5 How it could be done? (complete article)

Summary

All measures in my last article need a lot of space. As space will be a limiting factor, could compensation for letting space help finding space from many sources?

Carbon offset providers will have a very important role when more individuals invest in producers of mitigation services. I can see a need of offset providers local to investors and a new role as offset facilitators local to producers helping the latter setting up their services and include space in the package. To speed up the setup of new projects the process of verifying producers and release funds to them also needs to be simplified.

A global it-system will be needed, where spaces are catalogued, to monitor prospecting, and utilization of space for the different purposes. Such system could support material suppliers, mitigation producers, carbon offset providers and investors in finance and implementation. Researchers, authorities, the public and suppliers should be able to access consolidated data geographically on different levels to follow the growth of potentials, real effect of usage, and speed of different implementations.

Allowing 15 years of the wealthy's 360 billion/year could finance material and compensation for daytime radiation enough to, under circumstances described in the full article, reverse global overheating to zero, plants and planting for 1 trillion trees equal to 500 Gt of CO2 reduction when grown, and space to facilitate 440GW of solar electricity assuming the investments for solar cells are self-financed through sold electricity.

The calculation of daytime radiation assumes 5 trillion m2 of material costing 2 trillion US $. In 15 years 5,4 trillion US $ could be reached with the wealthy´s annual 360 billion US $. Per m2 it could give 0,4 US $ for material, 0,6 US $ for producer´s compensation and 0,08 for carbon offset provider's commission.

The full article discusses time, costs, and compensation for owners of space and contractors for implementation in desert projects and planting trees. Costs for large scale implementation of albedo increase is extrapolated from the referenced research document. How to support "Africa's Green Wall" project is discussed. Some ideas of implementations for the combined use of cooling and water production in the southwest of the USA and southeast of Australia are also exemplified.

Finally, I have suggested some organizational ideas for governance for the control of all cooling measures through an executive agency under UN using concessions as a tool.

Compensation for space as a driving force

All low-tech climate solutions, mentioned in my earlier article, needs space. As space will be a limiting factor measures need to be taken to utilize possible sources. A way of doing this could be making it worthwhile for different categories of space owners to contribute. To attract individuals, industry, public organizations, and landowners - revenues from letting space could be driving force that also could make space from multiple small sources used.

Carbon Offset Providers as facilitators

With investors and producers of climate mitigation not being the same, brokers are needed to connect the two.

Carbon offset providers could compile, and market different mitigation services as today and in addition include the separate space compensation in the market offers. To handle many small climate mitigation producers and compile their offerings to services, apart from selling to investors, I can see two types of carbon offset providers – one that face and are local to the producers and one that face and are local to the investors. I can see the traditional carbon offset providers co-working in a network with carbon offset facilitators where capacity is traded between the two and financed on a commission basis. However, carbon offset providers need to expand the market a lot and need help to do it.

The term “carbon offset provider” will be somewhat misleading as the service develops to include direct temperature reduction. More fitting could be “climate mitigation provider”. However, as the term is not recognized I will still use the term “carbon offset provider”.

With many more climate mitigation producers I think new methods of granting finance is needed. I choose an analogy with the marketing of hotel rooms to explain what I mean. The producers could present themselves directly to the investors, what service they offer and to what price. Carbon offset providers would still be needed to compile the offerings for the investors as the proposals otherwise would be too fragmented for the buyers. Carbon offset facilitators could offer help to local producers in evaluating, bundling, and classifying different services and initiate on-site inspections. As the investors always would know what specific projects invested money would go to and the offset producers always would know who the investors were, quality control could be more informal. Producers could supply verification, photos, and text, of fulfilled mitigation. Investors could supply reviews. This could cut bureaucracy and evaluation efforts to a minimum.

