10 YEARS TO CONTAIN CLIMATE CATASTROPHE...COUNTDOWN BEGINS

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The above title sounds alarmist; but it is not from me. The distinguished climate scientist James E Hansen from NASA along with an inter-disciplinary group of nine renowned scientists have put out this warning. In a recent research paper titled 'Target Atmospheric CO_2: Where Should Humanity Aim?', they have issued a re-assessment of earlier climate change predictions. The key points they have made are:

- The IPCC recommendation to stabilise CO_2 concentrations at 450 ppm to contain climate change at a 2°C increase in level is now outdated.
- The present global mean CO_2—385 ppm—is already in the dangerous zone. Equilibrium sea level rise for today's 385 ppm CO_2 is at least several metres, judging from paleoclimate history. Accelerating mass losses from Greenland and West Antarctica ice sheets heighten concerns about ice sheet stability.
- The two major visible environmental impacts are ice sheets or glacier melting and destruction of coral reefs. An initial CO_2 stabilisation target of 350 ppm is suggested. This should also be reassessed based on continued observation of effects on ice sheet mass balance. A further reduction of CO_2 to 300 ppm–325 ppm may be needed to restore sea ice to levels prevalent 25 years ago.
- The currently planned moderate phasing out and delay of fossil fuel use will not appreciably reduce long-term human-made climate change. Preservation of a climate resembling the one which humanity is accustomed to (the climate of the Holocene era) requires that most remaining fossil fuel carbon is never emitted into the atmosphere.
- Coal is the largest reservoir of conventional fossil fuels, exceeding combined reserves of oil and gas. The only realistic way to sharply curtail CO_2 emissions is to phase out coal use except where CO_2 is captured and sequestered.
- A complete ban on new coal-based projects by 2010 is needed. Existing coal based projects should be phased out by 2030. Even after doing this, maximum CO_2 concentration of 400 ppm will happen, depending on oil and gas reserves and reserve growth. Hence, there would be a need to bring CO_2 concentrations more rapidly back to 350 ppm or less.
- Currently, there is an addition of ~2 ppm of CO_2 per year. Besides containing this, we will have to reduce concentrations by 50 ppm (i.e. from 400 ppm to 350 ppm). This means air capture of CO_2 needs to be done and we need to initiate remedial actions on a 'war footing'.
- Considering this climate emergency, and given the short time-frame, the most ideal solution would be to draw out CO_2 from the air artificially. There are no large-scale technologies for this now, but with strong research and development it may be possible to do this. The costs would be $200 per tonne of carbon, or perhaps less. At this rate, the cost of removing 50 ppm of CO_2 is ~$20 trillion.
- If the world continues on a business-as-usual path for even another decade without initiating phase-out of unconstrained coal use, prospects for avoiding a dangerously large, extended overshot of the 350 ppm level will be dim. Continued growth of greenhouse gas emissions for the next 10 years practically eliminates the possibility of near-term return of atmospheric composition beneath the tipping level for catastrophic effects.

Presentations made by scientists at the International Scientific Congress on Climate Change that took place in Copenhagen from 10–12 March 2009 also showed that we might have underplayed the impacts of global warming in three important respects:

- The rise in sea levels this century could be twice or three times as great as that forecast by the IPCC, with grave implications for coastal cities, farmland and freshwater reserves, partly because the estimates by IPCC took no account of meltwater from Greenland's glaciers.
- Two degrees of warming in the Arctic (which is heating up much more quickly than the rest of the planet) could trigger a massive bacterial response in the soils there. As the permafrost melts, bacteria are able to start breaking down organic material that were previously locked up in ice, producing billions of tonnes of carbon dioxide and methane. This could catalyse one of the world's most powerful positive feedback loops: warming causing more warming.
- Four degree warming could almost eliminate the Amazon rainforests, with appalling implications for biodiversity and regional weather patterns, and with the result that a massive new pulse of carbon dioxide is released into the atmosphere. Trees are basically sticks of wet carbon. As they rot or burn, the carbon oxidises. This is another way in which climate feedbacks appear to have been underestimated in the last IPCC report.

