The Mess We Are In.

Politicians Support for Growth.

World leaders, politicians and most of the public are obsessed with increasing prosperity, economic growth and more and more consumption. This means more and more energy is used to produce goods and ship them about the world. Unregulated businesses set out to produce these goods in the economically cheapest fashion. This results in most goods being produced in the developing world, particularly India and China, using inefficient energy largely derived from coal. It is a bit rich therefore for people to complain about the growing emissions from these countries. However that aside the overall result is that world emissions of GHGs are rising. What is more politicians desperate to "come out of recession" encourage the growth of this process.

The Copenhagen Conference although it was supposed to sort out the problem never intended to take the kind of immediate action that is required and in the event has come up with a toothless plan for some reductions somewhen if we are lucky!

The Nature of Scientific Predictions.

Scientific predictions are not certainties they take the form of probabilities. The true scientist is a sceptic - something may always turn up which changes the situation - this is true of every prediction. However this does not invalidate scientific predictions, which are made on the balance of current evidence. Some predictions are extremely probable (like that if I drop an apple it will fall to the ground), others are quite improbable (like a prediction that the Yellowstone caldera will explode tomorrow. NB. Not extremely improbable, since evidence suggests that it is likely to happen within the next 5,000 years, but there is no recognisable evidence that tomorrow is the day).

Global Warming Science.

Science tells us that GHG emissions cause global warming and that this is disrupting the climate. Even without scientific study anecdotal evidence makes it is obvious that the climate is changing, the seasons are shifting, glaciers and snow cover are receding, the patterns of rainfall and drought are changing, and we have more extreme weather events, which are themselves becoming more extreme.

Already global warming is causing death and destruction(for 2009 it is estimated that 300,000 people died as a result of global warming induced climate change - mainly droughts and floods). It is predicted that as the global temperature rises the consequences will become progressively worse with further and greater disruption of the environment and ever more extreme weather phenomena - heat waves, storms, floods and changes in climate patterns. This will lead to:- extinction of species, great changes in food production, a rise in sea level. These changes will happen progressively - thus it is predicted that by 2020 (when the temperature rise will be about 1^0C) food production in several African countries will be halved, and will be considerably reduced in Australia.

The 2^0C Target.

Rather arbitrarily a rise of 2^0C was chosen as the temperature above which the consequences were completely unacceptably and this was taken as the limit of temperature rise which should not be exceeded. Politicians and world leaders have now taken this limit almost as a

target; a rise of 1.9^{0}C being acceptable and 2.1^{0}C being unacceptable. Further they appear to be trying put off striving to reach this target until the last possible moment - so that we can carry on as "normally" as possible for as long as possible. This was never the intention of the scientific advice. Further as will be seen below the chances of our now meeting this target using current strategy are extremely slim.

Joining the Dots - Probable Future Events.

The Copenhagen Scenario.

The rather disappointing result of the Copenhagen Accord is that the world is following a scenario of allowing GHG emissions to continue to rise, probably to 2030, and there is a rather vaguely expressed intent to reduce world emissions to 50% by 2050 (though this requires a huge - probably unrealistic - drop during 2030-50).

This scenario results in the following likely pattern of parameters:-

Year	Temp	CO_2 level	Rate of Temp Rise
2010	0.8^{0}C	390 ppm	0.18 ^{0}C/decade
2020	1.0^{0}C	415 ppm	0.22
2030	1.25	445 ppm	0.25
2050	1.9	480 ppm	0.35
2100	3.0+	?	depends on post 2050 policy.

As can be seen this scenario fails to keep below the 2^{0}C temperature and makes 3^{0}C or more by 2100 likely.

Any politician or world leader who justifies adopting this strategy is being dangerously irresponsible. It is a very difficult and dangerous scenario which gambles on no unexpected negative phenomena – though scientific research has already shown that positive feedbacks (which act to raise the temperature) are already cutting in, and scientists are unable to predict with much accuracy how these will increase as the temperature rises. It also gambles on the future being able to deliver huge cuts.

To Give Some Chance of Staying Below a 2^{0}C Rise.

To give a better chance of keeping below the 2^{0}C much more drastic strategies are needed.

A Better World Scenario.

One that has been talked about by some countries is that world emissions should peak by 2015 and thereafter fall to 50% by 2050. Assuming a linear reduction this would be likely to result in the following:-

Year	Temp	CO_2 level	Rate of Temp Rise
2010	0.8^{0}C	390 ppm	0.22 ^{0}C/decade
2020	1.0^{0}C	412 ppm	0.24
2030	1.4	428 ppm	0.23
2050	1.7	445 ppm	0.22
2100	2.0+	?	depends on post 2050 policy.