Present offset projects are often large and financed through an application procedure where national induced projects must apply for grants. The question then arises if the project in question should have been carried through anyway without a grant. “Additionality” has become a concept important to be included in the evaluation process. Some of the critics concerning the present offset projects has been about lack of additionality. As grants are paid only after projects are finalized and the promised carbon reductions have been verified the applicants have stood a risk of not getting paid if the level of reductions have not been met. As temporary finance has been necessary for the applicant to arrange, guarantees has sometimes been asked for as risk mitigation, to be able to apply for an offset grant. This can of course be seen as a breach of additionality - or a natural result of the granting system.

With smaller offset services where the results are easier to verify the investor does the evaluation and either buy into a service or not. I think a simplified and more direct method of evaluation could give better conditions for expanding the number of services fast rather than the expansion being held back over time consuming financial questions.

IT support to connect parties, refine offerings and monitor climate measure progress

To handle high volumes of transactions between the different roles new and common IT support would be needed. I can see two main areas. Marketing, sales, and payment functions where the specific investors and climate measure producers could meet through the services provided by carbon offset providers and facilitators. And in addition - monitoring functions where the work on climate measures could be followed locally and globally in consolidated steps.

The core of such IT-support could be an IT-system with an international database of objects describing areas and spaces and supporting different roles involved in climate mitigation. The objects could be identified by a global coordinate.

Of course, it-solutions would have to be developed and incentives made for the finance. Part of the infrastructure exists, however. Half the global population own smartphones and the deployment of global it-solutions is commonly known.

Primary use for mitigation and business

Typical users of such it-system could be owners of space, investors, carbon offset providers and carbon offset facilitators, authorities, research, and suppliers. Consolidation should be possible, summarizing single climate measure units to higher levels typically like postal-codes, towns, countries and global.

Properties for possible climate measures could be prospected by the land or space owners themselves. The measuring of the areas and surfaces could be supported with augmented reality thus helping to place surfaces on to maps and assigning the coordinates automatically.

The knowledge of possible potential and conditions for using the space could be informed through carbon offset facilitators who could also suggest agreements with technical and economic conditions with the common it-system as common ground.

Secondary use for research, authorities, and marketing

Researchers, authorities, and suppliers should be able to access consolidated data on different geographic levels and monitor potentials, real usage, and development speed of different sorts of mitigations. I believe it should also be possible for authorities, research, carbon offset providers and carbon offset facilitators and suppliers to intervene with instructions and information in the workflow.

Finance of the IT-support

One way of financing and motivate IT-support could be selling advertising space to the different users that benefit economically from the system with carbon offset providers as a

prioritized target. The it-support needs to stand in its own feet, however. I will describe how it could be possible in the next article.

Timescale and investments

Allowing about 15 years of the wealthy 1,5 billion people´s 20 US $ of monthly payment would do a lot. Enough material, paint, or film, for radiative cooling to reverse global overheating back to zero could be financed, the finance of planting 1 trillion trees, equal to say 500 Gt of CO2 reduction, would also be included as well as *the space* to facilitate a nominal effect of solar panels corresponding to the present 440 nuclear power plants in the world each one producing 1GW.

Cooling estimates

The calculation below first concerns the finance of radiative cooling as I believe it is the most urgent measure. The figures are meant as an example as more research and in-depth calculations need to be made. The example shows, however, that there is a good chance global warming could be reversed in decades rather than centuries using radiative cooling. It doesn´t make it less necessary to stop CO2 emissions but will instead provide more time for cuts and reductions and less need for abrupt unpopular and harsher measures.

Assuming 5 trillion m2 of material costing 2 trillion US $ is needed to reverse overheating to zero as described in the previous article. The needed investment could be reached in under 6 years with the wealthy 1,5 billion paying 20 US $ each/month. If 15 years are allowed, instead of 6 years, 5,4 trillion could be collected equaling 1,08 US $/m2. With a price of 0,4 US $ for material, 0,6 US $ could be reserved for compensation and 0.08 US $ could be reserved for carbon offset provider's commission. In other word, extending the time from 6 to 15 years allows for compensation for space and commissions to carbon offset providers.

