# *Preparing the design of robust climate policy architectures*

**Aviel Verbruggen**

**International Environmental Agreements: Politics, Law and Economics**

ISSN 1567-9764
Volume 11
Number 4

Int Environ Agreements (2011)
11:275-295
DOI 10.1007/s10784-010-9130-x


Springer

Int Environ Agreements (2011) 11:275–295
DOI 10.1007/s10784-010-9130-x

ORIGINAL PAPER

# Preparing the design of robust climate policy architectures

**Aviel Verbruggen**

Accepted: 15 July 2010 / Published online: 27 July 2010


**Abstract** The design of climate policy architectures depends on how its multiple designers identify the climate problem, on the principles they adhere to, and on the criteria they apply for assessing the performance of the constructed agreements. This article presents five core features of the climate policy problem, five principles demanding respect when designing policy, and a particular specification of the four general criteria: efficacy, efficiency, equity, and institutional feasibility. The central policy problem of climate change is the phasing out of non-sustainable energy use by orchestrating trillions of decisions by billions of people. Principles like universality, realism, and transparency are important, but when balancing a global agreement, taking into account diversity and sovereignty are outstanding. For addressing the climate change challenges, the equity criterion should be taken more seriously by the negotiating countries than at present. In a diverse world, equity conflicts are likely to be further exacerbated by attempts to impose uniform approaches like global carbon trading or a harmonized global carbon tax rate. The uniform approaches, lauded by economists and policy makers as superior, are also criticized here as not being so effective and efficient as pretended.

**Keywords** Equity · Climate policy design principles · Diversity

## 1 Introduction

Climate policy is being negotiated by representatives and politicians of more than 190 nations in the annual Conferences of the Parties (COPs; COP15 at Copenhagen, December 2009, having the highest attendance rate so far) to the United Nations Framework Convention on Climate Change (UNFCCC). Various nations rank values differently and pursue diverging interests, increasing the difficulty of adopting a global agreement in follow-up to the UNFCCC (1992) and the Kyoto Protocol (1997). Historically, the outcomes of negotiations were to a large degree directed by dominant values and interests, a bias happening

A. Verbruggen (✉)
University of Antwerp, Prinsstraat 13, 2000 Antwerp, Belgium
e-mail: aviel.verbruggen@ua.ac.be

almost implicitly but tending to bolster inequality. However, the formal acceptance of sustainable development as the new paradigm at the Rio Summit (1992), the growing success of major developing economies in copying western industrialization patterns, and the unprecedented and diverse impacts of the global threat of climate change are shifting historical balances of values and interests. This reshuffling creates new difficulties in aligning the commitments of parties along a given set of common values and more equitably balanced interests.

This contribution stays away from the political task of actually getting parties to agree with each other. To use a metaphor, the aim of this article is not to cook but rather to prepare and order the kitchen. Before engaging in the debate on quantitative emission reduction and limitation targets by countries, on the preferred policy instruments and on transfers from rich to poor countries, it may prove helpful to take a step back and describe in a more explicit way what is indirectly affecting the process of negotiations. Three aspects merit more explicit coverage: first, the identification of the climate change policy problem; second, the principles useful as guides and limits on format, contents and outcomes of negotiations; and third, the criteria for assessing ex-ante and ex-post the performance of the constructed agreements.

Designing a policy starts with clearly investigating, analyzing and identifying the policy problem at hand (Pershing 2007, p. 232). Although climate change today is a familiar and better known subject, the definitions, components, and attributes are emphasized differently by different actors and authors. For example, it took a long time before adaptation was accepted as an important issue (Gupta and van der Grijp 2010). Section 2 introduces five core features of the climate change policy problem in accordance or in discord with standard wisdom. The adopted set of features makes the conceived policy problem explicit and delineates the ballpark of policy opportunities.

Section 3 discusses principles for framing a global agreement. Principles provide a checklist for the rules of the game that can be played in the policy arena. In law, principles play a very dominant role in determining the allocation of responsibilities with respect to addressing problems. Often there exists a thin line between principles and criteria as buoys to structure policies and their instruments and to evaluate their performance. The latter case is valid for the aspect of 'equity'. This text is organized with Section 4 discussing equity as a criterion together with efficacy,[1] efficiency, and institutional feasibility (Gupta et al. 2007). The four general criteria are multi-dimensional with different weight assigned to the dimensions, depending on the policy field and problem at hand. A brief conclusion rounds off this contribution.

Bringing order into a kitchen where subsequently a global follow-up agreement has to be prepared starts with inventorying what is available. Sometimes one is lucky when others have performed a significant part of the inventory tasks, i.e., when meta-literature is available. This is the case here with publications like Pew Center (2005), Aldy and Stavins (2007a), and Kuik et al. (2008). This article adopts many proposals and findings from a variety of sources in its search for aligning respectively the core features of the climate change policy problem, main principles, and criteria. This is a mixed exercise of "descriptive understandings and normative recommendations" (Smith et al. 2005, p. 1492). The positive part is stock-taking what the available literature proposes; the normative part is

[1] Because the term cost-effectiveness is widely used as a sub-criterion of efficiency, the term efficacy is preferred for expressing physical effectiveness of the measures resulting from policies and policy instruments. Here efficacy is gauged by, for instance, reduced emissions of greenhouse gases, lower concentrations of such gases in the atmosphere, or less damage from ongoing climate change.

selecting among the propositions what fits consistently and matches the priority in recommending workable sets of problem features, principles, and criteria.

## 2 Core features of the climate change policy problem

Like an urban planner starts by visiting the area, observing, and inventorying, the policy planner best starts at a clear definition of the problem (Pershing 2007, p. 232). A fully satisfactory definition of the 'wicked' climate problem (Prins and Rayner 2007) is presumably not attainable, but considering ex-ante a set of core characteristics may save precious time and human resources. Five features typify the climate change policy problem: the atmosphere is unique; it is the ultimate global commons; energy economies are the centerpiece of the drama and of the solution; urgent and drastic turn-over of the energy systems is on the agenda; the full transition of the energy economies by 2050 needs the contribution of billions of decision-makers. This article does not offer a detailed description of each feature but suggests guidelines for climate policy that follow from the features. The guidelines proposed here may be controversial, as other authors may back different (sometimes opposite) ones, some salient controversies being highlighted further down. The article is however too short to expand on all the controversies.

### 2.1 The atmosphere is unique

The atmosphere is the principal asset making the Earth different from other planets. Endangering the proper functioning of the atmosphere is endangering the human future. Therefore, safeguarding climate stability is a global, national and local policy challenge of first order and of highest urgency. Many other important issues require care and cure (fresh water availability, food security, sanitation and health, etc.; Gupta et al. 2006) but climate change is a root cause of deteriorating evolutions (UNDP 2007).

This asks for a clear positioning regarding climate policy "mainstreaming and linking up with other regimes" (Gupta 2007, p. 122; Kuik et al. 2008, p. 322–325) and pursuing sustainable development goals. Tuning climate policy to be in line with sustainable development policies is a guiding principle, but when depicting sustainable development as a multi-dimensional diamond (Gouzée and Henry 2008), polishing must occur side by side. The cutting edge now is climate policy that must spearhead the processes of change. However, loading the train of climate policy with the full development agenda may block it at the station of departure. The spearheading approach differs from suggestions to address the full development agenda simultaneously (e.g. Athanasiou and Baer 2006).

### 2.2 The ultimate global commons

Global climate change requires "a multinational response. To combat the risks posed by climate change, efforts that draw in most if not all countries over the long term will need to be undertaken. The challenge lies in designing an international policy architecture that can guide such efforts" (Aldy and Stavins 2007b, p. 1). The global commons characteristic is basic, asking clarity on the issues of participation and compliance (Schelling 2007, p. 344; Aldy et al. 2003). Discord remains over the comprehensiveness of participation and ensuring compliance, and over voluntary or mandated contributions.

