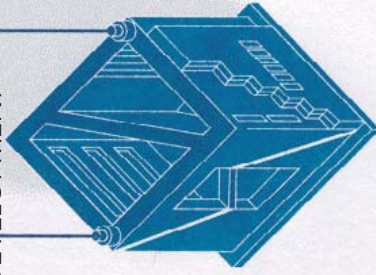


WORLD
BUSINESS
COUNCIL
For
SUSTAINABLE
DEVELOPMENT



'guess-work'

"Averting the
devastating trends
of climate change
is the
greatest challenge
facing the world."



As voted by
1,000 CEO's
at the DAVOS
World Economic Forum - Jan 2000

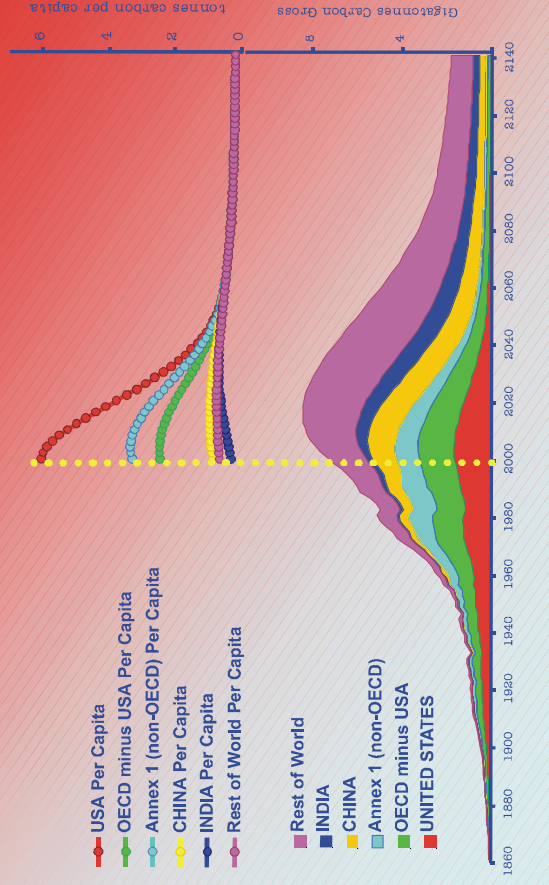
With **CLIMATE CHANGE**

"we face a critical situation."

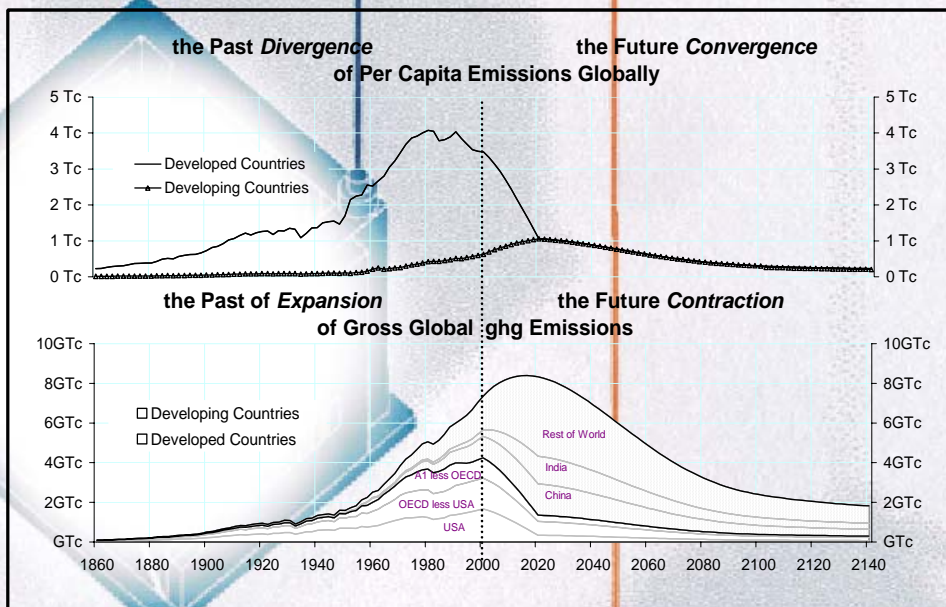
CEO's Met Office UK & NOAA US

Should we now respond with more
'guess-work' or a **'frame-work'?**

GLOBAL CO₂ "CONTRACTION" for 450 ppmv
6 Region Exponential "CONVERGENCE" to Equal Per Capita by 2060



?
Jazz



?
Geo-Polity

FRAME-WORK or GUESS-WORK? 'JAZZ' and 'Geo-Polity' or just-JAZZ?

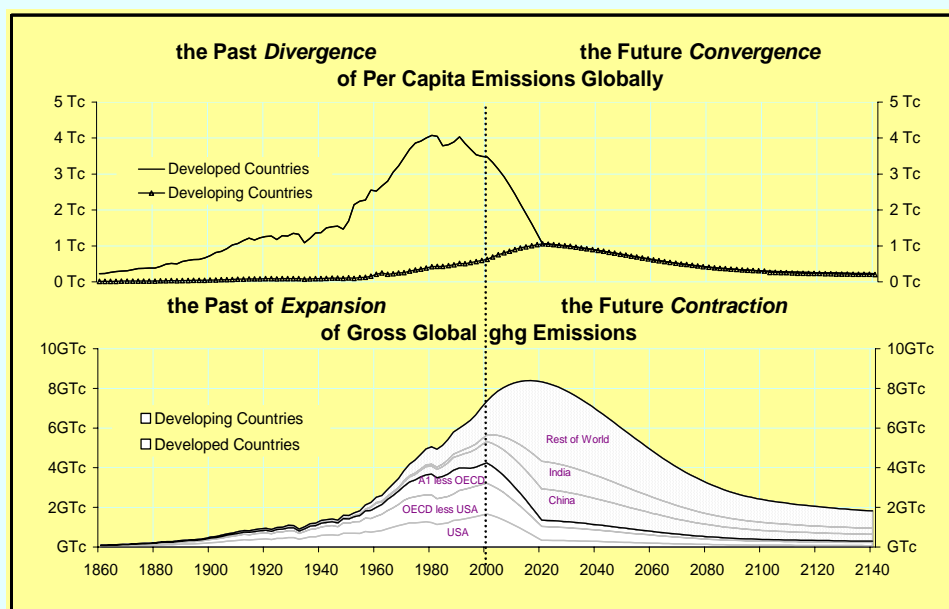
Academics in **IPCC Third Assessment Report Working Group 3** can explain and answer this fundamental question. The politicians already have.

"I do believe that 'contraction and convergence' provides an effective, equitable market-based framework within which governments can co-operate to avert climate change." **Michael Meacher MP, Environment Minister UK**

"That global partnership to avoid the danger of climate change requires that we start to discuss the arrangements for sharing of both responsibilities and entitlements, based on the principles of precaution and equity, that best defend the aspirations and security of all nations for the future.

The approach of 'Contraction and Convergence' is precisely such an idea."

Svend Auken MP, Environment Minister Denmark



These thoughts are addressed to those preparing Working Group Three (WG3) of the Intergovernmental Panel on Climate change (IPCC) Third Assessment Report (TAR).

They are supplied by: -

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This GCI booklet "*Framework or Guesswork?*" was written in during January 2000.

It is a review response to the first order drafts of the: -

- Intergovernmental Panel on Climate change (IPCC),
- Third Assessment Report (TAR) (due for publication in 2001),
- Working Group Three (WG3), the so-called 'mitigation' group.

The purpose of writing and circulating the booklet was to highlight the: -

- Arbitrarily selective choice of climate mitigation literature chosen for review at that point,
- Economic 'reluctance' and 'guesswork' character of these in aggregate and hence their conceptual inadequacy and even irrelevance,
- Need to recognise the literature focused on the imperative of establishing an international 'framework' based on precaution and equity (as in the United Nations Framework Convention on Climate Change (UNFCCC))
- "*Contraction and Convergence*" (C&C) literature reflecting this approach and the extensive references and support for this that in aggregate clearly mandate the inclusion of C&C in the TAR.

This 'intervention by booklet' - with other strategies (to be written up in due course) - resulted in C&C with key references being cited as the very first global policy concept in the second order drafts circulating at present (June 2000).

The booklet also contained an Annex listing support statements and references. This now appears in an expanded form in the final section of this document as a whole.

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IPCC Third Policy Assessment - General synthesis remarks about draft

Inconsistency internally

So far, the IPCC TAR WG3 mitigation policy drafts have no internal consistency. In their present state they will may evolve to create confusion for the future authors of the 'Summaries for Policy Makers' and then for the policy makers themselves.

Inconsistency with the UNFCCC

There is no obvious consistency with the already agreed global: -

1. objective and
2. principles of
 - ❖ precaution and
 - ❖ equity

in the United Nations Framework Convention on Climate Change (UNFCCC).

