CLIMATE TRANSFORMED

CO2 Permanence: Are We Being Distracted by the Quest for Perfect?

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CO2 Permanence: Are We Being Distracted by the Quest for Perfect?

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Summary

We discuss whether cheaper solutions that do not offer permanent carbon storage should be fast-tracked to "kick the can down the road." Should we embrace a temporary solution as part of a sequestration strategy? **Watch the full session here**.

Key takeaways

- In his recent article about CO2 permanence, Robert discusses temporary and permanent carbon storage. Carbon emissions go into the atmosphere and stay there for tens of thousands of years, and no amount of temporary carbon storage can address that unless:

1. Temporary storage must be replaced in the future. It is all well and good to make the bet that better tech will exist in 100 years, but we have to have a process to ensure it is used.
2. The harm from global warming decreases with time. For example, in 2050, with greater adaptation, warming is not as harmful as it is today.
3. Future harm could be discounted so that harm that happens in 100 years is given less importance than the harm that happens today. This is all about the discount rate in climate modeling. A high discount rate makes carbon captured and stored today significantly more important than implied with a low discount rate.

- If you have a calculation that does not consider that harm increases with increasing temperatures, you could make a case for using a negative discount rate, at least for the first 100 years or so. However, when the social cost of carbon is set, it is common to use different discount rates for additional periods, so higher discount rates are used for the short term—the social cost of carbon increases as temperature increases.
- Storing carbon past peak temperatures means that we have at least avoided that carbon contributing to the period of maximum harm. It also reduces the peak temperature and the risk of incurring feedback loops or trigger points.
- We must explore all possibilities to capture and store carbon because they all have limitations. For example, biomass-based solutions may encounter competition for biomass stocks. Direct Air Capture (DAC) is energy-intensive, so it may be limited by the capacity to build out sufficient clean energy production. These technologies are still in the prototype stage in the lab or the first real-world example. So a crucial part of getting costs down is to get on with it: operational hours, development, and scaling up.

Paul's observations

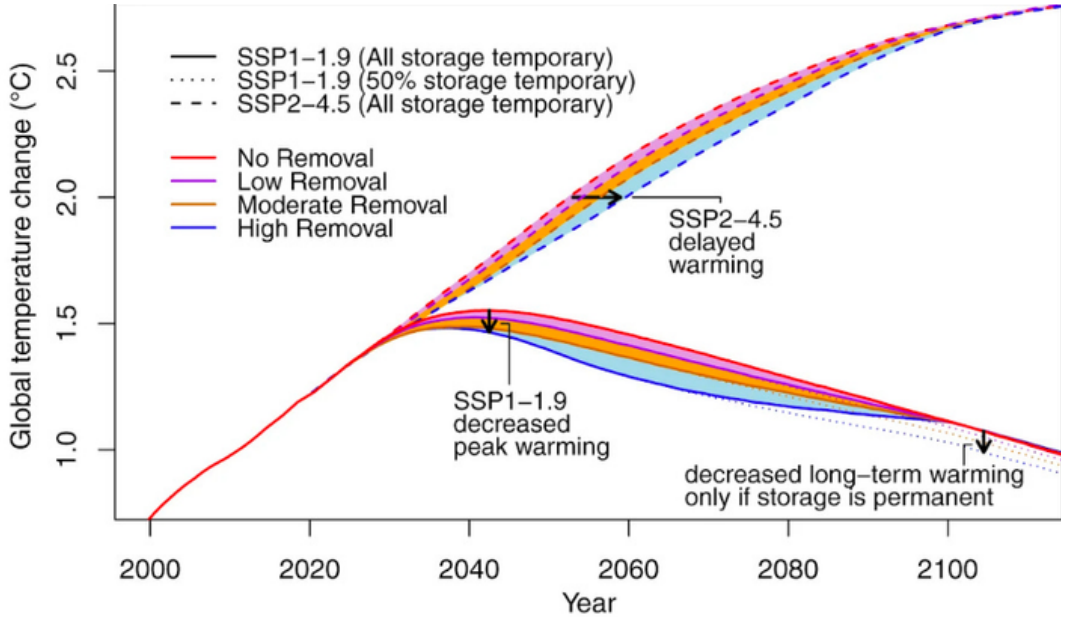
Many mission-driven climate investors are letting the perfect get in the way of the very good. My conversation with Robert Höglund and Josh Shaeffer explored this ongoing issue regarding the permanence of stored carbon. I think about this issue simply: instead of working on expensive technologies that store carbon for 500-1000 years, let's maximize cheaper storage efforts that may only successfully store carbon for 100 years and make the bet that improved solutions will be available in 2123. This way, we can remove as much carbon as possible cost-effectively, cap the earth's warming, and stem the tide. It is more complicated than that as Robert's Article, Are temporary and permanent carbon stores interchangeable? explains, but, big picture, I stick to this thinking.

