as "soft-law," are blurred (Bodansky, 2010a). Hard and soft law agreements are usually distinguished from each other along the dimensions of obligation, precision and delegation (Abbott and Snidal, 2000; Werksman, 2010). In particular, states may treat norms that lack a legal foundation as binding and enact domestic legislation required for implementation and enforcement; conversely, binding international legal commitments may lack binding domestic enforcement mechanisms (Boyle, 1999). An example of the first is the UN General Assembly's (UNGA's) resolution establishing a moratorium on high seas driftnet fishing, which many states treat as binding even though UNGA resolutions have the status only of recommendations (Bodansky, 2010a).

13.4.2.2 Goals and target

Most agreements that advance international cooperation to address climate change incorporate goals, which flow in large part from principles. "Goals" are "long-term and systemic" (as contrasted with absolute emissions-reduction "targets," which may flow logically from the goals but which are "near-term and specific") (Gupta, Tirpak, et al., 2007, pp. 769, 777). The goals of an international agreement might include, for example, stabilization levels (or a reduction in a previously-agreed stabilization level) of atmospheric concentrations of GHGs—or reductions in impacts of climate change.

Targets can be classified according to their metric or form in absolute or dynamic targets. GHG absolute emissions targets specify reductions relative to a historical baseline, while dynamic targets specify emissions reductions relative to economic output. In the most recent literature on targets´ metrics, there is a great emphasis on whether or not dynamic targets are superior to fixed ones when there is uncertainty about the future, e.g. (Jotzo and Pezzey, 2007; Marschinski and Edenhofer, 2010; Sue Wing et al., 2009). As several authors have already made clear, the superiority of intensity caps over absolute limits depends on "parameter values", it does not hold for the case of all countries. Another aspect that has being highlighted by the recent literature is that both the abatement cost variance and the possibility of "hot air" depends not only on the form of the target, but also on its stringency (Marschinski and Edenhofer, 2010).

In actual climate negotiations, examples of fixed targets are Kyoto Annex I emission reductions by 2008-2012 with respect to 1990 levels, and Copenhagen pledges (some of the developed countries propose emissions reductions by 2020 with respect to some base year -1990, 2000 or 2005 while some of the developing economies suggest reductions by 2020 with respect to their business as usual trend). On the other hand, dynamic targets have been proposed by China and India: their pledge is a reduction of carbon intensity (i.e., emissions/GDP) between 40 and 45% and 20 and 25% respectively by 2020 with respect to 2005 (Steckel et al., 2011; Zhang, 2011; Yuan et al., 2012; Cao, 2010b). Another carbon target linked to GDP is the one planned by Argentina in 1999 (Barros and Grand, 2002).

Targets can also be differentiated by their scope in terms of the sectors covered (i.e., they can be nationwide or only hold for some industries) or the gas involved (can be related to carbon dioxide, all GHGs, or some of them).

13.4.2.3 Flexible mechanisms

Given the perceived costs associated with GHG emissions reductions, international negotiations have focused on ways of enabling states to have flexibility in meeting obligations. In principle, there are numerous ways this could be achieved. For example, there could be provisions for renegotiating targets, or in relatively decentralized architectures (such as a "pledge and review" system), states may have the ability unilaterally to change a target. Many transnational or private agreements contain significant levels of flexibility in how participants pursue the collective goals of the agreement. For Hafner-Burton et al. (2012), a significant area of current debate and research is the question of whether increased flexibility in designing obligations for states helps them align their international obligations more readily with domestic political constraints.

In existing interstate agreements, flexibility has been pursued principally through mechanisms that involve the creation of markets. The rationale for these is to lower the cost of reducing emissions, relative to traditional regulatory regimes, as they direct investments in emissions reductions toward lower-cost opportunities available in various jurisdictions. Such flexible mechanisms can involve trading emissions allowances, in practice to date under cap-and-trade programs, generating project-based offsets credits, or combinations of the two. Generally, credits from non-capped sources can be generated through project-based mechanisms or crediting of policies and sectoral actions. The former have been developed since the mid-1990s. The latter are still being discussed with regards to post-2012 climate policies in the context of "new market mechanisms" related to mitigation policies in developing countries (Nationally Appropriate Mitigation Actions, or NAMAs). Additionally, inter-temporal flexibility may be added to an allowance-trading regime through banking and borrowing of allowances, by which regulated entities may transfer current obligations to the future or vice versa.

The Kyoto Protocol provides three flexible mechanisms (the so-called Kyoto Mechanisms, Articles 6, 12 and 17): Joint Implementation (JI), the Clean Development Mechanism (CDM), and international emissions trading (IET). JI and CDM both generate offset credits from projects that reduce GHG emissions, and IET allows for government-to-government trading of Kyoto emissions allowances. Most attention in the research on these mechanisms has focused on the CDM, in part because of the volume of trading compared to the others (on the relatively small volume in Kyoto emissions trading, see (Aldrich and Koerner, 2012)).

The credits from JI and CDM may be used by Annex B countries to meet their emissions-reduction obligations. In practice, the key driver of investment in CDM projects has been the European Union Emission Trading Scheme (EU ETS), which enables companies to meet some of their obligations via the purchase of Certified Emissions Reductions (CERs) through the CDM. The EU ETS—by far the world's largest market-based GHG-compliance regime—allows regulated entities (companies or installations) to use CDM and JI credits to meet a portion of their ETS obligations (see section 13.6.1.1 and chapter 14 for details).

Conversely, the CDM is intended to promote broader sustainable development benefits in developing countries that receive projects. Projects are thus supposed to be assessed in terms of these broader benefits. This provides a substantial part of the motivation of developing countries to participate in the CDM (for empirical assessments of the contribution of CDM projects to sustainable development, see section 13.13.1.1).

Ever since the start of negotiations on the post-2012 climate policy regime and especially since the emergence of bilateral approaches, as proposed by Japan under the Bilateral Offset Crediting Mechanism (Ministry of the Environment, Government of Japan, 2012), new market mechanisms have been one important element of the negotiations. The Copenhagen Accord referred to "various approaches, including opportunities to use markets, to enhance the cost-effectiveness of, and to promote mitigation actions". The Cancun Agreement listed criteria for new market mechanisms and asked the Durban conference to establish one or more mechanisms. The Durban conference in 2011 decided that two options for new market mechanisms should be pursued – one top-down, operating under authority of the COP ("new market-based mechanism", NMM) and one bottom-up developed by countries "in accordance with their national circumstances" ("Framework for various approaches", FVA).

13.4.2.4 Participation, equity, and effort-sharing methods

A central challenge to current negotiations is to work with the complicated relationship between participation and equity. While in principle universal participation might be desirable, actors participate in a context of inequalities in both economic capacity and emissions levels (both absolute and per capita). The pursuit of means of addressing climate change equitably is thus central to being able to pursue as broad participation in climate agreements as possible.

However there is wide disagreement about how to put equity principles into practice in international agreements. We can distinguish between proposals that attempt to do this by starting with the status quo of emissions, that thus focus on the question of "effort-sharing", or "burden-sharing", and those that start with a specific account of "rights" to greenhouse gas emissions (such as equal per capita or equal per GDP emissions) and derive targets for countries from that formula. Rao (2011) refers to these as burden-sharing vs. resource-sharing equity principles. Chapter 4.3 analyses challenges to agreement on the distribution of effort; equity rules already present in climate negotiations (in particular, under the auspices of the UNFCCC); and principles that might guide burden-sharing more generally (e.g., the right to promote sustainable development as in Article 3.4 of the UNFCCC).

International agreements might specify norms of fairness, or effort-sharing, commonly referred to as "burden-sharing", rules that partly determine how parties are differentially obligated. For example the UNFCCC states it will be guided by the principle of the "common but differentiated responsibilities and respective capabilities" of parties (Article 3.1), and established the objective of preventing "dangerous anthropogenic interference with the climate" (Article 2). Such effort-sharing rules may vary from the "bottom-up", such as "pledge and review", where the effort-sharing rule is in effect determined simply by what each state is prepared to do, to much more multilaterally-negotiated targets as in the Kyoto Protocol, and the development of a range of metrics to calculate how the effort could be distributed across countries. Burden-sharing methods are reviewed in (Böhringer and Heinz Welsch, 2006; Wagner and Sathaye, 2006; Jotzo and Pezzey, 2007; Marschinski and Edenhofer, 2010; den Elzen and Höhne, 2008, 2010; Winkler et al., 2009; Chakravarty et al., 2009; Mearns and Norton, 2010; Frankel, 2010; Ekholm et al., 2010; Gupta, Tirpak, et al., 2007; Cao, 2010a)

"Resource-sharing" approaches (Rao, 2011), by contrast, calculate emissions reductions for countries against a specific background claim to rights to the atmosphere's absorptive capacity (Baer et al., 2009). These proposals tend towards calculations of emissions levels that converge towards a common per capita level over time (Höhne et al., 2006), including the carbon budget approach (Kartha et al., 2012; Kanitkar et al., 2010; Jayaraman et al., 2011), which allocates an overall carbon budget, either on the basis of cumulative emissions (usually from some point in the 19th century) through to the proposed date for emissions stabilization (frequently 2050), or from the present point in time forward (Rao, 2011).

In both approaches, an important question is whether the equity principle operates at the level of states, or whether, as Chakravarty et al. (2009) for example propose, at the level of individual emitters (also (Rao, 2011)). An important, and unresolved, aspect of the academic debate about these is which principle or operational rule is likely to attract the broadest participation in such agreements.

13.4.3 Recent proposals for future climate change policy architecture

An extensive literature has examined what options could be pursued "post-2012", after the end of the first commitment period under the Kyoto Protocol. The literature now contains several surveys of diverse proposals (see summaries of pre-2007 literature in (Höhne et al., 2008; Moncel et al., 2011; Gupta, Tirpak, et al., 2007; Aldy and Stavins, 2010a; Rajamani, 2011b, 2012a). Table 13.3 describes recent proposals for climate policy architectures. Qualitative and quantitative performance assessments of these proposals, where available, are surveyed in Section 13.13.

Table 13.3: Description of recent proposals for climate change policy architectures

Proposed Architecture (recent references)	Description
Strong multilateralism	
Indicator-linked national participation and commitments (Baer et al., 2009; Chakravarty et al., 2009; Frankel, 2010; Bosetti	All countries adopt emissions targets and timetables, with time of participation and/or target levels based on one or more indicators (per capita income, economic cost as percentage of national income, historical emissions). Targets

and Frankel, 2011; WBGU, 2009; Cao, 2010c; BASIC Project, 2007; Winkler et al., 2011)	can both be reductions in emissions growth rates as well as absolute reductions.
Per capita commitments (Agarwala, 2010)	Countries implement equal per-capita emissions targets, resulting in significant emissions increases for many developing countries, and significant decreases for industrialized countries. Equalize annual reductions in carbon intensity per unit of GDP across countries.
Top-down burden sharing (Baer et al., 2009; Kartha et al., 2012; Cao, 2010c; Kanitkar et al., 2010; Jayaraman et al., 2011)	Emissions targets based on: equal per capita emissions; mitigation burden proportional to cumulative emissions and ability to pay; countries with similar economic circumstances have similar burdens; and poorest countries and individuals exempt from obligations.
Sectoral approaches (Sawa, 2010; Schmidt et al., 2008; Barrett, 2010; den Elzen et al., 2008)	Countries develop national emissions targets by sector, and governments make international commitments to implement policies to achieve targets (Sawa, 2010) or based on staged sectoral approach (Den Elzen et al., 2008); can be developed in a portfolio of treaties (Barrett, 2010). Alternatively, developing countries pledge to meet voluntary sectoral targets; reductions beyond targets can be sold to industrialized countries (Schmidt et al., 2008).
Portfolio system of treaties (Barrett, 2010; Stewart et al., 2012)	Separate international treaties concluded for different sectors, different greenhouse gases. Treaty obligations apply globally, and developing countries offered financial assistance to aid compliance and induce participation. Trade restrictions used to enforce agreements in trade-sensitive sectors.
Harmonized national policies	
Global emissions permit trading system (Ellerman, 2010)	The EU ETS serves as prototype for a global emissions trading system. Design informed by EU ETS experience with role of European Commission as a central coordinating institution, mechanisms to expand participation from original 15 to 30 countries, and effective financial flows resulting from trading. Distributional impacts addressed by specific design features.
International carbon tax (Cooper, 2010; Nordhaus, 2008; Metcalf and Weisbach, 2009)	A common charge levied on all global GHG emissions, most practically upstream (at oil refineries, gas pipelines, mine mouths, etc.). Each country collects and keeps its own revenues. Charges rise over time according to schedule to induce cost-effective technological change. Distributional impacts addressed by allocation of revenues.
Hybrid market-based approaches (Fell et al., 2012)	A tradable emissions permit system includes a price ceiling, a price floor, or a combination of the two (a price collar). System functions like a hybrid of a tax and a tradable permit system. The price ceiling (often called a "safety valve") can take the form of unlimited allowances sold at a fixed price or a limited allowance reserve.
Decentralized architectures and coordinated national policies	
Linked domestic cap-and-trade systems (Jaffe and Stavins, 2010; Jaffe et al., 2009; Bernstein et al., 2010; Metcalf and Weisbach, 2012;	Domestic and international emissions trading and emissions reduction credit systems linked, directly or indirectly, to achieve cost savings. Direct linkages require more coordination, while indirect linkages (of cap-and-trade systems through a common credit system, for example) require less.

Ranson and Stavins, 2013)	Linkage achieved independently (as a bottom-up architecture), as a transition to a new top-down architecture, or as an element of a broader climate agreement.
Linked heterogeneous policy instruments (Metcalf and Weisbach, 2012)	Domestic and international emissions trading systems linked with carbon tax systems, allowing emissions permits from one country to be remitted as tax payments, and/or allowing payments in excess of the tax in one country to satisfy the requirement to own a permit in another. Alternatively, fixed emissions standards (or even technology standards) linked with taxes or tradable permit systems across countries or regions.
Technology-oriented agreements (Newell, 2009, 2010a; de Coninck et al., 2008)	International climate change agreements to cover issues such as knowledge sharing and coordination, joint research and development, technology transfer, and/or technology deployment mandates or incentives. Distributional impacts affected by intellectual property sharing rules.

13.4.4 The special case of international cooperation regarding carbon dioxide removal (CDR) and solar radiation management (SRM)

As discussed in section 13.2.2.1, international climate policy can be designed to help countries adapt to climate change and/or to achieve goals and targets to attenuate climatic variation by reducing emissions from sources, and by enhancing sinks to remove greenhouse gases from the atmosphere. Alternatively, climate policy can be designed to undertake carbon dioxide removal (CDR) or solar radiation management (SRM), (for more detail see Section 6.9, as well as WGI report, chapter 7). CDR is the use of techniques to extract GHGs directly from the atmosphere and store them in sinks, or directly enhance sinks. SRM projects can be atmospheric (e.g. cloud seeding, cloud whitening, making low clouds more reflective, or adding reflective sulphate particles to the lower stratosphere), terrestrial (e.g. enhancing the albedo of the ground, or painting pavements and roof materials white to reflect solar radiation) and space-based (e.g. placing mirrors in space). See Working Group I report, Section 7.7, for details of these.

CDR and SRM have a number of differences (see below) but raise some similar questions for international cooperation. This issue has gained heightened attention since the publication of AR4, and raises particular questions for the structure of international cooperation. Some SRM options (e.g. diffusing sulphate particles into the lower stratosphere) may be inexpensive enough for individual states (Barrett, 2008a) and even non-state actors, such as wealthy individuals, to undertake (Bodansky, 2011b; Victor, 2008), though CDR and other SRM approaches might need to be implemented by numerous countries in order to be effective (Humphreys, 2011). Some SRM options may also have specific regional benefits (e.g. leaf albedo enhancement, or ocean circulation modification), enhancing direct benefits to actors undertaking them (Millard-Ball, 2012). Smaller-scale actors that are particularly vulnerable to climate change impacts may perceive advantages to be first-movers with SRM, in order to ensure both global climate protection and a favourable distribution of regional impacts from their selected SRM projects (Ricke et al., 2010). Hardly any cooperation might be needed for SRM's development and deployment—indeed, there might be a race to launch a preferred SRM project—if it turns out that its perceived benefits out-weigh the possibility of severe collateral damages—and its costs are indeed as low as suggested by much of the literature. Such unilateral action however may produce significant costs for other actors if the SRM option chosen is one that secures climate benefits for one part of the world, while creating climate damages in other parts (Lin, 2009).

Thus, SRM poses the converse of the collective action and governance challenges arising from emissions-reduction efforts (Victor, 2008; Victor et al., 2009; Virgoe, 2009; House of Commons Science and Technology Committee, 2010; Lloyd and Oppenheimer; Millard-Ball, 2012; Bodansky, 2011b). One of the main issues for international cooperation will be to develop institutions and norms to address potential negative consequences in other social or environmental fields, or for parts of the world either not protected or negatively affected by the SRM option chosen. Thus, some analysts have recommended that international governance be organized for SRM research and testing, to develop institutions to decide when to deploy them, how to maintain their capability, or to monitor and evaluate this research and its use (Victor et al., 2009; Blackstock and Long, 2010; Lin, 2009; Solar Radiation Management Governance initiative, 2011). Others emphasize that SRM is not an alternative to emissions reductions, and that any agreements that might enable SRM would have to also continue to focus on emissions reductions (Smith and Rasch, 2012).

FAQ 13.2. What options are available to make progress on international cooperation on climate change mitigation?

The literature suggests that there are trade-offs between inclusive approaches to negotiation and agreement (i.e., approaches with broad participation, as in the UNFCCC) and exclusive approaches (i.e., limiting participation according to chosen criteria—for example, including only the twenty largest emitters). The universal membership of the UNFCCC is an indicator of its high degree of legitimacy among states, as a central institution to develop international climate policy. However, a number of other multilateral forums have emerged as potentially valuable in advancing the international process. These smaller groups can advance the overall process through informal consultations, technical analysis and information sharing, and implementation of UNFCCC decisions or guidance (e.g., with regard to climate finance). Examples include the Major Economies Forum on Energy and Climate (MEF), the Group of Twenty (G-20) and Group of Eight (G-8) Finance Ministers, and the city-level C-40 Climate Leadership Group. Section 13.5 goes into more detail, and Figure 13.1 illustrates the overall landscape they make up.

In terms of how these organizations could foster international cooperation, there are a number of potential policy architectures (see Section 13.4.3). “Policy architecture” for global climate change refers to “the basic nature and structure of an international agreement or other multilateral (or bilateral) climate regime.” There is a wide range of potential policy architectures for global climate change, some of which may have the potential to be scientifically sound, economically sensible, and institutionally feasible—characteristics that might render the architecture more likely to be accepted by governments and more environmentally effective. Architectures may be categorized into three groups: strong multilateralism; harmonized national policies; and decentralized architectures. An example of strong multilateralism is a targets-and-timetables approach, which sets aggregate quantitative emissions-reduction targets over a fixed period of time and allocates responsibility for this reduction among countries, based on principles jointly accepted. The UNFCCC’s Kyoto Protocol is an example of an operative strong multilateral approach. The second approach is to harmonize national policies. An example in principle (though not put into practice) might be harmonizing domestic carbon taxes. An example of the third approach of decentralized architectures and coordinated national policies might be linkage among domestic cap-and-trade systems, driven not through a multilateral agreement but largely by bilateral arrangements. The literature suggests that each of the various proposed policy architectures (and categories of architectures) for global climate change has advantages and disadvantages with regard to mitigating climate change; Section 13.4 goes into more detail.

13.5 Multilateral and bilateral agreements and institutions across different scales

Having considered various climate policy architectures in section 13.4, and sketched the landscape in Figure 13.1, this section considers experience and evolution of international and transnational cooperation, as reflected in the literature.

13.5.1 International cooperation among governments

This sub-section considers international cooperation under the United Nations, under other climate-related fora, and the relationships with other institutions and international coalitions.

13.5.1.1 Climate agreements under the UNFCCC

Negotiations under the Convention

Due to its universal membership, the UNFCCC has a high degree of legitimacy among many parties around the world. Steps taken under the Convention and its Kyoto Protocol have led to more extensive action than under any other form of international cooperation on climate change.