In principle, climate policy must be globally comprehensive, as embodied by the UNFCCC with more than 190 countries participating. But progress in reducing greenhouse

gas emissions and in developing the disruptive low-carbon technologies of the future is slow. Limited participation initiatives show that universal participation is no longer sacrosanct (Dervis et al. 2009). Victor (2007, p. 156) pleads in favor of a variable geometry of participation but also argues for "more-universal agreements as a complement to the club approach". Advancing first with bottom-up coalitions of willing nations is argued by, for instance, Carraro (2007) and Pizer (2007). Although less profiled, the 55/55 rule of the Kyoto Protocol had a similar rationale: progress should not be stopped by minority interests. All significant change processes are spearheaded by pioneers, and climate policies must provide room for creativity and for pioneers, while avoiding regulations that counter their efforts by awarding laggards (grandfathering emission permits being a textbook example of the latter).

The global scope of climate change and the necessary measures involve all on earth. Therefore, global agreements should be kept open to adherence by all, including the poorest, countries. Not every country has to be involved in everything all the time, as long as the basic principles of procedural ethics are respected (Brown and Tuana 2006). The challenge is to accommodate the wide diversity in a comprehensive and coherent design: not the architecture of a 'Gothic cathedral' nor the chaos of a 'favela' (Jacoby 2007, p. 271, 273), but an agreed 'urban design'. The latter implies constraints, prescriptions, and recommendations for filling the space with diverse projects and constructions (Victor 2007; Pattberg and Stripple 2008).

Key to participation is compliance. Solid policy design cannot rest on voluntary compliance but builds on "mutual coercion mutually agreed upon" necessary for escaping the commons tragedy (Hardin 1968, p. 1247–1248). Too weak coercion, for example, based on reputation or even on national co-benefits that are real but not directly assigned to this international policy process, is ineffective, as is too strong coercion, for example, through "sanctions, military, diplomatic, commercial" (Schelling 2007, p. 344). Neither is there a global benevolent despot who adopts by fiat the economist's efficient policy design (Buchanan 1987). The successful policy design is collectively and individually rational: joining must offer net benefits for each participating country over not joining (Barrett 2003; Wiener 2007, p. 74), although institutionalists would argue differently.

With a public that increasingly sees the costs of climate change as real and wants policies that address the issues (Esty 2007, p. 265; BBC 2007), the benefits of participation and compliance grow. The policy design should include inducement, coercion, or persuasive invitations (Schelling 2007, p. 344) by self-enforcing mechanisms to keep participants on track toward preservation of the climate commons.

### 2.3 Commercial energy use has a leading role

Commercial energy use is the source of the bulk of greenhouse gas emissions, mainly carbon dioxide. Energy is a main driver of many other activities, processes and structures causing emissions, e.g. land-use practices, scattered settlement, and transport systems. Solving the energy issue is necessary and sufficient for untying the climate change nexus. This offers some comfort, but not much: energy use is intimately intertwined with human civilization, economic growth and development. "A safe, environmentally sound, and economically viable energy pathway that will sustain human progress into the distant future is clearly imperative" (WCED 1987, p. 202). As in the 1980s, the bifurcation between a non-sustainable and a sustainable energy future opens today.

Ever growing use of fossil fuels and grid electricity feeds industrial and industrializing societies. Expanding energy use follows from economic rational decisions by billions of

private agents, including companies, households, and individuals. Commercial energy prices were (and are) low because externalities and risks of intensive exploitation of fossil fuels and of nuclear power remain unpaid (Scheer 2001). Awareness about climate change has spread the conviction that energy prices must go up (BBC 2007). "One way or another, the energy-consuming public is going to have to pay higher prices […] to cut demand for fossil fuels and to induce emission-reducing technical changes in the energy sector" (Cooper 2007, p. 109).

With the full focus on climate change, the nuclear sector is organizing for a third chance to expand, stimulated by a low-carbon footprint and by IEA (2006) recommendations about including all options in the future energy supply portfolio. But is nuclear power a valid alternative when weighed on the main sustainability criteria (Verbruggen 2008a)? Policy designs that reduce climate change risks by increasing nuclear risks are in the end not sustainable. Therefore, a narrow focus on carbon as the only problem to address in the energy transition may be misleading.

Sustainable development requires sustainable energy, starring the twins—renewable energy and energy efficiency. Energy economies built around decentralized energy use and supply opportunities with everimproving energy use efficiency and integration of so-called passive energy (ambient, naturally available energy flows) pave the way to sustainable development (WCED 1987, Chap. 7). Phasing out non-sustainable energy use and phasing in sustainable energy options by 2050 should take a central position in climate policy designs.

### 2.4 Urgent and drastic action by rich countries

Evidence is growing that climate change implies more negative impacts and processes than expected from average values on future (mostly discounted) uncertainties (Stern 2006; Barker 2008; Weitzman 2008). The disturbance processes are expanding faster with also unexpected setbacks. The more threatening and faster changing climate supports findings by scientists that urgent and drastic action is needed (Stern 2006; IPCC 2007). An average global temperature increase ceiling to 2°C requires a rapid end to the emissions of more greenhouse gases into the atmosphere. Growing awareness worldwide (BBC 2007), by civil society organizations (Athanasiou and Baer 2006), by captains of industry (WBCSD 2006), etc. provides a solid foundation for a comprehensive climate policy architecture. The time is right to adopt the 450 ppm $CO_2$-eq. global stabilization trajectory (e.g. Bodansky 2007, p. 64), especially when considering recent studies recommending lower ppm levels (e.g. ADAM 2009). The trajectories end by 2050 in an almost zero carbon emission energy economy in the industrialized part of the world. This implies that there is a window of 40 years within which we should be able to realize the full transition of the energy systems. Indeed an urgent and drastic turn-over!

Decisions need to be made based on abandoning some tenacious conventional wisdom regarding responsibilities, emissions, and costs. First, rich countries command the technological, industrial and financial capabilities for developing and implementing the energy efficiency and renewable energy options in due time. But delay of innovations and deployment of sustainable low-carbon options is risky and may prove to be costly too. Such postponement of the energy transition by rich countries is covered up by buying carbon offsets through the clean development mechanism (CDM) for meeting reduction commitments (Pattberg and Stripple 2008, p. 376). Second, 'proof' that a full transition in the rich countries will be dwarfed by tremendous growth of emissions in developing

countries is static and conveys a biased message. As with the present non-sustainable technologies and practices of energy use, developing countries copy and try to emulate the affluent countries (Kuik et al. 2008, p. 323). They will be even more willing to copy affordable energy efficient and/or renewable energy technologies and practices if these become standard practice in the affluent countries. Third, to avoid that developing countries are also locked into non-sustainable energy systems, transfers of technology, know-how, and financial resources to kick-start energy efficiency and renewable energy are needed (de Coninck et al. 2008).

### 2.5 Global engagement by true energy prices

The ubiquitous economic trigger of the relentless expansion of non-sustainable energy systems was the low prices of fossil fuels and grid electricity (Kümmel 2007). Fossil fuel resources in the earth's crust were abundant and easy to mine, and the real costs of externalities and risks went un-priced and un-paid (Scheer 2001). Distinguishing private expenditures from public costs of non-sustainable energy supplies is essential.

Higher prices for commercial energy end-use will partly come by the shift from easy to explore and exploit resources to more difficult ones. Rent appropriation and monopoly power make prices exceed private expenditures, and extra profits boost non-sustainable investments and lifestyles. Higher monopoly prices also stimulate energy efficiency and renewable energy to some extent. However, progress is interrupted by price volatility and retarded by investment of monopoly profits in non-sustainable energy supplies. Preserving the public good requires public pricing, i.e. pricing the full costs of externalities and risks (Scheer 2001). All the knowledge of the world falls short of fixing the numbers of the social optimal carbon prices. What is needed is a 'trial and error' process within a solid pattern that resembles a mounting stair (Pizer 1997, p. 12). Prices of non-sustainable energy should go up irreversibly at the fastest pace that societies can afford. Such guidance contradicts the fluctuating and crashing prices as observed in the European Union emissions trading system over the last years.

Full public pricing of externalities and risks is the first step in the energy transition. This is understood by science (Nordhaus 2007) and by the global public (BBC 2007) but combated by incumbent interests, ranging from energy corporations to consumer organizations. Many give up on arguing in favor of full pricing of public goods (Michaelowa 2007; McKibbin and Wilcoxen 2007, p. 187–188) because the incumbent interests have been prolonging the stalemate for so long. But this is not the right attitude when the call for urgent and drastic change is out and climbing on the agenda. Pricing the full social costs of energy use by setting levies on external costs and providing subsidies only to external goods remain essential instruments in stimulating energy transitions (Fri 2003; Metcalf 2007; Milne et al. 2008).

