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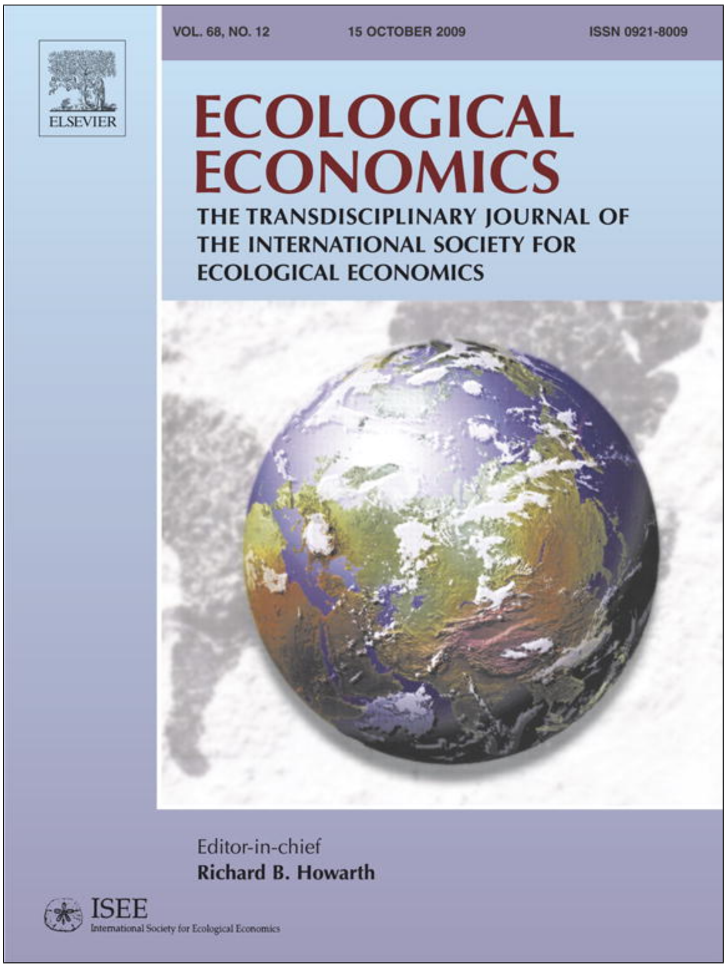

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Methods

Beyond Kyoto, plan B: A climate policy master plan based on transparent metrics

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ABSTRACT

Many scholars analyze the Kyoto–Copenhagen process, and offer corrective suggestions for identified flaws in the present design. Based on various proposals in the literature, this article adopts a global master-plan perspective, leaving executive architecture to sovereign participants. Transparent, flexible and fair top-down rules must synchronize the numerous bottom-up initiatives while addressing the diversity of national circumstances in the drastic transformation of the world's energy economies.

Plan B refutes absolute emission reduction targets on old or speculative baselines. It criticizes global tax and permit trade instruments for being ineffective, inefficient and unfair when uniformly applied on a tremendous differentiated world. Plan B is built on three annually observed variables measuring percentage progress against rolling baselines (the variables' values in the previous year): the ratio of net climate tax revenues to GDP, the commercial energy intensity of GDP, and the carbon intensity of commercial energy use. The three variables together indicate countries' progress affecting emissions per person, a metric that must converge to lower bands when climate change is addressed seriously. Long-term scenarios of global convergence "funnels" serve as guidance to frame near-term actions rich and poor countries individually propose to take. The global regime is common for all countries, and is ranked by GDP per person to determine whether a nation is a donor or a beneficiary in a Global Climate Transfer Fund. Fund payments and drawing rights depend on that ranking but also on the performances of the countries in realizing committed progress. The transparent mechanisms of the design and of the fund persuasively invite countries to participate in a fair, self-enforcing agreement.

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1. Introduction

While climate change has many causes, greenhouse gas emissions are diverse, and climate policy necessarily involves arguments over sustainable development, this article is limited to the energy component of the climate problem. Non-sustainable energy production and consumption are the dominant drivers of greenhouse gas emissions, indicating the need for the energy sector to spearhead climate policy.

A master plan only covers what has to be agreed and regulated at the global level. It outlines a comprehensive and consistent architecture, leaving national policy choices to implementing parties that can negotiate commitments. A global design provides but the tuning for national policies. It aims at a synchronized empowerment that takes into account the present status and conditions of all the various UNFCCC signatories. It also provides a policy regime common for all but implemented according the circumstances countries face. Progress is measured annually in a timely and reliable way, facilitating the monitoring of compliance and transparent communication. Clear transfers from donors (rich nations) to beneficiaries (poor nations) are contingent on progress of both parties in performing climate commitments. There are built-in incentives to perform better than average in groups of peer countries aggregated by wealth.

The article consists of two main sections. Section 2 dissects carbon dioxide emissions into underlying emissions drivers. A balanced policy addresses the main drivers both individually and simultaneously, and therefore Section 2 delivers the building blocks for solid policy architecture in Section 3. Plan B consists of five clear steps together delivering a comprehensive design: it organizes synchronized empowerment of sovereign parties in common but differentiated resolve. A more technical but vital part of the proposal is detailed in Appendix A.

The article rounds with an epilogue highlighting the main differences with the dominant approach taken in the Kyoto–Copenhagen process, concluding that plan B is realistic, worth consideration and eventually implementation.

