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Carbon Neutrality Should Not Be the End Goal: Lessons for Institutional Climate Action From U.S. Higher Education

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Perspective

Carbon neutrality should not be the end goal: Lessons for institutional climate action from U.S. higher education

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SUMMARY

Climate action pledges have increasingly taken the form of commitments to net carbon neutrality. Higher education institutions (HEIs) are uniquely positioned to innovate in this area, and over 800 United States (U.S.) colleges and universities have pledged to achieve net carbon neutrality. We examine the approaches of 11 U.S. HEIs that have already announced achieving net carbon neutrality, highlighting risks associated with treating carbon offsets, unbundled renewable energy certificates, and bioenergy (collectively 77% of reductions across institutions) as best practice under current frameworks. While pursuing neutrality has led to important institutional shifts toward sustainability, the initial mix of approaches used by these HEIs appears out of alignment with a broader U.S. decarbonization roadmap; in aggregate, these early neutrality efforts underutilize electrification and new zero-carbon electricity. We conclude by envisioning how HEIs (and others) can refocus climate mitigation efforts toward decarbonization and actions that will help shift policy and markets at larger scales.

INTRODUCTION

Net carbon-neutrality commitments are one of the most visible forms of leadership in the face of the climate crisis. As of 2020, at least 25 national governments and the European Union have pledged to achieve net carbon neutrality (also referred to as net zero emissions, although the precise meaning of "net zero" varies by jurisdiction) by 2050.[1] Broadly, these individual commitments can help align global emissions with a pathway that can keep temperature increases well below 2°C, consistent with the Paris Agreement.[2]

Because current government policies are not sufficient to avoid dangerous anthropogenic interference with the climate system,[3,4] non-state actors have become an important source of leadership to advance climate action.[5] Voluntary carbon mitigation by non-state actors can achieve reductions in carbon emissions, pilot and demonstrate innovations in decarbonization approaches, and signal to policy-makers a willingness to participate in a low- or zero-carbon economy in ways that can induce more ambitious action targets from governments.[6] Numerous non-profit and for-profit organizations have begun pursuing internal carbon pricing across supply chains,[7] purchasing renewable electricity,[8] making carbon-neutrality commitments,[9] and, increasingly, adopting targets for climate mitigation consistent with holding temperature increases below 2°C, including pledges to become carbon negative.[10]

As enduring non-profit institutions with educational missions, United States (U.S.) higher education institutions (HEIs) are uniquely positioned to play a role as climate action leaders. Beginning in 2006, U.S. HEI presidents signed onto the American College and University Presidents' Climate Commitment (ACUPCC) to develop targets and plans to achieve carbon neutrality "as soon as possible."[11] These early commitments to the ambitious goal of carbon neutrality make this sector unique in the U.S. As net carbon-neutrality commitments proliferate globally, it is appropriate to ask what approaches to achieving neutrality actually look like in practice. The approaches adopted by U.S. HEIs from 2006 to 2020 represent an empirical case study for what achieving neutrality might entail, and for exploring whether this approach represents a scalable solution to the climate crisis. Here, we analyze the carbon-neutrality pathways taken by the 11 leading U.S. HEIs that have already announced carbon neutrality as of December 2020 and analyze them in the context of a broader U.S. decarbonization roadmap.

CARBON-NEUTRALITY COMMITMENTS IN U.S. HIGHER EDUCATION

U.S. HEIs, like all parts of society in developed economies, have significant greenhouse gas (GHG) emissions that must be rapidly reduced to avoid dangerous anthropogenic climate change. Many HEIs function like small cities with their own heating, power, and transportation infrastructure. If all full-time students, faculty, and staff at HEIs in the U.S. were counted together, U.S. HEIs would be the second most populous U.S. state with over 29 million people.[12]