Evolution of multilateral climate regime

In Bali, discussions on long-term cooperative action under the Convention turned into negotiations under the Bali Action Plan (UNFCCC, 2007a). Also in Bali, countries agreed to measurement, reporting and verification (MRV) of mitigation commitments or actions by developed countries and mitigation actions by developing countries and support for those. For the first time, under the Copenhagen Accord and the Cancún Agreements, 44 developing countries proposed MRV mitigation actions, in some cases individual mitigation actions, in others relative emission reductions (expressed as reductions in emissions intensity, deviation below business-as-usual) and in a few countries, absolute reductions. 42 developed countries (including the 27 EU member states) submitted absolute reduction commitments against various base years in the form of quantified economy-wide emissions targets for 2020.

Durban in 2011 produced the Durban Platform for Enhanced Action (UNFCCC, 2011a), in which the delegates agreed to complete their work on a "protocol, legal instrument or agreed outcome with legal force under the Convention" no later than 2015, to come into effect by 2020. This approach is "applicable to all Parties."

New coalitions have arisen among countries across the international climate negotiations. These coalitions are groups of countries presenting coordinated positions in the international treaty negotiations (e.g. the UNFCCC, its Kyoto Protocol). Other coalitions exist outside of the climate domain, such as the G20 or OPEC (see above).

The G77 & China represents 131 developing countries, operating in the UN system more broadly as well as the UNFCCC in particular, and containing regional groups such as the African Group as well as sub-groups of LDCs and the Arab Group. Such international coalitions in the climate negotiations include the Alliance of Small Island States (AOSIS) which has played a significant role since the early 1990s; various groupings of industrialized countries at different times, including the Umbrella Group; the Environmental Integrity Group, which was the first coalition of industrialized and developing countries, and the BASIC countries (Brazil, South Africa, India and China) (Olsson et al., 2010; Rong, 2010; Nhamo, 2010). The Coalition of Rainforest Nations played a major role in getting REDD+ included in the international negotiations process in the years after Kyoto. Other active coalitions addressing other issues as well as climate include the Comision Centroamericana de Ambiente y Desarollo (CCAD), and the Bolivarian Alliance for the Americas (ALBA). In 2012, a coalition of thirty to forty "like-minded developing countries" was formed, including China, India, Saudi Arabia, and other Asian, Latin American, Middle East, and African developing countries. This was countered by the emergence of an Alliance of Independent Latin American and Caribbean states (AILAC) including market-oriented states like Chile, Colombia, Costa Rica and Peru.

Negotiations under the Kyoto Protocol

Negotiations on a second commitment period of the Kyoto Protocol were launched in Montréal in 2005 and concluded in late 2012 at COP-18 in Doha, Qatar with a decision and amendment establishing the second commitment period. However, five Annex B countries—Canada, Japan, New Zealand, Russia, and the United States—decided not to participate. There were differences with regard to transferring surplus Kyoto emissions allowances from the first to the second period; for an assessment of this issue see Section 13.13.1.1.

The Kyoto Protocol involves many links among different nations through the world's largest carbon market in 30 countries, made up of the 27 member states of the European Union and 3 non-EU countries -Iceland, Liechtenstein and Norway (that is, the European Union Emissions Trading Scheme or EU-ETS, see Chapter 14), the increasing number of emissions trading schemes in other countries and regions, and the mobilization of thousands of offset projects in developing countries through the CDM ((Michaelowa and Buen, 2012), see assessment in Section 13.13.1.1).

New institutions under the Kyoto Protocol

The UNFCCC and its Kyoto Protocol have brought about the creation of a number of new institutions focused on adaptation (funding and coordination), finance and technology. Under the Kyoto Protocol, an Adaptation Fund was set up to provide direct access to financing for developing countries, governed by a majority of developing countries (Liverman and Billett, 2010; Horstmann, 2011; Ratajczak-Juszko, 2012). (Ayers and Huq, 2009) maintain that its governance structure avoids many of the issues of ownership and accountability faced by other funds. (Harmeling and Kaloga, 2011) examine the influence of competing interests on funding decisions by the Adaptation Fund Board. Under the Fund, Multilateral Implementing Entities (MIEs) have had the most success in securing funding, followed by National Implementing Entities (NIEs), but none by Regional Implementing Entities (RIEs). This disparity has led to calls for transparency in project assessment (Harmeling and Kaloga, 2011). (Grasso and Sacchi, 2011) discuss issues of justice in Adaptation Fund financing decisions to date. Further research into the distribution of adaptation finance across countries, sectors and communities is required to assess the equity, efficiency, effectiveness and environmental impacts of the operation of the Adaptation Fund (Persson, 2011).

New institutions under the Convention

The literature on climate finance also shows innovations in a range of financial instruments and a new Green Climate Fund accountable to and functioning under the Conference of the Parties (Ballesteros et al., 2010; UNFCCC, 2010, 2011b; Nakhooda, 2010; AGF, 2010; Pew Center, 2010; Haites, 2011; Michaelowa, 2012a). Funds have proliferated but rarely have been financed (Michaelowa, 2012a). The Adaptation Committee has been established to coordinate previously fragmented aspects of adaptation policy under the Convention with modalities and linkages to other institutions being defined (UNFCCC, 2011c). Another institutional innovation is the Climate Technology Centre and Network (CTC&N) established in Cancún to exchange information regarding technology development and transfer for adaptation and mitigation (UNFCCC, 2011c). Various options were explored for the design of such a mechanism (UNEP, 2010b). The CTCN is discussed in more depth in section 13.9.

13.5.1.2 Other UN climate-related forums

A diverse set of forums has taken up the issue of climate change since AR4. As Figure 13.1 illustrates, the landscape of climate agreements is complex and multi-dimensional, so that not every example can be included. Acting on climate change requires functions other than negotiation under the UNFCCC and high-level governance, including analytical support to international mitigation and adaptation efforts, as well as implementation. Various institutions may be suited to various functions (Michonski and Levi, 2010). Because creating a new organization requires significant start-up costs, and the marginal effort of creating legitimacy for climate agreements in existing knowledge-based organizations may be low (Depledge, 2006; Oberthür, 2006), using existing institutions to facilitate climate agreements may be more cost-effective than creating new institutions.

Other UN forums beyond the UNFCCC are increasingly addressing funding for adaptation and mitigation. Fragmentation in the various objectives, conditions, and eligibility requirements of the different funds may make it difficult for developing countries to identify and access appropriate funding (Czarnecki and Guilanpour, 2009). The literature examines the relationship between adaptation and development finance, including concerns about measuring conventional official development assistance (ODA) and how much adaptation funding is ”new and additional” (Stadelmann et al., 2010; Smith et al., 2011). A number of developing countries have established national funding entities to coordinate domestic and international funding for adaptation with development funding (Smith et al., 2011).

International agreements on a related but distinct issue, depletion of the stratospheric ozone layer, have also contributed to reductions in greenhouse gas emissions. These agreements include the Montreal Protocol on Substances that Deplete the Stratospheric Ozone Layer (1987) and its successor agreements (see Section 13.13.1.3). Parties have proposed amendments to the Montreal Protocol in order to accelerate the phase out of substitutes of ozone depleting substances that are also strong greenhouse gases (Mauritius & Micronesia, 2009).

The UN Convention on Law of the Sea contains important provisions on environmental protection (Redgwell, 2006), and may have increased significance with regards to the governance of marine-based carbon sequestration or geo-engineering options (Virgoe, 2009). Several multilateral fora have recently taken up the issue of solar radiation management (the UNFCCC includes provisions in that regard (Article 4.1.f.) by requiring assessment of the adverse impacts of climate mitigation measures). Under the London Convention and Protocol, the International Maritime Organization (IMO) held that, given the uncertainty surrounding negative impacts, ocean fertilisation other than “legitimate scientific research” ought not be permitted (Reynolds, 2011). Other existing multilateral treaties and agreements that may relate to geo-engineering include the 1977 UN Convention on the Prohibition of Military or any Other Hostile Use of Environmental Modification Techniques (the ENMOD Convention), though it restricts only “hostile” actions; the 1992 Convention on Biological Diversity (CBD), which adopted a decision at its COP 10 (Convention on Biological Diversity, 2010) calling for a moratorium on geo-engineering (Tollefson, 2010); the convention on Environmental Impact Assessment in a Transboundary Context (UNECE, 1991); the Antarctic Treaty System (1959) (US Department of State, 2002); and finally, on-going developments in human rights law and in environmental law (Reynolds, 2011; UNEP, 2012a). Further, the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (1967) (United Nations, 2002) may apply to the use of sun-deflecting mirrors in space. See also, Section 13.4.2 on solar radiation management and its governance and Section 5.8.

13.5.1.3 Non-UN forums

Beyond the UNFCCC, climate change is addressed in other forums for international cooperation. (Gupta, Tirpak, et al., 2007) assessed several partnerships focused on particular themes, technologies, or regions. Some of these partnerships have defined themselves as contributions to the UNFCCC rather than as alternatives. For example, in addition to the inclusion of measures for Reducing Emissions from Deforestation and Degradation (REDD) in the UNFCCC/Copenhagen/Cancún process, the REDD+ partnership has “resulted in an Agreement on Financing and Quick-Start Measures to Protect Rainforests” in a non-binding agreement among more than 50 countries and pledges of more than $4 billion (Bodansky and Diringer, 2010). (Michaelowa, 2012a) and (Stewart et al., 2009) describe multiple avenues for climate change financing to assist transitions to low-carbon technologies. UN agencies beyond the UNFCCC have increasingly addressed various dimensions of climate change, including human development (UNDP, 2007; UNDESA, 2009), the emissions gap (Höhne et al., 2012; UNEP, 2012a) and finance (AGF, 2010). The International Renewable Energy Agency (IRENA) was established in 2009 to advance the development and transfer of renewable energy technologies, with a focus on financing renewable energy (Florini, 2011). By November 2010, IRENA’s membership included 148 states plus the European Union (Etcheverry, 2011).

The Major Economies Forum on Energy and Climate (MEF), which has a particular focus on policy for developing and deploying clean energy technologies, had its origins in a process initiated in 2007 by the George W. Bush administration in the United States as the "Major Economies Meetings", renamed from an original Major Emitters Meeting. The Obama administration subsequently continued the process under its new name. Its members -- Australia, Brazil, Canada, China, the European Union, France, Germany, India, Indonesia, Italy, Japan, the Republic of Korea, Mexico, Russia, South Africa, the United Kingdom, and the United States – together account for about 80% of global emissions (WRI, 2012). Its meetings are intended to advance discussion of international climate change agreements (MEF, 2009), with an offshoot of a Clean Energy Ministerial. However, the MEF is not recognized by its own participants as a forum for negotiating binding agreements – it is explicitly a venue for discussion, and outputs are a Chairs' summary rather than formally agreed text (Leal-Arcas, 2011). The existence of the MEF may be evidence of an overall increase in the fragmentation of global environmental governance (Biermann and Pattberg, 2008; Biermann, 2010).

The Group of Twenty (G-20) Finance Ministers from industrialized and developing economies may have a basis to address climate finance, building on its core mission, which is to discuss economic and finance policy. The make-up of the G-20 is similar to that of the MEF, with the addition of Argentina, Saudi Arabia, and Turkey. (Houser, 2010) finds that the G-20 might help to accelerate the deployment of clean energy technology, help vulnerable countries adapt to climate change impacts, and help phase out inefficient fossil-fuel subsidies. At its meeting in Pittsburgh in 2009 (G-20, 2009), the G20 gave considerable attention to climate change policy issues, in particular the related issue of phasing out fossil-fuel subsidies. Likewise, since 2005, the G8 heads of state and government have held a series of meetings relating to climate change and recognized the broad scientific view that the increase in global average temperature above pre-industrial levels ought not to exceed 2°C (G8, 2009). (Van de Graaf and Westphal, 2011) explore both opportunities for and constraints on the G20 and G8 with regard to climate.

Two forums growing in importance are the International Energy Agency (IEA) and the Organisation for Economic Co-operation and Development (OECD). While the IEA has limited itself to industrialized oil-importing countries as a response to actions by OPEC (Scott, 1994; Goldthau and Witte, 2011), the OECD has granted membership to advanced developing countries. Both institutions are increasingly mandated by their members to provide analytical support with regards to climate change mitigation. The OECD has a unit for economic analysis of climate policy and impacts, and already plays a role in building knowledge (OECD, 2009). The IEA may be well-placed to reduce uncertainty about countries' performance by collecting, analysing, and comparing energy and emissions data.

The Cartagena Group, formed at the Copenhagen COP in 2009 (including more than 30 industrialized and developing countries) meets mainly between formal sessions. In February 2012, a group of seven partners (Bangladesh, Canada, Ghana, Mexico, Sweden, and the United States, together with the UN Environment Programme) launched a new "Climate and Clean Air Coalition" as a forum for dialogue among state and non-state actors outside the UNFCCC process to reduce levels of black carbon, methane and HFCs; on 24 April 2012, UNEP announced the addition of six additional partners to this coalition (Colombia, Japan, Nigeria, Norway and the European Commission, along with the World Bank).

New initiatives on international cooperation for adaptation and its funding have been created, such as the World Bank's Pilot Program on Climate Resilience, and the European Commission-established Global Climate Change Alliance (GCCA), which pledges regional and country-specific finance.

13.5.2 Non-state international cooperation

13.5.2.1 Transnational cooperation among sub-national actors

A prominent development since AR4 is the emergence of a large number of international agreements not centered on sovereign states (see (Den Elzen, Hof, Mendoza Beltran, et al., 2011; Höhne et al., 2012; Hare et al., 2012)). These are most commonly referred to as transnational climate governance initiatives (Biermann and Pattberg, 2008; Pattberg and Stripple, 2008; Andonova et al., 2009; Bulkeley et al., 2012). In the most comprehensive survey, (Bulkeley et al., 2012) document 60 of these initiatives, which can be grouped into four principal types: public-private partnerships, private sector governance initiatives, NGO transnational initiatives, and sub-national transnational initiatives. The first two (dealing directly or indirectly with private sector initiatives) are dealt with in section 13.12; the other two (related to government or community initiatives) are discussed here.

NGO transnational initiatives attempt to influence the activities of corporations directly through transnational partnerships, some of which involve collaboration with the private sector. They have set up certification schemes for carbon offset credits, such as the Gold Standard – which is limited to renewable energy and demand-side energy efficiency projects - or the Community Carbon and Biodiversity Association standard, with its aim to increase the quality of forestry credits (Bayon et al., 2007; Bumpus and Liverman, 2008). Certified offset credits have commanded a price premium above other ("standard") credits (Sterk and Wittneben, 2006; Ellis et al., 2007; Nussbaumer, 2009; Newell and Paterson, 2010). These certification schemes have been used for the Voluntary Carbon Market as well as for the CDM (Conte and Kotchen, 2010).

Similarly, city-level governments have collaborated at international scale, notably ICLEI's Cities for Climate Protection program from 1993 and more recently through the C40 Climate Leadership Group and (Kern and Bulkeley, 2009; Román, 2010; Bulkeley et al., 2012). A World Mayors Summit in November 2010 had participation from 138 cities and agreed on a Global Cities Covenant on Climate, otherwise known otherwise known as the Mexico City Pact. The "carbonn Cities Climate Registry" is an effort of local governments for measurable, reportable and verifiable climate action, as one among several initiatives at carbon footprinting (Chavez and Ramaswami, 2011; Ibrahim et al., 2012; Otto-Zimmermann and Balbo, 2012; Richardson, 2012). City governments engage in both collaboration and competition to develop low-carbon development strategies. Increased engagement by local governments has produced a Local Government Climate Roadmap and explicit recognition in agreement among nation-states (UNFCCC, 2010, para. 7). Recognition of local governments as governmental stakeholders in para.7 of Cancún Decisions is a reflection of these efforts in the UNFCCC processes.

Larger sub-national units have developed transnational collaborative schemes. Most notable are the North American sub-federal cap and trade schemes being developed, notably the U.S. state of California's, which forms part of the regional Western Climate (see Chapter 13.6.2), to be implemented in early 2013 (Rabe, 2007b; Selin and VanDeveer, 2009; Bernstein et al., 2010) (See 13.6.1.2 and chapter 15).

13.5.2.2 Human Rights and Rights of Nature

Human rights law could frame an approach to climate change (Bodansky, 2010b). Some recent literature argues that a human rights framing helps 'to counteract gross imbalances of power' between states and individuals (Sinden, 2007; Bratspies, 2011; Akin, 2012). The human rights approach in relation to climate change has been acknowledged by the UN Human Rights Council (Resolution 7/23) and the Office of the United Nations High Commissioner for Human Rights (2009, A/HRC/10/61) (Limon, 2009). The literature discusses a variety of specific issues, including the implications for climate adaptation; the impacts of climate change on human rights to water, food, health, and development; obligations to undertake mitigation actions; and whether human rights law implies an obligation to receive refugees.

The potential for climate change to cause the largest refugee crisis in human history, displacing millions of people, largely in Africa and Asia, raises the matter of human rights. While some raise concerns about alarmist rhetoric and militarisation of responses (Hartmann, 2010), most of the literature focuses on the impacts on international cooperation as refugees move to other countries, and strains placed on the capacity of existing institutions (Biermann and Boas, 2008). Others point to legal hurdles, including the issue of causality, who is to be held responsible, who is the right bearer and the issue of standing (Limon, 2009).

A human rights approach has implications for global governance architecture, and proposals have been made in the literature for a Protocol to the UNFCCC, as well as a funding mechanism (Biermann, 2010) or a new convention on refugees due to the impacts of climate change (Docherty and Giannini, 2009). This could build on the 1951 Geneva Convention Relating to the Status of Refugees. In the meantime, the Special Procedures and the Universal Periodic Review of the Human Rights Council are advancing the human rights and climate change agenda (Cameron and Limon, 2012).

In 2010, Bolivia convened a World People's Conference on Climate Change and the Rights of Mother Earth in Cochabamba, culminating in a People's Agreement (WPCCC and RME, 2010). Analysis has emphasised the participation of social movements (Sandberg and Sandberg, 2010), arguing for "radical climate justice" (Roberts, 2011) and an approach to law that seeks to establish "rights of nature"(Cullinan, 2002; Aguirre and Cooper, 2010).

13.5.3 Advantages and disadvantages of different forums

The literature has considered the strengths and weaknesses of negotiating climate policy across multiple forums and institutions. If the UNFCCC defined its role as coordinating a global response to climate change, but not only by taking action itself, but also by catalysing efforts by others and providing coherence, this may help to achieve a more adequate aggregate effort (Moncel and Van Asselt, 2012). Other literature suggests that "regime complexes" may emerge from smaller "clubs" and then expand ((Keohane and Victor, 2011); (Victor, 2011)). Regimes need (external) incentives for participation and (internal) incentives for compliance (Aldy and Stavins, 2010c). A key advantage of smaller forums or "clubs" may be greater efficiency in the negotiation process, as emphasised in the general political science literature on negotiations (for example, (Oye, 1985)), but the literature also reflects key disadvantages, including that such clubs lack universality and hence legitimacy (Moncel et al., 2011), and that the environmental effectiveness of clubs may be undercut by leakage of emissions sources to other countries outside the club (Babiker, 2005). Some have suggested clubs as a way forward outside the UNFCCC, while others suggest they could contribute to the UNFCCC, for example by assisting in catalyzing greater ambition (Weischer et al., 2012). Several smaller 'clubs' have been assessed in 13.5.1.2 – cutting across categories (e.g. public / private) and scales (from international to local). Flexibility is another advantage cited, although the approach is not necessarily superior (Keohane and Victor, 2011) and has to date not brought about high levels of participation and action. Smaller clubs must address conflicts where the climate change regime intersects with other major policy regimes (Michonski and Levi, 2010). Analysis of existing clubs suggests they enable incremental change, and proposes that a set of incentives (related to related to trade, investment, labour mobility or access to finance) could turn these into "transformational clubs" (Weischer et al., 2012).