2. Dissection of CO_2 emissions from energy use

In this section the drivers of CO_2 emissions related to energy use are analyzed. First, total emissions and emissions per person are

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expressed as a product of composing driving factors. Next the three driving factors of energy-related CO_2 emissions per person are dissected one by one. Finally, the relationship is expressed in percentage changes of the variables, forming the building blocks of the international policy design in Section 3.

2.1. Emissions per person as central target

Ehrlich and Holdren (1971) wrote yearly impact on the environment as a product of the number of people, affluence per person and technology. This identity was emulated by others, e.g. Yamaji et al. (1991), IPCC (2007), Hummel (2007), Agnolucci et al. (2009). A starting decomposition of global CO_2 emissions is:

$$CO_2\,\text{emissions} = \text{of People} \times \frac{\$\,\text{GDP}}{\text{People}} \times \frac{\text{kWh energy}}{\$\,\text{GDP}} \times \frac{CO_2\,\text{emissions}}{\text{kWh energy}}. \quad (1)$$

Global yearly emissions are the aggregate of the emissions by various countries, and one can write Eq. (1) for all countries separately, revealing the high divergence in the roles played by all four right-hand factors in determining the total emissions by country. The formula highlights that emissions are partly determined by population size and by the level of wealth of a country. Both factors are linked to the sovereignty of nations, and efforts by third parties to change them are contentious, even when UN institutions are involved. This makes negotiating significant emission reduction targets tedious among industrial nations and almost unfeasible for industrializing nations (Bodansky, 2007: 61). In addition, GDP can be volatile, especially in many developing countries. This erodes the predictability and stability of emission reduction targets, particularly over the longer run.[2]

A one-step reduced form of Eq. (1) for either a global or national scale, provides emissions per person:

$$\frac{CO_2\,\text{emissions}}{\text{Person}} = \frac{\$\,\text{GDP}}{\text{Person}} \times \frac{\text{kWh energy}}{\$\,\text{GDP}} \times \frac{CO_2\,\text{emissions}}{\text{kWh energy}}. \quad (2)$$

All variables now are relative magnitudes (ratios). The left hand side, yearly emissions per person, can be connected to ceiling greenhouse gas or CO_2 concentration values, but this implies also control on population growth. It would be useful to develop indicative target values to be agreed upon in an international agreement, framed by an "aspirational long-term goal" of convergence towards "viewed as fair" bands of emissions/person (see Section 3.1). This echoes the ethically inspired "Contraction and Convergence" proposal widely advocated by the Global Commons Institute since the 1990s (Bodansky et al., 2004: 25; Philibert, 2005: 17). "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 its needs' would require rights to strictly equal amounts of physical resources" (Wiener, 2007: 70). But emission bands of all major economies must finally overlap in the lower end of the spectrum for achieving the global low-carbon energy economy. Such contraction and convergence provide enough guarantees for controlling total emissions when population growth is checked during coming decades. Contraction and convergence, although not towards one single number, is a worthwhile path, and one should find suitable approaches to control the associated drivers.

A multiplication equals zero when one of its factors is zero; it becomes small when one of the factors is very small (assuming the others do not increase in a commensurate pace). One way to achieve this is the widespread adoption of low- or zero-carbon energy technologies. Today there are two main candidates: atomic power and renewable energy sources, with carbon capture and storage (CCS) as a third way to trap emissions of fossil fuel use (IPCC, 2005). Verbruggen (2008) argues that only renewable energy offers a sustainable future and has no common future with atomic power. CCS may be part of the future low-carbon energy economy in a number of coal-intensive major economies (e.g. USA, China, Australia). Rai et al. (2009) conclude that development, demonstration and diffusion of CCS are unlikely without firm government support and that cost reduction is not automatic. Renewable energy technologies also will not simply appear across the globe. To make and keep the full transition to renewable energy affordable, significantly decreasing energy intensities of economies are a prerequisite. This will require economic reforms, such as taxes and subsidies to increase costs for CO_2-intensive activities and reward low-CO_2 activities.

2.2. Restructuring GDP composition

Total wealth in a country is mostly measured by its Gross Domestic Product (GDP), being the aggregate of particular quantities of activities A (goods and services) times their market prices P, or:

$$\text{Wealth Intensity} = \frac{\$\,\text{GDP}}{\text{Person}} = \sum\nolimits_A P_A \times \frac{\text{Activity A}}{\text{Person}}. \quad (3)$$

GDP is subject to growing criticism (Daly, 1999; UNDP, 2007) for not including the right activities and for applying biased prices. GDP and wealth are relative values that vary with the structure of the economies (what activities happen) and with the prices, both components being interrelated: when the price of a particular activity is low, more of it will be demanded and vice versa with high prices. The composition of wealth depends on historic, geographic, cultural, demographic, economic, and also public policy factors, e.g. via subsidizing some and taxing other activities. "Re-pricing GDP", also called budget reform or tax reform, is a recommended policy instrument to shift interest towards sustainable activities (Weizsäcker von, 1990; Parry, 1995; Myers and Kent, 1998; EEB, 2003; Dresner et al., 2006; Metcalf, 2007).