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George Monbiot, reporting the above details of the proceedings of the conference in *The Guardian* (12 March 2009) made the following comments:

"Apart from the sheer animal panic I felt on reading these reports, two things jumped out at me. The first is that governments are relying on IPCC assessments that are years out of date even before they are published, as a result of the IPCC's extremely careful and laborious review and consensus process. This lends its reports great scientific weight, but it also means that decisions on greenhouse gas reductions made by policy makers using this data as a guide are always well behind the curve. There is surely a strong case for the IPCC to publish interim reports every year, consisting of a summary of the latest science and its implications for global policy. The second is that we have to stop calling it climate change. Using 'climate change' to describe events like this, with their devastating implications for global food security, water supplies and human settlements, is like describing a foreign invasion as an unexpected visit, or bombs as unwanted deliveries. It is a ridiculously neutral term for the biggest potential catastrophe humankind has ever encountered. I think we should call it 'climate breakdown'."

> The commercialisation of such technologies for air capture or CO_2 should not result in any slackening of efforts to transition to a renewable energy economy.

Air Capture of CO_2

While analysing the policy relevance of their findings, Hansen et.al. give various solutions for air capture of CO_2 to reduce concentrations by 50 ppm. As already mentioned above, air capture of CO_2 is the best solution considering the short time available. But Hansen and his colleagues observe that no commercial scale technology exists to do this. However, one U.S. company called Global Research Technology, LLC (GRT) has claimed that it has developed an air-extraction prototype and is currently developing its ACCESSTM air-capture system for commercialisation. GRT is a Tucson-based technology company founded by Dr Klaus S Lackner along with his colleagues in 2004.

Dr Lackner began developing the technology at Los Alamos National Laboratory in the 1990s with chemist Patrick Grimes and physicist Hans J Ziock. Dr Lackner is now a professor at Columbia University's Earth Institute and the School of Engineering and Applied Science. GRT is backed financially by Land's End founder and Columbia benefactor Gary Comer and run by Allen Wright, the former director of research operations at Biosphere 2, the three-acre enclosed mini-environment previously used for ecological experiments in Oracle, Arizona. With Lackner serving as technical adviser, Global Research Technologies has recently achieved the successful demonstration of this technology. The 'air extraction' prototype has successfully demonstrated that carbon dioxide can be directly captured from the atmosphere. This is GRT's first step towards a commercially viable air capture device. This device is like a 'synthetic tree' and looks like a huge football goal post with Venetian blinds between its uprights.

The apparatus extracts carbon dioxide from the air using liquid sodium hydroxide which is converted into sodium carbonate as wind rushes over it. A series of further chemical reactions, Lackner says, would draw the carbon out of the sodium carbonate and turn it into a concentrated form of carbon dioxide that could be buried. A device with an opening of one square meter can extract about 10 tonnes of carbon dioxide from the atmosphere each year. If a single device were to measure 10 metres by 10 metres, it could extract 1000 tonnes each year. On this scale, one million devices would be required to remove one billion tonnes of carbon dioxide from the atmosphere.

The company claims that air capture devices are small and require much less land area than the wind mills that would be needed to offset an equal amount of CO_2 emissions. Indeed, if the CO_2 carried by air streams used to drive wind mills were to be captured, then on an energy equivalent basis, the CO_2 capture would reduce emissions hundred times more than a wind mill of equal sweep area. Like wind turbines, the GRT devices would be deployed in coordinated formations, but would extract the air's carbon dioxide, not its kinetic energy. The company also claims that the 'synthetic tree' can absorb 1000 times more CO_2 than a real one similar to its size. The cost of this air capture, would of course, be very high.

Another emerging idea of carbon dioxide absorption involves a new class of materials called metal-organic frameworks (MOFs), also called crystal sponges. Invented and developed by Omar Yaghi at the University of Michigan, the MOFs can store vast amounts of carbon dioxide. MOF molecules consist of scaffolds made up of metal hubs linked together with struts of organic compounds to maximise the surface area. Just one gram of an MOF has the surface area of a football field. One variant called MOF-177, which soaks upto140 percent of its weight of CO_2 at room temperature and reasonable pressure (32 bar) is found to be very effective.

(A tank filled with the material known as MOF-177 can hold as much carbon dioxide as nine tanks that do not contain MOF-177)

However, there is no commercial scale demonstration of this technology. Also, the hope about such 'techno-fixes' should not lure us into complacency to pursue business-as-usual. The proponents of fossil fuels who have not been able to develop commercially viable clean coal / carbon sequestration technologies for coal-based power plants can justify their emissions when such a technology is available.

