Methodologies for carbon budgets in South Africa

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Summary

The scientific principle that supports the concept of a 'carbon budget' is that climate change is driven by the concentration of greenhouse gases (GHGs) in the atmosphere. A carbon budget is the area under a trajectory of GHG emissions. It is not fundamentally different from a cap on emissions. A process of carbon budgeting involves the allocation of a limited resource, which should be based on equity and science (best available information). The goal of a low-carbon planning process is to remain within the budget, that is, at or under a GHG trajectory.

Carbon budgets frame the problem as sharing a scarce resource. Effort-sharing approaches focus on bringing emissions down from their rising trajectory, while resource-sharing approaches focus on allocating the area under a desired trajectory. The two approaches are two sides of the same coin, and for both, it is important the outcomes are fair shares.

Significant work on climate change preceded the pledge by South Africa for its GHG emissions to follow a 'peak, plateau and decline' (PPD) trajectory.

Climate policy sets a benchmark national GHG emission trajectory, building an upper and lower range around the 'peak, plateau and decline' path identified by Cabinet in 2008, pledged by President Zuma in Copenhagen in 2009, and formally submitted to the UNFCCC in 2010. Our climate policy, as set out in the White Paper 2011, has set a trajectory that limits emissions – initially relative to growth, and later in absolute terms. The National Development Plan launched by the NPC on 11/11/11 explores a carbon budget approach and elements for good design, including a "benchmark total carbon budget", but stops short of proposing a number.

A national carbon budget (NCB) of 19 Gt CO2–eq for 2010-2050 is readily calculated as the area below the trajectory. This number is an intermediate value between 15 and 23 Gt for the lower and upper bounds specified in the White Paper (see section 5.3).

Arguing from a strong perspective of equity, experts from China and India propose a much smaller carbon budget (7 or 11 Gt) than in South Africa's climate policy – little more than a third to half of the national carbon budget (19 Gt CO2–eq over 40 years). Some South African business leaders have proposed a more ambitious NCB, at 10.2 Gt. They point out that only 23 years remain before we must stop emitting CO_2. In short, some have proposed more stringent national carbon budgets than would be derived even from the area below the range set in our climate policy – even if we took the lower end.

Climate policy mandates the development of sectoral carbon budgets (SCBs) over the next two years, by October 2013. Good alignment will be needed with the New Growth Path (EDD 2011), industrial policy action plan (RSA 2010a), and other plans for relevant sectors of the economy – which includes most of them. Our electricity plan (IRP2010) results in a reduction of the emissions intensity of electricity supply by 34%, but by 2030. This is equivalent to a 34% deviation below BAU which is pledged for SA as a whole, but ten years later than 2020. Both framings are relative rather than absolute reductions.

The paper reviews previous work at national and sectoral level. Previous work on mitigation potential included the LTMS, on consideration of which Cabinet outlined its vision and strategic direction for emissions to peak, plateau and decline. Previous work directly on carbon budgets was commissioned by WWF, outlining the approach for a low-carbon action plan. The report suggested an important principle for allocation, namely that sectors should motivate for their share of the NCB based on the best used, in particular the most carbon-effective contribution to South Africa's development needs. The paper examines analytical tools based on work in South Africa, to model the energy economy as a system.

Several studies focusing on specific sectors have been undertaken to date (G:enesis 2008, 2010; Camco & TIPS 2010; Cohen, Lewis and Mason-Jones 2012), covering the major emitting sectors in the SA economy in more detail than national or economy-wide studies. While further research can always enhance information, existing studies have included many sectors – major ones including electricity generation, chemicals, liquid fuels, iron and steel, non-ferrous metals; mining; and a number of specific minerals; and several others (see section). Sectoral analysis

might in future assist in building the motivation by sectors and / or major emitting entities for the developmental benefits of allocating them a share of the carbon budget.

Considering international experience, the EU process of member states submitting national allocation plans to the European Commission and the third phase of the EU Emissions Trading Scheme (ETS) is to some extent comparable to bidding for an overall carbon budget. Methods for allocating allowances in the ETS started with grand-fathering and bench-marking, but over time are moving to full auctioning. The link to instruments that apply to sectors not covered by the ETS points to the need to design the interaction between instruments carefully.

The second half of the paper (sections 6 to 10) outlines, based on a reading of the White Paper, a process of national negotiation is crucial to allocation of a NCB to sectors. We outline our conception of the overall process in Figure 2, and it may be helpful to readers to consider that diagram in reading the following.

The overall objective of a national negotiation would be to allocate the national carbon budget in a fair, robust and adequate manner. Consistent with our climate policy, the NCB would be allocated to sectors, sub-sectors, entities and firms. An allocation process would need to be mandated at the Presidential level and take place in an appropriate forum, guided by Cabinet or an inter-ministerial committee. The process should have wide participation from all parts of South African society.

An analytical process should define an *initial* allocation of the NCB across sectors. Criteria would need to be defined for initially allocating shares, which should provide an objective analytical starting point. A developmental motivation for actual allocations would be required from sectors later in the process.

Clear definitions of sectors to be allocated carbon budgets will be needed, and any differences between these definitions and sectoral definitions for other purposes (GHG inventories, energy balances, SIC codes) would need to be specified. It is highly desirable that these definitions are fully aligned, or least differences well understood. If thresholds for entities that would have a direct allocation are to be used, the thresholds need to be clearly identified and have an objective basis. Provision will need to be made for new entrants into sectors of the economy, such as setting aside a reserve for new facilities. New facilities will need to be carefully designed to avoid conflict between new facilities and expansion / improvement of existing facilities.

Figure 4 illustrates how a comprehensive set of indicative sectoral carbon budgets might be derived from the overall national budget. These iSCBs would form a starting point, to which sectors and entities would respond in the next step. Sectors, sub-sectors, entities (e.g. companies) or installations should specify the policies and measures (PAMs) they intend implementing in order to remain within their budgets, according to the initial allocation as described above. Cross-cutting policies, notably a carbon tax, should also be taken into account. Before motivation for an increase, sectors should demonstrate that all PAMs are being utilised. If this can be shown, a motivation can be made for an increase in SCB, based on developmental benefit.

If the sum of all sectoral carbon budgets exceeds the national total, and a facilitative approach has failed, then an institution or several (the Presidency / Treasury / DEA) need to engage in arbitration. Following the arbitration, allocations of sectoral carbon budgets would be made.

Once SCBs are finally allocated, monitoring and evaluation (M&E) will be used to collect data on emissions, activity levels and the implementation of mitigation actions.

With more national communications for developing countries becoming more frequent – every four years with biennial updates – trends in emissions can be seen over time, including sectoral trends in emissions and any declining trends, i.e. reductions. This will be useful information for carbon budgeting, particularly for those sectors subject to sectoral regulation – that are big emitters, but where emissions are not attributable to large entities or installations and actions are across the sector. In addition to M&E, there would be MRV of implementation of mitigation actions for large entities or installations, or large actiovery lans by sectors.

Government will need to ensure that sectoral carbon budgets remain consistent within the GHG trajectory range, or what adjustment would be made if this is exceed or an individual sector exceeds its carbon budget. This could follow a facilitative approach initially, failing which mechanisms for compliance would be needed. Long-term planning against a carbon budget sends a signal that South Africa needs to make a transition to a low-carbon economy and society.

The risk of exceeding the national carbon budget is that South Africa would simply seek to renegotiate its national carbon budget internationally, even through our trajectory already exceeds a global 'fair share', and thereby risk its reputation as a responsible global citizen.

1. Introduction

Currently, GHG[1] emissions are rising rapidly(IPCC 2007b, 2007c), and this trend needs to be reversed if we are to avoid the worst impacts of climate change(IPCC 2007a). There are various ways to frame this problem. Methodologically, the problem of mitigation has typically been framed as one of reducing emissions from a business-as-usual (BAU) projection, assuming no climate policy(IPCC 2001).In this framing, the question of equity is about sharing amongst countries the effort of reducing the global emissions pathway to one which will keep us within safe limits. More recently, a different approach has emerged, which sets a global limit on cumulative emissions to 2050 (Gilbert et al. 2007; Kanitkar et al. 2010; WBGU 2009), and seeks to divide the remaining future 'carbon budget' between countries.

The scientific principle that supports the concept of a 'carbon budget' is that climate change is driven by the concentration of greenhouse gases (GHGs) in the atmosphere.

It is changes to the stock of GHGs in the atmosphere that determine radiative forcing, which together with indirect feedbacks through the coupled ocean-atmosphere system leads to temperatuer increase (IPCC 2007c). Stock changes are driven by cumulative global emissions over time, that are the root cause of climate change (Brazil 1997; Kanitkar et al. 2010). The problem of mitigation can thus also be seen as a problem of allocating a scarce resource – the quantity of emissions which can be absorbed by the atmosphere over a certain time period without a dangerous temperature increase. Conceptually, the carbon budget approach shifts the focus to sharing of the remaining resource – a very limited future carbon budget. Like any approach, carbon budgets have methodological strengths and weaknesses.

2. Concepts

2.1 Quantifying the global emissions objective

Several different concepts have been used in the international debate, and at national level, to express and quantify the mitigation problem, as an antecedent to tackling the problem of distributing responsibility amongst relevant actors for meeting a specific mitigation goal. Climate scientists have modelled the global climate system extensively to explore what kind of emissions patterns over the next couple of decades(IPCC 2005), and beyond, will restrict climate change to a 'safe' limit, internationally considered as 2°C warmer than pre-industrial times(G-8+5 2007; UNFCCC 2009, 2010, 2011b).[2] Conclusions from comparing a wide range of model results are that, to 2050, the key indicator for concentration levels is the cumulative global emissions between now and 2050; in other words the sum of all net annual emissions between now and 2050. There is also sensitivity to the global emissions level in 2050, but far less sensitivity to medium-term global emissions levels (for instance 2020)(Meinshausen et al. 2009). What this implies is that there are a number of global emissions pathways which could have the same global warming outcome; although in general, higher emissions pathways force more warming. In reality, however, the number of global pathways (bar a catastrophic event) which are possible to 2050 is limited by the scope for economic development and change. In addition, given that anticipated global emissions levels for 2020 (as currently expressed in the international climate regime) are, in the context of the 2°C target, relatively high and more

[1]For abbreviations, please see the glossary starting on page 27.

[2]Climate change results from higher concentrations of carbon dioxide and other GHGs in the atmosphere. For each concentration level, climate scientists are able to determine the probability of crossing a specific global warming threshold (such as two degrees). Thus, for a specific concentration, there is a probability that global warming will remain below two degrees, and there is a smaller probability that global warming will remain below 1.5°C. Many actors in the international climate change debate, particularly those whose livelihoods are at risk, point out that even with 2°C warming, there would be considerable impacts. Poor countries and communities are particularly poorly equipped to deal with those impacts – they have low adaptive capacity.

likely to lead to 3.5 °C warming and associated impacts (Rogelj et al. 2010), the range of global emissions pathways consistent with politically agreed 'safe' limits is fairly small.

Thus, the global emissions objective can be expressed in several ways:

1. A cumulative global emissions budget to 2050 (sum of annual emissions)
2. A medium and a long-term target (annual emissions level specified for two or more years, e.g. 2020 and 2050), and perhaps also a peaking level and year
3. A global emissions trajectory (annual emissions specified for each year in the period)

These are illustrated in the figure below.

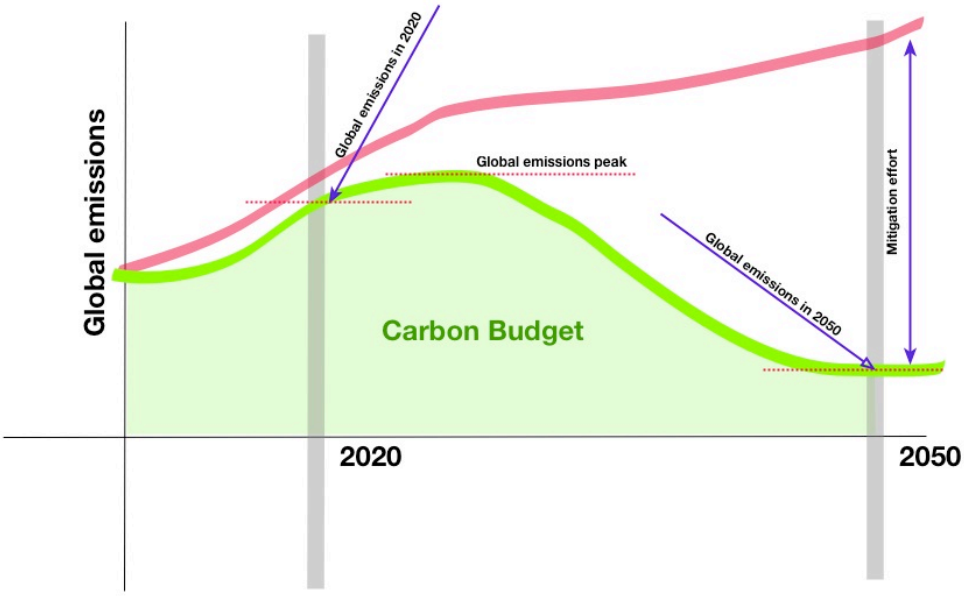

Figure 1: Resource and effort sharing approaches – areas above and below the line

In Figure 1, the carbon budget (option 1 of the bullets above) is the green area under the curve. The global trajectory is the green line itself (option 3). The targets (option 2) are marked by arrows and are points along the line, in this case in 2020 and 2050.

