Sky Harvest

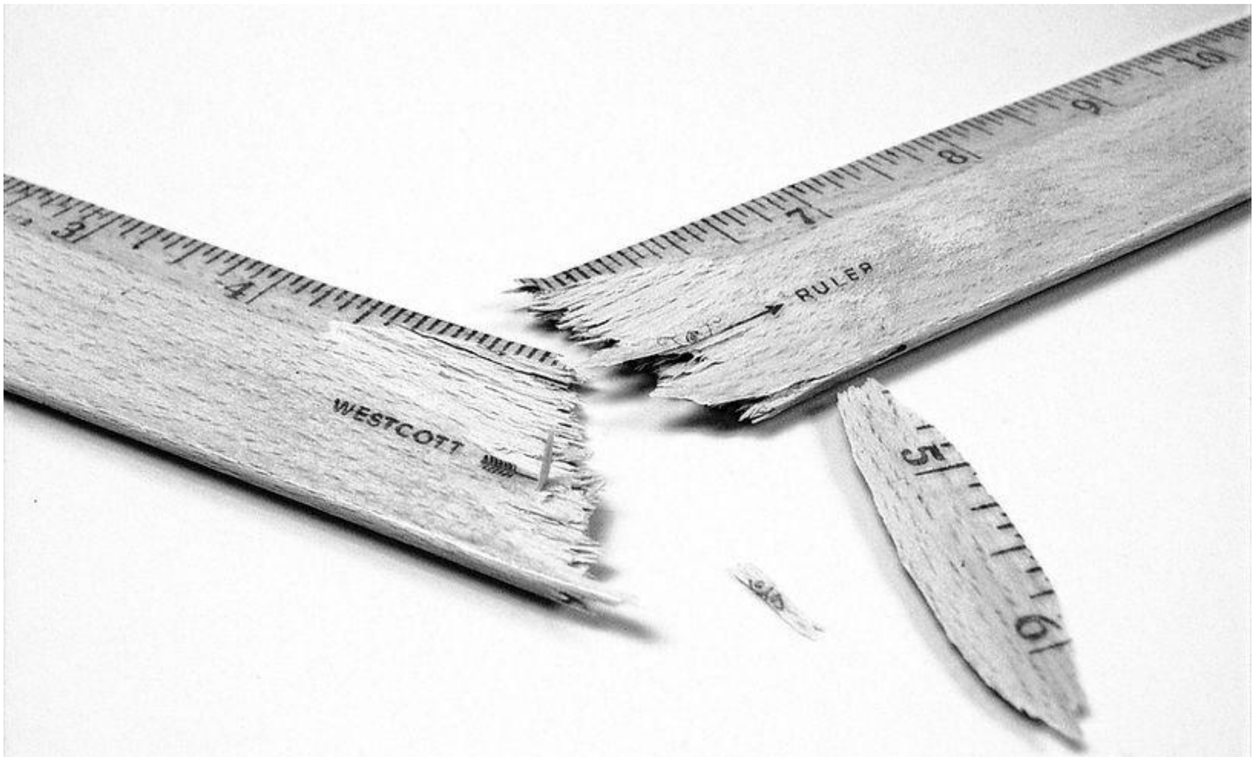
True Credit: A Better Yardstick for Carbon Markets

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 precise, complete, and irreversible measure of impact across all carbon projects. This new optimal set of measures accounts for and yields True Credits.

CHAPTER 1

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 metric ton 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 in the past.

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 that additional cost, 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—one that generates what we are calling True Credits—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, today's carbon credits are no commodity. Their values vary based on differentiable attributes like geography, technology, duration, and mass. We've identified 18 attributes in Figure 1 below.