In a fragmented world, linking multiple agreements into a coherent whole is a major challenge. For the landscape of climate agreements and related institutions to have an adequate aggregate effect (in terms of the criteria discussed in 13.2), linkages among multiple elements (see Figure 13.1) will need to be well coordinated. The connecting lines in Figure 13.1 illustrate potential linkages; the actual forms and effects of such linkages, existing or future (or of other linkages not depicted in

Figure 13.1), must be evaluated in each context. Linkages across the landscape of agreements on climate change might take several forms, such as mandating action by subsidiary bodies and reports-back, agreed links between institutions (e.g. memoranda of understanding), loose coordination, information sharing, and delegation. The literature on transnational governance acknowledges a gap in that "interactions are understudied in all areas of transnational governance" (Weischer et al., 2012). Related literatures suggest that important characteristics of linkages across regime components may be reciprocity (Saran, 2010), competition between (private) governance regimes (Helfer and Austin, 2011), relationships of conflict or interpretation (ILC, 2006), collaboration (Young, 2011), the catalytic role of the UNFCCC (UNFCCC, 2007a), NGOs as norm entrepreneurs (Finnemore and Sikkink, 1998), accountability (Bäckstrand, 2008; Ballesteros et al., 2010), learning (Kolstad and Ulph, 2008), experimentation and evaluation of policy approaches (Greenstone, 2009; (Stewart and Wiener, 2003)), as well as hierarchy (higher bodies mandating action by lower levels), mainstreaming (incorporating climate considerations into other areas of decision making), and redundancy (safeguards against inaction at lower levels). Delegation, for example under CDM to various subsidiary bodies, is said to increase efficiency by utilising best-equipped agents to address problems, by reducing transaction costs of policy-making, and by enhancing credibility through enforcement (Green, 2008). Still, relationships among international agreements and instruments are frequently unclear and often contested.

13.6 Linkages between international and regional cooperation

Due to the scale effects that occur when carbon markets are enlarged, carbon markets may be the primary means of regional policy integration. The most significant regional carbon market, by a wide margin, is the EU Emissions Trading Scheme (EU ETS), which since 2005 brings together 27 European Union member states and is linked with the Norwegian system. (For a full assessment of ETS systems see Chapter 15.) A sub-national system, the Western Climate Initiative (WCI), was considered in the United States and Canada, but California and Quebec are the only states that remain active in the cap-and-trade aspect of WCI. California and Québec's cap-and-trade systems became operational in January 2013, and the two governments are, in January 2013, in an advanced stage of discussions about linking the two systems. (For details on both systems see Chapter 14.4.2.1; for other emerging national emission trading systems see Chapter 13.7. For a full assessment of ETS systems see Chapter 15.)

13.6.1 Links with the European Union Emissions Trading Scheme (EU ETS)

The EU ETS was designed as the key means for the European Union to achieve its Kyoto commitments. The wave of accessions to the European Union from 2004 onwards expanded the scope of the ETS. The EU ETS now covers three very diverse sets of countries: Western/Northern/Southern Europe, generally seen as constrained by the Kyoto emission targets; Eastern Europe, with a surplus of emissions units; and Cyprus and Malta, without emission targets under the first commitment period of the Kyoto Protocol.

The states of the European Economic Area (EEA) (i.e. the EU member states plus Norway, Iceland and Liechtenstein) have been linked to the EU ETS through incorporation of the EU ETS Directive into the EEA agreement in 2007 from the start of the second trading period (Tuerk et al., 2009). Norway had previously had its own system, which suffered from low liquidity.

Interaction of the EU ETS with international carbon markets works through the project-based Kyoto Mechanisms. Import of units through international emissions trading is not allowed, but companies covered by the EU ETS can import CDM and JI credits. A relatively liberal import regime for the pilot phase was laid down in a "Linking Directive" approved in 2004 (Flåm, 2009). Forestry credits were banned and additional criteria for large hydro power projects were set. For the ETS second or Kyoto phase, 2008-2012, countries proposed import thresholds; several proposals were adjusted downwards by the Commission. For the phase 2013 to 2020, imports were limited to credits from

CDM projects registered before 2013 in the absence of an international climate change agreement. New (2013 inception or later) CDM projects can only be used in the EUETS if located in least developed countries (Skjærseth, 2010; Skjærseth and Wettestad, 2010). However, CDM credits from new projects in non-LDCs can be accepted after 2013 if the EU has concluded a bilateral agreement with the country in question regulating their level of use.

The European Union could potentially link the EU ETS to other schemes; legislation for the period until 2020 allows negotiation of such bilateral treaties. Linking is already agreed with the Australian system. Cross-boundary transfers of EU allowances are mirrored by transfers of Kyoto units.

13.6.2 Links with the Western Climate Initiative

The Western Climate Initiative (WCI) was triggered by the passage of a greenhouse gas mitigation bill in California with relatively ambitious mitigation objectives – the Global Warming Solutions Act of 2006 (Assembly Bill 32). The WCI was originally envisaged to include seven western U.S. states and four Canadian provinces, enter into force in 2012, and feature linkage among a set of state and provincial cap-and-trade systems, with an overall aim of reducing GHG emissions by the member states/provinces to 15 percent below 2005 levels by 2020 (Rabe, 2007a; Selin and VanDeveer, 2009; Bernstein et al., 2010). However, the launch of the WCI system was delayed to 2013, and – more importantly -- is now likely to include only California and Québec, with the possible addition of Ontario, British Columbia, and Manitoba.

California's rules are still being developed, but appear likely to allow some fraction of emission reductions to be covered by offsets from outside of the state (Haites and Mehling, 2009; Benson, 2010), which is essential for linkage to occur. Agreements between California and Québec on linking their systems are emerging, focused on joint auctions of allowances and rules permitting mutual recognition of offsets. Legal scholars (Barnett, 2010) have assessed whether the WCI infringes legal prerogatives of the federal governments of the United States and Canada, respectively, and found it to be legally valid.

13.6.3 Links with other regional policies

The Asia-Pacific Partnership for Clean Development and Climate, which was time-limited and has now concluded, involved about 50% of the world population, GHG emissions, and world economic output. It included countries that had not ratified the Kyoto Protocol, was very soft in the hard/soft legal continuum, but may have had a modest impact on governance (Karlsson-Vinkhuyzen and Van Asselt, 2009; McGee and Taplin, 2009) and encouraged voluntary action (Heggelund and Buan, 2009). After the end of the Asia-Pacific Partnership for Clean Development and Climate, the Global Superior Energy Performance Partnership (GSEP) took over some of the activities.

In addition, besides being covered by international organizations, such as ICLEI - Local Governments for Sustainability, voluntary mitigation action of cities is taking a regional/global character (Kern and Bulkeley, 2009). In Europe, the Climate Alliance has close to 1400 member cities from a number of countries. The Climate Alliance has supported rainforest conservation projects in the Amazonian region.

And increasingly, market-transformation initiatives for energy efficiency improvement are undertaken on a regional level. Examples are the Motor Challenge, which includes 30 European countries which share the aim of improving industrial motors (Bertoldi and Elle, 2010), the U.S. and Canada Consortium for Energy Efficiency, which brings together utilities and municipalities (IEA, 2010a) coordinated standard-setting in joint committees in Australia and New Zealand (Cogan, 2003).

13.7 Linkages between international and national policies

As the landscape of multilateral and other international agreements on climate has become more complex, the interactions between international and national levels have become more varied.

13.7.1 Influence of international climate policies on domestic action

International policy may trigger more ambitious national policies. Treaties provide greater certainty that others will also act, thus addressing key concerns that countries will free ride. International climate policy can shape domestic climate discourse, even if it may not be the main source to inspire proactive action (Tompkins and Amundsen, 2008). In fact, the implementation of international policy is affected by national political structure which can be decentralized, centralized, or consensus-based, e.g. decentralization in Italy (Massetti et al., 2007), France (Mathy, 2007) or Canada (Harrison, 2008), centralization in China (Teng and Gu, 2007) or the UK (Barry and Paterson, 2004; Compston and Bailey, 2008) and the consensus culture in the Netherlands (Gupta, Lasage, et al., 2007). Some literature suggests that national and sub-national settings may provide useful laboratories to test policy instruments before implementation at the international level, in a setting where actions may be less risky and/or more politically feasible (Michaelowa et al., 2005; Moncel et al., 2011; Zelli, 2011).

Where national policymaking lags, policy experimentation has occasionally taken place at the sub-national level (Rabe, 2007b), notably in California (see section 13.5 above) and Northeastern USA (RGGI). Another example is New South Wales (Australia), which operated an emissions trading system from 2003, though this system was terminated and folded into Australia's new carbon-tax scheme in July 2012.

13.7.2 Linkages between the Kyoto mechanisms and national policies

Linking national policies with international policies may provide flexibility by allowing a group of parties to meet obligations in the aggregate. The Kyoto Protocol (Article 4) provides for such inter-regional flexibility, and the European Union has taken advantage of the Protocol's provision through its internal burden-sharing decision, through which the Kyoto commitment of an 8% emissions reduction is redistributed among EU-15 member states in a way that the commitments of these states range from -28% (Luxembourg) to +27% (Portugal) (Michaelowa and Betz, 2001; Hunter et al., 2011).

Making use of the Kyoto mechanisms (e.g. CDM and JI) is driven by national mitigation policies to achieve industrialized countries' emissions commitments. While governments of some industrialized countries buy emissions credits directly, others introduce instruments with emissions commitments for private companies, like the EU Emissions Trading Scheme (EU ETS) and some countries such as Denmark have done both. These companies can then use emissions credits generated under the Kyoto Protocol to satisfy part of their commitments (Michaelowa and Buen, 2012). Another example is Japan's Industry Voluntary Action Plan (Mitsutsune, 2012).

Many industrialized countries limit imports of credits generated by the Kyoto mechanisms for various reasons. One reason is to keep the carbon price high to induce technological innovation and another reason is to ensure modernisation of the economy for future competitiveness (A Bowen, 2011). Yet another reason is to avoid diminishing environmental effectiveness by allowing required emissions-reduction to occur in other jurisdictions because of concerns about the quality of credits ("additionality"). For example, the European Union has prohibited the import of Assigned Amount Units (AAU) into the EU-ETS in order to prevent the use of surplus units from countries in transition, colloquially called "hot air" (Michaelowa and Buen, 2012), although Japanese companies have used AAUs from Green Investment Schemes for meeting their targets (Tuerk et al., 2010). In 2011, credits from certain CDM project types were banned for use in the EU-ETS from 2013 onwards (Schneider, 2011).

The Kyoto mechanisms also interact with the national policies of countries in which projects are implemented. However, the CDM Executive Board decided that the effects of new policies implemented in host countries should not be considered when assessing the additionality of new projects to avoid perverse incentives not to adopt mitigation policies (Winkler, 2004; Michaelowa, 2010). Instead, countries may subsidize renewable energy while generating CDM credits. There are indications that the availability of CDM credits has accelerated the introduction of feed-in tariffs in China (Schroeder, 2009). Freeing emission units for sale under international emissions trading requires national mitigation policies, unless there is a surplus of units in a business-as-usual situation as in countries in transition (Böhringer et al., 2007).

Investment law, defined through over 3,000 multilateral and bilateral investment treaties, and private international law apply to the CDM and emissions trading contracts. Proposed standardised contracts link the CDM to investment law by covering the choice of language and the process and forum for dispute resolution, and could expose contractors to the costs associated with international arbitration (Gupta, 2008; Klijn et al., 2009).

Linkage can be direct or indirect. In the former case, the same units are valid throughout the linked systems. Indirect linkage is achieved through acceptance of a third unit in a certified emission reduction credit system by several systems. Figure 13.3 shows trading schemes and linkages.

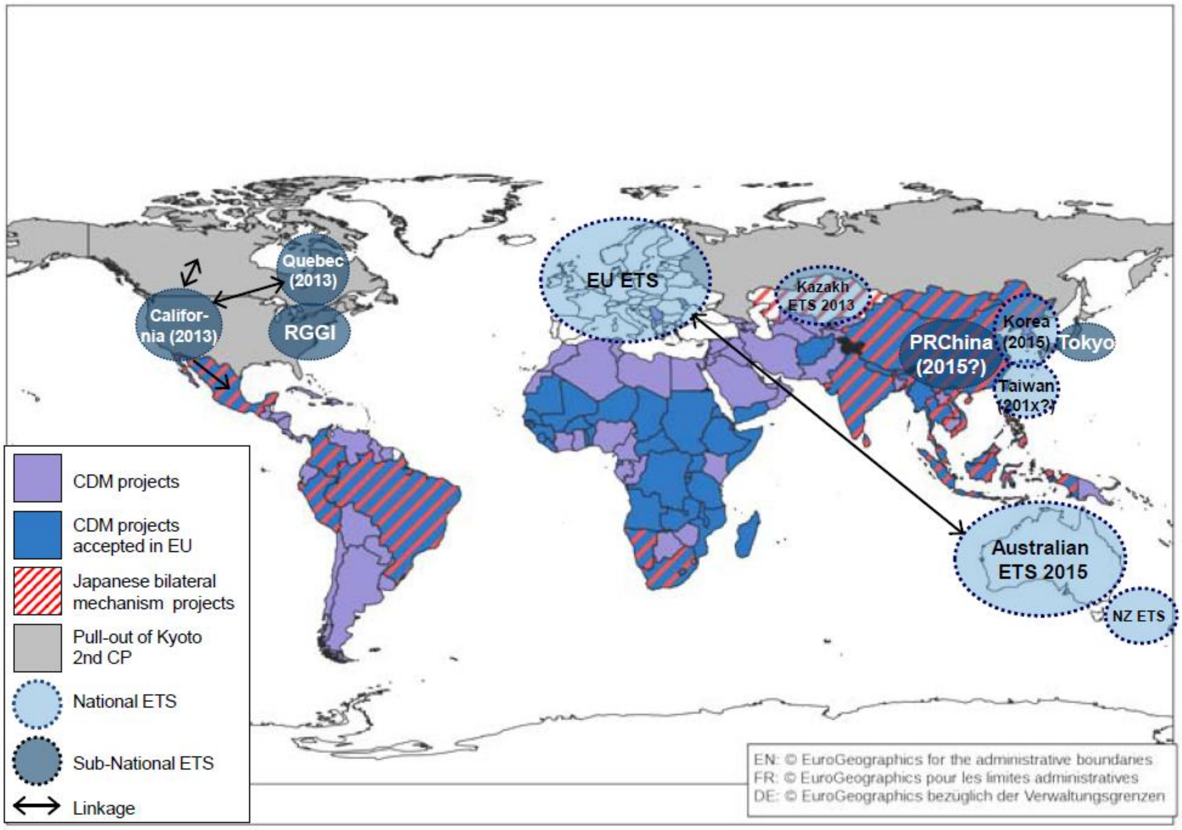


Figure 13.3. Cap and trade schemes with existing linkages

The only formal *direct* linkage between two trading schemes agreed as of January 2013 is between the Australian Emission Trading Scheme and the EU-ETS. California and Quebec are, at that date, in an advanced stage of deliberation on linkage. A strong indirect linkage between carbon markets exists through the CDM, whose credits are accepted under the EU-ETS, the Australian Carbon Pricing Scheme, and the New Zealand ETS. (Nazifi, 2010) finds that EU demand has driven the price for CDM credits.

Review of unilateral and bilateral direct linkages demonstrates that bilateral direct linkage reduces mitigation costs, increase credibility of the price signal, and expand market size and liquidity (Anger, 2008; Flachsland et al., 2009; Jaffe et al., 2009; Dellink et al., 2010; Cason and Gangadharan, 2011; Lanzi et al., 2012). However, direct linkage also raises a variety of concerns (Jaffe et al., 2009), including that linking can lead to a dilution of mitigation achieved through trading schemes, as linked systems are only as good as the weakest among them (e.g. the one that allows imports of offsets of doubtful quality). (Grubb, 2009) also warns that countries may be unwilling to accept an increase of carbon prices that would result from linking with an ambitious system. (Tuerk et al., 2009) see the biggest challenges to linking in differential stringencies of targets in each system, varying degrees of enforcement, differences in eligible project-based credits, and the existence of cost containment measures, such as price ceilings. (Haites and Mehling, 2009) stress that only bilateral links (or reciprocal unilateral links) yield the full benefits of linkage, but would entail, in the case of bilateral links, cumbersome adoption procedures as well as legal and procedural constraints. Whereas reciprocal unilateral links, possibly accompanied by an informal agreement, would be easier to implement and offer more flexibility, and achieve almost the same economic benefits. Possibly more attractive than any of these approaches are indirect linkages among regional, national, or sub-national cap-and-trade systems, an approach that maintains the benefits of linkage without much of the downside. Such indirect linkages achieve cost savings and avoid risk diversification without the need for too much harmonization of emerging and existing cap-and-trade systems. It is attractive because indirect linkages limit potential distributional concerns and preserves a high degree of national control over allowance markets (Jaffe et al., 2009).

13.8 Interactions between climate change mitigation policy and trade

Research on interactions between climate change mitigation policy and trade indicates a diversity of compatibilities, synergies, and conflicts, as well as cooperative arrangements(Brewer, 2003, 2004, 2010; Cosbey, 2007; ICTSD, 2008; Cottier et al., 2009; Epps and Green, 2010). Consideration of these and other issues and options needs to take into account the context of the provisions of the principal existing multilateral climate change framework (Yamin and Depledge, 2004) and multilateral trade framework (Hoekman and Kostecki, 2009). Negotiators have recognized the importance and opportunities for international cooperation on climate change-trade interactions in both the (UNFCCC, 1992) and in a Ministerial Decision at the time of the negotiations of the Marrakech Agreement establishing the World Trade Organization (1994), but they have also recognized the potential for conflict (see Kyoto Protocol Article 2.3). The Kyoto Protocol notes in Article 2.3 that Annex I Parties "shall strive to implement policies and measures under this Article in such a way as to minimize adverse effects, including … effects on international trade."

Trade and climate policy interact at many levels: multilateral, plurilateral, regional, bilateral and sectoral (Copeland and Taylor, 2005; Tamiotti et al., 2009; UNEP, 2009; UNCTAD, 2010; World Bank, 2010). For instance, on the one hand, according to (Peters and Hertwich, 2008), one-quarter of CO_2 released to the atmosphere is emitted in the production of internationally-traded goods and services (see also (Peters et al., 2011)). Transportation associated with trade is another related issue (Conca, 2000). On the other hand, various climate change policies currently in place affect prices of goods and services and hence relative prices which affect trade flows and the total volume of traded goods (Whalley, 2011). Moreover, trade barriers and regulations regarding intellectual property rights of "green technology" as well as many WTO/GATT regulations impinge on climate policy (Thomas, 2004; Khor, 2010a; Johnson and Brewster, 2012).

The production of internationally traded goods gives rise to a "labelling" issue, a problem for accounting purposes and also for possible policy intervention, as a proportion of a country's greenhouse gas emissions resulting from the production of goods and services in one country may be "embedded" in traded products which are consumed in other countries. At issue is whether to attribute the emissions to the producing (exporting) country or consuming (importing) country

(Kainuma et al., 2000; Peters and Hertwich, 2008). As (Peters et al., 2011) indicate, "most developed countries have increased their consumption-based emissions faster than their territorial emissions" and "the net emission transfers via international trade from developing to developed countries increased from 0.4 Gt CO2 in 1990 to 1.6 Gt CO2 in 2008." Hence, the accounting question touches on several issues. There is an ethical and equity issue about how to define climate responsibility and allocate climate mitigation costs (discussed in detail in Chapters 3 and 4). There is a political and economic issue whether climate policy instruments ought to address production- or consumption-induced greenhouse gases ((Droege, 2011a; b); see also Chapter 14.2.4). There is a technical issue as territorial measurement is the current greenhouse accounting practice under the UNFCC and switching to consumption-induced measurement appears to be technically more difficult (Droege, 2011a; b; Peters et al., 2011).

There are significant differences among researchers and policymakers in their perspectives on economic relations between climate change and trade. These differences include fundamental empirical assumptions and policy preferences concerning the roles of markets and governments (Bhagwati, 2009). Economic analysis of environmental issues in general, including climate change economic analysis in particular, typically assumes that government measures (including regulations and subsidies) are needed to address the market failures that contribute to the climate change problem and constrain solutions to it. Economic analyses of trade issues (for a qualification see e.g. (Krugman, 1979)) typically assume that there are gains from free trade based on countries' comparative advantages and that government intervention tends to create inefficiencies. Issues at the intersection of trade and climate change with regard to governments' participation and compliance in international environmental agreements are discussed in (Barrett, 2003, 2007, 2008b) and (Barrett and Stavins, 2003). (See also sections 13.2-13.3.)

Trade measures (e.g. trade sanctions, trade enticements and trade-relevant domestic product standards; see section 13.8.1 below) could conceivably be used to address free-rider problems of international agreements - specifically participation and/or compliance problems (Victor, 2010), with some (e.g. (Victor, 2011)) suggesting these may be useful measures to achieve an effective climate agreement. However, there are also voices which clearly dismiss trade measures as an appropriate tool to pursue climate change policy objectives, pointing to the possibility of "green protectionism" (Khor, 2010a; Johnson and Brewster, 2012).