Paradigm shift from 'no-regrets'

The fundamental failing at this point in the drafts concerns the failure to explicitly recognise the generically different attitudes that exist towards the existence of the objectives and principles of the UNFCCC.

The dominant perceptions and policy approaches during the 1990's were: -

1. 'contrariansim',
2. 'no regrets' - do it if it makes sense anyway, maybe there's no problem, and
3. 'look & learn' or 'make-it-up-as-you-go-along' or hedging & guess-work.

To the Precautionary Paradigm

IPCC Working Group One scientists are now clearly on the record affirming the: -
'critical situation' we are in with a *'rapidly changing climate'*, and that we *'must act soon'*. (Ewins and Baker. 24 12 1999 - The Independent, UK).

This affirms the need for action in a precautionary framework, not more guess-work.

'Bolin Dictum'

Former IPCC chairman 'Bert Bolin's Dicutm' was: -

"Where differences of approach and perception exist, IPCC's job is to reveal these and to explain them," (WG3 SAR Montreal May 1993).

This recognised the sensible way to deal with contentious issues in the IPCC debates.

This dictum has not yet been applied with regard to the most basic difference of approach to the problem of climate change and how to mitigate it. This is the most serious problem in the drafts at this time.

In this paradigm shift, the global policy relationship between: -

- ❖ 'evolution' and random guess-work and a
- ❖ 'constitution' or evolution within a precautionary frame-work

must be addressed in the TAR.

Global Orientation

JAZZ, FROG and Geo-Polity

We can face this critical situation with a frame-work, or guess-work or chaos.

The scenarios 'Geo-Polity' 'JAZZ' and 'FROG', (see <http://www.wbcsd.ch/scenarios/>) or 'stories-of-the-future' of the World Business Council for Sustainable Development address this. This material was published under the name of TAR/WG3/SRES Lead Author Gerald Davis of Shell International in late 1997.

To some extent these have informed conceptualization of the draft WG3 Special Emissions Scenarios (SRES) which is the 'non-policy' document. They do not yet inform the content or the conceptualization of the TAR/WG3 itself, which is where mitigation policy and any conflicts about these are supposed to be explained. To help policy makers face this paradigm shift, this omission should be redressed.

In the light of the warnings from the scientists, the questions arising are these.

1. JAZZ - Do we merely act 'aspirationally' in the culture of 'markets' and 'increased efficiency' (JAZZ) without targets and timetables even as per Kyoto?

This is the position of David Victor of the CFR, TAR author and Kyoto antagonist (<http://www.gristmagazine.com/grist/heatbeat/debates011700.stm>).

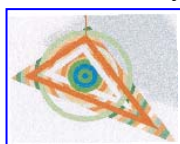


It is the cultural habit and habitat of some 'progressive' big business and its lobbyists. This position, like the one that follows, effectively defaults to antagonism to the UNFCCC as well as the Kyoto Protocol.

2. FROG - (First Raise our Growth) - Do we just carry on regardless, acting as usual, with contrarianisms, hedging and disagreements until it is too late to do anything effective? This position is advocated by the Global Climate Coalition by default.

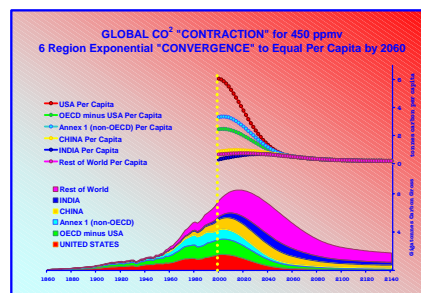


3. Geo-Polity - Do we now act collectively and rationally on the already agreed basis of precaution and equity, as the objective of the United Nations Framework Convention on Climate Change (UNFCCC) requires us to do (with GEO-Polity or Global Environmental Organisation)?



This position is advocated by the European parliament for example: -

(<http://www2.europarl.eu.int/omk/omnsapir.so/pv2?PRG=CALEND&APP=PV2&LANGUE=EN&TPV=DEF&FILE=980917>).



4. A fourth question arises as to the 'mix' of these three, where for example Kyoto is a mosaic of one, two and three that - in failure - defaults to either one or two, but without three.

Third Assessment Report (TAR) Structure

Some authors suggested that general discussion around these points at this stage of the evolution of the drafts (February 2000) was as helpful as - even more helpful than - specific proposals line-by-line for textual alternative wording. So here are: -

Some Specific Suggestions

1. This meta-level choice about the future and how to address it - defaults or design - should be spelled out using the WBCSD story lines.
2. Chapters ONE (Scope) TWO (Mitigation Policy) & TEN (Decision-Taking Framework) are the chapters where consistency with the UNFCCC needs to be explained in terms of the choices above.
3. It is from these chapters and the establishment of consistency here with the UNFCCC and the precautionary paradigm that the general internal consistency of the report as a whole needs to be referenced.
4. There is so much discursive and reductionist material in the report at this time, that in parts it appears to take on the character of repudiating WG1 and the UNFCCC. It is diversity as diversion.
5. It is important to keep clear at a headline level that most argue that the objective of the UNFCCC is unachievable without the precautionary imperative of global carbon contraction and the diplomatic imperative of the equity of convergence.
6. And while informal understanding of the need to manifest contraction and convergence by some default, in the view of some represents a possible scenario for being consistent with the UNFCCC
7. formal "*Contraction and Convergence*" represents the basis of being consistent with the UNFCCC on a precautionary basis by design in the view of others.
8. Jazz [as guess-work] and Geo-Polity [as frame-work] should be used to highlight the difference of the informal and the formal way of understanding "*Contraction and Convergence*"
9. Formal "*Contraction and Convergence*" is a widely know global policy concept which is written up not only in peer-reviewed literature (Refs. supplied by the TSU), but also passed as parliamentary resolutions over the last ten years. It represents a rigorous and pre-defined application of the objective and principles of the UNFCCC.
10. So chapters ONE, TWO and TEN of TAR WG3 drafts should reflect the literature that reflects this approach too. For the purposes of internal consistency, the product of this review should be available to authors of the other chapters of the report.

Specific Comments

Equity is the basis of the UNFCCC. The TAR section on 'Equity' [Chapter 1, Page 18, Line 5 onwards], should try to ensure that the language has shared meaning in the inter/intra-national/generational matrix posed [p19 Line 4 onwards].

EQUITY - Resolving the epistemological conflict

Equity has related, varied and in some ways contradictory usage in English.

1. Justice - Natural, Human, Constitutional & Legal i.e. perennial properties (ontology) and the common good.
2. Fairness - Social and Ethical i.e. distributional rights and universal/religious responsibilities - effectively in this context 'rights-by-people'.
3. Shares - Cash-convertible fractions of capital as property rights, or equity as shares of 100% - effectively in this context 'rights-by-income'.
4. Collateral - total of owned cash-convertible fractions of capital, less debts i.e. equity as 100%.

Because of rising atmospheric CO₂ concentrations, the global climate crisis represents a condition of increasing negative global ecological equity.

This reflects the incurred conflict in the above uses of the term equity.

Formal "*Contraction and Convergence*", resolves this conflict, affirming a global 'epistemology of equity' following D. Meadows (The Economist 1995) - as cited in Lovins 1999, as follows: -

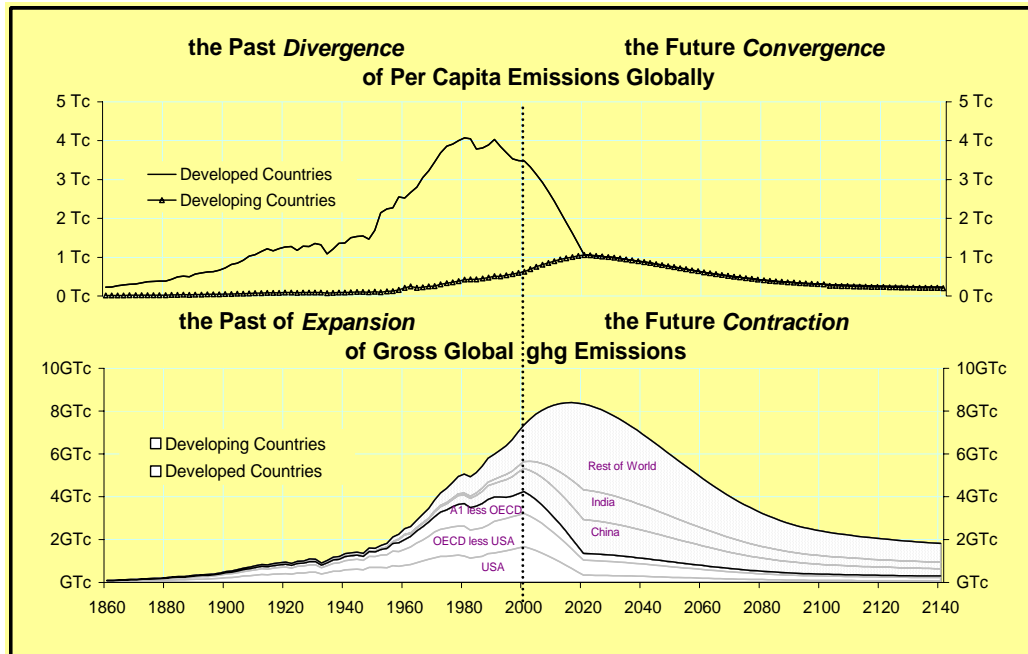
1. The precautionary (pre-determined) emissions 'contraction budget' is the basic collateral for climate stability (natural capital) or the 100% 'green' equity.
2. Since emissions shares globally are currently proportional to income [\$s per tonne carbon], the present distribution represents a randomly unsustainable and socially inequitable dominance of 'blue' or commercial equity
3. A global solution to this will only be achievable based on a 'constitution' which agrees to a deliberate convergence by an agreed date to a pre-distribution of this 100% as emissions 'commitment/entitlements' that become proportional to people or 'red' equity within the 100% collateral available.