Each of these options has different degrees of flexibility and different degrees of rigour as regards the global mitigation goal. The emissions pathway is the most rigid, and has no flexibility since emissions for each year are defined. Deviation from a specific emissions pathway would require amending the future pathway, to meet the same emissions objective. The specification of two or more key points provides limited flexibility, but the different pathways which are possible as a result could result in a range (probably fairly small, but significant) of global warming outcomes. The cumulative carbon budget to 2050 provides the most certainty regarding the global emissions objective in that it has the most direct relationship to GHG concentrations in the atmosphere, and provides a significant degree of flexibility in which emissions pathway is followed in reaching the emissions objective.

A carbon budget is the area under a trajectory of GHG emissions. It is not fundamentally different from a cap on emissions. A process of carbon budgeting involves the allocation of a limited resource, which should be based on equity and science (best available information). The goal of a low-carbonplanning process is to remain within the budget, that is, at or under a GHG trajectory. It sends a signal, through far-sighted planning, of the need to make a transition to a low-carbon economy and society.

2.2 Achieving the global emissions objective – framing mitigation

Attaining the global emissions objective will require a significant degree of international co-operation, which is the subject of the ongoing negotiations on the current and future global climate regime under the UNFCCC and its Kyoto Protocol. Emissions from national economies will have to be constrained in some way, and these constraints will have to be internationally co-ordinated, and probably enforced. A key problem in the international negotiations (and reason for lack of progress) is the so-called burden-sharing problem. Working downward from BAU emissions (e.g. the SRES) would involve sharing the effort, or burden. In a carbon budget approach, the remaining emissions space needs to be shared amongst countries, given the global goal of limiting global warming to 2°C. In both cases, equity is crucial – as an ethical matter, but also a very practical one: an outcome that is unfair (or even perceived to be unfair) to some actors is unlikely to be accepted by them.

The problem can be expressed in different ways:

- Effort-sharing: defined as the effort (in new investment requirements, loss of national resources, and any other costs) required by a country to either reduce emissions from a base year level (usually 1990 in the UNFCCC), or to reduce emissions from a hypothetical baseline (an emissions pathway assumed in the absence of climate policy).
- Resource sharing: since the global emissions objective implies that there is a limit to cumulative global emissions to 2050, another approach is to view this 'emissions space' as a scarce resource. Thus, instead of being required to reduce emissions by a percentage from a base year or baseline, countries would be given 'emissions budgets' which they could not exceed.

Effort-sharing approaches focus on bringing emissions down from their rising trajectory, while resource-sharing approaches focus on allocating the area under a desired trajectory. For both approaches, it is important the the outcomes are fair shares.

In Figure 1above, the mitigation effort is related to effort-sharing, whereas the carbon budget is about sharing the resource (the areas below the desired GHG pathway). The figure shows the two approaches conceptually, at the global level. The two approaches are best understood as complementary. Effort-sharing focuses on bringing emissions down from a baseline projection of future emissions, and taking responsibility to limit future growth by making efforts to reduce this to safe levels. The future global carbon budget is the area under the line – the same line of a safe emissions pathway. It should be remembered that exceeding this safe pathway would have adverse impacts on climate change, that the poor suffer the most from adverse impacts, and that this too is a matter of equity. This resource – the remaining carbon budget – is quite limited and needs to be shared fairly. So equity is important in mitigation. And the third element is the means to achieve development (finance, technology and capacity), which need to be arranged in a fair manner too and be made more sustainable.

Within the UNFCCC process, the mitigation problem has conventionally been framed in terms of the first approach. Commonly, developed countries propose mitigation targets for a specific year (usually 2020 or 2050) in terms of their base year emissions, whereas developing countries propose emissions reductions in terms of a baseline.[3] Some other countries have chosen to express their targets in intensity terms (for instance, China). However, in practice, the only binding legal instrument, the Kyoto Protocol, uses an accounting system which is based on a carbon budget for a 'commitment period'. Recent proposals by developing country experts

[3]Base year and baseline are not the same thing. A base year refers to a single year, typically historical), and a commitment or target is defined in relation to emissions levels in that year. A baseline is a projection forward, and hence a line representing the assumed growth of future emissions. A reduction against a base year (e.g. 40% below 1990 levels by 2020) is an absolute reduction. A reduction against a baseline (e.g. 34% below BAU by 2020) is a relative reduction; if growth in the baseline is high and percentage reduction modest, a reduction against baseline may still allow growth in emissions in absolute terms.

advocate the allocation of the remaining emissions space over the period to 2050 in a similar way. While the baseline approach conveys valuable information about a country's national circumstances, uncertainty surrounding the baseline, and how this is determined, raises a number of difficulties. Baseline by their nature are projections and thus open to gaming, that is, there is an interest (by project developers for CDM or countries for national pledges) to artificially inflate their baseline projections. These difficulties are significant, but methodologies exist to develop baseline is a rigorous manner. It must be noted, however, that the Kyoto Protocol budgets are expressed as reductions from a base year, from which carbon budgets are derived.

2.3 Framing mitigation at a national level

Putting a cap on emissions is one of GHG emissions over time. South Africa has done this in defining a trajectory. Analytically, there is not much difference between keeping to a benchmark national GHG emission trajectory and staying within a carbon budget. It is a distinct planning process, that should be informed by the best available information. What is different conceptually is that there is only an indirect link between national emissions and climate change impacts. At the global level this connection is direct, subject to the issues described above. But any individual country only contributes a small share to global emissions. The indirect link that remains is one of collective action – if South Africa does not act, others are less likely to do so, and eventually, if no-one acts, the impacts affect everyone adversely (and poor countries and communities have least capacity to adapt).

Considering implementation of carbon budgets from national to sectoral level, the context for framing mitigation is somewhat different, in two important ways.

- The assessment of the mitigation potential of a specific sector, or of the economy as a whole,and therefore their ability to remain within a limited carbon budget; and
- The regulation of emissions, which includes solving the problem of sharing the effort of mitigation amongst different sectors and policy instruments.

The key problem for policymakers is thus to work out how best to meet a specific target, and how to ensure that whatever options are chosen are effectively implemented. Mitigation potential is conventionally measured in terms of unit cost – rand per ton mitigated. There are, however, additional important indicators, such as the impact of measures on the rest of the economy, the impact on employment and income distribution (and poverty), and the impact on other aspects of the environment such as water use. This requires the modelling of a complex set of interactions within the national economy, and this has been done most effectively from an effort-sharing perspective on a national level to date. Recently published work has suggested the use of a budget-based approach instead for the South African context (WWF-SA 2011a, 2011b), but since both approaches involve costing future mitigation scenarios, the results are not likely to be significantly different.

From a regulatory point of view, the issue is somewhat more complex. The approaches outlined in section 2.2. offer a range of different approaches to the problem of regulating sectoral and national targets. Emissions reductions or avoiding growth of future emissions can be pursued in a number of ways:

- by setting a carbon budgets for sectors, subsectors, firms or installations;
- by setting other types of targets such as intensity targets (physical or value added); or
- by putting in place a number of policies, which will result in emissions reductions, but do not specify a quantitative goal.

In many cases there would be synergies between the three approaches. The term 'carbon budget' has been used in a number of ways in this context. It can denote one of the following:

- a cumulative national emissions budget over a period of time; or
- a sectoral, sub-sectoral, firm or entity budget over a period of time.

Thus cap and trade systems are a form of carbon budgeting. The time element is an important variable – if carbon budgets are specified for only one year, with no mechanism to transfer units to the next or subsequent years, entities will not be able to manage fluctuations in the economy, etc. On the other hand, longer-term carbon budgets may result in a situation in which entities use too many credits too soon, and are unable to reduce emissions in the long term. The trading component of emissions trading may lead to entities planning to buy credits late, so that demand in the short-term falls, prices drop and new, more emissions-intensive investments are made and make reductions difficult.

In our national policy, informed both by domestic process and the multilateral context, some choices have been made about this.

3. National policy and international context

3.1 Climate policy

While there was much work done on climate change before 2011, a formal climate policy was gazetted in October 2011, Government published a *National Climate Change Response White Paper* (RSA 2011), having consulted previously on a Green Paper issue late in 2010 (RSA 2010c). Consultations were run by the Department of Environmental Affairs (DEA) and also the Parliamentary Portfolio Committee.

A climate change response strategy was drafted earlier (RSA 2003), but was not turned into a White Paper but remained a strategy document issued by then Department of Environment Affairs (DEAT 2004). The same year, South Africa submitted its Initial National Communication (RSA 2004) to the United Nations Framework Convention on Climate Change (UNFCCC), addressing both adaptation and mitigation. A Technology Needs Assessment was compiled (DST 2007). Following the Long-Term Mitigation Scenarios (LTMS), Cabinet adopted a strategic direction which had political significance, but was not published as formal policy (RSA 2008). Another strategy document emerged out of the second consultative conference, which confirmed the LTMS emission trajectory (DEAT & DST 2009), but again did not have the status of formal policy.

Significant work on climate change preceded the pledge by South Africa for its GHG emissions to follow a 'peak, plateau and decline' (PPD) trajectory.

President Zuma attended the negotiations in Copenhagen and announced that 'South Africa will undertake mitigation actions which will result in a deviation below the current emissions baseline of around 34% by 2020 and by around 42% by 2025. This level of effort enables South Africa's emissions to peak between 2020 and 2025, plateau for approximately a decade and decline in absolute terms thereafter.' The extent of action, it was made clear, depends on the support provided in the form of finance, technology and capacity-building. This commitment to act was formally submitted to the UNFCCC in January 2010 (RSA 2010b).

The key principles in the National Climate Change Response White Paper which underpin mitigation policy are outlined in its Chapters 2 and 3. The 'Response Objective' regarding mitigation is defined as making 'a fair contribution to the global effort to stabilize GHG concentrations in the atmosphere at a level that avoids dangerous anthropogenic interference with the climate system within a timeframe that enables economic, social and environmental development to proceed in a sustainable manner'(RSA 2011).

Chapter 6 identifies further key elements for implementation:

- setting a national emissions trajectory range from 2010 to 2050, which is framed as a 'performance benchmark' against which the 'response objective' will be measured; (see further discussion in section National carbon budget)
- identifying 'desired' sectoral contributions to mitigation, taking into account development benefit, and costs, and other relevant indicators;

- using a range of policy instruments to tackle small-scale emissions, and a 'carbon budget approach' to tackle large emitters;
- carbon budgets will be defined for the short, medium and long terms for relevant sectors and/or subsectors, and for very large emitters, carbon budgets will be defined on a firm level;
- a range of economic instruments will be deployed; and
- a monitoring and evaluation system will be developed and implemented.

These elements provide a framing for allocation sectoral carbon budgets, that we seek to elaborate with a focus on methodologies. Before turning to the allocation process, however, it is important to recall the global context in which this takes place.