## 3 Principles framing the design of global climate policies

Principles[2] frame design concepts and determine the distribution of responsibility and the design of instruments. "Global climate governance is marked by divergent polities and principles on how the overall architecture of climate governance should be structured"

[2] Webster's Dictionary defines a principle as "a comprehensive and fundamental law, doctrine or assumption".

(Pattberg and Stripple 2008, p. 368). Some principles are cut in UNFCCC stone, like the principle of "common but differentiated responsibilities and respective capabilities" (Article 3.1 UNFCCC), and through linkage principles of sustainable development are attached to, or incorporated in the climate policy discourse. Principles can be extracted from the Rio Declaration that focused on the palette of principles available to address environmental and developmental issues.

Principles range from hard legal conditions, over widely observed attributes, over recommendations, to contemplative considerations. Stavins (2004) argues for a treaty based on "sound science, rational economics and pragmatic politics". The Pocantico Dialogue organized by the Pew Center (2005, p. 1–2) draws a framework of six strategic guidelines: "To effectively advance the climate effort beyond 2012, the international framework must: engage major economies; provide flexibility, couple near-term action with long-term focus; integrate climate and development; address adaptation; be viewed as fair". The fourth Pew Center principle refers to development but does not explicitly mention 'sustainable development'. Sustainability is the full focus of Sachs' (2009) "eight principles for a global agreement on climate change (…) to bridge the existing wide gaps between rich and poor countries". Particular principles cover different agendas, but the search for a common list remains worthwhile. Here, five principles are discussed: universality, realism, diversity, sovereignty, and transparency.

### 3.1 Universality

Climate policy covers the full global scope in time horizons stretching from medium to long term, 2050 and beyond. Designers in 2010 build on decades of good and bad experiences in 'engineering' the world, including globalization with all its turmoil, costs, and benefits; sustainable development as the new paradigm; the Kyoto Protocol; and the Millennium Development Goals.

Against this background, spatial and temporal universality sets buoys for the design of climate policies. Three such buoys are mentioned here. First, nations and people own equal rights being the alpha and omega check on the lines drawn on the design board. For example, countries demand possibilities to develop economically, and one should "take seriously developing country opposition to emission targets", representing "both symbolically and in practice, a constraint on a country's economy as a whole." (Bodansky 2007, p. 61). Second, Summers (2007, p. xx) speaks of "present generations bringing offers in addressing climate change for the benefit of subsequent generations"; this is a vision that is growing obsolete and testifies a kind of 'reverse' ethics. In reality, post-war generations, in particular people living in affluence, accumulated a loaded slate of duties in rolling off externalities and risks by consuming thoughtless quantities of fossil fuels and grid power. When affluent states would take the lead in the energy transition, thoughtful attitudes come in place, what can be seen as living upon differentiated responsibilities and capabilities. Third, the most suitable long-term focus is convergence of the annual quantities per capita of greenhouse gas emissions across nations and within nations toward the lower end of the range (kg rather than tons of emissions per year per person) (Global Commons Institute 1996; Höhne et al. 2005). Contraction and convergence should not strive for artificial equal tons/capita but it is an argument for clear signposts during the transition journey toward emissions per person that diverge by no more than for instance a factor 10 (Frankel 2007, p. 40; Wiener 2007, p. 70; Hof et al. 2009, p. 44; Verbruggen 2009, p. 2933).

### 3.2 Realism

Real states and real people have to agree and implement the designs. On this, Summers (2007, p. xxii–xxiii) notes two basic aspects: "first, there is the constraint imposed by politics that governments are unlikely to write substantial checks to each other pursuant to international treaties". Second, cooperation potential is considerable, "reinforced by international emulation effects of a kind not factored into standard 'realist' analyses in political economy. Because of emulation effects, the scope for coordination may actually be greater than it seems". This balanced behavior by states parallels individuals' and organizations' behavior forth-and-back between self-interest and cooperation with others to realize plans and goals in life (Neiman 2008).

This realism is vented by many authors, including Pew Center (2005, p. 9), Bodansky (2007, p. 58), Wiener (2007, p. 74), Gupta (2007, p. 118), Olmstead (2007, p. 176), McKibbin and Wilcoxen (2007), and Hammitt (2007, p. 316). Morgenstern (2007, p. 219) emphasizes: "While some may criticize the lack of elegance or speed of the walk-before-you-run approach, in my view it is the only realistic way forward." Athanasiou and Baer (2006, p. 8) advance the opposite realism of "what will be necessary if we're to have a good chance of preventing a climate catastrophe". Neiman (2008) too reveals the dangers of inaction due to biased interpretations of realism. She argues with Kant's ethical categories for moral clarity to realize better social contracts than the present ones.

Robust climate policy designs address the relentless and ubiquitous creativity of economic agents serving nearby self-interests that in real life prevail over goodwill and intentions. Coercion is necessary to complement and extend goodwill (Hardin 1968). "The Holy Grail of climate policy is the self-enforcing agreement" (Jacoby 2007, p. 275). Not fully attainable, but a good design may end nearby and should start to consider where real decisions, i.e. allocation of resources, are taken. Therefore, a look into the mechanisms of economic allocation at all levels is recommended. "We must find the level of 'appropriate federalism'. That is, it is necessary to locate the decision-making at the political level that can internalize the spillovers" (Nordhaus 2005, p. 4). Victor (2007) and Pizer (2007) advocate the central role of national governments in climate policy, one step below the international level but still facing the thorny problems of rallying private interests for the common good. Also the national level faces the challenge to "provide credible incentives for individuals and firms to make the investments (in capital equipment and in R&D, both with long-payback periods) that will be needed to reduce emissions" (McKibbin and Wilcoxen 2007, p. 186).

Realism in climate policy means stepwise but urgent progress by countries, in directions outlined and at paces agreed upon at the global level. Because emissions result from trillions of decisions by billions of people and because nations are sovereign, brute enforcement is not effective. However, compliance by countries must be monitored and imposed through mechanisms agreed upon at the global level. The focus at the latest COPs on 'measurement, reporting, and verification' confirms this necessity (Dervis et al. 2009).

### 3.3 Diversity

Diversity is an essential attribute of ecosystems, human societies, populations, cultures, economies, sectors, governments (Stirling 1998). Diversity is the substrate of creativity, resilience, and essential for evolutionary systems (Gowdy and Erickson 2005). Diversity can be frugal but "there are no free lunches for diversity" (Weitzman 1992, p. 363). More diversity may reduce efficiency gains, for example, by losing economies of scale.

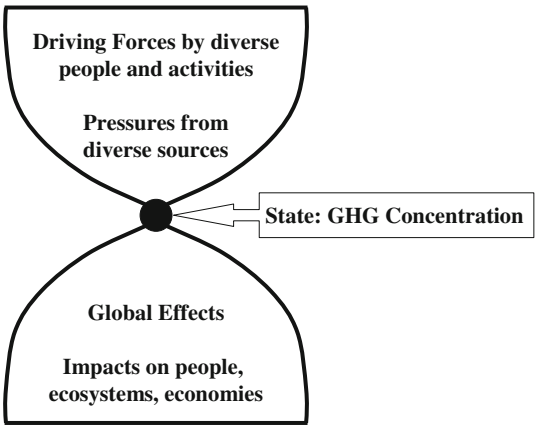


**Fig. 1** Hourglass structure of climate change in the framework. Driving forces—Pressures—State—Impacts [DPSI]

Debates on climate policy instruments are polarized by two visions, which are both proponents of essentially uniform economic instruments: the 'harmonized global carbon tax rate' (Cooper 2007; Nordhaus 2007) and the 'global carbon emissions permit market' (European Commission, followed by NGOs like WWF, and most academic economists). Economists worship the theoretical efficiency of uniform approaches: "Overall, Cooper's proposal for a uniform carbon tax shares the strengths of an ideal quantity-based approach (with perfect trading)", and assign them a "similar weakness: the difficulty in enforcing participation and compliance" (Aldy et al. 2003, p. 13). The global tax rate and the global permit trade strive to impose a uniform price on all emission sources. But overstretched use of uniform rules is the root cause of policy instruments being flawed and badly performing on the criteria efficacy, efficiency, equity, and institutional feasibility, resulting in foot-dragging participation and poor compliance. The widespread and deep-rooted belief in uniform approaches is worth a separate study. Here, I explore two lanes that drive minds into the uniformity funnel.