I work on the premise that we need to remove around 10 gigatons of carbon per year via non-nature-based solutions by 2050 to get to net zero. We are nowhere near this, and while the cost curves for capture will fall over time, it is not commercially viable for hard-to-abate segments to utilize carbon capture. Direct Air Capture (DAC) is pricy, and cheaper methods, such as biochar, are not yet scalable. The IRA is a tremendous help for US efforts to make carbon capture more economical, but we will require global support. When it comes to the technology of carbon capture, we need to focus more on cost and less on permanence. Kicking the can down the road for 100 years may be the "very good" we need.

Venture Capital community: Invest in cheaper 100-200 year scalable solutions and leave the 500 years of technologies for your great-grandchildren to discover.

"When it comes to the technology of carbon capture, we need to focus more on cost and less on permanence."

Peak warming can be delayed with temporary storage



Source: Temporary nature-based carbon removal can lower peak warming in a well-below 2 °C scenario

Discussion

Milkywire

Milkywire is an impact platform that gets money from environmental organizations working with biodiversity and ocean health. Robert manages the Climate Transformation Fund, an alternative to climate offsetting. Clients set an internal carbon fee that they then use to support climate solutions. Milkywire maximizes the climate impact per dollar through carbon removal, nature protection, and decarbonization. This is done as an offtake agreement, not as an equity holder in the company.
The costs of different techniques and technologies can be viewed in the long run, so if a company needs 5 billion tonnes in the long run, it should consider how it can have the maximum impact long-term. If a company wants to be net zero today, it will not support new solutions. Still, for long-term goals, it can be hugely catalytic to be the first buyer of new technology, enabling a significant impact in the future.

Boomitra

Boomitra is focused on understanding the first 30 cm of soil carbon. Credits relating to deforestation are quite different from credits that concentrate on soil carbon.
People have degraded billions of acres of land. The Intergovernmental Panel on Climate Change (IPCC) said soils could hold 3.8 billion tonnes more carbon annually, so there is a huge opportunity to return carbon to soils. It is essential to stop degrading soils and start improving them, leveraging technology, particularly for monitoring, and land management, amongst other tools.

Are temporary and permanent carbon storage comparable?

Robert Höglund:

In his recent article about CO2 permanence, Robert discusses temporary and permanent carbon storage. Carbon emissions go into the atmosphere and stay there for tens of thousands of years, and no amount of temporary carbon storage can address that unless:

1. The temporary storage can be replaced in the future, which can be done by setting up a trust or foundation or by making it the government's responsibility to replace the temporary storage when or if it is released. Delaying carbon release is vital. Suppose a forest is to be cut down or harvested even with a year's delay, it improves annual carbon accounting.
2. The harm from global warming decreases with time. For example, in 2050, with greater adaptation, warming is not as harmful as it is today.
3. Future harm could be discounted so that harm that happens in 100 years is given less importance than the harm that happens today. This is all about the discount rate in climate modeling. A high discount rate makes carbon captured and stored today significantly more important than implied with a low discount rate.

The primary conclusion of the article is that if you have short-term carbon storage for decades only, that

storage would undoubtedly need to be replaced for that storage to have any real long-term value. On the other hand, carbon storage that lasts for hundreds of years, such as biochar, could be compared to permanent storage, albeit with some adjustments.

Replacing expired storage with future technologies

Robert Höglund:

New technologies could make it cheap and easy to replace temporary carbon storage, though we can't be sure this will happen. In this case, replacement would still be a part of the strategy. Some people talk about carbon tonne years, equating 1 tonne stored for 100 years to 100 tonnes stored for one year. When looking at carbon claims relating to temporary storage, it is essential to understand who plans to replace that temporary storage and who doesn't have a plan. Governments and companies may use temporary storage and hedge their bets on future technologies, but replacing that storage should be in their strategy.

Permanence in nature-based carbon storage

Josh Shaeffer:

Boomitra is focused on understanding the first 30 cm of soil carbon. Credits relating to deforestation are quite different from credits that concentrate on soil carbon.
People have degraded billions of acres of land. The Intergovernmental Panel on Climate Change (IPCC) said soils could hold 3.8 billion tonnes more carbon annually, so there is a huge opportunity to return carbon to soils. It is essential to stop degrading soils and start improving them, leveraging technology, particularly for monitoring, and land management, amongst other tools. By improving soil quality, we can keep 570,000 smallholders farming worldwide. We can also regenerate grasslands to be carbon sinks. We need to improve safeguards and permanence and increase carbon in the soil. Some of that will be short-term carbon, but improving practices can reduce nitrous oxide, which is 300 times worse than CO2, and we can stop using synthetic fertilizers and pesticides.