3.2 Global context and our fair share derived from future carbon budgets

Deriving national allocations starting from the remaining future *global* carbon budgets is an important approach to address equity in the climate negotiations. BASIC experts worked extensively on this issue during 2010 and 2011, starting from different approaches but achieving significant convergence by working on a common set of parameters.[4] Chinese and Indian researchers followed the same fundamental allocation principle of cumulative emission per capita; Brazil has, since its proposal of 1997, continued to focus on historical responsibility as the prime criterion; while experts from South Africa used indicators of responsibility, capability and responsibility (with proxies of cumulative emissions, allocated per capita and also taking into account capability including GDP but also the other two parameters of the human development index, education and health) (Winkler, Letete & Marquard 2011b). The differences in resulting carbon budgets for South Africa are wide, as the results in Table 1 make clear.[5]

Table 1: Carbon budgets for South Africa based on the same future global carbon budget according to different allocation approaches, Gt CO_2-eq for the period 2000- 2049

	Carbon budget account proposal (CASS, DRC China)	*The Indian approach (TISS)*		*South African approach – responsibility, capability and sustainable development (ERC)*	
Starting year 1850, excluding historical LULUCF	7	7		29	
	Without historical LULUCF	*With LULUCF*	*Without historical LULUCF*	*With LULUCF*	*Without historical LULUCF*
Starting year 1970, showing with and without historical LULUCF	8	11	8	31	28

The carbon budget approach of Chinese (CASS / DRC joint project team 2011) and Indian researchers (Jayaraman, Kanitkar & DSouza 2011) allocates 7 Gt CO_2 –eq to South Africa for the period 2000–2049, if a starting year of 1850 is assumed for historical responsibility. This increases in the Indian approach to 11 Gt, but this is only just over half of a national carbon budget derived as the area under the PPD curve. Note that the National Carbon Budget (NCB) is over a longer period – 50 years – compared to the derivation of the NCB under PPD or the GHG emissions trajectory in the White Paper, which are from 2010–2050, i.e. 40 years. The differences in NCBs, however, far outweigh this difference. If a later starting year is assumed, this might rise to 8 Gt, or with a later starting year (1970) to account for historical LULUCF emissions LULUCF in the TISS approach perhaps 11 Gt. Even in the best case, this is still less

than half of the 23 Gt under the higher range, and only just over half of the intermediate 19–20 Gt. The ERC study shows that metrics can be applied to provide higher carbon budgets, but note that the per capita approach is strongly supported not only by India and China, but some developed countries too.

Arguing from a strong perspective of equity, China and India would propose a much smaller carbon budget than in our climate policy. If fellow members of the BASIC countries make such proposals, South Africa's negotiating partners should be expected to propose even smaller national carbon budgets (NCB). In negotiating terms, the approach used by South African researchers give budgets of 28–31 Gt, depending on parameters chosen.[6] This suggests that South Africa would argue in negotiations for broader criteria of responsibility, capability and sustainable development. Indeed, the argument that time for development is a fundamental dimension of equity, has been made. It is reflected in the shift discussions on equity (which in the past have focused only on carbon space) to equitable access to sustainable development.

In reinterpreting the principle of common but differentiated responsibilities and respective capabilities (UNFCCC 1992) in a way that might work for carbon budgets in the 21st century, it is important to recall that responsibility and capability have different dimensions. The experts from South Africa in their contribution treated capability not just as size of economy or income, but also brought in dimensions from the Human Development Index. The broader points is that capability is not limited to GDP.

The South African experts mostly followed an effort-sharing approach. Methodologically, the difference is that it examines the effort of reducing emissions from projected levels under a BAU or baseline, to desired levels. The area between the curves is divided up or allocated. The carbon budget approach allocates the area under the desired trajectory. Certainly baselines can be gamed, although methodologies exist to provide some rigour and environmental integrity. Conceptually, what BAU projections represent is the future. Effort-sharing remains an important approach in consider responsibility for the future – in particular to develop in a low-carbon manner, that does not allow emissions to grow as current trend suggest they will.

Arguing from a strong perspective of equity, experts from China and India propose a much smaller carbon budget (7 or 11 Gt) than in South Africa's climate policy – little more than a third to half of the national carbon budget (19 Gt CO_2–eqover 40 years)

3.3 Ambitious national carbon budgets

Some South African business leaders have proposed a significantly more ambitious carbon budget for South Africa, of 10.2 Gt CO_2 from 2011 to 2050 (Brown & Cutifani 2011). This assumes South Africa receives 1.5% of a global carbon budget, and they estimate that, at a rate of 0.45 Gt per year, only 23 years remain 'before we must cease emitting CO^2'(Brown & Cutifani 2011). Their estimate of current emission levels of 450 Mt CO_2 is probably lower than the actual levels in 2010, so even less time remains and the challenge is even greater.

Some South African business leaders have proposed a more ambitious NCB, at 10.2 Gt. They point out that only 23 years remain before we must stop emitting CO_2.In short, some have proposed more stringent national carbon budgets than would be derived even from the area below the range set in our climate policy – even if we took the lower end.

[6] Note that these numbers (28-31 Gt) are derived from a top-down allocation starting with the remaining future global carbon budget; and thus different in methodology to the bottom-up national analysis of mitigation potential done during the LTMS, which give a smaller carbon budget (19.1-20.4 $GtCO_2Gt$ CO_2–eq), elaborated above.

3.4 National policy performance benchmark and an allocation process

The White Paper set a 'benchmark national GHG emissions trajectory range'. It added an upper and lower range around the 'peak, plateau and decline' (PPD) projections from LTMS and the Copenhagen commitment to act. Specific numbers are stated in the policy for business-as-usual for 2020 and 2025 (the two years specified in Copenhagen), a period during which emission stay flat (2025–2035), and the decline from 2036 to 2050.

Our climate policy frames this trajectory as 'setting the performance benchmark', and states that this trajectory is the benchmark 'against which the collective outcome of all mitigation actions Carbon budget methods ERC, March 2012.docxeasured'(RSA 2011).The policy itself specifies the key points that define the trajectory (RSA 2011), with lower and upper limits for 2020 and 2025, and around a plateau from 2025 to 2035:

- in 2020, a lower limit of 398 Mt CO_2-eq, and an upper limit of 583 Mt CO_2–eq;
- in 2025, a lower limit of 398 Mt CO_2-eq, and an upper limit of 614 Mt CO_2–eq;
- from 2025-2035, a 'plateau' between 398 Mt and 614 Mt CO_2–eq; and
- from 2036 to 2050, declining (presumably by 2050) to between 212 Mt and 428 Mt CO_2–eq

Climate policy sets a benchmark national GHG emission trajectory, building an upper and lower range around the 'peak, plateau and decline' path identified by Cabinet in 2008, pledged by President Zuma in Copenhagen in 2009, and formally submitted to the UNFCCC in 2010. Our climate policy (White Paper) has set a trajectory that limits emissions – initially relative to growth, and later in absolute terms.

A definition of the trajectory with a more detailed derivation of these values was published during the consultations in the policy-making process(DEA 2011). By defining these ranges, the baseline or projection of business-as-usual was settled in public policy (DEA 2011; RSA 2011).We outline a process for carbon budgeting in **Error! Reference source not found.**. The process outlined in this diagram is elaborated in this paper.

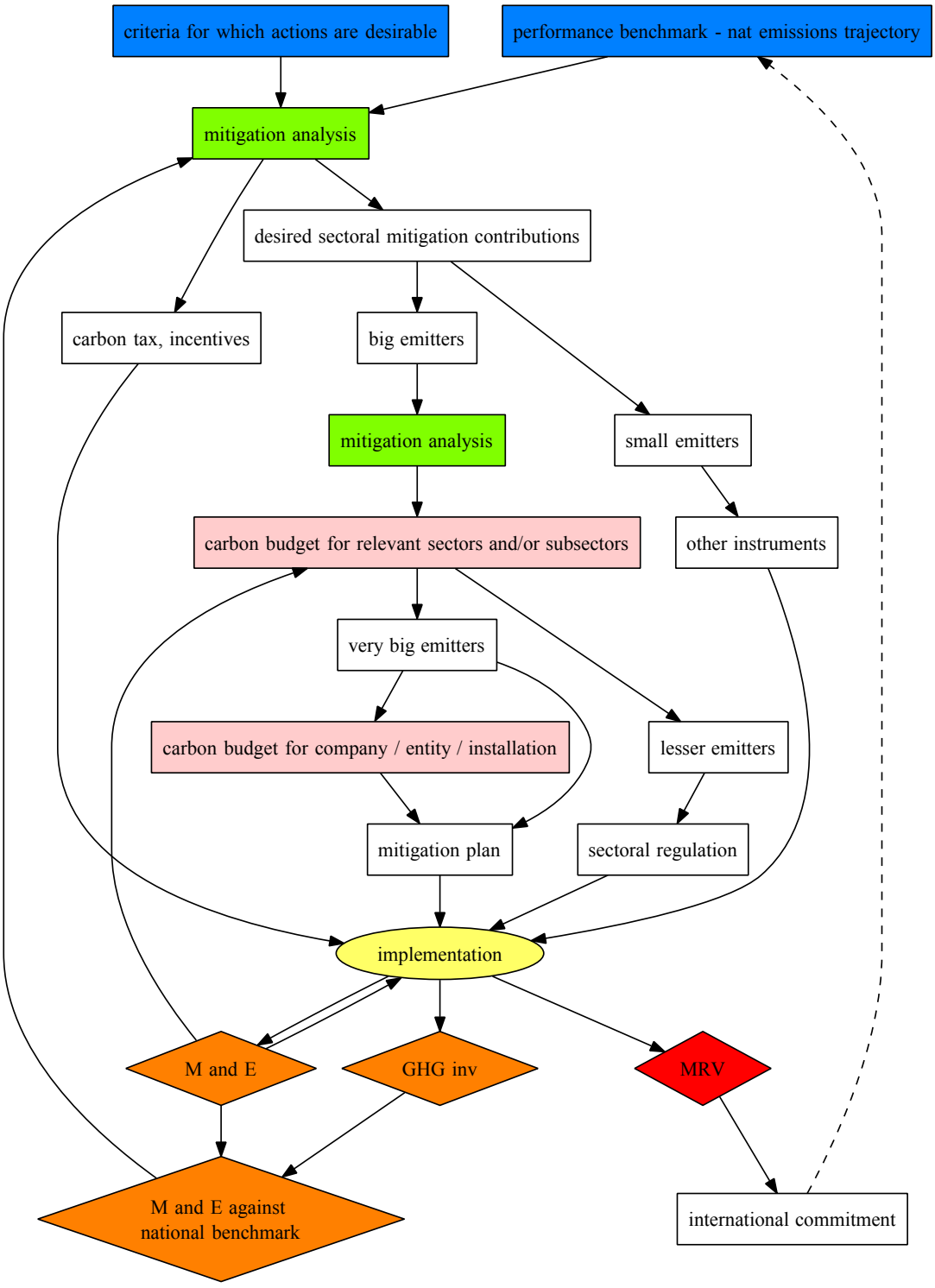

Figure 2: Process of allocating carbon budgets
Source: Based on authors' reading of White Paper (RSA 2011)

Climate policy mandates the development of sectoral carbon budgets (SCBs) over the next two years, by October 2013.

Section 6.1.2 of the White Paper deals with identifying desired contributions from sectors. Such contributions are to be for 'each sector and sub-sector of the economy', and where appropriate, even for 'individual company or entity level', within two years of publication of the policy (DEA 2011).'Initial carbon budgets' or SCBs are to be adopted by 18 October 2013. A mechanism is to be established in the first two years for cases where there are significant GHG emissions at company level; and the implementation should occur within three years, i.e. by

October 2014. Companies and economic sectors for which carbon budgets have been defined must submit annual mitigation plans and explain how they intend to achieve mitigation outcomes.

3.5 Other policies and plans

There is increasing recognition that climate change is not only an environmental problem, but a deeply socio-economic one too. Responding to climate change will require good coordination across government – across various national departments, and between national and local spheres..Furthermore, climate change will require strong action by industry and business.

Coordination and alignment are thus central – and not always given. Earlier work pointed to lack of full alignment of energy policy and climate change mitigation (Tyler 2010) and the National Development Plan has indicate the need for greater coordination and 'building a capable state'(NPC 2011).It goes beyond the scope of this short paper to analyse the degree of alignment between climate and other policy. It should be noted, however, that coordination is important for equity – to ensure a fair and inclusive process, that would result in a outcome – an allocated carbon budget – that is agreed to by all.

For electricity planning, there has been progress in alignment but there is still room for improvement. IRP2010 made an important shift from least-cost analysis (single criterion: cost) to multi-criterion decision-making, with carbon a major new criterion(DoE 2011a).Yet the underlying assumption that electricity generators should get 50% of the carbon budget (or 50% of 550 Mt CO_2–eqas assumed in the IRP) has not been tested. It is higher than the share of emissions from electricity supply in the GHG inventory at 41%[7] – and an allocation according to previous emissions would be 'grandfathering', a principle that would require further debate. Also, the IRP reported GHG emissions for a large number of plans it considered – but not for the preferred plan (DoE 2011b). The policy-adjusted case recommended to Cabinet sees the emissions intensity of 912 g CO_2 /kWh in 2010 decline to 820 g in 2020 and 600 g in 2030 – and the latter number happens to be 34% of the 2010 intensity(DoE 2011a, 2011b).[8]

Our electricity plan (IRP2010) results in a reduction of the emissions intensity of electricity supply by 34%, but by 2030. This is equivalent to a 34% deviation below BAU which is pledged for SA as a whole, but ten years later than 2020. Both framings are relative rather than absolute reductions.