Obviously this is a bit better and theoretically it might be possible to keep the temperature rise to less than the 2^{0}C target but this is likely to require almost impossible reductions after 2050, involving actively removing huge quantities of GHGs from the atmosphere.

A Defensive Scenario.

In TGWS we have long argued that the situation is much more serious than is generally recognised. We should not be where we are! However the situation now is that we need to stop world emissions rising and to start them falling more or less immediately and to make

very much larger reductions than are currently contemplated. This is what the IPCC recommend though in careful diplomatic language. It is very important that we "front-load" reductions as once GHGs are in the atmosphere it is very hard to remove them and they force the temperature up.

If we really take on board the seriousness of the threat we believe that it is feasible (and wise) to achieve the following world emission reductions - :-

Year	% Reduction	Tot C equiv	CO_2 Emissions
2011	10%	12 Gts	28.5 Gts
2025	30%	9 Gts	22.5
2040	50%	6.5 Gts	16
2050	70%	4 Gts	9

Such a pattern of cuts is likely to deliver the following parameters:-

Year	Temp	CO_2 level	Rate of Temp Rise
2010	0.8^0C	390 ppm	0.22 ^{0}C/decade
2020	0.95	408 ppm	0.2
2030	1.2	420 ppm	0.22
2050	1.65	415 ppm	0.15
2100	2.0-	?	depends on post 2050 policy

Such a scenario (, which is probably about the best, at least in the early years, that is realistically achievable) has all kinds of merits. It gives a reasonable likelihood of keeping the temperature under 2^0C. It sets out to do all that is possible as early, as is now possible, which applying the precautionary principle is the only sensible thing to do. It will minimise the death and destruction which global warming is already causing. It does not rely on finding a magic bullet to solve the problem and it gives us as much breathing space as possible for any undesirable new findings.

About the one prediction about global warming that is near certain is that something unexpected will turn up.

So far all the unexpected new findings have been that things are worse than was previously thought.

Do Any of These Strategy Ensure Safety?

Even for our recommended strategy regretfully the answer to this question is still:- "No" because:-

* A 2^0C temperature rise will in any case have dire consequences.
* The predictions remain probability predictions - this means that there is some possibility even with the best strategy the temperature rise might exceed 2^0C.
* The actual consequences of 2^0C might be worse than predicted.
* Furthermore there are positive feedback events, which are not well understood. The security of the predictions that the effect of these will be sufficiently small are not good. If we have got this wrong - even the most drastic strategy might be completely undermined.

Global Warming Poses a Catastrophic Threat.

There are criticisms of people who talk - as we do in TGWS - of global warming having catastrophic consequences. We think people who make these criticisms are unduly heartless and complacent. Science predicts that a 2^0C temperature rise will:-

* Halve food production in several poor countries.

* Bring about the inundation of several island nations.
* Increase water stress for hundreds of millions of people.
* Increase the threat of extinction for 30% of species.
* Destroy many unique eco-systems - coral reefs, arctic, etc.

We believe that catastrophic is not too strong a ward for these things. Further unless we take rapid and responsible action we are on course for a 3^0C+ temperature rise for which things will be much more serious.

Conclusion.

We are in a mess.
We need to start action now.

Appendix

This section gives parameters and observations relevant to the calculations above.

Some Basic Parameters.

1 ton of carbon produces 3.67 tons CO_2.

The Atmosphere

Weight of Atmosphere c 4.41×10^6 Gts

14.5 lbs x 39.37^2 = c 10 tons /sq m

Surface area = 4 x pie x 59252 = c 441 million sq kilometres

So 4.41 Gts = 1 ppm(vol)

CO_2 in 2010 390 ppm(wt)	c	1,720 Gts	
Carbon in the atmosphere	c	470 Gts	
Human actions add:-			
Carbon from fuels	c	8.5 Gts	
CO_2 from fuels	c	30 Gts	= 7 ppm
CO_2 from cement production	c	1.5 Gts	
Per person (assumes 6.5 billion)	c	4.7 tonnes	
CO_2 from de-forestation	c	7 Gts	
Total CO_2	c	38 Gts	= 8.5 ppm
Per person	c	5.8 Gts	
Add CO_2 equiv from other GHGs			
CH_4, N_2O, and O_3	c	11 Gts.	
Total CO_2 equivalent	c	49 Gts	= 11 ppm
Total carbon equivalent	c	13 Gts	
Per person	c	6.5 Gts	

Natural Absorption in excess of normal natural cycle.

NB. BUT over long periods the natural cycle is in balance. Every so often there is a huge belch of CO_2 from volcanic activity to restore the absorbed gas.

CO_2	c	24 Gts	5.5 ppm
Carbon equivalent	c	6.6 Gts	

There is More to The Problem than Fossil Fuels.