13.8.1 WTO-related issues

A central issue for WTO members is whether policies are consistent with principles of non-discrimination: Most Favoured Nation Treatment, which prohibits more favourable treatment of the goods, services, or corporations of any one member as compared with other members, and National Treatment, which prohibits less favourable treatment of foreign relative to domestic goods, services or corporations. Of the more than 60 WTO agreements, annexes, and understandings that apply these principles, many are pertinent to climate change, including the General Agreement on Tariffs and Trade (GATT), the General Agreement on Trade in Services (GATS), the Agreement on Trade Related Intellectual Property Rights (TRIPs), the Agreement on Trade Related Investment Measures (TRIMs) and the Dispute Settlement Understanding (DSU), as well as agreements on subsidies, technical barriers, government procurement, and agriculture (Brewer, 2003, 2004, 2010; Cottier et al., 2009; Hufbauer et al., 2009; Epps and Green, 2010).

Trade issues concerning CDM projects have received special attention (Werksman et al., 2001; Rechsteiner et al., 2009; Werksman, 2009). Although no trade or investment disputes have arisen yet in connection with CDM projects, there is the possibility that they will in the future as the number and economic significance of CDM projects continue to increase. Significant attention has also been given to product labelling and standards issues can arise in relation to the WTO Agreement on Technical Barriers to Trade (Appleton, 2009), which could be pertinent to the use of labels concerning "food miles" (ICTSD, 2007; World Bank, 2010). Although long-distance air transport of agricultural products inevitably involves aviation industry GHG emissions, the agricultural practices of many exporting countries are less GHG-intensive than those of the importing countries; determining the relative GHG emissions levels of imported versus domestic products thus requires complete life-cycle analyses of individual products and specific pairs of exporting-importing countries.

Government procurement restrictions on imports of climate-friendly goods and services have emerged as an issue under the principle of non-discrimination in the context of national economic stimulus programs. The applicability of the plurilateral WTO Agreement on Government Procurement to such trade issues is limited because many countries have not agreed to it; among those that have, there are many government agencies whose programs are not covered (Van Asselt et al., 2006; Hoekman and Kostecki, 2009; Malumfashi, 2009; van Calster, 2009).

Government subsidies for renewable energy and energy-efficiency goods and services have also become issues in relation to the WTO Agreement on Subsidies and Countervailing Measures as well as the Trade Related Investment Measures agreement. Such issues have prompted WTO dispute cases - one involving subsidies for producers of wind turbines (WTO, 2010) and another involving feed-in tariffs (WTO, 2011). Although the application of WTO subsidy rules may retard the development and diffusion of climate-friendly technologies, it is not yet clear that this will happen (Bigdeli, 2009; Howse and Eliason, 2009; Howse, 2010).

WTO- related issues have to do with tariffs and non tariff barriers based on climate change reasons. In general, non-tariff barriers tend to be more important barriers than tariffs at the climate-trade interface, but tariffs are still high in some industries and countries (Steenblik, 2006; World Bank, 2008a). Countries may seek to limit competitive disadvantage introduced by domestic climate policy, for example by a local carbon tax, by raising tariffs and introducing non-tariff barriers which restrict imports, or by other border adjustment measures. Barriers to transfers of technologies identified by the (IPCC, 2011) as potential contributors to climate change mitigation have been issues in the on-going WTO Doha Round negotiations (Tamiotti et al., 2009) Domestic subsidies, especially in agricultural products, (this has been the case with biofuels) have been at issue in the Doha Round of WTO negotiations.

Border adjustment measures (BAMs) to offset international differences in costs—and thus possible international leakage (see Chapter 5 on the terminology) arising from international differences in measures to address climate change—have become one of the most contentious and researched points of interaction (see sections 13.3.1 and 13.3.2 above, and (Babiker, 2005; de Cendra, 2006; Cosbey and Tarasofsky, 2007; Ismer and Neuhoff, 2007; Genasci, 2008; Frankel, 2008; Tamiotti and Kulacoglu, 2009; Zhang, 2009; O'Brien, 2009; van Asselt and Brewer, 2010; Tamiotti, 2011). BAMs include policy options ranging from tariffs on imports or export subsidies based on the amount of greenhouse gases released in their production to "compensatory measures," as for instance the free-allocation emission permits or export rebates to energy-intensive sectors, in those jurisdictions that are pursuing some form of climate policy. There is a shared view that if BAMs are to be useful, they constitute a second-best policy option, at least in economic-efficiency terms. Nevertheless, theoretical arguments in favour of BAMs include (1) the reduction of economic inefficiencies in the context of an externality, (2) the reduction of carbon leakage and (3) increasing participation in and compliance with a climate agreement.

First, the economic discussion stresses that the inclusion of more countries in climate policy, e.g. by linking permits trading scheme and including more sectors and countries, is preferable to unilateral BAMs. Welfare effects may be negative for consumers and countries facing BAMs on their exports. Overall welfare effects accounting for externalities are mainly perceived to be positive at an abstract theoretical level (Gros and Egenhofer, 2011) the evidence is more blurred at an empirical level and is sensitive to assumptions (*Tackling carbon leakage*, 2010; Fischer and Fox, 2012; Lanzi et al., 2012). Export rebates, the exclusion of energy/CO2-intensive industries from regulation or the free-allocation of permits to these industries are recognized as causing efficiency losses (Lanzi et al., 2012). Most empirical studies also do not confirm a need for BAMs in the first place: they tended to find that climate policy is not a significant trade issue at the macro-economic level of national economies, though there are competitiveness and leakage issues for a few industries which are both greenhouse gas-intensive and trade-intensive. They hold that the main channel of impact of climate policies is through world energy prices and not through manufactured goods (Grubb and Neuhoff, 2006; Houser et al., 2008; Aldy and Pizer, 2009; *Tackling carbon leakage*, 2010).

Second, the political discussion tends to be divided into two perspectives. Developed countries and/or countries with some form of climate policy either already in place or considering this for the future argue that BAMs are necessary to "avoid that carbon controls drive production abroad". Arguments along this line have emerged in the EU and the USA for instance. See (Veel, 2009; *Tackling carbon leakage*, 2010; Fischer and Fox, 2012) for an extensive discussion. Developing countries tend to oppose BAMs, being afraid of negative welfare effects for their countries and pointing to the violation of the principle of common but differentiated responsibilities as agreed under the UNFCCC (Khor, 2010a; Droege, 2011a; Scott and Rajamani, 2012). Nevertheless, the technical difficulties of measuring production-induced or consumption-induced greenhouse gases emissions are not negligible (Droege, 2011a) and addressing them may be associated with high administrative costs, possibly outweighing the potential benefits of BMAs (McKibbin and Wilcoxen, 2009).

Third, from the discussion of legal issues related to BAMs three major conclusions emerge. BAMs may well clash with WTO/GATT-regulations (Condon, 2009; Holzer, 2010, 2011; Tamiotti, 2011; Du, 2011). However, even under current regulations, BAMs can most likely be designed to be compatible with these regulations (Condon, 2009; Droege, 2011a; b). These regulations and their legal interpretation have evolved over time, allowing for the possibility to bring trade and climate policy goals more in line in the future (Kelemen, 2001; Neumayer, 2004).

13.8.2 Other international venues

Two greenhouse-gas-emitting industries that are centrally involved in international trade as modes of transportation are covered by separate international agreements that are outside the WTO system (see also Chapter 8). International aviation issues are covered by the Chicago Convention and the International Civil Aviation Organisation (ICAO), while international maritime shipping issues have been addressed by the International Maritime Organisation (IMO). (See Section 13.13.1.4 for performance assessments of the ICAO and IMO.)

There has been increasing interest in recent years in both ICAO and IMO in industry practices concerning greenhouse gas emissions, with some efforts at international cooperation to address them. However, there has been conflict in ICAO and in other venues about the European Union's inclusion of aviation within the EU ETS. (See (Scott and Rajamani, 2012; Ireland, 2012), who point to concerns about the violation of principle of common but differentiated responsibility of the UNFCC.) Though studies indicate that the economic impacts are small relative to other airline expenses and ticket prices and that much of the cost can be passed on to consumers (Scheelhaase and Grimme, 2007; Anger and Köhler, 2010), economic, political and legal issues have nevertheless made international cooperation difficult. See (Hepburn and Müller, 2010) for a proposal for an international aviation adaptation levy and (Keen et al., 2012) for market-based instruments in general.

In the WTO, the GATS includes commitments concerning aviation ground services only, and the Agreement on Trade in Civil Aircraft is a plurilateral agreement that pertains only to manufactured goods in the form of aircraft and parts. Climate change issues in maritime transport have been on the WTO agenda through the Negotiating Group on Maritime Transport Services. The effect of a carbon levy combined with a rebate for developing countries is discussed in (Keen et al., 2012).

(*Second IMO GHG study 2009*, 2009) concluded that a significant potential for CO2 reduction exists through technical and operational measures, many of which appear to be cost-effective, although both financial and nonfinancial barriers may discourage their implementation. A link of carbon controls of aviation and shipping to the EU-ETS and/or a possible US-ETS is suggested by (Haites, 2009) with the view that carbon offsets under the CDM can also be used. This is in line with the plans of the EU to include not only emissions from aviation but also shipping into the EU-ETS from 2013 onwards. Direct regulation under ICAO and IMO have been discussed but not yet agreed (Keen et al., 2012).

There are other international institutional contexts within which climate change-trade interaction issues have been addressed, namely, the World Bank, G-8, G-20, International Energy Agency, Major Economies Forum, and Organisation for Economic Cooperation and Development (section 13.5).

13.8.3 Implications for policy options

In terms of WTO and/or UNFCCC involvement, there are logically four possible sets of options for institutional architectures at the multilateral level for addressing climate change-trade interactions: WTO-based, UNFCCC-based, joint UNFCCC-WTO, and stand-alone. In addition, there could be hybrid arrangements involving combinations of these four “pure” types. For instance, proposals for Sustainable Energy Trade Agreements (SETAs) could be addressed in a variety of venues (ICTSD, 2011).

Of the four options, WTO-based ones have received the most attention in the literature. Alternatives include making revisions in existing WTO arrangements or undertaking new arrangements (Epps and Green, 2010). Possible changes in existing WTO arrangements include a “peace clause” (Hufbauer et al., 2009) or waiver agreement (Howse and Eliason, 2009; Howse, 2010), whereby WTO members would agree - within some limits - not to challenge on WTO grounds, respectively, climate policies in general or climate-related subsidies in particular. An extensive list of other possible changes to existing WTO arrangements has been discussed by (Epps and Green, 2010), whose suggestions include: change GATT Article XX so that climate measures are explicitly identified as qualifying for exceptional treatment; add a similar provision to the Subsidies Agreement; change the burden of proof or standard of review for the scientific evidence presented in climate change cases to Dispute Settlement panels; change Dispute Appellate Body rules to take into account the scientific uncertainties in climate change cases; establish a notification process for members to inform other members of the adoption of climate policies with trade implications; and establish a Climate Change Committee, which could facilitate conflict resolution without resorting to the Dispute Resolution process.

Many possibilities for a new Climate Change Agreement at the WTO have also been discussed by (Epps and Green, 2010). The elements of such an agreement could include: establishment of a Climate Change Committee (as above); establishment of a notification procedure for climate change measures (as above); establishment of climate change mitigation as a legitimate objective; development of a ”non-aggression clause” that would prohibit unilateral actions, such as border adjustment measures; adoption of transparency requirements for national climate change policymaking processes to determine their legitimacy in relation to climate change concerns and protect against disguised trade protectionism; adoption of environmental rationales for subsidies; reviews of members’ trade-related climate measures to insure that they are substantive responses to climate issues; and clarification of the potential application of “process and production methods” (PPMs) questions to climate change disputes. Although these ideas have been mentioned in the literature, they have not been specific proposals on the WTO agenda.

UNFCCC-based options (Werksman et al., 2009) relate to creating an equal playing field, such as through border charges on imports, or border rebates for exports, though views differ greatly as already mentioned above in the discussion of BAMs.

A potential joint UNFCCC-WTO agreement has not yet received much attention in the published literature (Epps and Green, 2010). However, there are already in effect arrangements whereby the UNFCCC secretariat is an observer in meetings of the WTO Committee on Trade and Environment (CTE) and is invited on an ad hoc basis to meetings of the Committee overseeing the specific trade and environment negotiations (CTESS) (Cossey and Marceau, 2009). In addition, WTO Secretariat staff members attend the annual UNFCCC COP meetings.

Finally, a stand-alone arrangement could – in principle -- be developed (Epps and Green, 2010), a possibility that has not yet been analysed in the published literature. Because published analyses of these various options are relatively recent and evolving rapidly, it would be premature to summarize them. Nevertheless, options for one or more such agreements are at the frontiers of the research and policy agendas of both the climate change and trade communities of researchers and policymakers. The agenda includes not only greater cooperation at the multilateral institutional level, but also many issues at other institutional levels.

There are numerous and diverse unexplored opportunities for greater international cooperation in trade-climate policy interactions. While mutually destructive conflicts between the two systems have thus far been largely avoided, pre-emptive cooperation could protect against such developments in the future. Whether such cooperative arrangements can be most effectively devised within the existing institutional architectures for trade and for climate change or through new architectures is an open issue (section 13.4).

13.9 Mechanisms for technology development, transfer, and diffusion

Because of the long-term nature of the climate change problem and the high costs associated with significant emissions-reduction strategies, technological change in mitigation methods and other, related technologies is likely to play an important role in the implementation of future policies.

Technology-related policy may play a significant role in an international climate policy regime (De Coninck et al., 2008). It potentially lowers the cost of climate change mitigation and increases the likelihood that countries will commit to reducing their GHG emissions. By lowering the cost of environmentally sound technologies relative to climate-damaging technologies, appropriate policy can increase incentives for countries to comply with international climate obligations and could therefore play an important role in increasing the robustness of long-run international frameworks (Barrett, 2003). Further, incentives for participation in international climate agreements may be derived where policy facilitates access to climate change-mitigating technologies or funding to cover the additional costs of such technologies.

Technology-related policy may also advance goals beyond climate policy, such as economic development, local air quality improvement, and energy security. However, inequalities in the development of technology and the resultant concentration of intellectual property for climate friendly- technologies means that distributional issues may be affected. Issues of equity in relation to technology are considered in Chapter 4.

Finally, technology-oriented agreements could include activities across the technology life-cycle for knowledge sharing, coordinated or joint research and development of climate change-mitigating technologies, technology transfer, and technology deployment policies (such as technology or performance standards and incentives for technology development or adoption) (Newell, 2010a). More precisely, international technology policy may play an important role in improving the efficiency of existing R&D activities by increasing the international exchange of scientific and technical knowledge and by reducing duplicated R&D effort which could be shared across nations.

13.9.1 Modes of international incentive schemes to encourage technology-investment flows

Absent additional market failures, underinvestment in innovative activity below socially-optimal levels can occur due to several well-understood general properties of innovation: indivisibility (i.e. prices of newly innovated projects need to be above the marginal cost of their production if innovators are to be compensated for the costs of R&D), uncertainty in the returns to R&D effort, and inappropriability (when the full social benefits of innovation cannot be appropriated) (Arrow, 1962). Inappropriability, due to knowledge "spillovers", tends to be a greater concern the further up the chain of technological change: from development to applied and finally to basic scientific research (IEA, 2008; Henderson and Newell, 2011).

Incentives for private-sector investment in lower-cost technologies for mitigation can be created by placing a price on GHG emissions (explicitly created through market-based regulation or implicitly created through non-market-based regulation). This creates a demand-driven, and therefore profit-based, incentive for the private sector to invest in developing lower-cost technologies for mitigation. This phenomenon, referred to as "demand pull" (Schmookler, 1962) encourages private firms to invest in R&D and other types of innovative activities to bring lower-GHG technologies to market (for surveys see (Jaffe et al., 2003; Popp et al., 2010).

Significant factors in inducing private sector investment in innovation are the credibility of policy commitments and the duration of incentive schemes. Given the long lifetimes of emission-intensive capital (e.g. power plants may operate for more than 50 years and building shells may last 100 years), long-term credible incentives allow the owners of such capital to form appropriate expectations to structure their investments. Extending the time horizon of climate policy commitments and decreasing the downside uncertainty surrounding the level of incentives will bring about more innovation because firms will expect a market for climate change-mitigating technologies further into the future (Corfee-Morlot et al., 2012).

At a global level international carbon markets and the flexibility mechanisms they may employ, such as international linkage of domestic emission programs, offsets, and the Clean Development Mechanism (CDM), may be used to finance emission reductions in developing countries and transferring technology between nations and regions (see section 13.13, and (Haščič and Johnstone, 2011)). Clear rules for these markets and their associated flexibility mechanisms may be established under international agreements and domestic policies to aid the removal of unnecessary barriers to technology transfer and to facilitate investment flows.

Therefore, national and supra-national policies that provide incentives for climate change mitigation will likely play an essential role in stimulating demand and therefore inducing innovation in the necessary new technologies for climate mitigation goals. Reducing fossil-fuel subsidies may have a similar effect (UNEP, 2008).

13.9.2 Intellectual property rights and technology development and transfer

The degree of protection afforded to intellectual property rights, together with other conditions related to the rule of law, regulatory transparency, and market openness affect technology transfer rates (see also chapters 3 and 16).

Protecting intellectual property (IP) through patents is one of the principal means by which innovators can capture value lost because of the indivisibility of R&D costs and product manufacturing costs and the public good nature of information associated with new GHG-reducing technologies. Apart from the intellectual property regime remedying the problem of public goods, producers of innovative products can internalize some of the benefits of their research efforts by requiring purchasers to enter into long term contracts and licensing agreements that prohibit reproduction of the product and dissemination of information embodied in the product. The literature surveyed in Chapter 15 shows that there is some evidence (clouded by difficulties of establishing the direction of causality) that stronger IP protection in developed countries fosters investment in R&D (and hence presumably innovation) in those countries. Theoretical analysis suggests that this effect also means that stronger IP protection in developing countries would similarly increase the incentive for R&D in the developed countries, by extending the protected market for the resulting products (Grossman and Lai, 2004). The empirical evidence, however, provides at best ambiguous evidence that stronger IP protection fosters indigenous innovation in middle income developing countries, and no evidence that it does so in the poorest countries (Hall and Helmers, 2010). Further, compulsory licensing has been proposed as a mechanism to encourage transfer with compensation to the patent holder while overcoming market power inhibitions on voluntary licensing (Reichman and Hasenzahl, 2003).

Even if stronger IP protection does not foster creation and development of new technologies, it may be beneficial to technology development for mitigation if it fosters transfer of technologies from developed to less developed countries. Theoretically, strong IP protection in developing countries may be necessary to limit the risk for foreign firms that transfer of their technology will lead to imitation and resulting profit erosion. Empirical literature finds a role of strong IP protection in receiving countries in facilitating technology transfer from advanced countries through exports, foreign direct investment ("FDI"), and licensing for: transfers from the OECD (Maskus and Penubarti, 1995); FDI to 16 countries originating in the U.S., Germany and Japan (Lee and Mansfield, 1996; Mansfield, 2000); and transfers from the U.S. (Smith, 1999). Regarding recipients, (Awokuse and Yin, 2010) find evidence for transfers to China, and (Javorcik, 2004) for FDI to twenty-four Eastern European transition economies. (Branstetter et al., 2006) assessed FDI to sixteen middle income countries after those countries strengthened their IP protection and found indicators for U.S. technology transfer increasing subsequently.

Overall, there does seem to be consistent evidence that, all else equal, stronger IP protection fosters greater incoming FDI, particularly for middle income countries. It is important to note, however, that IP rules are but one of many factors affecting FDI decisions. Others, particularly more general aspects of the legal and institutional environment that affect the riskiness of investments, may be more significant (Fosfuri, 2004). The results investigating the effect of IP strength on technology licensing parallel those for FDI. The (Branstetter et al., 2006) results discussed above included royalty payments among the measures of technology transfer that increased after IP strengthening. (Smith, 2001) finds that the association between strong IP and licenses is stronger than the relationship between IP and exports. Further research could clarify differences between arms-length, market-based licenses and licenses between related entities in multi-national firms, in terms of the effects of IP on technology transfers.

In summary, the evidence indicates a systematic impact of IP protection on technology transfer through exports, FDI and technology licensing, particularly for middle-income countries for which the risk of imitation in the absence of such protection is relatively high. It is unclear whether or not these effects extend to the least developed countries whose absorptive capacity and ability to appropriate foreign technology in the absence of strong IP protections is less (Hall and Helmers, 2010).