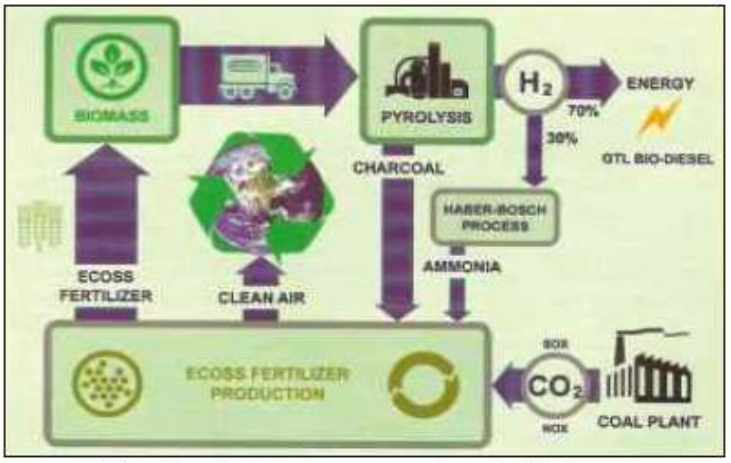
A major challenge facing them has been the fact that it is too expensive to retrofit many of the world's existing power plants to make them more eco-friendly. In general, building new technologies is easier and cheaper than adding retrofits to existing infrastructure. The GRT device, they claim, can capture emissions from existing power plants without imposing retrofit costs. We should remember that such devices should be used only to undo the damage already done (like the need to bring down CO_2 concentrations to 350 ppm) and not to perpetuate continued emissions. The commercialisation of such technologies for air capture of CO_2 should not result in any slackening of efforts to transition to a renewable energy economy.

The Bio-Sequestration Route

Hansen and his co-authors believe that improved agricultural and forestry practices offer a more natural way to cut down CO_2. Deforestation contributed a net emission of 60±30 ppm over the past few hundred years, of which 20 ppm CO_2 remains in the air today. Reforestation could absorb a substantial fraction of the 60±30 ppm net deforestation emissions. A 50 ppm drawdown via agricultural and forestry practices seems plausible. But if most of the CO_2 in coal is put into the air, no such 'natural' drawdown of CO_2 to 350 ppm is feasible. Although it has been found that natural carbon sinks such as forests and oceans are unable to cope with the increasing amount of carbon emissions, a recent study by researchers at the University of Helsinki found that European forests are expanding and taking up more carbon dioxide from the atmosphere than was initially expected. The scientists examined changes in forest cover in Europe and calculated how much carbon they store. According to the study detailed in the journal *Energy Policy*, over the last 15 years, forests have grown in 22 of the world's 50 most forested countries, which include several EU countries. They found that between 1990 and 2005, the expanding forests absorbed an amount of carbon equal to about 11% of the region's emissions. According to rough estimates, their impact in reducing atmospheric carbon may be twice that achieved by the use of renewable energy in Europe today. Such natural carbon storage systems could help the European Union meet its goal of reducing greenhouse gas emissions, researchers say.

Carbon sequestration in soil also has significant potential. Biochar, produced during pyrolysis of residues from crops, forestry, and animal wastes, can be used to restore soil fertility while storing carbon for centuries to millennia. Biochar helps soil retain nutrients and fertilizers, reducing emissions of GHGs such as N_2O. Replacing slash-and-burn agriculture with slash-and-char and use of agricultural and forestry wastes for biochar production could provide a CO_2 drawdown of ~8 ppm or more in half a century.

Biochar refers to the process that takes carbon captured by living plants and turns it into the solid form of charcoal. Although plants are nature's primary way of absorbing carbon dioxide from the atmosphere, they only store the carbon temporarily. When the plant dies and decomposes, the carbon is released back into the atmosphere. Or if the plant is burnt, the carbon is immediately released. The biochar process takes the waste from food crops, forest debris, and other plant material and turns them into charcoal through a process that captures the gases released (which include hydrogen and other non-carbon fuel gases). The carbon is then used to create a fertilizer that is ploughed back into the land, promoting the growth of further crops. The net result is that the carbon captured by the plants is now returned to the soil in a stable form. Thus, besides reduction of carbon dioxide on a large scale, the process also offers a multitude of advantages such as carbon negativity, application of low-end technology, local application, and production of large quantities of non-carbon fuel, etc.