Hence it remains ambiguous whether the IRP is consistent with South Africa's climate commitments under Copenhagen, and much depends on underlying assumptions.

Good alignment will be needed with the New Growth Path (EDD 2011), industrial policy action plan (RSA 2010a), and other plans.

The National Planning Commission released South Africa's first National Development Plan (NDP) in November 2011 (NPC 2011). That emissions should 'peak, plateau and decline' is referenced several times, but the NDP says that emissions will 'peak around 2025', which shifts that level to the end of the range of 2020–2025 that was identified by Cabinet in 2008. The NPC puts no numbers to this peak, unlike climate policy. The NDP does envisage an 'absolute constraint' on GHG emissions, but only from 2030–2050, i.e. after the time-period of its own vision.

The NDP explores a carbon budget approach and elements for good design, including a "benchmark total carbon budget", but stops short of proposing a number.

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7 The latest official inventory is for the year 2000, and reports 171 578 Mt CO2-eq of emissions from bituminous coal for public electricity, and another 7 858 Mt from auto-producers (see Table 3-2), of a total of 442 484 (including LULUCF). (DEA 2009)

8 However, the emissions reported in the IRP's revised balanced scenario only give a 19% reduction relative to its own reference case, taking numbers from the final draft plan that are understood to be very close to the final policy-adjusted IRP (DoE 2011b).

The NPC suggests important elements for "a well-designed carbon budgeting system", including a benchmark total carbon budget (understood as the area under a trajectory over time); emphasises its cumulative nature over time; an initial bottom-up approach blended with consideration of the long-term limit on emissions space; and providing flexibility in achieving emission reductions across sectors and time (NPC 2011).

Chapter 5 on the transition to a low-carbon economy explores the carbon-budget approach as the first of the "proposed mitigation instruments" it discusses. It suggests elements for a "well-designed carbon budgeting system" but also considers constraints to implementation, notably "interests in some of the most carbon- and energy-intensive sectors" (NPC 2011).

4. National carbon budget

A national carbon budget (NCB) is implicit in the area below the benchmark national GHG emissions trajectory range in climate policy (RSA 2011). An explanatory note issued in the consultations on the Green and White Papers defined South Africa's peak, plateau and decline greenhouse gas emissions trajectory (DEA 2011), which is shown in as the green band in Figure 3, along with other "popularised conceptions of PPD".

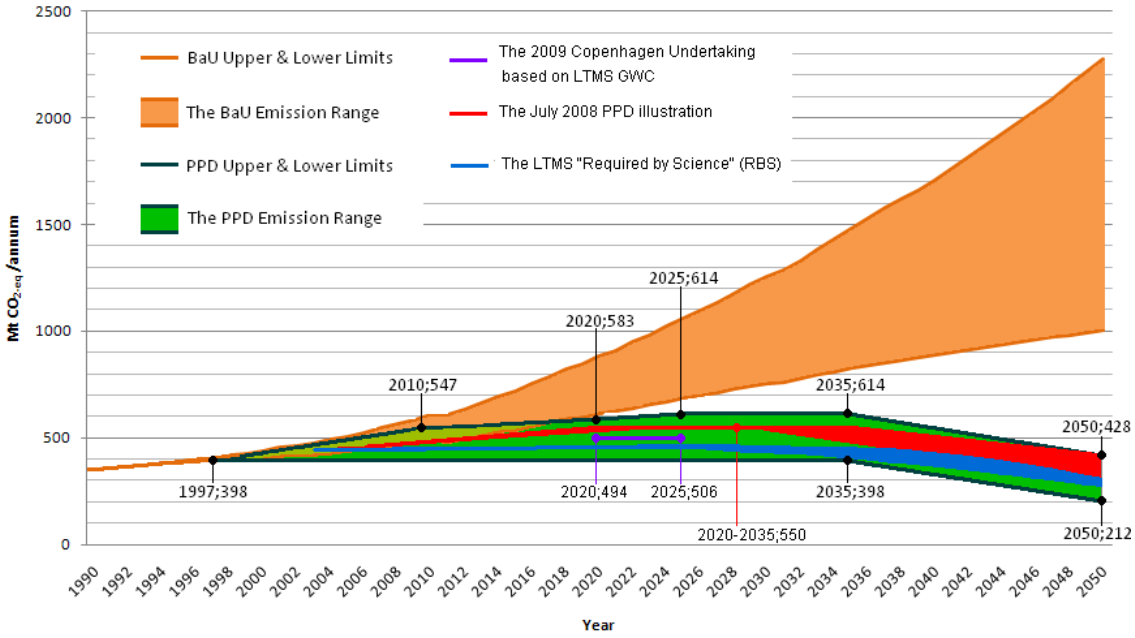

Figure 3: South Africa's peak, plateau and decline GHG trajectory
Source: DEA (2011)

A NCB is readily calculated by integrating the area under the curve, which we do by integrating the emissions under the national emission GHG emissions trajectory range. In plain language, this means adding up the sum of annual emissions over the time period.

4.1 National carbon budget as the area under the GHG emission trajectory

South Africa's national carbon budget from 2010 to 2050 is derived as

- 15 Gt CO_2–eq, under the lower limit.
- 23 Gt CO2–eq, under the upper limit.
- Simply averaging gives an intermediate value of the national carbon budget of 19 Gt CO2 -eq .

The intermediate value is consistent with national carbon budgets under the LTMS peak, plateau and decline level, which we have previously estimated at 19 to 20 Gt CO_2–eq,

depending on where our current emissions are. A very similar, but 'indicative'[9] number of 18.5 $GtCO_2$-eq from 2010 to 2050is derived from LTMS in the LCAP report (WWF-SA 2011a).As noted above, analysis in the process of formulating climate policy indicated a range of numbers, concluding that about 19 $GtCO_2$–eqfor the same forty-year period was SA's current proposed allowance (Marquard, Trollip & Winkler 2011).

A national carbon budget of 19 Gt CO_2–eq for 2010-2050 is readily calculated as the area below the trajectory. This number is an intermediate value between 15 and 23 Gt for the lower and upper bounds specified in the White Paper (see section 4).

The White Paper specifies the GHG emissions trajectory (RSA 2011), rather than the area underneath it, which we have derived above. However, the climate policy does state clearly that sectoral carbon budgets will be defined within two years (i.e. 2012-13) 'for significant GHG emitting sectors and/or sub-sectors' (RSA 2011: 25).It also envisages 'company level desired emission reduction outcomes' to be developed and implemented within three years, i.e. by 2014.

4.2 Carbon budgets in SA in previous research

4.2.1 Long-term mitigation scenarios (effort-sharing)

Research and facilitated stakeholder process led to Long-Term Mitigation Scenarios for South Africa. Technical work in the LTMS was discussed by a Scenario Building Team that approved summaries in October 2007 (SBT 2007) and accepted the underlying research (ERC 2007a, 2007b; Kornelius, Marquard & Winkler 2007; Midgley et al. 2007; Pauw 2007; Taviv et al. 2007; Winkler 2007) as robust basis for considering a wide range of mitigation options. The process was aimed at assessing the mitigation potential of the country and actions to realise that potential, and was not a formal policy process. Cabinet, which has mandated the process at the outset, considered the results following further high-level consultations in the first half of 2008 and then Environment Minister van Schalkwyk presented Government's vision, strategic direction and framework for climate policy after a *lekgotla* in July 2008 (RSA 2008). The Cabinet outcome included the 'peak plateau and decline' (PPD) trajectory.

The LTMS methodology was based on an effort sharing approach, as distinct from carbon budgets as a resource-sharing approach (the latter emerged for national analysis more recently, see section2.2above).A projection of business-as-usual (Growth without constraints, or GWC in LTMS abbreviations) was compared in modeling of various actions – aimed at getting emission to the second scenario, Required by science (RBS). The Scenario Building Team combined groups of actions into 'strategic options', and further analysis of Start now, Scale up and Use the markets were analysed, including further modeling of economy-wide implications.

The LTMS produced results of strategic options which implied a limit on emissions or carbon budget, but did not frame the results in these terms. Notably, the LTMS resulted in a political commitment that South Africa's GHG emissions should 'peak, plateau and decline'. The area under the PPD trajectory as quantified in LTMS implied a national carbon budget for the period 2010 to 2050 of between 19.1 and 19.6 Gt CO_2–eqif emissions peaked in 2020 and declined to 40% and 30% of 2003 levels respectively by 2050; and between 20.2 and 20.4 Gt CO_2–eqif the peak was later, in 2025.These numbers were reflected in a synthesis of information on mitigation compiled during the Green Paper, the discussion document which preceded the White Paper. The analysis indicated that '[o]ur current proposed allowance for this period is in the region of 19 Gt', with the period being 2010–2050 and units of Gt CO_2–eq (Marquard et al. 2011).These numbers were sensitive baseline assumptions, which might yield slightly higher budgets of 15–25 Gt, while a reasonable representation of international effort-sharing showed lower budgets of 5 – 18 Gt CO_2–eq (Marquard et al. 2011).

[9] The LCAP report strongly emphasizes that WWF does not endorse this number, nor consider it what is ''required by science' taking into account equity considerations' (WWF-SA 2011).

Previous work included the LTMS, on consideration of which Cabinet outlined its vision and strategic direction for emissions to peak, plateau and decline.

4.2.2 Low-carbon action plan (resource sharing / carbon budget)

Work done for the World Wildlife Fund sought to turn analysis of potential (as in LTMS) into low-carbon action plan (LCAP). To our knowledge, this was the first work done explicitly applying a carbon budget to South Africa at a national level (rather than deriving allocations of carbon budgets from a global total). The LCAP study asks a different question (among others): 'What is the best deployment of the limited emissions space left to achieve South Africa's development needs?'(WWF-SA 2011a). In this sense, the WWF paper asks a developmental question: it suggests that those wishing to claim part of the national carbon budget must motivate their share based on contributing to development. The most carbon-effective (or lowest carbon-intensity) means of achieving development would be prioritised in such an approach.

The idea of motivating for mitigation on the basis of (sustainable) development has been suggested before. In the debate about a 'post-2012' climate regime, South Africa proposed an approach of sustainable development policies and measures (SD-PAMs) (RSA 2006).This proposal built on work by South African researchers (Winkler et al. 2008; Winkler et al. 2002) and international researchers (Bradley, Baumert & Pershing 2005; Ellis, Baron & Buchner 2007). With shift in language in the negotiations, SD-PAMs might nowadays be referred to as nationally appropriate mitigation actions, particularly developmental and poverty-alleviating mitigation actions.

Previous work directly on carbon budgets was commissioned by WWF, outlining the appraoch for a low-carbon action plan. The report suggested an important principle for allocation, namely that sectors should motivate for their share of the NCB based on the best used, in particular the most carbon-effective contribution to South Africa's development needs.

Released prior to the White Paper, the LCAP report does not state quantities for sectoral carbon budgets – although it does put forward the powerful principle of allocating these based on contribution to meeting development needs.

It also indicates that possible sectors in a carbon allocation process might be forestry, agriculture, industry, transport, electricity, commerce, residential – and identifies key stakeholders (WWF-SA 2011a). Slightly surprising in that list is forestry (a relatively small contributor to GHG emissions in South Africa) and noticeable by their absence are liquid fuels, industrial process emissions and waste. A careful process of defining sectors will be needed.

The LCAP report has a substantial suggestion on process. Key steps are shown in Figure 3, where the process provides a good starting point. The allocation is conceived as a negotiation among stakeholders, who would motivate for parts of the carbon budget based on agreed indicators (essentially motivating their contribution to development of a better South Africa). The process of 'mediated modelling' is expected to resolve some conflicts, failing which 'the President will confirm the budget allocation, resolving any outstanding allocation issues' (WWF-SA 2011a). Subsequent to allocation, compliance with carbon budget allocations will be monitored and a compliance mechanism established. The report does not spell out consequences of non-compliance. The figure suggests that data generation and research should enhance the evidence base as an on-going activity throughout the carbon budgeting process.