Soil management techniques

Josh Shaeffer:

No tilling and cover crops are two simple techniques that can improve soil carbon. However, a more systems-based approach is required to understand how to work harmoniously with nature. Seeds in desertified soils can last hundreds of years, so even poor-quality soil can be reactivated. Crop rotations and bio amendment have a significant and positive impact, but they require time, capital, and a willingness for farmers to change practices.

"By improving soil quality, we can keep 570,000 smallholders farming worldwide." – Josh Shaeffer

must use water as a coolant at high pressure and operate the plant at a relatively low temperature. That has profound limiting commercial consequences. We also use molten salt as a coolant, which allows us to operate at a higher temperature, low pressure, and with high health and safety.
In terms of climate change, we have done things at the margin for 25 years, and now we need to do transformational things because we are barely even treading water on the problem.
Nuclear innovation has never been driven by young high-tech companies, but by governments. It does not need to be left to national labs and governments now because we have 60 years of experience in the supply chain and powerful analytical tools. The support of government policy remains critical, of course.
The principles of nuclear safety are agnostic to whether it is molten salt or water used as a coolant. After 75 years, these principles are similar wherever you go, though they may be articulated with a different vernacular at the state level, with different terms and regulatory documents. Nuclear regulation is sovereign to the state and will remain so for a while. The regulators in major nuclear markets are increasingly capable of analyzing and understanding, ultimately acting on a license to construct a power plant with one of these new technologies.

How long does it take to build a nuclear plant?

Kateřina Bohuslavová:

ČEZ Group is going through the tendering process for constructing a new plant, and we have received offers from America, France, and South Korea. The evaluation of bids has just begun, but it is a long process due to security and cost. The files are so thick that it is hard to summarize, but we hope to process all of that to decide by the end of next year.
Due to the war in Ukraine, we are particularly motivated to accelerate the development of new plants. At the same time, we are modernizing existing plants and looking at innovating smaller plants. We launched a project a couple of weeks ago for one of our plants to supply heat to a regional capital city in the Czech Republic by the end of 2023. I would be cautious about timelines because every project takes longer and more money than planned. However, there is a greater sense of urgency in crisis, albeit without jeopardizing safety.

Are you expecting any changes in European or other international legislation to make developing nuclear plants easier?

Kateřina Bohuslavová:

I see more openness and a more data-based approach to nuclear energy, considering sustainability and net zero targets such as Fit for 55. So I don't expect any legislative changes in favor or against nuclear.

Simon Irish:

There is a standard set of permitting requirements for any industrial plant or infrastructure construction, which all take a long time to achieve. For example, a transmission line from Quebec down to New York State goes through the permissions process. We are now 20 years into that. In this instance, it is a linear permitting problem that is complicated in western markets.

If soil could be 40% of the solution, where does the other 60% come from to achieve ten gigatonnes of carbon capture per year by 2050?

Robert Hoglund:

Carbon in soil is a short carbon cycle, so we can store carbon in the soil to replace the loss of soil carbon elsewhere, but it is not appropriate to offset carbon from a long-carbon cycle, such as burning fossil fuels.

There is an extensive portfolio of carbon removal solutions, with new solutions always coming through because the carbon removal industry is in its infancy. This includes using photosynthesis through trees, seagrass, etc., to capture carbon which can then be stored in standing biomass by turning it into biochar and bio-oil or buried carbon under specific conditions that promote long-term storage.

Other methods include enhanced weathering of rocks that react with water and CO2 to store carbon stably and permanently. This can be done by grinding rocks and spreading them on farmland or in the ocean.

Direct Air Capture also has several pathways but generally removes CO2 from the air and stores it. CO2 can be used in food production, stored underground in liquid form, or through acid reaction. Direct ocean capture uses electrochemistry.

We must explore the full possibilities because they all run into limitations. For example, biomass-based solutions may encounter competition for biomass stocks. Direct Air Capture (DAC) is energy-intensive, so it may be limited by the capacity to build out sufficient clean energy production.

These technologies are still in the prototype stage, either in the lab or the first real-world example. So a crucial part of getting costs down is to get on with it: operational hours, development, and scaling up.

Early-stage funding for taking projects out of the lab

Robert Hoglund:

Funding streams for DAC include venture capital, but it is competitive, and building a whole facility is generally not possible using venture capital entirely. In fact, for each $1 of venture capital, a DAC project may require $1000 from other sources, such as project financing and bank loans, and to secure those, a project needs to have buyers of carbon removal credits lined up.

It is critical to DAC project funding. Buyers are in place to buy the CO2 tonnes upfront or as Power Purchase Agreement (PPA). On the other hand, a government may be incentivizing the project. Either way, there needs to be more financial support for DAC projects. However, the US has sped up with the Inflation Reduction Act.

