

## THE BUDGET APPROACH—A FRAMEWORK FOR A GLOBAL TRANSFORMATION TOWARDS A LOW CARBON ECONOMY

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Latest research shows that there is only a realistic chance of restricting global warming to 2°C if a limit is set to the total amount of CO<sub>2</sub> emitted globally between now and 2050 (global carbon dioxide budget). We move this global budget to the forefront of our considerations regarding a new global climate treaty in the post-Copenhagen process.<sup>3</sup> Combining findings from climate science and economics with fundamental concepts of equity, the 'budget approach' provides concrete figures for the emissions allowances which are still available to countries, assuming they want to prevent the destabilization of the planet's climate system. Our calculations demonstrate that the time pressure for acting is almost overwhelming—in industrialized countries, but also in emerging economies and many developing nations. We suggest several institutional innovations and rules to manage the global and the national CO<sub>2</sub> budgets in a transparent, fair and flexible way. A sober analysis of the state of the art of climate change science and of the state of multi-lateral attempts to create an effective climate protection accord so far reveals that the budget approach can provide crucial orientation for the negotiations towards a comprehensive post-Copenhagen climate regime. The approach facilitates at the same time an institutional design for a low carbon global economy, setting the necessary incentives for decoupling economic growth from the burning of fossil fuels.

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<sup>3</sup> The authors are members of the German Advisory Council on Global Change (WBGU). The WBGU recently published a study on 'Solving the climate dilemma: The budget approach'. This paper builds on the fundamental ideas and findings of the WBGU study and demonstrates that the budget approach could serve as a cornerstone for an institutional design for a global low carbon economy.

## 1. THE 2°C-GUARDRAIL REQUIRES IMMEDIATE ACTION

In 1995, the German Advisory Council on Global Change (WBGU) suggested that global warming should be limited to a maximum of 2°C above the pre-industrial level in order to prevent dangerous anthropogenic interference with the climate system.<sup>4</sup> However, in the light of more recent research even a warming of 2°C cannot be regarded as 'safe', but is likely to generate already serious consequences—such as sea-level rise that could render certain island states and densely populated coastal regions uninhabitable. In the 'Copenhagen Accord' from December 2009 the importance of limiting global warming to 2°C or less has been accepted. Many countries have already made the 2°C-guardrail an official goal of their climate policy. Scientists broadly support this climate protection target.<sup>5</sup> A growing number of studies indicate that in a world that has overshoot the 2°C-limit, our civilization—which has developed in the amazingly stable climatic conditions of the Holocene—would face unprecedented challenges.<sup>6</sup>

In estimating the level of emissions reductions necessary for compliance with the 2°C-guardrail, various important factors must be considered: these include the emitted quantities of CO<sub>2</sub>, but also the emissions of other greenhouse gases, the cooling effect of air pollution (especially sulphur particles), the warming effect of soot particles, the inertia of the climate system (most notably of the oceans), and all the other uncertainties which make a probability analysis the only appropriate assessment. Recent studies show, however, that this complexity can be substantially reduced.<sup>7</sup> Due to the remarkable longevity of CO<sub>2</sub> in the atmosphere, this

<sup>4</sup> WBGU, 'Scenario for the Derivation of Global CO<sub>2</sub> Reduction Targets and Implementation Strategies', Statement on the Occasion of the First Conference of the Parties to the Framework Convention on Climate Change in Berlin (Special Report 1995).

<sup>5</sup> John Schellnhuber et al., *Avoiding Dangerous Climate Change* (Cambridge University Press 2006); Katherine Richardson et al., Synthesis Report Climate Change, Global Risks, Challenges and Decisions (2009), Climate Congress Copenhagen, 10–12. March 2009, Copenhagen: University Copenhagen.

<sup>6</sup> WBGU (German Advisory Council on Global Change), 'World in Transition: Climate Change as a Security Risk' (Earthscan Publications 2008); Ian Allison et al., 'The Copenhagen Diagnosis. Updating the World on the Latest Climate Science' (2009); World Bank, World Development Report 2010, Development and Climate Change (2009); Oli Brown and Alec Crawford, 'Climate Change and Security in Africa—A Study for the Nordic-African Foreign Ministers Meeting' (2009).

<sup>7</sup> Malte Meinshausen et al., 'Greenhouse Gas Emission Targets for limiting Global Warming to 2 °C' (2009) 458 Nature 1158; Myles R. Allen et al. (2009): 'Warming caused by cumulative carbon emissions towards the trillionth tonne' (2009) 458 Nature 1163.

particular substance will become increasingly dominant in the long term in comparison with rather short-lived greenhouse gases and aerosols. For that reason, the trend of atmospheric warming over the course of this century will mainly depend on how much more CO<sub>2</sub> is emitted in total. Specifically, cumulative CO<sub>2</sub> emissions till 2050 will largely determine the extent to which global temperature rise can be kept within the 2°C-guardrail. In order to achieve this with a probability of 67%, fossil CO<sub>2</sub> emissions till 2050 must be capped at around 750 Gt, with only a small residual amount being emitted post-2050. At current emissions rates, however, this CO<sub>2</sub> budget will be exhausted within around 25 years—and even sooner if emissions continue to rise (after a short dip in the wake of the recent economic downturn).

