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Article

A Turbo Drive for the Global Reduction of Energy-related CO_2 Emissions

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Abstract: The Copenhagen Accord performed a seizure in the COP ungainly crawl. The Accord's *urgent combat* against climate change and *deep cuts in emissions* require a policy reversal, ending the zero sum games on pledged caps, creating clarity on immediate marching directions and eliciting worldwide action by today's operational institutes at all levels. For reducing energy-related CO_2 emissions, all turbo drive components are available. First the global 2 ℃ ceiling needs translation into, by country, marching directions and indicative future paths of their national average CO_2 emissions per person. The latter intensity indicator is the product of three driving intensities: wealth per person, energy used for wealth production, and CO_2 emissions of energy use, all observed annually for virtually all countries in the world. Second, parties should commit to nearby year improvements on the three driving intensities. Third, transfers from rich to poor countries depend on ability to pay and on ability to spend, and on countries' mitigation progress. The approach dissolves main barriers to mitigation progress, like: outdated emissions baselines; illusory global instruments; bureaucratic MRV (monitoring, reporting and verification) concepts; blocked graduation of parties; unclear transfer mechanisms. In revamping the jammed COP rituals, UNFCCC now leaves operations to established global institutes and mainly to the parties acting in common resolve, stimulated and verified by a lightweight, transparent global framework.

Keywords: climate policy architecture; emissions reduction targets; intensity performance indicators

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1. Introduction

Slow progress in international climate policy is due partly to the huge stakes involved, and partly to the stupefying complication of the Conference of Parties (COP) processes. On stakes and related distributional aspects, representatives of constituencies are the only ones empowered to negotiate and compromise. However, processes should be designed and run to facilitate negotiations and not to complicate them as COP processes are currently doing today. Three main Kyoto institutions show structural flaws: the allocation of emissions reduction targets, the construction and operation of flexible instruments, and related with the preceding ones: proposals about distributional adjustments. First, pledged emissions caps by (Annex I) countries correspond with distant, moving, and fuzzy targets [1]. They dilute the state of urgency, allow deferment in real actions on the ground, and cover up defecting policies for the forthcoming years. Cap negotiations among parties are played as zero sum games, seeding distrust and causing stalemates. This atmosphere of suspicion was publicly denounced by Y. De Boer in his position of Executive Secretary of the UNFCCC, at the European Parliament hearing, April 14, 2010. Second, new global instruments have been imagined, like global emissions trading or the universal carbon tax [2,3]. Both scythes are assumed to efficiently shave emissions around the globe, forgetting however what giant institute would be necessary to forge and handle the scythe. Several new institutions have been created without expedient audits of operational institutions embedded in institutes with trained and experienced staff, knowledge and know-how, data and memory, *etc.* Even having economic giants available, uniform scything has little effect, and is inefficient and unfair because emissions are resulting from "trillions of decisions made by billions of people" [3], representing the high diversity and complexity of human communities on earth [4]. Instruments creating the necessary additional climate pricing pressures must take into account the pressures already in place and the different areas the forces are working on, considering also unequal carrying capacity of people [5,6]. Third, distributional issues stay central in the appropriation of commons. The Clean Development Mechanisms (CDM) do not function as effective and efficient instruments for augmenting fairness in climate relations between rich and poor nations [7]. Neither does providing *ad hoc* pledged funds, where results systematically fall short of announcements.

Preserving the climate commons as expressed by the 2 ℃ maximum increase of global mean temperature on earth, implies that by 2050 *all countries must own low-carbon energy economies*. The clear goal and task of rebuilding the energy sectors in every country creates a common framework for ubiquitous mitigation efforts without delay. Transfers of finances, technologies, and institutional capabilities from rich to poor nations are necessary, and should be adequate, predictable, sustainable, and steered by yearly measured scores on performance indicators. Ranked classification of donors and recipients, and graduation of countries in this ranking must be obvious.

The process and outcomes of the 2009 COP15 in Copenhagen are evaluated differently by the variety of participants and observers. Measured by process efficacy and efficiency, COP15 is a failure: the set objectives (and implicit higher hopes fostered by most attendants in and around the meeting rooms) are not realized [8], with disproportional resources spent on the event, which some call "non-event" [9]. Several scholars have for a long time been critical of the Kyoto approach [10,11] and may find their analysis confirmed by the facts. Proponents of the Kyoto-Bali-Copenhagen route were very disappointed by the COP15 outcome but seem to lack alternatives: preparatory meetings (Bonn,

August 2010; Tianjin, October 2010) and Cancun itself kept to the Bali roadmap, with little results because many of the accords from Cancun simply firm up non-binding deals from the Copenhagen Summit.