Research that examines the role of IP rights in the specific context of climate-friendly technologies has been limited to a few industries (Reichman et al., 2008). In an analysis of existing solar, wind, and biofuel technologies, for example, (Barton, 2007) on wind, also see (Lewis, 2007, 2011; Pueyo et al., 2011) found that IP protection has elicited innovation without significantly impeding technology transfer, although problems could arise if new, very broad patents were granted that impede the development of future, more efficient technologies (though even then, IPR may provide some flexibility)

The two key international institutions for developing and implementing IP policies are the World Intellectual Property Organization (WIPO), a specialized agency of the United Nations that administers numerous intellectual property treaties, and the WTO, through the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS). (See Section 13.8)

It may also be noted that patents can limit the use of new technologies by allowing the price to be set above marginal cost. A way to address this problem is to use prizes, which promote R&D without granting patent protection and allow new technologies to be sold at marginal cost (assuming competitive markets). This is an alternative to IP protection as a way to encourage the spread of new technologies.

13.9.3 International collaboration to encourage knowledge development

A wide variety of factors drive technology development (Acemoglu et al., 2012). Domestic actions for emissions mitigation may thus be a critical feature of any internationally coordinated response to climate change that induces long-term innovation (see Chapter 15). Nonetheless, transferring the resulting technological knowledge and equipment internationally, and ensuring that technologies are deployed in appropriate national contexts, may require additional actions at an international level. While technology transfer strategies may address typical impediments to technology adoption, such as information availability and technological maturity, they also can address international and domestic barriers to financing in developing countries (Ivus, 2010).

13.9.3.1 International agreement on R&D knowledge sharing, coordination, and joint collaboration

The possibilities for international R&D collaboration include agreements for knowledge sharing and coordination of R&D, joint collaboration and funding of R&D, and commitments to increase domestic R&D funding, as well as public-private partnerships (Okazaki and Yamaguchi, 2011).

Activities undertaken under knowledge-sharing and coordination agreements can include planning meetings, information exchange, coordinated or harmonized research agendas, measurement standards, and integrated or cooperative R&D (IEA, 2008; de Coninck et al., 2008). Examples of such existing international agreements include the Carbon Sequestration Leadership Forum, the former Asia Pacific Partnership on Clean Development and Climate, and the International Partnership for a Hydrogen Economy. Energy science and technology agreements that feature a higher degree of joint, collaborative R&D have been more frequently implemented in more basic research areas. Examples include the ITER fusion reactor and European Organization for Nuclear Research (CERN) (De Coninck et al., 2008). In addition to expanding the international exchange of scientific and technical information, joint R&D can increase cost-effectiveness through cost sharing and reduced duplication of effort.

Most existing international agreements relevant to climate mitigation technology have been developed as so-called Technology Implementing Agreements under the auspices of the IEA, organized under its Committee on Energy Research and Technology. IEA Implementing Agreements use two primary mechanisms: task sharing and cost sharing. In task sharing, a joint program is pursued within participating countries, but each country funds and implements its own contribution to the project. In cost sharing, participating countries pool funding for a single contractor to perform a research task. There are forty-one existing IEA Implementing Agreements, all of which incorporate task sharing and about half of which have cost sharing (Newell, 2010a).

13.9.3.2 International agreement on domestic climate technology R&D funding

Public sector investment in energy and climate-related R&D has fallen considerably since the early 1980s, although there has been a rebound in recent years (Newell, 2010a, 2011). An international agreement could include provisions to increase domestic funding of climate technology R&D, analogous to internationally agreed emission targets for each country. Such an agreement could, for example, target a level of climate technology R&D as a percentage of GDP, or as a percentage increase from recent levels to incorporate notions of burden-sharing (Newell, 2010a). The general idea is not without precedent: In 2002, the European Union set a goal of increasing its level of overall R&D spending—which was 1.8 percent of GDP at the time—to 3 percent of GDP by 2010; the actual level achieved was 1.9 percent (OECD, 2012). Also, at a G-8 meeting, in the context of a consideration of how to address climate change, there was agreement to seek to double public investment in R&D between 2009 and 2015 (G8, 2009). (See (Torvanger and Meadowcroft, 2011; Fischer et al., 2012), on issues in the design and support of climate friendly technologies.) International coordination of R&D portfolios may reduce the duplication of R&D effort, cover a broader technological base, and enhance the exchange of information gained through national-level R&D processes. This coordination could cover the allocation of effort by government scientists and engineers, the targeting of extramural research funding to specific projects, and public-private partnerships. Engaging developing economies in developing and deploying new technologies may require further technology development to meet the needs of domestic institutions and norms.

Bringing newly-developed technologies to full commercialization often presents challenges, and for some technologies, the private sector may not have sufficient incentives under existing conditions to commercialize new technologies. Since some of the economic risk the private sector faces reflects uncertainty about the incentives that future climate policies would create, governments may have a role in financing technology demonstration projects (Newell, 2007). The case for such demonstration projects may be even stronger in developing and emerging economies where incomplete capital markets may further undermine investment in commercializing these technologies.

13.9.3.3 International policies to facilitate technology transfer

At a global level international carbon markets can contribute to technology transfer. (See section 13.13.1.1 on technology transfer contributions of the CDM.) International trade and foreign direct investment, including international mergers and acquisitions, are the primary means by which new know-how and equipment are transferred among countries (World Bank, 2008b) with private-sector investments constituting 86% of global investment and financial flows (UNFCCC, 2007b). In addition to domestic actions that foster a positive environment for technology transfer investments through regulatory flexibility, transparency, and stability, specific international actions could be taken to reduce barriers to trade in environmental goods and services. In particular, the literature has identified tariffs and non-tariff trade barriers as an impediment to the transfer of energy technologies to developing countries (World Bank, 2008b); also see this chapter 13.9.8).

The UNFCCC in Article 4.5 mandates that “The developed country Parties and other developed Parties included in Annex II shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties….” This builds on the model established by the Multilateral Fund under the Montreal Protocol to support developing countries’ efforts to reduce their emissions of ozone-depleting substances. After a modest record of financial assistance for technology transfer through the Global Environmental Facility, several developed countries pledged six billion dollars for technology transfer at the Hokkaido Summit in 2008 (IPCC, 2000; Aldy and Stavins, 2008). The performance of the international institutional arrangements and the adequacy of the amounts of financing are subject to a variety of interpretations. (See Chapter 14 for a discussion of the UNFCCC Climate Technology Center and Network, and see Chapter 15 for a discussion of financial issues.)

13.10 Capacity building

Capacity building refers to strengthening the capacity of developing societies so they can reach their development goals. The literature on capacity building includes social change and institutional change theories, lessons on the effectiveness of aid and capacity building, and adaptive capacity theories. It also deals with the use of disaster management techniques (Aragón and Giles Macedo, 2010). Capacity building can both empower and disempower (Armitage, 2005; Barnett, 2008).

Aid-effectiveness theory argues that once we are “freed from the delusion that it can accomplish development” (Easterly, 2007, p. 331), it can be effective when the type of aid and capacity building is aligned to the type and needs of the partner country, when there is partner ownership of the projects and conditionality is minimized, when simplistic formulae are not used, when imbalances in the local economy are not caused and when stakeholders are included and mobilized (Gupta and Thompson, 2010).

(UNEP and UNDP, 2007) argue that mainstreaming environment in development processes calls for finding the right entry point, finding a ‘champion’, ensuring the commitment of the planning or finance team, providing country-specific evidence, performing integrated policy appraisals, engaging key sector agencies, considering the environment-agency capacity and acknowledging the need for sustained support. Such processes are not always efficient but may need to be ‘clumsy’ to allow local actors to redesign and gain ownership of the process (Verweij and Thompson, 2006) and take gender issues into account (Makhabane, 2002). They need to allow for systemic capacity to develop which can only result from relationships between actors ‘who want to make a difference, rather than just resulting from improvements to technique, structure or assets’ (Pitpit and Baser, 2010, p. 60). However, some evidences indicate that there is a distressing dissonance between what international development agencies know about capacity development and what they implement because these agencies are often driven more by self-interest (James, 2010), prefer linear causal logic, replicable ‘best practice’ models, the promotion of discrete skills and individual capacity over collective reflection, struggle and engagement with power relations which is critical for change (Clarke and Oswald, 2010; Harvey and Langdon, 2010; Pearson, 2010).

13.10.1 Capacity building in mitigation and adaptation

With respect to climate, the two capacities to address it are adaptive capacity and mitigative capacity. Chapter 4 considers them jointly as dimensions of “response capacity”. Capacity building for adaptation include (i) risk management approaches to address adverse effects of climate change; (ii) maintenance and revision of a database on local coping strategies; and (iii) maintenance and revision of the adaptation practices interface (UNFCCC, 2009b). The process of preparing the National Adaptation Programmes of Action (NAPAs) for and by least developed countries (LDCs) identifies their most “urgent” adaptation needs. However, capacity building for adaptation is insufficient because the costs in such regards are rarely estimated (Smith et al., 2011). At the community level, adaptation projects require time and patience and can be successful if they raise awareness, develop and use partnerships, combine reactive and anticipatory approaches, and are in line with local culture and context (Dumaru, 2010).

Capacity building for mitigation from the national level to the individual level has occurred in CDM experiences of raising awareness, the establishment of Designated National Authorities (DNAs), the training of private and public personnel, and project support (Michaelowa, 2005; Okubo and Michaelowa, 2010)(Michaelowa, 2005; Okubo and Michaelowa, 2010). Capacity building for Nationally Appropriate Mitigation Actions (NAMAs) and REDD-plus are expected (Bosetti and Rose, 2011).

13.10.2 Capacity building scope

Several Articles in the UNFCCC (such as Article 4.1(i), Article 4.5, Article 6 and Article 9.2(d)) and the Kyoto Protocol (such as Article 10(e)) mention capacity building. In those Articles, special attention is given to developing countries while capacity building is acknowledged as a general need for all countries.

Monitoring and evaluation activities can play an important role in ensuring effective implementation of a capacity-building framework – they can be used to address gaps and needs in capacity building, promote best practices, and encourage more efficient use of resources (UNFCCC, 2009c). At the same time, technology transfer and financial assistance can be complemented by capacity building efforts to promote effective implementation. The IPCC special report on technology transfer (IPCC, 2000) treated capacity building under the goal of technology transfer.

Many multilateral and bilateral institutions provide activities in support of institutional capacity building for government workers, scientists, and public and private sector practitioners. For example, UNEP and UNDP do so by helping develop local policies, institutional frameworks, partnerships, and implementation capacities to reshape and refocus policies, investments, and spending on a range of green economic sectors that contribute to climate change mitigation and adaptation (Diakhité, 2009).

As part of the institutional evolution under the UNFCCC, a Durban Forum on capacity building was created, with annual discussions under the Subsidiary Body for Implementation drawing on work by organisations and experts outside of the UNFCCC (UNFCCC, 2011c), with the first meeting taking place in Doha (UNFCCC, 2012a). There are few assessments of current capacity building approaches in relation to climate change (Virji et al., 2012).

13.11 Investment and finance

International cooperation has been used to promote public as well as private investment and finance for mitigation and adaptation activities; the largest share goes to mitigation: (Abadie et al., 2012) provide reasons for this, such as the differences between mitigation and adaptation regarding public good characteristics. Such cooperation has included the setup of market mechanisms to generate private investment as well as public transfers through dedicated institutions (Michaelowa, 2012b). In the follow-up to the Copenhagen conference, the term “climate finance” has been coined for financial flows to developing countries, but there exists no internationally agreed definition (Buchner et al., 2011). (Stadelmann, Roberts, et al., 2011) provide a discussion of what could be counted and how the baseline for international climate finance could be set in order to provide “new and additional” funds.

A goal of the Copenhagen Accord of 2009 was to jointly mobilize USD 100 billion per year by 2020 to address the needs of developing countries, in the context of meaningful mitigation actions and transparency of implementation. In order to reach this financial goal, the (AGF, 2010) identified two potential sources of finance: public funds from UNFCCC or development bank-type sources, and carbon market finance, or mobilization of private capital. Note that Chapter 16.2.1 describes the potential financing need and Chapter 16.2.3 gives a description of possible funding sources.

13.11.1 Public finance flows

13.11.1.1 Public funding vehicles under the UNFCCC

International collaboration regarding public climate finance under the UNFCCC dates back to 1991, when the Climate Change Program of the Global Environment Facility (GEF) was set up. Today, the UNFCCC mobilizes financial flows to developing countries and countries in transition through four primary vehicles (see also Chapter 16.6.2; (UNFCCC, 2012b): the GEF that focuses on mitigation (GEF, 2011); the Least Developed Country Fund (LDCF) and Special Climate Change Fund (SCCF), created in 2001 for adaptation purposes; the Adaptation Fund set up in 2008; and the Green Climate Fund (GCF), established in 2010 for mitigation and adaptation. GEF administers all funds other than the GCF. (Tatrallyay and Stadelmann, 2012)’s study on GEF projects in India and Brazil finds that mostly negative-cost abatement has been targeted. The Adaptation Fund is financed through a 2% in-kind levy on emissions credits generated by CDM projects, though parties to the Kyoto Protocol have pledged and contributed additional funding (Horstmann, 2011; Ratajczak-Juszko, 2012). All other UNFCCC funding vehicles are based on voluntary government contributions that can be counted as official development assistance.

The Conference of the Parties to the UNFCCC has decisionmaking power regarding the representation of country groups on the governing boards of the UNFCCC's funding vehicles, voting rules, the choice of secretariat and the choice of trustee (e.g., who oversees the finances and ensures funds go where they are supposed to go). However, due to its complex, multilevel structure, the GEF faces the challenge of coordination with UNFCCC decisions (COWI and IIED, 2009; Ayers and Huq, 2009).Recipient countries have a majority in the board of the Adaptation Fund, while the decisionmaking bodies for the other UNFCCC financing institutions have equal representation for developing and industrialized countries. The Adaptation Fund has allowed the possibility of "direct access" by host country institutions, which has been used sparingly to date (Ratajczak-Juszko, 2012). The GEF is also starting to experiment with this approach (GEF, 2011, p. 4).

Funding per country eligible under the Adaptation Fund is limited to 10 million USD, essentially leading to a situation where each country gets financing for a single project. The GEF operates funding ceilings and caps for each country (currently 2 million USD and 11% of the total volume available, respectively). In between these thresholds, a complex allocation formula is used whose variables consist of GDP, project portfolio performance , country environmental policy and institutional performance, greenhouse gas emissions level, development of carbon intensity, forestry emissions and changes in deforestation.

A step change with regards to the international coordination of public finance flows was the collective pledge by industrialized countries in the Copenhagen Accord of 2009 to provide 30 billion USD as "Fast Start Finance" (FSF) during the period 2010-2012 for mitigation and adaptation in developing countries. FSF was to provide "new and additional" resources, flowing through existing multilateral, regional and bilateral channels. Official development assistance (ODA) made up a high share of total funding (Ballesteros et al., 2010) and several studies argue that the use of ODA as a substitute for new climate finance mechanisms could divert funding away from other important imperatives such as the Millennium Development Goals (Michaelowa and Michaelowa, 2007; Ayers and Huq, 2009; Gupta and van der Grijp, 2010, p. 347).

Given the challenges in raising public funds from state budgets, (Grubb, 2011a) proposed the following criteria for robust sources of public funds: they should not fall naturally under any specific national jurisdiction, would preferably contribute directly to the mitigation of climate change, and should carry mutual incentives that could facilitate all sides agreeing to use it as a funding source. (Hourcade et al., 2012) propose creation of carbon certificates as international reserve assets, backed up by an international agreement on a social cost of carbon.

13.11.1.2 Multilateral Development Banks (MDBs)

The MDBs were established to promote balanced economic growth and poverty reduction (Nakhooda, 2011). With global environment governance being delegated, in part, to MDBs, they have had to integrate environmental considerations into economic development and hence take an active role in addressing climate change (Arner and Buckley, 2010; Newell, 2011).

For example, the World Bank provides services as trustee or interim trustee for all the UNFCCC-related funds noted above. A group of MDBs manages and governs the Climate Investment Funds (CIFs) which were set up in 2008 and are financed through voluntary government contributions. The Clean Technology Fund supports investments in low carbon technologies while the Strategic Climate Fund is an umbrella for improving resilience against climate change, reducing deforestation and renewable energy support for low-income countries.

(Tirpak and Adams, 2008) see increases in MDBs' funding and shifts to low greenhouse gas technologies being fragile. (Bowen, 2011) proposes expansion of the capital base of multilateral financial institutions in order to increase concessional financing of mitigation and adaptation activities.

Funding may be perceived differently by funders and recipients. While government funders strive for accountability of recipients, the latter want to have more influence regarding project choice and allocation of funding (Ghosh and Woods, 2009). Over the last two decades, recipients have gained more decision making power in the institutions under the UNFCCC, while multilateral financial institutions have not followed this trend. Financing is typically not directly given to the project recipients but provided through implementing agencies – mostly multilateral financial institutions or UN agencies - that fulfil predefined fiduciary standards.

13.11.2 Mobilizing private investment and financial flows

Mobilization of private finance through international cooperation is increasingly seen as part of international climate finance. As discussed in section 13.4.1.4 and 13.13.1.1, carbon credits from market mechanisms generate revenues for private sector players, thus leveraging large investments in mitigation. Such leverage is seen as important by (Urpelainen, 2012), in whose game-theoretical model, capacity building leverages private mitigation investment. Therefore, a number of international initiatives have supported capacity building for market mechanisms (Okubo and Michaelowa, 2010). Also, the multilateral financing institutions discussed in section 13.11.1 argue that their public funding will "leverage" private finance.

The potential for leveraging to lead to double- and multiple-counting has led to suggestions that internationally agreed methodologies to account for leveraging are needed (Clapp et al., 2012), which would be of help in consistent reporting of finance against the goal agreed under the UNFCCC. As summarized by (Stadelmann, Castro, et al., 2011), leverage factors – defined as the ratio between mobilised private funding and mobilising public finance –reported by the Climate Technology Fund under the CIFs and the GEF reach 8.4 and 6.2, respectively. However, an analysis of over 200 CDM and close to 400 GEF projects by (Stadelmann, Castro, et al., 2011) finds a leverage ratio of just 3 to 4.5. Moreover, high leverage factors may mean that the underlying project is not additional, i.e. not contributing to mitigation at all. Finally, instead of leveraging in the private sector through capacity building, the World Bank engagement in the Kyoto mechanisms has at least partially crowded out private sector activities, as shown empirically by (Michaelowa and Michaelowa, 2011).

Besides market mechanisms, other instruments such as grants, loans at concessional rates, provision of equity through financial institutions, or guarantees can mobilize private funds. This can happen directly on the company level or be channelled through national governments (Neuhoff et al., 2010). While they can be implemented on any level of aggregation, the level of incentive provided could be coordinated internationally, e.g. by basing it on a previously agreed "social cost of carbon." (Hourcade et al., 2012). The success of the Multilateral Investment Guarantee Agency (MIGA) shows that costs of guarantees are likely to be low if multilateral financial institutions with strong financial ratings provide them.

13.12 The role of public and private sectors and public-private partnerships

International responses to climate change ultimately depend on private sector action (see Figure 13.1). Large multinational corporations produce about half of the global world product and global GHG emissions (Morgera, 2004). Hence, private companies will need to generate investment and innovation necessary to pursue a low carbon economy (Forsyth, 2005). Not surprisingly, given that GHG emissions are an externality, a gap remains between the need for GHG reduction targets and the commitments of the largest international companies (Knox-Hayes and Levy, 2011, p. 97).

However, strategies of international business towards climate change have shifted significantly, from opposition to emissions reductions, such as through the Global Climate Coalition (Newell, 2000; Lacy, 2005), towards proactive engagement with climate change, sometimes focused on opportunities for low-carbon development (Pulver, 2007; Falkner, 2008; Pinkse and Kolk, 2009). While challenges remain for businesses from the climate regime (regarding, for example, competitiveness issues), many businesses see opportunities coming from the climate regime. An example are manufacturers of energy-generation equipment and energy-consuming durable goods, the current stocks of both of which will – in general – be rendered prematurely obsolete by higher energy prices.