Expansion and divergence have dangerously embedded these divergent meanings of equity. This growing conflict between the blue, red and green dimensions of equity is deepening the overall condition of negative ecological equity or accelerating loss of natural capital in the form of climate stability. This divergence must be corrected if arrangements and planning for ecological recovery are to be useful and effective.

The present thesis of blue equity and its antithesis with red equity must be re-synthesized within the green equity, i.e. with a controlled decrease of negative global ecological equity or what becomes the "*United Nations Framework Constitution for Contraction & Convergence*"(UNFCCC). The UNFCCC and its objective are based on the principles of 'Precaution' (emissions contraction) and 'Equity' (emissions convergence) where 'Efficiency' (emissions trading) is not a principle as such and therefore cannot sensibly be cast in the role of leading the entire process. It is only meaningful in the context of contraction and convergence, i.e. seen simply as a performance indicator and understood as a *derivative* of the above. On its own it is not an end, so it cannot be the means'.

Correcting titles & images - 'Framing the Problem, Framing the Solution'

Chapter 1, Page 4, Line 10 onwards, the following should be resolved in the section presently called 'Framing the Problem'. Using the title "carbon trajectories for stabilisation at 450 ppmv," authors have introduced contraction and convergence imagery at the outset (called fig 1.1). This early introduction is sensible as the TAR WG3 is fundamentally about mitigation [i.e. about 'solutions' not just about rehearsing problems], and contraction and convergence is about solutions.



'Past Expansion and Divergence' - 'Future Contraction and Convergence'

So the first suggestion is that this section could sensibly be called and imaged as, 'Framing the Problem, Framing the Solution' or 'Past Expansion and Divergence, Future Contraction and Convergence' with an image such as above to represent this.

However, the imagery and the subsequent language used to address it, are problematical. Moreover, they - so far - fail to represent the published literature, imagery and political agreements based on contraction and convergence.

With regard to the present image in the draft: -

1. It is arbitrary in its derivation - i.e. it has no source.
2. It appears to have been semi-randomly generated. Its computation is obscure. The implication is that it was 'modeled' but is unclear as to what the integrating assumptions are. In other words, it is entirely unclear as to why the curves are behaving as they do - i.e. so they actually achieve an overall contraction consistent with a 450 ppmv outcome - other than in some apparently accidental way.
3. Specifically, it appears to represent the discourse about the contraction and convergence 'trajectories' of Annex One and Non-Annex One that appear later in chapter one (between lines 11 and 55 on page 23 in section 1.4 - 'Alternative Development Pathways'). This 'binary adversarial' approach is politically unrealistic and a sub-optimal recognition of the opportunities in formal "Contraction and Convergence".

This goes to the fundamental question in this report. What is the future with regard to humanity in general and its/our influence on global climate change, and why will this future be whatever it turns out to be? Will it be led by negativistic anti-precautionary guess-work (JAZZ) or a positivistic precautionary framework (Geo-Polity)?

So far the whole TAR WG3 draft report seems largely trapped in the negativistic literature of the 'economics of resistance', written during the 1990s. In other words it draws on the discourse which was generated at a time when the generic character of the (largely but not only, 'economic') commentary regarding policy responses to global climate change was in the 'no-regrets' mode of thinking and not in the 'precautionary' mode.

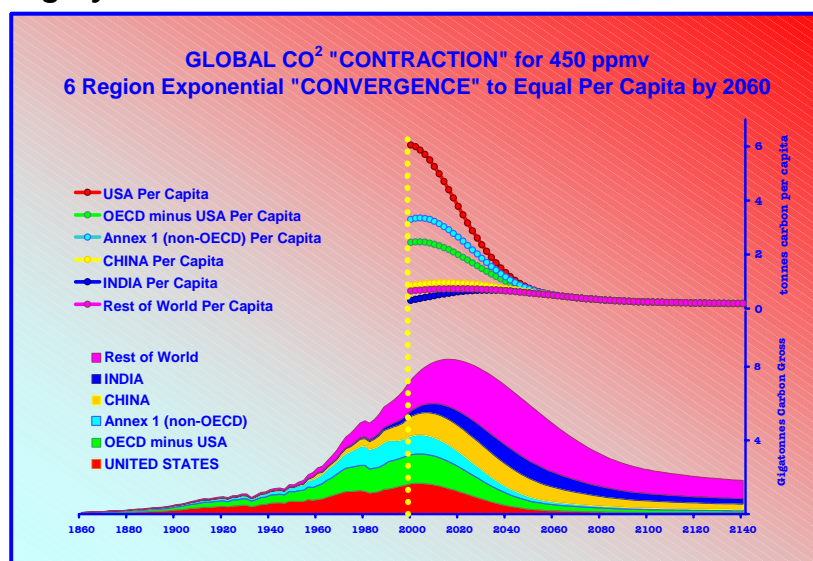
Clearly the situation has now changed. Scientists in IPCC WG1 (Ewins, Baker) have taken initiatives in public (23 12 1999) using language regarding the urgency of responding in a precautionary way to human-induced global climate changes.

