From: Will Clayton
Sent: Thursday, June 15, 2023 12:50 PM
To: Supervisory-Body@unfccc.int
Subject: Structured Public Consultation - Removal Activities

Dear Supervisory Body,

We submit this feedback in response to the public consultation regarding removal activities under the Article 6.4 mechanism: A6.4-SB005-A02. Prior to answering the specific questions, we would like to summarily express our view:

Summarily expressed viewpoint:

- Our view is that the questions posed for public consultation[1] were previously and superbly answered by the Supervisory Body in its prior information note through the proposal of tonne-year accounting[2]. We are disappointed that the Supervisory Body declined further pursuit of tonne-year accounting in its 5th meeting and request that the Supervisory Body reconsider the inclusion of tonne-year accounting to answer the very questions posed for public consultation.
- Of the 104 responses received to the prior information note, only 18 commented on tonne-year accounting. It is immediately apparent to us that the "silent majority" consenting to tonne-year accounting through its omission of commentary has been ignored in favor of the "vocal minority" submitting criticism at the behest of its own interests – namely, lobbying for high-cost engineered solutions that will take a decade or more to ramp up. These corporations, startups, and trade groups currently benefit from ambiguity in how the permanence of those credits should be valued. Tonne-year accounting provides a rigorous and quantitative framework for valuing the duration of carbon storage, and its adoption would undermine their perceived value proposition by effectively demonstrating how nature-based solutions, with proper accounting, can provide the same durability/permanence value as DACCS credits at lower cost.
- Lastly, we would like to submit for consideration *A Better Yardstick for Carbon Markets* (attached), a white-paper specifically addressing the shortfalls of our current tonne-tonne accounting system, the solutions provided by tonne-year accounting, and answers to its common criticisms. Though this white paper was published in October 2022, you will find the conclusions are the same as those of the Supervisory Body in its previously published information note[2]. This is no coincidence. This is convergent thinking – the process through which better ideas can replace the overly simplistic ideas that are currently inhibiting the growth of carbon markets.
- Of note:
    - Sky Harvest would advocate that the Supervisory Body adopt a time horizon of infinity (or the effective mathematical equivalent of one million years), in lieu of the 100-year or 200-300-year time horizon. Because of the adoption of a discount rate, there is no need to arbitrarily limit the time horizon considered (see our calculator).
    - While Sky Harvest advocates the use of a higher discount rate, we acknowledge the normative nature of this selection, and think the Supervisory Body has proposed a reasonable approach to narrowing in on what appears to be a 2.0% discount rate. More importantly, the only discount rate that we know to be wrong – 0.0% – is the very discount rate assumed by the status quo: tonne-tonne accounting.
    - We acknowledge that tonne-tonne accounting is the status quo of carbon markets today, and think the Supervisory Body's proposal to allow *both* tonne-tonne accounting and tonne-year accounting simultaneously is an important interim step

in transitioning towards a market that can employ tonne-year accounting universally in the future.

Responses to specific questions:

- 2.1 | No comment
- 2.2 | No comment
- 2.3(a) | Consistent with *ex-post* tonne-year accounting, the "monitoring period" should span the time horizon of all sequential crediting periods for any specific project and is the time period over which the project is monitored. The monitoring period should end with the end of the final crediting period, after which no further credits will be generated. If a project is renewed or extended, such action would add additional crediting periods and extend the project's monitoring period.
- 2.3(b) | Consistent with *ex-post* tonne-year accounting, the "crediting period" represents any period for which the carbon benefit is quantified, and credits are issued. A carbon project may have multiple subsequent crediting periods. For example, the first crediting period represents Years 1-10, the second Years 11-15, the third years 16-25, and the fourth Years 26-30 for a 30-year project. Credits would be issued after Year 10, 15, 25, and 30. The monitoring period would be Years 1-30.
- 2.3(c) | Consistent with *ex-post* tonne-year accounting, reversals do not need to be addressed and therefore no timeframe for addressing them is needed. Note: Reversals do not need to be addressed because there is no dependence on future storage of carbon like that of tonne-tonne accounting; the credits issued are for climate benefits that have already occurred.[3]
- 2.A | "Removals" should include all approaches to removing greenhouse gases from the atmosphere, including engineered solutions (e.g., DACCS, enhanced weathering) and nature-based solutions (e.g., IFM, afforestation, ocean-based methods).
- 2.B.1 | Using *ex-post* tonne-year accounting, there is no risk of reversal[3]. That said, the maximum timeframe *between* monitoring should be the shorter of the crediting period and 10-years. This will ensure that there are not large fluctuations in carbon stocks which may not be measured if the maximum period between monitoring is greater than 10 years. There should be no minimum timeframe for monitoring, which may in the future unlock *continuous* monitoring as technology advances.
- 2.B.2 | No comment
- 2.C.1 | We advocate minimum project activity periods as a necessary companion to tonne-year accounting for reasons of additionality. It is our current view that minimum activity periods are activity-specific and should be determined accordingly in the respective methodologies. For the activity with which we are most familiar, Improved Forestry Management, the minimum activity period should be five years. Five years is conservatively longer than the lead time for procuring logging services, ensuring that the deferral extends beyond a landowner's known intent to harvest, which better demonstrates additionality. This is confirmed by feedback in a Verra public consultation which advocated a minimum five-year project activity period for the same reason.
- 2.C.2 | Simplistically, removals should include the storage of any greenhouse gas that was previously in the atmosphere (including that stored in the biosphere) and reductions should include the avoidance of emissions from the geosphere into the atmosphere.
    - This definition of removals would include various types of credits sold as removals, like biochar and BECCS, that are in fact *avoiding emissions* of carbon previously sequestered from the atmosphere.
    - We acknowledge this definition is a simplistic framework for the current carbon market. In the future, we think a better framework would monitor the *flow of carbon* in and out of the atmosphere, which appropriately side-steps the imprecision

of the false removal-reduction dichotomy. However, current carbon markets are not prepared to adopt such a framework in the near term.

- 2.D | Assuming the option of *ex-post* tonne-year accounting, the crediting period should have a minimum of one year and a maximum of 10 years, in between which it is at the discretion of the project proponent. This minimum – which must be subject to the minimum project activity period (see response to 2.C.1) – ensures that the project is measuring over a reasonable time horizon. The maximum crediting period ensures consistency with the maximum timeframe between monitoring for the same reasons (see response to 2.B.1)
- 2.E.1-6 | The need to address reversals is eliminated when using *ex-post* tonne-year accounting.[3] This is a primary benefit of tonne-year accounting. Other methods for addressing reversals have proven their inadequacy. Moreover, future sources of reversals (e.g., geological leakage) are unknown and therefore impractical to address through such mechanisms as buffer-pools or insurance.
- 2.F | No comment
- 2.G | No comment

About Sky Harvest

Sky Harvest is an independent carbon project developer seeking to solve integrity issues in the carbon market, through the development of new methodologies that solve legacy issues undermining the credibility of carbon markets and inhibiting their growth.

Thank you for the invitation to provide input, and thank you for your thoughtful consideration and due process with which you have approached this important decision.