13.12.1 Public-private partnerships

Public-private partnerships (PPPs) have grown as international responses to climate change (Bäckstrand, 2008; Pattberg, 2010; Andonova, 2010; Kolk et al., 2010). They involve countries, private sector actors, and sometimes NGOs. Examples include: the Renewable Energy and Energy Efficiency Partnership (Parthan et al., 2010); the Methane to Markets initiative (now renamed the Global Methane Initiative) (De Coninck et al., 2008); the former Asia Pacific Partnership on Climate and Energy (which was largely organized through sector-specific PPPs (Karlsson-Vinkhuyzen and Van Asselt, 2009; McGee and Taplin, 2009; Okazaki and Yamaguchi, 2011); the Global Superior Energy Performance Partnership (taking sector-specific activities from the regional scale to the global scale (Fujiwara, 2012; Okazaki et al., 2012); the CDM (where some projects can take the character of PPPs (Streck, 2004; Green, 2008; Newell, 2009); the World Bank Prototype Carbon Fund (Lecocq, 2003; Andonova, 2010); the UN Fund for International Partnerships (39% of whose environmental partnerships are in climate change-related projects (Andonova, 2010, pp. 45–47); the UN Global Compact's "Caring for Climate" initiative (Abbott, 2011); the Green Power Market Development Group (Andonova, 2009); and the Munich Climate Insurance Initiative (Pinkse and Kolk, 2011). Those partnerships can facilitate development and commercial deployment of low carbon technologies as governments remove barriers to the entry and provide stakeholders with new business frameworks and industries also demonstrate leadership through active involvement with regards to their technologies, investments and know-how. (IEA, 2010b, p. 52 and 469).

Some international PPPs concentrate on the development of specific technologies. Others focus on low-carbon energy development in general, or rural renewable energy. Others center their attention on carbon market development. Few focus on adaptation, with the insurance sector involved in such initiatives(Pinkse and Kolk, 2011). Partnerships for sustainable development have, in general, delivered less than expected. They exist mainly in areas that are heavily regulated and institutionalized, and they focus on institution building and not implementation. Many have insufficient resources, and most focus on partners (governments, organizations and civil society bodies) that are already active. Effective partnerships are institutionalized partnerships with representatives of major stakeholders, a permanent secretariat, resources and a dedicated mission (Pattberg et al., 2012, pp. 241–246). Company willingness to engage in adaptation depends on their capacity, their past exposure to disasters, and the link between their business planning horizons and climate impact uncertainty (Agrawala et al., 2011). They also need to ensure that they are able to adapt to changing climatic circumstances (Linnenluecke and Griffiths, 2010; Vine, 2012).

13.12.2 Private sector led governance initiatives

Private sector actors have also engaged in direct attempts to govern aspects of climate change transnationally. First, some institutional investors now ask companies to report on their greenhouse gas emissions, strategies to reduce them, and more broadly on climate risk exposures, in order to affect investor behaviour (Kolk et al., 2008; Newell and Paterson, 2010; Harmes, 2011; MacLeod and Park, 2011). The most important example of this is the Carbon Disclosure Project, whose signatories controlled US$71 trillion in assets in 2011 (Carbon Disclosure Project, 2011). Indeed the private sector is playing a role in accounting carbon (Lovell and MacKenzie, 2011).

Second, private sector actors have, like NGOs (see section 13.5.2), developed initiatives to govern voluntary carbon markets, either through the development of certification standards for offset markets (, or by developing the infrastructure that governs carbon markets – notably the exchanges, registries, and protocols for reporting GHGs(Green, 2010; Hoffmann, 2011). Many of the certification schemes are either developed by private sector actors themselves (such as the Voluntary Carbon

Standard, developed by the International Emissions Trading Association, the Climate Group, and the World Business Council for Sustainable Development) or by such actors in collaboration with environmental NGOs (such as the Social Carbon standard).

13.12.3 Motivations for public-private sector collaboration and private sector governance

For private sector actors, partnerships may create direct economic benefits; through financial support, learning opportunities, or market access (Pinkse, 2007; Perusse et al., 2009). Since direct regulation of firms at the international level is unavailable, states have incentives to pursue partnerships in order to affect transnational private sector activities. International organizations pursue partnerships for similar reasons (Andonova, 2010). Partnerships or private governance may create club goods for participants (Andonova, 2009). Sometimes, firms are motivated more by concerns for public relations (Pinkse and Kolk, 2009, pp. 55–56). Private sector finance can be stimulated by a five step approach: strategic goal setting and policy alignment, an enabling process and incentives for low-carbon and climate resilient (LCR) investment, financial policies and instruments, harnessing resources and building capacity for a LCR economy, and promoting green business and consumer behaviour (Corfee-Morlot et al., 2012).

13.13 Performance assessment on policies and institutions including market mechanisms

This section surveys and synthesizes quantitative and qualitative assessments (that have appeared in the literature since AR4) of existing and proposed forms of international cooperation to address climate-change mitigation. Existing cooperation is considered with reference to: the UNFCCC's Kyoto Protocol in general; the Kyoto Protocol's Clean Development Mechanism; further agreements under the UNFCCC pertaining to the post-2012 period; and agreements and other forms of international cooperation outside of the UNFCCC. The section concludes with consideration of the literature that assesses various proposed forms of future international cooperation (described in section 13.4.3). Throughout, we synthesize assessments in terms of the four criteria discussed in Section 13.2: environmental effectiveness, aggregate economic performance, distributional impacts, and institutional feasibility. Table 13.4 summarizes the key findings of this section's performance assessment.

13.13.1 Performance assessment of existing cooperation

13.13.1.1 Assessment of the UNFCCC Kyoto Protocol and its Flexible Mechanisms

The United Nations Framework Convention on Climate Change is a statement of aspirations, principles, and goals; the Kyoto Protocol was its first elaboration including binding mitigation commitments. Nations listed in Annex B made commitments – in aggregate -- to reduce their GHG emissions by approximately 5%--for most relative to 1990 levels—over the course of the Protocol's first commitment period, 2008-2012 (UNFCCC, 1998).

The Protocol is based on emission-reduction commitments made by 37 industrialized nations and economies in transition (the formerly centrally-planned economies of central and Eastern Europe, Russia, and Ukraine) listed in Annex I of the UNFCCC. Other countries are not constrained (but can participate in other ways; in particular, see discussion of CDM in 13.13.1.2). The Protocol has been the only legally-binding international agreement intended to reduce greenhouse-gas emissions. Although emissions have decreased among Annex I countries, the Protocol's environmental effectiveness within this set of countries has been less than it could have been, for several reasons.

First, not all Annex B parties have participated. The United States, until recently the country with the largest share of global emissions (Gregg et al., 2008), did not ratify the Protocol. (See also section 13.3.1.) Therefore, its target emissions reduction of 7 percent – which would have amounted to, in absolute terms, one-half of total Annex I commitments – was not binding (Den Elzen and De Moor, 2002). In addition, Canada withdrew from the Protocol in December 2011 (effective December 2012), and Russia, Japan, and New Zealand opted not to participate in the second commitment period (2013-2020).

Second, despite the Kyoto Protocol's compliance system (Oberthür and Ott, 1999; Hare et al., 2010; Brunnée et al., 2012), it is difficult in practice to enforce the Kyoto Protocol's targets. This is true of most international agreements—even if based on treaties (Van Kooten, 2003; Böhringer, 2003; Barrett, 2008b). (See also sections 13.3.2 and 13.4.2.1.)

Third, the Annex I "economies in transition" (EITs) were credited for emissions reductions that would have occurred without the Protocol—due to their significant economic contraction during the 1990s (Den Elzen, Van Vuuren, et al., 2010; den Elzen, Roelfsema, et al., 2010). In principle, these countries were allowed to sell resultant surplus emissions-reduction credits to other Annex I countries, enabled by the Protocol's flexible mechanisms, which might have further reduced environmental effectiveness. However, in practice, EITs sold few surplus allowances, relative to their stock, during the first commitment period; thus environmental effectiveness was not affected as much as it could have been (Brandt and Svendsen, 2002; Böhringer, 2003; IPCC, 2007, p. 778; Crowley, 2007; Aldrich and Koerner, 2012; den Elzen et al., 2012). Moreover, the UNFCCC's Eighteenth Conference of the Parties—along with, separately, several Annex I parties that would participate in the second commitment period—decided in late 2012 to substantially limit the carryover of the surplus from the first to second commitment periods.

Nevertheless, aggregate emission reductions by Annex I countries have exceeded the Kyoto Protocol's reduction goal; according to UNFCCC GHG inventories, aggregate GHG emissions from Annex I countries in 2010 were 14% lower than in 1990, if land use and forestry-sector changes are taken into account, and 10% lower than in 1990 if they are not (UNFCCC, 2012c). Excluding EITs, Annex I countries' emissions increased by 4.9 and 4.1% respectively. This implies that most of these emission reductions were due to the scaling-back of GHG-intensive industries in the EITs. Leakage and the related issue of emissions being "embedded" in traded goods are also of concern with any approach requiring emissions reductions in a subset of jurisdictions, and could potentially have had an impact on the environmental effectiveness of Annex I countries' efforts under the Kyoto Protocol. (See Section 13.5.1.2 on leakage and Section 13.8 on "embeddedness.")

Emission reductions achieved by Annex I countries during the first Kyoto commitment period—or that could be achieved during the second commitment period, given reduced participation—will not be sufficient to achieve environmental performance consistent with the goal of limiting global-average-temperature increases to 2°C above pre-industrial levels (Bosetti et al., 2006; Bosetti and Buchner, 2009); see also Section 13.2.2.1, and Chapter 6).

The criterion of economic performance encompasses both efficiency and cost-effectiveness. (See Chapter 2 and Section 13.2.) Assessments of the efficiency of the Kyoto Protocol depend on respective estimates of the costs and benefits of mitigation and assumptions regarding the appropriate discount rate (see Chapter 2.2.3, 2.3.2, 3.6 and 3.10). Researchers who have estimated relatively high costs and low benefits of mitigation, coupled with relatively high discount rates (e.g. (Nordhaus, 2007)) have found that the Kyoto Protocol's emissions-reduction commitments over the short term generate costs significantly in excess of benefits, rendering the Protocol inefficient. Researchers who have estimated relatively low costs and high benefits of mitigation, coupled with lower discount rates (e.g. (Stern, 2007), or (Weitzman, 2007) who stresses the non-zero probability of catastrophic climate outcomes) have found that the Kyoto commitments are cost-effective, but on their own insufficient. (Jakob et al., 2012), as well as (Den Elzen, Van Vuuren, et al., 2010), stress that postponing emission reductions substantially increases mitigation costs.

With respect to cost-effectiveness, the Kyoto Protocol included provisions for three market-based instruments (flexible mechanisms) intended to lower the cost of the global regime (see 13.4.2.3 for a description of the mechanisms): the Clean Development Mechanism (CDM) and Joint Implementation (JI), both emission-reduction credit systems; and International Emissions Trading (IET) of Kyoto assigned amount units (AAUs). Most research on the Kyoto mechanisms has focused on the CDM primarily because transaction volumes of CDM credits have been so much greater than JI credits or AAUs. Performance assessment of the CDM is discussed separately in Section 13.13.1.2.

IET could, in theory, reduce abatement costs by as much as 50% if trades took place among Annex I countries (Blanford et al., 2010; Bosetti et al., 2010; Jacoby et al., 2010). However, in practice, the provision has not improved the cost-effectiveness of the Protocol's implementation, because trading under this mechanism has been very limited, partly due to the surplus problem discussed above (Aldrich and Koerner, 2012). The few trades that were made generally required reinvestment of the revenues into projects that reduce greenhouse gas emissions, under so-called "Green Investment Schemes." That said, even if countries had significantly employed IET, trading would have taken place among national governments rather than among private-sector firms. Unlike firms, nation-states are not simple cost-minimizers, and even if they were, they may not have had sufficient information on the marginal abatement costs of potential emission reduction sources within their borders to carry out cost-effective trades with other countries (Hahn and Stavins, 1999; Driesen, 2009).

JI also has the potential to improve the cost-effectiveness of Annex I countries' activities under the Protocol (Böhringer, 2003; Vlachou and Konstantinidis, 2010). A large majority of JI projects have been in the transition economies, especially Russia and Ukraine, given the low cost of emissions reductions there relative to other Annex I countries (Korppoo and Moe, 2008). JI had led to the issuance of over 600 million emission credits by the end of 2012 from over 600 projects (Point Carbon, 2013). Over half of this volume was issued by Ukraine and Russia in the last days of 2012 as a reaction to the limitation of sales of AAU surplus. The actual distribution of JI projects is not consistent with the theoretical potential, as some countries, such as Ukraine, proactively supported JI, while in others, including Russia, JI lacked political support, and efficient frameworks could only be established after several years. In Western Europe, a number of companies in the chemical industry generated emission credits for their own use in the EU ETS, demonstrating the cost-reduction potential (Shishlov et al., 2012). Countries without a surplus of emission units usually applied strict rules to capture part of the emission reductions achieved by JI projects (Michaelowa and O'brien, 2006; Shishlov et al., 2012).

In addition to the three Kyoto mechanisms, the Protocol provides for participating Annex-I countries to employ policies of their own choice to meet their commitments—a sort of flexibility—including the use of domestically-issued tradable emission permits to meet their national commitments in a relatively cost-effective manner. The EU has taken fullest advantage of this provision; the performance of the EU Emissions Trading System is discussed in Chapter 14 (Convery and Redmond, 2007; Ellerman and Buchner, 2007; Ellerman and Joskow, 2008; Ellerman, 2010)(Olmstead and Stavins, 2012).

Distributional impacts of the Kyoto Protocol have been examined both cross-sectionally (mainly geographically) and temporally. In terms of cross-sectional distributional impacts, the Kyoto Protocol places emissions mitigation requirements on the Annex I countries, largely the wealthiest countries and those responsible for the majority of the current stock of anthropogenic GHGs in the atmosphere (Olmstead and Stavins, 2012). This is consistent with the UNFCCC principle of "common but differentiated responsibilities and respective capabilities." Income patterns and trends—as well as distribution of GHG emissions—have changed significantly since the UNFCCC divided countries into two categories in 1992 (U.S. Department of Energy, 2012; WRI, 2012; Aldy and Stavins, 2012), though income inequality—and variations in related capacity and per-capita responsibility for current emissions—remains substantial both within and between countries (IMF; U.S. CIA; World Bank; Padilla and Serrano, 2006; Chakravarty et al., 2009; Milanovic, 2012).

More broadly, although quantitative mitigation requirements are limited to Annex I countries, the economic impacts of these requirements may spill over to non-Annex I countries (Böhringer and Rutherford, 2004). In terms of intertemporal distributional equity, some have noted that climate change mitigation that requires emissions reductions in the short term for uncertain long-term benefits, also involves inter-generational distributional impacts (Schelling, 1997; Leach, 2009).

Among Annex I countries, the Kyoto Protocol's emissions-target allocation is generally progressive – one common measure of distributional equity – exhibiting positive correlation between gross domestic product per capita and the degree of targeted emissions reduction below business-as-usual levels. For a 10 percent increase in per-capita GDP, Annex I country's emissions reduction targets are, on average, about 1.4 percent more stringent (Frankel, 1999, 2005).

That the Kyoto Protocol has been ratified (or the equivalent) by 190 countries (plus the EU separately) by January 2013 speaks to its political and institutional feasibility (Falkner et al., 2010). As noted above, participation among Annex I countries in emissions-reduction commitments dropped significantly from the first to the second commitment periods, though the emission-reduction commitments of those countries still participating increased for the second period (2013-2020). More broadly, the high rate of participation may be due in part to the lack of emissions-reduction commitments imposed on non-Annex I countries.

Allowing Annex I countries the flexibility to choose policies to meet their national emissions commitments may have contributed to institutional feasibility. However, compromises made during the negotiation of the Protocol that enabled its institutional and political viability may have reduced its environmental effectiveness (Victor, 2004; Helm, 2010; Falkner et al., 2010). This serves as an example of the trade-off across ambition, participation, and compliance discussed in Section 13.2.2.5.

13.13.1.2 Assessment of the Kyoto Protocol's Clean Development Mechanism

The CDM aims to reduce mitigation costs for Annex I countries and contribute to sustainable development in non-Annex I countries (UNFCCC, 1998) (Article 12). This mechanism had led to the issuance of 1.15 billion emission credits from over 5,500 registered projects by the end of 2012 (see section 13.5.1.1). This performance may be surprising, given that the CDM suffers from many disadvantages relative to the other flexibility mechanisms (Woerdman, 2000). With regard to abatement cost, (Castro, 2012) assessed whether the CDM mobilized abatement options with the lowest cost and found that many low-cost opportunities had not been taken up. However, the largest CDM projects that abate the industrial gases HFC-23 and N_2O have relatively lower cost and had been largely ignored before the CDM mobilized them (Wara, 2007). Activities in energy efficiency and other sectors, such as transport and buildings, have been hampered by regulatory challenges in baseline determination and monitoring, as well as transaction costs that are significant compared with the magnitude of emission credits generated (Sirohi and Michaelowa, 2008; Michaelowa et al., 2009; Millard-Ball and Ortolano, 2010).

Environmental effectiveness of the CDM depends on three key factors: whether project developers are indeed motivated primarily by expected revenue from the sale of the emission credits (so-called "**additionality**"), the validity of the **baseline** from which emission reductions are calculated, as well as indirect emissions impacts ("**leakage**") caused by the projects.

The **additionality** issue (Gupta, Tirpak, et al., 2007, p. 779f; IPCC, 2007) continues to generate controversy, despite an increasing elaboration of additionality tests by CDM regulators (Michaelowa et al., 2009). On the one hand, (Schneider, 2009) found that key assumptions regarding additionality were often not substantiated with credible, documented evidence, in a sample of 93 projects. On the other hand, (Lewis, 2010) finds a clear contribution of the CDM to the rapid upswing of the renewable energy sector in China.

(Kollmuss et al., 2010) suggest that it may be possible to prevent **baseline** gaming through a clear regulatory framework. Heeding this advice, CDM regulators have increased the conservativeness of approved methodologies, after rejecting a significant share of baseline methodology proposals (Michaelowa et al., 2009; Millard-Ball and Ortolano, 2010). Recent attempts by CDM regulators to standardize baselines have triggered a debate regarding their impacts on environmental effectiveness and transaction costs. Making the choice between standardized and project-specific baselines voluntary (Spalding-Fecher and Michaelowa, 2013), as well as simple, highly aggregated performance standards (Hayashi and Michaelowa, 2013) could reduce environmental effectiveness.

With regard to **leakage**, (Vöhringer et al., 2006) argue that emission leakage due to market price effects is unavoidable (as it is for mitigation within Annex I countries), while (Kallbekken et al., 2007) stress that regardless of the baseline used, the CDM will reduce carbon leakage. (Schneider, 2011) shows that for HFC-23 reduction projects, baseline gaming enabled production of the underlying commodity to shift from industrialized to developing countries (Wara, 2008).

Compared to ex-ante estimates of emission credit generation, actual credit generation is often lower. Moreover, a significant share of projects has not yet achieved issuance at all. According to (UNEP Risoe Centre), average issuance performance is 92.5% of forecasts, but varies strongly across project types

The long-term contribution of the CDM to cost-effectiveness depends in part on its ability to transfer technology from industrialized to developing countries. (See also Chapter 16.6.2.1 regarding an overview of the technology transfer component of CDM). Roughly a third of CDM projects involve technology transfer (Haites et al., 2006). (Dechezleprêtre et al., 2008) find that the likelihood of technology transfer is higher for CDM projects operated by subsidiaries of companies from industrialized countries. (Seres et al., 2009) find that 36% of 3,296 registered and proposed projects accounting for 59% of the annual emission reductions claim to involve technology transfer, confirming (Dechezleprêtre et al., 2008)'s results. But all of these technology transfer studies limit themselves to assessment of project documents, which are not subject to rigorous and independent verification. Project developers have the incentive to argue that there is technology transfer, even if there is none. (Wang, 2010) is an exception, and underpins his analyses of many project documents with background interviews and assesses government policies. He finds that in all but one of the industrial gas projects in China, technology transfer occurred, but only in about a quarter of wind and coal mine methane projects.

Distributional impacts of the CDM relate to contributions to sustainable development, as well as the distribution of rents generated by the sale of emission credits. (Olsen, 2007) provides a summary of the early literature that did not find significant support for sustainable development by CDM projects. Several researchers (Sutter and Parreño, 2007; Gupta et al., 2008; Headon, 2009; Boyd et al., 2009; Alexeew et al., 2010) see the process of host country responsibility for sustainable development and competition between host countries for CDM investment as a reason for the lack of sustainability benefits of CDM projects in some countries, as Designated National Authorities may not adequately scrutinize the environmental or social benefits of projects. (Parnphumeesup and Kerr, 2011) find that experts and the local population weight sustainability criteria differently in the context of biopower projects in Thailand. (Ellis et al., 2007) found wide variation in the contribution to local sustainable development by project type, with greater contributions in small-scale renewable energy and energy efficiency than in large-scale industrial CDM projects. Using a sample of 39 projects, (Nussbaumer, 2009) finds that CDM projects certified by "The Gold Standard"—referring both to the organization and the certification scheme by that name—slightly outperform "normal" CDM projects with respect to sustainable-development benefits. A similar result is found by (Drupp, 2011) for a sample of 18 Gold Standard projects compared with 30 projects certified through other means.