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

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

18 attributes

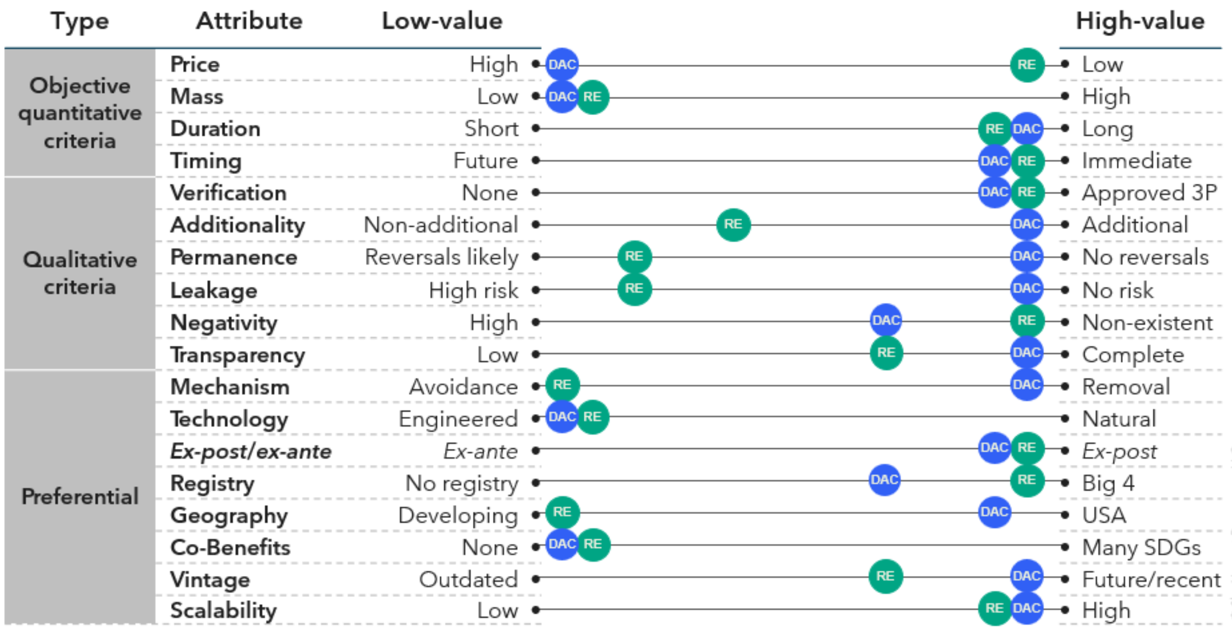
Type	Attribute	Description	Applicability
Objective quantitative criteria	**Price**	• Price of a carbon credit	Market-level
	Volume	• The volume of carbon kept out of the atmosphere	
	Duration	• The length of time that carbon remains out of the atmosphere	
	Timing	• The time period over which the benefit is realized	
Qualitative 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	
Preferential	**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 technology	
	Ex-post/ex-ante	• Credit 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	

"Yardstick Attributes" (Volume, Duration, Timing)

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, it's nearly impossible for a buyer to assess the relative value of two credits, like the renewable energy credit and a direct-air-capture credit illustrated in Figure 2 below. 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.

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



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 criteria (what we've called here "yardstick attributes"), another including qualitative criteria, and a final group of preferential attributes. We need standardization across *each* of these groups of attributes.

For the preferential 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 qualitative 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.