The Copenhagen Accord however made a seizure, of depth and length to be assessed from an independent, non-advocacy perspective. Kyoto Protocol ("top-down" architecture) defenders on the one hand, and proponents of free-wheeling "pledge and review" ("bottom-up") efforts on the other hand, often describe the opponent in a caricatured way, instead of searching "a constructive middle ground" [8]. Because climate is a global commons there is "need for global coordination" by the United Nations Framework Convention on Climate Change (UNFCCC) [12], but this provides no excuse for the unwieldy crawling at the stapled COP meetings. The seriousness and urgency of climate change imposes the plight to explore innovative approaches and to search for the lightest but most robust and resilient UNFCCC framework. Light institutions at the international level imply that the bulk of the action is placed at the national state level [13,14]. This article develops mechanisms that link design and control by UNFCCC to national performances. Proper assignment of authority, responsibility, and accountability is advanced by orderly compartmenting of the main challenges and tasks in climate policy: adaptation, technology transfer, land-use, land-use change and forestry, reduction of emissions of industrial gases, reduction of CO_2 emissions from the energy sector. Only the latter (major cause of climate change) is dealt with here, but the novel approach may generate inspiration and experience for tackling other main climate policy issues, like land-use, forests, and technology transfer.

This article comprises six sections after this introduction: highlights of the Copenhagen Accord (Section 2); salient conditions that the Accord's urgent combat and deep cuts impose on climate policies (Section 3); Kyoto pledged caps or targets are less useful than mostly believed, and the better alternative is immediate stepwise progress on four measured intensity performance indicators currently valid (Section 4); decomposition of the intensity indicators to clarify their underlying drivers (Section 5); a proposal for performance adjusted transfers and for yearly graduation of parties on the related donor-beneficiary transfer scale (Section 6); arguments in favor of a light and realistic global climate policy architecture (Section 7).

2. Highlights of the Copenhagen Accord [15]

The Copenhagen Accord covers two main issues: (1) goals and targets, and (2) means, which implies the sidelining of other components of the policy process (for example: the Accord sidelines instruments like emissions trading, of high parlance since the 1997-COP in Kyoto).

The main result of the Accord is the confirmation of climate policy *goals* with, as eye catcher, the 2 degrees Celsius ceiling on global temperature increase (Art.1). This is further strengthened by Art.12 announcing consideration in 2015 of a 1.5 degrees Celsius ceiling. The "will to *urgently combat* climate change" (Art.1) is confirmed by "an assessment of this Accord to be completed by 2015" (Art.12). The latter halves the horizon of reconsideration compared to the Kyoto extension route with 2020 as next signpost. It is agreed "that *deep cuts* in global emissions are required" (Art.2), for developing countries "a low-emission development strategy is indispensable" (Art.2) and "low emitting economies should be provided incentives to continue to develop on a low emission pathway"

(Art.7). Next to mitigation is stressed "the need to establish a comprehensive adaptation program" (Art.1). Art.6 exclusively addresses deforestation and forest degradation and the role of forests.

To meet the goals, the Accord follows two main avenues: (a) emissions (reduction) *targets* for developed countries and mitigation *actions* by developing countries, and (b) cooperation, transfers and support. Similar to the Kyoto approach, pledged emissions reduction targets are adopted as proof of advancement. By 31 January 2010 Annex I Parties were to submit their "quantified economy-wide emissions *targets* for 2020" and mention also the base year (Art.4 and Appendix I). Non-Annex I Parties will implement mitigation *actions* (Art.5 and Appendix II) with extensive attention for the measuring, reporting, and verification aspects of such actions (Art.5). The Accord emphasizes cooperation on adaptation and mitigation: "developed countries shall provide adequate, predictable and sustainable financial resources, technology and capacity-building" (Art.3), reiterated in Art.8 as "scaled-up, new and additional, predictable and adequate funding" where also the USD 30 billion for the period 2010–2012 and the "goal of mobilizing jointly USD 100 billion dollars a year by 2020" are mentioned. "A High Level Panel" for financial supervision is announced in Art.9; "the Copenhagen Green Climate Fund" in Art.10; and "a Technology Mechanism" in Art.11.

The brief coverage in Articles 9, 10 and 11 reveals that the institutional framework has not thought through, nor developed. The same holds for the policy instruments that could or should be applied to convert means into results. Scant reference is made to joint implementation (Art.4), REDD (Art.6 and 8), markets (Art.7), offsets (Art.10). The lack of clarity on institutions and instruments confirms the intentional character of the Accord, but conveys also an implicit rejection of top-down uniform Kyoto policies (for example the global carbon market). The Copenhagen Accord has stopped the unwieldy crawl of the UNFCCC Conferences and closed the wharfs of global instruments; it engaged major non-Annex I countries in preparedness to take mitigation actions, but maintained cap pledging by Annex I Parties and new institutions were announced again. The Accord provides openness and room to reconsider the Kyoto approach and instruments, and to investigate what else could bring more immediate progress and long-term success in climate policy. As such, the Accord may be the best occurrence for climate policy since the UNFCCC (1992).