2.3. Lowering commercial energy intensity

The second driving variable of Eq. (3) is energy intensity of wealth. This is to be decomposed as:

$$\text{Energy Intensity} = \frac{\text{kWh energy}}{\$\,\text{GDP}} = \sum\nolimits_A \frac{\text{kWh energy}}{\text{Activity}} \times \frac{\text{Activity}}{\$\,\text{GDP}}. \quad (4)$$

Only 'commercial' energy is considered, i.e. energy measured and traded as a commodity; not included is the (important) use of 'natural' energy freely available in the environment, such as daylight, ventilation, solar heating and drying, etc. Renewable commodity energy that is traded and commercialized is included, while renewable commodity energy that is generated for use on site is not included. As such, energy use[3] here is what official statistics yearly publish, e.g. IEA or BP's Statistical Review of World Energy. Hummel (2007) analyzes the effects of commercial primary energy use as indicator, such as the

[2] Also in industrial countries the impact is significant, e.g. the economic crisis starting summer 2008 may contribute significantly in meeting the Kyoto goals over the period 2008–2012.

[3] There are some intricacies between primary and end-use energy, in particular related to power generation. A refined version may distinguish between use of primary commercial fossil fuels and grid power supplies (being secondary energy).

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inclusion of energy conversion and transfer losses. Also poor countries substituting bottled gas for locally collected firewood will show rising energy intensities. Yet preference is given here to the rather coarse indicator of commercial primary energy use, because of clarity about the numbers. When all participants publish verified yearly energy balances, more detailed measures can be added.

Energy intensities are directly observable from yearly available statistics. The indicator is the sum of many products of two factors: the technical energy efficiency in performing a societal activity, and the weight of that activity in the GDP of the country (Schipper and Meyers, 1992; Schipper et al., 2001; Agnolucci et al., 2009 decompose energy intensity differently). The latter factors depend on the sector structure of the economy (relative importance of agriculture, industry, commercial sector, transportation), and of the detailed composition of the various sectors, technologies, goods and services, etc (see Eq. (3)). Production, consumption, recreation, education, culture-everything imply energy use.

Energy Intensity can be lowered by improving the energy efficiency of activities and by shifts in activities towards less commercial energy requiring alternatives. Improving efficiencies is technology driven. Inducing disruptive innovations in efficiency technologies is a mainly price driven process (Fri, 2003). Efficiencies as such are difficult to accurately define and measure in practice (Patterson, 1996; Lovins, 2004). Therefore, global policy regimes require unequivocal variables like energy intensities. Optimizing and lowering energy intensities are crucial for the affordability of the transition to the full renewable energy economy.

2.4. Lowering carbon intensity of commercial energy use

The third driver in Eq. (2) is Carbon intensity of energy use, or:

$$CO_2\,\text{Intensity} = \sum\nolimits_{\kappa} \frac{CO_2\,\text{emissions}}{\text{kWh type}\,\kappa} \times \frac{\text{kWh type}\,\kappa}{\text{Total energy use}}. \quad (5)$$

This intensity is the sum of several products of two factors: CO_2 emission intensity of particular energy uses and the share of that use in the commercial energy mix.[4] Implementing available renewable energy technologies and developing more performing and efficient technologies to harness renewable resources are widely considered as the way to sustainable, low-carbon energy economies. As long as that future is distant CO_2 intensity has to be abated. This indicator is well defined and documented and a useful building block of a global policy regime.

2.5. Focusing on progress step-by-step

Countries differ in present performance on the four indicators of Eq. (2). There are many reasons and causes, but for advancing in a global agreement attention should not be focused on spitting out historic responsibilities. Every country starts from the position it is in today, and baselines are rolling with progress made. This is necessary to avoid three things: reproving pioneers, rewarding laggards, and stimulating status quo and perverse incentives. Baseline issues are millstones round the neck of the present Kyoto treaty; suggestions like the use of action targets (Baumert and Goldberg, 2006) provide better but not fully satisfying alternatives (Philibert, 2005).

Progress is measured by percentage change from a reference (starting) position. For ease of notation Eq. (2) is rewritten with simpler symbols, i.e. B = emissions Budgets per person; W = Wealth intensity per person; E = Energy intensity of wealth; $C = CO_2$ emission intensity of energy use, with the (y) referring to the year the variables relate to, or:

$$B(y) = W(y) \times E(y) \times C(y). \quad (6)$$

All variables take different values by year of observation and are time dependent. The purpose of climate policy is changing the variables more in the future: lowering B, E and C and restructuring W. Taking percentage changes of both sides of Eq. (6), gives:

$$\frac{B(y+1)-B(y)}{B(y)} = \frac{W(y+1)-W(y)}{W(y)} + \frac{E(y+1)-E(y)}{E(y)} + \frac{C(y+1)-C(y)}{C(y)}$$

$$\text{or}: \%B = \%W + \%E + \%C. \quad (7)$$

Yearly percentage change in average CO_2 emissions per person of a country is the sum of three percentage changes the country has to work on for realizing the first change. Decreasing B can be realized in principle by decreasing W, E and C. Decreasing C is widely supported as a policy goal. Decreasing E faces enthusiasm (for the technical efficiency component) and skepticism (for the structural component). Decreasing W is broadly resisted, but awareness is growing that wealth is a multi-faceted reality and that restructuring GDP entails benefits.

