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Accounting for Carbon Offsets

by Robert S. Kaplan, Karthik Ramanna, and Marc Roston

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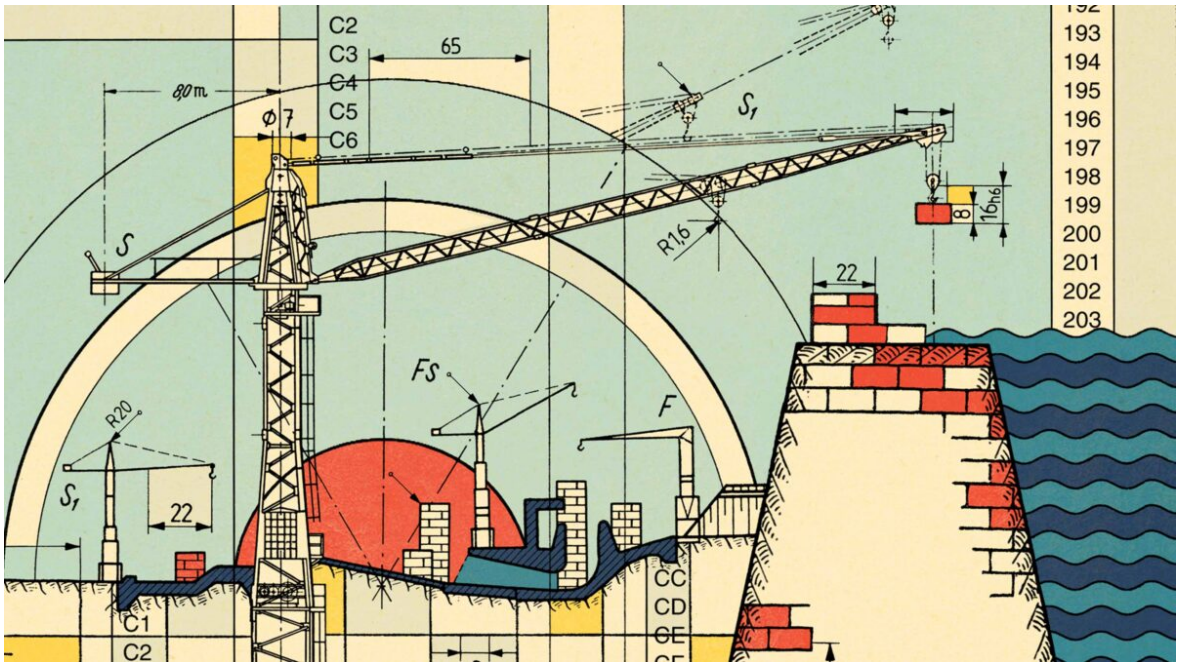

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Summary. Markets for carbon trading function poorly, and many traded offsets do not actually perform as promised. Without robust protocols for monitoring offsets and in the absence of proper accounting mechanisms, market-based approaches to reducing atmospheric... **more**

Three sources account for the great majority of human-created greenhouse gas (GHG) emissions: burning fossil fuels for energy, industrial chemical processes unrelated to energy production, and agriculture. Even with advances in "clean" energy technologies, the world remains heavily dependent on fossil fuels, and we do not have a realistic path to sustaining society without using current agricultural or industrial chemical

processes, which together account for over 25% of GHG emissions today. Any plausible strategy for addressing climate change must, therefore, include *removing* GHG emissions from the atmosphere.

Natural processes, such as photosynthesis, and technologies, such as mineralization, can capture existing atmospheric GHG. Corporations, nonprofits, and government entities with net-zero emissions targets, and with limited options for removing GHG themselves, need to contract with organizations that have more-efficient carbon-sequestration processes and technologies to purchase quantities of extracted GHG from them. Such products are known as “carbon offsets.”

In theory, competitive markets for the purchase and sale of carbon offsets should help to finance entities that have a comparative advantage in capturing the most GHG at the least cost. Unfortunately, carbon-offset markets are, to date, nowhere near as effective as traditional commodity and financial markets. Indeed, recent media investigations have suggested that the great majority of products transacted on offset markets remove very little GHG from the atmosphere. Part of the problem is that the measurement of GHG extraction is challenging. How, for instance, can you accurately measure the quantity of carbon captured over the productive lifetime of a forest? Is a kilogram of carbon captured in trees equivalent to a kilogram of carbon stored in rocks or soil? And will the carbon being captured in trees or underground be sequestered for the same duration as current CO_2 emissions will linger in the atmosphere?