CHAPTER 2

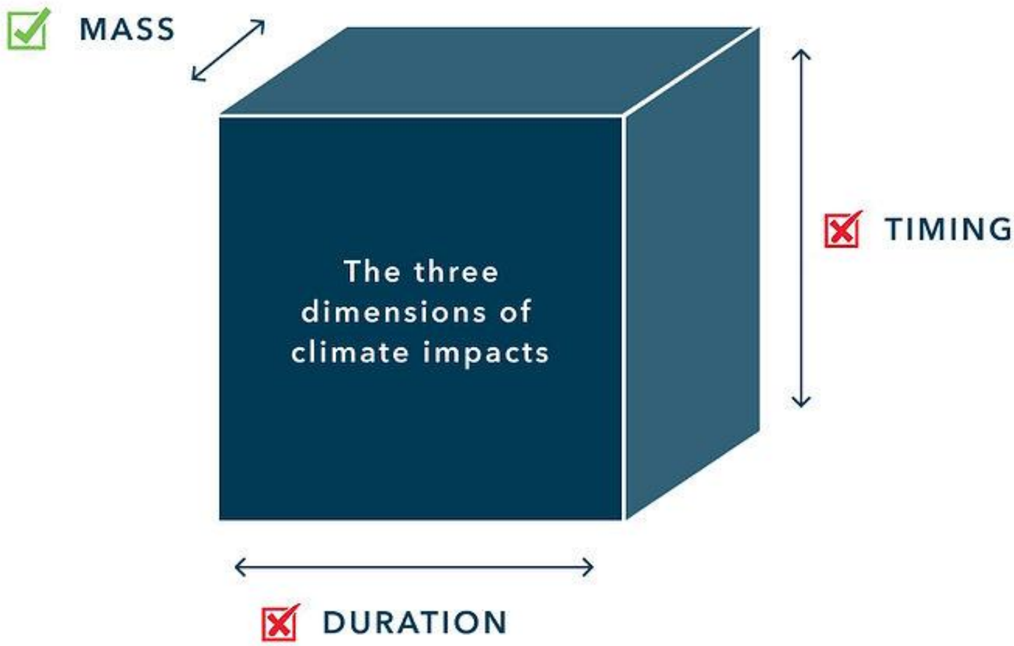
A Better Yardstick

Measuring climate impact: mass, duration, and timing

Climate impact, much like a box, has three dimensions. To measure it, you must measure all three dimensions. It can't be measured any other way. However, today's carbon market only measures one dimension. It's like trying to measure the volume of a box with just the width—it doesn't work. To be honest, we were flabbergasted and sad when we realized this. It's the reason we started Sky Harvest.

A box's three dimensions are width, length, and height. The three dimensions of climate impact—the yardstick attributes—are mass, duration, and timing.[2] Of the three, today's carbon credits only account for mass well, not so duration and timing.

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 today: the adoption of *ton-year accounting*, coupled with *a discount rate representing the social cost of carbon* will effectively measure duration and timing, as well as mass. The marriage of these two mechanisms

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[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.
[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.

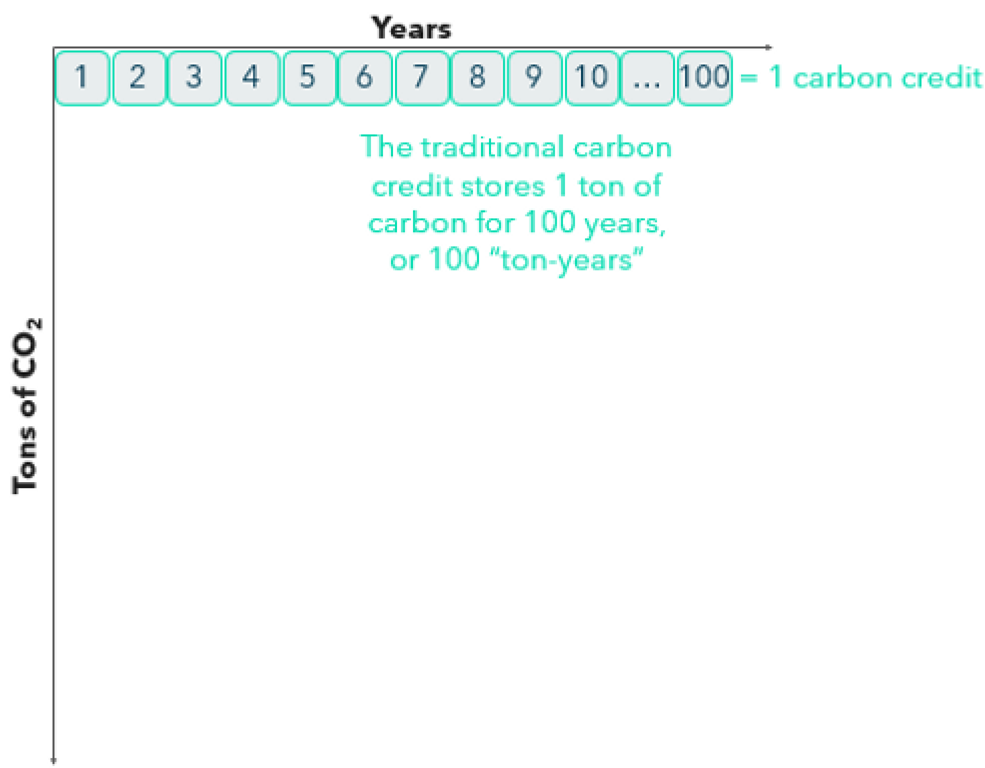
is our new yardstick. Using this yardstick, we can see that unfortunately most carbon credits today only offset a fraction of the emissions they claim (typically only 15-45%). However, we can use this new yardstick to generate a True Credit that offsets 100% of the impact of emissions. This new yardstick is like the Rosetta Stone for carbon projects, translating impact across any duration, any mass, and any time period into a common measure of impact: a True Credit.