Eq. (7) is sufficiently accurate for small changes in individual drivers, but imprecise for larger ones, as the drivers are interrelated. For example, countries with higher economic growth may invest more in efficient technologies, bringing energy intensities down; lower energy intensities may stimulate lower carbon intensities because obsolete carbon intense plants can be closed earlier (Duro and Padilla, 2006). Due to the limited number of factors considered, Eqs. (2) and (6) may generate significant residuals that can be resolved by suitable decomposition techniques (Ang et al., 2003). While the application of the techniques to resolve the residual terms is recommended in statistical analysis, here the Ehrlich–Holdren formula is but used as a mental framework to discuss four metrics to construct an international climate policy master plan (see Table 1).

3. Policy design: Synchronizing and empowering sovereign parties[5]

This section provides a blueprint of a global policy design. Wiener (2007: 67) distinguishes "two architectures: the architecture of a climate treaty regime, and the larger surrounding structure or 'meta-architecture' of the institutions and decision framework within which the climate regime must be constructed." The climate regime properly also consists of two levels: the overarching level of the master plan, and the more detailed constructions within the contours of the master plan. The proposal here consists of only a comprehensive master plan; providing more detail would be fantasy and counter-productive.

Eileen Claussen and Ged Davis, chairs of the Pocantico dialogue, provide us two clear legs to walk on: "First, there is ample scientific justification for much stronger action now, and in coming decades, to stem the causes and prepare for the consequences of global climate change. Second, this requires that the world's major economies accept their responsibility to agree and act on fair and effective approaches to curb global greenhouse gas emissions." (PEW, 2005). Next the challenge is identified: "The critical question is how best to engage nations and their inhabitants in a long-term effort that fairly and

[4] Depending on the scope of the policy (only low-carbon or inclusive low-risk) nuclear power is adopted or rejected as part of the efforts delivered by countries.

[5] This proposal is indebted to the ideas and proposals of tens of colleagues. Larding the text with all the references would double the page length. Let me express gratitude here to especially Aldy et al. (2003); Bodansky et al. (2004); Philibert (2005); Aldy and Stavins (2007) and Kuik et al. (2008) for their overviews, and to all the authors whose work is covered by the overviews.

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Table 1
Yearly measured indicators by country, reviewed by UNFCCC.

Definition	Type	Policy content	Task by country
B(y): Budget CO_2 emissions/person	Goal	Intentional, indicative; monitored are 5 year moving averages	Converge to low-end bands (contract for rich countries; control growth for poor countries)
C(y): Carbon intensity of commercial energy use	Driver 3	Monitored yearly progress in *C*(y) decline compared to rolling country baseline	Bring to almost zero by transition to renewable energy economy
E(y): Commercial energy intensity of GDP	Driver 2	Monitored yearly progress in *E*(y) reduction compared to rolling country baseline	Optimize with priority for energy efficiency and renewable sources
W(y): Wealth as GDP/person	Driver 1	Monitored yearly share of net climate tax revenues in national GDPs	Steadily increase shares; restructure GDP to more sustainable activities

effectively mobilizes technology and resources to protect the global climate and sustain economic growth."

To advance, necessary steps are: first, recognize the problems at hand plainly and accurately; second, consider fundamental principles and constraints as opportunities; and third, go for quality measured by the established criteria of efficacy, efficiency and equity. The dissection of the emission flows provides the building blocks to puzzle a beyond Kyoto master plan in five steps.

3.1. Agree on short-term directions within long-term goals

A global climate policy agreement is framed by a long-term global emissions target, e.g. the IPCC 450 ppm CO_2-eq. emissions trajectory for the post-Kyoto period up to 2050. Central in a global climate agreement are the CO_2-emissions from energy use, and the transition to a low-carbon energy economy.[6] The global emissions trajectory is translated into annual emissions per person *B*(y), adopting average world population predictions, and funneled by an upper-B and a lower-B curve reducing inequality and showing the bands every country has to respect (Fig. 1).

Some rich countries have present *B* values around 20,000 kg CO_2/person and higher, while some poor countries only about 100 kg CO_2/person (UNDP, 2007: 14). Within the global limits *indicative B*(y)-trajectories *by country*[7] are outlined (Höhne et al., 2005), based on realistic estimates of changes in *W*(y) and with likely trajectories for *E*(y) and *C*(y). The world's major economies will wrangle in outlining *B*(y)-trajectories within the imposed bands (Heyward, 2007: 526).

During the starting years of the agreement it is not important to reach full consensus on precise long-term (2030–2050) goals; orders of magnitude suffice (Pershing 2007: 222). More important is to clearly fix and agree on non-regret short-term *marching directions* for the next few years (in Fig. 1: the gradients starting at the left side of the funnel). Climate policies face temporal challenges because governments cannot fully commit successors (nor predecessors), opening traps for evading and postponing present responsibilities (Wiener 2007: 77; Hammitt 2007: 319).

3.2. Engage the world's major economies with optional participation by all UNFCCC signatories

A country's engagement starts with accepting the long-term intentional goals and a nearby commitment to bring the country's emissions per person within the stabilization funnel.

The approach is bottom-up, considers national circumstances and provides maximum flexibility. As such it can be labeled as an "action driven" (Baumert and Goldberg, 2006) and "harmonized pledge and review" (Baumert and Winkler, 2005: 17) type. However, other than intentional pledges and soft reviews (Victor, 2007; Pizer, 2007), a common regime applicable to all participants is designed with yearly reviews of progress on set numerical indicators. Countries' obligations differ with levels of GDP per person, reflecting their ability to pay (Section 3.5; Appendix A) and with the rolling baselines they start from, taking into account diverse national circumstances. Countries' implementations are fully left over to their own discretion.