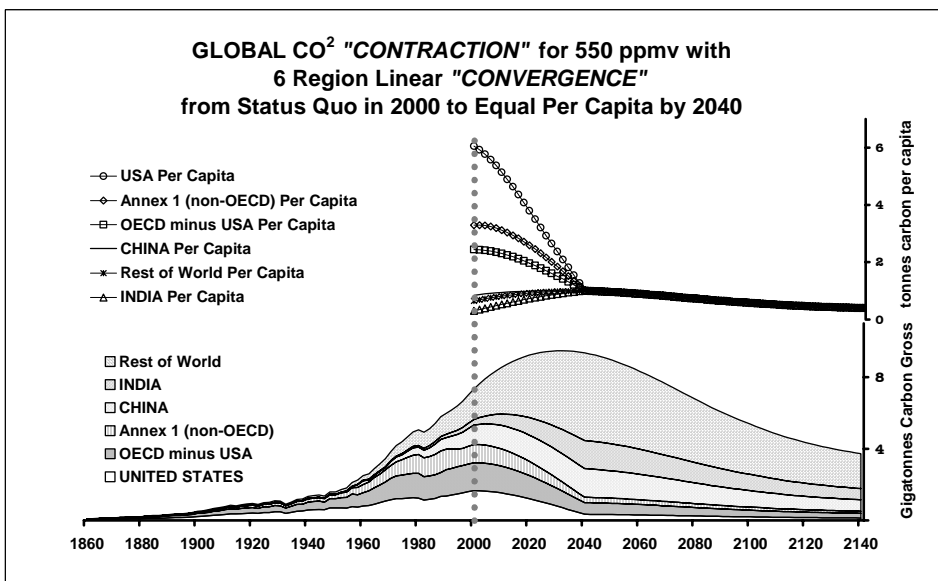
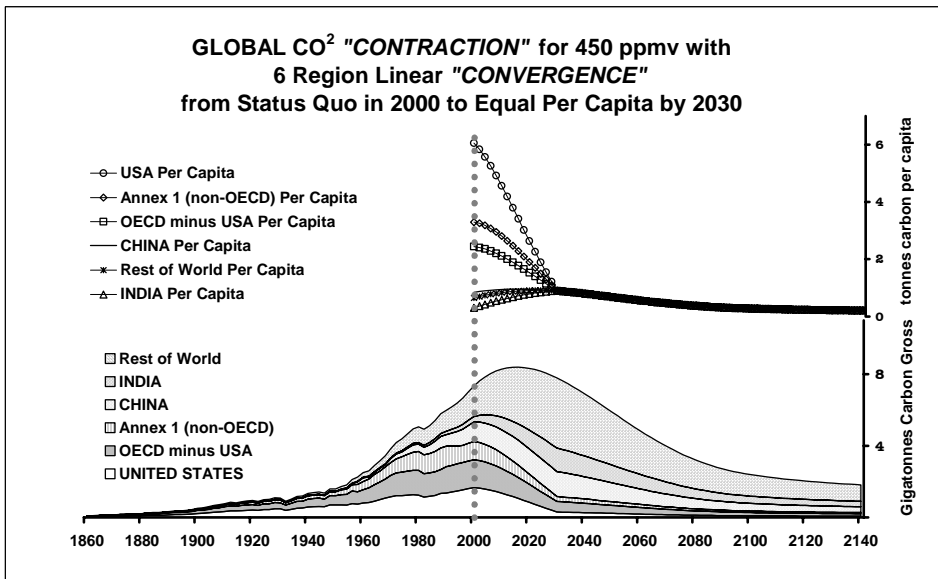
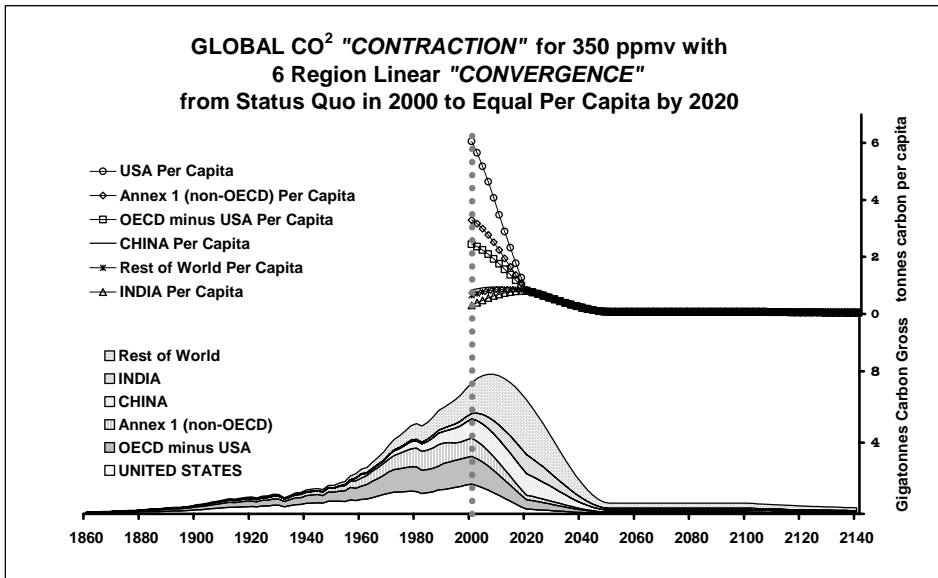
It is vital that the TAR and especially its 'scene-setting' chapter - 'The scope of the Assessment' - responds to these changed circumstances by drawing on the literature and imagery that has responded to - or indeed anticipated - these changed circumstances.

We propose that the imagery used at present is either accompanied by or preferably replaced by published imagery from specifically computed contraction and convergence budget runs (see <http://www.gci.org.uk/ccweb/test/cac.html>) such as those which follow since they demonstrate clearly: -

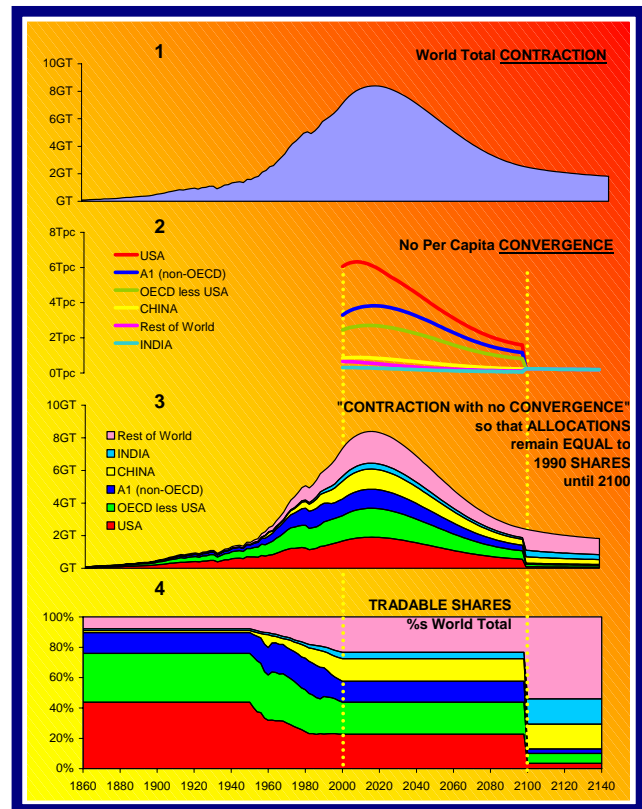
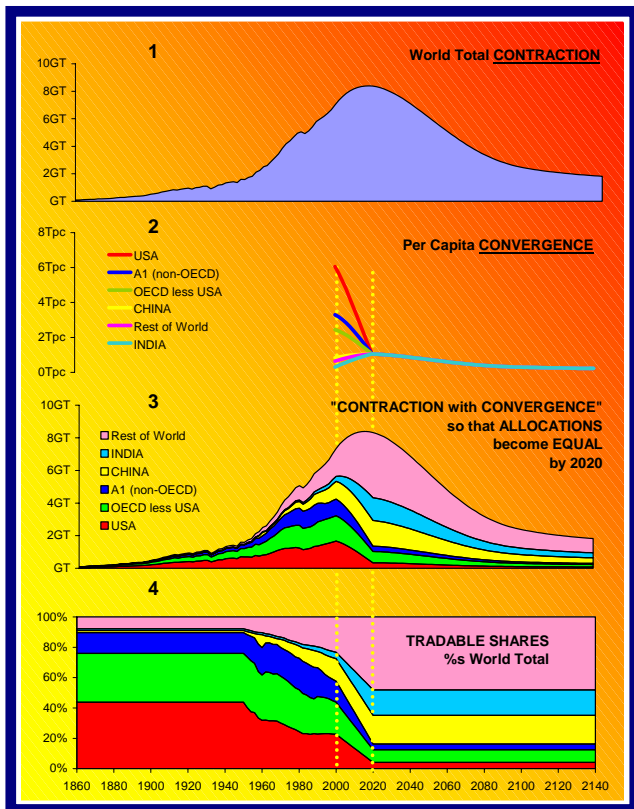
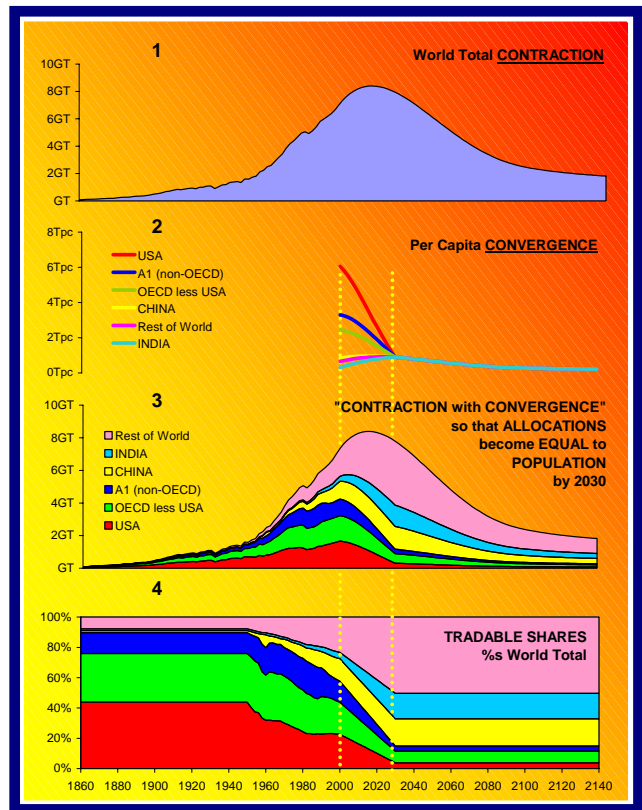
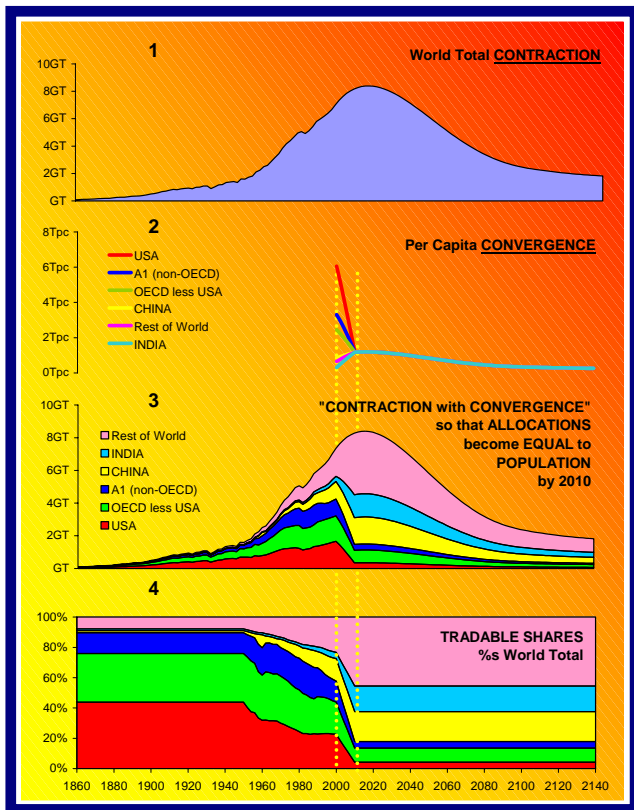
1. the 100% 'contraction' budget or equity or collateral (the global budget) computed consistent with a pre-specified outcome value (in the e.g. chosen here and the TAR drafts with the IPCC SAR 450 ppmv integral), and the
2. the derived equity of per capita 'convergence', from initial shares [that are proportional to income] to future shares [that are proportional to population or a base year thereof], showing different rates of convergence, and the
3. shares of this equity (as shares of the 100%) to emphasize that it is emissions 'rights' that are so created that are also tradable if desired.