First, climate change reflects a remarkable 'hourglass' embedment in the DPSI@R[3] template (Fig. 1). Driving forces (D-stage) of climate change are incomprehensibly diverse covering all human activities on earth. Working Group III of the IPCC (2007) describes seven main activity sectors that emit the bulk of the greenhouse gases, for example: transport, industry, agriculture, and residential and commercial buildings. This mosaic of actors causes a widespread of greenhouse gas emissions sources, but the gases are chemically identified and their total quantities are enumerable (Pressure P-stage).

All emissions of long-living greenhouse gases add to the $CO_2$-equivalent concentration in the atmosphere, causing global radiative forcing and pushing upward global average temperatures (State S-stage). This is the bottleneck of the hourglass. Then, effects (ambient temperature rise, droughts, storms, floods) fan out widely, unevenly affecting ecosystems and societies in all continents (Gupta and van der Grijp 2010), with consequences for nature, human health and well-being, and economic property (Impact I-stage). Responses (@R stage) address Driving forces and Pressures (mitigation) and Effects and Impacts (adaptation) based on an evaluation of the effectiveness of past response strategies in worlds of "tremendous diversity" (Pew Center 2005, p. 9).

[3] DPSI@R stands for Driving forces—Pressures—State—Impacts—Responses. It is a conceptual framework for studying environmental issues. OECD (1997) initiated the PSR stages. Other authors and institutes (e.g. EEA 2003) extended the framework to DPSI@R.

A uniform approach cannot tailor the right incentives for the intricate problems at hand. The logical flaw of imposing uniformity consists in transferring the uniqueness of the $CO_2$-eq. concentration onto the other stages of the climate change nexus. The 'Provide Flexibility' guideline coming out of the Pocantico Dialogue (Pew Center 2005, p. 9) addresses this issue clearly: "The types of policies that can effectively address greenhouse emissions in a manner consistent with national interest will by necessity vary from country to country (…) to achieve broad participation". However, diversity could also be considered as an opportunity to better integrate climate policy with sustainable development policies encompassing versatile mitigation and adaptation wings. Victor (2007, p. 150) is more outspoken on a successful climate policy architecture being diverse, with his plea "for variable geometry of participation" and "for a variety of efforts that are tailored to each key member's capabilities and interests—rather than a single integrated system within which all members must adopt similar instruments".

Second, economists are trained in neoclassical theory, centered on abstract consumption utility and production technology functions (Williamson 1985; Barker 2008). Reducing tremendous diverse realities to comparable and exchangeable components in formal mathematical optimization models leads to the logical prescription of equating marginal benefits and costs for all components (activities, sectors, countries) covered by the models. The evident corollary of the assumed exchangeability of all the components is that the least mitigation costs are obtained, the wider the melting pot of mitigation efforts is made. This is once more confirmed by one of the latest model studies on environmental effectiveness and economic consequences: Hof et al. (2009, p. 39) "conclude that stabilizing greenhouse gas concentrations at low levels is more costly with a fragmented regime than with a universal regime, because reduction targets must be achieved by a smaller number of countries or because fragmented treaties may prevent reducing greenhouse gases where it is cheapest to do so". This type of logic overrides the importance of technological diversity and the necessity of simultaneous investment in a wide range of new options, not just in the cheapest one today (Jacobsson et al. 2009).

The intractable diversity and complexity of countries, economies, sectors, and activities may be reducible to uniform treatment in abstract models. It is not possible, not necessary, and not desirable to press the living world through the bottleneck of the neoclassical hourglass. Dahrendorf stated that "diversity is desirable in economic policies across time and space according to local needs", or "the existence of a diversity of economic policies or even a variety of capitalisms, is not only a fact, but also a praiseworthy fact" (quoted by Schnellenbach 2005, p. 11).

The observations lead me to policy recommendations opposite to the dominant discourse: uniform global taxing and amalgamated emissions trading (like the EU emissions trading scheme) are no suitable instruments for tackling climate change. The reality is too diverse and dogged in diversity: in practice, announced uniform rules are turned in opaque complexes of exceptions, adjustments, exceptions on the exceptions, etc. (the EU 'comitology' practice is a lively example). This experience is not limited to climate policy: from detailed studies of environmental regimes, Lejano (2006, p. 198) observes that "the considerable differentiation found among even formally similar programs suggests the powerful action of context. The fact that, even among programs that all pursue the UNEP model, we found considerable diversity suggests that the influence of context (i.e., local policy actors, local resources, political dynamics) is considerable". The taxing and permit market instruments are as such of great value and their application is possible, necessary and desirable, but in a versatile and flexible way, each application tailored to the category of diverse problems that need to be addressed.

### 3.4 Sovereignty

Nations are legally sovereign. Nordhaus (2007, p. 28) reminds us that "[u]nder international law as it developed out of the 1648 Treaty of Westphalia and evolved in the West, obligations may be imposed on a sovereign state only with its consent". Carraro (2007, p. 162) specifies: "climate change control is managed as a global common property good, but there is no institution that possesses power to regulate it by means of supranational legislation, economic instruments, or by imposing a system of global property rights." The legal principle of sovereignty of nations is helpful in negotiating a better global agreement, once combined with universality, realism and diversity. True, in the short term, the reciprocal force of sovereignty is embarrassing for nations wanting to impose their approach on others. True, lifetime beneficiaries of non-sustainable growth economies have to learn to listen to the concerns and arguments of developing nations about divergent historical responsibilities (such as posited in the Brazilian proposal). The present large gaps in greenhouse gas emissions per inhabitant, also in GDP per person (UNDP 2007), and uneven command over governance capabilities, technologies, and financing to engage mitigation and adaptation actions (Heyward 2007), all have to be addressed.

Yet, "the global public-good nature of the problem forces us to insist on the need for coordinated international efforts" (Montero 2007, p. 328). Bodansky (2007, p. 61) observes that for China and India "economy-wide, binding emission targets are unacceptable because they would unduly restrict their national sovereignty" and he recommends "to take seriously developing country opposition to emission targets", and not "to assume that their opposition is transitory and changeable". Maybe rich countries first have to listen before talking, willing to question their convictions and sacrosanct approaches. Developing countries have shown in the Annex to the Copenhagen Accord the extent to which they are willing to constructively engage in developing (quantified and non-quantified) targets that may contribute to addressing the climate change problem.

Sovereignty coupled to diversity, universalism and realism makes globally uniform approaches unlikely, takes equity and sustainable development serious, and focuses on subsidiary approaches with a predominant role for nation states (Victor 2007; Pizer 2007), and for bottom-up initiatives (Heyward 2007, p. 529), reassessing the true performance of "transnational climate governance" (Pattberg and Stripple 2008).

Successful climate policy designs foster sovereignty of nations. Next to the legal status of sovereign nations, sovereignty is also a term used in the context of sub-national entities deciding by and for themselves, such as organizations and people. For example, market economists have argued about consumer sovereignty as follows: "the individual has a sense of freedom. He is free to act within the system; there is no direct order telling him what to do" (Arrow 1974, p. 21). Cooperation by millions of organizations and by billions of people is necessary. Governments face the challenge of convincingly inviting their constituencies to participate and to comply. A policy design that leaves more authority and responsibilities with the participants empowers them by overarching regulations of minimum weight and maximum thrust. "Design in this sense is something that evolves as an outcome of manifold institutional processes" (Lejano 2006: 197).

### 3.5 Transparency

The acceptance of a global agreement is narrowly related to global understanding, because all countries, institutions and citizens are affected and involved in mitigation and adaptation responses. No one can know the full details but all want to comprehend the essence

of systems and mechanisms that affect them. This requires that the details of a global agreement should also be straightforward and clear, not subject to opaque language, irresponsible adaptations, covert manipulations, etc.