3. Urgent Combat and Deep Cuts Impose Conditions on Policy Designs

The Copenhagen Accord emphasizes the urgency of a climate policy that realizes deep cuts in the emissions. The Stern review [16] argued along the same lines, and derived the necessity of pricing carbon emissions, technological innovation, removal of barriers to behavioral change, international collective action and cooperation between developed and developing countries. Yet, the steps from willing to doing seem difficult to take. In exploring ways forward, some conditions are salient, but the five highlighted here are only a small selection from many considerations discussed in the literature [4,17].

First, when urgency is important, time is lacking for uncertain experiments in imagining, designing, building, and testing extensive new institutes and institutions. Effective urgency is only deliverable by performing organizations, trained people, proven data collection and processing systems, established monitoring, reporting and verification mechanisms. At the global level World Bank and IMF govern economic and financial issues, IEA(International Energy Agency) and similar institutes [18] provide

energy balances, the UNDP (United Nations Development Programme) [19] can best care for development problems, *etc.* Also at regional, country, state, provincial and municipal levels, existing policy processes, legislation, administrations, instruments, *etc.*, are starting points for urgent advancement in climate policies [13,20]. Adopting performance indicators that are available or derivable from already measured and processed statistics is a win-win option. Today's operational institutes may need re-engineering, strengthening and extension. This is arguably more effective, efficient and institutionally feasible, than the invention and deployment of new institutes and institutions as the Kyoto approach engaged in.

Second, managing and sharing the atmosphere and climate as global commons, demands for a complexity of nested approaches and polycentric governance systems [21,22]. The Copenhagen Accord opens that road by sidelining the top-down directed instruments. Effectiveness, efficiency and equity criteria are not respected by imposing uniform rules on a tremendously diverse reality [4]. On the contrary: matching a uniform fiction with diverse realities necessitates never-ending *ad hoc* adjustments, mostly through obscure "comitology" processes [23,24]. This destroys trust and goodwill needed to lubricate workable instruments for managing and sharing the commons. Diversity in climate policy leaves responsibilities and power with the parties of the UNFCCC. The urgently needed post-Kyoto international agreement should respect and build upon the efforts already undertaken by national and local authorities and by their constituencies, households and companies [13]. There is no other reality than starting from the condition every member state is in today. Then establishing a light overarching construction, the simplest solution that still solves the problem, suffices and corresponds with the mandate of UN institutions in general, and of the UNFCCC in particular. Not a "top-down" [12] nor a "bottom-up" [25] architecture, but a "top to bottom and bottom to top" full scale coverage is due; called "a constructive middle ground" by Dubash and Rajamani [8].

Third, and related to the previous condition, what is internationally discussed and agreed should be transparent, verifiable, and acceptable by the majority of sovereign nations and their peoples. The UNFCCC (1992) and Copenhagen Accord (2009) are appealing by providing an overview, different from the unwieldy COP processes with complex and contingent arrangements. A workable agreement uses a limited number of performance indicators that are precise and robust, transparent and verifiable. Monitoring, reporting and verification of actions and programs, high on the Cancun agenda, are cumbersome and seldom satisfactory (see CDM as latest experience). Better would be to measure actual performance and results of the parties by a few accurate quantitative indicators applicable to all parties, yearly available and published widely, advertising the progress made by every country.

Fourth, addressing the right price signals to the many diverse emissions sources requires that they are ordered in separate, rather homogenous groups. Finding the right degree of policy diversity is a difficult balancing exercise for every successful governmental intervention. Already Aristotle stated: "treat equal cases equally, unequal cases unequally". Economists argue that diversity has a cost, for example loss of economies of scale [26]. Institutional economics [22] and evolutionary economics [27] assign an indispensable role to diversity. For energy related mitigation, a first main split is between categories of globally registered, enumerable, large CO_2 sources on the one hand, and the numerous small sources on the other. Registered categories are for example steel making, aluminum, cement, basic chemical processes, power generation, ocean-borne shipping, and aviation (only units above a minimum size are registered). A global approach by registered category is recommended to avoid

discrimination among the members [14]. Redirecting the price signals for all the other (small scale) sources is the result of steadily advancing reforms of subsidies and levies applied autonomously by the sovereign COP member countries and by their subsidiary authorities. Present energy subsidy, levy and tax systems are of such a high diversity and complexity that comparing the systems of two similarly developed countries is already a hell of a job. Smearing over the uneven systems, the uniform layer of a global carbon tax or global price of traded emission permits will not and cannot deliver a leveled playing field for emitters. In every debate on these matters, I ask my opponents (in vain) to materialize their illusory unicorn "global carbon price" (or even the "national carbon price").