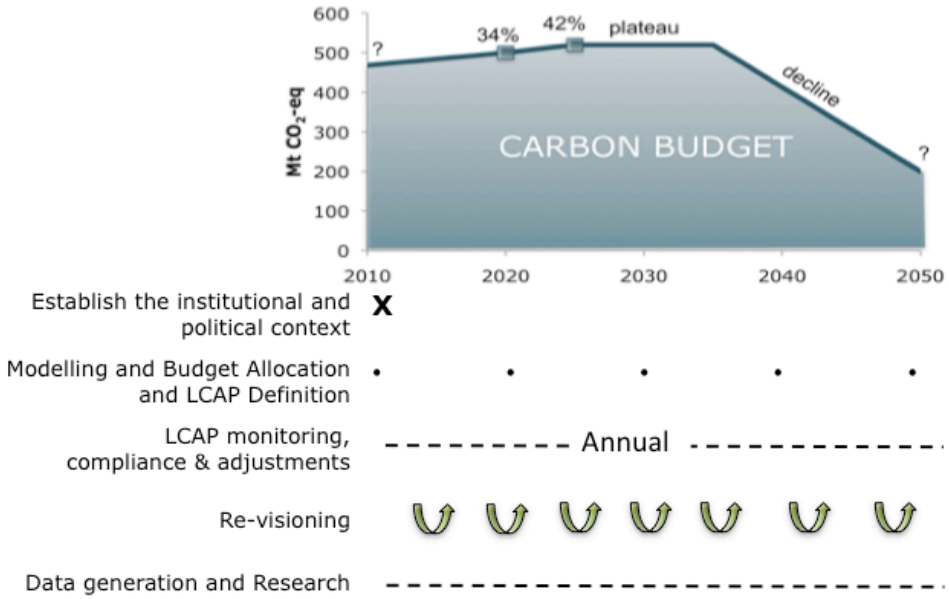

Figure 4: Key process components of the LCAP
Source: (WWF-SA 2011a)

5. Case studies of approaches to and methodologies for carbon budgeting

We critically examine various methodologies to translate a national CB into sectoral CBs, drawing on experience in the European Union.

5.1 EU national allocation plans

The assigned amount which the EU is allocated under the Kyoto Protocol for each commitment period is a very precise form of carbon budget, at the international level. An extensive set of rules were negotiated multilaterally, have been implemented and are being revised for the second commitment period of the Kyoto Protocol (UNFCCC 2011a). Key instruments to enable the EU to remain within this carbon budget are the emissions trading scheme (ETS) and its 'Effort Sharing Decision' governing emissions from sectors not covered by the EU ETS. Both were agreed as part of the Climate and Energy Package adopted in 2009, for the period up to 2020 (REFERENCE). The interaction between ETS and non-ETS allocations has evolved over time.

The EU ETS covers some 55% of emissions. Climate policy in the EU therefore make a strong distinction between emissions covered (energy, industry) and not covered by the ETS. For energy and industry, the ETS defines the carbon budget. The other sectors, emissions are allocated at Member State level and they decide how best to achieve their budget.

For the first commitment period of the Kyoto Protocol, national carbon budgets were effectively derived from the EU-wide goal negotiated, a reduction of 8% below 1990 levels for the period 2008–2012. Internally, a burden-sharing agreement had been agreed, drawing on the Triptych methodology (Phylipsen 2000; Phylipsen et al. 1998) and operationalised within the EU and its trading scheme. The policy for non-ETS emissions remains somewhat uncertain, as it needs to pick up whatever it is not achieved by ETS sectors. The approach that was later also suggested for global allocations (Den Elzen et al. 2007; Ekholm et al. 2010; Groenenberg, Phylipsen & Blok 2001), although is the case with as all other global proposals to date, none has been accepted by all Parties.

National allocation plans were submitted for the first phase of the ETS (2005 – 2007), aiming at a trajectory that achieved the Kyoto commitment at national level. Considerations of

grandfathering (allocating to historical emissions) and reduction potential were prominent for countries; with firms often arguing for business-as-usual projections.

The second phase of the ETS (2008- 2012) saw further NAPs, with grandfathering and some benchmarking. Prior to Copenhagen, the EU adopted a Climate and Energy Package(EU Parliament and Council 2009b), explicitly deciding on effort-sharing for 2020 targets in sectors not covered by the ETS.

For the future in the ETS , there will be no more NAPs. Allocations will be made from Brussels, based on a combination of benchmark (free allocation based on best-benchmarks and historic production levels) and auctioning of allowances. The system is to move to full auctioning by 2027(EU Parliament and Council 2009a).

Auctioning is widely regarded in the academic literature on emissions trading as the optimal approach, in the EU and much the literature on emissions trading schemes, including for South Africa (Blignaut 2001; Goldblatt 2010; Grubb & Neuhoff 2006; Reinaud 2008; Tyler, du Toit & Burchell 2011; Victor & House 2006; Winkler, Jooste & Marquard 2010). In practice, ETSes have tended to evolve gradually from systems that start from grandfathering (Clo 2010; Hofmann 2006; Neuhoff & Matthes 2008).

For the ETS, important methods of allocation considered were grandfathering (allocating to large emitters), benchmarking and auctioning. In the next phase of the EU-ETS, there will be less emphasis on national allocation plans and a move to auctioning allowances.

The process of member states submitting national allocation plans to the European Commission and thesecond phase of the EU Emissions Trading Scheme (ETS) is to some extent comparable to bidding for an overall carbon budget. Methods for allocating allowances in the ETS started with grand-fathering and bench-marking, but over time are moving to full auctioning. The link to instruments that apply to sectors not covered by the ETS points to the need to design the interaction between instruments carefully.

The Commission in Brussels has a key role in ensure that the EU meets it Kyoto commitments. The example of the EU (Section 5.1) suggests that different instruments can be applied for different sectors and across scales. The interaction between the European Commission in Brussels and member states may provide useful lessons on how to negotiate carbon budgets. It might be possible to use a carbon budget for some sectors, sub-sectors and entities, and other instruments (including a carbon tax, or regulation) for others.

5.2 SA energy system models

Since close to four-fifths of South Africa's emissions are due to energy use and supply, an energy system model is rigorous methodology[10] for quantifying carbon budgets.

Energy models have been has been used in an initial way in the South African Low Emissions Pathways (LEP) project. Results and underlying documentation are documented into two reports (ERC 2011a, 2011b). Currently, the Department of Energy is undertaking work towards our second integrated energy plan (IEP) and has commissioned the CSIR on modelling the energy system.

To model options for meeting the emissions constraint, it is thus necessary to quantify the green area, which is the emissions space available to the energy system over this period. If non-energy emissions are taken as given at the lower level, there are two variables which would determine the size of the energy emissions in the green area:

1) the national emissions constraint or NCB; and

[10]Systems models can provide projections that take into account affects across the energy system and avoid double-counting and (if assumptions are transparently stated and discussed with stakeholders), the provide a methodologically rigorous projection of 'business-as-usual' emissions. This methodology was used for LTMS with an effort-sharing approach (see section 4.2.1), and the methodological issues published in peer-reviewed literature since (Winkler et al. 2011a).

2) to what extend mitigation actions are implemented for non-energy emissions.

If the overall NCB is larger, the green area is larger. If the red area is reduced due to more mitigation in non-energy sectors, then more carbon budget would be available for the energy sector, or conversely less mitigation action required.

Thus a plausible range of emissions space for the energy system would be between the median trajectory combined with no mitigation of non-energy emissions, which would be a lower bound, and the higher trajectory combined with full implementation of mitigation measures for non-energy emissions. Mitigation measures for synfuels process emissions are NOT included, and only occur in this analysis via avoided investment in further synfuels plants, or through curtailing production.

We also examine analytical tools based on work in South Africa, to model the energy economy as a system, and detailed analysis of individual sectors.

5.3 Detailed analysis of sectors

Analysis of individual sectors is detailed and sector-specific research that provides a richly textured account of what is possible in each sector. This detailed analysis is complementary to national models, which are most useful in comparing a range of mitigation actions, and understanding the interactions between them. For implementation, more detailed analysis should provide further information.

Several studies focusing on specific sectors have been undertaken to date (G:enesis 2008, 2010; Camco & TIPS 2010; Cohen, Lewis and Mason-Jones 2012), covering the major emitting sectors in the SA economy in more detail than national or economy-wide studies.

A study on the 'Risks and opportunities for the South African economy' arising from climate change focused on agriculture, forestry and fishing; mining and quarrying; manufacturing; utilities; construction sectors; trade, catering and accommodation services; transport, storage and communication; financial, insurance, real estate and business services (Camco & TIPS 2010). TIPS and Camco provided more detailed case studies on several sectors, including electricity and construction.

FRIDGE commissioned a 'Study to provide an overview of the use of economic instruments and develop sectoral plans to mitigate the effects of climate change' (G:enesis 2010). This study looked at policy instruments (both regulatory and economic) and detailed case studies of agro-processing, electricity generation, chemicals, liquid fuels, iron and steel, non-ferrous metals and mining. In the case of chemicals, this built on a previous in-depth study (G:enesis 2008). More recently, Sustainable Energy Africa engaged consultants in work on the minerals sector, for which results have been presented to a roundtable convened by the National Planning Commission, focusing among minerals on aluminium, coal, ferroalloys, gold, iron ore, iron and steel and platinum group metals (Cohen, Lewis & Mason-Jones 2012).

While further research can always enhance information, eisting studes have included many sectors – electricity generation, chemicals, liquid fuels, iron and steel, non-ferrous metals; mining; construction, agriculture and agro-processing, forestry and fishing; mining and quarrying; specific minerals (of aluminium, coal, ferroalloys, gold, iron ore, iron and steel and platinum group metals); manufacturing; utilities; trade, catering and accommodation services; transport, storage and communication; financial, insurance, real estate and business services. Sectoral analysis might in future assist in building the motivation by sectors and / or major emitting entities for the developmental benefits of allocating them a share of the carbon budget.

6. Process of initial allocation of sectoral carbon budgets

Setting up a process of national negotiation is crucial to allocation of a NCB to sectors. We outline our conception of the overall process in Error! Reference source not found..

As indicated above, the mandate in our climate policy is to develop SCBs by 2013.

6.1 Objective

The overall objective of a national negotiation would be to allocate the national carbon budget in a fair, robust and adequate manner. Consistent with our climate policy, the NCB would be allocated to sectors, sub-sectors, entities and firms.

The national carbon budget should be allocated based on a rigorous methodology. Fairness requires that an inclusive process and an outcome that is considered equitable by the full range of stakeholders. To receive a share of the available NCB, each sector or entity must demonstrate that this allocation makes a contribution to development. Adequacy implies that the sum of carbon budgets for sectors or major emitting entities does not exceed the national total.

6.2 Mandate and forum

The mandate for sectoral carbon budgets already exists (RSA 2011) and the Department of Environmental Affairs is beginning work. It would be helpful to explicitly define the mandate of the *process* of carbon budget. What forum is chosen and who participates should be clear to all.

Part of the negotiating process might take place within government, for example between Ministers engaging in an inter-ministerial committee and ultimately in Cabinet. But to have full buy-in, a process with stakeholders from business and civil society is essential. Good representation of sectors and the full range to stakeholders is an important part of South Africa's political culture. It is important to include the major emitters and equally those who stand most to lose from inaction.

An allocation process would need to be mandated at the Presidential level and take place in an appropriate forum, guided by Cabinet or an inter-ministerial committee. The process should have wide participation from all parts of South African society.

One option would be to create a dedicated forum to address this issue, for example, an inter-departmental task team as used during IRP2010. Another option is to convene strategic thinkers across government, business and civil society, as was done with the Scenario Building Team that developed the LTMS. Another would be to use existing structures, such as the IGCCC and NCCC. Expert input would be needed in all cases. The mandate of the process will have to make clear at the outset the legal form in which the carbon budgets will eventually be encoded.

6.3 Criteria for allocation of shares

An analytical process should define an initial allocation of the NCB across sectors. Criteria would need to be defined for initially allocating shares, which should provide an objective analytical starting point. A developmental motivation for actual allocations would be required from sectors later in the process.

Possible criteria might be current emissions (grandfathering), although auctioning is considered as preferable in the context of emission trading (Clo 2010; Hofmann 2006; Neuhoff & Matthes 2008). Grandfathering can be seen to reward pollution, and auctioning will favour those with ability to pay. Benchmarking-based criteria in principle reward most efficient producers , rather than historically higher emitters but in practice expected production levels will also inform the setting of benchmarks. The mitigation potential (scale of possible emission reductions), mitigation costs (allowing comparison across different actions) and broader socio-economic implications would provide a better, objective basis.In the context of emissions trading, auctioning of allowances may bypass complicated allocation criteria, but whether the allocation is fair remains an open question.

6.4 Analytical issues: Definitions, custodians and new entrants

The custodian of data on emissions and mitigation actions must be clearly specified, and independent third-party verification of data provided into the system will be essential for its integrity.