The unifying structure is built with the four basic variables of the CO_2 emission problem (Section 2). A participating country engages to outline a scenario of future CO_2 budgets per citizen (idea of convergence; Global Commons Institute). The scenario is indicative and progress is monitored by five year moving average values. For realizing its CO_2 emission budget per person scenario, every country must learn to control commercial energy intensities and carbon intensities of energy use, bringing the latter close to zero in the long run, mainly by developing and implementing renewable energy opportunities (the technological aspect). In parallel it must restructure its GDP through a national policy of raising commercial energy and carbon emission prices (the pricing aspect). The variables *C*(y) and *E*(y), shown in Table 1 need no further elaboration here; the "share of climate taxes in national GDP" is discussed next in Section 3.3.

3.3. Use proved instruments functional and robust in diverse conditions

N. Stern (2006) and W. Nordhaus (2007) are not best friends in appraising their mutual benefit-cost analyses (Barker, 2008), but they both agree that "pricing carbon" is an urgent necessity. The question unsolved is "Pricing How?" Because of their lack of efficacy, efficiency, fairness and of unrealistic practical feasibility, the global uniform instruments such as the global harmonized carbon tax and international emissions trading schemes must be sidelined. The actual diversity of emission sources is too wide and deep for one-fits-all straitjackets (De Cendra De Larragán, 2008). The uniform treatment of diverse cases (type II discrimination) is as discriminatory as diverse treatment of similar cases (type I discrimination), but in many cases not perceived as such. On the contrary the adagio "uniform" is confused with "equal", and installs an impression of being fair, also when applied on very different cases.

The invisible hand of Adam Smith has been at work addicting the world to low-priced fossil fuels and grid electricity. That same hand is

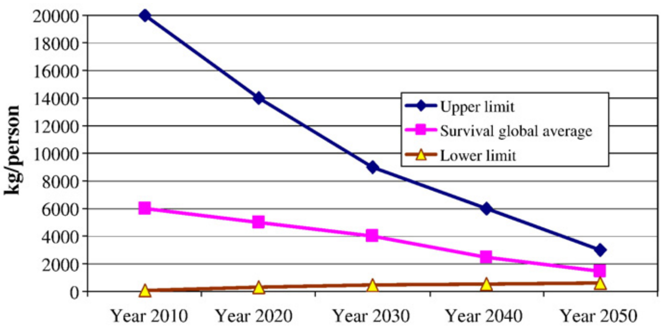

Fig. 1. Global long-term scenarios of CO_2 emissions per person.

[6] For the other greenhouse gases next to carbon dioxide, and for the non-energy sector sources of greenhouse gas emissions (LULUCF), separate approaches and agreements have to be worked out.

[7] "A shift in its (UNFCCC) negotiating structure away from the Annex I/non-Annex I divide and its various groupings towards fuller consideration of each country's national circumstances may be more productive" (Heyward, 2007: 531).

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needed to do the reverse. But the hand is not a fist: finely-tuned incentives must match numerous decision-making processes for redirecting the activities currently causing emissions.

Applying the right dose by source requires a division of the many diverse emission sources in more or less homogenous groups. A first useful division is the split between emission sources in two main groups: categories of globally registered, i.e. enumerated or enumerable large sources and all other, i.e. numerous not individually identifiable sources. The registered categories encompass activities such as steel making, aluminum fabrication, cement manufacturing, particular basic chemical processes, commercial power generation, ocean-borne shipping, commercial aviation (with capacity thresholds to withhold the main sources and to keep the registers manageable). A common approach by homogenous group is recommended to avoid type I discrimination.

Redirecting activities of the "all other" sources localized in a particular country is the result of a steadily advancing tax reform in the participating countries. By definition such reform is a country-wise (and within large countries also state-wise) task. Measuring yearly advancement is possible by earmarking particular activities as climate unfriendly, all others then been considered as neutral or friendly.[8] Government receipts collected by taxing climate unfriendly activities diminished by subsidies given to such activities (UNEP and OECD/IEA, 2002) are summed, and added to the revenues obtained from pricing emissions of registered sources. Identifying climate unfriendly subsidies and measuring the quantitative flows could lead to problems of information, transparency, and accuracy in carbon tax accounting. This is the case already for existing tax and subsidy regimes in the various countries, and problems may increase with the central role of the indicator in performance measurement and transfer obligations (Appendix A). IMF, World Bank, WTO, and OECD, will have an important task to structure and certify this indicator.

Redirecting activities of sources enumerated in registers should result from redesigning pricing and billing conditions in a way compatible with policies applied on the "all other sources" group. This excludes systems of grandfathering and other free-lunch options. First, global registers are differentiated by the type of installations. Within the named registers activities and technologies are similar, and of sufficient size. In some registers members are exposed to significant mutual international competition, in others to modest or no competition. Climate policy for the competition exposed registers is best organized on a global scale by register. While binding all its members to the choice, a register may choose between two instruments: either a harmonized carbon tax applied on all members' emissions globally, or a register specific emission trading system. The implementation of both instruments adopts energy and carbon tax rates at the height of the averages applied on all other sources.[9] When a register prefers the tax mechanism, tax rates may be diversified by participating country around the average rate for adjusting for uneven development and for Purchasing Power Parity issues. When a register prefers an emissions permit market, all permits are auctioned yearly in sealed-bids,[10] steered by set prices equivalent to the global average tax rate.