A flow chart showing carbon sequestration using biocharcoal

Solarisation or Rapid R.E. Transition

The emphasis on immediate phasing out of coal and other fossil fuels underscores the need for rapid deployment of zero-carbon energy technologies. Hansen and his co-authors have left an opening for continued use of coal if carbon capture technology is employed during its combustion.

Box: Worldwide Installed R.E. Capacity, 2009

Selected Indicators	2008 (estimated)
Investment in new renewable capacity (annual)	$155 billion
Renewables power capacity (existing, excl. large hydro)	> 275 GW
Wind power capacity (existing)	122 GW
Grid-connected solar PV capacity (existing)	11 GW
Solar PV production (annual)	5.96 GW
Grid connected solar thermal power (existing)	0.5 GW

Available information on the so-called 'clean coal' or 'carbon sequestration' from coal-based power plants by retrofitting such sequestration equipment seems remote. Despite years of research, no commercial scale application has been proven. Given the time-frame of a decade or so to contain emissions, it is impractical to bank on such on-site sequestration. So, besides exploring the possibility of above mentioned air capture methods of CO_2, what we need to do is to effect a rapid transition to a clean and green energy system.

Mature technologies exist to effect this rapid transition. Given the right fiscal, financial and policy environment, their rapid scaling up is also possible. What is lacking is the political and bureaucratic will to do so. Despite mounting evidence of catastrophic climate change, policy makers who are fixed on 'economic growth' at any cost seem to think that it is an issue that can be postponed or some miracle solution will appear one day.

Collapsing Glaciers: Horror Continues

But efforts of the international community is nowhere close to meeting this triple 'C' challenge—the challenge of catastrophic climate change. The Kyoto Protocol has not in anyway helped to reduce carbon emissions. Commendable progress has been made in the development of renewables. But there has not been any reduction in CO_2 emissions because fossil fuels continue to be burnt in ever increasing quantities. The United Nations Framework Convention on Climate Change (UNFCCC) is still groping and struggling to evolve real solutions. In the first week of April 2009, the ADHOC Working Group on long-term co-operative action under the UNFCCC met in Bonn. One redeeming feature was that the U.S. team was back.

> Himalayan glaciers are receding in a similar way... Many glaciers in these areas could, at current rates of global warming, disappear within the coming decades, as early as 2035.

Addressing the meeting, President Obama's special envoy for climate change, Todd Stern made this positive statement: "We are very glad to be back, we want to make up for lost time and we are seized with the urgency of the task before us" (summary). But the optimism began to tumble as negotiations began on how fast and far countries should cut their greenhouse gas emissions. Stern stuck to the new President's proposal that America should trim its emissions back to the level of 1990 by 2020. But some 70 poor and low lying countries, faced with the threat of submergence and drought insisted that by 2020 the developed world should reduce their emissions to 45% below the 1990 levels. The meeting concluded with no with real solutions to clinch a deal in the December 2009 Copenhagen (COP 15) conference.

As these bickerings were going on in Bonn, in faraway Antarctica one more huge ice shelf collapsed. Based on satellite pictures from the European Space Agency, the UNEP announced on 7 April 2009 that an ice bridge linking the Wilkins ice shelf to two islands in Antarctica had collapsed, adding further evidence to the clear impact of climate change on the region.

In brief, the UNEP report states as follows:

The Wilkins Ice Shelf

"The satellite picture shows that a 40 km long strip of ice holding the Wilkins in place had splintered at its narrowest point, about 500 meters wide. The Wilkins shelf, which is the size of Jamaica, has been retreating since the 1990s. It is one of many Antarctic ice shelves that have begun to break up over the past few decades and is part of the Antarctic peninsula, which has seen some of the most dramatic temperature increases in the area—up to 3 degrees. Although the Wilkins Ice Bridge collapse will have no direct consequence on sea level rise, it might have an indirect impact, as the decay of the ice shelf will reduce the stability of the glaciers that are feeding it. The collapse of the Ice Bridge will expose a new expanse of sea surfaces that absorb an increased amount of solar radiation, contributing to continued and accelerated warming. Recent research found that a freshening of the bottom water near Antarctica is consistent with increased ice melt from that continent that could affect ocean circulation. Indeed, the loss of the Wilkins Ice Bridge, jutting about 20 metres out of the water and which was almost 100 km wide in 1950, may now allow ocean currents to wash away far more of the shelf." Antarctica's fate is critical to the fate of the Earth.