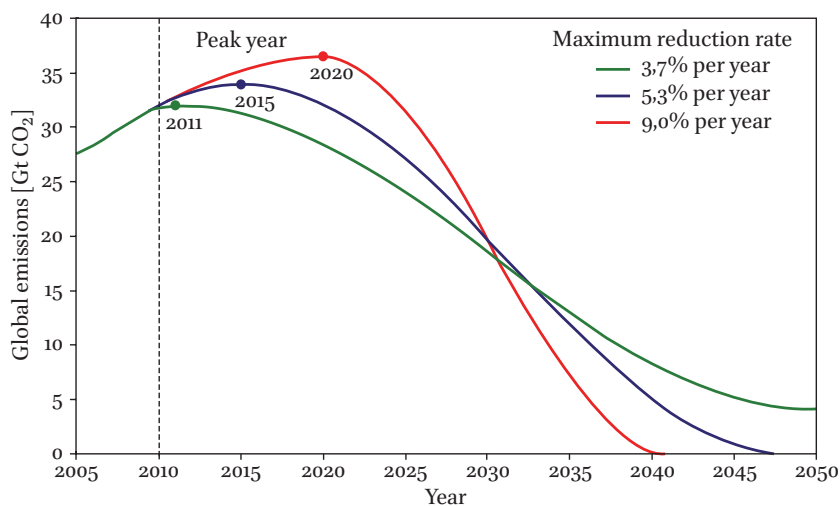
The reversal of the global emissions trend must therefore start as soon as possible; in view of the very limited CO<sub>2</sub> budget, any delay will result in almost unachievable reduction requirements. With a reversal of the trend (and the emissions peak being passed) by 2010, global emissions would need to fall to 50–80% below the 1990 baseline by 2050, with further reductions towards zero emissions being achieved thereafter. Even a slight delay in the reversal of the trend, i.e. postponement of the peak year to 2015, would trigger annual global emissions reduction requirements of up to 5% (as a fraction of 2008 emissions) (Fig. 1). In other words, the world would then have to meet *annual* emissions reduction targets equivalent to those established by the Kyoto Protocol for two full decades! And this would apply not only to the group of Annex-I countries but globally. Delaying the peak year even further to 2020 could necessitate global emissions reduction rates of up to 9% per year—i.e. reductions on an almost inconceivable scale, entailing technological feats and social sacrifices comparable to those of the Allied mobilization during the Second World War. Whatever the details, there is no option but to halt the hitherto unabated rise in CO<sub>2</sub> emissions as quickly as possible and to immediately switch to emissions reductions on a global scale thereafter.<sup>8</sup>

## 2. THE INTERNATIONAL CLIMATE POLICY CONTEXT

The current international climate policy context is far from favorable. After the Copenhagen summit and based on the Copenhagen Accord

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<sup>8</sup> United Nations Department of Economic and Social Affairs, 'A Global green New Deal for Climate, Energy, and Development' (2009).



Source: WBGU 2009

Figure 1. Examples of global emission pathways for the period 2010–2050 with global CO<sub>2</sub> emissions capped at 750 Gt during this period. At this level, there is a 67% probability of achieving compliance with the 2°C guard rail. The figure shows variants of a global emissions trend with different peak years: 2011 (green), 2015 (blue) and 2020 (red). In order to achieve compliance with these curves, annual reduction rates of 3.7% (green), 5.3% (blue) or 9.0% (red) would be required in the early 2030s (relative to 2008).

there is a real risk that the UN Climate Change Conference in Mexico at the end of 2010 will only produce a weak compromise which cannot prevent dangerous climate change. According to recent analyses, the various national emissions reduction pledges submitted so far would almost certainly result in warming the planet by significantly more than 2°C.<sup>9</sup> The major actors are moving into the right direction, but far too slowly.

In the climate-negotiations-as-usual process, the world's countries cling to their usual long winded approach, in which complex interests are weighed up in minute detail. The major polluters lay the responsibility at each other's doors: China and other newly-industrializing economies, supported by the Least Developed Countries, point to the high per-capita

<sup>9</sup> Joeri Rogelj et al., 'Halfway to Copenhagen, no way to 2°C' [2009] Nature Reports Climate Change <[www.nature.com/climate/2009/0907/full/climate.2009.57.html](http://www.nature.com/climate/2009/0907/full/climate.2009.57.html)> accessed 03 July 2009.

emissions produced by the industrialized countries and their emissions-based economic growth since the Industrial Revolution. By way of contrast, the industrialized countries maintain that China is now the largest emitter of GHGs and that emissions in the developing regions, especially Asia, will increase substantially in the future. Finally, the EU stresses that the USA's per-capita emissions are twice as high as its own. The Copenhagen climate conference reflected these beggar-my-neighbor strategies, translating into results at the lowest common denominator. The negotiations appear to have all but stalled now. Therefore a transparent and fair concept for international burden sharing is needed.

### 3. THE BUDGET APPROACH—SOLVING THE CLIMATE DILEMMA

In support of the international climate negotiations, the German Advisory Council on Global Change developed a new approach that derives national emissions budgets by determining the total ecologically tolerable quantity of global CO<sub>2</sub> emissions up to the year 2050, and apportioning this in line with fundamental principles of equity.<sup>10</sup> Based on a simple, transparent and equitable 'climate formula', all countries' reduction commitments and the requisite financial transfers between industrialized and developing countries are established and calculated on a clear and comprehensible basis.

#### 3.1. *Basic Principles*

We start with the scientific knowledge that in order to keep atmospheric warming below 2°C, the total amount of anthropogenic CO<sub>2</sub> emitted to the atmosphere must be limited.<sup>11</sup> Therefore, the budget approach rests of a binding cap on the total amount of CO<sub>2</sub> that can be emitted from fossil sources up to 2050 (or an alternative meaningful deadline). This ceiling is

<sup>10</sup> See for similar concepts: Sven Bode, 'Equal emissions per capita over time—A Proposal to combining responsibility and equity of rights for post 2012 GHG emission entitlement allocation' (2004) 14 *European Environment* 300; Development Research Center of the State Council of China, Project Team Climate Change, 'Greenhouse Gas Emissions Reduction. A Theoretical Framework and Global Solutions' in: Ross Garnaut et al. (eds), *China's New Place in a World in Crisis* (Brookings Institution Press 2009) 389; J. Pan and Y. Chen, 'Carbon Budget Proposal, Research Centre for Sustainable Development' Chinese Academy of Social Sciences, Beijing (2009).