Beyond measurement issues, weaknesses in the accountability infrastructure of offset markets contribute to moral hazard problems. Without robust protocols for monitoring the status of offsets, sellers of carbon offsets pay less attention than they should to ensuring that the carbon stays sequestered over the lifetime of their implied obligations. Meanwhile, buyers of carbon offsets are tempted to relax the direct management of their own GHG emissions, believing that their purchased offsets have relieved them of their responsibilities. Unless offset contracts are properly accounted for and audited, market-based approaches to reducing GHG will be vulnerable to misrepresentation and fraud.

In this article, we sketch out an accurate and auditable accounting framework for atmospheric carbon removal. The principles presented here extend the E- (or environmental) liability method of carbon accounting, described in the 2021 HBR article "Accounting for Climate Change," which enables organizations to measure and manage the cradle-to-gate GHG emissions incurred in their outputs.

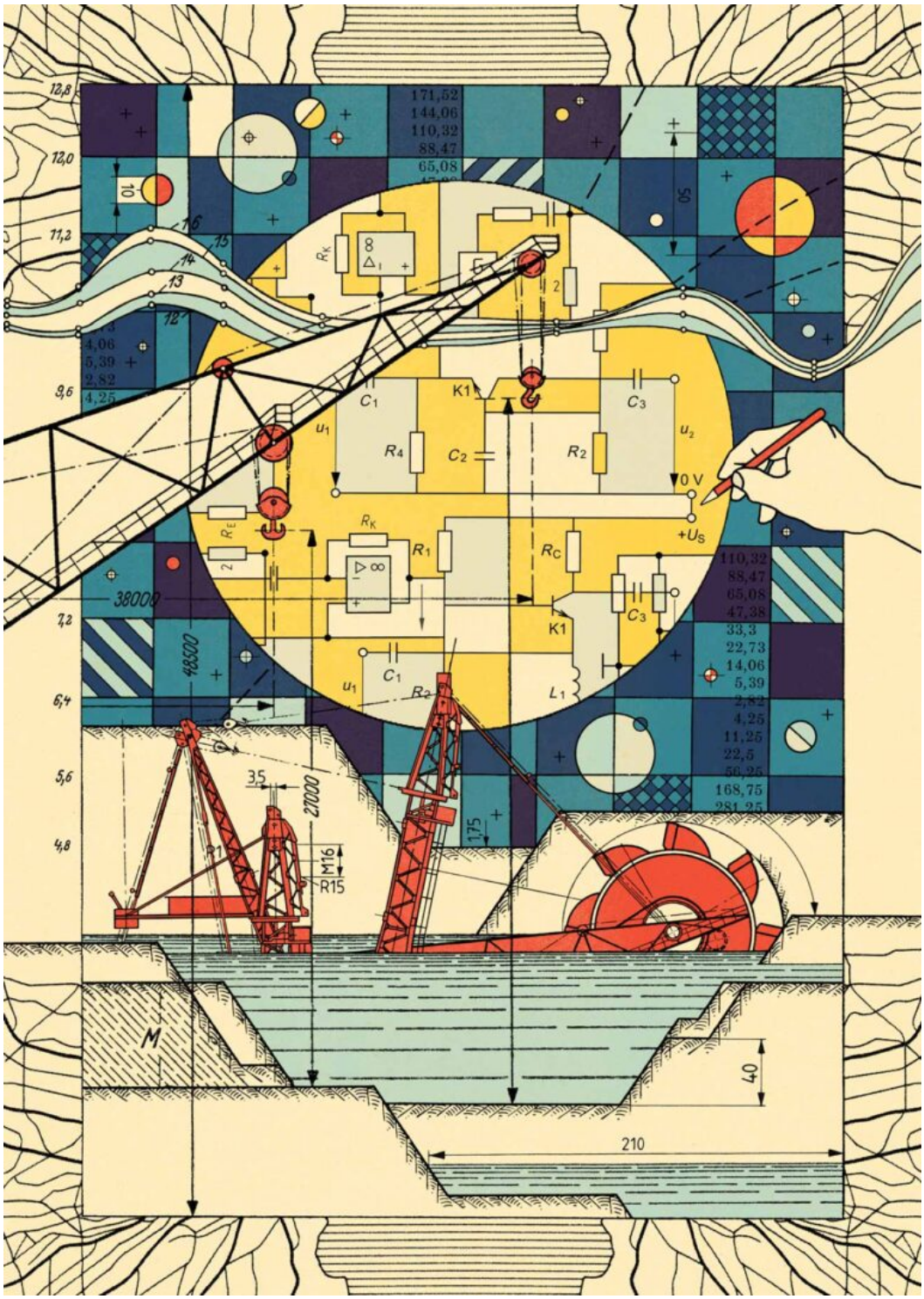
Our principles extend that system by specifying how accurately measured and verified carbon offsets can be recognized as E-assets on organizations' environmental balance sheets; when such E-assets can be used to extinguish E-liabilities; and when they must be modified to reflect offset impairments (that is, reductions in the quantity of carbon sequestered previously recorded on an E-balance sheet). With sound accounting principles in place, robust market practices and institutions for carbon-offset trading can develop, as they have for other products. And with well-functioning markets, the invisible hand of competition can accelerate innovation and deployment of improved offsetting technologies, leading to atmospheric decarbonization.