Published Imagery

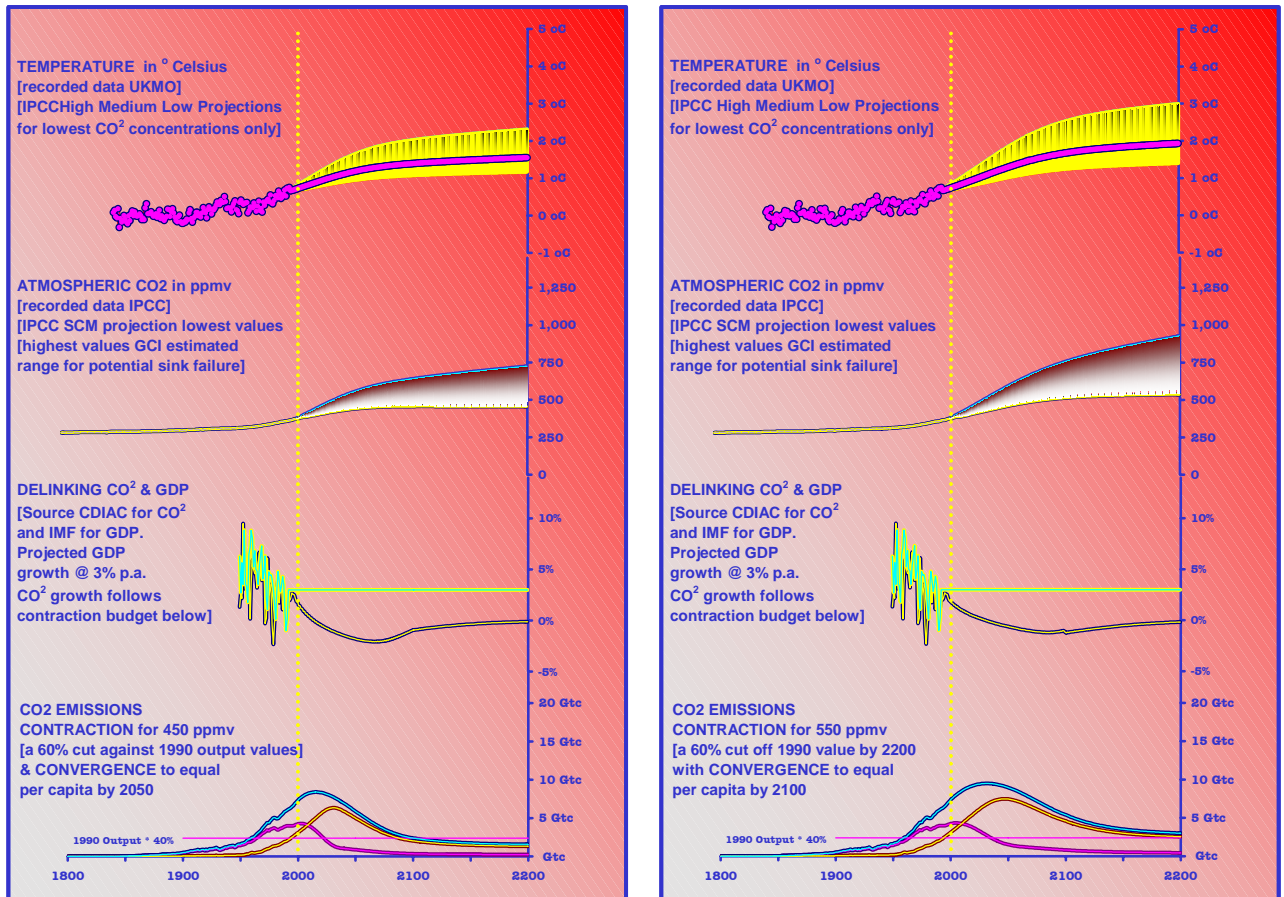




In the use of such imagery it is important to stress the independently variable and revisable rates of "Contraction and Convergence" that are possible.



Linking these images to projections of temperature and concentrations is also required. Moreover, if the section page 4 line 18 section 1.1.1 continues to dwell on 'Emissions and Economic Growth', then it would be appropriate to have composite imagery that portrays CO₂:GDP delinkage as well. The following images were published by GLOBE International in 1997.



International 'Efficiency/inefficiency' comparison

Composite imagery that includes comparative representation of international GDP:CO₂ (or 'efficiency/inefficiency') de/linkage is required as well. The reality that the biomass-based economies are more efficient than the fossilmass-based economies has been obscured by propaganda coming from the industrial countries.

Indicators are: -

- ❖ per capita impact (as tonnes of carbon from fossil fuel consumption)
- ❖ per capita income (as national currency units adjusted for international purchasing power disparities or exchange rate distortions)
- ❖ 'carbon-efficiency' as the number of dollars per tonne

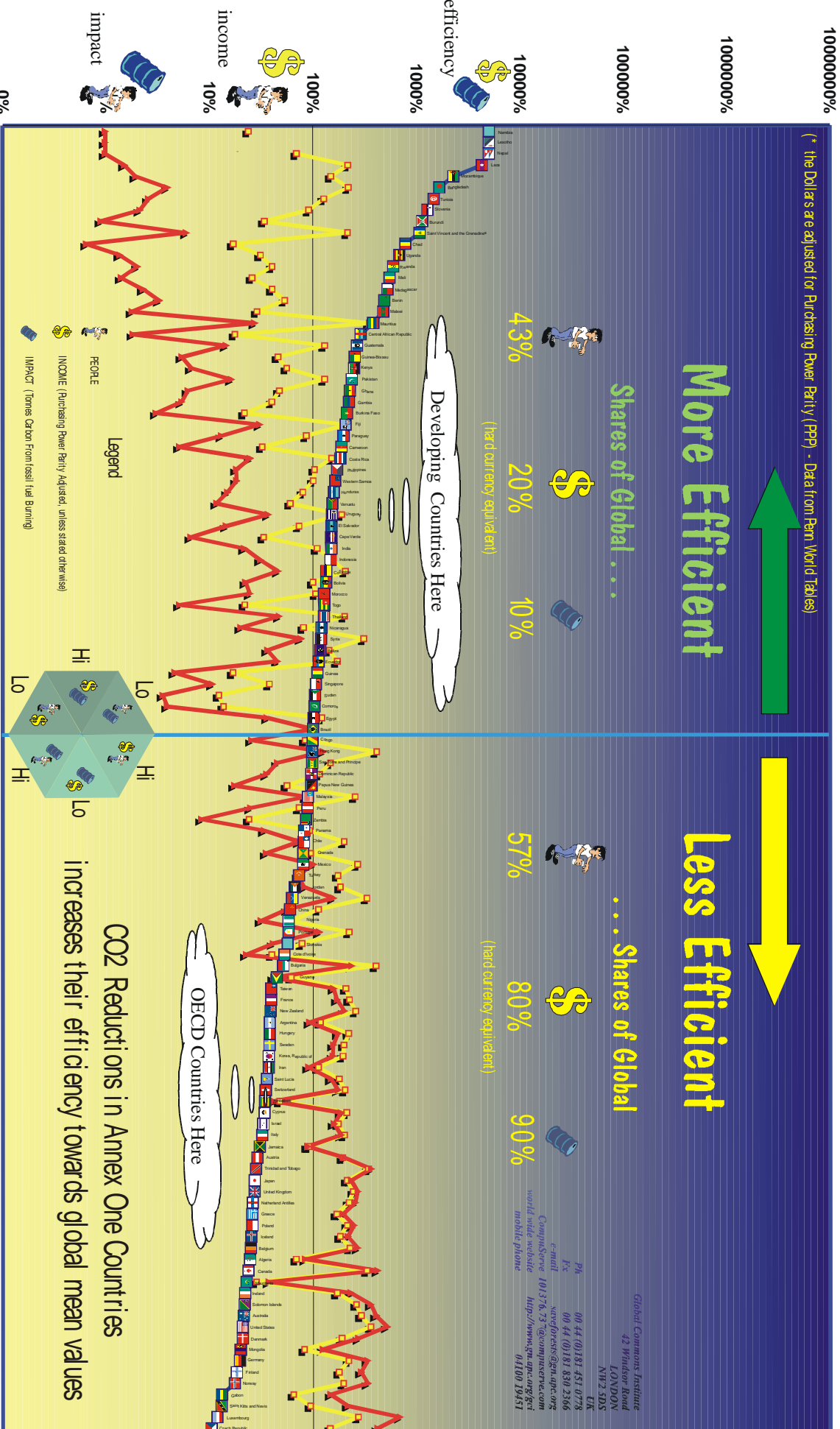
The ratio between averages for per capita income and carbon impact, go from: -