<sup>11</sup> Malte Meinshausen et al. (n. 7).

an essential prerequisite for ensuring, with a certain level of probability, that the 2°C-guardrail will not be crossed. In this way, humankind would have a specific and defined amount of emissions available. The allocation of this amount would be subject to negotiations; in particular, it can be broken down into national emissions budgets based on equal-per-capita entitlements worldwide.

Proposals for the allocation of emission rights have particularly good prospects of being accepted by the international community if they are viewed as fundamentally equitable by as many stakeholders and affected parties as possible. In this context, we propose that the allocation should be based on three 'first principles', namely the polluter-pays principle, the precautionary principle, and the principle of equality.

In accordance with the *polluter-pays principle*, the industrialized countries have a particular responsibility to cut their greenhouse gas emissions due to their high cumulative emissions in the past. Unless the industrialized countries act according to this responsibility, no global climate treaty will hardly ever be achieved.

In line with the principle of sustainability<sup>12</sup> and based on the 2°C-guardrail, the *precautionary principle*<sup>13</sup> must be respected; this means that timely action is required to prevent irreversible damage to present and future generations. The global emissions budget as induced by the 2°C guardrail requires not only the industrialized countries but also the emerging economies and developing countries to adopt a course towards a low-carbon future. 'Catch-up' development in Africa, Asia and Latin America during the 21st century that is based primarily on fossil fuels would gamble with many of humankind's natural life-support systems.

Conversely, the populations of the industrialized countries do not have a natural right to per-capita emissions many times greater than those of the developing countries. The *principle of equality*—which postulates individuals' equal rights, without distinction, to the benefits of the global commons—is recognized by many countries but is not yet enshrined in law. The UN General Assembly<sup>14</sup> and the UNFCCC<sup>15</sup> acknowledge 'that change in the Earth's climate and its adverse effects are a common concern of humankind'. From a theory-of-justice perspective, this concern does

<sup>12</sup> Article 3, Paragraph 4, first sentence UNFCCC.

<sup>13</sup> Article 3, Paragraph 3 UNFCCC.

<sup>14</sup> Resolution 43/53, 1989.

<sup>15</sup> See Preamble of the UNFCCC.

not permit any differentiation based on national or individual interests.<sup>16</sup> It requires emissions to be allocated in a manner which reflects the interests of the global community and humankind as a whole. The principle of equality does imply that equity in per-capita emissions should be the basis for the allocation of national emissions budgets.

Due to the socio-economic conditions, the global budget allocated on a country-by-country level cannot be utilized entirely without time constraints, as the 2°C-line can only be held if realistic decarbonization dynamics are taken into full account. Firstly, it takes decades to restructure emission-intensive infrastructures and production processes and to transform consumer behaviour, so there is no easy way to reduce global emissions at high speed. Secondly, global decarbonization must commence as soon as possible, as the best of our current knowledge indicates that any postponement now would necessitate emissions reductions at an unattainable rate in future. Thirdly, at the end of the budget period, i.e. around 2050, a virtually zero-emissions economy must have emerged, as the remaining environmental space for the subsequent decades is likely to be very limited: the accumulation of CO<sub>2</sub> in the Earth System by the middle of this century would be just about tolerable, yet the high carbon load would persist for a long time due to the geophysical and biochemical processes and peculiarities involved.

In order to accommodate these constraints, the budget approach must therefore be fleshed out with specific rules:

1. *Global interim targets:* As an important milestone, it should be stipulated that the global CO<sub>2</sub> emissions curve must peak between 2015 and 2020 and decline thereafter (see Fig. 1). As a further milestone it should be stipulated that by 2050 full decarbonization is to be widely accomplished.
2. *National decarbonization road maps and interim targets:* All countries should pledge to develop and present national strategies to manage their own CO<sub>2</sub> budgets ('decarbonization road maps'). These should be based on realistic evaluations of the national emissions reduction potentials as a function of time; their plausibility and operability should be verified by an independent international institution. This would reduce the risk that certain governments would postpone the necessary action indefinitely and leave all burdens to future generations. By

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<sup>16</sup> John Rawls, *A Theory of Justice* (Cambridge University Press 1971).



allowing high flexibility in the choice of transformation pathways, the strengthening of countries' individual responsibility is coupled with accountability to the international community.

3. *Interregional flexibility*: The unrestricted and efficient management of national budgets via a global CO<sub>2</sub>-emissions trading system is highly recommended. As a prerequisite, the national budgets must be declared to be tradable quota. International emissions trading allows and encourages a very wide range of bilateral and multilateral transactions. For example, trading permits industrialized countries, who have used up almost all of their CO<sub>2</sub> budget, to purchase allowances, but also enhances the incentives for countries to reduce their own emissions. Substantial capital flows are generated for the developing countries and here too, incentives are created for emissions reductions, as CO<sub>2</sub> budget surpluses can be traded and monetized.

### 3.2. *Calculating National Emission Budgets*

For the proposed budget approach, the total available global emissions budget of CO<sub>2</sub> from fossil sources that allows compliance with the 2°C-guardrail is calculated for a specific period. This amount is then allocated among the individual countries, based on equal cumulative per-capita emissions over a fixed period.