Mass and duration: Ton-year accounting

The first tool in of this better yardstick is ton-year accounting or "TYA". A ton-year is a single metric ton of carbon dioxide stored for one year. One *ton* stored for one *year* equals one *ton-year*.

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

Figure 4 - Illustration of a typical forestry credit

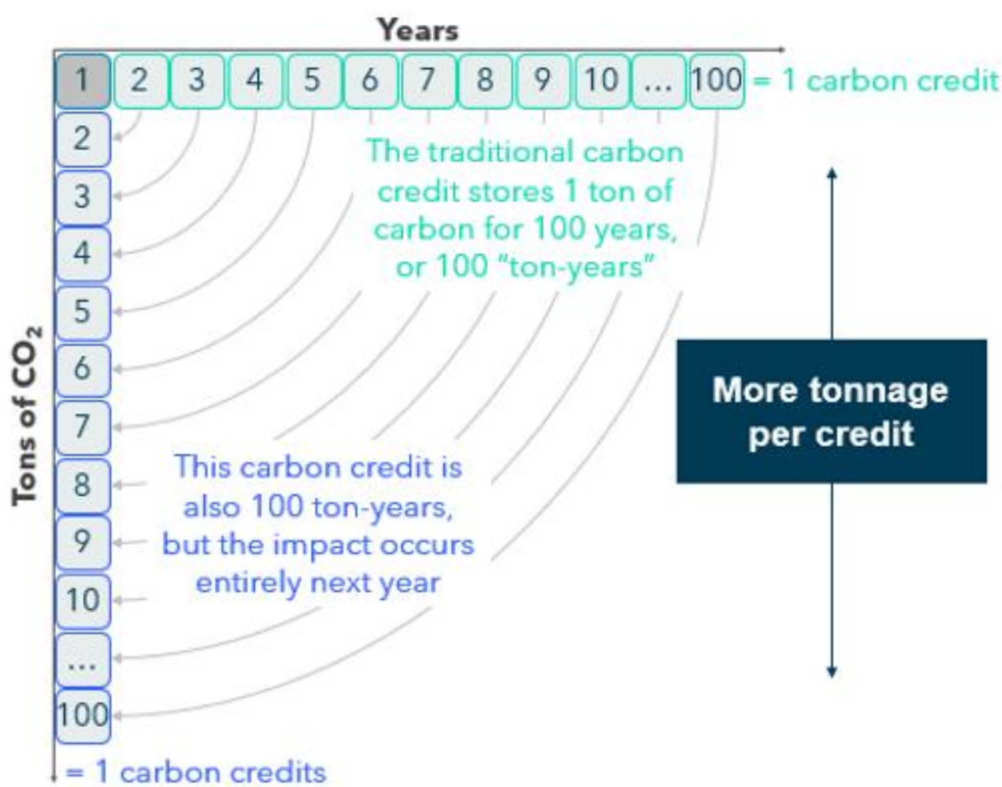


Another project under a different methodology certified by a different standards body may store one metric ton of carbon dioxide for 40 or 20 years. Because these projects are, in fact, credited, those credits are worth 40 ton-years and 20 ton-years, respectively.

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.

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

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

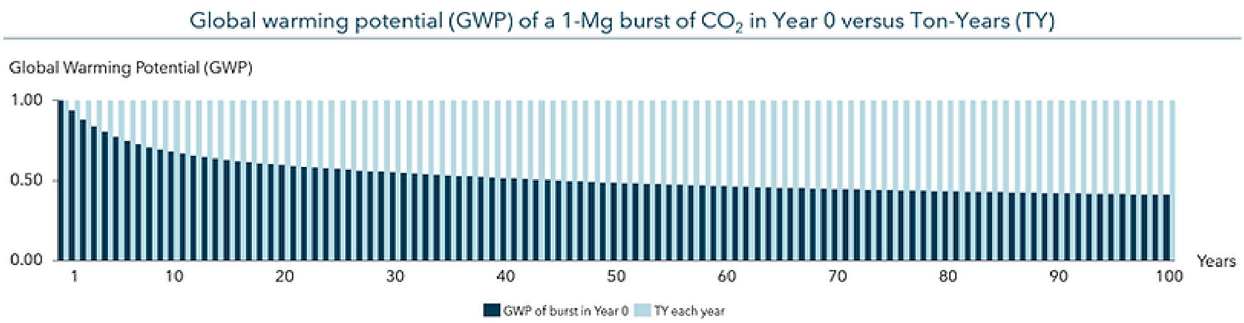


Alternatively, you could have credits representing 10-year durations and 10 metric tons or 5-year durations and 20 metric tons. Four quarters, 10 dimes, 20 nickels: it's all one dollar. The point is that TYA creates the flexibility to trade off duration and mass in such a way that standardizes the climate 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 mass 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 we built at Sky Harvest.