Let's begin by reviewing the main issues with the current arrangements for offset trading.

Carbon-Trading Markets Today

At present, most offsets are purchased by firms to reduce their reported net emissions and to demonstrate that they are on a trajectory to net-zero status. Companies also use offsets to introduce additional supply in government-run cap-and-trade systems by claiming that the captured carbon in the offset creates a right to emit beyond the regulated cap. In most cases, the offset takes the form of a certificate, issued by one of several private registries, that points to sequestered carbon at specified projects.

A typical offset project—say, the planting of a forest—develops as follows. A project-management entity acquires land on which to sequester carbon and establishes a forest development plan that may involve various service providers to plant, support, and maintain the development; estimate tree-growth expectations; identify methods to measure the carbon captured over time; and so on. The project manager then negotiates with the various certification agencies (or registries) to reach an agreement about the offset tonnage the project will create. The "winning" agency issues certificates that point to the identified tonnage of the project. The project manager assures the certification agency that the project conforms to the agency's rules and will not be registered with another agency. The penalties to the project manager for any misrepresentation, however, are unclear.



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Intermediaries for the project manager then sell the certificates issued by the registry to organizations seeking to offset their emissions, passing the received payments to the project manager, ostensibly to fund operations. The registry acts like a transfer agent in securities markets, keeping records of certificate ownership. But the certificate does not convey ownership of any captured carbon; rather, it represents the holder's entitlement to account for, as its own, some of the carbon (to be) captured, as

underwritten by the registry. The certificate sale agreement typically excludes any substantive penalties for the registry over misrepresentation or wrongdoing. The certificate buyer has no direct legal relationship with the offset project, which means it cannot monitor any actual carbon capture and sequestration.

In many cases, carbon certificate buyers “retire” the certificates shortly after purchase by returning them to the registry with instructions to remove them from the marketplace, not to be resold. The buyers then claim to have permanently removed the carbon quantity printed on the certificates from the atmosphere, at least for the purposes of their net-zero calculation and disclosure.

Obviously, this practice ignores even the most basic risks associated with carbon-removal projects (such as newly planted forests) that have long horizons to actual delivery of captured carbon and a material likelihood of impairment along the way (for example, from fire or disease). Registries attempt to mitigate such concerns in two ways.

First, they require that offset project managers confirm that they have the capacity to replace or refund the value of offsets should things go wrong. That mitigation device, however, has limited value. Certificate buyers have already retired their certificates and taken credit for the captured carbon immediately after purchase; they have neither an incentive to demand the replacement of any carbon lost through impairment nor a legal claim related to a retired certificate. Consequently, project managers have no incentive to maintain any capital to cover risk of impairment to the project or failure to capture carbon. Moreover, depending on a project manager’s revenue-recognition methods, buyers’ claims regarding their certificates could arrive long after revenues (and profits) from selling them have been distributed to investors in the project. Finally, the complex, often cross-border processes necessary to mediate any claims would be infeasible for many registries, most of which are low-resourced nonprofits.