Fifth, transfers and support from developed to developing countries, from rich to poor people, should be "adequate, predictable and sustainable" (Copenhagen Accord, Art.3), "scaled up, new and additional" (Art.8). The Accord plans "mobilizing jointly" billions of USD. The pledges for more transfers and support are crucial to respect the basic principle of common but differentiated responsibilities and respective capabilities. But money transfers are always hard to materialize and to manage. Grants to beneficiaries should be linked to their performance on adequate, predictable and verifiable indicators, reflecting progress as a result of efficient spending. The status and degree of being donor or beneficiary should depend on the wealth standard GDP/person; yearly countries would graduate on this standard according to their economic and demographic successes [28]. Contributions by donors should be based on their GDP/person, and modulated by their performance on the same indicators that measures the performance of beneficiary countries.

4. Emissions Caps *versus* Progress Indicators

Emissions caps own a few positive, but many more negative, properties as the totem of mitigation policies. Caps like the Copenhagen Accord's global 2 °C increase ceiling imply a wake-up call to rally the parties. The real job starts when this overall long-term goal must be specified in work packages by individual countries. The UNFCCC works with pledged tons of CO_2 emissions reduction "quota" to be realized in a "mandated" (Annex I Parties) or voluntary way (Subsection 4.1). "Contracting and converging" emissions per person of countries has been lauded, rejected, mauled, recomposed, yet the idea is tenacious (Subsection 4.2). Policy would better focus on the drivers of the emissions than on the emissions as such (Subsection 4.3).

4.1. Emissions Reduction Targets

In the first column of Table 1 the definition of Kyoto emissions targets is dissected in five parts. Part by part, the second column explains the weaknesses of the targets approach and a workable alternative is offered in the third column. Baseline issues are millstones round the neck of the present Kyoto treaty and targets; suggestions like the use of action targets provide better but not satisfying alternatives [29,30]. The Kyoto targets approach also creates problems like erosion of urgency and graduation of parties when, through economic development, they no longer belong to a previously created classification in Annexes of the UNFCCC.

Table 1. Kyoto emissions reduction targets: Definition, Weaknesses and Workable Alternatives.

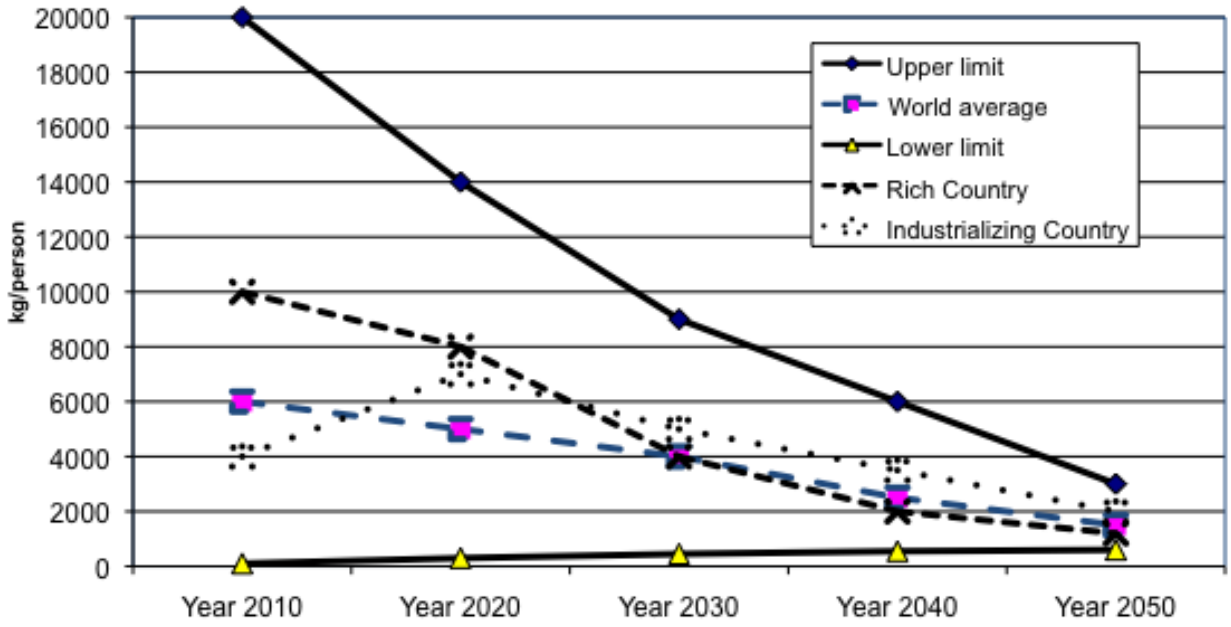
Definition	Weaknesses	Workable Alternative
Pledged targets for (caps on) GHG emission reductions	GHG emissions cover too much at once: population, wealth, energy intensity, and carbon intensity.	Address drivers one by one, for lowering energy and carbon intensities
Numbered tons or percentage reductions	Actual meaning of numbers is obscure and shifts with population, economic and technology dynamics, offsets allowed	Obligations for step-wise reducing a country's energy and carbon intensities are defined unambiguously
By some distant future year (e.g. 2020, 2030, 2050)	Delivery beyond 5–8 years (one or two presidential terms) lacks urgency and erodes responsibility	Immediate steps in the right direction, with yearly evaluating progress and adjusting step-width
From baseline 1990	Link with reality is further diluted with every passing year. However, updating baselines entails perverse effects, and would create an additional stalemate	Intensity baselines are two years behind, and move up every year; energy intensity must continue to decrease and carbon intensity must decline to almost zero
For Annex-I countries	Annex I/II classification is too rudimentary, linked to 1990 emissions	Countries are ranked only by $GDP/capita, and yearly graduate on that scale