Given that companies in developing countries finance CDM projects out of their own resources and eventually sell the credits as a new export product, with the CDM consultant receiving a share (Michaelowa, 2007), a substantial amount of the rents remain in the host country. At the same time, the demand for CERs is evidence that it reduces costs compared to domestic reductions by developed countries. The fear, even if unfounded, of losing this export revenue may be a deterrent against taking up national emissions commitments (Castro, 2012), although in practice many such countries are developing policies aimed at emissions limitations. Therefore, it has been proposed to discount CDM credits in order to provide an incentive for taking up stricter national targets (Schneider, 2009).

In terms of institutional feasibility, baselines, additionality, and emissions-reductions are subject to third-party audit. However, due to the inadequate quality of many audits, regulators have been forced to introduce multi-layered procedures that have led to high transaction costs. (Flues et al., 2010) show econometrically that regulatory decisions about project registration and baseline methodology approval have been influenced by political economy considerations.

There is ongoing debate in the literature about the efficacy of CDM governance (Green, 2008; Lund, 2010; Michaelowa, 2011; Okazaki and Yamaguchi, 2011; Böhm and Dhabi, 2011; Newell, 2012, p. 136) and the UNFCCC has organized a major process of evaluation of the CDM in the CDM policy dialogue, the report of which made recommendations for reform of CDM governance (CDM Policy Dialogue, 2012). (Michaelowa, 2009) and (Schneider, 2009) propose a shift from the current 1:1 offsetting system to a system that only credits part of the reductions. This would improve additionality on the aggregate level and provide an incentive for advanced developing countries to accept their own emission reduction commitments. Giving preferential treatment in procedures and methodology to certain project categories, certain sectors – notably forestry (Thomas et al., 2010; CDM Policy Dialogue, 2012), or certain regions (Nguyen et al., 2010; Bakker et al., 2011) might expand the reach of CDM. Due to the price crash on the CDM market, (CDM Policy Dialogue, 2012) proposed creation of a central bank for carbon markets to bolster credit prices as well as further standardization of baseline and additionality determination to reduce transaction costs. The benefits of the latter two recommendations are disputed in the literature (Hayashi and Michaelowa, 2013; Spalding-Fecher and Michaelowa, 2013).

13.13.1.3 Assessment of further agreements under the UNFCCC

Since AR4, negotiations under the UNFCCC have continued under the Bali Action Plan—a decision of COP-13 in late 2007 (UNFCCC, 2007a) and, since COP-17 in December 2011, the Durban Platform for Enhanced Action (UNFCCC, 2011a). Key points of political agreement were reflected in the Copenhagen Accord, which was "noted" by the Conference of the Parties at COP-15 in late 2009 (UNFCCC, 2009a). The Accord included voluntary pledges for mitigation targets by developed countries and actions by many developing countries (including the major emerging economies); these became associated with a decision of COP-16 the following year, in the Cancun Agreements (UNFCCC, 2010). The Cancun Agreements also operationalized the Green Climate Fund, as a key new channel for $100 billion per year to be mobilised by 2020. The Durban Platform, decided by COP-17 in late 2011, committed parties to negotiate a regime "applicable to all Parties" under the UNFCCC no later than 2015, to come into effect in 2020 (UNFCCC, 2011a). In terms of environmental performance, these agreements together formalized (for the first time within the UNFCCC) a goal of limiting global average temperature increases to 2°C and agreed to a 2013-2015 review with a view to possibly strengthening this to 1.5 °C (UNFCCC, 2010).

The literature has assessed the probabilities of emissions pathways staying below 2^{o}C (WBGU, 2009; Victor, 2009; Rogelj et al., 2011; UNEP, 2012b), and there is broad agreement among analyses, that, while the global emissions path implied by the Cancún pledges in aggregate represented a significant break from then-current trends, the cumulative pledges for 2020 will not be sufficient to keep emissions below the path that would be necessary to stay within the 2-degree target (Rogelj et al., 2010; Dellink et al., 2011; den Elzen, Hof, and Roelfsema, 2011; Höhne et al., 2012). Though these analyses are in agreement with this basic message, they exhibit substantial differences in quantitative results, owing in part to uncertainties in current and projected emissions estimates and interpretations of reduction proposals (UNEP, 2010a, 2011, 2012b; Höhne et al., 2012). Studies suggest that the emissions gap between current pledges and a trajectory consistent with the 2-degree target could – in principle – be narrowed through implementation of more stringent pledges, minimizing the use of "lenient" credits from forests (Grassi et al., 2012) and surplus emission units (Den Elzen et al., 2012), avoiding double-counting of offsets (UNEP, 2012b), increasing support for action in developing countries (Winkler et al., 2009), and implementing measures beyond current pledges (UNEP, 2011; den Elzen, Hof, and Roelfsema, 2011; Blok et al., 2012; Weischer et al., 2012).

Figure 13.4 illustrates results from modelling of pledges by various research groups. Note that the analysis reconciles pledges for all countries against a business-as-usual counterfactual based on what has been described in the literature, even though developed country pledges for 2020 are absolute (against a historical base year) and developing country pledges relative (with rare exceptions; see section 13.5.1).

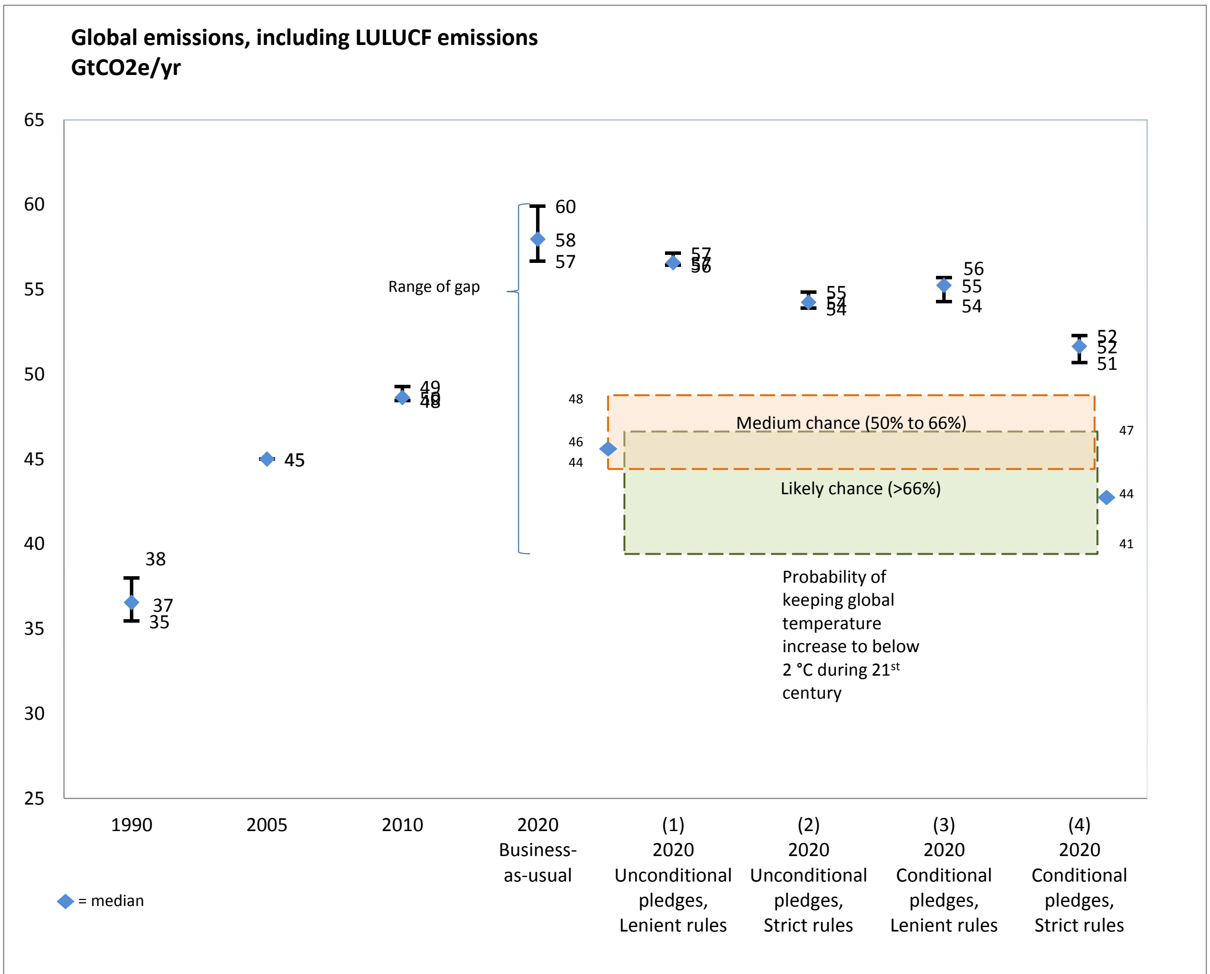


Figure 13.4. Global greenhouse gas emissions by 2020 expected from the business-as-usual projections and pledges found by various modelling groups. Four cases are considered which combine assumptions about pledges (unconditional or conditional) and rules for complying with pledges (lenient or strict). Source: (UNEP, 2012b).

In terms of aggregate economic performance, some analyses have estimated the direct costs of the Cancún pledges (Den Elzen, Hof, Mendoza Beltran, et al., 2011), as well as broader economic effects (Mckibbin et al., 2011; Dellink et al., 2011; Peterson et al., 2011). For example, (Dellink et al., 2011) estimate costs of action at around 0.3% of GDP for both Annex I and non-Annex I countries and 0.5–

0.6% of global real income. However, there have been no published comparisons of the benefits and costs of the Cancún pledges, and thus no quantitative assessments of economic efficiency. In terms of cost-effectiveness, the Cancún Agreements endorsed an ongoing role for domestic and international market-based mechanisms, among various approaches, to improve cost-effectiveness. They also made a potential further step forward on the cost-effectiveness criterion by emphasizing the role of mitigation actions in the forestry sector (UNFCCC, 2010; Grassi et al., 2012), which could possibly be integrated with other actions through market mechanisms. Including the forestry sector could reduce global mitigation costs by taking advantage of low-cost mitigation opportunities in that sector (Eliasch, 2008; Busch et al., 2009; Bosetti et al., 2011; UNEP, 2012b). (See also Section 13.5.1.1.)

Distributional impacts will depend, in part, on sources of financing for developing-country emission plans. Studies of the climate change mitigation “financing gap” have suggested potential approaches to providing financial resources (Ballesteros et al., 2010; AGF, 2010; Haites, 2011). (See also Chapter 16 and Section 13.11.) Distributional considerations have also been examined with respect to the more prominent role taken in the Cancún Agreements on reducing emissions from deforestation and degradation (REDD) (Peskett et al., 2011). Distribution issues may arise both across and within countries where REDD readiness activities are being carried out (Gupta et al., 2013). Additionally, the distributional equity of recent emission-reduction pledges could – in principle -- be increased through financing of reductions in non-Annex I countries. By one study’s estimate, between 2.1 – 3.3 Gt CO2-e could be reduced in non-Annex I countries with $50 billion in financing, half of the financing agreed to under the Copenhagen Accord (Carraro and Massetti, 2012). Distributional impacts of further agreements under the UNFCCC will also be affected by the financing of adaptation. However, for several of the more recently developed financing mechanisms under the Convention, the financial means of the institutions falls far behind the expected means (Harmeling et al., 2011) and potential synergies with development and other issues may be under-exploited (Liu, 2011).

The literature following the Copenhagen, Cancún and Durban UN climate conferences reflects differing interpretations of recent negotiations (Dubash, 2009; Rajamani, 2010, 2012a; Werksman and Herbertson, 2010; Müller, 2010). Copenhagen was assessed as a failure by those who expected a new climate treaty and the continuation of the Kyoto Protocol, while others saw the political agreement reached among a small group of world leaders as a major step forward, even though not legally binding (Ladislaw, 2010). Others noted more specific effects, such as the change in the organization of carbon markets (Bernstein et al., 2010). The literature suggests that views diverge on the Cancún Agreements: some see them as a step forward of the multilateral process (Grubb, 2011b) potentially towards a later legal agreement (Bodansky and Diringer, 2010), while others suggest that the move to a voluntary pledge system has weakened the multilateral climate regime(Khor, 2010b). Following a decision of COP-16 to adopt the Agreements, approximately 80 member countries formally submitted their various pledges, many made earlier outside the UNFCCC for 2020. This moderate degree of support is a necessary, but not sufficient condition for institutional feasibility.

13.13.1.4 Assessment of envisioned international cooperation outside of the UNFCCC

A wide variety of international institutions outside of the UNFCCC that have some role in international climate change policy are described in Sections 13.5.1.2-13.5.1.4. Here, we consider only those institutions for which there exist published assessments of performance for at least one of the criteria from Section 13.2.2. With the exception of the Montreal Protocol’s actions on ozone-depleting substances (ODS), no *ex post* analyses of international cooperation outside of the UNFCCC are available in the literature.

The G8

At the 2007 G8 summit, member countries agreed (though without a binding commitment) to a 50% reduction in GHG emissions by 2050, conditional on major developing countries making significant reductions. There are several model studies on global emission pathways that show that this global emission reduction is possible (Edenhofer et al., 2010); see also Chapter 6). Analysts have examined the economic impacts of achieving the G8 pledge on individual countries, such as the United Kingdom (Dagoumas and Barker, 2010) and the United States (Paltsev et al., 2008). The former finds no simple trade-off between emission reductions and economic growth in the UK, with all reduction scenarios showing higher GDP than reference, and 80% reductions by 2050 performing better than 60%. Of the more aggressive reductions modelled for the US, this particular study finds carbon prices rising to between $120 and $210 by 2050, a level of cost that "would not seriously affect US GDP growth but would imply large-scale changes in its energy system" (Paltsev et al., 2008). The literature does not provide evidence of the environmental or cost-effectiveness of the G8 as a forum.

The Major Economies Form on Energy and Climate Change

International discussions regarding 2050 GHG reduction goals and other goals have also taken place in the Major Economies Forum on Energy and Climate Change (MEF), which, with similar membership to the G20, accounts for almost 80% of global greenhouse gas emissions (WRI, 2012). While the smaller number of countries represented in the MEF might make it a more effective negotiation forum than the more inclusive UNFCCC (if in fact the MEF were given authority to host negotiations by its members), some are concerned about a small set of large countries reaching decisions that affect a much larger set; and some may not be comfortable with a process chaired by a single nation (Stavins, 2010). As one example, (Massetti, 2011) considers a scheme that achieves the MEF's "50% by 2050" goal through 80% reductions by high-income MEF countries and 25-30% reductions by low-income countries and finds costs exceed 1.5% of GDP.

The G20

At their 2009 Pittsburgh meeting, G20 members came to a political agreement to phase out fossil fuel subsidies, but this was not followed by a legally binding agreement. In terms of environmental effectiveness, this effort could significantly affect GHG emissions, if countries in fact implemented it; by one modelled estimate, complete phase-out by 2020 could reduce CO2 emissions by 4.7% (IEA, 2011). Analysis suggests that, of the economies identified by the IEA as having fossil-fuel consumption subsidies, almost half had either implemented fossil-fuel subsidy reforms or announced related plans by 2011 (IEA et al., 2011). However, other analysts note that progress towards this goal can be attributed to changes in reporting and subsidy estimation, and that no fossil fuel subsidies have been eliminated under this pledge (Koplow, 2012).

Studies have confirmed that countries reforming fossil fuel consumer subsidies would realize positive economic benefits (IEA et al., 2011) However, benefits for oil-exporting countries could be offset by negative trade impacts due to reduced global demand for fossil fuels attributable to subsidy removal, raising distributional issues (IEA et al., 2011). The G20 initiative on fossil fuel subsidies could have positive distributional impacts within some countries, however. Since fossil fuel subsidies tend to benefit high-income households more than the poor in developing countries, their removal would be progressive in such nations (World Bank, 2008c). Some note that the mere creation of the G20 and its elevation to a premier global international economic forum during the financial crisis in 2008 (Houser, 2010) has led to more open and dynamic negotiations between industrialized and developing countries (Hurrell and Sengupta, 2012), suggesting a potentially positive outcome for institutional feasibility.

To the extent that their memberships include only a subset of countries, in comparison to global participation in the UNFCCC, the G8, MEF, G20, and the other institutions described in Sections 13.5.1.2-13.5.1.4 represent a potential tradeoff between institutional feasibility and environmental effectiveness. On the one hand, narrowing participation may result in a collection of countries that may more easily achieve consensus (Houser, 2010). On the other hand, the more countries that are excluded from these coalitions, the more likely it is that leakage will at least partially undermine possible environmental achievements (see Sections 13.13.1 and 13.5.1.2).

It is not necessarily the case that such institutions represent a distinct institutional feasibility advantage. For example, despite being a forum of finance ministers, the G20 has to date not mobilised any climate finance (see chapter 16). Bringing climate discussions into international forums such as the G8 and G20, and creating alternative forums such as the MEF, have been seen by some emerging economies as attempts by industrialized countries to reduce the UNFCCC's legitimacy and achieve preferred outcomes by other means (Hurrell and Sengupta, 2012). In addition, there is some risk that issues of low agreement within the UNFCCC could simply migrate to these smaller institutions (Houser, 2010).

The Montreal Protocol

The Montreal Protocol is one agreement outside of the UNFCCC that has achieved both comprehensive participation and made a significant contribution to reducing GHG emissions (Molina et al., 2009; Velders et al., 2007). The Montreal Protocol initially banned chlorofluorocarbons (CFCs), which harm the ozone layer and also have very high global warming potential (GWP), and in 2007 decided to accelerate the phase-out schedule for HCFCs—an interim replacement for CFCs with a somewhat lower, but still very significant, GWP—by 10 years. The latter decision was affected by climate considerations (Bodansky, 2011a). The Kyoto Protocol precludes itself from regulating ozone depleting substances, due to their having already been covered by the Montreal Protocol. Even before the HCFC decision, one estimate suggested that the Montreal Protocol's overall net contribution to climate change mitigation had been approximately 5 to 6 times what the Kyoto Protocol would achieve under its first commitment period (Velders et al., 2007). However, this comparison may be unfair because while not always smooth, the more rapid progress in reducing ozone depleting gases relative to greenhouse gases may be due to the fact that the major ozone depleting gases are less central to economic activities than the major greenhouse gases.

Hydrofluorocarbons (HFCs), which lack ozone-harming chlorine and which are being widely adopted as a longer-term substitute for CFCs, have extremely high GWP, and their use will partially negate climate gains otherwise achieved by the Montreal Protocol (Moncel and Van Asselt, 2012). (Zaelke et al., 2012) suggest that a combination of reductions of HFCs and significant cuts in CO_2, the largest contributor to climate change, can significantly increase the chances of remaining below the 2°C limit. However, as of early 2013, parties to the Montreal Protocol had not agreed to an HFC phase-out.

The International Maritime Organization and the International Civil Aviation Organization

Finally, the UNFCCC has delegated portions of the climate mitigation problem to other existing institutions that were perceived to have appropriate jurisdiction and expertise. Under the Kyoto Protocol's Article 2.2, Annex I countries pursue GHG limitations from maritime and air transport through the International Maritime Organization (IMO) and International Civil Aviation Organization (ICAO).

Approximately 3.3% of global CO2 emissions in 2007 were attributable to shipping (International Maritime Organization, 2009, p. 3). In 2011, the IMO adopted the first mandatory standards for a sector relating to GHG emissions, instituting a performance-based energy-efficiency regulation for ships greater than 400 GT (where "GT" is a standard measure of size related to a ship's internal volume) built after January 1, 2013 (Bodansky, 2011c). This regulation applies uniformly to all countries, implying more equitable impacts. These standard were adopted by majority vote (over some objections), and includes a provision to promote technical cooperation and assistance for developing countries (Bodansky, 2011c), enhancing its institutional feasibility.