- ❖ Low per capita income/impact at high efficiency at one end to
- ❖ High per capita income/impact at low efficiency at the other.

The next graph shows this on a comparative international scale: - this dollar/tonne carbon 'efficiency' decreases proportional to the increase in 'wealth'.

\$\$/tonne carbon EFFICIENCY RANKINGS for 1990

(* the Dollars are adjusted for Purchasing Power Parity (PPP) - Data from Penn World Tables)



More Efficient

Less Efficient

Shares of Global ...

... Shares of Global

100000%

43%

20%

10%

57%

80%

90%

1000%

(hard currency equivalent)

(hard currency equivalent)

Developing Countries Here

OECD Countries Here

CO2 Reductions in Annex One Countries

increases their efficiency towards global mean values

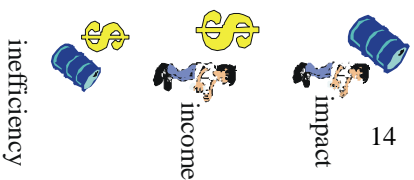
This graphic compares the dollar/tonne "EFFICIENCY" for 120 countries in 1990.

Dollars (INCOME) are adjusted to "Purchasing Power Parity" (PPP). Tonnes (IMPACT) are of carbon from CO2 from fossil fuel burning.

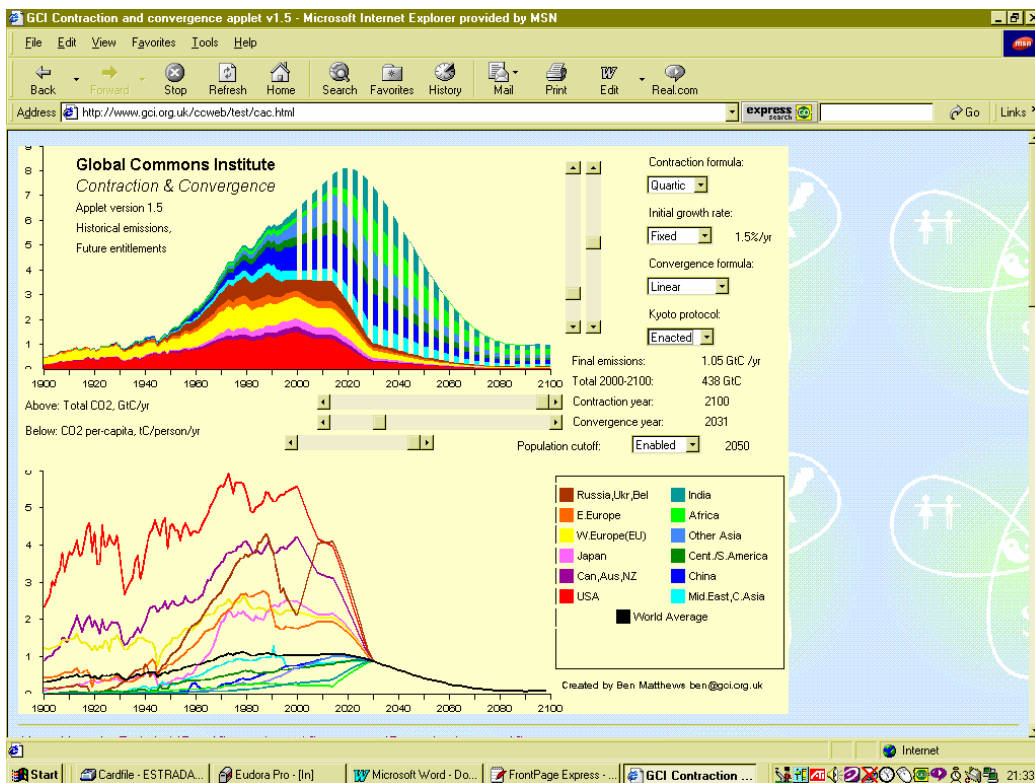
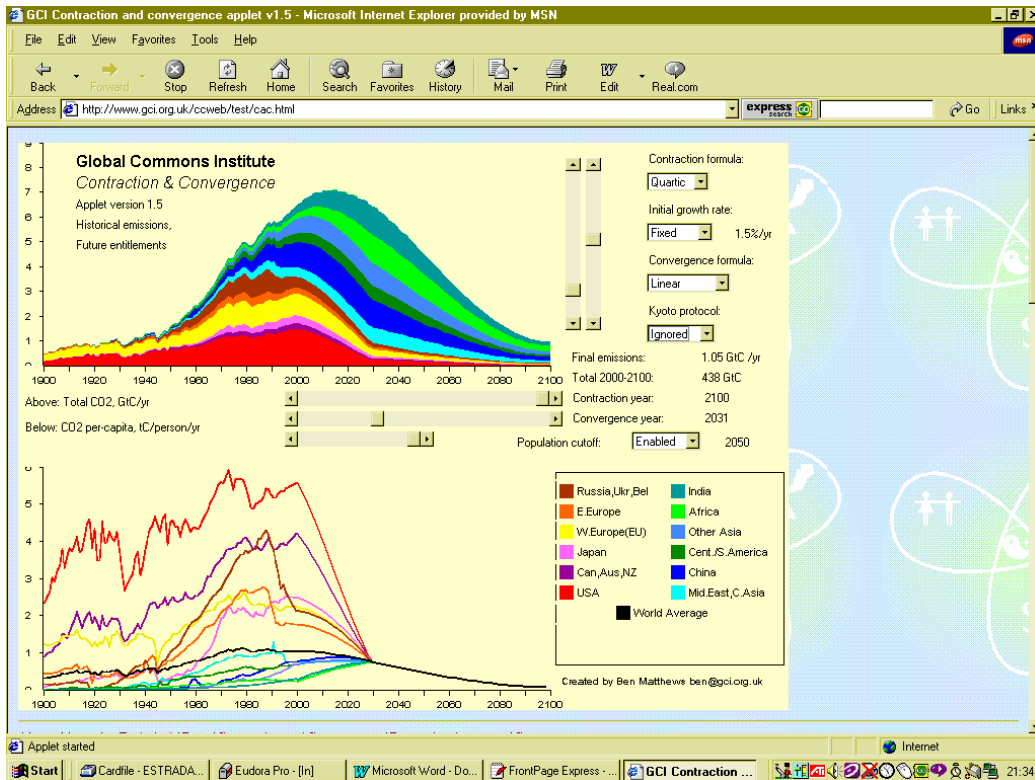
INCOME per capita is shown on the yellow line. IMPACT per capita is shown on the red line.

EFFICIENCY is the ratio between INCOME and IMPACT and international rankings are shown in the line of flags.

The trend in the graphic shows that poor countries are much more efficient than rich countries.



Ultimately it would be sensible to draw policy maker's attention to inter-active C&C imagery of the following kind: - **APPLY "Contraction and Convergence" at <http://www.gci.org.uk/ccweb/test/cac.html>**. This version of the model will shortly have 'responses' to ghg emissions budgets and variable land/sea sink functions set by the user for atmospheric ghg concentrations and temperature with an attempt to portray threshold events to 'nasty surprises'.



WORDING for REASONING BEHIND "Contraction and Convergence"

1. "*Contraction and Convergence*" responds to human caused global climate change as 'a global security interest' that must now be handled on a precautionary global basis.
2. "*Contraction and Convergence*" is a formal and internally consistent framework for sharing greenhouse gas emissions on a global basis that is, consistent with the *already agreed* Objective and Principles of the United Nations Framework Convention on Climate Change (UNFCCC).