Caps by tons of emissions in distant future years (for example 2020) are difficult to understand and not precisely identified [1]. Dividing a global cap in packages for assignment to responsible parties is troubled by uncertainties, growing exponentially with the number and diversity of parties involved. Parties readily slip into zero-sum games on sharing the global cap, raising distrust and demand for intense monitoring, reporting and verification of programs, actions and measures. Yet, target enforcement is not guaranteed, neither is the additional character of emission reductions [31]; volatility in economic up- or downturns and offset projects continuously trouble the effective meaning of emissions targets.

4.2. Contraction and Convergence

For reasons of clarity and mutual understanding the global 2 ℃ ceiling is best translated in individual parties' annual emissions per person "contraction and convergence" trajectories from 2010 to 2050 (Figure 1). Every trajectory is subject to the constraint of the "Upper limit" of the funnel. Figure 1 also shows a "Lower limit" to express that development of poor countries should not be truncated because their emissions increase; although the natural lower limit is simply zero (the abscissa). Even a line below the abscissa is plausible when including carbon dioxide capture and storage of bio fueled combustion emissions [32]. A world average, as shown in Figure 1, may function as a useful reference during negotiations.

Figure 1. Contraction and convergence funnel and paths for reducing CO_2 emissions/person.



The London based Global Commons Institute has propagated the contraction and convergence idea since the 1990s. When not fixated on a globally uniform emissions budget per person, the concept stays central in discussing long-term responsibilities [14,33]. Some rich countries are emitting more than 20,000 kg CO_2/person annually, with several poor countries below 100 kg CO_2/person [19]. The world's major economies will haggle in outlining trajectories within the bands necessary to respect the 2 ℃ increase limit. Two possible trajectories for a rich country (say Germany) and for an industrializing country (say Mexico) are shown. Crossings of the trajectories may occur but every trajectory should stay within the funnel boundaries. All trajectories must converge to pass (for example decennial) funnel bands of contracted range, ending for example in a range [600–3,000] kg/person in 2050, implying a 1:5 ratio significantly terser than 1:200 in 2010.

Statements made by presidents and other heads of state about medium and long-term reduction goals (e.g., the 80% reduction by 2050 in the USA) can be helpful as milestones in projecting trajectories. When parties do not succeed in projecting trajectories as shown in Figure 1, the 2 ℃ engagement is an empty box. The exercise of designing trajectories is a worthwhile test of commitment. Depending on how registered large sources and sectors are treated in the convention, the contraction and convergence trajectories can be made either including or excluding their emissions.

During the starting years of the agreement, full consensus on precise trajectories over the full period 2010–2050 may not be feasible, but neither is necessary; orders of magnitude suffice [17]. More important is to clearly fix and agree on immediate *marching directions* for the coming years (in Figure 1: the gradients starting on the left side entrance of the funnel) [25]. Although the identification of every party's starting directions (deflections from ongoing business-as-usual) may be difficult, the danger to slip into zero sum games is far less than with unclear quantitative targets, because there is common agreement and resolve to respect the funnel and to pass decennially narrowing funnel bands.

4.3. Focus on the Drivers of Emissions per Person

Focus on the present state and on the real drivers of CO_2 emissions should substitute continued trials to fix emissions caps in distant future years. Two main groups of drivers are: fossil energy use and land use (the latter mostly expanded to LULUCF: land use, land use changes and forestry). Fossil energy use causes more than two-thirds of the emissions, is narrowly related to today's development and wealth, and has received most attention in climate policy analysis. Following Ehrlich and Holdren, the emissions by energy use are broken down to a first degree as [34-36]:

$$\text{CO}_2 \text{ emissions} = \text{Number of People x } \frac{\$\text{ GDP}}{\text{Person}} \text{ x } \frac{\text{kWh energy}}{\$\text{ GDP}} \text{ x } \frac{\text{CO}_2 \text{ emissions}}{\text{kWh energy}} \quad (1)$$

Equation (1) highlights that emissions are partly determined by population size and by the average level of wealth in a country. Population and wealth are proprietary policy issues linked to the sovereignty of nations, and initiatives by third parties to influence them are contentious. This makes negotiating significant CO_2 emissions reduction targets for a plurality of nations quite tedious among industrial nations and almost unfeasible for industrializing nations [37]. In addition, GDP can be volatile, especially in many developing countries, but also in rich industrialized nations (see 2008/09). This erodes the meaning and predictability of emissions reduction targets, particularly over the longer term [38].