It is not as though it is happening only in faraway Antarctica or Arctic. All around the world, glaciers are melting at unprecedented rates. In March 2008, the UNEP brought out the findings of the World Glacier Monitoring Service (WGMS), a centre based at the University of Zurich in Switzerland (supported by UNEP). Data from close to 30 reference glaciers in nine mountain ranges indicate that between the years 2004–2005 and 2005–06, the average rate of melting and thinning more than doubled. The WGMS findings also contain figures from around 100 glaciers found in Antarctica, Asia, Europe, North America, Latin America and the Pacific, of which 30 form the core assessment. Some of the most dramatic shrinking has taken place in Europe with Norway's Breidalblikkbrea glacier thinning by close to 3.1 metres (2.9 metres water equivalent) during 2006, compared with a thinning of 0.3 metres (0.28 metres water equivalent) in the year 2005. Other dramatic shrinking has been registered at Austria's Grosser Goldbergkees glacier, 1.2 metres in 2006 versus 0.3 in 2005; France's Ossoue glacier, nearly 3 metres versus around 2.7 metres in 2005; Italy's Malavalle glacier, 1.4 metres versus around 0.9 metres in 2005; Spain's Maladeta glacier, nearly 2 metres versus 1.6 metres in 2005; Sweden's Storglaciaeren glacier, 1.8 metres versus close to 0.080 metres in 2005 and Switzerland's Findelen glacier, 1.3 metres versus 0.22 metres in 2005. Similar results have been obtained from the U.S. and Latin America.

Closer home, the Himalayan glaciers are receding in a similar way as glaciers in other mountain ranges at low latitudes. Many glaciers in these areas could, at current rates of global warming, disappear within the coming decades, as early as 2035. Half a billion people in the Himalayan-Hindukush region and a quarter billion downstream who rely on glacial melt waters could be seriously affected.

The current trends in glacial melt suggest that the Ganga, Indus, Brahmaputra and other rivers that criss-cross the northern Indian plain may become seasonal rivers in the near future as a consequence of climate change, with important ramifications for poverty and the economies in the region. In March 2008, Lester Brown of the Earth Policy Institute warned that the melting Himalayan glaciers will shrink grain harvests in China and India. Mountain glaciers in the Himalayas and on the Tibet-Qinghai Plateau are melting and could soon deprive the major rivers of India and China of the ice melt needed to sustain them during the dry season. In the Ganges, the Yellow, and the Yangtze river basins, where irrigated agriculture depends heavily on rivers, this loss of dry-season flow will shrink harvests. Like Jim Hansen, Lester Brown had, earlier in his book, 'Plan B 3.0: Mobilizing to Save Civilization', argued for the need to cut carbon emissions by 80 percent, not by 2050 as many political leaders or IPCC suggest, but by 2020—ten years from now! The cascading effects of inaction would be so very severe, ranging from massive famine, mass migration, social unrest, pestilence, submergence of coastal areas and chronic water shortages. One shudders to think of such a future awaiting us in the next two decades!

Along with oil, coal was instrumental in creating today's urbanised, industrial civilisation. Economic growth has definitely facilitated positive humanitarian changes: freedom from poverty, drudgery and oppression, at least for large sections of the world population. But the fuels we depended on to achieve this have created the gravest threat to our existence—the threat of 'catastrophic climate change'. About 40% of the world's electricity is produced in power stations burning coal. In India, about 65% of our electricity comes from fossil-fuel based power stations. And coal continues to flourish all over the world, despite it being the single biggest contributor to climate catastrophe. The celebrities, wannabe do-gooders and scientific fraudsters who spearhead 'television greenathons', 'walkathons', 'earth hour' and such other 'tokenisms' never utter a word against coal. They are eloquent on the need to eat less meat (!), planting trees, energy conservation and 'buying green products'; but never point a finger at the real culprit. In fact, after this superficial 'green washing', these climate fraudsters move on to other stages to speak about the necessity of unrequited economic growth and the need for continued use of 'abundant' coal, albeit using the non-existent 'clean coal technology'. Our continued emphasis on blind 'pragmatism' will only bring disaster. And if you trust Jim Hansen, it is just a decade or more away from us. It is time for all of us to speak the truth, like Jim Hansen, Lester Brown, and hundreds of other scientists and visionaries. Not just speak, but act to prevent catastrophe. Because the truth involves us all!