Defining sectors and entities

Climate policy makes a distinction between 'desired emission reductions outcomes' for sectors, sub-sectors and in 'respect of significant point-source emissions … sub-sectors and sub-sectors and, ultimately, companies whose emissions are above a specified threshold'(RSA 2011).There would be very large emitters (above the threshold), fairly large ones within major emitting sectors, and relatively small emitters.

Clear definitions of sectors to be allocated carbon budgets will be needed, and any differences between these definitions and sectoral definitions for other purposes (GHG inventories, energy balances, SIC codes) would need to be specified. It is highly desirable that these definitions are fully aligned, or least differences well understood.

The definition should allow clear placement of entities within sectors, and where subsectors are used, be mutually exclusive and comprehensive.

The White Paper includes a threshold *for mandatory reporting of emissions* of 0.1 Mt of emissions annually or equivalent electricity consumption, but it is not clear whether the same threshold is to be used for carbon budgeting for very large emitters. We have reflected this broadly in Figure, where the process divides initially between 'big' and 'small' emitters, and then later within the big, again between 'very large' and 'lesser' emitters.

If thresholds for entities that would have a direct allocation are to be used, the thresholds need to be clearly identified and have an objective basis.

Provision for new entrants

An initial allocation would be made to existing sectors and entities.

Provision will need to be made for new entrants into sectors of the economy, such as setting aside a reserve for new facilities. New facilities will need to be carefully designed to avoid conflict between new facilities and expansion / improvement of existing facilities.

6.5 Indicative sectoral carbon budgets

A fine but important distinction needs to be made between *indicative sectoral carbon budgets* (iSCBs) and the *allocation of carbon budgets* to some sectors, sub-sectors and entities. The analysis that would produce iSCBs applies criteria, using a robust methodology, to define iSCBs. These would be for the whole economy and include small emitters (e.g. households) who would not receive an allocation. The iSCBs provide a starting point for the allocation process. In that process, the (final, actual) allocation of CBs takes place – and this covers only some sectors, sub-sectors and entities (see section 6.4 on the importance of definitions).

Figure 5 illustrates how a comprehensive set of indicative sectoral carbon budgets might be derived from the overall national budget. These iSCBs would form a starting point, to which sectors and entities would respond in the next step.

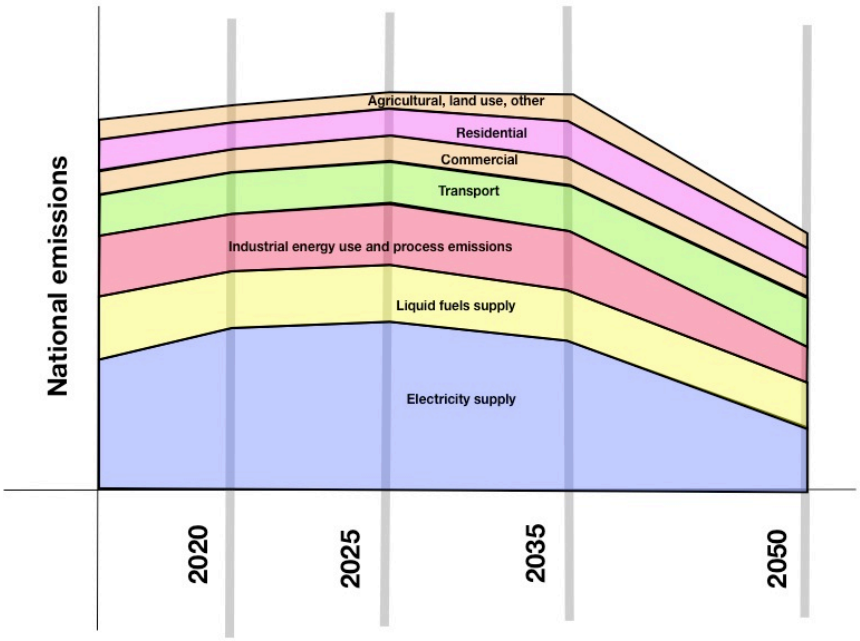

Figure 5: Indicative sectoral carbon budgets under the GHG emission trajectory

The final allocation of carbon budgets is addressed in the processes outlined below, starting in section 7, starting with a response to the iSCBs by sectors and entities.

7. Carbon budgets defined by sectors, entities or installations

7.1 Defining PAMs to remain within sectoral carbon budget

Sectors, sub-sectors, entities (e.g. companies) or installations should specify the policies and measures (PAMs) they intend implementing in order to remain within their budgets. Cross-cutting policies, notably a carbon tax, should also be taken into account.

Individual policies and measures (PAMs) might include specific measures such as the introduction of mandatory energy efficiency standards in government and commercial buildings; incentives to install solar water heaters; or measures to reduce the frequency of fire in certain ecosystems. They may also include existing sectoral plans, such as the integrated resource plan for electricity generation (DoE 2011a). In all cases, the overall test will remain whether these PAMs contribute to remaining within the carbon budgets and keeping South Africa on the path of its performance benchmark.

Note that the process of allocation carbon budgets in **Error! Reference source not found.** divides up between small and big emitters by sector; and then among the big emitters, would distinguish in process:

- 'very big emitters' would have a mitigation plan and be subject to MRV, i.e. assessment of implementing the action; while
- 'lesser' emitters (among the big ones) would be subject to sectoral regulation, and GHG inventories would provide information that may suffice for MRV, or need additional assessment and mitigation plans at a sectoral level.

There are also cross-cutting policies, notably a carbon tax (and possibly incentives, if they are applied widely across the economy).Here, another important consideration is the relationship between carbon budgets and the carbon tax (National Treasury 2010, 2012). Generally, either a budget or a tax would be used for a particular entity. While there some exceptions to the rule of not applying both (e.g. entities in European countries that had carbon taxes and are now participating in the EU-ETS and under its cap as well). Under South African circumstances, policy seems to be indicating that carbon budgets would be applied to major emitters. It may be that the price instrument of a carbon tax is better at covering multiple and smaller sources (which together add up to substantial emissions, but would be administratively difficult to provide an individual allocation). The carbon tax, however, faces the same consideration of administrative ease in tax collection.

The recycling of revenue to ensure that poor households receive a net benefit are a key consideration, and Treasury has signalled that it intends to include this in the design of the carbon tax to be implemented from financial year 2013/14 (National Treasury 2012). The thresholds indicated in the budget review appear more like exemptions (though information is sketchy); if put on an objective basis such as energy or carbon content, this might provide a means of distinguishing which instrument applies where. The 0.1 Mt reporting thresholds in the White Paper (see section 6.4above) are another element that might help to draw a line between different sectors and entities. The relationship of carbon budget and tax requires further work and discussion across government.

7.2 Motivation for increases in sectoral carbon budgets

Climate policy calls for the 'development of desired emission reduction outcomes for each sector and sub-sector of the economy. These will include short-, medium- and long-term CBs for sectors and sub-sectors where a CB approach is relevant'(RSA 2011). These effectively amount to SCBs. Sectors would be given an opportunity to develop their own SCBs, taking into account the national carbon budget. In this, the indicative allocation above will provide an important starting point.

It will be important to specify the PAMs that would allow a sector or entity to remain within the SCB.

Before motivation for an increase, sectors should demonstrate that all PAMs are being utilised. If this can be shown,a motivation can be made for an increase in SCB, based on developmental benefit.

There are at least two options for how such increases would be negotiated:

- Option 1: Industry associations and major entities negotiate.
- Option 2: Sectoral departments negotiate on behalf of their key stakeholders, DEA/ Treasury mediates / arbitrates.

8. Mediating and arbitrating differences

The processes outlined above may well lead to difference between the national carbon budget (the area under the GHG emission trajectory) and the sum of carbon budgets for sectors and entities. As an allocation process, the dynamics might follow a mediation-arbitration process. The DEA has a mandate in climate policy to develop SCBs and monitor and evaluate against them. An initial step may be for DEA to engage in a mediatory manner with sectors and entities whose proposed SCBs are too large to enable the country as a whole to follow its GHG emission trajectory.

If a mediatory approach fails to resolve issues, arbitration may be needed. This may still be a role for DEA, or it might involve Treasury (as the department familiar with resolving issues around the financial budget) or indeed the Presidency. The LCAP report suggested that '[i]n the final analysis, the highest authority in the form of the President will confirm the budget allocation, resolving any outstanding allocation issues'(WWF-SA 2011b).

If the sum of all sectoral carbon budgets exceeds the national total, and a facilitative approach has failed, then an institution or several (Presidency / Treasury / DEA) need to engage in arbitration. Following the arbitration, allocations of sectoral carbon budgets would be made.

One area of flexibility may be time – if carbon budgets are exceeded in an individual year, then there is at least potential to make up the short-fall in following years.

Note that this mediation-arbitration process is for the allocation of carbon budgets, initially or *ex ante*. The process of adjustment (section 10) is *ex post*, that is adjusting after PAMS have been implemented to stay within the carbon budget allocated. Other things being equal, one might apply an 'equal correction factor' across all sectors.

9. Monitoring and evaluation to stay within carbon budgets

Information will be needed to assess whether sectors and major entities are remaining within their carbon budget. Monitoring and evaluation of carbon budgets is essential, so that carbon budgets should be allocated to those sectors, sub-sectors and entities where GHG emissions can be monitored effectively.

Once SCBs are finally allocated, monitoring and evaluation (M&E) will be used to collect data on emissions, activity levels and the implementation of mitigation actions.

The GHG information management system will be a critical information source for emissions and MRV of mitigation actions will provide information on reductions achieved. Information on the development benefits actually delivered should be an integral part of the M&E system.

9.1 GHG inventory

Greenhouse gas inventories (GHG-Is) are designed to assess emissions, not emission reductions. Yet frequent reporting of GHG-Is, as will be required following recent COP decisions (UNFCCC 2009, 2010, 2011b), will require South Africa to provide information about emission trends. There is some level of sectoral disaggregation in GHG-Is, and so trends in some sectors will be an important basis for assessing sectoral carbon budgets.

With more national communications for developing countries becoming more frequent – every four years with biennial updates – trends in emissions can be seen over time, including sectoral trends in emissions and any declining trends, i.e. reductions. This will be useful information for carobn budgeting, particularly for those sectors subject to sectoral regulation – that are big emitters, but where emissions are not attributable to large entities or installations and actions are across the sector.

9.2 MRV of action / PAMs

The systems established in the Presidency for M&E are to be used at the national level, which is slightly different wording to the international requirement for mitigation actions and support to be 'measurable, reportable and verifiable' (MRV) (UNFCCC 2007, 2009, 2010, 2011b). What is clear is that our climate policy sets out a clear trajectory for GHG emissions and systems to report progress in remaining on or below that line, and therefore within our carbon budget.

South Africa, together with other developing countries, will be subject to international requirements of transparency (UNFCCC 2011b). In addition to M&E, there would be MRV of implementation of mitigation actions for large entities or installations, or large actions by sectors.

10. Adjustment process

Government will need to ensure that sectoral carbon budgets remain consistent within the GHG trajectory range, or what adjustment would be made if this is exceed or an individual sector

exceeds its carbon budget. This could follow a facilitative or mediation approach initially, failing which mechanisms for compliance would be needed.

The DEA would need to engage in a facilitative manner, initially, in such cases. Should sectors or entities fail to come into compliance with their sectoral carbon budgets, then disputes might arise and arbitration would be needed to resolve issues and ensure the overall integrity of the national carbon budget. Compliance would presumably apply at the level of firms rather than sectors.

The risk of exceeding the national carbon budget is that South Africa would simply seek to renegotiate its national carbon budget internationally, even through our trajectory already exceeds a global 'fair share', and thereby risk its reputation as a responsible global citizen.

References

Blignaut, J 2001. Domestic pollution permit allocation regimes. Study for the ATRIP project on the Clean Development Mechanism and future emissions trading regimes: Economic opportunities for South Africa. Cape Town, Energy & Development Research Centre, University of Cape Town.

Bradley, R, Baumert, K & Pershing, J (Eds) 2005. *Growing in the greenhouse: Protecting the climate by putting development first*. Washington DC, World Resources Institute. http://pubs.wri.org/pubs_description.cfm?PubID=4087

Brazil 1997. Proposed elements of a protocol to the UNFCCC, presented by Brazil in response to the Berlin mandate, FCCC/AGBM/1997/MISC.1/Add.3. Bonn, UNFCCC.

Brown, M & Cutifani, M 2011. Climate change: Global carbon budget gives all a clear and simple target. . *Business Day*. 20 October. http://www.businessday.co.za/articles/Content.aspx?id=156468

Camco & TIPS (Camco Asset Management Company and Trade and Industrial Policy Strategies) 2010. Climate change: Risks and opportunities for the South African economy: An assessment of mitigation response measures. prepared by A McNamara Johannesburg. http://www.climateriskandopportunity.co.za/downloads.htm accessed 14 May 2010.