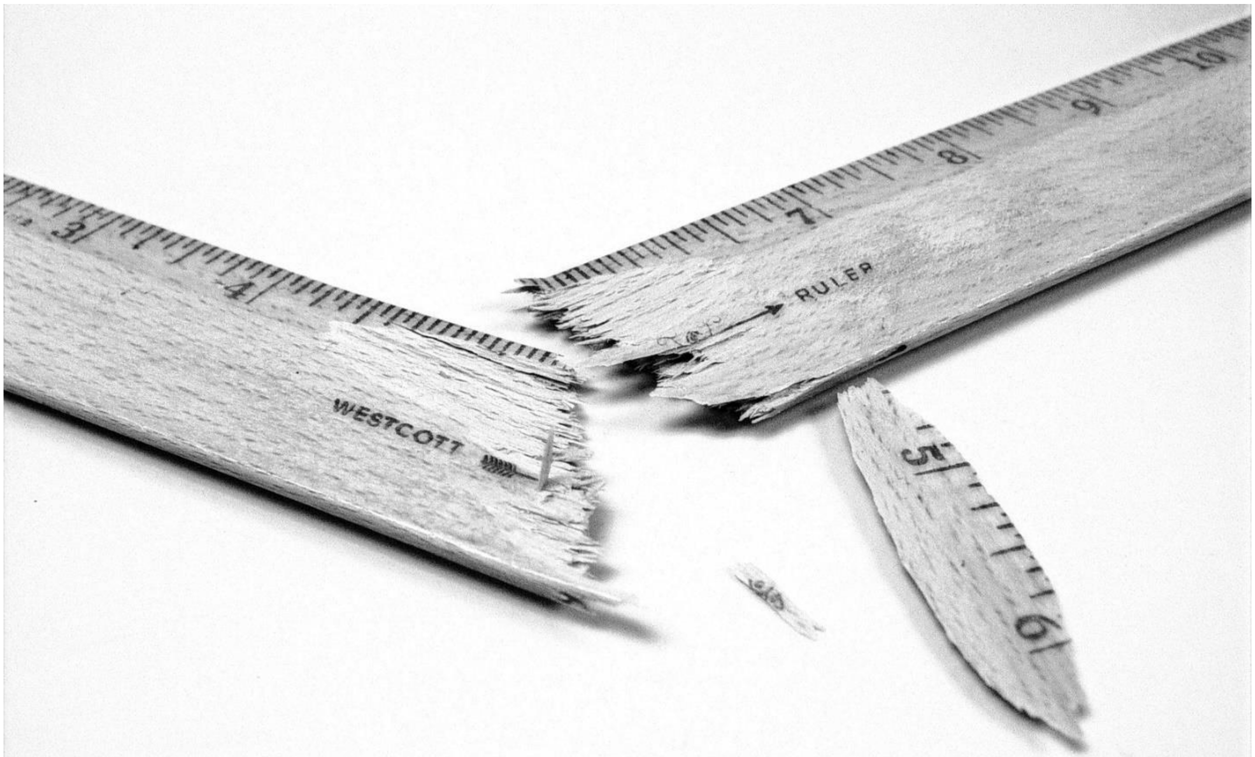
Best regards,

William M. Clayton

Will Clayton
CEO, Sky Harvest

Carbon 2.0 | A Better Yardstick for Carbon Markets

Today's carbon markets use a broken yardstick to measure the impact of carbon credits, and it's inhibiting our progress against climate change. We propose a better yardstick that promises a specific, uniform, and consistent measure of impact across all carbon projects.



October 2022

Our broken yardstick

Buyer beware

Buyer beware: we're using a broken yardstick to measure the impact of carbon credits. Buyers have no assurance about a carbon credit bought today – it could represent one tonne of carbon dioxide stored out of the atmosphere for 20 years, 100 years or 10,000 years, and there's no guarantee of when the impact occurs, which in some cases can be more than a decade into the future or a decade ago.

This puts an onerous burden on buyers to tread carefully or pay-up for advisors to navigate the shifting and nuanced carbon markets. Climate pioneers like Microsoft, Stripe, etc. can bear the burden, but the average company cannot. Either way, the lack of standardization causes higher transaction costs, increased confusion, greater market manipulation, lower credibility, lower volumes of purchased credits, and ultimately less progress against climate change.

In short, we're using a broken yard stick, and it's creating a credibility gap that is limiting the growth of carbon markets.

But there's a better yardstick – we call it Carbon 2.0 – and it's ready to adopt today. It won't standardize all project-related issues such as additionality and leakage, but it will standardize the purported impact of the project and solve permanence at the same time.

Carbon credits aren't the commodity you thought

Carbon credits were designed to be a commodity – indifferentiable, of equal value, and thus fluidly marketable.[1] A true commodity would allow market forces to most efficiently allocate capital to projects, and most efficiently combat climate change.

However, carbon credits are no commodity today. Their values vary based on differentiable attributes like geography, technology, duration, and volume. We've identified 18 attributes in Figure 1 below.

Figure 1 – A carbon credit's value is the product of 18 distinct attributes

18 attributes

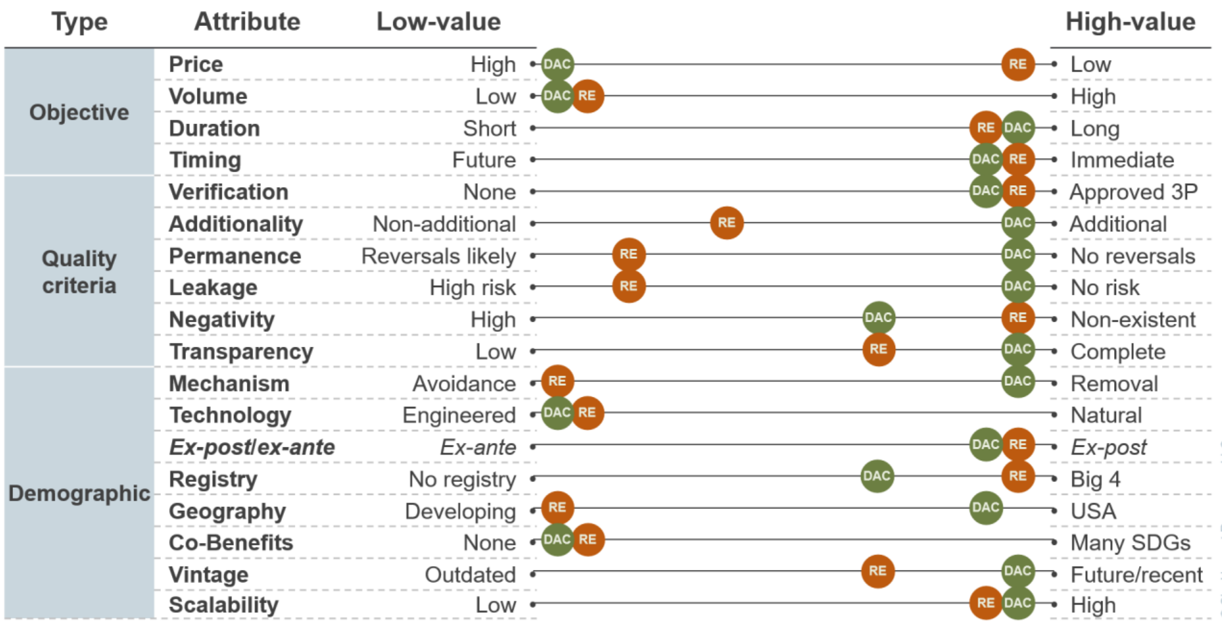
Type	Attribute	Description	Applicability
Objective	Price	• Price of the carbon credit	Market-level
	Volume	• The volume of carbon kept out of the atmosphere ("Yardstick attributes")	
	Duration	• The length of time that carbon remains out of the atmosphere ("Yardstick attributes")	
	Timing	• The time period over which the benefit is realized ("Yardstick attributes")	
Quality criteria	Verification	• Whether the credit is certified by a 3rd-party auditor	Methodology-level and/or project-level
	Additionality	• Likelihood that benefit would occur absent the financial incentive of the credit	
	Permanence	• Risk of reversal, such as the unintended release of carbon back into the atmosphere	
	Leakage	• Likelihood of substitutionary, negating impacts (e.g., emissions elsewhere)	
	Negativity	• Negative externalities of the credit (e.g., operational emissions, enabled emissions)	
	Transparency	• The extent to which the developer's project design and calculation are understandable	
Demographic	Mechanism	• Whether the credit removes existing CO_2 or avoids would-have-been CO_2 emissions	
	Technology	• Whether the credit is a nature-based technology or an engineered solution	
	Ex-post/ex-ante	• Credits can be issued based on value delivered or anticipated forecasts	
	Registry	• Perceived quality of the registry on which the credit is listed	
	Geography	• Both perceived quality of country's verification and proximity to the buyer	
	Co-Benefits	• Additional benefits beyond carbon (e.g., biodiversity, economic development, etc…)	
	Vintage	• Year in which the credits are issued	
	Scalability	• The degree to which the project can scale to global impact levels	