These key features of the UNFCCC and of "*Contraction and Convergence*" are sequenced as follows:

- The global Objective: - the stabilisation of ghg concentrations in the global atmosphere at a non-dangerous level.
 - The global organising Principles of:
 - ❖ *Precaution* and
 - ❖ *Equity*
 - The globally *efficient* emissions trading process enabled through the above.
3. The "*Contraction and Convergence*" framework puts the future evolution of climate mitigation policies within a universally consistent set of procedures for internationally distributing future ghg emissions entitlements, as the UNFCCC objective, principles and trading require [see following page]. In other words it provides shared language with shared meaning that integrates these key features within a Constitution.
 4. All other types of approach, however sub-globally and locally logical they might seem, cannot be effective at a global level. The endemically random character of the 'evolutionary sub-global' approach will always make specification as well as achievement of its objective impossible, so disabling the UNFCCC.
 5. Scientist and politicians have re-emphasised that, as atmospheric concentrations of greenhouse gases continue to rise, the probability of rapid non-linear events - their term for nasty and uncontrollable surprises - in the behaviour of the global climate system increases. Emissions have therefore to be controlled and reduced globally so as to slow their rising accumulation in the atmosphere as rapidly as possible.
 6. So great are the hazards presented by global warming that the choice between the evolution of policies and measures with or without the formal framework of "*Contraction and Convergence*" amounts to deciding between control and chaos.
 7. However difficult a road it might seem, "*Contraction and Convergence*" could - if adopted with international emissions trading - be the means that enable humanity to escape from its present vicious circle into the virtuous cycles of sustainability.
 8. "*Contraction and Convergence*" is moreover, consistent with almost every policy statement on reducing the effects of climate change to have been issued in the past decade by signatories to the UNFCCC. It is therefore the key concept that enables these statements to acquire effective meaning [see following pages].

"Contraction, Convergence, Allocation & Trade"- A Simple Formulation

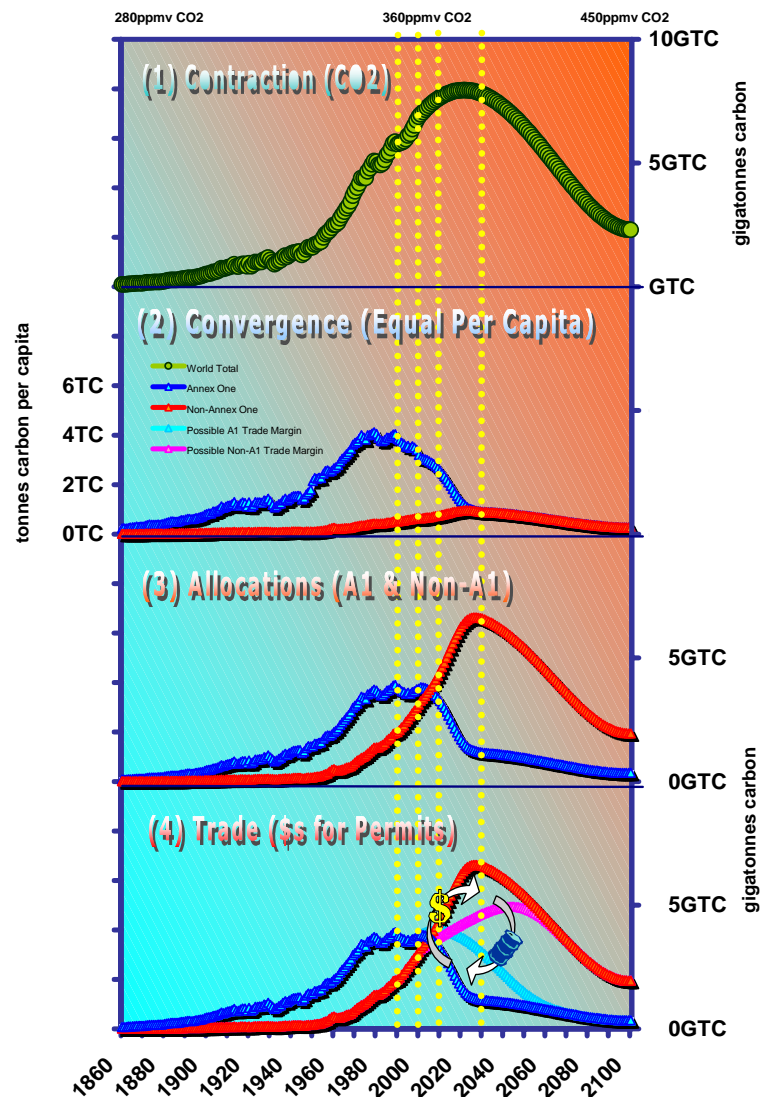
Simply illustrated, here is a global model with two zones and one greenhouse gas, industrial CO². Zone One is the Annex One group of the UNFCCC. Zone Two everybody else.

(1) This example has a **Contraction** budget calculated for the goal of stabilising atmospheric concentrations of CO² at 450 ppmv by 2100. This means a total emissions budget of 640 billion tonnes of carbon from CO² under a global curve progressively limiting and reducing the annual output of global emissions to 2.3 billion tonnes by 2100, or 40% of the value in 1990.

(2) **Convergence** to equal per capita entitlements globally is set to complete by 2030 exponentially.

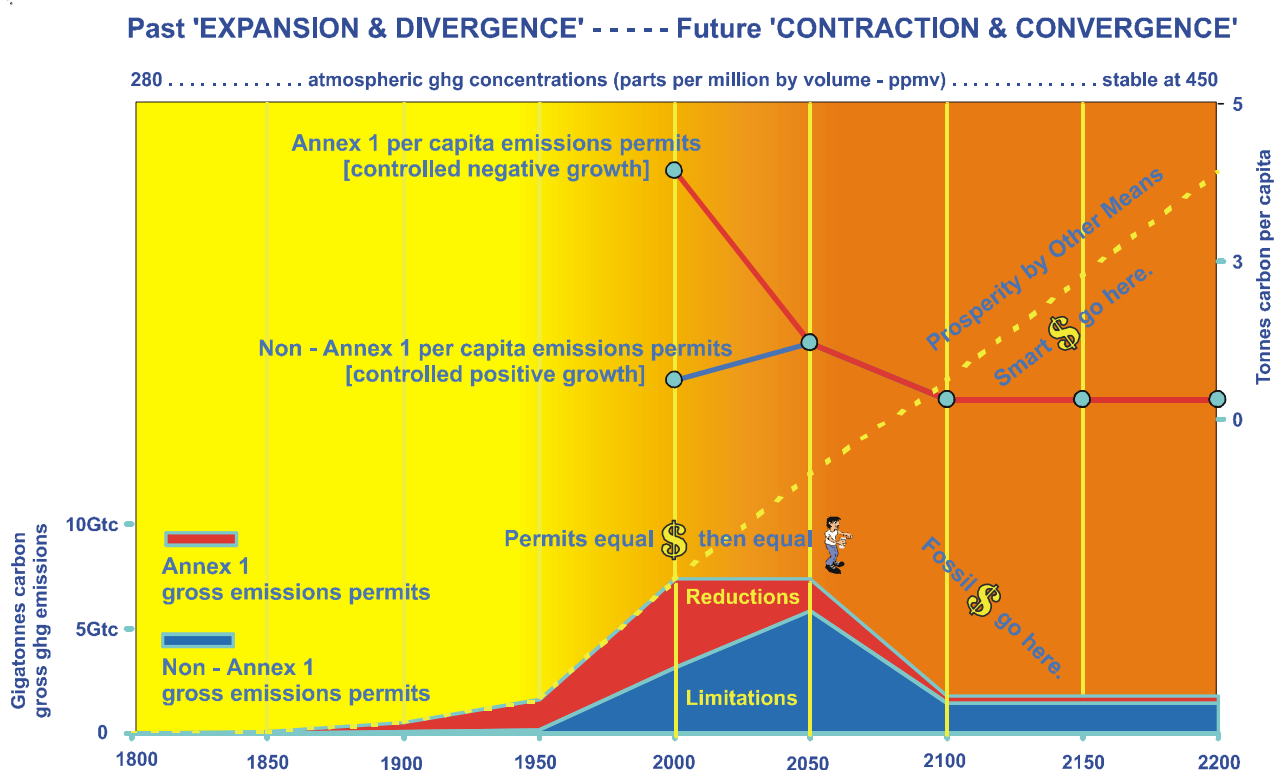
(3) The **Allocation** of the emissions entitlements is the product of the contraction budget and the convergence rate.