It is then very easy to determine the national budgets because the model only contains *four*—political, i.e. negotiable—parameters: the period for the total budgeting as defined by a *start* year and an *end* year; the *probability* of achieving compliance with the 2°C-guardrail, and finally, a *demographic reference year* for the national population strengths that form the basis for the concrete allocation figures. We propose that the year 2050 be selected as the end point for the budget period, as there is no doubt that most of the requisite emissions reductions will need to have been achieved by that date.

The other three parameters determine the overall budget amount and its relative distribution. They are therefore parameters of the utmost political relevance.

- The *start year* determines the point at which global equitable emissions management—in other words, the proposed distribution formula—should come into effect. If the start year is backdated (i.e., a year in the past is defined as the commencement point), the budget to be distributed will include emissions that have already taken place. This



inevitably means that countries with high historical per-capita emissions will have a proportionately smaller emissions budget available in the future.

- Due to the complexity of the climate system, it is not possible to calculate *precisely* what additional amount of CO<sub>2</sub> can still be absorbed by the Earth's atmosphere without breaching the 2°C-guardrail. However, with the help of so-called ensemble calculations and using the best simulation models available worldwide as well as sophisticated statistical methodologies, climate science can compute the *probabilities* that a specific total amount of emissions will remain 'sub-critical' and will thus be compatible with restricting warming to 2°C. The global budget that is available for distribution can thus be calculated directly on the basis of a political global risk assessment: the higher the probability of compliance with the 2°C-guardrail that is chosen, the smaller the budget to be spent world-wide over the chosen period must be. It is crucial to note at this point that probabilities of averting damage that fall within the 50–90%-range—i.e., the range generally discussed in relation to the climate problem—would be considered completely unacceptable in every-day contexts (e.g. with respect to traffic safety, prevention of infectious diseases, etc.)! Unfortunately, global environmental change has progressed too far already for a genuine precautionary policy that satisfies the criteria of common sense.
- The *demographic reference year* determines the national share of the global budget based on the country's relative demographic weight for the given year. The later the reference year that is chosen, the higher the benefit for countries with rapidly growing populations as their relative demographic weight is steadily increasing and, concomitantly, their relative cumulative-emissions share. Instead of accounting for the population figures in a single year, allocation could also be based on the (mean) population weight over a longer period, involving projections of trends. The argument in favour of using a fixed reference year is that in countries with high population growth rates, it could serve as an incentive for demographic change, since unabated population growth after the reference year would stretch the allocated budget, effectively reducing emissions per capita. This reflects the fact that the absolute amount of cumulative emissions world-wide is limited, so per-capita allowances shrink with a growing global population.

In a broader perspective, the outlined budget approach serves to analyze the low-carbon transformation challenge from four angles:

- Taking stock with respect to national emissions budgets—defining the magnitude of the transformation challenge;
- Developing the foundations for a new global climate architecture—simplifying the negotiation process and focusing on environmental integrity;
- Proposing an institutional design for a low-carbon world economy—setting incentives for a deep transformation process;
- Outlining new climate and development partnership patterns among high-emitting and low-emitting countries.

### 3.3. *Taking Stock Based on National Emissions Budgets*

The budget approach allows to discuss—in quantitative terms—different policy options based on different decisions regarding the four parameters of the ‘climate formula’ (see Table 1). Here we outline one of the evident (although by no means self-evident) options, termed ‘Future Responsibility’. It already constitutes a compromise between what is scientifically necessary, on the one hand, and politically and economically feasible, on the other: the probability of holding the 2°C-line is set at 67% and the global emissions budget is apportioned based on the current reference year (i.e. 2010). The historical responsibility of developed countries for past emissions would not be considered explicitly in the national budgets available. Therefore, additional compensation mechanisms in developing countries, particularly support and financial resources for adaptation measures, could help bring about a more politically acceptable, yet reasonably equitable agreement.<sup>17</sup>

Table 1 shows examples of the national emissions budgets, based on a permissible global budget of 750 Gt CO<sub>2</sub> from fossil sources between 2010 and 2050 that is allocated to the countries on an equal per-capita basis. In this option, the start year 2010 would appear to be a suitable demographic reference year. As a consequence, every person (based on the 2010 world population) would be allocated a budget of around 110 t CO<sub>2</sub> emissions for the next 40 years, equivalent to average annual per-capita emissions of approx. 2.7 t CO<sub>2</sub>. However, in order to safeguard the transition to those low emissions that are permissible post-2050, global mean per-capita

<sup>17</sup> WBGU, ‘Solving the Climate Dilemma. The Budget Approach’ (Special Report 2009) 33. We also calculated a “Historical Responsibility” scenario, with a 75% probability of compliance with the 2°C guard rail, adopting 1990 at the start year for the budget period, *ibid.*, 25–26.

Table 1. Allocation option 'Future responsibility', 2010–2050; 67% probability of compliance with the 2°C guard rail; 2010 as the reference year for population data. Only includes CO<sub>2</sub> emissions from fossil sources. CO<sub>2</sub> emissions for 2008 and population numbers for 2010 are estimations.