Cement companies can implement carbon capture and storage (CCS) solutions to manage their emissions and persuade customers that it is worth buying from them, even though cheaper cement is elsewhere. The willingness of people to pay is crucial.

Buyers of nature-based carbon credits

Josh Shaeffer:

AgFunder said less than 1% of carbon credits came from agriculture in 2021. Farmers need financial flow through the voluntary carbon market. Some engagement from 2500 companies has made science-based targets, making up the lion's share of investment at present, including directly supporting some projects. They do a lot of due diligence to ensure projects are legitimate.

There is an investment from companies on a higher price point, such as Microsoft at $20 per tonne, not counting their DAC work which is closer to $200 per tonne. Tech and energy companies are some of the most substantial in backing this. Those energy companies are supporting the transition of farming to more regenerative methods.

Unfortunately, carbon credits become attractive to farmers when they get up to over $30 per tonne. They are around $20 per tonne. We need more people to come into this space, purchasing credits to improve an acre at a time.

Less than 3% of land in the US is enrolled in any type of carbon program, despite ample programs available. This is partly because it involves changing practices, including acquiring appropriate and expensive machinery and tools. Unfortunately, this can also affect the farmer's crop insurance, making it even more difficult for farmers to change.

Negative discount rates

Robert Hoglund:

If you have a calculation that does not consider that harm increases with increasing temperatures, you could make a case for using a negative discount rate, at least for the first 100 years or so. However, when the social cost of carbon is set, it is common to use different discount rates for additional periods, so higher discount rates are used for the short term—the social cost of carbon increases as temperature increases.

Climate economists have put considerable effort into developing the logic behind discount rates. It makes sense to apply some discount to the future, at least in the long term, as humanity could become extinct for some other reason. The complexity is in deciding how the discount rate should be set, whether it should be based on the return of capital, time preference, or certainty.

Products that support soil carbon

Josh Shaeffer:

There are grasses and woody plants that can be used to store carbon in building structures. They can be grown regeneratively, improving soils. There needs to be more timber in the Southeast of the US, so there is an opportunity for well-managed timber.

Some grasses are beneficial for remediating soils with too much arsenic or mercury, bringing them back to productivity. This is particularly useful on mining sites and other industrial sites.

The "permanence" of biochar

Robert Hoglund:

Biochar is wood waste heated up to around 600 degrees to create a stable form of carbon. It can then be stored in concrete and then classed as permanent. If kept in soil, there is scientific uncertainty, with some data showing that it degrades slowly, releasing carbon at a rate of about 20% in 100 years under average conditions if it is high-quality biochar and 50% after 500 years. So, it is still a medium-long-term solution. Some claims have been that this is underselling biochar, though further study is required to improve confidence. Biochar has co-benefits, including increased water retention. It is important to consider where the biomass used in the biochar came from and whether there might have been a better use for it. It may be considered relatively permanent, though to account for degradation, entities can purchase 1.5 tonnes of carbon for each 1 tonne they wish to offset permanently.

Carbon storage past peak temperatures

Robert Hoglund:

Storing carbon past peak temperatures means that we have at least avoided that carbon contributing to the period of maximum harm. It also reduces the peak temperature and the risk of incurring feedback loops or trigger points. There are various estimates for peak temperature, but the hope is that it will happen around 2050. However, many projections place it more like 100 years from now.
Suppose only a temporary carbon reduction is being implemented. In that case, waiting to achieve the benefit when the temperature is warmer is best, and therefore more harm is avoided. The aim of investing immediately is not to purchase expensive tonnes of CO2 at the moment but bring forward solutions that will have an impact later on.
It is complicated because there are many dynamic possibilities, and avoided emissions credits would be a great option if they worked. Unfortunately, however, that mechanism is broken.

Short and long-term carbon storage in parallel

Josh Shaeffer:

Companies need to invest in immediate and short-term carbon solutions, such as protecting the forest, and a longer-term project that needs to be activated as soon as possible, such as DAC technologies. But unfortunately, companies operate with a quarterly mindset.

Robert Hoglund:

Any requirements now that all companies have to offset their carbon footprint would be harmful, leading to a race to the bottom, prioritizing cheap credits with very low impact. Therefore, we should not require companies to be carbon neutral yet, though this would be good when carbon removal is more available, and companies have more time to reduce their emissions.
Emissions should be offset like-for-like, and while it may be acceptable to offset emissions due to deforestation using temporary credits, the burning of fossil fuels must be offset with permanent carbon storage or temporary storage, which is then replaced. Again, a long view of cost must be considered, focusing on the longer-term impact.

Thank you for reading.