Not all carbon credits are equal

The 18 attributes identified here create an enormous amount of variability in the impact and quality of each credit. For example, if a buyer is trying to assess the relative value of two credits, like the renewable energy credit and a direct-air-capture credit illustrated below in Figure 2 below, it's nearly impossible. And buyers typically aren't challenged with assessing credit value across just two types of projects; rather they are seeking to build a blended portfolio from dozens of options. Without any standardization, buyers face the impractical task of evaluating the impact of each carbon credit individually. As mentioned above, this results in higher transaction costs for buyers and less climate impact overall.

[1] https://www.weforum.org/agenda/2022/01/nature-more-than-carbon-sink/

Figure 2 – Buyers face the challenge of determining the relative value proposition of credits across so many attributes



If we are to remedy this flaw in carbon markets, we need to think about how to standardize the measurement of carbon. To do so, we must consider these attributes in three groups: one comprised of objective, quantitative attributes (what we've called here "yardstick attributes"), another including quality criteria, and a final group of demographic attributes. We need standardization across *each* of these groups of attributes.

For the demographic attributes, the key is transparency, which must occur on a methodology-level and/or project-level basis, so that buyers can identify what credits they are buying. The group of quality criteria is a tougher challenge – one that we will not attempt to address here. However, existing standards bodies – like Verra, The Gold Standard, The Climate Action Reserve, and The American Carbon Registry – are working constantly to standardize quality. Moreover, a new wave of emerging, tech-focused entities, such as Sylvera, BeZero, and Pachama, seek to reinforce and improve on the standards bodies' efforts. Ultimately, this also requires rigorous standards on the methodology-level and/or project-level, and may eventually merit gradation of carbon credits, rather than today's binary certification model.

For the first group of attributes, however – the yardstick attributes – the answer is much simpler. And we can adopt it across the carbon market today.

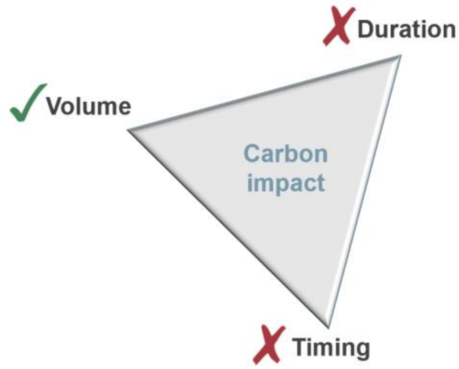
Carbon 2.0: A better yardstick

Measuring volume, duration, and timing

There are three yardstick attributes: volume, duration, and timing.[2] Of the three, our current system accounts for volume well, but not so duration and timing.

[2] Note: we intentionally exclude price; though it is a quantitative attribute of the carbon credit's value, price must remain the dependent variable to enable market forces to operate efficiently.

Figure 3 – Today's standards account for 1 of 3 "yardstick attributes"



Why? Today's standards for carbon credits originate from simpler times when a credit simply meant avoiding an emission of carbon dioxide into the atmosphere.[3] As a swelling number of entrepreneurs and innovators discover new ways to avoid emissions and remove carbon dioxide already in the atmosphere, attributes that were once standard – duration and timing – are now variable. Even so, we will need to account for each attribute to standardize the measurement of impact.

Fortunately, we have the tools to do so: the adoption of *tonne-year accounting*, coupled with *a discount rate representing the social cost of carbon* will effectively measure duration and timing, as well as volume. The marriage of these two mechanisms is what we call "Carbon 2.0." It functions as a Rosetta Stone for carbon projects, translating impact across any duration, any volume, and any time period into a common measure of impact.

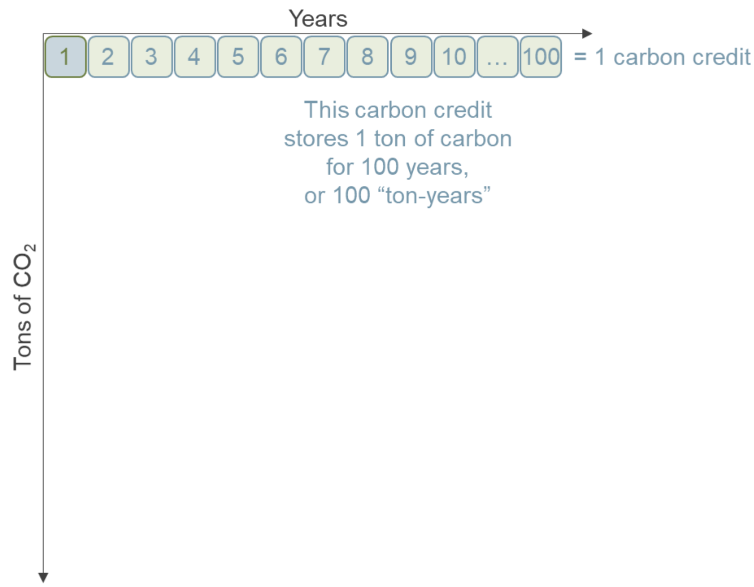
Volume and duration: Tonne-year accounting

The first tool in Carbon 2.0 is tonne-year accounting or "TYA". A tonne-year is a single tonne of carbon dioxide stored for one year. One *tonne* stored for one *year* equals one *tonne-year*.