Recent media investigations suggest that the great majority of products transacted on offset markets remove very little GHG from the atmosphere.

A registry's second protection method is to hold back some quantity of certificates that could have been sold but that now, like an insurance company's reserves, remain available to substitute for unrealized or impaired projects. Unlike an insurance company, however, the registry lacks transparency into its operations, independent evaluation of claims-paying ability, regulatory oversight, and the ability to raise additional capital.

A recent investigation of a large supplier of carbon offsets, published by *The Guardian,* found those deficiencies manifest in practice. The investigators concluded that "more than 90% of [the provider's] rainforest offset credits—among the most commonly used by companies—are likely to be 'phantom credits' and do not represent genuine carbon reductions."

Let's look at how we can fix this.

Five Principles of a Functioning Offset Marketplace

A functioning marketplace depends on clear definitions and measures of what is being traded. We propose five principles to underpin markets for the removal and storage of GHG emissions. The first two determine the scope of the markets by defining what can and cannot be counted as an offset and what may or may not be traded. The remaining principles set out basic accounting guidelines for offsets. The principles are grounded in the core bilateral agreement between an offset producer and a purchaser, because even if markets function through layers of intermediaries, they exist to connect offset producers with purchasers.

Principle 1: Only offsets that remove carbon from the atmosphere may be used to reduce an organization's reported emissions. This principle follows directly from a frequently overlooked truth: The only emissions entering the atmosphere are direct emissions—those labeled by the Greenhouse Gas Protocol as Scope 1. The principle states that a valid offset to a given quantity of Scope 1 emissions must remove an equivalent quantity of GHG already in the atmosphere and sequester it for at least as long as the underlying emissions are expected to remain in the atmosphere. Such offsets are known as removal offsets. This principle departs from current practice. The GHG Protocol, the dominant global standard for carbon accounting, does not at present substantively distinguish between actions taken to remove incurred GHGs (removal offsets) and actions taken to avoid emitting prospective GHGs (avoidance offsets). What's more, the protocol's lack of endorsement for the netting of removal offsets against emissions—using E-assets to remove E-liabilities from an environmental balance sheet—disincentivizes companies from spending money to sequester emissions themselves or to compensate other, more efficient entities to perform carbon-removal activities. As a result, markets today are most likely undersupplying legitimate carbon removals.

Why Emissions Avoidance Should Not Be Treated as an Offset

Currently, some offset-trading markets monetize actions taken to avoid future emissions and sell them to third parties ...

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Principle 1 eliminates the accounting error of treating prospective emissions reductions as current offsets while encouraging companies either to invest more to green their operations or to purchase more removal offsets from efficient carbon removers. (See the sidebar "Why Emissions Avoidance Should Not Be Treated as an Offset.")

Principle 2: A company may buy or sell removal offsets, but it may not similarly trade E-liabilities. Principle 2 allows firms to reduce their E-liability balances by purchasing valid removal offsets. It encourages firms to treat carbon removals like any other purchased good or service: Companies acquire them from those better able to provide them at lower cost. Enabling carbon-offset trading in well-functioning markets promotes these gainful exchanges and increases the supply of capital for the most-efficient offset producers.

Principle 2 also states that companies cannot separate their E-liabilities from the underlying product inventories to which they are attached. Doing so would be like keeping separate inventory books for costs and volumes, rendering them meaningless. In the E-accounting system, a company records the emissions it produces from its own operations as E-liabilities. It adds to those E-liabilities the emissions produced upstream by the suppliers of its purchased inputs. Outside of using legitimate removal offsets (Principle 1), it reduces its E-liabilities only when its customers voluntarily assume them, on their own E-balance sheets, by buying the company's products. This process, which works like a value-added-tax system, leverages market forces in the supplier-customer exchange to drive emissions reduction. Allowing a company to trade away its E-liabilities (separate from the underlying inventories) would undermine supply-chain decarbonization by enabling entities to "park" their E-liabilities in shell entities domiciled in unregulated jurisdictions.

Principle 3: Rights to carbon removals shall be recognized as an E-asset, and be tradable as a removal offset, when the timing

and magnitude of the offsets are both reasonably estimable and probable. We now turn to principles for timing when an offset producer may recognize and trade captured carbon as an E-asset, and when such assets may be used to net out E-liabilities. We offer a hypothetical case to explain the principles.