[8] Two additional points: first, one could extend the scope from climate unfriendly to all non-sustainable activities (e.g. including nuclear power activities); second, one could qualify the activities on a multi-point scale rather than use the binary one.

[9] The average tax rate is the ratio of the sum of net climate tax revenues divided by the summed tons of CO_2 emissions, both sums calculated over all tons of all participants during the given year. Starting up the regime will face some difficulties in observing and agreeing on the height of the global average tax rates (facing issues of international currency exchange rates, and perhaps no direct availability of all data files). This teething problem can be solved within a few years.

[10] Sealed-bid auctions reveal well the true marginal mitigation cost functions of bidders (without gaming when more than a handful installations compete; Montero, 2007). Price-steered auctions are necessary to equilibrate the assignment across diverse registers in an efficient and fair way. Negotiating efficient and fair quota assignments across incommensurable activities and installations is a mission impossible.

Most of the detailed regulations can be administered by an international register committee that coordinates separate registers committees, the latter representing the members by register. The annual revenues of taxes and auctions are assigned to the countries pro rata the payments by installations registered in the various countries. Subsidies given to the installations are subtracted from those revenues. The organization by register is helpful in identifying subsidy mechanisms that a particular country would apply, because members of a register are competitive colleagues. Referencing to a global carbon price meets concerns on efficiency (pushing global uniform instruments) and equity (avoiding unbalanced charges on some activities). The crucial difference with uniform instruments is that *average price* signals are dosed by activity group and that within the groups significant price diversity can occur. The variance of prices is expected to be smaller when activities are more alike as is the case in the registers of large-scale sources. But also there considerations on state of development and on purchasing power disparity can result in different prices by groups of countries.

Net tax revenues of re-pricing all climate unfriendly activities (registered and others) are summed by country and expressed as a share of its GDP. This share is a valid indicator of real effort organized in a country to redesign the activities in a low-carbon direction.

Tax reform is a bottom-up country-wise approach, with allowance for respecting specific values and conditions (Heyward, 2007: 527). Contrary to a harmonized global tax rate it may be composed of a high variety of climate taxes when stamped as such by IMF controllers. The indicator of relevance is not a particular price but the total net revenues in climate taxes. An additional advantage of using and comparing tax revenue shares in GDP is sidelining international currency exchange issues. Also, the least developed countries lack capabilities and resources for governing complex policy instruments. The instruments they master most are indirect tax settings and raising revenues from it.

In principle, every country could pledge on a country specific net climate tax revenues share. It is recommended that similar countries agree on similar shares or trajectories towards similar shares, ironing out unfair competitive conditions. By applying the global average prices on the registered activities, unfair competition and leakage are minimized.

3.4. Measure and verify, register, report and review yearly progress and compliance by country

The availability of yearly statistics by country is necessary to embed climate policies into regular budgeting operations, covering all major aspects of government policies. "The key to success for any international system is to establish a credible evaluation process which encourages institutional learning at the scale of the nation-state. Such a process should include specific performance metrics involving transparent, internationally acceptable, measures of effort and/or actual environmental outcomes. In the context of a formal international process to review the progress made by individual nations, these metrics would provide feedback to individual countries on their own progress and, simultaneously, serve as a prod to further action." (Morgenstern, 2007: 218).

Reliable and timely statistics on the four variables of Table 1 are available and can be upgraded at negligible cost. Appraisal of compliance is ultimately based on the moving average of decreasing emissions per person and progress is analyzed with the help of Eq. (7); see Section 2.5. The UNFCCC secretariat is well placed to maintain the registry, review and publish results on a common denominator, more accurately than present rankings can offer (Burck et al., 2008). The annual aggregate of the results shows common progress and may contribute to strengthening common resolve.

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3.5. Commit to real progress and connect mandatory climate transfer funding to actual performance of donors and of beneficiaries

A global climate agreement is not functional without industrialized nations transferring technologies and finances to developing nations. The Global Environmental Facility is a multilateral financial mechanism set up as a pilot phase in 1991 and formally established in 1994. It has not evolved to the transfer table of billions of dollars supplied by wealthy donor countries for adaptation and mitigation in developing countries (Clémençon, 2006). Brazil proposed a Clean Development Fund at Kyoto, but the conference agreed on the Clean Development Mechanism (CDM). Criticism on the performance of the CDM is broad (Lohmann, 2006; Schneider, 2007; Wara, 2007), and continuous improvements are made (e.g. at Nairobi COP/MOP).

GDP-dependent transfers (e.g. Gupta, 2007) are completed here with performance measures in meeting agreed commitments on three variables: climate tax shares in GDP, change in commercial energy intensity and decline in carbon intensity of commercial energy use. Commitments and performance are requested from all participating countries, be they donors or beneficiaries of finances. Countries can be grouped by GDP (Gupta, 2007) or just ranked by GDP/person. Parties have outlined a long-term indicative path of their emissions per person within the convergence funnel (Section 3.1 and Fig. 1). Within that frame, countries have to commit to average or annual percentages of declining intensities for the coming years. Table 2 shows an example for four different countries. For logical consistence line 3 equals line 2 minus line 1.