Any project – every project – can be measured using tonne-year accounting because every project has both volume and duration attributes, whether both attributes were measured historically or not. For example, a typical forestry credit that stores one tonne of carbon dioxide in a forest for 100 years is creating a carbon credit made up of 100 tonne-years (See Figure 4 below). In this example, the "equivalency ratio" is 100 tonne-years per carbon credit.

[3] Sarofim, M. C. and Giordano, M. R.: A quantitative approach to evaluating the GWP timescale through implicit discount rates, Earth Syst. Dynam., 9, 1013–1024, 2018.

Figure 4 - Illustration of a typical forestry credit

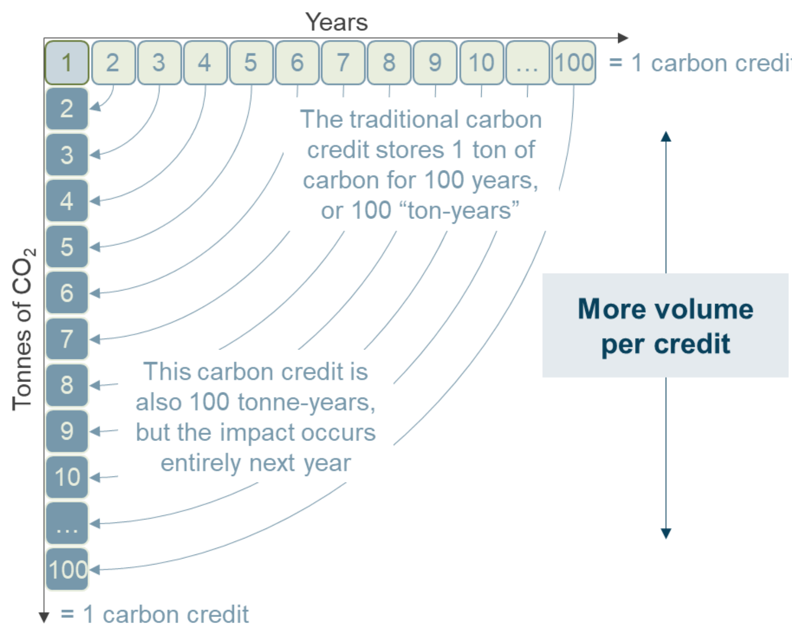


Another project under a different methodology certified by a different standards body may store one tonne of carbon dioxide for 40 or 20 years. Because these projects are, in fact, credited, those credits are worth 40 tonne-years and 20 tonne-years, respectively.

Herein lies the problem: not all carbon credit standards or protocols enforce the same equivalency ratios across credits. In fact, most neglect the concept of equivalency ratios entirely, incentivizing project developers to create low-impact credits with the shortest contract length possible. With varying equivalency ratios or no equivalency ratios at all, the quality of carbon credits varies widely and trends downward.

Tonne-year accounting (TYA) uniquely and elegantly standardizes this impact by trading off duration with volume. That is, one can use TYA to create high-quality equivalencies of projects with shorter durations by compensating with increases in volume. For example, a project that stores carbon dioxide for one year would require 100 tonnes of carbon dioxide to maintain the equivalency ratio equal to 100 tonne-years per credit (see Figure 5).

Figure 5 – Illustration of 100 tonne-years in a different carbon credit

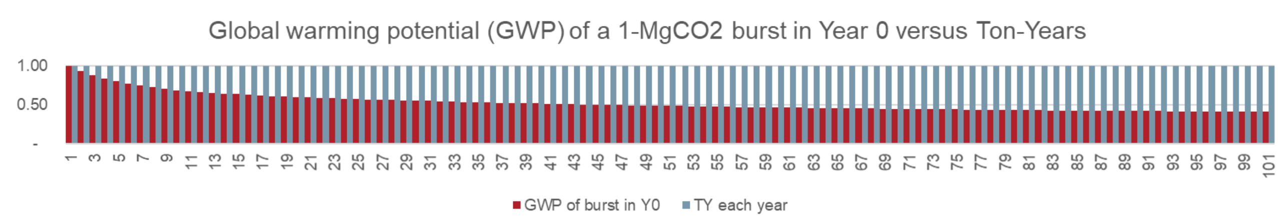


Alternatively, you could have credits representing 10-year durations and 10 metric tonnes or 5-year durations and 20 metric tonnes. Four quarters, 10 dimes, 20 nickels – it's all a dollar. The point is that TYA creates the flexibility to trade off duration and volume in such a way that standardizes the climate impact per credit, regardless of project duration.

The effect on atmospheric temperatures

We wish it were as easy as that: simple algebra to equate a project's impact across volume and duration. However, we must also consider the influence of the carbon dioxide stored out of the atmosphere on temperature rise. This is complicated by the fact that carbon dioxide's warming effect on atmospheric temperatures, a concept called "global warming potential", diminishes over time (see Figure 6).

Figure 6 - Illustration of carbon dioxide's diminishing effect on temperature over time



Fear not, however. For this effect has been duly modeled[4] (see Figure 7) and can be accounted for across time with a simple calculator, such as the one included in Appendix A: Carbon 2.0 Calculator.

[4] Joos, Fortunat & Roth, R. & Fuglestvedt, J. & Peters, G. & Enting, I. & Von Bloh, Werner & Brovkin, V. & Burke, Eleanor & Eby, M. & Edwards, Neil & Friedrich, Tobias & Frölicher, Thomas & Halloran, Paul & Holden, Philip & Jones, Chris & Kleinen, Thomas & Mackenzie, F. & Matsumoto, K. & Meinshausen, Malte & Weaver, Andrew. (2013). Carbon dioxide and climate impulse response functions for the computation of greenhouse gas metrics: A multi-model analysis. ATMOSPHERIC CHEMISTRY AND PHYSICS. 13. 10.5194/acpd-12-19799-2012.

Figure 7 - Global Warming Potential of carbon dioxide over time

$$GWP_t = \frac{21.73 + 22.4e^{-\frac{t}{394.4}} + 28.24e^{-\frac{t}{36.54}} + 27.63e^{-\frac{t}{4.304}}}{100}, where\ t\ is\ the\ year$$

For more details on tonne-year accounting, CarbonPlan.org has published a very effective *Ton-Year Explainer.*[5]

The importance of timing
With volume and duration accounted for, we're left with timing. And timing matters.

Timing matters for two reasons. First, as just mentioned, the global warming potential of carbon dioxide in the atmosphere diminishes over time. Second, the societal costs of doing nothing increase over time, which is why climate change is an urgent issue.

The IPCC estimates we have until 2050 to reach net zero to limit Earth's average temperature increase to 1.5-2.0^{0} Celsius above pre-industrial levels. With any further increase, we hit a tipping point of accelerated temperature rise. 2050 is 28 years away. We've got a countdown clock, and the next decade is 35% of the time left before the buzzer sounds.