A clear problem analysis and definition (Sect. 2) and an explicit framework of principles (this section) advanced the notion of transparency. Additional transparency aspects are briefly mentioned here. First, international agreements and policies should be built with well-identified components, linked by evident logic. Goals, targets, actions, and practices should be defined unequivocally. The database for measuring, reporting and verification of performance and progress by parties on agreed targets, actions, and practices must be reliable, accessible for the public, updated every year, audited and supervised by independent international authorities. To this end, Verbruggen (2009) develops a proposal using three indicators that are already measured annually for most UN nations: commercial energy intensity, renewable energy supplies, and environmental tax revenues as a percentage of GDP. Second, the proposed global long-term emission targets as ppm $CO_2$-eq. ceiling trajectories are still scientific jargon; it would be more transparent to translate the trajectories in contraction and convergence patterns referring to kg emissions/person numbers. Third, the theoretical idea behind emissions trading is simple Langrangean optimization (SANDBAG 2009), but the practical implementation is bedeviled. Before starting real-life applications long lists of concepts and assumptions require qualification to approach workable definitions for an experienced PhD holding audience (Faure and Peeters 2008).

Implementation problems with the European emissions trading scheme are such that crucial issues are left over to the 'comitology' procedure, where EU officials and representatives of stakeholders (lobbyists) agree on the outcomes. Examples here are the following: what sectors will get the allowances for free and what sectors will be submitted to some type of auction. How will the auctions look like, when will they take place? What are the legal rights connected to the allowances? (Faure and Peeters 2008). A global tax is conceptually and practically simpler but its harmonized application is also undefined, as $10/ton emissions may mean different things for Belarus, Belgium, or Benin.

## 4 Performance criteria for policies and policy instruments

A core set of criteria for assessing the performance of environmental and energy policies is generally accepted and comprises efficacy, efficiency, and equity (Baron et al. 2007). Other authors reshuffle and extend the criteria list, for instance, by putting special emphasis on participation and compliance (Aldy et al. 2003, p. 1–6). Bodansky et al. (2004, p. 5–6) distinguish policy and political criteria, adding specific ones, such as 'complementarity of designs', defined as: "In the event of multiple regimes or approaches facilitating linkages among them". Also borders between guidelines (Pew Center 2005, p. 9–11; Sect. 3 above) and the various sub-criteria are permeable. Gupta et al. (2007) add 'institutional feasibility' as fourth criterion, drawing attention to the institutional and policy aspects. This extension corresponds to the institutional and governance dimension being an essential component of sustainable development (WCED 1987, Chap. 2). Following Gupta et al. (2007), I also adopt four criteria in this analysis. All criteria are composed of sub-criteria with circumstantial weights depending on the type of the policy problem. Here, I detail sub-criteria of interest for climate policy.

### 4.1 Efficacy

Clearly identifying the problem at hand, (Sect. 2) significantly helps in defining what outcomes should be obtained by whom by when (and sometimes also how). The Kyoto Protocol provides specific answers: outcomes for the industrialized countries are defined as percentage reductions by 2008–2012 of greenhouse gas emissions compared to 1990 levels, and with flexible mechanisms as central to the 'how' issue. Other policy architects propose alternative definitions. Barrett (2007, p. 242) argues that "the problem is not only to limit concentrations; it is to reduce climate change risk: to make climate change, especially abrupt and catastrophic climate change, less likely; and to make the consequences of climate change less harmful". Centering on risks helps avoiding the trap of nuclear risks (Barrett 2007, p. 238). Pocantico dialoguers open the discussions by including "aspirational long-term goals, more flexible targets, sectoral and policy-based approaches and parallel tracks" (Pew Center 2005, p. 13–19). This is echoed by Victor (2007) and Pizer (2007), with growing difficulty for defining the metrics of effective performance when more badly defined variables are included.

At the global scale, the UNFCCC specifies the commitment to "prevent dangerous anthropogenic interference with the climate system" (Article 2 UNFCCC) in a global emission trajectory that is linked to a high likelihood that global temperature rise stays below 2°C. The next part is more difficult: how to assign the common duty of emission reduction or limitation targets to countries over time. Direct emission (reduction) targets "depend on unpredictable variables such as economic and population growth, and the rate of technological change." (Bodansky et al. 2004, p. 6). "The global conference circuit, once touted as an indispensable part of the global social learning process, seems unable to move beyond rhetoric" (Gupta et al. 2006). The European Commission machinery for setting and monitoring member state reduction targets is already impressive, but far from finished to deliver (Faure and Peeters 2008).

Efficacy is often seen as easy to identify and measure, but one must take into account various factors that change the actual meaning of the targeted indicators, and therefore have an impact on final efficacy. Three often overlooked factors that may significantly affect the real weight of the first hand outcomes (efficacy) of climate policies are discussed here.

#### *4.1.1 Targets in context*

Targets stimulate action but can entail perverse side effects. Short-term targets strengthen myopia when not designed as stepping stones in a long-term process (Jacobsson et al. 2009). Pocantico dialoguers recommend to "couple near-term action with a long-term focus" (Pew Center 2005, p. 10). Exclusive focus on carbon dioxide emissions reduction targets shadows the full dimension of climate change risks (Barrett 2007) and could support the growth of other risks, in this case, atomic power. Verbruggen (2008a) argues that the growth of nuclear power is contradictory with, and will oppose in practice, the real low-carbon options consisting of energy efficiency and renewable energy supplies.

#### *4.1.2 Robustness and flexibility*

Effects need to be guaranteed under adverse changes in circumstances; this is referred to as robustness under uncertainty (Frankel 2007: 39). For example, success in meeting reduction targets because of an economic recession cannot be considered as a proof of

efficacy. Robustness is different from rigor, the latter leading to stickiness and lock-in. Flexibility is recommended to allow a sequential decision-making approach to adequately react on new information (Aldy et al. 2003) and to address diversity (Pew Center 2005, p. 9).

#### *4.1.3 Leakage*

Policies failing to cover the full scope of the problem or being biased, occasion leakages that are not observed by the policy designers. Without taking forthcoming leakages into account, they overestimate the efficacy of their policies. Leakages erode the foundations of any public goods or commons policy. Shifts in competitive positions of industries due to uneven climate policies are the most exposed potential source of leakage. This is why climate policies have to be designed, agreed and monitored at the global level. But leakage sneaks in through many cracks. For example, the demand for green resources by wealthy consumers often leave only the more dirty alternatives for poorer consumers, what overall may end in negative outcomes. Another example is rebound effects in energy use when energy bills fall through higher energy efficiency; rebound effects can make targeted reductions in energy use almost zero (Sorrell 2007).

### 4.2 Efficiency

Efficiency is the ratio of outcomes to efforts: without efficacy, there is no efficiency. Both criteria are intertwined, mainly in the dynamics of innovation that helps to obtain more results at lower costs. Efficiency is also a multi-layered concept.

Static cost-effectiveness is based on the logic of optimization or rational choice, simple to express in mathematical formats. It is the basis of the belief that globally uniform instruments (harmonized taxes or emissions trading) would guarantee the highest efficiency. The more activities and circumstances covered and the more diverse they are, the higher are the announced and pretended cost-effectiveness of uniform instruments. However, this logic is only valid when activities and circumstances are comparable and suitable for uniform treatment. If not, one must classify diverse activities, technologies, effects, etc. in categories of comparable cases. Cases within a particular category are treated uniformly to maximize cost-effectiveness. Cases across various categories warrant differential treatment. When amalgamating diverse categories together, fictive gains are assumed, or when amalgamation is actually imposed, fictive gains materialize paid by the losers of the linear rules.

Dynamic efficiency is taking precedence over static cost-effectiveness because of the role of technological inventions and innovations, crucial in realizing the low-carbon energy economy of the future. Push and pull instruments are most effective and efficient when working in conjunction. Fri (2003) and Popp (2002) emphasize that successful energy innovations are mainly induced by higher energy prices. For convincing investors to fully turn to low-carbon energy supplies as standard options, price signals need to be “clear, consistent and stable”, not provided by emissions trading that “results in volatility and uncertainty in the price” (stated by Ken Cohen, vice-president Exxon, in Euractiv newsletter, April 14, 2007).

Transaction costs (Williamson 1985) are signaled, but not systematically taken into account when comparing policy designs. At first glance, the simplicity of uniform instruments seems advantageous in reducing transaction costs (Stirling 1998: 30). In reality, a uniform size suits only a small part of diverse populations; remaking delivered material is far more costly than first measuring by category for tailoring the variety in sizes.

