7 Alternatives (Complete article)

Summary

I believe voluntary investors, consisting of the wealthy population in the world, together with local private entrepreneurs around the globe could be the new driving force for fast reversing of global overheating. I think their effort is necessary to get enough momentum.

So far there have been no effective alternatives. UN:s CDM program has achieved a lot and has shown the way for offset providers but the effect in CO2 reduction is small compared to the need. The promise from the world's richest countries from 2009 to raise 100 billion US $ yearly for poorer countries has never been met. In the article I am referring to a report from last year suggesting private funding and more offset among other suggestions as a cure.

The problem with the necessary task of cutting CO2 emissions is the time it takes and that the cutting of CO2 increase is not solving the overheating for a long time. Instead, even if present international goals are met, the temperature will increase the next 50 years or so and not start to come down until the level of CO2 starts coming down. Negative climate change will likely worsen compared with today for next 100 years before getting better.

Of course, there are methods of taking CO2 out of the air but even the most mature of them are either too limited in how much they can be used before the methods are exhausted, too expensive, or not developed enough.

I have formed a baseline of my assumption of what is needed for cooling measures to reverse the overheating to be able to compare some of these alternatives.

The best alternative I can see is the combined use of large-scale planting of trees and produce of biochar followed by enhanced weathering as soon as it can be scaled up. I have left out direct air capture and storage as, though it is interesting for the future, it is presently too expensive and resource consuming to be a prioritized method.

Taking away CO2 with the best possible option would only slow down the present increase a few years. Even if the reduction of CO2 is continued for about 70 years when all possible land suitable for forestation is used the reduction has not yet taken away the accumulated increase forecasted in the 30 years from now when the world is supposed to have reached zero emission. No cooling, but instead increased global overheating the next 100 years could be foreseen even using this alternative.

I conclude in suggesting the best remedy being successive implementation, during thorough investigation, of radiative cooling and albedo increase, parallel to fast stopping of new CO2 emissions, followed by the reduction of the level of CO2 for the next few hundred years.

My mission

I have tried to show that there could be affordable alternatives to the consequences of global overheating. The world doesn´t necessarily have to accept the effect of 2 degrees higher temperature or more although experts claim that the 1,5 -degree target can´t be reached even though many governments now are ramping up their CO2-cutting efforts.

I believe the incitements for the chain of investors, distributors/carbon offset providers and offset producers as well as for facilitators like software and game producers could be the new driving force.

What about the alternatives?

Financial alternatives

The money the wealthy could set aside in my calculations is an example of how relatively little could be needed by a relatively small portion of the global population to reverse global overheating if everyone would participate, and new methods were implemented.

The financing could of course be done in other ways than from voluntary contributions. However, so far it has been impossible for the international community to reach funding agreements or CO2 removal programs of any substance compared to the need.

Can´t the governments or UN fix it?

The UN CDM (offset) program was 2018 summarized in an internal report - *Achievements of the clean development mechanism* - by Arthur Rolle Chair of the CDM Executive Board [1] for the 17 years of operation between 2001 and 2018. During these years 304 billion US $ was invested thus reducing about 2 gigaton of CO2 among a lot of other climate achievements.

The report describes many good results, and the UN CDM program has shown the way for the present offset industry. However, the results need to be put in context of the total need. A reduction of 2 Gt in 17 years gives 118 Mt per year. The yearly increase of 40Gt CO2 is 339 times the average annual decrease of 0,118 Gt. More is needed as not only the annual 40Gt but also the 2000 Gt already in the air needs to be taken out of the air.

Need for private initiatives

United Nations richest countries have since 2009, every year, agreed to raise 100 billion US dollar yearly to support climate actions in poorer countries. So far, those rich countries haven´t succeeded to reach that amount any year. An independent expert group on climate finance consisting of Amar Bhattacharya, Richard Calland (co-chairs); Alina Averchenkova, Lorena Gonzalez, Leonardo Martinez-Diaz and Jerome van Rooij published in November 2020 the report *Delivering on the $ 100 billion climate finance commitment and transforming climate*

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[1] Rolle. UN CDM (2018) *Achievements of the clean development mechanism* ［UN summary］ accessed December 30 2020 from https://unfccc.int/sites/default/files/resource/UNFCCC_CDM_report_2018.pdf

finance[2] that give an in-depth understanding of the reasons for underfinancing and how to accelerate future funding. Among many suggestions the authors see a potential in private funding and further development of the use of offset. The report also emphasizes that the support to developing countries must increase.