Time-value of carbon
The concept of valuing when climate impact occurs is called the "time-value of carbon"[6] and parallels the time-value of money. Simply illustrated, would you prefer $100 today or $100 in 10 years? You'd like it today because it's worth more in your pocket where you can use it. What about $100 today versus $105 in ten years? That's tougher, but you may still prefer $100 today. At some number though, say $1,000, you'd clearly prefer the money in 10 years, because that represents a growth rate above 25% compounded every year for those 10 years.

The same is true with carbon. Carbon impact in the near-term is more valuable than carbon impact created over the long term – all else equal – because it gives us greater optionality and more time to innovate new climate solutions.

The problem with ignoring the time-value of carbon
Because timing matters, we need to measure it, and today's carbon crediting systems do not.

The closest mechanism for time-value of carbon today is the 100-year global warming potential standard, adopted by Verra and others.[7] However, there are three primary issues with this approach.

The first issue is the 100-year standard is arbitrary. Its origin dates to the 1990s when the IPCC proposed three scenarios by which to consider the impact of carbon dioxide emissions: 20-year, 100-year, and 500-year scenarios.[8] This arbitrariness creates arbitrary incentives for carbon project developers. For example, many forestry projects are required to contract with landowners for a period of 100-years, an

[5] https://carbonplan.org/research/ton-year-explainer
[6] Generation Capital, "Time Value of Carbon"
[7] https://verra.org/wp-content/uploads/2022/04/Tonne-year-additional-background-2022.04.01.pdf
[8] Sarofim, M. C. and Giordano, M. R.: A quantitative approach to evaluating the GWP timescale through implicit discount rates, Earth Syst. Dynam., 9, 1013–1024, 2018.

unrealistic time horizon for most timberland owners, who are not willing to shackle their property or descendants with liabilities over the next century. This barrier to participation excludes willing participants in carbon markets and fails to unlock new sources of climate action.

A second issue with the 100-year standard is its binary cutoff. It essentially overvalues the benefit for the project during the first 100 years (using a 0% discount rate) and then devalues the benefit thereafter (100% discount rate). This implies that Year 99 is infinitely more valuable than Year 101. The binary cutoff oversimplifies the nature of carbon impact and lacks the capacity to measure it in a more nuanced, accurate manner.

A third issue is that not all carbon projects fit the 100-year convention, and increasingly innovative projects – like soil carbon – defy it entirely. In the absence of an effective mechanism to value timing, project developers have no incentive to create projects with badly needed near-term impacts.

For example, a project that can deliver the same physical impact in a shorter time period (let's say five tonnes of carbon dioxide for 20 years compared to a project with one tonne for 100 years) is not valued any more in today's systems of measurement, despite delivering the impact entirely before the IPCC's buzzer sounds in 2050.

In another less obvious example, a direct-air-capture credit, which stores carbon dioxide for 10,000 years, can claim to be 100x more impactful than a traditional credit worth 100 tonne-years. However, this fails to account for the value of near-term impacts over long-term impacts. In this case, 99.7% of that credit's benefit occurs after the buzzer sounds in 2050. There is certainly considerable value to that tail of benefit, but the value of each year is less beneficial the further the impact is into the future. And if you think 10,000 years is long, some projects claim infinite durations!

In short, we need standards that not only account for volume and duration, but also accurately reflect the value of timing.

The timing solution: A discount rate representing the social cost of carbon

There is broad support that a more accurate mechanism to account for the time-value of carbon is a *discount rate* applied consistently across each year throughout the effective lifetime of the project. [9,10]

This mechanism is the same used by our most sophisticated financial systems to determine the time-value of money. That is because it accurately reflects the *continuous*, rather than *binary*, nature of time. In short, it's a proven, tested mechanism.

The largest barrier to adopting this solution is a lack of consensus on the appropriate discount rate. It is, in essence, a question of the value of urgency. A discount rate set too high risks incentivizing urgency too strongly at the expense of long-term benefits. A discount rate set too low risks the opposite: a weak signal for urgency and bias for long-term impacts at the expense of near-term impacts.

What's the right discount rate?

But should it be 1% or 5% or 50%?

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[9] Wigley et al., 1998; Shine et al., 2005; Allen et al., 2016; Edwards et al., 2016

[10] Schmalensee, Richard. 1993. "Symposium on Global Climate Change." *Journal of Economic Perspectives*, 7 (4): 3-10.

There's no perfect answer, *per se*, as this is a measure of the urgency of climate change which is yet unknown – and hopefully will remain so! However, we can rule out wrong answers and triangulate close to the right answer.

To eliminate wrong answers on the low side: we know 0% is too low because we know climate change is urgent. If it were 0%, we'd solve climate change in 10,000 years or never, but certainly not today. We can also assume that rates near 0 are too low, and so set a floor at 0.5% or so.

On the high end, we can assume that discount rates used in corporate finance – typically ranging from 6-12% – are too high, because they are typically used for investments over a shorter time horizon, while organizations like utilities using rates on the lower side of the range for long term infrastructure projects that might span 30 or 50 years.

So now we can conclude the rate should be somewhere between 0.5% and 6%. Within that range, we can triangulate from other sources. The mathematical equivalent of the binary 100-year global warming potential is a 3.3% discount rate. [11,12] And the social cost of carbon was calculated by the US Government as 3.0% annually, which is to say that the environmental and societal cost of waiting increases 3% every year if no action is taken. [13]

Thus, we find two sources near the midpoint of the 0.5-6% range at 3.0% and 3.3%. Between the two, we recommend the 3.0% discount rate to reflect the environmental and societal cost of rising temperatures.

More importantly, we recommend the adoption of *any* discount rate over the confusion and inefficiency of not accounting for the time-value of carbon. Then, we can collectively refine and tweak this number as needed to reflect the latest research and knowledge.

Re-defining a carbon credit

Finally, we need a new definition of a carbon credit. If the idea is to propose a definition that equates to the permanent (i.e., infinite) reduction of one metric tonne of carbon dioxide, then, mathematically speaking, there is no amount of volume that will ever compensate using a duration shorter than infinity. So, instead we propose a new, pragmatic definition:

> A carbon credit is a permit or certificate to emit greenhouse gases equivalent to the global warming potential of one metric tonne of carbon dioxide and is generated by delivering the equivalent global warming potential of one metric tonne of carbon dioxide released into the atmosphere indefinitely, *rounded to one-thousandth of a tonne*.

This definition has three primary benefits. First, it is specific and thus eliminates the fungible ambiguity of the conventional definition that is so often manipulated by developers and buyers alike. Second, it is

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[11] Mallapragada, D.S., Mignone, B.K. A theoretical basis for the equivalence between physical and economic climate metrics and implications for the choice of Global Warming Potential time horizon. *Climatic Change* **158,** 107–124 (2020).