Imagine that a landowner plants a new forest with the aim of selling the carbon that the forest will remove and sequester to a buyer seeking to offset its E-liabilities. We assume that the forest requires 10 years of growth before it begins to remove carbon in significant quantities. For the next 20 years, the forest absorbs carbon at a predictable rate. After 30 years, the fully grown trees capture no new carbon, but they continue to sequester previously captured carbon for 20 more years before decaying and releasing the carbon. The landowner, as the producer of the removals, owns the rights to the carbon capture.

A functioning marketplace depends on clear definitions and measures of what is being traded.

Applying standard financial-accounting principles to the case of captured emissions, the landowner can capitalize such rights as an E-asset based on both the measurability of how much and when the carbon will be captured and the likelihood that it will be captured. In accounting parlance, these criteria are known as "reasonably estimable and probable," where "probable" means at least 50% likelihood but may also be defined (in regulations) as 90% or higher. Our landowner can estimate the tons of carbon capturable (the offset quantity) based on average annual growth of like tree species during years 11 through 30. Of course, disease, pests, wildfires, and illegal deforestation may reduce the quantity or duration of capture, and unexpectedly favorable weather conditions may increase the carbon captured per year and the duration of the forest's productive life. Landowners wishing to

book and sell legitimate carbon offsets as E-assets must demonstrate that their estimates are well-founded and that risks will be well managed.

Even if an offset qualifies as an E-asset on measurability and likelihood grounds, we must guard against the risk that the sale of the offset fundamentally changes the magnitude and duration of the carbon capture. The separation of an asset (rights to carbon capture) from the originator creates an "alienability risk" when the asset is sold. Some rights to an asset, such as a patent, are alienable and may be sold by a parent entity since their properties do not change under new ownership. Other intangible assets, however, such as the synergies from a highly motivated and aligned workforce, are not alienable. A firm that attempted to separately identify and sell its HR synergies as a financial asset would most likely precipitate the intangible asset's impairment, lowering its value.

Alienability risk occurs in our forest example after the landowner has sold the forest's future carbon offsets. The landowner no longer has an incentive to maintain the forest's long-term capabilities for capturing and sequestering carbon. Principle 3's probable and estimable criteria thus can be met only when no reasonable expectation exists that the offset will be impaired as a consequence of its sale. This provision can be satisfied through standard performance contracts (which we'll discuss later).

Principle 4: A company shall net a given quantity of E-assets against its E-liability account only when that quantity of GHG has been actually removed from the atmosphere and indefinitely sequestered. A company that purchases or produces an offset asset must determine when it can use that E-asset to reduce its E-liability balance. Principle 4 addresses this issue using the financial-accounting standard for revenue recognition. A company may recognize revenue from a sale only when it is both realizable and earned. A selling company "realizes" revenue when it receives cash, a cash-equivalent asset such as a marketable

security, or a highly likely commitment to pay cash in the future. The company "earns" the revenue when it delivers its product or service. For example, a theater that receives cash from ticket sales in advance of a performance (satisfying the realizable criterion) may recognize that cash receipt as revenue only after the performance has occurred (satisfying the earned criterion). In the context of netting E-assets against E-liabilities, it works like this: The landowner in our example meets the realizable criterion at the time its E-asset recognition criteria have been satisfied (that is, the capture of carbon is both estimable and probable). That could be in year 0 for a high-quality landowner or somewhat later for a less reputable or less capable one. But regardless of when the realizable criterion is satisfied, the landowner does not start to "earn" the carbon offset until year 10, when it can verifiably demonstrate that nontrivial quantities of carbon are being captured by the forest.

If the forest manager sells the offset asset before the 10th year, the purchasing entity has to keep the E-asset unchanged on its books until year 10, when the earned criterion is met upon receipt of an audited report from the forest manager about the quantity of carbon that has been captured. Thereafter, the offset buyer may proportionately draw down its E-asset, up to the "earned" amount, to reduce (or "net") its E-liabilities. (In practice, this accounting transaction should happen via a contra-asset as described in the exhibit "Sample Flows of E-Assets and E-Liabilities.")