An example of covering deserts with radiative cooling paint

Using deserts is the obvious first choice when looking for large areas of unused space suitable for cooling purposes. I can see two ways of applying the cooling material in deserts. One way is spraying paint. Another is using film where the water production capacity of radiative cooling also is used.

This example concerns spraying paint by drones with a coverage, or opacity, of 10%. In the earlier article I also assumed that 10% of the stony parts of all deserts could be used equaling 2,2 million km2. I assume that covering that area with a density of 10% could be acceptable as a temporary solution lasting say one or two hundred years until weathering has worn the thin coat away. 10% would then give 220.000 km2 of effective radiative area.
To reach 220.000 km2 effective area 2,2 million km2 must still be overflown.

If 22 days are needed to cover 1 km2 for 1 drone and the fee from a drone service provider is 1300 US $ per day the price per km2 would be 28600 US $. See previous article for details. With 220 workdays in a year, after compensation for weekends and holidays, the crew consisting of 1 drone pilot, 1 drone and 1 support-truck could cover 10 km2 and earn 220*1300 US $ = 286.000 US $/ year – to cover a salary and depreciation costs of drone, and support-car. Allowing 5 years to cover the total 2.2 million km2 with full-time drone crews 44.000 crews would be needed. The crews could be shared on the more then 30 countries

with deserts within their borders. An average of 1500 drone crews would be manageable for any country.

1 km2 overflown area equals 10 ha effective radiative area at 10% density. 10 ha equals 100.000 m2. At a price of 0,6 US $/m2 the compensation for the landowner would be 60.000 US $. After deduction of 28.600 US $ for the cost of painting 31.400 US $ would remain. A price of 0,08 US $/m2 for carbon offset commission gives 8.000 US $. All per km2.

The whole market of 220.000 effective km2 would be worth 130 billion US $ for the owners and 17,6 billion US $ for the carbon offset providers. As a comparison - the country of Morocco has a yearly official budget of about 26 billion US $ so a slice of this market would most likely be very welcome.

All in all, I have calculated with 1% effective use of all deserts on the planet. If a combination of using more land and a higher opacity reaching a total of 10% effective area this alone would cater for nearly half of the global need.

Helping the underfinanced "Africa´s Great Green Wall"

This example shows how the water production of radiative cooling could help both finance a project and contribute with water production – two needs that are specifically asked for.

Africa´s "Great Green Wall"-project[1] started 2007 with 7 countries planning to build a 7775 km long, 15 km wide green belt stretching from the Atlantic to the Red Sea covering an area of 1 million km2. It´s an ambitious plan to replace the south rim of the Sahara-desert with trees and plantations, creating 10 million jobs and binding 250 Mt of CO2 in the process. After 10 years only 15% of the plan is completed. The reason is lack of funding and irrigation as well as political problems in some countries. The future until 2030 has changed to producing more of a mosaic pattern of green areas.

Assuming the Great Green Wall projects planned areas of 1 million km2 was mixed with another 1 million km2 of radiating material for cooling and water production, the Wall would be widened from typical 15 to 30 km. Of course, the spaces of green as well as radiating material would have to be broken up in small patches.

This measure alone could have a large impact on the climate. 1 million km2 of radiating material is 20% of the needed area to completely reverse global overheating back to zero or assumed equal to 0,3 degrees. Apart from the material some 600 billion US $ could be added to the present finance of the green wall. The 10 m3 of water /ha/day would help solving the present lack of irrigation. The integration of cooling film in the plantation could ideally be done so the plants were surrounded with the cooling film serving the triple purposes of simple application, direct watering contact with the plants and soil-cover protecting the crop from insects and the soil from unnecessary evaporation. And of course, with 1 million km2 of new land it should be possible to produce large areas of oil-palms, trees for long term absorption of CO2 and crops for human consumption.