A reduced form of Equation (1) provides average emissions per person, making the link with the contraction and convergence patterns as shown in Figure 1:

$$\frac{\text{CO}_2 \text{ emissions}}{\text{Number of People}} = \frac{\text{kg CO}_2}{\text{Person}} = \frac{\$\text{ GDP}}{\text{Person}} \text{ x } \frac{\text{kWh energy}}{\$\text{ GDP}} \text{ x } \frac{\text{CO}_2 \text{ emissions}}{\text{kWh energy}} \quad (2)$$

The drivers in (2) are respectively: wealth intensity, energy intensity of wealth, and CO_2 intensity of energy use. Total emissions are reduced when population growth is checked, and when the product of the associated drivers (right side variables) diminishes. By referring to emissions per person, some perverse incentives like impeding migration are avoided, and checks on total population growth are excluded from the climate policy discussion arena. This is a step forward: global population policies should not be hidden in the plies of the COP processes but have to be handled on another UN forum with the right knowledgeable representatives on duty. Intensity targets are criticized because they do not guarantee absolute emission reductions. This critique is not valid when various intensities are managed in context and monitored for irrevocable and deep decline (80–95% emission reductions by 2050). The multiplication at the right side of Equation (2) 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 at a commensurate pace). A way to achieve this is the widespread adoption of low-carbon energy technologies. Most impact is expected from renewable energy technologies [39] that, however, will not simply appear across the globe. A prerequisite for making and keeping the full transition to renewable energy globally affordable is significantly decreasing energy intensities of economies. This in turn will require economic reforms, such as taxes and subsidies to increase costs for CO_2-intensive activities and reward low-CO_2 activities.

5. Decomposition of the Drivers of Energy Related Emissions

For better understanding their content, the three intensity drivers (Equation 2) are broken down by one step. This reveals what underlying variables affect the main drivers and via which levers incentives can be created. Mostly more detailed decompositions are feasible [40].

Here a methodological caveat is necessary: if over more years variables are broken down in interdependent components, care for the growing impact of their interactions is needed [41]. The proposed approach here does not require the projection of decompositions beyond three (to five) years in the future, with baselines being annually adjusted on observed magnitudes. This keeps the size and significance of the residual terms manageable.

5.1. Wealth Intensity

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 prices P_A, or :

$$\text{Wealth Intensity} = \frac{\$\ \text{GDP}}{\text{Person}} = \sum_A \frac{P_A \text{ x Activity}_A}{\text{Person}} \tag{3}$$

A further decomposition could create population strata of mutually exclusive and collectively exhaustive groups (e.g., by income, or by age, or by income-age classes), refining but also complicating the analysis. GDP is subject to criticism for not including all the right activities, for not excluding detrimental activities, and for applying biased prices. GDP and wealth vary with the structure of the economy (what activities happen) and with applied prices. Price and structure are interrelated due to the "Law of demand": when the price of an activity is low, more of it will be demanded; and *vice versa* with high prices. The shift in activities is what the literature refers to as changes in lifestyles, behavioral changes, *etc.*, assuming mostly that such changes have to be designed, told and eventually imposed by politicians, officials, academics, NGOs, *etc.* on other people. Here the creativity of producers and consumers is counted on, reacting to the pressure executed by adaptation of prices (mainly by specific taxes and subsidies) to bring effective and efficient changes in their activities and practices. The pressure is permanent, ubiquitous, and understood by all economic agents.

The composition of wealth depends on historic, geographic, cultural, demographic, economic, technological, *etc.*, factors. Public policy has a significant impact on the composition of GDP, e.g., by subsidizing some and levying other activities. "Re-pricing GDP" or budget reform is a workable policy to shift interest of households and companies from carbon-intensive towards low-carbon activities [42]. Influencing prices by subsidies and levies is a core task of public authorities at all levels, and documented by IMF, OECD, EU, national banks, *etc.* They record subsidies and levies by category. For example EUROSTAT [43] publishes the shares of environmental taxing in the GDP of EU member states. One should further refine the labeling of both subsidies and levies related to carbon-intensive and low-carbon activities. Addition of all levies on carbon-intensive activities with all subsidies for low-carbon activities provides the positive side of "climate budget reform". Addition of all levies on low-carbon activities and all subsidies for carbon-intensive activities is the negative side of "climate budget reform". The net balance of both sides divided by a country's total tax revenues or total public budget could be a starting indicator (moreover independent of the country's currency).

Year after year progress on the indicator can be measured. It is a necessary and sufficient indicator of a country's progress in creating price pressures towards a low-carbon economy. The diversity of activities and of policies by country can be respected, with the aggregate indicator of budget reform monitored at the international level.