Sample Flows of E-Assets and E-Liabilities

This table shows a fictitious company's flows of E-assets and E-liabilities in one reporting period.

The company begins with E-assets of 15 tons of GHG from purchases in an offset project (the planting of a forest) and E-liabilities of 20 tons from its operating activities.

The firm receives documentation from an auditor that 9 tons of its E-assets have been "earned" (that is, the forest has delivered 9 tons of GHG removal). The company "nets" this amount against its E-liability balance. On the E-asset side, the 9 tons are placed in a contra-asset account (analogous to an accumulated depreciation account for a tangible asset), signifying the portion of offsets no longer available for future netting against E-liabilities.

Later in the accounting period, the company learns that due to a forest fire, 4 tons of its netted E-assets have been impaired. This impairment triggers a write-off from its E-asset balance and an adjustment to its contra-asset account, along with a reversal from its E-liability balance of netted offsets.

At the end of the period, the firm's E-asset balance is 11 tons, of which 5 have been netted. The closing E-liability balance stands at 15 tons.

Sample E-liability account: Snapshot

E-asset (tons of GHG)		E-liability (tons of GHG)	
Purchased offsets	15	E-liabilities from operations	20
Contra-asset: Earned offset netted	9	Netted earned emissions	9
Balance	15	Balance	11
Contra-asset balance of netted offsets	9		

Sample E-liability account: End of period

E-asset (tons of GHG)		E-liability (tons of GHG)	
Purchased offsets	15	E-liabilities from operations	20
Contra-asset: Earned offset netted	9	Netted earned emissions	9
Less impairment of purchased offsets	-4		
Contra-asset adjustment	-4	Reversal of netted emissions	-4
Closing balance	11	Closing balance	15
Contra-asset balance of netted offsets	5		

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The higher standard of "earned" for eliminating E-liabilities (relative to "realizable" for recognizing E-assets) is based on the economic significance of netting. Just as revenue recognition increases a firm's income, raising shareholders' expectation for dividends, reducing a company's E-liabilities communicates to

customers, shareholders, and regulators that the firm's products (its inputs and operations) generated less carbon than those of its peers did. New customer sales and new investments can be made based on such claimed efficiencies. Eliminating an E-liability, therefore, should meet a higher accounting threshold to be meaningful and less influenced by management's subjective judgments.

Principle 4 also states that GHG must be sequestered "indefinitely," which addresses a particularly challenging aspect of netting due to the duration of emissions liabilities. Estimates from NASA suggest that man-made carbon emissions persist in the atmosphere for at least 300 years (and possibly more than 1,000 years), an exceedingly long time horizon compared with that of virtually all other commercial contracts. In principle, the netting condition requires that the duration of an earned removal offset equal or exceed the duration of the E-liability. In practice, the term "indefinite" represents this principle. "Indefinite" does not mean "infinite"; it means that the sequestration has no definite end, based on technology, legal restrictions, or regulatory oversight.

Subterranean Mineralization: The Long-Term Solution?

The carbon captured by nature-based offsets (NBOs) is eventually rereleased into the atmosphere when biomaterials ...

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This means that our forest offset project, which holds carbon for at most 40 years from first "earning" it, cannot on its own extinguish a centuries-long E-liability. Netting requires, therefore,

an assurance that the offset owner has the financial capacity to repeat the process so that the carbon can remain sequestered over multiple forest-generation cycles, which could involve placing very long duration funds in an endowment- or pension-fund-type structure (more on this later). This problem is not shared by all approaches to creating carbon offsets. Carbon capture through subterranean mineralization, for example, can enable indefinite sequestration without multiple reinvestment cycles. (See the sidebar "Subterranean Mineralization: The Long-Term Solution?")

Principle 5: An offset asset shall be impaired or accreted on the basis of new information about the quantity and duration of actual carbon sequestration. Our final principle directly addresses the risk that an offset asset's value may fluctuate over its lifetime. In the case of our forest, as noted above, impairment risks generally rise over time as increasing quantities of sequestered tree carbon become subject to fire, disease, pestilence, mismanagement, or other forms of catastrophic loss, in addition to the risk that the actual amount of carbon captured will fall short of expectations. Other long-lived assets are subject to such risks, and standard financial-accounting criteria exist for recognizing and measuring impairments. These criteria can also be applied to carbon assets.