There is no rose garden of international negotiations. There is no time left to fool ourselves by trying to fool others. Drafting the numbers as Table 2 shows is a transparent process dealing with the crucial indicators of development and climate interconnected in a logical approach. When parties are serious about both, they can find out what they can and have to do (Athanasiou and Baer, 2006).

The regime will collapse without the keystone of steady and predictable transfers from rich to poor countries. The proposed mechanism is based on the principle of a transfer fund similar to the Global Environmental Fund (Clémençon, 2006), but with systemic rules for donations and drawing rights, based on a double standard: ability to pay (GDP/person) and performance on committed climate policy indicators (Tables 1 and 2). One has to agree on an incentive formula common for donor countries with above world's average GDP/person and on an incentive formula for beneficiary countries with GDP/person below the world's average.

Suggestions are presented in Appendix A. They provide to both sides self-enforcing incentives to perform on or above average of their group. The mechanism makes donors pay along their ability to pay and beneficiaries receive along their ability to invest and use the money well. Alongside this mechanism there will be need for additional transfers in direct technology (De Coninck et al., 2008) and aid for adaptation (BASIC, 2006), as well as for the broader millennium goals (Sachs, 2009) and for development (Baumert and Winkler, 2005).

4. Why a beyond Kyoto plan B?

"The art of building an effective and inclusive post-2012 climate regime, which provides dynamic incentives for technological innovation and behavior change and spreads burdens fairly, is an enormous challenge." (Kuik et al., 2008: 331).

The outlined regime would have major strengths:

- Addressing five essential policy characteristics of climate change: priority on the climate problem balanced with economic development and growth concerns; care for the ultimate global commons by self-interested parties lined by sound and self-enforcing incentives; transforming the energy economy as a necessary mission; immediate steps in the right direction on the drastic change route; assigning the right prices to non-sustainable energy and other practices.
- Respecting five main principles: universal long-term scope starting without delay by the willing nations; realism about self-interested resolve of individuals and communities; diversity as opportunity refuting top-down uniform straitjackets; sovereignty, supporting the creation of bottom-up flexible architectures; transparency, as a condition for seriously involving diverse and sovereign parties. The variables and mechanics of the design are basic and clearly defined; data on their evolution by country are yearly available and accurate. This allows the integration with national accounts and other policies, enhancing empowerment and common resolve.
- Peers may assess the design ex-ante on the main criteria. Efficacy is promoted by the clarity of the targets, by cutting leakage and free-riding, by expected wide participation, yearly measurable compliance and self-enforcing performance. Efficiency depends on a tremendous diversity of activities, practices and circumstances and is gauged as such. Most important is dynamic efficiency by inducing disruptive innovations in energy efficiency and renewable energy technologies, reflected in reducing energy and carbon intensities and driven by clever tax reforms.
- Equity is the keystone of a global climate policy agreement and regime, and permeates many parts of this plan B. E.g. equity in process by sovereign access to an open, transparent regime, in capacity according ability to pay and considering uneven national circumstances, in responsibility by converging to the polluter pays principle and to balanced emissions per person.

Major components of the present Kyoto process are adjusted and some refuted. First, country-wise absolute tonnage emission reduction targets provide too little buoyancy (the literature suggests many substitutes; Bodansky et al., 2004; Philibert, 2005). Second, the search is stopped for the unicorn of perfect top-down globally uniform instruments (harmonized tax or permit trade). The economists' profession and speculators will stagger, but practitioners will understand. Third, GEF and CDM should be transformed into a Global Climate Transfer Fund.

By limiting the analysis to the master-plan level, obtruding the creativity and discretionary sovereignty of the negotiating parties is avoided. The design aims at a light-weighed, transparent and verifiable, yet thrusting agreement.

Table 2
Annually planned and committed percentage changes in main emission drivers and committed net climate tax revenues as GDP shares.

Percentage change in	Rich	Industrializing	Developing	Least developed
GDP/person	+2	+7	+3	+5
Emissions/person	−4	+3	+1	+3
Energy + Carbon intensities	−6	−4	−2	−2
Net climate tax share in GDP	7.50	6.25	12.00	9.50

Appendix A. Formulae for donor payments and beneficiary drawing rights on a Global Climate Transfer Fund (GCTF)

First the participating countries are ranked by GDP/person. Here the choice has to be made how GDP is measured. In particular the choice between measurement in Market Exchange Rate (MER) or in Purchasing Power Parity (PPP) may have some impact on the ranking. Van Vuuren and Alfsen (2006), using World Bank data with the US$ as numéraire, show PPP/MER ratios for 17 global regions, covering a range from about 0.5 (Japan) to 4.5 (Eastern Africa region). The data show four groups of regions by similar wealth (measured by MER or by PPP). Changing MER to PPP metrics occasions a few reversals in the ranking of regions, but all reversals occur among regions of the same group.

Second it is possible to classify groups of countries along their GDP/person (Gupta, 2007: 121), but here are considered just two groups:

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rich, with above average world GDP/capita, and poor for the other countries. The first group consists of donors, the second of beneficiaries. Main questions are: how to decide on annual donations and on annual drawing rights?

Donations and drawing rights are expressed as a part of or addition upon the net climate tax revenues that have been committed and realized by rich and poor countries. The actual parts due or received depend on observed variables (expressing commitments and measuring compliance) and agreed parameters (adjusted for diversity). The variables are:

- GDP/person
- Committed values for net climate tax revenues as GDP share, and for percentage reduction of commercial energy intensity of GDP + carbon emission intensity of commercial energy use, and their distance to the average values within the group
- Realized values for the above variables.