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[1] Fröhlich. Deutsche Welle (2020) *What happened to Africas ambitious green belt project* Accessed mars 23 2021 from https://www.dw.com/en/what-happened-to-africas-ambitious-green-belt-project/a-53004690

As the wealthy could contribute with 360 billion US $ /year the radiating material, plants and all labor could be financed in less than two years.

A second project could supply north Africa with water

Assume the northwestern coast of Africa could have a similar amount of water producing facilities built with radiative cooling material as an effective part as a rim some 20 km inland, where the inhabited land finishes and the desert takes over and used for producing fresh water. The potential could be another 1 million km2 of cooling material and another 20%- or 0,3-degrees reduction on global temperature apart from solving a good part of the water supply in the populated areas by the coast.

Projects to mitigate heatwaves, draughts and restoring rivers and aquifers

Apart from the south- and north rim of the Sahara Desert the west of the US and southeast of Australia, often hit by extreme heat and devastating fires, could be early installations with mitigating draughts and restoring aquifers as important side-effects. The possibility to mitigate water shortage could be a decisive factor especially in the southwest of the US where exploiting rivers and aquifers presently are under strain.

Two examples of how radiative cooling could be distributed in small scale

In the paragraphs below I have described 2 alternatives of distributing cooling material for the producer and the revenues for typical use.

Alternative 1 describes someone who wants to cover a relatively small area for direct cooling of a house on top of a roof, condensation of water or just as a climate contribution. Typical installation of 100 m2. The compensation for 100m2 could be 60 US $ for the (house) owner after receiving free 40 US $ worth of radiating material. Assuming in the example that the material used is paint applied on existing structures (roofs) by the owner.

Alternative 2 describes covering large areas with radiating film on multiples of hectares optionally as part of other projects with established financing. In addition to cooling, the water produced for irrigation, human, or cattle consumption could be the economical facilitator. The water condensation rate could reach up to 10m3/hectares/day. The compensation per hectare, after receiving free material to a value of 4000 US $, could be 6000 US $. If the water production from the cooling film would replace other means of water production the provided film and compensation could be seen as items for lowering the investment costs in suitable projects like alternatives to water desalination plants, irrigation for plantations and water supplies for cattle. The commission for Carbon Offset Providers and Carbon Offset Facilitators could be a shared 800 US $ for selling 1 hectare. Large installations would then make it worthwhile for the agents to compose.

Estimates of increased albedo in the polar seas

This measure entails factory production of the microspheres, heavy transport and specialized distribution that can´t be performed at a local scale. It could however show to be very effective and could still be financed in a distributed through carbon offset providers. In the referred modelling described in the previous article the cost for achieving increased polar ice is estimated to 300 million US $ for covering 25.000 km2.

If the area of lost ice around the poles equals 1 million km2 at each pole, and this area is to be replaced, the cost could be estimated as 2.000.000/25.000*300 million US $ = 24 billion US $. A cost of 24 billion US $ is less than a month of the wealthy 1,5 billion's contribution.

Estimates for facilitating solar electric generation

I can only guess the future need of electricity. It will be a lot however and it must be advantageous if the electricity could be produced locally, close to the consumers. The calculation below shows that *facilitating roof space* enough to accommodate solar panels with a nominal effect corresponding to all nuclear reactors in the world does only marginally inflict, with a portion of 7% or about 1 year, of the capital flow from the wealthy 1,5 billion. It is an example made to get a feeling of what could be done parallel to installing radiative cooling without much inflicting delays in that process.

A fast way of facilitating electric generation with solar panels could be through supplying roof space to solar energy companies where the actual panels are financed with incomes from sold electricity. The house owner would ideally not invest anything but instead receive income from the provided space. The solar energy company would install panels seen as an investment in a part of a widespread production unit. With a competitive production cost of solar + battery storage, as shown in the previous article, the solar energy company would still be able to make a profit. As solar-panels already are financed with the profit from sold electricity the addition of a direct income for the roof-space could accelerate implementations and make installations larger.