CASS / DRC joint project team 2011. Equitable access to sustainable development: Carbon budget account proposal, in BASIC experts (Ed). *Equitable access to sustainable development: Contribution to the body of scientific knowledge*. Beijing, Brasilia, Cape Town and Mumbai, BASIC expert group.

Clo, S 2010. Grandfathering, auctioning and Carbon Leakage: Assessing the inconsistencies of the new ETS Directive *Energy Policy* 38 (5): 2420–2430.

Cohen, B, Lewis, Y & Mason-Jones, K 2012. Predictions of low-carbon emissions trajectories from the South African minerals sector. Report for the NPC low carbon economy work programme Cape Town, The Greenhouse.

DEA (Department of Environmental Affairs) 2009. Greenhouse gas inventory 2000: National inventory report. Compilation under the United Nations Framework Convention on Climate Change. May 2009. Pretoria.

DEA (Department of Environmental Affairs) 2011. Defining South Africa's peak, plateau and decline greenhouse gas emissions trajectory. Explanatory note. Pretoria. http://www.environment.gov.za//PolLeg/WhitePapers/climatechange_whitepaper.htm accessed 26 October 2011.

DEAT (Department of Environmental Affairs and Tourism) 2004. A national climate change response strategy. Pretoria. http://www.environment.gov.za/Documents/Documents/2004Oct7/Climate change response strategy 10Sept04.doc Accessed 12 May 2008.

DEAT & DST (Department of Environmental Affairs and Tourism & Department of Science and Technology) 2009. Towards an effective South African climate change response policy. Conference statement, 6 March 2009. http://www.ccsummit2009.co.za/ accessed 27 April 2009.

Den Elzen, M, Höhne, N, Lucas, P L, Moltmann, S & Kuramochi, T 2007. The Triptych approach revisited: A staged sectoral approach for climate mitigation. MNP Report 500114008/2007. Bilthoven, Netherlands Environmental Assessment Agency (MNP).

DoE (Department of Energy) 2011a. Integrated resource plan for electricity, 2010-2030. Government Gazette No. 34263 6 May 2011. Pretoria. http://www.energy.gov.za accessed 6 March 2012.

DoE (Department of Energy) 2011b. Integrated resource plan for electricity, 2010-2030. Revision 2, final report, 25 March. Pretoria. http://www.energy.gov.za accessed 26 March 2011.

DST (Department of Science and Technology) 2007. South Africa's climate change technology needs assessment. Synthesis report September 2007. Pretoria, Republic of South Africa. http://www.dst.gov.za/publications-policies/strategies-reports/SA climate change technology needs assessment.pdf Accessed 14 January 2009.

EDD (Economic Development Department) 2011. New growth path framework. Pretoria, EDD. http://www.economic.gov.za/publications/new-growth-path-series/125-new-growth-path-framework accessed 17 February 2012.

Ekholm, T, Soimakallio, S, Moltmann, S, Hoehne, N, Syri, S & Savolainen, I 2010. Effort sharing in ambitious, global climate change mitigation scenarios. *Energy Policy* 38 (4): 1797-1810. http://search.ebscohost.com/login.aspx?direct=true&db=buh&AN=47827477&site=ehost-live.

Ellis, J, Baron, R & Buchner, B 2007. SD-PAMs: What, where, when and how. Report for the Annex I Expert Group on the UNFCCC (draft for review).

ERC (Energy Research Centre) 2007a. Long Term Mitigation Scenarios: Technical Appendix. Prepared by the Energy Research Centre for Department of Environment Affairs and Tourism, Pretoria, October 2007. http://www.erc.uct.ac.za/Research/LTMS/LTMS-intro.htm Accessed 30 October 2008.

ERC (Energy Research Centre) 2007b. Long Term Mitigation Scenarios: Technical summary. October 2007. Pretoria, Department of Environment Affairs and Tourism. http://www.erc.uct.ac.za/Research/LTMS/LTMS-intro.htm Accessed 30 October 2008.

ERC (Energy Research Centre) 2011a. Final technical report, South African Low Emissions Pathways Project, November 2011. Cape Town, Energy Research Centre, University of Cape Town.

ERC (Energy Research Centre) 2011b. Initial analysis of low emissions pathways proposed in the National Climate Change Response White Paper, November 2011. South African Low Emissions Pathways Project. Cape Town, Energy Research Centre, University of Cape Town.

EU Parliament and Council 2009a. EU ETS phase III directive: amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community (Text with EEA relevance). Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009.

Brussels. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32009L0029:EN:NOT accessed 28 March 2012.

EU Parliament and Council 2009b. On the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009. Brussels. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32009D0406:EN:NOT accessed 28 March 2012.

G-8+5 2007. Joint Statement by the German G8 Presidency and the Heads of State and/or Government of Brazil, China, India, Mexico and South Africa on the occasion of the G8 Summit in Heiligendamm, Germany, 8 June 2007, G8 Summit 2007. Heiligendamm, Germany.

G:enesis (G:enesis Analytics) 2008. Carbon regulation in the South African chemical and allied industries sector: An analysis of policy options and their impact by Genesis Analytics climate change practice. 30 April. prepared by E Tyler, B Cloete and G Biacuana Cape Town, Genesis Analytics

G:enesis (Genesis Analytics) 2010. Study to provide an overview of the use of economic instruments and develop sectoral plans to mitigate the effects of cliamte change. Report by Genesis Analytics for prepared by B Cloete, G Robb, E Tyler, W Engel, B Cohen, P Notten, M Ncwadi and S Thorne Johannesburg, Fund for Research into Industrial Development, Growth and Equity (FRIDGE). http://www.dti.gov.za/fridge/FRIDGE_Final Report.pdf accessed 3 June 2010.

Gilbert, A, Reece, G, Moltmann, S & Gardiner, A 2007. Developing an EU carbon budget. Supported by Friends of the Earth and Christian Aid. London, Ecofys UK. http://www.foeeurope.org/climate/download/Ecofys_EU_Carbon_Budget.pdf accessed 6 March 2012.

Goldblatt, M 2010. Comparison of emissions trading and carbon taxation in South Africa. *Climate Policy* 10 (5): 511–526.

Groenenberg, H, Phylipsen, D & Blok, K 2001. Differentiating the burden world-wide: Global burden differentiation of GHG emissions reductions based on the Triptych approach - a preliminary assessment. *Energy Policy* 29: 1007-1030.

Grubb, M & Neuhoff, K 2006. Emissions trading and competitiveness. Special Issue. *Climate Policy* 6 (1).

Hofmann, Y 2006. Auctioning of CO2 emission allowances in the EU ETS. Report by Ecofys under the project Review of EU Emissions Trading Scheme. Brussels European Commission Directorate General for Environment. http://ec.europa.eu/environment/climat/emission/pdf/etsreview/ets_co2_emission_auctioning.pdf accessed 24 May 2010.

IPCC (Intergovernmental Panel on Climate Change) 2001. Working Group II Third Assessment Report: Technical Summary. Final government distribution. Geneva.

IPCC (Intergovernmental Panel on Climate Change) 2005. Special report on carbon dioxide capture and storage. prepared by B Metz, O D Davidson, H de Coninck, M Loos and L M Meyer Geneva.

IPCC 2007a. Climate Change 2007: Climate Change Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva.

IPCC (Intergovernmental Panel on Climate Change) 2007b. Climate Change 2007: Mitigation of Climate Change. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Bern, IPCC working Group I Technical Support Unit. http://www.ipcc.ch accessed 29 September 2011.

IPCC (Intergovernmental Panel on Climate Change) 2007c. Climate Change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva. http://www.ipcc.ch

Jayaraman, T, Kanitkar, T & DSouza, M 2011. Equitable access to sustainable development: An Indian approach, in BASIC experts (Ed). *Equitable access to sustainable development: Contribution to the body of scientific knowledge*. Beijing, Brasilia, Cape Town and Mumbai, BASIC expert group.

Kanitkar, T, Jayaraman, T, D'Souza, M, Sanwal, M, Purkayastha, P & Talwar, R 2010. Meeting equity in a finite carbon world: Global carbon budgets and burden sharing in mitigation actions. *Global Carbon Budgets and Equity in Climate Change, June 28-29, 2010*. Mumbai, Tata Institute of Social Sciences**:** 47.

Kornelius, G, Marquard, A & Winkler, H 2007. Non-energy emissions - Industrial processes: An input into the Long Term Mitigation Scenarios process, LTMS Input Report 3. Cape Town, Energy Research Centre. http://www.erc.uct.ac.za/Research/LTMS/LTMS-intro.htm Accessed 30 October 2008.

Marquard, A, Trollip, H & Winkler, H 2011. Opportunities for and costs of mitigation in South African economy. Paper for the climate change response science-policy dialogue series. Pretoria, Department of Environmental Affairs.

Meinshausen, M, Meinshausen, N, Hare, W, Raper, S C, Frieler, K, Knutti, R, Frame, D J & Allen, M R 2009. Greenhouse gas emission targets for limiting global warming to 2ºC *Nature* Letters 265-279.

Midgley, G F, Chapman, R A, Mukheibir, P, Tadross, M, Hewitson, B, Wand, S, Schulze, R E, Lumsden, T, Horan, M, Warburton, M, Kgope, B, Mantlana, B, Knowles, A, Abayomi, A, Ziervogel, G, Cullis, R & Theron, A 2007. Impacts, vulnerability and adaptation in key South African sectors: An input into the Long Term Mitigation Scenarios process, LTMS Input Report 5. Cape Town, Energy Research Centre. http://www.erc.uct.ac.za/Research/LTMS/LTMS-intro.htm Accessed 30 October 2008.

National Treasury 2010. Reducing greenhouse gas emissions: The carbon tax option. Discussion paper for public comment, December 2010. Pretoria. http://www.treasury.gov.za/public comments/Discussion Paper Carbon Taxes 81210.pdf accessed 20 December 2010.

National Treasury 2012. Budget review. Pretoria. http://www.treasury.gov.za/documents/national budget/2012/review/FullReview.pdf accessed 29 February 2012.

Neuhoff, K & Matthes, F 2008. The role of auctions for emissions trading. Cambridge, Climate Strategies. http://www.climatestrategies.org/reportfiles/role_of_auctions_09_oct_08final.pdf last accessed 11 September 2009.

NPC (National Planning Commission) 2011. National development plan: Vision for 2030. Pretoria, The Presidency, Republic of South Africa. http://tinyurl.com/d3vzndr accessed 14 November 2011.

Pauw, K 2007. Economy-wide modeling: An input into the Long Term Mitigation Scenarios process, LTMS Input Report 4. Cape Town, Energy Research Centre. http://www.erc.uct.ac.za/Research/LTMS/LTMS-intro.htm Accessed 30 October 2008.

Phylipsen, D 2000. International comparisons and national commitments: Analysing energy and technology differences in the climate debate. Dissertation. Department of Science, Technology, and Society. Utrecht, University Utrecht**:** 205.

Phylipsen, D, Bode, J W, Blok, K, Merkus, H & Metz, B 1998. A Triptych approach to burden differentiation: GHG emissions in the European bubble. *Energy Policy* 26 (12): 929-943.

Reinaud, J 2008. Climate policy and carbon leakage: Impacts of the European emissions trading scheme on aluminium. Paris, International Energy Agency.

Rogelj, J, Nabel, J, Chen, C, Hare, W, Markmann, K, Meinshausen, M, Schaeffer, M, Macey, K & Höhne, N 2010. Copenhagen Accord pledges are paltry. *Nature* 464 (22 April 2010): 1126-1128. April. http://www.nature.com/nature/journal/v464/n7292/full/4641126a.html accessed 3 October 2011.

RSA (Republic of South Africa) 2003. A national climate change response strategy. Draft October 2003. Pretoria. unfccc.int/resource/docs/natc/zafnc01.pdf.

RSA (Republic of South Africa) 2004. South Africa: Initial National Communication under the United Nations Framework Convention on Climate Change. Submitted at COP-9. Pretoria. unfccc.int/resource/docs/natc/zafnc01.pdf.

RSA 2006. Dialogue working paper 18: Submission from South Africa: Sustainable Development Policies and Measures. Pretoria, Department of Environmental Affairs & Tourism**:** 3.

RSA (Republic of South Africa) 2008. Government's vision, strategic direction and framework for climate policy. Presentation by the Minister of Environmental Affairs and Tourism on the July Cabinet *lekgotla*. Cape Town, Department of Environmental Affairs and Tourism. http://www.environment.gov.za/NewsMedia/MedStat/2008Jul28_2/Media LTMS 29July2008.ppt last accessed 27 April 2009.