Figure 7 - Global Warming Potential of carbon dioxide over time

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

[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.

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

The importance of timing

With mass 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 Intergovernmental Panel for Climate Change (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 2+ decades away. We've got a countdown clock, and the next decade is more than 40% 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 financial concept of 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.

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[5] https://carbonplan.org/research/ton-year-explainer
[6] Generation Capital, "Time Value of Carbon"

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 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 benefits of the project during the first 100 years (using a 0% discount rate) and then undervalues the benefits thereafter (100% discount rate). This implies that Year 99 is infinitely more valuable than Year 101, which obviously makes no sense. 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 tons of carbon dioxide for 20 years compared to a project with one ton 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 (DAC) credit, which stores carbon dioxide for 10,000 years, can claim to be 100x more impactful than a traditional credit worth 100 ton-years. However, this fails to account for the value of near-term impacts over long-term impacts. In this case, 99.7% of the DAC 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!

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[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.

In short, we need standards that not only account for mass 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%?

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 the right discount rate 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

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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.

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 ton of carbon dioxide, then, mathematically speaking, there is no mass of CO_2 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 representing stored greenhouse gases equivalent to the present-value climate impact of emitting one metric ton of carbon dioxide *permanently* into the atmosphere.

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 universally applicable, broad enough to

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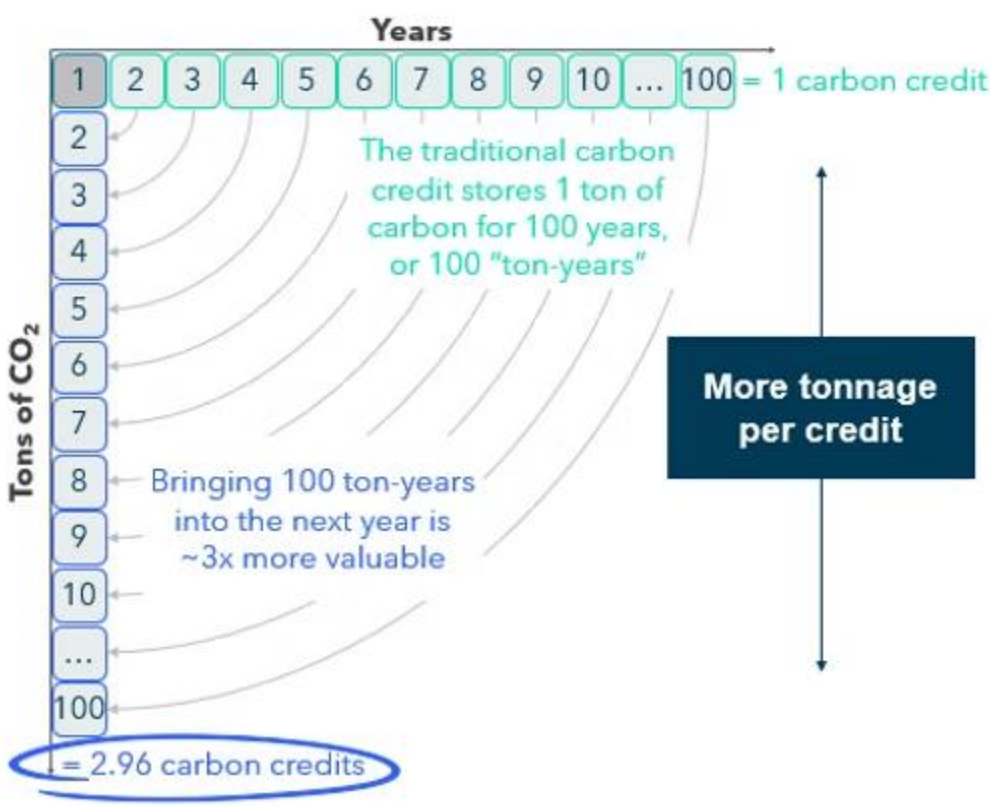
[11] Mallapragada, D.S., Mignone, B.K. A theoretical basis for the equivalence between physical and economic climate metrics and implications for the choice of Global Warming Potential time horizon. *Climatic Change* 158, 107–124 (2020).
[12] Sarofim, M. C. and Giordano, M. R.: A quantitative approach to evaluating the GWP timescale through implicit discount rates, Earth Syst. Dynam., 9, 1013–1024
[13] IWG Social Cost of GHG