These parameters show that to stop global warming occurring we have to also address the issues of:- de-forestation; other GHGs; & cement.

The IPCC Data for Stabilisation.

The IPCC give CO_2 levels for stabilisation temperatures. Obviously these require that other GHGs are also dealt with in proportion.

CO_2 level	Stab Temp
375 ppm	2.2 ^0C
420	2.6
462	3.0
528	3.6

For a stable CO_2 level the temperature will rise to its eventual stabilisation temperature in a decreasing parabolic manner (the temperature will rise most rapidly at first and the rate of

rise will decrease as the end temperature is approached, the rise of the last few fractions of a degree will take centuries to occur).

Conclusion 1. To Stabilise CO_2 in the Atmosphere.

So to Stabilise CO_2 at any level we need to reduce our emissions to the level which the natural environment is able to absorb. Currently to stabilise at 390 ppm we would need to reduce our CO_2 equiv emissions to:-

CO_2 equiv c 24 Gts 5.5 ppm.

And assuming the same general mix of sources of global warming this would give:-

CO_2 emissions from fuels c 13 Gts

Per person (assumes 7.5 billion) c 2 tonnes.

NB. BUT this assumes that even with the rising temperatures the absorption remains the same – a doubtful assumption.

To stabilise at higher CO_2 levels we would need to reduce our emissions to the level the natural environment can absorb at that level. There is some doubt as to what these would be because with higher temperatures and increasing acidification of the sea, the rate of absorption may well reduce.

Conclusion 2. To Stop the Temperature Rising.

Actually reducing the CO_2 level is needed if we wish:- to slow the rate of temperature rise - reduce the CO_2 level; or to stop the temperature rising - reduce the CO_2 level to the appropriate stabilisation value; or to reduce a temperature already reached - reduce the CO_2 level to less than the current stabilisation value. To achieve this it is necessary to contribute less than the amount which can be absorbed by the natural system.

However the current CO_2 level (already c 390 ppm. and rising) is greater than the level likely to lead to a 2 ^0C rise. If we are to stay under, or even close to 2^0C we need to get back down to the 350 ppm level before the temperature has exceeded 2 ^0C.

Temperature Rise Predictions.

We give temperature rise predictions in the main part of this article (above) for three scenarios:-

The current post Copenhagen plan.

The slightly improved plan which at least was, and is, being talked about.

Our TGWS emergency action plan

As can be seen it is extremely difficult to give us more than a slim chance of keeping the temperature below the 2^0C limit which is supposed to be the aim.

Our predictions are based on the following:-

Predictions about temperature rise are both complex and rather unclear. Simplifying somewhat the IPCC say the following:-

Temp rise over late 20th century has been c 0.1^0C per decade on average

Temp rise for early 21st century expected to increases to c 0.2^0C.

If CO_2 level rises the temp rise will increase c 0.25^0C (for 445 ppm)

Factors which are predicted to cause the temperature to rise even more are:-

* The increase in GHG concentrations.

* A reduction in "global dimming" - caused by air pollution.

We anticipate that there will be a considerable increase in GHGs and a considerable reduction in global dimming. We have allowed a 0.2^0C increase for the reduction in global dimming - it might be much larger.

The Copenhagen Scenarios.

In the main body of this article we give our estimate of the likely results of the Copenhagen scenario – and pretty bleak they are too. We also give details of the improved scenario that some world leaders are talking about as a possibility. The estimates for this are better but still far from good.

A Defensive Scenario.

In TGWS we believe that the situation is now very grave and that the world should be to stop world emissions rising and to start them falling more or less immediately. This is what the IPCC recommend in the AR4 though in careful diplomatic language. Making emission reductions has various stages, which can be achieved in differing timescales.

In TGWS we believe that given the will some initial quite substantial reductions could be made very quickly. It should be possible to reduce our energy consumption by about 10% very quickly (within 1 year) simply by cutting out waste throughout our processes:- turning off lighting (including street lighting, office lighting, advertising etc), doing away with unnecessary journeys, car sharing, rationing flying, reducing consumption. To the complaint that this might plunge the world back into recession, we can only comment better recession now than total environmental and economic collapse in the medium term. Also, - we should start implementing the sustainable green economy immediately, as a means of maintaining employment.

There are quick technological improvements which could be implemented over a longer period (say 5 years):- improving home and building insulation and heating systems. This could get us to 30% within 5 years.

Longer term changes involve the replacement of private transport by public transport, the implementation of better methods of electricity generation, making goods more long-lasting and repairable, changing our methods of agricultural production and improving the efficiency of systems. All these should also be implemented as rapidly as possible and as on-going developments.

We give details of our estimate of the consequent scenario in the main body of the article above.

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