Symbols used are:

W_c	GDP/person of country
W_h	GDP/person of highest income country in the group
W_l	GDP/person of lowest income country in the group
T_c	Committed tax revenues as share of GDP
T_r	Realized tax revenues as share of GDP
T_a	Average tax revenues as share of GDP of the group the country belongs to
I_c	Committed percentage reduction of energy + carbon intensities (in absolute values)
I_r	Realized
I_a	Average of the group the country belongs to
Z	Distance factor between realizations and commitments, on T and I combined E.g. most simple $Z=(T_r-T_c)+(I_r-I_c)$, but other formulas are feasible.
X	Part of its net climate tax revenues a rich country donates when its $Z=0$ (realizations equal commitments)
Y	Drawing rights on top of the own climate tax revenues raised by a poor country when its $Z=0$

The principle of donations is shown in graph A1.

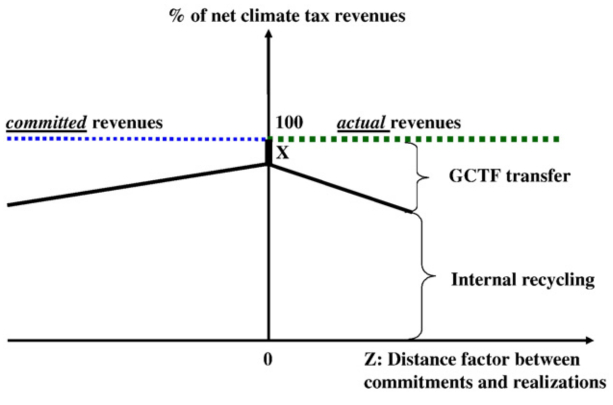

Fig. A1. Rich nations fund GCTF (Global Climate Transfer Fund).

The abscissa of graph A1 represents the Z-factor.

The ordinate axis shows the splitting of the net climate tax revenues in a rich country between internal recycling (the major part) and donations to the climate fund. When the country perfectly realizes its commitments ($Z=0$), a minor part X is donated to the fund. When $Z<0$, a growing part of the *committed* GDP share has to be donated; when $Z>0$ a growing part of the *realized* tax revenues should be donated. The slopes of both lines can be adapted during negotiations, but the mechanism helps countries stating the true GDP share they plan to realize.

Next one must agree on the formula for the number X. One proposal is to see X as a sum of three terms: a constant X_1 + a parameter X_2 weighted with a linear ratio of the country's wealth within its group + a parameter X_3 weighted by the distance of the country's commitments from the averages in the group, or:

$$X = X_1 + X_2 \cdot \left[\frac{W_c - W_l}{W_h - W_l}\right] + X_3 \cdot [(T_a - T_c) + (I_a - I_c)].$$

By careful selection of the parameters in the X formula (with likely constraints that guarantee $X>0$, or $X>X_1$) incentives are provided to do better than average in the group on the drivers to bring emissions/person down.

The principle of drawing rights on the fund is shown in graph A2.

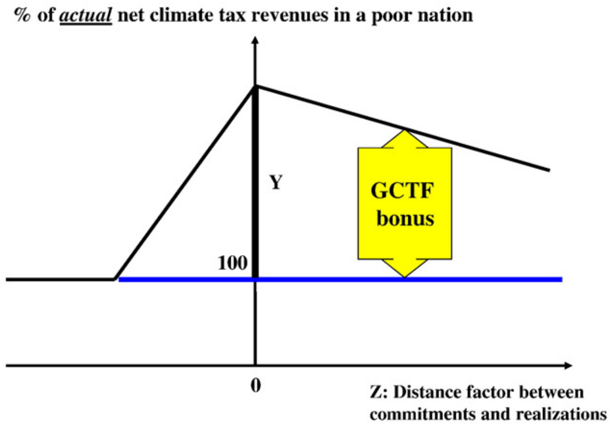

Fig. A2. Poor nations get drawing rights on GCTF.

The abscissa of graph A2 represents the Z-factor. It means that developing countries function within the same regime.

The ordinate axis shows the additional drawing rights a poor country can obtain on top of the internal recycling of the own climate tax revenues. When a poor country perfectly realizes its commitments ($Z=0$), a significant amount Y may be attracted. For Y a formula similar as for X may be adopted, e.g.:

$$Y = Y_1 + Y_2 \cdot \left[\frac{W_h - W_c}{W_h - W_l}\right] + Y_3 \cdot [(T_a - T_c) + (I_a - I_c)].$$

For the poor countries segmentation in more groups may be helpful in tuning the parameters. Executing the drawing rights may be made conditional on assigning the resources to improving performance on the three drivers for keeping emissions/person low in an efficient way. The mechanism provides self-enforcing incentives in that direction because countries that do not perform will end with a low Y value.

The mechanics are transparent and simple and can be organized in a standard spreadsheet. "Real comparability of effort is unlikely, nor is full differentiation based on national circumstances possible. International consensus on a formula is highly unlikely." This statement by Heyward (2007:528) is accommodated here because comparability and differentiation are maximized and the formulae only apply on the transfer mechanism, not on the commitments of the countries as such.

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