RSA (Republic of South Africa) 2010a. Industrial Policy Action Plan, 2010/11 – 2012/13. Pretoria, Economic Sectors and Employment Cluster. http://www.dti.gov.za/ipap/IPAP2010-2013_18_FEB_2010.pdf accessed 19 February 2010.

RSA (Republic of South Africa) 2010b. Letter dated 29 January, for the South African national focal point. Pretoria, Department of Environmental Affairs http://unfccc.int/files/meetings/application/pdf/southafricacphaccord_app2.pdf Accessed 8 February 2010.

RSA (Republic of South Africa) 2010c. National climate change response green paper. Pretoria, Department for Environmental Affairs. http://www.info.gov.za/view/DownloadFileAction?id=135920 last accessed 11 January 2011.

RSA (Republic of South Africa) 2011. National Climate Change Response White Paper. Government Gazette No. 34695, Notice 757 of 2011. Pretoria, Department of Environmental Affairs. http://www.info.gov.za/view/DynamicAction?pageid=623&myID=315325 and http://www.environment.gov.za//PolLeg/WhitePapers/climatechange_whitepaper.htm accessed 26 October 2011.

SBT (Scenario Building Team) 2007. Long Term Mitigation Scenarios: Strategic Options for South Africa. Pretoria Department of Environment Affairs and Tourism. http://www.environment.gov.za/HotIssues/2008/LTMS/A LTMS Scenarios for SA.pdf Accessed 15 October 2008.

Taviv, R, van der Merwe, M, Scholes, R J & Collet, G 2007. Non-energy emissions – Agriculture, forestry & waste: An input into the Long Term Mitigation Scenarios process, LTMS Input Report 2. Cape Town, Energy Research Centre. http://www.erc.uct.ac.za/Research/LTMS/LTMS-intro.htm Accessed 30 October 2008.

Tyler, E 2010. Aligning South African energy and climate change mitigation policy. *Putting a price on carbon: Economic instruments to mitigate climate change in South Africa and other developing countries*. H Winkler, A Marquard and M Jooste. Proceedings of a conference held on 23-24 March 2010 in Cape Town. ISBN 978–0–7992–2357-6, Energy Research Centre, University of Cape Town**:** 1-15.

Tyler, E, du Toit, M & Burchell, Z 2011. Emissions trading as a policy option for greenhouse gas mitigation in South Africa. *Journal of Energy in Southern Africa* 22 (1): 26-41.

UNFCCC 1992. United Nations Framework Convention on Climate Change. New York, United Nations. http://unfccc.int/resource/docs/convkp/conveng.pdf.

UNFCCC (United Nations Framework Convention on Climate Change) 2007. Bali Action Plan. Decision 1/CP.13. Bali, Indonesia.

UNFCCC (United Nations Framework Convention on Climate Change) 2009. Decision 2/CP.15: Copenhagen Accord. Noted in COP Report, FCCC/CP/2009/11/Add.1. New York, United Nations. http://unfccc.int/documentation/documents/advanced_search/items/3594.php?rec=j&priref=600005735 - beg accessed 8 October 2011.

UNFCCC (United Nations Framework Convention on Climate Change) 2010. Decision 1/CP.16: The Cancun Agreements: Outcome of the work of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention. Document FCCC/CP/2010/7/Add.1. New York, United Nations. http://unfccc.int/files/meetings/cop_16/application/pdf/cop16_lca.pdf last accessed 8 October 2011.

UNFCCC 2011a. Decision -/CMP.7: Outcome of the work of the Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol at its sixteenth session. Document FCCC/KP/CMP/2011/ to be issued.

UNFCCC 2011b. Decision -/CP.7: Outcome of the work of the Ad Hoc Working Group on Long-term Cooperative Action under the Conventio. Advance copy, document no. to be issued.

Victor, D G & House, J 2006. BP's emissions trading system. *Energy Policy* 34: 2100–2112.

WBGU (German Advisory Council on Global Change) 2009. Solving the climate dilemma: The budget approach. Berlin, German Advisory Council on Global Change. http://www.wbgu.de/fileadmin/templates/dateien/veroeffentlichungen/sondergutachten/sn2009/wbgu_sn2009_en.pdf accessed 8 October 2011.

Winkler, H (Ed) 2007. *Long Term Mitigation Scenarios: Technical Report*. Prepared by the Energy Research Centre for Department of Environment Affairs and Tourism, Pretoria, October 2007. http://www.erc.uct.ac.za/Research/LTMS/LTMS-intro.htm Accessed 30 October 2008.

Winkler, H, Hughes, A, Marquard, A, Haw, M & Merven, B 2011a. South Africa's greenhouse gas emissions under Business-as-Usual: The technical basis of 'Growth without Constraints' in the Long-Term Mitigation Scenarios. *Energy Policy* 39 (10): 5818–5828. doi:10.1016/j.enpol.2011.06.009.

Winkler, H, Jooste, M & Marquard, A 2010. Structuring approaches to pricing carbon in energy- and trade-intensive sectors in South Africa. *Climate Policy* 10 (5): 527–543.

Winkler, H, Letete, T & Marquard, A 2011b. A South African approach - responsibility, capability and sustainable development, in BASIC experts (Ed). *Equitable access to sustainable development: Contribution to the body of scientific knowledge*. Beijing, Brasilia, Cape Town and Mumbai, BASIC expert group.

Winkler, H, Marquard, A, Manley, J, Davis, S, Trikam, A, den Elzen, M, Höhne, N & Witi, J 2008. Quantifying SD-PAMs: National energy models and international allocation models for climate change mitigation. South African case study. Cape Town, Energy Research Centre.

Winkler, H, Spalding-Fecher, R, Mwakasonda, S & Davidson, O 2002. Sustainable development policies and measures: starting from development to tackle climate change, in K Baumert, O Blanchard, S Llosa and J F Perkaus (Eds). *Building on the Kyoto Protocol: Options for protecting the climate*. Washington DC, World Resources Institute**:** 61-87.

WWF-SA (WWF South Africa) 2011a. Approaching the 'why, what and how' of low-carbon planning in South Africa. prepared by S Fakir, T ESsop, R Worthington, L Naudé, L Tyrer, B Cohen, E Tyler, Y Lewis, B Cloete and S Raubenheimer Cape Town, WWF-SA. http://assets.wwfza.panda.org.wwf-web-1.bluegecko.net/downloads/lcap_report_2011_web.pdf accessed 21 September 2011.

WWF-SA (Worldwide Fund for Nature) 2011b. Development of a low carbon action plan for South Africa. Final report for WWF: October 2010. prepared by B Cohen, E Tyler, S Raubenheimer and Y Hansen Cape Town, WWF-SA.

Glossary

A short glossary of terms and acronyms that are used in climate negotiations

Annex B. An Annex to the Kyoto Protocol that lists agreed emission targets taken by the industrialized and transitioning countries for the so-called first commitment period, which runs from 2008 to 2012.

Annex I Parties. The industrialized and transitioning countries listed in this Annex to the Climate Convention. These countries accepted emission targets for the period 2008 to 2012 in Annex B of the Kyoto Protocol.

Annex II Parties. The wealthy countries listed in this Annex to the Climate Convention that have a special obligation to help developing countries with financial and technological resources. They include the 24 original members of the Organization for Economic Cooperation and Development (OECD) plus the European Union.

AOSIS. Alliance of Small Island States. An ad hoc coalition of 42 low-lying and island countries that are particularly vulnerable to sea-level rise and share common positions on climate change.

AWG-KP. Ad hoc Working Group on further commitments of Annex I Parties under the Kyoto Protocol

AWG-LCA. Ad Hoc Working Group on Long-term Cooperative Action under the Convention

BAP. Bali Action Plan

BASIC. Brazil, South Africa, India and China. Environment Ministers coordinate on climate change issues, not a formal negotiating group – does not adopt formal positions.

Bunker fuels. Fuels used in aviation and maritime transport.

CDM. Clean Development Mechanism. A project-based emissions trading system under the Kyoto Protocol that allows industrialized countries to use emission reduction credits from projects in developing countries that both reduce greenhouse gas emissions and promote sustainable development.

COP. Conference of the Parties to the Climate Convention. The supreme body of the Convention. It currently meets once a year to review the Convention's progress. The word "conference" is not used here in the sense of "meeting" but rather of "association," which explains the seemingly redundant expression "fourth session of the Conference of the Parties."

COP/MOP or CMP. Conference of the Parties serving as the Meeting of the Parties to the Protocol. The Kyoto Protocol's supreme body, which will serve as the Protocol's meeting of the Parties. The sessions of the COP and the COP/MOP will be held during the same period. This will improve cost-effectiveness and coordination with the Convention.

Copenhagen Accord. Political agreement at COP-15 in 2009. The COP did "took note" of the Accord in decision 1/CP.15 (i.e. weaker than making it its own decision).

EIT. Economy in transition. EITs typically include the countries of Central and Eastern Europe (e.g., Poland), the former Soviet Union (e.g., Russia), and Central Asian Republics (e.g., Kazakhstan).

EU. European Union. Earlier included 15 member states, now 27.

G-77. Group of 77. Founded in 1967 under the auspices of the United Nations Conference for Trade and Development (UNCTAD); seeks to harmonize the negotiating positions of its 133 developing-country members.

G-8. An international forum for the governments of Canada, France, Germany, Italy, Japan, Russia, the United Kingdom, and the United States

GEF. Global Environment Facility. A designated financial mechanism for international agreements on biodiversity, climate change (i.e., the UNFCCC), and persistent organic

pollutants. Established in 1991, the GEF helps developing countries fund projects and programs that protect the global environment.

GCF: Green Climate Fund, established in Cancun, with detailed design underway in 2011.

GHG. Greenhouse gas. Any gas that absorbs and re-emits infrared radiation into the atmosphere. The greenhouse gases controlled by th KP include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) plus three trace gases that occur in smaller amounts – HFCs, PFCs and SF_6.

Global Warming Potential (GWP). An index that allows for comparison of the various greenhouse gases. It is the radiative forcing that results from the addition of 1 kilogram of a gas to the atmosphere compared to an equal mass of carbon dioxide. Over 100 years, methane has a GWP of 21 and nitrous oxide of 310, although GWPs are under review in IPCC assessments and global temperature potentials have been suggested as an alternative common metric in negotiations.

IPCC. Intergovernmental Panel on Climate Change**.** The leading international body for the assessment of climate change, as a scientific body with thousands of scientists from across the world, reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change. The work of the organization is policy-relevant and yet policy-neutral, never policy-prescriptive. The inter-govenrmental panel takes decisions and reports written by scientists are accepted, adopted and approved. See http://www.ipcc.ch/organization/organization.shtml#.T3RWTMzlWDE

KP. Kyoto Protocol. An international agreement adopted by all Parties to the Climate Convention in Kyoto, Japan, in December 1997. Not ratified by the US.

LDC. Least developed country. A category of countries (currently 49) deemed by the United Nations to be structurally handicapped in their development process, facing more than other developing countries the risk of failing to come out of poverty as a result of these handicaps, and in need of the highest degree of consideration from the international community in support of their development efforts.

MRV. Measurable, reportable and verifiable

NAI Parties. non-Annex I Parities (see above, countries who are not Parties listed in Annex I), mostly developing countries

PAMs. Policies and measures. The promotion of renewable energy, energy efficiency, forest conservation, or other actions for the reduction or limitation of greenhouse gases or for sustainable development (to be implemented by Annex I Parties under Article 2.1 of the Protocol).

Party. A state (or regional economic integration organization, such as the European Union) that agrees to be bound by a treaty and for which the treaty has entered into force.

QELROs. Quantified emission limitation and reduction objectives, established under the Kyoto Protocol

QEERTs. Quantified economy-wide emission reduction targets, for developed countries in the Cancun decision 1/CP.16

SBI. Subsidiary Body for Implementation. An official body of the Climate Convention, open to all Parties, that makes recommendations on policy and implementation issues to the Conference of the Parties and, if requested, other bodies.

SBSTA. Subsidiary Body for Scientific and Technological Advice. An official body of the Climate Convention, open to all Parties, that serves as the link between the information and assessment provided by expert sources (such as the Intergovernmental Panel on Climate Change) on the one hand, and the policy-oriented needs of the Conference of the Parties on the other.

SIDS. Small Island Developing States

UNFCCC. United Nations Framework Convention on Climate Change (Climate Convention, or Convention). A treaty signed at the 1992 Earth Summit in Rio de Janeiro by more than 150 countries.

WB. World bank

WTO. World Trade Organisation