[12] Sarofim, M. C. and Giordano, M. R.: A quantitative approach to evaluating the GWP timescale through implicit discount rates, Earth Syst. Dynam., 9, 1013–1024

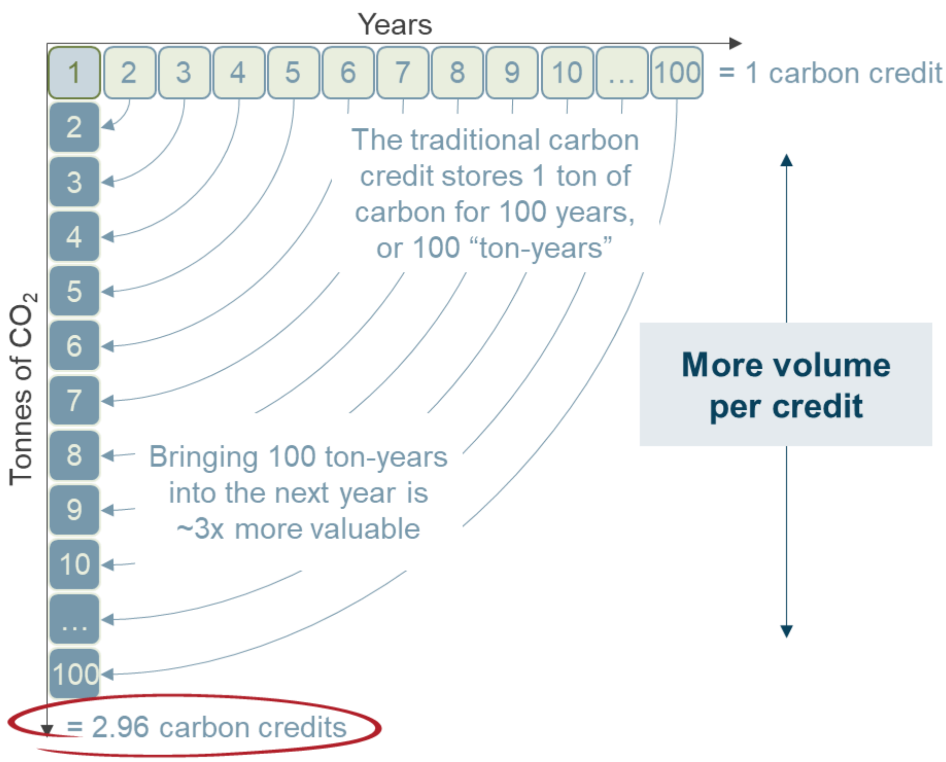
[13] IWG Social Cost of GHG

universally applicable, broad enough to encapsulate projects of any volume, any duration, and any time period. And lastly, it is inclusive of existing carbon credits that truly offset the emissions of a tonne of carbon dioxide.

Bringing it all together

Let's bring it together by reconsidering two projects, both 100 tonne-years, where one was spread out over the next century (horizontal row of tonne-years) and the other occurred entirely next year (vertical column of tonne-years). We determined the second project was more valuable because the impact occurred in the near-term, however, we didn't have a way to assess that value. Now we do, using a discount rate representing the time-value of carbon. Instead of generating one credit from the 100 tonne-years next year, a project would generate 2.96 credits, as shown below in Figure 8. This can be calculated using a simple calculator, such as the one in Appendix A: Carbon 2.0 Calculator.

Figure 8



When we marry these two mechanisms – (1) tonne-year accounting and (2) a discount rate representing the time-value of carbon – we can equate the impact of any project, of any volume, for any duration, across any time period. This is Carbon 2.0.

Benefits of Carbon 2.0

Carbon 2.0 is available today

Carbon 2.0 is ready to adopt today. The tools exist, and they are free. No technological development or research is required. Buyers, like Piva Capital[14], have already begun adopting Carbon 2.0, but widescale adoption and market efficiency will hinge on adoption by our standards bodies, not individual buyers.

Carbon 2.0 is universally applicable

This new yardstick is universally applicable across all types of carbon projects. It is not specific to direct air capture or blue carbon kelp projects or terrestrial nature-based solutions. It is universally applicable because TYA and discounting both measure the impact of storing carbon dioxide with greater granularity – TYA by accounting for impact at the more granular tonne-year level and discounting by considering the urgency of climate change on a continuous, rather than discreet timeline.

The best way to demonstrate the new yardstick is to measure existing carbon credits. Figure 9 contains several examples. We have also built a simple excel calculator included in Appendix A: Carbon 2.0 Calculator that can be used to apply the same yardstick to *any* project.

Figure 9 – Example of Carbon 2.0 equivalencies across various types of credits

Credit	Volume (MgCO2e)	Duration (Years)	Timing	Today's standard		Carbon 2.0 (TYA+D)	
				Credits	Price	Credits	Price
Emission reduction	100	∞	Starts today	100	$5	100	$5
Direct-air-capture	100	10,000	Starts today	100	$600	100	$600
CARB Forestry	100	100	Starts today	100	$15	95	$16
Afforestation	100	100	Starts in 15yrs	100	$22	92	$24
FFCP by AFF	100	20	Starts today	100	$20	45	$44
Soil carbon	100	10	Starts today	100	$30	26	$115
Short-term deferred harvest	100	1	Next year	N/A	N/A	3	

Effect is pronounced on projects with shorter durations and near-term impacts

Note: Assumes a 3.0% discount rate which represents the midpoint social cost of carbon studied by the IWG; Assumes a carbon credit definition equivalent to the storage of 1 Mg of CO2e infinitely; Assumes a 100,000-year time horizon, effectively equivalent to infinity; Assumes the Lashof model of temporary carbon storage and then re-release; Assumes today's pricing based on general market feedback, subject to change

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Carbon 2.0 reports *ex-post* impact

Ex-post credits are carbon credits that are issued *after* monitoring and verification has occurred. For many types of carbon credits, ex-post reporting would require issuing the credit *after* the 100-year contract period, which would of course make the project unattractive to a project developer. When coupled with Carbon 2.0, however, carbon projects can issue credits as often as they perform measurement and verification based on the number of tonne-years delivered *ex-post* since the last measurement. That is a win for buyers who want irreversible, delivered impact and for suppliers who need near-term cash flow to finance projects.

[14] https://medium.com/piva-insights/carbon-neutral-in-2021-grappling-with-permanence-51f91e25d9

Carbon 2.0 eliminates risk of reversal (non-permanence)

Carbon 2.0 eliminates the risk of reversal present with many nature-based solutions today. Consider a traditional forestry project that protects a forest for 100-years issuing credits upfront, *ex-ante*. There is a risk that wildfire, pestilence, flooding, or a hurricane could reverse the impact of the carbon credit, after the credit has been issued and sold. Today, this risk is managed by "buffer pools" of credits set aside for such instances. These pools effectively act as an insurance policy for carbon reversals. And unfortunately, it appears they have been greatly underestimated.[15]

With Carbon 2.0, no buffer pools are needed because the credits issued represent only the carbon dioxide that was not in the atmosphere *prior* to issuance. If a wildfire burns the forest, no further credits will be issued, of course, but any credits previously issued remain valid.

Without risk of reversal, on-going monitoring responsibilities after the crediting period are no longer necessary. This eliminates substantial cost and an issue that registries have historically struggled to tackle.

Carbon 2.0 increases access and inclusion to carbon markets

Access and inclusion strengthen the fabric of communities anywhere. And nowhere is that truer than in the global community and its enormous effort to stop rising temperatures. We need all hands-on deck. All hands.

Carbon 2.0 enables a greater variety of projects and a decentralization of projects – think crowdsourcing and grassroots campaigns versus institutional capital and K-Street lobbying firms.