encapsulate projects of any mass, any duration, and any time period. And lastly, it is inclusive of existing carbon credits that truly offset the emissions of a ton of carbon dioxide.

Bringing it all together

Let's bring it together by reconsidering two projects, both 100 ton-years, where one was spread out over the next century (horizontal row of ton-years) and the other occurred entirely next year (vertical column of ton-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 ton-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 developed by Sky Harvest.

Figure 8



When we marry these two mechanisms – (1) ton-year accounting and (2) a discount rate representing the time-value of carbon – we can equate the impact of any project, of any mass, for any duration, across any time period. This is a better yardstick. This generates True Credits.

Benefits of A Better Yardstick

This better yardstick is available today

It 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 it, but widescale adoption and market efficiency will hinge on its adoption by our standards bodies, not individual buyers.

This better yardstick 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 ton-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.

Figure 9 – Example of True Credit equivalencies across various types of credits

Credit	Mass ($MgCO_2e$)	Duration (Years)	Timing	Today's standard		True Credits	
				Credit	Price	Credits	Implied price
Emissions 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	$38	95	$40
Afforestation	100	100	Starts in 15yrs	100	$35	92	$38
FFCP by AFF	100	20	Starts today	100	$25	45	$56
Soil Carbon	100	10	Starts today	100	$20	26	$77
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 1,000,000-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

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

Forget *ex-post* credits, try *ex-post* impact

Ex-post credits are carbon credits that are issued *after* monitoring and verification has occurred. Still for many ex-post credits, they rely on speculative promises of carbon storage for decades into the future. True Credits, on the other hand, only measure carbon storage that has already occurred and been verified. True Credits eliminate the risk of reversals. True Credits do not require buffer pools. Moreover, project developers can issue credits every time they measure backwards-looking impacts of their project. That is a win for buyers who want irreversible, delivered impact and for suppliers who need near-term cash flow to finance projects.

This yardstick eliminates risk of reversal (non-permanence)

The better yardstick 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. 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] This is no surprise given the conflicts of interest for both project developers and registries when sizing these buffer pools: "Show me the incentive, and I will show you the outcome." - Charlie Munger.

With the better yardstick, 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 (except to issue new credits). This eliminates substantial cost and an issue that registries have historically struggled to tackle.

The better yardstick increases access and inclusion to carbon markets

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

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.

Our yardstick 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. This yardstick creates access for them to contribute to the reduction of atmospheric carbon dioxide without shackling their great-grandchildren with legal liabilities.

Ton-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 this better yardstick again furthers the cause of climate.

Conclusion and a call for a better yardstick

This yardstick 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 mass, for any duration, across any time period.

While we must continue improving standards that normalize other attributes of carbon offsets (such as additionality and co-benefits), this new yardstick 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.

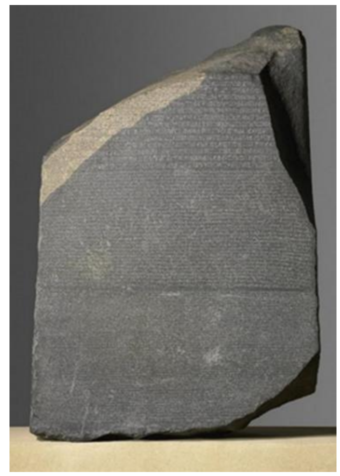


Figure 10 - Ton-year accounting is the Rosetta Stone of carbon projects

Of the ICROA-approved standards bodies, The Climate Action Reserve has led the way by adopting ton-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 ton-year accounting, pending further stakeholder engagement[16]. We call on all standards bodies to adopt TYA.