What about the cuts of CO2 most countries try to achieve in the coming 30 years?

As the level of CO2 in the air is going up before it can come down again it could take hundreds of years until the overheating is mitigated if mitigation is only relying on reducing the level of CO2.

Estimates of the increase of CO2 before the decrease can start

About 2000 gigatons of fossil CO2 have accumulated in the atmosphere during the last 150 years. If the reduction of the increase, according to commitments made from many of the world´s countries to the IPCC, is linear during the 30 years starting with the present rate of 40 Gton/year and ending with zero increase in 30 years, the average increase will be 20 Gton/year or a total of 600 Gton after the 30 years. If the 30-year goal is not met, more than 600 Gton will be added. As present projections are not too optimistic it is easy to assume that at least 700 Gtons will be added giving a total of some 2700 Gtons in the atmosphere around year 2050 before the actual decrease can start. If the best combination of the present realistic measures to take the level down can reach 10 Gt/year it will take 70 years to get rid of the extra 700 Gt and to get back to the present level of 2000 Gt. In other word the level of CO2 will be higher than today for a hundred years before it can start coming down from today´s level. It is easy to believe that it would take another 100-200 years to get rid of the remaining 2000 Gt.

Even if the goal of maximizing the temperature increase to 1,5 degrees is met it will mean the temperature going up by 0,4 degrees from the present 1,1 degrees in turn leading to increased fires, floods, and heatwaves the next 30 years and staying on that level for a long time. It must be better also trying to get the *temperature* down as fast as possible.

The level of the sea has risen about 20 cm the last 100 years and continues to rise by 3 mm each year. As the speed increases over time the level will rise considerably[3] . Present projections show 0,3 – 1,2 meters until year 2100 with a worst case of 2,5 meter. No doubt even an increase of 1 meter in the next 80 years will cause very high costs for all coastal cities around the globe and devastate many coastlines. And as the level of the sea doesn´t stop rising until the overheating of the globe is mitigated the level will continue to go up even after year 2100. It is possible to find projections of 2-4 meters year 2200 and 7 meters year 2300.

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[2] Independent Expert Group on Climate Finance - Bhattacharya, Calland, Averchenkova, Gonzalez, Martinez-Diaz, Van Rooij (2020) *Delivering on the $ 100 billion climate finance commitment and transforming climate finance* ［Analysis ］ accessed December 30 2020 from https://www.un.org/sites/un2.un.org/files/100_billion_climate_finance_report.pdf

[3] Wikipedia (2021) *Sea level rise* Accessed 2021-03-12 from https://en.wikipedia.org/wiki/Sea_level_rise

The time it takes to cool the planet with different alternatives

One way of comparing alternatives is to use the estimates for radiative cooling as a baseline and compare that with other alternatives of CO2 reduction described by Oxfam[4] below. What effect is then possible to reach at the same cost as that of the baseline?

Assume the process of fully reversing overheating with radiative cooling could take 15 years and the cooling material cost could be 5,4 trillion US $. (1.5 billion paying 20 US $/month for 15 years)

Summary of comparison

I mean priority should be given to the alternative of forestation until there is no more suitable land and when approximately 260 GtCO2 is absorbed. Enhanced weathering should be prioritized after forestation when the technology has matured. The potential is unlimited, and the capacity / year has got a potential to go up to 95 Gt/year although 3 Gt/year is presently assumed being realistic. Until enhanced weathering has matured Biochar should be prioritized. The potential is limited but could take up over 400 GtCO2. DACCS is just a too resource consuming method to be an alternative now and need time to be developed.

A compilation of the alternatives below shows that it is possible to get a maximum reduction of approx. 9 Gt/year using the combined capacity of forestation, enhanced weathering, and biochar due to the restraints described by Oxfam. The cost for these 9 GtCO2 a year could amount to 425 billion US $/year. That is 18% more than the wealthy could contribute with paying 20 US $/month but in the same order of magnitude.