	Share of world population in 2010 [%]	Budget 2010–2050 [Gt CO <sub>2</sub> ]		Estimated emissions in 2008 [Gt CO <sub>2</sub> ]	Reach of the budget lifetime, assuming annual emissions as in 2008 [years]
		Total period	Per year		
Germany	1.2	9.0	0.22	0.91	10
USA	4.6	35	0.85	6.1	6
China	20	148	3.6	6.2	24
Brazil	2.8	21	0.52	0.46	46
Burkina Faso	0.24	1.8	0.043	0.00062	2892
Japan	1.8	14	0.34	1.3	11
Russia	2.0	15	0.37	1.6	9
Mexico	1.6	12	0.29	0.46	26
Indonesia	3.4	25	0.62	0.38	67
India	18	133	3.2	1.5	88
Maldives	0.0058	0.043	0.0011	0.00071	61
EU	7.2	54	1.3	4.5	12
<i>World</i>	100	750	18	30	25

Source: WBGU 2009, using data from: Meinshausen et al., 2009; WRI-CAIT, 2009; U.S. Census Bureau, 2009

emissions at the end of the budget period must lie well below this average: by 2050, global CO<sub>2</sub> emissions must be around two thirds lower than the 1990 baseline despite a growing world population. This would result in an entitlement to annual per-capita emissions of around 1 t CO<sub>2</sub> by 2050! Fig. 2 shows selected countries and the mean annual budget to which they would be entitled, as compared with their respective emissions in 2005.

The results depict a dramatic state of affairs for the USA, Germany, and the EU: for instance, at current emissions levels the German CO<sub>2</sub> budget allocated according to the option discussed would be exhausted within 10 years. In the light of this situation, it is clear that the industrialized countries must carry out a rapid and comprehensive decarbonization of their economies by 2050. However, even drastic domestic reduction efforts will not be enough to keep OECD countries within their budget constraints. It is remarkable that within this scenario, the situation for China (and similar for Mexico, Argentina, Chile or Thailand) is also rather challenging. If China maintains its emissions on a 2008 level, its budget would

only last for some 24 years—a similar observation applies for the world as a whole.<sup>18</sup>

On the other hand, it is neither possible nor necessary for all countries to tackle mitigation solely through their own domestic emissions reductions efforts. The allocation scheme proposed is equitable, yet should be regarded as the basis for effective and efficient burden-sharing. This can take place in a variety of ways: alongside domestic emissions reductions, the trading of emission allowances is likely to play a key role, but other flexible mechanisms for international climate cooperation, along with financial and technology transfers, can help to speed up progress towards low-carbon development all over the world.

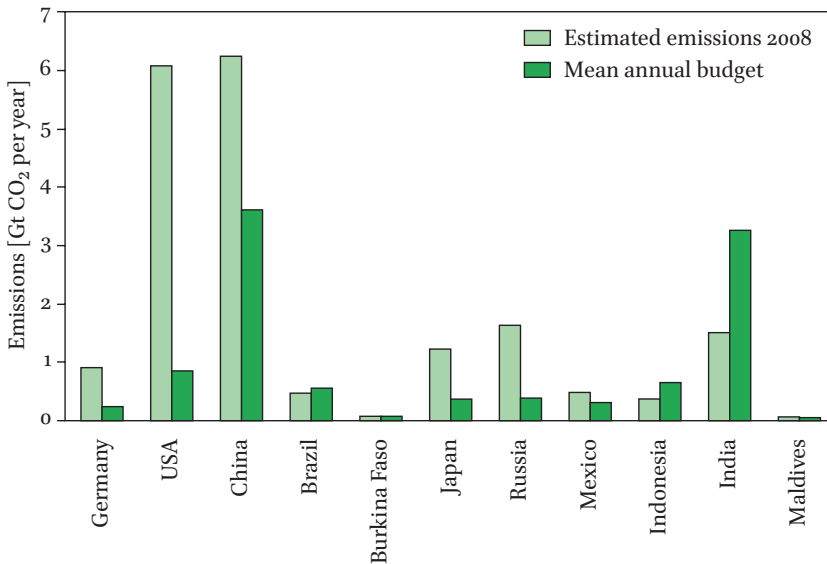
### 3.4. *Foundations for a New Global Climate Architecture*

The budget approach has the potential to make two critical contributions to the construction of a global climate architecture, namely to maintain the environmental integrity of a new climate regime while breaking the negotiation stalemate between the major global emitters. This ‘Gordian Knot of climate policy’—a knot tied mainly by the USA, the EU, China and the G77 countries—can be described in terms of game theory as a ‘social dilemma’: rationally justified individual preferences lead collectively to an outcome whereby all players end up worse off in the future, and furthermore—in the case of climate change—sustain massive and irreversible damage to the Earth’s life-support systems. Unless the key players rise above the tactics of self-interest at the ongoing and forthcoming climate negotiations, ‘dangerous anthropogenic interference with the climate system’ (Article 2 UNFCCC) can no longer be prevented.

A further factor impeding the negotiations is that even an agreement on ambitious and binding greenhouse-gas reductions between the industrialized countries and the populous or fast-growing newly industrializing economies is no longer enough to keep warming below the 2°C-limit. Many developing countries are now achieving high dynamic economic growth, accompanied by rising fossil fuel consumption. For that reason,

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<sup>18</sup> All figures refer to fossil CO<sub>2</sub> emissions (i.e. without land-use changes). The emissions from land-use changes between 2010–2050 are estimated at around 60 Gt CO<sub>2</sub>. We consider these additional emissions in our calculations of future climatic warming. But in relation to land-use changes, we suggest that a separate regime is likely to be more successful. The key issue is that allocating the national emissions budgets creates a shared responsibility for climate change mitigation.



Source: WBGU 2009

Figure 2. Fossil CO<sub>2</sub> emissions in 2008 (estimated figures) and permissible average annual budgets under allocation option 'Future responsibility' for selected countries.

a course must be set on a global basis towards a low-carbon economy. It is clear that even for the majority of developing countries, doggedly pursuing fossil-fuel-driven growth is no longer an option if dangerous climate change is to be averted. Economic and social development must be decoupled from greenhouse gas emissions worldwide.