Project size is one barrier to participation. For example, one million landowners with 20 acres can have the same impact as ten landowners with two million acres if we create the right access to carbon incentives. What's more: it's not exclusive, so we get 40 million acres at work to reverse global warming.

Another barrier is project duration. Landowners that are not willing to commit to longer project durations are willing to commit for shorter durations. If we could create access for them to do so, they still contribute to the reduction of atmospheric carbon dioxide without shackling their great-grandchildren with legal liabilities.

Tonne-year accounting creates access for large and small landowners, long-term and short-term projects to participate in carbon markets. If the need is to open access to all channels for contribution – and it is – then Carbon 2.0 again furthers the cause of climate.

Conclusion: A call for Carbon 2.0

Carbon 2.0 is a powerful marriage of mechanisms – a Rosetta Stone – that unlocks the ability to translate climate impact across different types of carbon credits. With it, we can equate the impact of any project, of any volume, for any duration, across any time period.

[15] https://www.ft.com/content/d54d5526-6f56-4c01-8207-7fa7e532fa09

While we must continue improving standards that normalize other attributes of carbon offsets (such as additionality and co-benefits), Carbon 2.0 is a major step towards commoditizing carbon credits, and it is ready to adopt now. By doing so, we remove the onus from consumers to understand each type of carbon credit and facilitate a more efficient, liquid market that will increase our ability to combat rising temperatures.

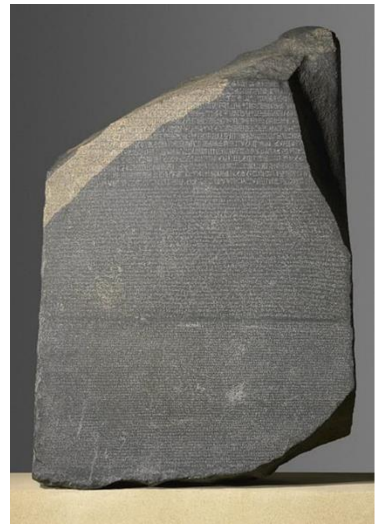


Figure 10 - Tonne-year accounting is the Rosetta Stone of carbon projects

Of the four ICROA-approved standards bodies, The Climate Action Reserve has led the way to Carbon 2.0 by adopting tonne-year accounting across several protocols, though not yet incorporating the time-value of carbon. Verra, the largest such body, recently deferred a decision to adopt tonne-year accounting, pending further stakeholder engagement[16]. We call on all standards bodies to adopt Carbon 2.0.

Specifically, we propose global carbon standards adopt two mechanisms: (1) tonne-year accounting and (2) a uniform discount rate representing the social cost of carbon. Let's replace our broken yardstick with a better one that will increase the effectiveness and scale of carbon markets and give us the best chance of reversing climate change.

Sky Harvest

Sky Harvest is a carbon project developer committed to seeking sensible solutions to climate change.

For Sky Harvest's response to Verra's public consultation on tonne-year accounting, see Perspectives.

[16] Verra Defers Updates to the VCS Program

Appendix A: Carbon 2.0 Calculator

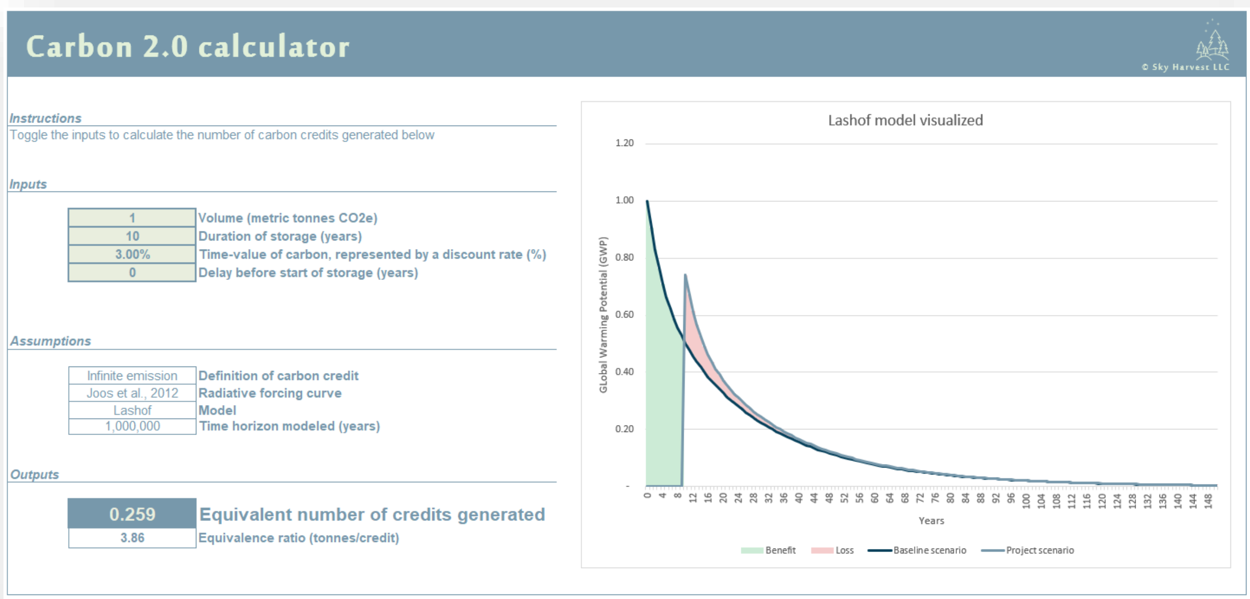
Sky Harvest's Carbon 2.0 calculator provides simple carbon credit equivalencies through an easy-to-use Excel interface.

Simply toggle the variables that describe the carbon project, such as volume, duration, time-value of carbon, etc. Then, the outputs will automatically calculate the number of equivalent carbon credits, including a visualization of the carbon benefit under the Lashof model relative to a baseline scenario.

Get started here: [Carbon 2.0 Calculator](https://skyharvestcarbon.com/equivalencycalculator)

(https://skyharvestcarbon.com/equivalencycalculator)

Note: Sky Harvest recommends a discount rate of 3.0% and a carbon credit definition equal to an infinite emission of a tonne of carbon dioxide. However, these inputs remain variable for those interested in testing alternative scenarios.



Appendix B: Common critiques of Carbon 2.0

Carbon 2.0 can undermine additionality

One critique of Carbon 2.0 is that it enables shorter-term contracts which can undermine additionality. For example, if a landowner only had to defer the harvest of timber for a single day, then he or she could do so at no cost, because the time interval between deciding to harvest timber and the actual harvest is longer than a single day. In that case, if you used Carbon 2.0 to quantify the piecemeal credits generated during that day, it would no longer be additional to the status quo, because the landowner did not change behavior.

While problematic, attributing this to Carbon 2.0 conflates two issues: additionality and the quantification of carbon impact. Additionality and other qualitative standards should be set at the methodology level. In contrast, the "yardstick attributes" – volume, duration, and timing – can be universally used to standardize how we quantify the carbon credits.