This indicator is a good substitute for the futile trials (ending in errors) to install globally uniform pricing instruments like emissions trading or a universal carbon tax rate.

5.2. Energy Intensity

Energy intensity of wealth is the product of the budget shares of activities in the GDP with the energy use for realizing the activity [44]. The second factor of the product includes the technical efficiency (how much energy is used in performing an activity). In the context of climate policy, energy is to be understood as not forthcoming from on-site renewable energy sources, *i.e.*, energy covers fossil fuels and grid electricity. The full analysis of what energy is considered non-sustainable and should be reduced in use is beyond the scope of this article, and will be influenced by the latest nuclear disaster in Fukushima.

$$\text{Energy Intensity} = \frac{\text{kWh energy}}{\$\ \text{GDP}} = \sum_{A} \frac{P_A \text{ x Activity}_A}{\$\ \text{GDP}} \text{ x } \frac{\text{kWh energy}}{P_A \text{ x Activity}_A} \tag{4}$$

Energy intensity is lowered by shifts in activities towards alternatives asking less energy supplies and by improving the technical energy efficiency of activities. The changes in activities and practices are discussed in Section 5.1 under wealth intensity. Energy efficiencies as such are difficult to accurately define and measure in practice [45,46]. Improving efficiencies is technology driven. Inducing disruptive innovations in efficiency technologies is mainly a price influenced process [47]. Reduction of energy intensities is crucial for the affordability of the global transition to energy economies where the full cost is borne by end-users, as would be the case when the full transition to a renewable energy economy is made.

5.3. Carbon Intensity

Carbon dioxide intensity of energy use can be broken down as:

$$CO_2 \text{ Intensity} = \frac{CO_2 \text{ emissions}}{\text{kWh energy}} = \sum_{E} \frac{\text{kWh type}_E}{\text{kWh energy}} \text{ x } \frac{CO_2 \text{ emissions}}{\text{kWh type}_E} \tag{5}$$

This intensity is the sum of several products of two factors: the share of particular energy uses in the commercial energy mix with their CO_2 emission intensity. Implementing available renewable energy technologies and developing more functional and efficient technologies to harness renewable resources are the main ways to sustainable, low-carbon energy economies [39,48]. As long as that future is distant, CO_2 intensity has to be abated.

6. Transfers for Climate Change Mitigation

A global climate agreement on mitigation is not functional when industrialized nations drag their feet in transferring technologies and finances to developing nations. The Global Environmental

Facility, the Clean Development Mechanism, the System for Transparent Allocation of Resources, the Copenhagen Green Climate Fund, *etc.*, have transfer mechanisms set up. Their coverage and performance are mostly far below announced levels [7,49]. *Ad hoc* repairs (see the frequent CDM rule changes in 2010) are permanently under way showcasing the deficiency of the mechanisms. Duties of donors and rights of beneficiaries remain unclear, making actual transfers vulnerable for circumstantial changes. Improvement in transfers linked to energy related CO_2 emission reductions (transfers for adaptation, technological development, land-use policies are not considered here) is due on mainly two points: delineation of donors and beneficiaries, and quantification of duties and rights including indicators of mitigation performance by donating and by receiving parties.

Delineation of donors and beneficiaries is feasible by yearly graduation of all countries on the GDP/person metrics, eventually with the adoption of graduation classes [50]. Mitigation performance is measured annually as a distance to targets on the intensity performance indicators. According to their long-term indicative paths of converging (and for the high-emitters: contracting) emissions per person (Figure 1), countries yearly commit to percentages improvement for the following three years on three indicators: climate budget reform, energy intensity and carbon intensity of energy use (Section 5). Table 2 shows an example for four countries belonging to different categories. For logical consistence line 3 equals line 2 minus line 1. I am neither informed nor authorized to come up with the right numbers; Table 2 only shows the interaction among the intensity indicators (omitting secondary interdependency effects) and how growth in wealth can be combined with declining emissions per person by lowering energy and carbon intensities. The illustration emphasizes that the interactions are quite different by category and type of country.

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	+2	+3
Energy + Carbon intensities	−6	−4	−1	−2
Net climate tax share in GDP	7.50	6.25	12.00	9.50

Commitments and performance are requested from all parties, be they donors or beneficiaries. Donor countries agree on aggregate transfer budgets (billion dollars) for every upcoming year (up to three years ahead) to a climate fund. The contribution by donor country is GDP-dependent but actual payments by country are adjusted with their performance on the three climate policy progress indicators. Beneficiary parties get an initial GDP-dependent drawing right on the fund that can significantly increase by improving performance on the three indicators [48]. As such the principles of "ability to pay" and "ability to spend" are respected, with incentives stimulating all countries to improve their energy related CO_2 emissions mitigation policies and results.