(4) Once the first three steps are secure the option of the global **Trade** of the entitlements can be exercised. Only with the global cap secure could it be claimed that this trade would be indexed to the control of atmospheric greenhouse gas concentrations.



In other words without the global calculus of "Contraction and Convergence" the trade will be unbounded and useless and probably dangerous.

THE USA and "CONTRACTION & CONVERGENCE"



The US has affirmed:

1. That 'a global solution' to the 'global problem' of climate change is needed.
2. The objective of the UNFCCC [stabilisation of ghg concentration in the global atmosphere] is ghg emissions 'contraction' by definition [here 2000 - 2100].
3. That all countries must be involved in emissions control [here 2000 - 2200].
4. That a 'central organising principle' is applied to distribution (initially this was 'all countries will reduce ghg emissions by x% pro rata' [here 2050 - 2200]
5. The 'Byrd Hagel Resolution', where this central organising principle was modified to combine 'Reductions' [controlled negative growth] with 'Limitations' [controlled positive growth] giving 'convergence' [here 2000 - 2050].
6. That the 'commitments/entitlements' arising from this controlled 'contraction and convergence' must be 100% tradable.
7. That inter-emissions-budget-period borrowing must be allowed.

CONCLUSION

As there is no other way to combine all their requirements, *other than with anti-precautionary guess-work*, it is logical *minima* to observe that the US proposals are not in conflict with "*Contraction and Convergence*" to equal per capita tradable entitlements globally by an agreed date under a predefined global cap. It is also logical to ask what else is intended if not this?

The IPCC Third Assessment Report (TAR) should ask this question

SUGGESTED WORDING for "Contraction and Convergence"

Support list for this statement later in this book: see "Letter to *'the Independent'*."

"A statement by Michael Meacher, the UK Environment Minister, has recognised the arguments above. He recently told the Royal Geological Society that, *"the future of our planet, our civilisation and our survival as a human species . . . may well depend on [our responding to the climate crisis by] fusing the disciplines of politics and science within a single coherent system."*

"Contraction and Convergence" is such a system. It is the 'logical approach'. As Sir John Houghton, Chair of the Intergovernmental Panel on Climate Change Sciences (IPCC) recently told the British Association for the Advancement of Science, global greenhouse gas emissions must be reduced by more than 60% in less than a hundred years merely to stabilise their rising concentrations in the atmosphere. Even this value would be 70% higher than any time past. So faster reductions to a lower value are desirable because this lowers the risks of dangerous surprises in the global climate changes taking place.

"Contraction" - For precautionary reasons, all governments must collectively agree to be bound by such a target. This makes it possible to calculate the diminishing amount of carbon dioxide and the other greenhouse gases that the world can release for each year in the coming century while staying within this target. Subject to annual scientific and political review, this is the contraction part of the process.

"Convergence" - On the basis of equity, the convergence part means that each year's ration of this global emissions budget gets shared out among the nations of the world so that every country converges on the same allocation per inhabitant by an agreed date. This rate of convergence is negotiable but 2030 was the date Sir John suggested. The convergence method recognises that most people globally expect a 'pre-distribution' of the rights to 'global commons' of the atmosphere that observes the principle of globally equal rights per capita.

Once agreed, countries unable to manage within their shares would, within limits, be able to buy the unused parts of the allocations of other, more frugal, countries. Sales of unused allocations would give the countries of the South the income to purchase or develop zero-emission ways of meeting their needs. The countries of the North would benefit from the export markets this restructuring would create. And the whole world would benefit by the slowing the rate at which damage was being done. Bilateral emissions trade and related deals between UNFCCC Parties, would not form part of the negotiations in that forum.

Because *"Contraction and Convergence"* is an effective, equitable, efficient and flexible framework in which governments can co-operate to avert climate change, even some fossil fuel producers have begun to demonstrate positive interest in the concept.

Further, as Jubilee 2000 and Seattle have shown, governments and powerful interests are helped to change by coherent co-ordinated pressure from civil society."

As things hot up

Global warming will preoccupy the next generation, predicts **Sir John Houghton**, of the Intergovernmental Panel on Climate Change.

One hundred years ago Claude Monet painted scenes of London through its smoggy atmosphere. That was local pollution. What is relatively new and more worrying is global pollution—that is pollution emitted by people locally that has global effects. The first example to emerge was damage to the earth's ozone layer. International action was promptly taken through the Montreal Protocol to phase out the use of the chemicals responsible. Although full recovery of the ozone layer will now happen, it will take at least a century.

Another example is pollution that leads to global warming and climate change. Carbon dioxide and other "greenhouse" gases such as methane are released into the atmosphere through the burning of fossil fuels (coal, oil and gas) and also through deforestation. These gases absorb "heat" radiation emitted by the earth's surface that would otherwise be lost to space, so maintaining the surface and the lower atmosphere at a warmer level than normal.

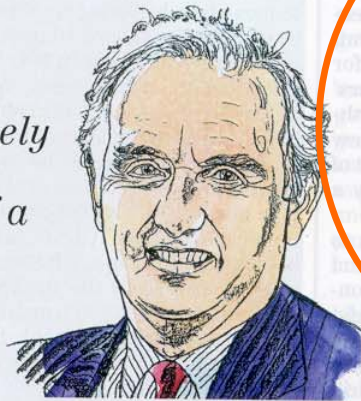
The amount of carbon dioxide in the atmosphere has already increased by over 30% since 1750 and, if no action is taken to stem the increase, it will reach double its pre-industrial value during the second half of the 21st century. As a result, the average rate of warming of the climate is expected to be greater than at any time during the past 10,000 years. This is not of itself necessarily bad; some communities will experience a net benefit. But many ecosystems as well as humans will find it difficult, if not impossible, to adapt.

Although there is a lot of uncertainty concerning the detail, the basic science underlying global warming and climate change is well understood. It is not in question. Hundreds of scientists from over 50 countries have contributed as authors or reviewers to the assessments of the Intergovernmental Panel on Climate Change (ipcc). Because of the uncertainties it is easy either to exaggerate the possible impacts to calamitous proportions or to suggest that too little is known to justify any action. What the ipcc has done is

explain clearly what is known together with the major uncertainties. Then, taking account of all relevant scientific data, best estimates have been provided of climate change and its impact over the next century. Here are a few of the ipcc's main findings and an outline of the agenda for the years ahead.

First, largely because of the thermal expansion of ocean water and the accelerated melting of glaciers, sea levels are likely to rise by approximately half a metre by 2100. Therefore, sea

"The sea level is likely to rise by about half a metre by 2100."



defences in many coastal regions will need to be improved, albeit at considerable cost. However, adaptation is just not possible for countries with large river deltas such as Bangladesh, Southern China and Egypt, and for many island states in the Pacific.

A second major result of global warming will be, on average, a more intense hydrological cycle leading to impacts on water distribution and availability. In many areas heavy rainfall will tend to become heavier while some semi-arid areas will receive less rainfall. There will be more frequent and more intense floods or droughts, especially in sub-tropical areas. Since, in many places, water is rapidly becoming a critical resource and since floods and droughts are the natural disasters that already cause most deaths, misery and economic damage, these could represent the most damaging impacts of global warming. When combined with the rise in sea levels, a recent study has estimated that this could lead to 150m environmental refugees by 2050.

Three widely accepted principles will

govern the international agreements needed to meet this threat. The first is the "Precautionary Principle", already clearly imbedded in the UN Framework Convention on Climate Change agreed at the Earth Summit in Rio in 1992. This states that the existence of uncertainty should not preclude the taking of appropriate action. The reason for such action is simply stated as the stabilisation of the concentrations of greenhouse gases (such as carbon dioxide) in the atmosphere in ways that allow also for necessary economic development. The second principle is the "Polluter Pays Principle", which implies the imposition of measures such as carbon taxes or carbon trading arrangements. The third is the "Principle of Equity (both Intergenerational and International)" which is the most difficult to apply. However, a proposal of the Global Commons Institute that is being widely discussed applies the second and third principles by allowing eventually for the allocation of carbon emissions to nations on an equal per capita basis while also allowing for emissions trading.

The action agreed at Kyoto in 1997 is a first step. Necessary post-Kyoto action, however, will be more demanding. The rate of increase of global emissions must first be substantially slowed; then there must be reductions in these emissions to well below 1990 levels before the end of the next century. Many of the required technologies to bring about these reductions are already available, but they require adequate resources for investment and development. Studies show that the necessary action may cost around 1% of the total world product, much less than the likely cost of damage and adaptation if there is no action.

If human communities are to be fulfilled and creative, they not only need goals related to their economic performance but also moral and spiritual goals. Care for the overall health of the planet is such a goal. It demands action by scientists to provide better information about likely climate change, by governments to set the necessary frameworks for change, by business and industry to seize the opportunities for innovation and the introduction of new technologies, and by all world citizens to support the action being taken and contribute to it.