Specifically, we propose global carbon standards adopt two mechanisms: (1) ton-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 more on Sky Harvest and True Credits, see: *skyharvest.com/true-credits*

[16] *Verra Defers Updates to the VCS Program*

Responses to Critiques of this Better Yardstick

It can undermine additionality

One critique of this better yardstick 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 this yardstick 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 the yardstick 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" – mass, 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.

It is physically inconsistent with the emissions it offsets

Another critique is that the better yardstick 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 mass 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

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

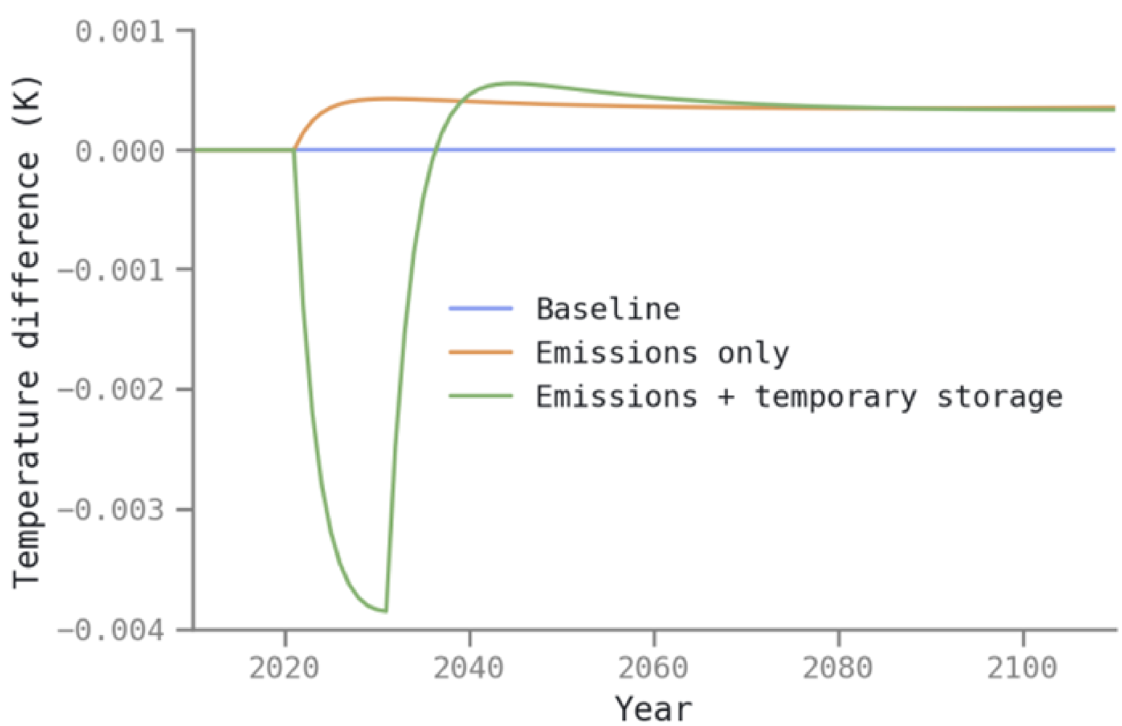
appropriate benefit of an emission's offset should be *economically* equivalent to the cost of the emission.

The better yardstick creates economic equivalency—not physical equivalency—between the cost of one ton of emitted carbon dioxide and the benefit of a carbon credit, regardless of the credit's mass, 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 ton 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 (source: Carbonplan.org)



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

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 our better yardstick 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 more than 40% 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 with this yardstick, 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 this better yardstick 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, however, they are not proven to be existential in the way that global warming is. If future research suggests otherwise, we can appropriately revise our frameworks at that time. 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 this better yardstick is that the math behind it is very complex… radiative forcing curves and Lashof models and what not. True, it is more complex than today’s standards, where one ton of carbon dioxide equals one carbon credit, regardless of storage duration or delivery timeline. However, today's standards are simply inaccurate. The better yardstick measures the true impact of a carbon credit’s effect on temperature in a way that offers standardization, greater precision, and greater access to carbon markets.

Moreover, the complexity will be managed by experts at the point of verification using simple, user-friendly tools like the True Credit Calculator, developed by Sky Harvest.

Most importantly, this greatly simplifies the entire process for the most critical stakeholder group: buyers. With a better yardstick, 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, increasing climate impact.