Unlike typical tangible assets, some E-assets may become more valuable than originally expected, such as when the forest grows larger and faster than anticipated, enabling it to capture and store more carbon. Thus, Principle 5 also allows for accretions in value.

Under Principle 5, all offset contracts will need periodic audits to determine whether an impairment or an accretion has occurred and to attest to the magnitude of any change. The potential for impairments provides an incentive for companies to purchase from reliable offset producers—those that consistently deliver on the expected quantity and duration of sequestered carbon.

The existence of impairment risks also underlies our rationale for maintaining the gross value of purchased removal offsets on the company's E-accounting books, with "netted" offsets recorded in a contra-asset account. With that approach, when an offset has been impaired, the impairment quantity is booked against the offset asset account, which, analogous to clawback provisions in insurance contracts, increases the net liability balance in the firm's E-balance sheet and, correspondingly, increases the quantity of E-liabilities to be allocated in the future to the firm's outputs. This treatment counteracts a company's tendency to be overly optimistic about the "nettability" of its E-asset offsets and to underestimate the E-liabilities it transfers to customers.

Accounting for "Orphan" Carbon Deposits

Substantial natural carbon stocks exist globally for which no accounting or apparent ownership exists, such as ...

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The five principles have important implications for how to manage and monitor the vast terrestrial biospheres, such as those in Brazil, Canada, Congo, and Russia, where much of the world's current forest offsets are stored and remain vulnerable to plunder. (See the sidebar "Accounting for 'Orphan' Carbon Deposits.") They should also promote dynamic and efficient markets to support the production and trading of new carbon-removal offsets.

A Robust Market for Mitigating Climate Change

In many ways the practices and institutions that support a functioning market in offsets resemble those that have evolved over time to serve other successful markets. To give a flavor of

such a future, let's zero in on key institutions that underlie efficient markets.

Accounting and reporting. At present, reporting systems for carbon emissions and offsets are inconsistent and idiosyncratic. Many companies today calculate emissions by selectively applying Greenhouse Gas Protocol rules to some activities (such as purchasing electricity) but not others (such as employee travel) and then buying offsets that they immediately retire to achieve their self-declared net-zero targets.

A new market system, based on our principles, would have companies managing an E-balance sheet containing purchased and generated E-liabilities along with offset assets. Each period, they would add to their E-liabilities the carbon emissions acquired with product inputs they purchase and the emissions they generate through operations. They would subtract from their E-liability balance the emissions in products sold to customers and their realized and earned offsets. In this system, a firm would qualify as net zero for a given reporting year only if its closing E-liability balance at the end of that year had been matched by nettable E-assets. A similar logic would apply to the firm's individual products and services claimed to be net zero.

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Sellers of offsets would also maintain E-balance sheets and financial balance sheets. From their perspective, the sale of an unearned offset—say, a newly planted tree—would lower the quantity of their E-assets and create a financial liability, listed as deferred revenue, to cover the cost of caring for the tree and protecting it against impairment. The deferred revenue would be recognized as “earned” only when the tree started removing carbon.

This approach will make the economics of producing carbon offsets transparent and deter offset producers from walking away from an E-asset after pocketing the unearned revenue from the sale of its future carbon capture (the previously described alienability risk). Likewise, if the offset seller is contracted by a buyer to renew the forest indefinitely to account for the long duration of E-liabilities against which forest offsets are netted, some portion of that deferred revenue will remain as a long-term financial liability, with the equivalent invested cash used to fund future forest-planting cycles.

Auditing. The current approach to carbon reporting, based on selective disclosures of emissions and the accelerated use of offsets, is generally unaudited. In the few instances where companies voluntarily purchase assurance services, these are usually "limited in scope," with the auditor's opinion carefully phrased in highly hedged language, such as stating that the company's claimed net-zero position is "not obviously false."

In contrast, our system of E-balance sheets, operating in parallel with financial balance sheets, can be fully audited to provide a "true and fair" representation of an entity's carbon emissions and carbon-removal offsets. Such E-audits would rely on knowledge of both environmental chemistry and accounting principles and could be performed by traditional financial-audit firms, using environmental experts, or by climate-science firms, using accounting experts. Complementary financial auditing would also be needed to monitor how offset providers account for unearned revenues and preserve capital to sustain the permanence of recognized offsets.