But any future attempt to accomplish this based on the business-as-usual model of international climate policy would require all 194 signatories (as of December 2009) to the UNFCCC to negotiate emissions stabilization and reduction targets for around 100 countries! This is the group of countries that already is emitting more than the yearly emissions allowance of around 2.7 t CO<sub>2</sub> per capita for the 2010-to-2050 budget period. The process is at risk of deteriorating into a 'talking shop' in which negotiators haggle over every decimal point and comma at marathon bargaining sessions even as global warming spirals out of control. Against this background, the budget approach presents the basic structure for a global architecture for climate protection, and shows how compliance with the 2°C-guardrail can be achieved. The proposal that countries agree on a simple and equitable 'climate formula' as the basis on which all countries can be allocated

a precisely determined national emissions budget in the future is the fundamental concept behind the global climate compromise. As a result, the budget approach reduces the complexity of the climate negotiations and thus identifies a way forward for the climate negotiation process which helps countries to move on from their narrow national agendas.

Based on this analysis, we conclude that parties to the UNFCCC will have to agree on the following general principles in the next negotiation rounds:

- The *2°C-guardrail* is adopted as legally binding in international law.
- For carbon dioxide—the greenhouse gas crucial to climate protection efforts in the long term—a *global emissions budget* for fossil sources up to the year 2050 that is compatible with the *2°C-guardrail* is adopted on a legally binding basis as well.
- The following *milestones* are stipulated: (1) The peak year of worldwide CO<sub>2</sub> emissions is to be reached between 2015 and 2020; (2) global emissions by mid-century are to be reduced to a level consistent with the narrow emissions budget remaining post-2050.
- The global CO<sub>2</sub> budget is distributed among the world's population on an equal per-capita basis so that *national CO<sub>2</sub> budgets* can be calculated for all countries, and adopted on a legally binding basis. These budgets provide orientation for countries on how swiftly and substantially their CO<sub>2</sub> emissions need to be reduced.
- Each country is committed to producing internationally and objectively verifiable *decarbonisation road maps*, which provide information on the planned national emissions path up to the year 2050. These road maps should be based on the national CO<sub>2</sub> budgets as well as on the respective national emissions reduction potentials.
- In addition, for the countries with presently high per-capita emissions, *reduction commitments up to 2020* are agreed in order to avoid delaying decarbonisation efforts.
- *Flexible mechanisms* (international emissions trading and Joint Implementation) as well as appropriate additional financial and technological transfers by the industrialized countries are agreed upon.
- The *separate regulation* of CO<sub>2</sub> from non-fossil sources, other relevant greenhouse gases and future radiative-forcing substances is to be pursued intensively as it creates opportunities for swift reductions in total emissions harmful to the climate.

#### 4. THE INSTITUTIONAL DESIGN FOR A LOW-CARBON GLOBAL ECONOMY

The budget approach does not only serve as a compass for the future climate regime, it provides at the same time the fundamental elements of an institutional design for a global low-carbon economy. The approach provides great transparency as it explicitly reveals the global and national CO<sub>2</sub> scarcities that have to be accounted for in the creation of public and private welfare. The pertinent scarcities are actually of a character that should compel many countries to develop low-carbon strategies without further delay. Moreover, the obvious quantitative limitations as reflected in the global and the national budgets, respectively, create clear incentives for the transition towards a trans-fossil era. The budgets define the space in which the economic actors need to accommodate their strategies and activities. For the private sector, this transparency and the long-term constraints agreed upon result in stability, anticipatory certainty for the whole budget period from 2010–2050, a global level playing field, and a clear system of incentives for investments in the future and low-carbon innovation efforts. Within the framework of the budget approach, every success in reducing emissions is rewarded equally, regardless of the country in which it is achieved. CO<sub>2</sub>-emissions reductions translate into a form of capital. Climate protection and carbon efficiency become key factors in boosting competitiveness. International competition for the most innovative decarbonization strategy, i.e. a race to the top, can finally start to roll.

We have demonstrated that the high-emitting countries will not be able to meet their climate challenges within their own national budgets. When implementing the budget approach, the industrialized countries in particular would need to decide to what extent they wish to undertake the necessary greenhouse gas reductions at home or would rather make use of flexible mechanisms (emissions trading, Joint Implementation) which permit cost-efficient fulfilment of national reduction commitments. Emissions trading will therefore be a key institutional element of a global low-carbon economy and a major driver of low-carbon innovation.

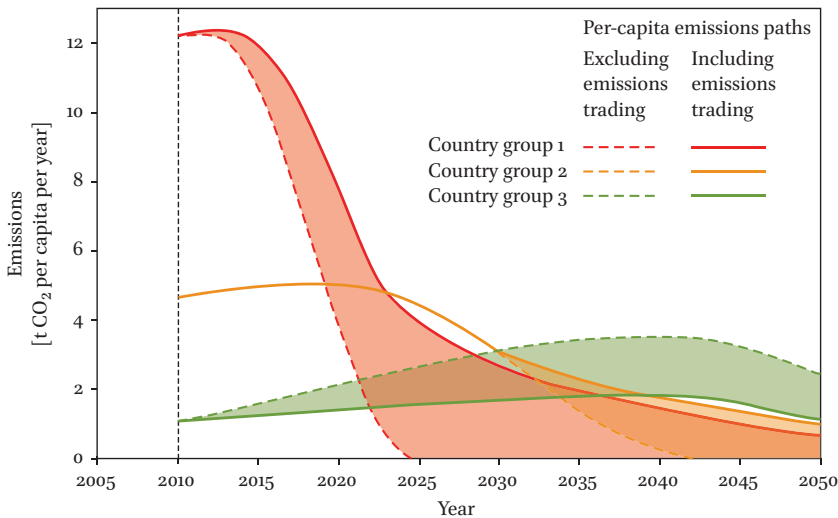
How would the trading patterns between countries look like? Three major groups can be distinguished (Fig. 3) according to the number of years which their allocated budgets can be expected to last (excluding emissions trading):