If the revenue is set to 1 US $/m2/month the income from the space alone could be 25 US $/ month if a typical 25m2 of generating capacity were used facilitating a nominal 5kw.

To achieve a nominal effect from solar panels corresponding to all nuclear reactors in the world, assuming a total effect of 440GW, 88 million roofs would have to be covered each one producing 5kw from 25m2 of panels. 2.2 billion US $/month would need to be allocated for the space rental. 2.2 billion equals about 7% of the monthly payment.

Estimates for planting trees

If 0,5 US $/plant is allocated and with a price of 0,3 US $/plant, 0,2 US $ could be used as a revenue for planting. Assuming a planting speed of 2 plants a minute would result in 960 plants in an 8 -hour day and 960*0,2=192 US $ a day in revenue per person or equivalent of 3800 US $/month for 20 days of work.

Under reasonably normal conditions 1 person working 210 days a year would plant about 80.000 a year. Based on that speed planting 1 trillion trees would take 12,5 million people to do it in 1 year. Done in 10 years means still a lot of people – but possible.

Another measure of planting speed comes from Ethiopia, see article, where 350 million trees were planted in 1 day![2]. Extended to a year say 70 billion. With that speed 1 trillion trees could be planted in 14 years. The project has been criticized on quality grounds but gives a hint of what can be done in one country.

My own calculations and the example in the article show that planting 1 trillion trees could well be planted in a few decades if spread out on many countries.

At 0,5 dollar a plant and 360 billion/year in payments from the wealthy a trillion trees would be financed in 1,5 years seen as a single project. Spread over 15 years the finance would take 10% of the total capital from the wealthy per year.

An even more effective way to find lots of land for planting trees, and do it fast, could be if the planting is "super distributed". If all gardens, all roads, in all villages, in all countries would have trees planted it could amount to large spread forests and beautify the landscape at the same time. Ideally the work with planting should be distributed to concern a large proportion of the global population. Plants could still be distributed free and compensation could still go to the persons planting but the motivation would ideally come from the common task of beautifying the environment.

Controlling the expansion of cooling measures

Discussions of direct cooling of the planet leads to concerns about global governance. Who will set the temperature, to what and where? Some measures, like vailing, could be affordable for single countries to implement. If they did, conflicts could occur between countries blaming each other for unwanted weather.

Before measures to lower temperature would be able to start, international agreements therefore need to be made concerning governance.

As use of cooling measures needs to be regulated, I think concessions should be used to keep track on entrepreneurs. Carbon offset facilitators wanting to commercialize certain districts for cooling purposes would need to apply for concessions. When granted certain, of authorities decided, amounts of cooling measures could then gradually be released for possible implementation. Concessions should be granted with conditions of fulfilling reporting criteria that could include contracted producer, location, chosen method, areas involved and time for implementing. Not meeting conditions should lead to loss of concession.

UN could delegate "the climate cooling accelerator" to an executive agency reporting to a scientific board. The outcome could be plotted basically as a map showing locations, ideal changes of temperature, planned as speed of change and feedback. The rest could be delegated to governments to distribute and left to private enterprises to implement.

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[2] Euronews (2019) *Ethiopia breaks world record by planting 350 million trees in one day* Accessed June 22, from https://www.euronews.com/green/2019/08/02/ethiopia-breaks-world-record-by-planting-350-million-trees-in-one-day

Countries could have their own executive agencies and govern a free quota. The free quota could be small enough not to make any real assumed climate effect and big enough to get the involved companies, including carbon offset facilitators, carbon offset providers, suppliers, climate measure producers and investors established and up to speed – while the negotiations to establish “the climate cooling accelerator” and it´s first temperature goals would take place.

If the cooling producers, would be spread evenly on the planet the cooling could be spread accordingly. If implemented gradually it would allow time to adjust for not wanted side-effects.

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