The above alternative of spending 5,4 trillion dollar on CO2 reduction alone would take 117 Gt of CO2 out of the air in 13 years. Equaling 3 years of the present addition of CO2 to the air and not contributing to any significant temperature reduction.

If CO2 reduction alone is continued with the same method and at the same pace as described above forestation as a method will be exhausted after about 70 years. After that when using more of the alternatives price will go up dramatically using today´s prices. On the other hand, new cost-effective methods might have been developed by then making any forecast beyond 70 years too uncertain to have any value just now. After 70 years 630 Gt CO2 or 23% of the stored 2700 Gt CO2 could be in the process of being taken away. However, the full effect would come some 50-100 years later when all the planted trees have grown up and all the minerals using enhanced weathering are dissolved.

The comparison shows that with the same time and money as applied on radiative cooling, that would reverse the planets overheating, just taking away CO2 with the best possible option would only slow down the present increase a few years. Even if the reduction of CO2 is continued for about 70 years when all possible land suitable for forestation is used and some 30 quadrillion US $ are spent, the reduction has not yet taken away the accumulated increase forecasted in the 30 years from now when the world is supposed to have reached

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[4] Oxfam (2020) *Removing Carbon Now* Accessed February 11, from https://oxfamilibrary.openrepository.com/bitstream/handle/10546/621034/bp-carbon-removal-now-190820-en.pdf?sequence=4&isAllowed=y

zero emission. No cooling, but instead increased global overheating the next 100 years could be foreseen even using this alternative.

Forestation

It will take 70 years to reach the maximum 260 GtCO2. Price 20 US $/ton
According to Oxfam the limitation is 3,7 Gt/year and the total cumulative potential estimated to be between 80 and 260 GtCO2. Based on the optimistic 260 GtCO2 maximum could be reached in 70 years. Add 50 years for the trees to grow up and you get 120 years.
3,7 GtCO2/year would cost 74 billion US $/year.

Enhanced weathering /dissolving minerals

Seen as an unlimited option it would take 900 years to reduce 2700 GtCO2 at a speed of 3GtCO2/year. Price 50 US $/ton. If the yearly capacity could increase to 95 GtCO2/year, it could be possible in time according to Oxfam, the job of taking away 2700 GtCO2 would then take just under 30 years. However according to Oxfam, a realistic present limitation is around 3 Gt/year, but the total cumulative potential is estimated to be almost unlimited. The minerals need time to be dissolved. If one assumes that it takes 100 years to reach 100% dissolvement of the 3Gt added every year the total time for 2700Gt would be 900+100=1000 years. 3 GtCO2/year cost 150 billion US $/year.

Biochar/coal produced by oxygen-free combustion

Biochar. It will take 200 years to reach the maximum 400 GtCO2. Price 100 US $/ton
According to Oxfam the capacity is estimated to a maximum of up to 2 Gt/year and the total cumulative potential estimated to be between 180– 410 GtCO2, (after which all suitable soils are saturated). 2GtCO2/year cost 200 billion US $/year.

DACCS/Direct Air Carbon Capture and Storage

DACCS. Seen as an unlimited option but it could take 540 years to reduce 2700 GtCO2. A current price is 600 US $/ton. Price could probably come down in the future. According to Oxfam 0,5-5 Gt could be managed by 2050 due to practical constraints. (Enormous quantities of electricity and heat are needed and many plants must be built). The potential however is unlimited. At its most optimistic capacity 5 GtCO2 /year it would take 540 years to take all 2700 GtCO2 away and at the most pessimistic guess it would take 5400 years. There are discussions of price coming down to 100 US $/ton. The use is presently scaled up but still experimental.

Conclusion

The total cost of rebuilding a few hundred coastal cities plus the personal loss of millions of people's private properties and the loss of recreational coastlines and all beaches by the sea on the whole planet should be considered when alternatives are compared.

I believe the prospect of being able to reverse the overheating back to zero in a few decades rather than in hundreds of years should steer the priority of measures. I suggest successive implementation during thorough investigation of the possibilities with daytime radiative

cooling and albedo increase parallel to the present plans of stopping new CO2 emissions should be a priority the next 30 years followed by the reduction of the level of CO2 for the next few hundred years. I mean it could be done.

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