- Group 1: Countries whose budget—at their current rate of emissions—would be exhausted in *less than 20 years*. Under the assumption of a linear reduction trajectory, these economies (around 60 countries including the EU, US, Saudi Arabia, Venezuela, and Malaysia) would therefore have to achieve zero emissions before 2025/30 if they are to stay within the budget.
- Group 2: Countries whose budget—at their current rate of emissions—would last for at most *20–40 years* (around 30 countries including China, Mexico, Chile, and Thailand), i.e., roughly till the end of the global budget period in 2050.
- Group 3: Countries whose budget—at their current rate of emissions—would last for *more than 40 years* (some 95 countries in total including the least developed countries in Subsaharan Africa, Vietnam, and India), i.e., beyond the end of the global budget period.

For all our calculations, assumptions for the ‘current rate of emissions’ are based on estimated values for 2008. Group 3-countries would be the main suppliers of allowances, as even Group 2-countries would probably only be able to generate small emissions surpluses over the entire budget period. Emissions trading would create novel prospects for income generation for the suppliers of emission allowances. For climate policy to succeed, it would be essential that those Group 3-countries that do not fully exploit their emissions budget (even when experiencing rapid economic growth) invest their revenues from the sale of allowances in low-emissions technologies rather than remaining on ‘fossil trajectories’. Thus not only national decarbonization milestones should be set; there should also be at least a partial earmarking of revenues from inter-country emissions trading. In such a scheme, a substantial proportion of the so-generated revenues should be invested in low-emissions technologies, especially into energy production from renewables sources.

Joint Implementation (JI) is a further flexible mechanism, established by the Kyoto Protocol, and also relevant for the budget approach. JI allows countries subject to reduction commitments to create additional domestic emission rights by carrying out emissions reduction projects in other countries that have also accepted commitments to limit emissions. Within the budget approach, Joint Implementation would create incentives for industrialized and other high-emission countries to invest in mitigation technologies in developing countries and emerging economies, i.e., countries belonging to Group 2 or Group 3. For countries in those groups that



Source: WBGU 2009

Figure 3. Examples of per-capita emissions paths of CO<sub>2</sub> from fossil sources for three groups of countries according to the WBGU budget approach, which could emerge through emissions trading (*unbroken curves*). Here it is assumed that the countries of group 1 (> 5,4 t CO<sub>2</sub> per capita per year) will raise their budgets by 75% by purchasing emission rights for 122 Gt CO<sub>2</sub>. The countries in group 2 (2,7–5,4 t CO<sub>2</sub> per capita per year) purchase additional emission rights for a total amount of 41 Gt CO<sub>2</sub>. The countries of group 3 (< 2,7 t CO<sub>2</sub> per capita per year) become sellers of a total of 163 Gt CO<sub>2</sub> and, accordingly, their budget sinks by approximately 43%. Towards the end of the budget time period there is a convergence of the actual CO<sub>2</sub> emissions at approximately 1 t CO<sub>2</sub> per capita per year (relating to the population in 2010). The *broken curves* show the theoretical per-capita emissions paths for CO<sub>2</sub> without emissions trading. The areas between the curves illustrate the traded amount of emission allowances. Due to the fact that the illustration shows the per-capita situation and the country groups have varying sizes of population, the areas between the purchasing country groups 1 and 2 do not coincide with the area of the selling country group 3.

are unable to sell emission rights, JI is a promising mechanism by which to finance their transformation processes. The basis for this very mechanism would be substantially broadened in comparison to the Kyoto Protocol, because national CO<sub>2</sub>-emissions budgets would be allocated to all states, with the Clean Development Mechanism (CDM) being subsumed under Joint Implementation.

To make the budget approach and the global emissions trading scheme work, we recommend the establishment of a World Climate Bank.<sup>19</sup> The World Climate Bank would have several important tasks. Firstly, it would be responsible for the monitoring of the actual emissions of countries and the imposition of sanctions. To ensure, in a systematic manner, that budgets are not exceeded, it would be helpful to set national milestones for manageable time periods and to develop other corresponding rules. The sanction rules should be publicized at the beginning of the budget period and should be sufficiently effective to create strong incentives to remain within the budget constraints. Secondly, to avoid that countries make wasteful use of their national budgets in the early phases of the budget period and thus become 'carbon bankrupt' later, all nations should be obliged to develop and publish decarbonization roadmaps. They have to be assessed by and improved with the help of the World Climate Bank. Thirdly, The World Climate Bank should play an important role in shaping Joint Implementation partnerships. Fourthly, the bank would need to monitor the development over time of the national (and thus of the global) emissions, in order to ensure compliance with the 2°C-guardrail. In particular, it is important to make sure that global CO<sub>2</sub>-emissions start to decrease at some point during the period from 2015 to 2020 and reach very low levels towards the year 2050. In order to accomplish that global CO<sub>2</sub> emissions actually peak prior to 2020, it would be expedient to structure the use of the flexible mechanisms by introducing trading periods. The World Climate Bank, as an institutional innovation, would form a 'climate pillar' of the revised global economic governance architecture, becoming as important as the Bretton Woods institutions (International Monetary Fund, World Bank) and the World Trade Organization.