Offset portfolio management. Given that many E-assets will be nettable only gradually and well after purchase, buyers will need to consider the mismatch between E-assets and E-liabilities in structuring funding for the purchase of offsets as well as take into account the variations in impairment risk across offsets. They should attempt to build a diversified portfolio of removal offsets

that vary in terms of impairment risk, duration, and technology. For example, an organization purchasing nature-based offsets might create an endowment-like portfolio of E-assets (such as forests of different varietals and in different regions) to offset E-liabilities indefinitely into the future. That would be similar to the portfolios of insurance companies, pension funds, and university endowments, which also have obligations stretching far into the future. Specialized firms could emerge to provide such E-asset portfolio services.

> **Landowners wishing to book and sell legitimate carbon offsets as E-assets must demonstrate that their estimates are well-founded and that risks will be well managed.**

Meanwhile, E-asset providers, such as our hypothetical forest manager, will have to consider the capital implications of selling long-lived E-assets. Private-equity funds offer a potential model here. A general partner (GP) operates a fund on behalf of limited partners (LPs), providing services such as monitoring, asset valuation, auditing, and reporting over the 10-year life of a typical fund. The GP earns compensation only after LPs receive specified returns. In the context of forest projects, funds raised from LPs (such as offset buyers) would be used to purchase land and plant trees that could be sold as E-assets once they had met Principle 3's asset-recognition criteria. Once the trees began removing carbon, distributions to the LPs in terms of nettable E-assets would also begin, and the GP (the offset manager) could "earn" the revenue it had collected.

Unlike PE funds, however, a forest offset manager has a much longer time horizon than 10 years, given the obligation to capture and store carbon indefinitely. To manage this, a GP/LP contract

could commission producers to provide fixed amounts of carbon removal over shorter durations at lower costs, with the expectation that buyers would be the ones to recapitalize the E-asset by investing in new forests to replace degraded ones.

Capital market participants might also develop innovative mechanisms to fund the provision of long-duration and reliable offsets. It's theoretically possible, for example, for forests or other natural E-assets to be financed at least partly through perpetual bonds structured to allow offset buyers to purchase nettable E-assets on a spot market without tying up their own capital indefinitely.

Governance. The long duration of offset production and delivery gives rise to significant counterparty risks for buyers. Financial incentives can help mitigate them, but independent bodies for regulating and enforcing offset performance will also be needed. In U.S. equity markets, for example, the NYSE and Nasdaq verify that companies whose shares trade on their exchanges comply with listing requirements, and the SEC, in turn, oversees the exchanges.

In the offset context, existing registries might convert from their current passive role as transactional intermediaries into something like exchange authorities. Alternatively, they might function as a reciprocal or mutual insurer, operated by and for the benefit of the insured. In this model, an offset purchaser would pay a premium to the insurer to guarantee the offset's success

over the long term. Different registries and insurers might specialize in specific types of offsets, and they would develop the expertise to price and manage the risks of the guarantees.

What we've described is an early sketch of a thriving economic sector that advances human well-being by combating climate change. Our accounting principles provide a bedrock for a comprehensive market-based solution for carbon-emissions management.

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In the 1940s William Temple, the archbishop of Canterbury, wrote, "The art of government...is the art of so ordering life that self-interest prompts what justice demands." By introducing the five offset accounting principles in this article, we hope to bring order to the current Wild West of offset trading in a way that directs the powerful forces of human competition and innovation to the challenge of reducing atmospheric carbon. As Temple implicitly acknowledged, most attempts by governments and elites to direct and manage grand projects from above are doomed to fail. A more plausible approach is to set clear, measurable goals, design the appropriate rules of the game, and then leave the results to the players.

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Robert S. Kaplan is a senior fellow and the Marvin Bower Professor of Leadership Development emeritus at Harvard Business School. He coauthored the McKinsey Award–winning HBR article "Accounting for Climate Change" (November–December 2021).

Karthik Ramanna is a professor of business and public policy at University of Oxford's Blavatnik School of Government. He coauthored the McKinsey Award–winning HBR article "Accounting for Climate Change" (November–December 2021)."

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Marc Roston is a research fellow at Stanford University's Steyer-Taylor Center for Energy Policy and Finance.