7. A Light and Realistic Global Climate Policy Architecture

The Conferences of Parties of the UNFCCC are unlikely to generate effective climate policies when continuing on the Kyoto track. On the one hand, circumventing the UNFCCC is not necessary, not desirable, and not meaningful. However, this is not a free ticket for non-delivering COP processes. Thorough rethinking of "the only game in town" is necessary with Prins and Rayner [11] advising that it is time to ditch Kyoto to avoid throwing good money after bad. The proposed approach here is one "from top to bottom and from bottom to top": a lightweight international agreement is part of it; decisions and actions reside where the capacity is available: in the member parties of the UNFCCC [13].

For a workable global architecture all components and institutions are available and ready to function, but their assembly and ignition are blocked by political deadweight. In addressing that deadweight one cannot advance without novel perspectives and internally consistent alternatives. While in the beginning they are alien and rejected, the necessity of "Urgent and Drastic Change" ([16] Copenhagen Accord 2 ℃ limit) will rally support. The transparency and practical feasibility of the proposed approach dissolve most barriers to a robust mitigation policy created by the unwieldy COP processes since Kyoto. China is organizing its domestic climate policy along the indicators this article proposes as progress milestones for de-carbonizing all economies in the world.

A hands-on approach for mitigating CO_2 emissions from energy use is proposed here: the essential variables are clearly defined and easy to understand; current statistics for their yearly measurement, reporting and verification by country are available; the institutes generating the statistics by country are globally respected and can further improve accuracy and clarity of the metrics. Monitoring, reporting, verification of countries' performance in this way is similar to technical jobs IMF and IEA are executing today. The statutes and membership of IEA needs updating although, through cooperation with similar organizations, its scope is already quite global.

The member parties can immediately start to make progress on the indicators (the urgency of climate policy). A long journey starts with the first steps in the right direction and guarantees the stepwise realization of deep cuts. No new global institutes have to be vested; the parties to the FCCC are fully made responsible and empowered to organize advancement on the indicators, starting from their institutes, policies and regulations in place today. The suggestions can be made operational within a year. The proposal reconnects the necessary top-down framework and control with the maximum bottom-up operational freedom and power by the member states.

Countries differ in their present performance on CO_2 emissions mitigation. There are many reasons and causes, but, to advance global agreement, attention should not be focused on pointing out differences and historic responsibilities. Each country can anyway only start from the position it is in today. Policy best focuses on step-by-step progress in lowering energy and carbon intensities and restructuring GDP. Progress by the year is measured on (rolling) intensity baselines of two years ago. This avoids setbacks like reproving pioneers, rewarding laggards, stimulating status quo and perverse incentives. The unfounded belief that global uniform instruments would be superior is replaced by a reorientation of ongoing policies and practices in all countries towards low-carbon energy technologies and activities. Alongside or connected to energy related emissions mitigation, additional policies are necessary for mitigating the emissions caused by changing land-uses, for direct technology transfers,

and for adaptation. The approach of year-by-year progress, monitored by reliable indicators, may also prove helpful here, but a detailed analysis is beyond the scope of this article.

One reviewer of this article "would also like some more discussion related to political feasibility". This opens the road to highly relevant research about the political deadweight of the present UNFCCC process. Such research requires due experts, resources and time, to mobilize the knowledge, insight and independent diligence required. Obviously this short article cannot deal with this aspect in an appropriate way. Here I provide only a principled answer on the political feasibility question: the proposals here are possible, desirable, and necessary. The proposals are *possible* because they address the essential characteristics of climate change and the related common-pool resource issues [4,21] using existing operational institutes, instruments and practices. Nothing has to be invented or founded anew. True, UNFCCC must clear the road of illusions and from interests vested in carbon-intensive economies. However, this clearing is a necessity for every agreement, policy and measure that may have a chance to deliver the 2 ℃ target. The approach is not perfect and not finished. But is there a better one that addresses the jamming barriers? The unfinished character is an advantage: academics may propose pathways, solutions, directions, headlines, *etc.* Policy makers are in charge of final design, implementation, and operation. The proposals are *desirable* because they respect basic principles of global partnership: universality, sovereignty, realism, transparency, and diversity. Evaluated on the four basic criteria: efficacy, efficiency, equity, and institutional feasibility [36], the proposals get a high grade. The proposals are *necessary* to construct the solid pavement for the "urgent and drastic change" [12,16] that the jamming Kyoto-Bali-Copenhagen-Cancun-Durban road will not and cannot deliver. They may substitute common resolve and emulation of low-carbon technologies and practices for the zero-sum games and despair that the present COP track offers.

However, academic proposals are mere proposals: blueprinting and realizing a novel architecture is the responsibility of UNFCCC. In her opening speech as Executive Secretary of the UNFCCC (Bonn, 2 August 2010) Christiana Figueres stated: "Time is not on our side. Decisions need to be taken, perhaps in an incremental manner, but most certainly with firm steps and unwavering resolve"; where she also cited Nelson Mandela: "We must use time wisely, and forever realize that the time is always ripe to do right."

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