### 4.3 Equity

Equity concerns stay central in climate policy designs. Some argue from a moral perspective (Athanasiou and Baer 2006; Sachs 2009), others from a pragmatic perspective: "a new global bargain on climate change will be possible only if each participating government can justify the outcome to its people as reasonably fair" (Pew Center 2005, p. 11). "Given the wide variances in national circumstances, universal acceptance of any particular equity formula is unlikely". Equity again is multi-dimensional (Heyward 2007) and more contentious than efficacy and efficiency. While it is not possible to highlight all dimensions of equity, some aspects of high relevance for climate policy designs are discussed here.

#### *4.3.1 Type I and type II discrimination*

A large majority of people is sensitive to discriminations of type I: the uneven treatment of equal cases. Most oppose such treatment and support initiatives to end or at least attenuate the conditions. Type II discrimination, the uniform treatment of different cases, is less understood and recognized but often promulgated as fair because 'all should obey the same rules'. This is, however, basically wrong because imposing 'the same rules' is exactly the source of this type II discrimination. To avoid type II discrimination, diverse regulations are required when diverse categories are scoped. This refers to the criticism above on uniform instruments as being not effective nor efficient because of amalgamating diverse categories under a single regime. Here is added that uniform approaches for diverse realities also are unfair.

#### *4.3.2 Interpreting and applying the polluter pays principle (PPP)*

For respecting the "principle of equality (…), the polluter pays principle constitutes the relevant criterion to introduce allocation methodologies that treat different undertakings differently" (De Cendra De Larragán 2008, p. 62–65). The OECD-1972 light version of this principle requires polluters to pay for only their own abatement expenses in meeting environmental policy obligations. The PPP-extended version adds the commitment to compensate for damages occasioned to the public good. Damages being observed and measured mostly after the facts, 'historic responsibility' for climate change enters the debate. The Brazilian proposal addresses this point explicitly (Bodansky et al. 2004, p. 22). Evidently, wealthy nations do not favor it. It also is tedious and presumably impossible to accurately disentangle historic responsibility. Moreover, debates on past differences will end in conflicts. This is contrary to the field leveling needed for creating a globally common resolve for urgently tackling climate change (Verbruggen 2009). Full pricing of external costs by imposing levies is the recommended method of applying the PPP. In practice, implementation of the instrument involves many caveats. The argument on discrimination above also rejects uniform tax scythes and pleads for better tuned levies by diverse categories.

#### *4.3.3 Contraction and convergence*

In this approach, a low long-term concentration level is specified, and emission entitlements are shared among countries so that emissions per person converge (Global Commons Institute 1996). Egalitarians propose the principle of equal emissions per person (Heyward 2007, p. 521) but others are negative about this. Frankel (2007, p. 40), for example, states: "In their more unrealistic moments, spokesman for developing countries argue that equity requires setting quantitative targets at equal amounts per capita. (…)

It is true that equity in itself suggests moving in this direction". Wiener (2007, p. 70) specifies: "Fairness does not seem to require equal emissions per capita, just as fairness does not require equal land area per capita or equal water use per capita. It is not clear why, say, Rawlsian justice or even Marxian 'to each according to his needs' would require rights to strictly equal amounts of physical resources". But Heyward (2007, p. 526) offers a balanced and positive vision: "Contraction and convergence probably has limited political feasibility in the face of significant opposition by some major emitters. However, it is flexible and has considerable support in other quarters; and thus some elements may figure in future action". Opinions on contraction and convergence differ but can be reconciled. Verbruggen (2009) proposes a projection over time (up to 2050) of contracting annual emissions per person as global average and as funnels around the average where every country has to converge to; this is helpful in making the emissions trajectories (IPCC 2007) transparent (Sect. 3.5) and more useful for reaching clear agreement.

#### *4.3.4 Excluding free riders*

Preserving common goods requires excluding free riders and stopping leakages, mostly due to poor regulations and defective policy instruments. The latter provides ample opportunities to economic agents for gaining pecuniary or other advantages (Laffont and Tirole 1998). Rent seeking is documented in the EU emissions trading scheme where large corporations could gain high profits by charging a price to their clients for allowances that they got for free. Sijm et al. (2006) consider such profits as windfalls based on the application of the opportunity cost principle in a competitive electricity market. However, real windfall profits are very exceptional. In opposition to Sijm et al. (2006), Verbruggen (2008b) argues that only monopoly power allows companies charging fictive costs, and that the profits better are labeled as excessive. Also the CDM has been a source of easy money for project developers and their clients (Wara 2007). Opaque policies and defective regulations are preferred hunting grounds for little scrupulous lobbyists and rent seekers.

#### *4.3.5 Distribution of burdens and benefits*

Stating that present generations offer sacrifices for future generations when caring for the climate illustrates reverse ethics: actually, present generations have duties because they profited for decades from rolling off immense external costs and risks. Those who profited most have generally appropriated most financial, technological and organizational abilities to address climate change by mitigation and adaptation. This is reflected in Article 3.1 of the UNFCCC as "common but differentiated responsibilities and respective capabilities. Accordingly, the developed country parties should take the lead in combating climate change and the adverse effects thereof." Resuming responsibility is urgent with steady progress at the highest pace that the socio-economic-technological fabrics of the countries can accommodate and afford.

### 4.4 Institutional feasibility

Gupta et al. (2007, p. 752) state that "instrument design and implementation must take political realities into account" and that "policy choices must be both acceptable to a wide range of stakeholders and supported by institutions, notably the legal system". In climate policy, global international institutional realities are important on top of regional, national,

sub-national realities. I specify a number of institutional items to be considered when designing climate policies.

#### *4.4.1 Participation*

As a truly global issue, climate policy is best served by universal participation. Some substitute 'more comprehensive' or 'broad' or 'variable geometry' participation for universal participation as being essential (Aldy et al. 2003, p. 5–6; Frankel 2007, p. 32; Victor 2007, p. 150). Participation is generally understood as the number and economic-political weight of signatories of international treaties, but the deeper meaning is important too, as indicated by Gupta (2007, p. 127): "In the ultimate analysis, we need to create a mass movement, and the role of research in this process is to identify the policy instruments that can be adopted by a range of different actors in order to deal with the problem". Obligations that are connected to participation by a variety of actors are moderated by their diverging 'ability to pay'.

#### *4.4.2 Compliance and enforcement*

Hard-handed top-down enforcement is not feasible among sovereign states and not workable for the problem at hand involving millions of organizations and billions of actors. One must find a midway between the search for the perfection of self-enforcing agreements and "avoiding the discussion" (Schelling 2007, p. 344). Monitoring, accounting, auditing, and communication systems that reveal timely (preferably annually with national budget controls) and accurately the true performance of participating nations are needed to foster common resolve and concurrent emulation (Verbruggen 2009).

#### *4.4.3 Flexible mechanisms*

Emissions trading is advocated as preferred instrument to install the global carbon price. For ever realizing this goal, the markets also should be global, what requires a global regulator. It is hard to imagine how the UN, the only public institutional structure at the global level, could organize such a market. Then, only regional, national or state wise markets are realistic but face the difficulty of compatibility, linking, and eventual integration. Because organizing emissions trading systems requires sophisticated and endowed administrations, it is unlikely they can be set up in most developing nations (Van Asselt and Gupta 2009). The main policy instruments that developing nations master is the application of indirect taxes on goods and services. International agreements that consider the creation of particular instruments should first investigate the institutional realities and specify the governance prerequisites of complex instruments. Study of the real performance and cost/benefit balance of the EU emissions trading system may provide many lessons in this regard (Faure and Peeters 2008; ADAM 2009).

## 5 Conclusion

This article discusses how the global negotiation kitchen could or should be prepared to craft global climate agreements. Three main aspects have been discussed: the identification of essential features of the global climate change policy problem at hand; a selection of five principles governing the creativity of the parties; and clarification of four criteria for

assessing the performance of the adopted designs. On all issues, the literature provides a wealth of ideas, with many incorporated in the proposals and suggestions coined here.

On some important points, my analysis and conclusions deviate from mainstream visions and propositions. The depiction of the essential features of the climate policy problem leads to recommendations that are contentious, for example: give first and full preference to the transformation of the energy systems, putting other drivers of climate change and imperatives of sustainable development in second order. The Copenhagen Accord confirms the role of asymmetric and informal governance mechanisms in breaking ground, what this article also endorses with arguments about differentiated responsibilities (Sect. 2.4), diversity (Sect. 3.3), and equity (Sect. 4.3).