In the example above, it is appropriate to have a minimal contract period that should in all cases exceed the time interval between a landowner's decision to harvest timber and the actual harvest. For example, if it takes two months for harvest to occur, the contract period should be significantly and conservatively greater than two months.

Carbon 2.0 is physically inconsistent with the emissions it offsets

Another critique is that Carbon 2.0 accounts for the economic impacts of offsetting carbon dioxide emissions, rather than the physical properties equivalent to emissions, i.e., an equal number of greenhouse gas molecules in the atmosphere.[17] Specifically, this critique relates to the practice of discounting, which is ultimately an economic consideration.

This critique is correct, and ultimately the question of physical equivalency or economic equivalency is subjective. We believe that the environmental and societal cost of rising temperatures (economic) is a more appropriate yardstick than the precise volume of carbon dioxide molecules in the atmosphere (physical) because the costs of climate change exceed the benefits. The social cost of climate change is inherently an economic question, "What cost will society incur as climate changes?" Therefore, the appropriate benefit of an emission's offset should be *economically* equivalent to the cost of the emission.

Carbon 2.0 is designed to create economic equivalency – not physical equivalency – between the cost of one tonne of emitted carbon dioxide and the benefit of a carbon credit, regardless of the credit's volume, duration, or timing.

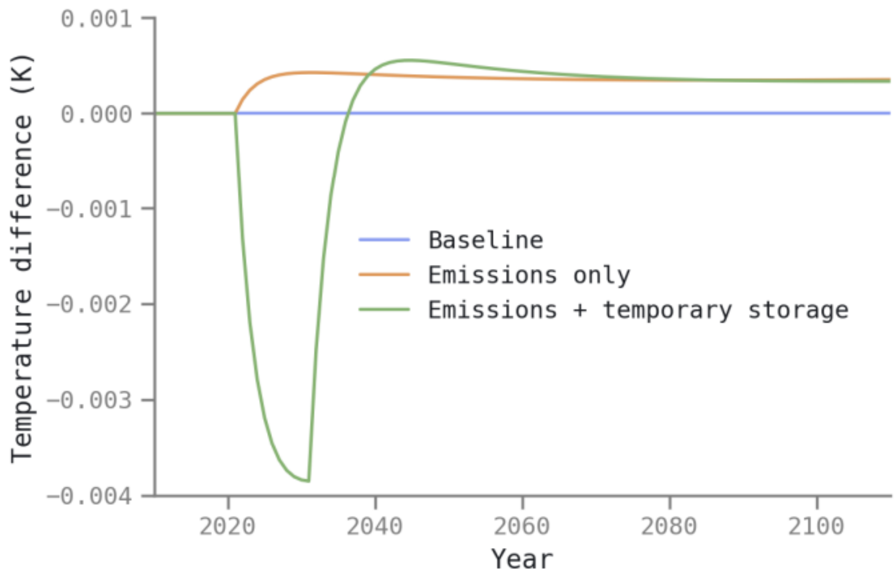
Short-term storage of carbon dioxide causes a spike in temperatures

Another critique is that short-term storage of carbon dioxide in nature-based solutions ultimately results in an increased atmospheric temperature at the end of the storage period. This is true when isolating for a given tonne of carbon dioxide over a single period. It also holds true for projects that store carbon dioxide for 10 years, 50 years, or 150 years. See Figure 11 below, created by CarbonPlan.org[18].

Figure 11: Illustration of short-term storage of carbon dioxide, isolated from broader programmatic impacts

[17] Carbonplan.org, *A Critique of NCX...*

[18] Carbonplan.org, *Verra Ton Year Comment Letter*



Source: carbonplan.org

However, this critique has two flaws. First, a portion of the temperature increase is caused by the incremental release of carbon dioxide that would have remained in the atmosphere without the project. That is because throughout the project, the trees grow and continue to sequester carbon dioxide. It is only released at the delayed harvest date because it was first removed from the atmosphere, where it would have remained, contributing to global warming. This is a benefit of the project, not a cost.

Second, and more importantly, this critique takes a narrow perspective on what would happen to a specific unit of carbon dioxide over a specific time threshold. A broader *programmatic* or *systemic* view, however, would show a net long-term reduction in atmospheric carbon dioxide. Using the example above, one acre of forest may be harvested after ten years, while another is enrolled in the program on a rolling basis to replace it, and another after that, and so on…. The net impact at a programmatic level is a net reduction in atmospheric carbon dioxide for the duration of the *program*, not any specific project.

Short-term storage is less valuable than longer-term solutions

First, we need all solutions, and if short-term storage does not cannibalize long-term storage, then we should welcome it into the tent of solutions to combat climate change.

Second, all carbon credits represent the storage of carbon dioxide, whether the duration of that storage is one year or one hundred thousand years. And all durations have some value, however small, so long as they satisfy the requirements for high quality credits. Thus, the challenge is not to decide which projects do and do not meet arbitrary duration thresholds, but rather to measure the value of carbon dioxide storage appropriately across all thresholds, as Carbon 2.0 does.

Third, the near-term impacts of carbon dioxide storage are more valuable than the long-term impacts of carbon dioxide storage. Delaying the harvest of a forest for just ten years is 35% of the time before the IPCC's target in 2050. That is a critical window in which policymakers, technologists, investors, and entrepreneurs can progress the fight against climate change. In short, ten years of short-term storage today is many times more valuable than the storage during years 990-1,000. So long as the shorter duration is accounted for, as it is in Carbon 2.0, then this impact is incrementally helpful and welcome.

Environmental systems are complex, and there is much we do not know
No counterargument here; this is simply true. However, that is no excuse for not standardizing the impact of carbon credits based on what we do know. With further research, we will undoubtedly learn more about radiative forcing, global temperature rise, and the social cost of climate change. However, in the meantime, we must adopt a framework for measuring climate impact that is standard across projects and time periods.

Radiative forcing may correlate with temperature but cause other problems
Another critique is that Carbon 2.0 is based on the radiative forcing of carbon dioxide in the atmosphere, which directly relates to temperature increase, but may not account for other issues related to increased carbon dioxide in the atmosphere. For example, more carbon dioxide in the atmosphere, even if we control for radiative forcing, may acidify the oceans. These are valid concerns that require more research. Then, we need to appropriately revise our frameworks considering that research. For now, the primary intent of carbon credits is to limit the global rise in temperatures, and it seems that radiative forcing is the best framework through which to assess that.

Complexity of the accounting system
A final critique of Carbon 2.0 is that the math behind it is very complex… radiative forcing curves and Lashof models and what not. True, it is more complicated than today's standards, where one tonne of carbon dioxide equals one carbon credit, regardless of storage duration or delivery timeline. However, Carbon 2.0 measures the true impact of a carbon credit's effect on temperature in a way that offers standardization, greater accuracy, and greater access to carbon markets.

Moreover, the math can be managed at the point of verification using simple, user-friendly tools like the Carbon 2.0 calculator included in Appendix A: Carbon 2.0 Calculator.

Most importantly, this greatly simplifies the entire process for the most critical stakeholder group: buyers. With Carbon 2.0, buyers will no longer need to understand the nuances, variations, and hidden assumptions of carbon markets; rather they will simply buy standardized, commoditized carbon credits.