The ICAO adopted a resolution on climate change in 2010. In contrast to the IMO, the ICAO's climate change goals are "voluntary and aspirational." Perceived inadequate progress by the ICAO toward aviation emissions reduction goals may have prompted the inclusion of aviation emissions in the EU-ETS in January 2012 (Bodansky, 2011c). This unilateral decision prompted strong reactions (Mueller, 2012; Scott and Rajamani, 2012), and full implementation of aviation in the ETS was deferred by the EU pending the possibility of ICAO action in 2013.

Agreements among non-state actors and agreements among sub-national actors

It is unclear whether agreements among non-state (NGOs, private sector) or sub-national actors (transnational city networks) have been effective in reducing emissions. Partly this is because of their novelty; and partly because the units of measurement for such effectiveness are considerably more complex than for interstate agreements (Pinkse and Kolk, 2009). For subnational efforts, the question of attribution requires better disaggregation, to understand whether reductions are additional to national effort, or only contribute to delivering national pledges. While these sub-national efforts may make a small contribution to climate action, they may be valuable in influencing nation states engaged in multilateral agreement or helping them meet commitments (Osofsky, 2012).

Other measures of impacts do exist. In private sector initiatives, the Carbon Disclosure Project has high rates of reporting, with about 91% of Global 500 companies surveyed in 2011 disclosing GHG emissions (Carbon Disclosure Project, 2011, p. 7). There is little evidence of substantial changes in investor behaviour, with disagreement as to the potential for such changes in the future (Kolk et al., 2008; Harmes, 2011; MacLeod and Park, 2011). Some assessments have focused on how transnational city initiatives promote technology uptake within cities (Hoffmann, 2011, pp. 103–122) or on how they create a combination of competition and learning among member cities.

Another venue for international cooperation on climate change is the voluntary carbon market (VCM), which had grown to 131 million tCO2-e (about 1/10th of the size of the CDM), with a value of US $424 million in 2010 (Peters-Stanley et al., 2011) and created a varied landscape of emission-offset providers, registries, and standards (Peters-Stanley et al., 2011). However, (Dhanda and Hartman, 2011) find that the voluntary market is highly non-transparent and suffers from large swings of demand for specific project types. Offset prices for the same project type differ by up to two orders of magnitude. Competing registries and standard providers proliferate, and additionality of a significant share of projects is doubtful. An earlier assessment by (Corbera et al., 2009) concluded that the voluntary market does not perform better than the CDM. However, performance in the VCM seems to improve with the increased use of third-party certification systems (Hamilton et al., 2008; Capoor and Ambrosi, 2009; Newell and Paterson, 2010). In 2004, virtually no VCM projects underwent third party verified certification, but by 2009, this figure had reached 90% (Peters-Stanley et al., 2011, p. 31). However, some regard certification systems as primarily public relations exercises (Bumpus and Liverman, 2008).

There is evidence that the importance of partnerships between the private sector and government depends on their relations to more traditional state-led governance. Partnerships may work once government regulations send strong signals to investors (Pfeifer and Sullivan, 2008). Rules developed in private sector agreements may then become incorporated into government regulations (Knox-Hayes and Levy, 2011), and private carbon market offset standards may be introduced into regulated carbon markets (Hoffmann, 2011, pp. 123–150).

13.13.2 Performance assessments of proposed cooperation

13.13.2.1 Assessment of proposed international climate policy architectures

Global climate change policy architectures are surveyed in Section 13.4, where it is explained that they may vary in terms of: the degree to which they are legally binding, their goals and targets, any incorporation of flexible mechanisms, and their burden and resource-sharing approaches. This section describes proposed policy architectures, focusing on those that have been described for the first time since AR4, and older proposals for which new research on anticipated performance is available. Earlier proposals are listed in Table 13.2 of (Gupta, Lasage, et al., 2007).

The environmental performance of a cooperative approach and its ability to meet a specific goal depends on the level of participation, stringency of targets or actions for participants, and actual achievements of proposed targets and actions. The stricter the requirements of the goal (e.g. lower global emissions in a given future year, lower level of GHG concentrations, or lower level of global temperature increase), the greater will be the need for participation, action, and compliance to meet the goal.

Simulations reported in Chapter 6 indicate that for higher concentration stabilization levels, it is possible that some countries could take the lead in reducing emissions, while some other countries could initially follow business as usual until they also reduce their emissions at a later date. Proposals for international regimes that use this as incentive for participation, such as (Bosetti and Frankel, 2011), realise such higher concentration levels. But for lower concentration stabilization levels, in particular those compatible with limiting temperature increase to 2°C, emissions would have to be reduced in most regions almost immediately. This means that for low stabilisation levels, international cooperation would need to bring about immediate mitigation in *almost all* countries.

We classify proposals using the taxonomy developed in Section 13.4.3 and Table 13.3: (a) strong multilateralism; (b) harmonized national policies; and (c) decentralized architectures and coordinated national policies. Combinations of these categories have also been proposed and assessed. For example, strong multilateralism can be advanced by "clubs" of selected ambitious countries (Weischer et al., 2012) or by non-state actors (Blok et al., 2012).

Strong multilateralism

The anticipated performance of various proposals for strong multilateralism (understood as establishing goals or targets for participating countries over a set of future years, along with the means of implementation and other policy elements) has been assessed in the literature. In addition, another body of research has examined the ends (but not the policy architecture) associated with various aggregate goals in terms of country- or region-level emission targets based on specific notions of distributional equity, so-called "burden-sharing approaches." The equity principles which serve as the foundation for those scenarios are surveyed in Chapter 4, and their quantitative assessment is found in Chapter 6, along with other scenarios.

Comprehensive proposals for strong multilateralism have in some cases been closely related to the targets and timetables approach of the Kyoto Protocol. Negotiations under the Bali Roadmap developed different forms for absolute targets by developed countries – quantified economy-wide emission reduction targets – and relative reductions by many developing countries. This approach would maintain the UNFCCC principle of common but differentiated responsibility while introducing a more nuanced differentiation and broader base of participation, along with some specifics of the means of implementation. This is well reflected in the literature around reduction proposals with national emission targets and emissions trading (see Table 13.2 in (Gupta, Lasage, et al., 2007)), in particular gradually increasing emission reductions commitments linked to indicators such as per capita income (literature since AR4 including (Cao, 2010a; Frankel, 2010; Bosetti and Frankel, 2011), differentiating groups of countries (Den Elzen et al., 2007), common but differentiated convergence (Höhne et al., 2006; Luderer et al., 2012), and per capita targets (Agarwala, 2010).

Distributional impacts differ significantly with underlying criteria for effort sharing. In general, the proposals focussing on principles, such as responsibility and capability, are relatively stringent for "early" emitters assigning to them lower allocations. Such approaches tend to put relative weight on the greater responsibility and capability of wealthier countries. Proposals based on potential are less stringent for "early" emitters, as they capture the mitigation potential in developing countries, assumed to be relatively low-cost.

Especially for low stabilization levels, the approaches differ in the extent to which they rely on contributions from all countries from emissions reduction within their borders, and on international assistance between countries. Approaches in the categories of "carbon budget" and "responsibility, capability and need" translate into significantly stricter targets for developed countries and therefore in higher financial transfers from developed to developing countries than other approaches (Den Elzen and Höhne, 2008; den Elzen and Höhne, 2010; Edenhofer et al., 2010; Bosetti and Frankel, 2011). See Chapter 6. Some studies were based on regimes assuming an accumulated per-capita emission convergence approach (Bode, 2004), carbon budget approaches (Ding et al., 2009; Jayaraman et al., 2012; Khor, 2010; Messner et al., 2010) and greenhouse development rights (Baer et al., 2008; Höhne and Moltmann, 2008). Other studies based on equal marginal abatement costs or an uniform carbon tax for all countries show less ambitious reduction targets for the developed countries as a group (Van Vuuren et al., 2009).

Sectoral approaches are second-best, in comparison with economy-wide approaches, in terms of both environmental effectiveness and economic performance (Bradley et al., 2007; Schmidt et al., 2008; den Elzen et al., 2008; Meckling and Chung, 2009). Sectors that are homogenous and already globally integrated, such as aviation, may lend themselves better to international cooperation than those that are heterogeneous. Omitting some sectors makes it more difficult to achieve emissions or stabilization goals and also reduces cost-effectiveness, relative to economy-wide approaches, as required emissions reductions must be made within-sector, failing to take advantage of the lower of heterogeneous marginal abatement costs across sectors. Transaction costs may also be higher with sectoral approaches, including, for example, greater challenges to negotiation (Bradley et al., 2007).

However, these approaches could potentially help mitigate leakage within particular industries (Bradley et al., 2007; Sawa, 2010). In terms of institutional feasibility, sectoral approaches may encourage the participation of a wider range of countries than economy-wide approaches, because sectoral agreements can be more politically manageable in domestic policy processes (Bradley et al., 2007; Sawa, 2010). Developing countries may also be more likely to participate meaningfully in sectoral processes than economy-wide agreements limiting emissions (Meckling and Chung, 2009).

Several researchers have suggested that a system of multiple, related climate regimes is emerging, (see section 13.5), with the strong implication that component regimes may display a range of architectures—from strong multilateralism through more decentralized systems (Carraro et al., 2007; Biermann et al., 2009; Barrett, 2010; Keohane and Victor, 2011). The portfolio of treaties approach is similar in some ways to the sectoral approaches described above. However, the approach described in (Barrett, 2010) includes much more significant enforcement possibilities, potentially increasing environmental effectiveness, while potentially reducing institutional feasibility.

Harmonized national policies

A wide variety of national climate policies can – in principle – be harmonized across countries. This holds for cap-and-trade systems (e.g. a global emissions permit trading system (Ellerman, 2010), as we discuss in the context of linkage below, as well as for national carbon or other greenhouse gas taxes. The most studied approach in terms of performance assessments has been harmonized carbon taxes. Their environmental performance would depend upon the level of the tax, and relative to non-market-based approaches, this approach would be cost-effective. The impact of a carbon tax on economic efficiency will depend, in part, on how tax revenues are used (Bovenberg and De Mooij, 1994; Parry, 1995; Bovenberg and Goulder, 1996; Cooper, 2010).

Estimates in the recent literature of the environmental effectiveness and economic performance of proposed carbon taxes vary dramatically depending upon assumptions (Edmonds et al., 2008; Clarke et al., 2009; van Vuuren et al., 2009; Bosetti et al., 2010; Luderer et al., 2012). The distributional impacts of a carbon tax include negative impacts on the fossil fuel industry as a whole, with stronger impacts for fuels with higher carbon emissions per unit of energy. For example, impacts on coal would be much greater than on natural gas (Cooper, 2010). Impacts on consumers would likely be somewhat regressive (Metcalf 2007) in high-income countries but progressive in low-income countries. Tax revenues could be used by individual countries to address these domestic distributional concerns. (See, e.g., (Winkler and Marquard, 2011; Alton et al., 2012)).

Under a global carbon tax, fossil-fuel-exporting countries might experience negative impacts, and net importers could experience decreasing prices due to reduced demand, while some regions could experience increased bio-energy exports (Persson et al., 2006; OECD, 2008; Cooper, 2010; Leimbach et al., 2010). International transfers drawing on revenues of such a tax could, in theory, be used to address these concerns or to encourage participation by developing countries (Nordhaus, 2006). As with emissions trading (Frankel 2010), the extent of developing country participation in an international carbon tax scheme could be based upon income thresholds (Nordhaus, 2006).

The institutional feasibility of a global carbon tax is rarely considered in the literature. The relatively large number of studies on a global carbon tax is at least partly due to the fact that economic modellers often model a global carbon tax as a proxy for other mitigation policy instruments that would impose shadow prices on the carbon content of fossil fuels and/or CO_2 emissions.

Many hybrid market-based approaches to emissions mitigation, combining tradable emissions permits with some characteristics of a carbon tax, have been proposed and examined in the recent literature (Pizer, 2002; Murray et al., 2009; FELL et al., 2010; Webster et al., 2010; Grüll and Taschini, 2011). These hybrid approaches can – in principle – provide better aggregate economic performance in an emissions trading system, lowering compliance costs and reducing price volatility, at the potential expense of environmental effectiveness in the form of uncertain changes in aggregate emissions (Grüll and Taschini, 2011). However, recent research suggests that “soft” price collars, which provide a modest reserve of additional emission allowances at the price ceiling, may achieve most of the expected compliance cost savings provided by “hard” collars (unlimited supplies of additional allowances), while maintaining a more predictable cap on emissions (Fell et al., 2012). In terms of distributional equity, hybrid systems may reduce expected compliance costs for regulated firms, though they may increase regulatory costs (Grüll and Taschini, 2011). This characteristic may also increase political feasibility.

Decentralized architectures and coordinated national polices

The recent literature on linked domestic cap-and-trade systems suggests that economic performance of existing GHG allowance trading systems could be enhanced through linkage, which would reduce compliance costs and improve market liquidity (Haites and Mehling, 2009; Mehling and Haites, 2009; Sterk and Kruger, 2009; Anger et al., 2009; Jaffe et al., 2009; Jaffe and Stavins, 2010; Grüll and Taschini, 2011; Metcalf and Weisbach, 2012; Ranson and Stavins, 2013). In terms of environmental performance, linkage can increase or reduce emissions leakage, depending on the quality of credits within linked systems.

Linkages among cap-and-trade systems as well as linkages with and among emission-reduction-credit systems would create winners and losers, generating distributional impacts relative to un-linked systems, depending upon impacts on allowance prices and whether participating entities are net buyers or net sellers of emissions (Jaffe and Stavins, 2010). While it does preserve the ability of countries to meet their commitments through means of their own choice, consistent with the UNFCCC, linkage also poses some challenges for institutional feasibility, since it reduces domestic control over prices, emissions, and other aspects of policy design and impact (Buchner and Carraro, 2007; Jaffe et al., 2009; Jaffe and Stavins, 2010; Ranson and Stavins, 2013). In addition, due to general equilibrium effects and potential market distortions, linking may not benefit all participating countries (Marschinski et al., 2012). In one analysis that modelled the heterogeneous costs and benefits of participation in a climate coalition using a game-theoretic framework, incentives to deviate from cooperation could not be compensated by transfers (Bosetti et al., 2013).

Institutional feasibility challenges may be more significant for linked heterogeneous policy instruments (such as taxes and emissions permit systems, or taxes and technology standards) relative to linked regimes that use similar instruments (Metcalf and Weisbach, 2012). For example, unrestricted linkage would effectively turn a permit trading system into a tax, pegging the permit price to the other country's tax rate, and allowing aggregate emissions above the permit system's established cap (Metcalf and Weisbach, 2012).

Climate policy architectures that can be characterized as technology-oriented agreements may seek to share and coordinate knowledge and enhance technology research, development, demonstration, and transfer. Some literature suggests that such agreements may increase economic efficiency and environmental effectiveness of international climate cooperation, but will have limited environmental effectiveness operating alone (De Coninck et al., 2008). Though technology-oriented policies can promote the development of new technologies, environmental effectiveness hinges on the need for other policies to provide incentives for adoption(Fischer, 2008; Newell, 2010b). For example, (Bosetti, Carraro, Duval, et al., 2009) show that R&D alone is insufficient to stabilize CO_2 levels without an accompanying carbon tax or functionally equivalent policy instrument.

Table 13.4: Summary of Performance Assessment

	Specific Policy		Assessment Criteria			
			Environmental Effectiveness	Aggregate Economic Performance	Distributional Impacts	Institutional Feasibility
13.13.1. Existing Cooperation	The Kyoto Protocol		Emission targets for Annex I countries only. Reductions occurred in countries in transition, but emissions increased in others due to surplus emissions allowances. Incomplete participation and non-compliance among Annex I countries. Not sufficient to reach 2°C.	Cost-effectiveness improved by flexible mechanisms and allowing for countries to choose policies to meet commitments. Efficiency subject to assumptions of discount rate and degree of participation, and evaluation of mitigation benefits and costs.	Commitments are progressive, but dichotomous distinction correlates only partly with historical emissions and evolving economic circumstances. Intertemporal equity affected by short term actions.	Ratified (or equivalent) by more than 190 countries. High participation partially due to recognition of responsibility, domestic sovereignty, limited efforts for developing countries, and flexible mechanisms.
	The Kyoto Mechanisms		1.15 billion tCO_2e credits under the CDM, 0.6 billion under JI and 0.2 billion under IET. Additionality of CDM projects remains an issue but attempts at regulatory reform underway.	CDM mobilized low cost options, particularly industrial gases, reducing costs. Underperformance of some project types. Some evidence that technology is transferred to non-Annex I countries.	Limited direct investment from Annex I countries. Domestic investment dominates, leading to concentration of CDM projects in few countries. Limited contributions to local sustainable development.	Helped enable political feasibility of Kyoto Protocol. Has multi-layered governance. Largest carbon markets to date. Has built institutional capacity in developing countries.
	Further Agreements under the UNFCCC		Pledges made by all major emitters under Cancun Agreements, but unlikely sufficient to reach 2°C. Depends on treatment of measures beyond current pledges for mitigation and finance.	Efficiency not assessed. Cost-effectiveness might be improved by market-based policy instruments, inclusion of forestry sector, commitments by more nations than Annex I countries.	Depends on sources of financing, particularly for actions of developing countries.	COP decision; 80 countries agreed to emission targets or actions for 2020.
	Agreements outside the UNFCCC	G8, G20, MEF	May stimulate CO_2 reductions by phase out of fossil fuel subsidies, but implementation unknown. Otherwise not assessed.	Potential efficiency gains through subsidy removal. Too early to assess economic performance empirically.	Has not mobilized climate finance. Removing fuel subsidies would be progressive but have negative effects on oil-exporting countries.	Lower participation of countries than UNFCCC, yet covers 80% of global emissions. Opens possibility for forum-shopping of issues.
		Montreal Protocol	Stimulated emission reductions through ODS phase outs 5-6 times the magnitude of Kyoto FCP targets. Contribution may be negated by high-GWP substitutes.	[No literature cited.]	[No literature cited.]	Universal participation with different timing of phase-out.
		Voluntary Carbon Market	Covers 0.1 billion tCO_2-e, but certification remains an issue	Credit prices are heterogeneous, indicating market inefficiencies	[No literature cited.]	Fragmented and non-transparent market.

13.13.2. Proposed Cooperation	Proposed architectures	Strong multilateralism	Tradeoff between ambition (deep) and participation (broad).	More cost effective with greater reliance on market mechanism.	Can be more equitable if targets and actions related to criteria such as per capita income, emissions, historical responsibility, and/or sustainable development	Depends on number of parties; degree of ambition
		Harmonized national policies	Depends on net aggregate change in ambition across countries resulting from harmonization.	More cost effective with greater reliance on market mechanisms.	Depends on specific national policies	Depends on similarity of national policies; if more similar, more feasible. National enforcement more feasible.
		Decentralized architectures, coordinated national polices	National systems can be better enforced than multilateral. Integrity depends on quality of standards and credits across countries	Often (though not necessarily) refers to linkage of national cap and trade systems, in which case cost effective.	Depends on national policies	Depends on similarity of national policies; if more similar, more feasible
	Effort (burden) sharing arrangements		Refer to Chapter 4 for discussion of the principles on which effort (burden) sharing arrangements may be based, and Chapter 6 for quantitative evaluation.			

13.14 Gaps in knowledge and data

While there is a growing literature on performance assessment of existing and proposed forms of international cooperation (13.13), there have not been many studies that provide direct comparisons between proposals (in terms of present-discounted costs, costs per year, disaggregated regional- or country-level costs per year) or that incorporate uncertainty in their estimation of evaluation metrics.

The landscape of international climate agreements has changed considerably since AR4, with a range of new intergovernmental and transnational (private sector, NGO, subnational) agreements emerging. However, while there has been much research charting and explaining the emergence of these agreements (see 13.5 and 13.12, in particular), the challenge of assessing their effectiveness according to various criteria (notably environmental and economic) has yet to be adequately researched.

The literature on multilateral and bilateral agreements and institutions highlights the need for synergy building linkages across the multi-scale landscape (13.5). However, the literature does not provide information on the typology of relationships between different parts of the landscape of climate agreements, which might enable better assessment whether the sum of efforts across the landscape delivers environmental effectiveness, enhances aggregate economic performance and distributional equity, and whether it is institutionally feasible.

The literature provides little information on the environmental effectiveness, aggregate economic performance, distributional impacts, and institutional feasibility of other climate-related forums (13.5.1.2, 13.13.1.4).

The literature on transnational governance acknowledges a gap in that “interactions are understudied in all areas of transnational governance” (Abbott, 2011).

Also, little is known on how the relationship with other potentially relevant institutions (13.5.1.3) would enhance performance for all four criteria of evaluation.

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