The article selects five explicit principles, links them together and reveals their significance for climate change policies. It extends attention for the diversity principle because it is decisive in criticizing standard thinking about the supremacy of uniform policy instruments (the global carbon tax or the worldwide amalgamated emissions trading system). Four criteria are adopted for evaluating the expected performance of policy proposals and the measured performance of actual policies. Most focus is put on the equity criterion, because equity is a crucial but too much neglected criterion in practice. The diversity principle and the equity criterion are linked in the definition of type I and type II discrimination, giving further strength to the discord with mainstream preference for uniform economic policy instruments.

Although this article does not provide ready-made policy propositions, it is hoped that the discussions on how to prepare and order the kitchen provide food for thought for the international negotiations.

**Acknowledgments** Two anonymous reviewers have offered useful comments for improving the contents and language of the article. The editors contributed significantly by identifying unclear statements and arguments and by suggesting several valuable corrections. The usual disclaimer that only the author is responsible for the final text applies.

## References

ADAM. (2009). *Adaptation and mitigation strategies. Supporting European climate policy*. Final report. Retrieved from www.adamproject.eu.

Aldy, J. E., Barrett, S., & Stavins, R. N. (2003). *13 + 1: A comparison of global climate change policy architectures*. Washington: Resources for the Future. DP 03–26.

Aldy, J. E., & Stavins, R. N. (Eds.). (2007a). *Architectures for agreement. Addressing global climate change in the post-Kyoto world*. Cambridge: Cambridge University Press.

Aldy, J. E., & Stavins, R. N. (2007b). International policy architecture for global climate change. In J. E. Aldy & R. N. Stavins (Eds.), *Architectures for agreement* (pp. 1–27). Cambridge: Cambridge University Press.

Arrow, K. J. (1974). *The limits of organization*. New York: W.W. Norton & Company.

Athanasiou, T., & Baer, P. (2006). *Greenhouse development rights: An approach to the global climate regime that takes climate protection seriously while also preserving the right to human development*. Berkeley, USA: EcoEquity and Christian Aid c/o Earth Island Institute. www.ecoequity.org.

Barker, T. (2008). *The economics of avoiding dangerous climate change*. Tyndall Centre for Climate Change Research, WP117.

Baron, R., Reinaud, J., Genasci, M., & Philibert, C. (2007). *Sectoral approaches to greenhouse gas mitigation*. Paris: International Energy Agency.

Barrett, S. A. (2003). *Environment & statecraft: The strategy of environmental treaty-making*. Oxford: Oxford University Press.

Barrett, S. A. (2007). Multitrack climate treaty system. In J. E. Aldy & R. N. Stavins (Eds.), *Architectures for agreement* (pp. 237–259). Cambridge: Cambridge University Press.

BBC. (2007). *World service*: *Poll on lifestyle changes, energy costs, tax increases related to climate change*. Retrieved from www.bbcworldservice.com.
Bodansky, D. (2007). Targets and timetables: Good policy but bad politics? In J. E. Aldy & R. N. Stavins (Eds.), *Architectures for agreement* (pp. 57–66). Cambridge: Cambridge University Press.
Bodansky, D., Chou, S., & Jorge-Tresolini, C. (2004). *International climate efforts beyond 2012: A survey of approaches*. Washington, D.C.: Pew Center on Global Climate Change.
Brown, D., & Tuana, N. (2006). *White paper on the ethical dimensions of climate change*. Rock Ethics Institute. Retrieved from http://rockethics.psu.edu/climate.
Buchanan, J. M. (1987). The constitution of economic policy. *American Economic Review, 77*, 243–250.
Carraro, C. (2007). Incentives and institutions: A bottom-up approach to climate change. In J. E. Aldy & R. N. Stavins (Eds.), *Architectures for agreement* (pp. 161–172). Cambridge: Cambridge University Press.
Cooper, R. N. (2007). Alternatives to Kyoto: The case for a carbon tax. In J. E. Aldy & R. N. Stavins (Eds.), *Architectures for agreement* (pp. 105–115). Cambridge: Cambridge University Press.
De Cendra De Larragán, J. (2008). Too much harmonization? An analysis of the commission's proposal to amend the EU ETS from the perspective of legal principles. In M. Faure & M. Peeters (Eds.), *Climate change and European emissions trading* (pp. 53–87). Cheltenham, UK: Edward Elgar.
De Coninck, H., Fischer, C., Newell, R. G., & Ueno, T. (2008). International technology-oriented agreements to address climate change. *Energy Policy, 36*, 335–356.
Dervis, K., Jones, A., Kornbluh, K., & Puritz, S. (2009). *Climate crisis; credit crisis; the quest for green growth*. Brookings Blum Roundtable 2009. Global Economy and Development. Retrieved from www.brookings.edu/global.
EEA. (2003). *Environmental indicators: Typology and use in reporting*. Copenhagen: European Environment Agency.
Esty, D. C. (2007). Beyond Kyoto: Learning from the Montreal protocol. In J. E. Aldy & R. N. Stavins (Eds.), *Architectures for agreement* (pp. 260–269). Cambridge: Cambridge University Press.
Faure, M., & Peeters, M. (Eds.). (2008). *Climate change and European emissions trading. Lessons for theory and practice*. Cheltenham, UK: Edward Elgar.
Frankel, J. (2007). Formulas for quantitative emission targets. In J. E. Aldy & R. N. Stavins (Eds.), *Architectures for agreement* (pp. 31–56). Cambridge: Cambridge University Press.
Fri, R. W. (2003). The role of knowledge: Technological innovation in the energy system. *The Energy Journal, 24*(4), 51–74.
Global Commons Institute. (1996). *Contraction and convergence (C&C); climate justice without vengeance*. Retrieved from www.gci.org.uk.
Gouzée, N., & Henry, A. (2008). Quels scénarios de développement durable pour la Belgique? Annual forum FRDO-CFDD, Brussels. Retrieved November 13, 2008, from www.belspo.be/frdocfdd.
Gowdy, J., & Erickson, J. D. (2005). The approach of ecological economics. *Cambridge Journal of Economics, 29*, 207–222.
Gupta, J. (2007). Beyond graduation and deepening: Toward cosmopolitan scholarship. In J. E. Aldy & R. N. Stavins (Eds.), *Architectures for agreement* (pp. 116–130). Cambridge: Cambridge University Press.
Gupta, J., Howarth, R., Sand, P., & Young, O. (2006). Environmental issues and global politics, Anno 2006 (Editorial). *International Environmental Agreements*: *Politics, Law and Economics*, *6*. doi:10.1007/s10784-006-9000-8.
Gupta, S., Tirpak, D., Boncheva, A. I., Gupta, J., Hohne, N., Konoan, G. M., et al. (2007). Policies, instruments and co-operative arrangements. In IPCC (Ed.), *Climate change 2007. Fourth assessment report. Mitigation of climate change* (pp. 745–807). Cambridge: Cambridge University Press.
Gupta, J., & van der Grijp, N. (Eds.). (2010). *Mainstreaming climate change in development cooperation: Theory, practice and implications for the European Union*. Cambridge: Cambridge University Press.
Hammitt, J. K. (2007). Is "practical global climate policy" sufficient? In J. E. Aldy & R. N. Stavins (Eds.), *Architectures for agreement* (pp. 315–326). Cambridge: Cambridge University Press.
Hardin, G. (1968). The tragedy of the commons. *Science, 162*, 1243–1248.
Heyward, M. (2007). Equity and international climate change negotiations: A matter of perspective. *Climate Policy, 7*, 518–534.
Hof, A. F., den Elzen, M. G. J., & van Vuuren, D. P. (2009). Environmental effectiveness and economic consequences of fragmented versus universal regimes: What can we learn from model studies? *International Environmental Agreements: Politics, Law and Economics, 9*, 39–62.
Höhne, N., Phylipsen, D., Ullrich, S., & Blok, K. (2005). *Options for the second commitment period of the Kyoto protocol*. Berlin: Umweltbundesamt.