## 5. NEW CLIMATE PARTNERSHIP PATTERNS

If the world succeeds in setting a course towards a global low-carbon economy via the budget approach, then the national actors will need to stick closely to the following script: More than 100 countries, whose emissions are already today beyond the 2.7 t-CO<sub>2</sub>-per-capita-emissions amount that

<sup>19</sup> For a similar concept see Lutz Wicke, *Beyond Kyoto—A New Global Climate Certificate System. Continuing Kyoto Commitments or a Global 'Cap and Trade' Scheme for a Sustainable Climate Policy?* (Springer 2005).

would be available on average between 2010 and 2050, should initiate, as quickly as possible, a transformation process which allows them to stabilize their emissions before long and then to move towards almost complete decarbonization. Only 65 countries have economies whose emissions are currently below 1–1.5 t CO<sub>2</sub> per capita per year and are thus (mostly *non-volens*) climate friendly. The CO<sub>2</sub> budgets of the industrialized countries are extremely limited. These countries should therefore combine strategies for the radical restructuring of their ‘fossil’ economies with the use of flexible mechanisms (such as technology transfer to reduce greenhouse gas emissions in developing countries) and the purchase of substantial quantities of emission allowances. Many emerging economies also need to make substantial decarbonization efforts if they are to stay within their budgets by mid-century without having to purchase additional emission certificates. The majority of emerging economies are therefore highly unlikely to become suppliers of tradable allowances. This gives developing countries with consistently low levels of emissions an overwhelming strategic importance, as owners—and sellers—of such emission rights. The budget approach offers them an unprecedented opportunity to accelerate their future development through technology and financial transfers, and to move towards a low-carbon industrial metabolism from the outset. It becomes clear that the budget approach binds together climate policies, the creation of essential elements of institutional design for a climate-efficient economy, and mechanisms for a global low-carbon development partnership.

From the above clusters of interests, it becomes apparent, *firstly*, that an historic climate partnership between Group 1-countries (essentially the industrialized countries) and Group 3-countries (essentially today’s poorest countries) is vital in solving the climate problem. They will operate on the principle of technology and financial transfers in exchange for ‘budget surpluses’. The ‘donors’ and ‘recipients’ who have traditionally been the key actors in development cooperation thus become partners with mutual common interests.<sup>20</sup> International climate change mitigation must thus go hand in hand with a global development partnership between

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<sup>20</sup> Dirk Messner, ‘Four Lessons from the Present Global Financial Crisis for the 21st Century’, in Ashwani Kumar and Dirk Messner (eds), *Power Shifts and Global Governance. Challenges from North and South* (Anthem Press 2009), 42.

'high-emission countries' and 'low-emission countries'.<sup>21</sup> For many developing nations, these transfers hold the key to a zero-emissions future, as the development of their sustainable energy systems could largely be funded through emissions trading. The dual benefit is that these countries can avoid the burden of fossil path dependency without forfeiting their opportunities for development.

A more detailed analysis of the potential suppliers of emission allowances generates the following, fairly realistic scenario: sub-Saharan Africa is the region with the largest number of countries that could sell their surpluses. However, many of the suppliers in Group 3 are small economies which—from a potential purchaser's perspective—have only very modest amounts of greenhouse gas emissions available to sell. From the perspective of the Group 1-countries, the more attractive potential suppliers with large volumes of emission allowances are India (population: 1.2 billion; budget would last for 88 years if emissions remain constant, see Table 1), Bangladesh (population: 164 million; 384 years), Pakistan (population: 185 million; 125 years) and Ethiopia (population: 85 million; 1251 years). Although their geostrategic role is negligible at present, climate change issues in the future could make them major players with whom the industrialized countries should maintain particularly constructive relations.

*Secondly*, it is clear that emissions trading between Group 1-countries and Group 2-countries is likely to be very limited due to the minimal or modest budgets available to both groups. Nonetheless, the industrialized countries are likely to have great interest in technology partnerships on equal terms in order to reduce the greenhouse gas intensity of the newly-industrializing countries (especially China) and thus to prevent these countries from becoming major purchasers of emission allowances themselves. Competition between Group 1 and Group 2 for Group 3's limited supply of emission allowances would undoubtedly drive up prices. This insight could encourage the formation of climate alliances between China, the EU and the USA, for example. Despite such common interests, however, there is likely to be intense future competition between the industrialized countries and China in particular regarding technological leadership during the phase of global decarbonization.

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<sup>21</sup> Ottmar Edenhofer et al., *The Economics of Decarbonization* (Potsdam Institute for Climate Impact Research 2009), 43 et seq.; Leggewie, C./D. Messner (2012): The low carbon transformation—a social science perspective, *Journal for Renewable and Sustainable Energy*, No. 4, 2012, doi: 10.1063/1.4730138 (added in October 2012).

*Thirdly*, our analysis shows that the two most important emerging economies in Asia, namely China and India, will be confronted with very different challenges under the budget approach. China, due to its impressive economic growth dynamics and an already highly level of per-capita emissions, will need to implement a comprehensive decarbonization strategy with great urgency (McKinsey, 2009).<sup>22</sup> India, by way of contrast, due to its still relatively low per-capita emissions, has the chance to pursue a gentler transformation pathway towards a low-carbon economy, despite its high economic growth potential: In other words, India will face far less time pressure than China in starting to decouple economic development from greenhouse gas emissions. The sooner India recognizes this opportunity to avoid 'catch-up' carbonization, the greater its prospects of becoming a major supplier of emission allowances in future. India could thus greatly facilitate its pathway towards a low-carbon future through partnership with the industrialized countries. Equally, climate cooperation with India would be of great strategic interest for the North, especially for securing its own access to India's emission allowances. In summary, India could become a key actor and major winner if a world climate treaty would be adopted in line with the budget approach after all.

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<sup>22</sup> McKinsey, *Pathways to a Low-Carbon Economy. Version 2 of the Global Greenhouse Gas Abatement cost Curve* (McKinsey & Company 2009).