IEA. (2006). *Energy technology perspectives. Scenarios & strategies to 2050*. Paris: International Energy Agency.
IPCC. (2007). *Intergovernmental panel on climate change*: *Climate change 2007*. Fourth assessment report. Retrieved from www.ippc.ch.
Jacobsson, S., Bergek, A., Finon, D., Lauber, V., Mitchell, C., Toke, D., et al. (2009). EU renewable energy support policy: Faith or facts? *Energy Policy, 37*, 2143–2146.
Jacoby, H. D. (2007). Climate favela. In J. E. Aldy & R. N. Stavins (Eds.), *Architectures for agreement* (pp. 270–279). Cambridge: Cambridge University Press.
Kuik, O., Aerts, J., Berkhout, F., Biermann, F., Bruggink, J., Gupta, J., et al. (2008). Post-2012 climate policy dilemmas: A review of proposals. *Climate Policy, 8*, 317–336.
Kümmel, R. (2007). *The productive power of energy and its taxation*. Paper presented at the 4th European congress economics and management of energy in industry, Porto.
Laffont, J.-J., & Tirole, J. (1998). *A theory of incentives in procurement and regulation*. Cambridge, MA: The MIT Press.
Lejano, R. P. (2006). The design of environmental regimes: Social construction, contextuality, and improvisation. *International Environmental Agreements: Politics, Law and Economics, 6*, 187–207.
McKibbin, W. J., & Wilcoxen, P. J. (2007). A credible formulation for long-term international cooperation on climate change. In J. E. Aldy & R. N. Stavins (Eds.), *Architectures for agreement* (pp. 185–208). Cambridge: Cambridge University Press.
Metcalf, G. E. (2007). *A proposal for a U.S. carbon tax swap. An equitable tax reform to address global climate change*. Washington, D.C.: The Brookings Institution.
Michaelowa, A. (2007). Graduation and deepening. In J. E. Aldy & R. N. Stavins (Eds.), *Architectures for agreement* (pp. 81–104). Cambridge: Cambridge University Press.
Milne, J. E., Speck, S., Andersen, M. S., & Duff, D. G. (2008). *The reality of carbon taxes*. USA: Environmental Tax Policy Institute, Vermont Law School.
Montero, J. P. (2007). An auction mechanism in a climate policy architecture. In J. E. Aldy & R. N. Stavins (Eds.), *Architectures for agreement* (pp. 327–339). Cambridge: Cambridge University Press.
Morgenstern, R. D. (2007). The case for greater flexibility in an international climate change agreement. In J. E. Aldy & R. N. Stavins (Eds.), *Architectures for agreement* (pp. 209–219). Cambridge: Cambridge University Press.
Neiman, S. (2008). Moral clarity. A guide for grown-up idealists (Harcourt).
Nordhaus, W. H. (2005). *Life after Kyoto*: *Alternative approaches to global warming policies*. National Bureau of Economic Research, WP 11889.
Nordhaus, W. H. (2007). To tax or not to tax: Alternative approaches to slowing global warming. *Review of Environmental Economics and Policy, 1*, 26–44.
OECD. (1997). *OECD environmental performance reviews. A practical introduction*. Paris: Organisation for Economic Co-Operation and Development.
Olmstead, S. M. (2007). The whole and the sum of the parts. In J. E. Aldy & R. N. Stavins (Eds.), *Architectures for agreement* (pp. 173–184). Cambridge: Cambridge University Press.
Pattberg, P., & Stripple, J. (2008). Beyond the public and private divide: remapping transnational climate governance in the 21st century. *International Environmental Agreements: Politics, Law and Economics, 8*, 367–388.
Pershing, J. (2007). Using the development agenda to build climate mitigation support. In J. E. Aldy & R. N. Stavins (Eds.), *Architectures for agreement* (pp. 220–233). Cambridge: Cambridge University Press.
Pew Center. (2005). *International climate efforts beyond 2012. Report of the climate dialogue at Pocantico*. Washington, D.C.: Pew Center on Global Climate Change.
Pizer, W. A. (1997). *Prices vs. quantities revisited: The case of climate change. RFF discussion paper 98–02*. Washington, D.C.: Resources for the Future.
Pizer, W. A. (2007). Practical global climate policy. In J. E. Aldy & R. N. Stavins (Eds.), *Architectures for agreement* (pp. 280–314). Cambridge: Cambridge University Press.
Popp, D. (2002). Induced innovation and energy prices. *American Economic Review, 92*, 160–180.
Prins, G., & Rayner, S. (2007). Time to ditch Kyoto. *Nature, 449*, 973–975. Commentary.
Sachs, J. (2009). *Eight principles for a global agreement on climate change*. New York: Earth Institute, Columbia University.
SANDBAG (2009). *ETS S.O.S.*: *Why the flagship 'EU emissions trading policy' needs rescuing*. Retrieved from www.sandbag.org.uk.
Scheer, H. (2001). *A solar manifesto*. London: James & James.
Schelling, T. (2007). Epilogue: Architectures for agreement. In J. E. Aldy & R. N. Stavins (Eds.), *Architectures for agreement* (pp. 343–349). Cambridge: Cambridge University Press.

Schnellenbach, J. (2005). The Dahrendorf hypothesis and its implications for (the theory of) economic policy-making. *Cambridge Journal of Economics, 29*, 997–1009.
Sijm, J., Neuhoff, K., & Chen, Y. (2006). $CO_2$ cost pass through and windfall profits in the power sector. *Climate Policy, 6*, 49–72.
Smith, A., Stirling, A., & Berkhout, F. (2005). The governance of sustainable socio-technical transitions. *Research Policy, 34*, 1491–1510.
Sorrell, S. (2007). *The rebound effect*: *An assessment of the evidence for economy-wide energy savings from improved energy efficiency*. London: UK Energy Research Centre. www.ukerc.ac.uk.
Stavins, R. N. (2004). *Can an effective global climate treaty be based on sound science, rational economics and pragmatic politics?*. Washington, D.C.: Resources for the Future.
Stern, N. (2006). *Stern review*: *The economics of climate change*. Executive summary. Retrieved from http://webarchive.nationalarchives.gov.uk.
Stirling, A. (1998). *On the economics and analysis of diversity*. Brighton: Science Policy Research Unit. Electronic working paper No. 28.
Summers, L. (2007). Foreword. In J. E. Aldy & R. N. Stavins (Eds.), *Architectures for agreement* (pp. xviii–xxvii). Cambridge: Cambridge University Press.
UNDP. (2007). *Human development report 2007/2008*. *Fighting climate change*: *Human solidarity in a divided world*. United Nations Development Programme. Retrieved from http://hdr.undp.org/reports.
van Asselt, H., & Gupta, J. (2009). Stretching too far? Developing countries and the role of flexibility mechanisms beyond Kyoto. *Stanford Environmental Law Journal, 28*(2), 311–378.
Verbruggen, A. (2008a). Renewable and nuclear power: A common future? *Energy Policy, 36*, 4036–4047.
Verbruggen, A. (2008b). Windfalls and other profits. *Energy Policy, 36*, 3249–3251.
Verbruggen, A. (2009). Beyond Kyoto, plan B: A climate policy master plan based on transparent metrics. *Ecological Economics, 68*, 2930–2937.
Victor, D. G. (2007). Fragmented carbon markets and reluctant nations: Implications for the design of effective architectures. In J. E. Aldy & R. N. Stavins (Eds.), *Architectures for agreement* (pp. 133–160). Cambridge: Cambridge University Press.
Wara, M. (2007). Is the global carbon market working? *Nature, 445*, 595–596.
WBCSD. (2006). *Powering a sustainable future. An agenda for concerted action*. Washington, D.C., USA: World Business Council for Sustainable Development.
WCED. (1987). *Our common future. UN world commission on environment and development*. Oxford, UK: Oxford University Press.
Weitzman, M. (1992). On diversity. *Quarterly Journal of Economics, 107*, 363–405.
Weitzman, M. (2008). *On modeling and interpreting the economics of catastrophic climate change*. USA: Department of Economics, Harvard University.
Wiener, J. B. (2007). Incentives for meta-architecture. In J. E. Aldy & R. N. Stavins (Eds.), *Architectures for agreement* (pp. 67–80). Cambridge: Cambridge University Press.
Williamson, O. E. (1985). *The economic institutions of capitalism*. New York: The Free Press.