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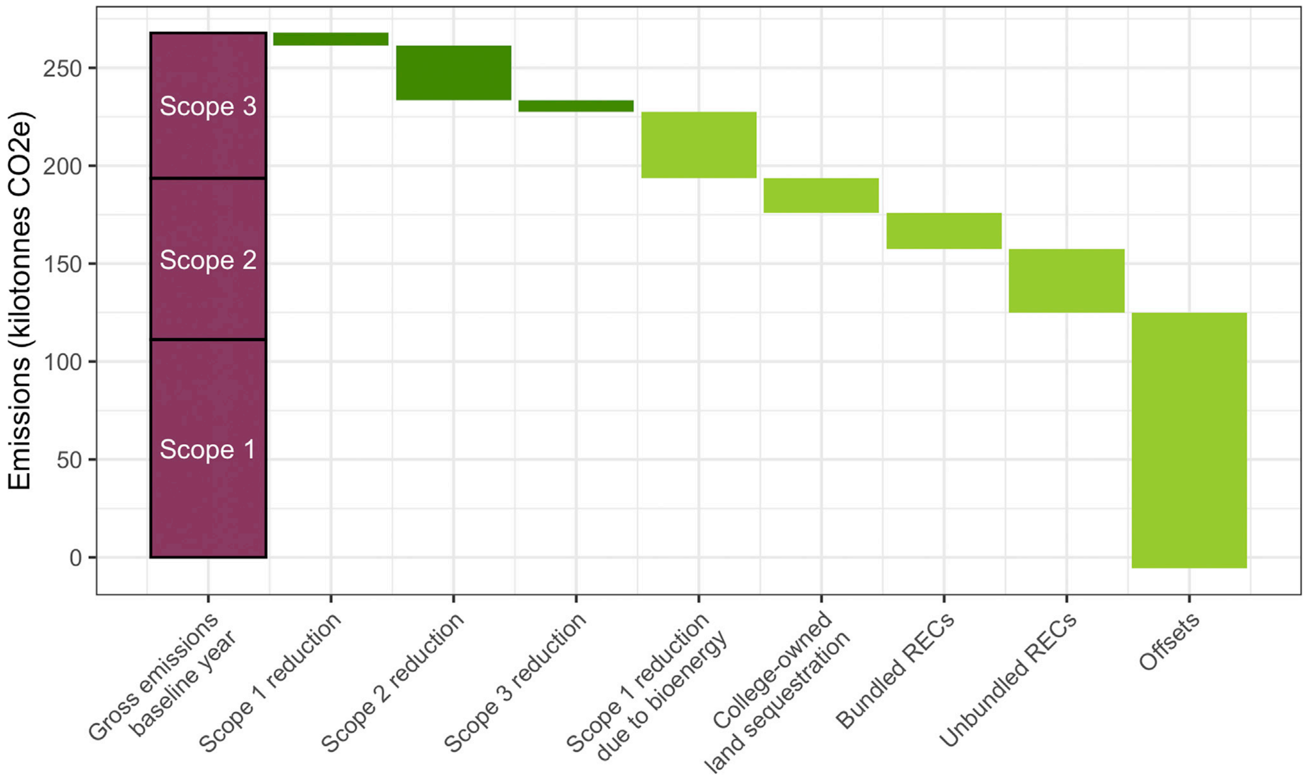

Figure 1. Aggregate reductions in emissions across 11 carbon-neutral U.S. higher education institutions (HEIs) by type of reduction, as well as aggregate emissions by scope in the baseline years

Dark-green bars show reductions by scope excluding the specific sources of reductions covered by the light-green bars (i.e., Scope 1 emissions without including bioenergy or institution-owned land sequestration, Scope 2 excluding the use of renewable energy certificates [RECs], and Scope 3 emissions from employee commuting and travel). RECs are divided according to whether they were associated with a power purchase agreement (bundled) or not associated with a power purchase agreement (unbundled). At schools that switched to bioenergy between their baseline and carbon-neutral year, we attributed all reductions in on-site stationary combustion emissions to bioenergy.

Since the start of the ACUPCC in 2006, over 800 American HEIs have signed the carbon-neutrality commitment. In 2015, the non-profit Second Nature, which has administered the commitment since 2009, rebranded the ACUPCC as the Carbon Commitment and expanded the program to include a stand-alone climate resilience commitment. Second Nature maintains a database of the 426 institutions still actively reporting annual emissions under the Carbon Commitment,[13] 362 of which have set carbon-neutrality target dates, which range from 2012 to 2100 (the median date being 2050 [Figure S1]).

Consistent with practices in the for-profit sectors, carbon neutrality in the context of U.S. HEI commitments is ‘‘net’’ neutrality, allowing for continued emissions, as long as an equivalent amount of off-site emissions reductions or carbon sequestration activities are purchased or undertaken to offset those continued emissions. Under current guidelines, HEI carbon-neutrality commitments usually apply to emissions from direct on-site fossil-fuel use (Scope 1 emissions) and purchased electricity (Scope 2 emissions). Some also include institutionally-funded air travel and employee commuting (a subset of Scope 3 emissions), but few encompass other supply-chain emissions.[14]

CARBON-NEUTRAL INSTITUTIONS IN THE UNITED STATES

While hundreds of institutions are working toward carbon neutrality, 11 HEIs in the U.S. have already announced neutrality under the terms of the Carbon Commitment as of December 2020. We commend these HEIs on their leadership, their ambitious climate actions, and their achievement of carbon neutrality within the standards of the Climate Leadership Commitments.

We refer to the approach taken by these schools as ‘‘neutrality first.’’ The institutions have combined on-campus emissions reductions with off-campus accounting-based reductions to meet neutrality across Scopes 1, 2, and 3 earlier than major campus infrastructure would generally allow. As many of these institutions have emphasized, a neutrality-first approach is based on the scientific consensus that we must reduce emissions rapidly to get on track for less than 1.5°C warming.[2] Figure 1 shows the aggregate emissions of the carbon-neutral HEIs in their year of neutrality and the aggregate emission reductions by category (see Notes S1–S11 for more details on each school).

Each institution achieved neutrality through a different pathway (Figures 2 and 3), yet there are some similarities in

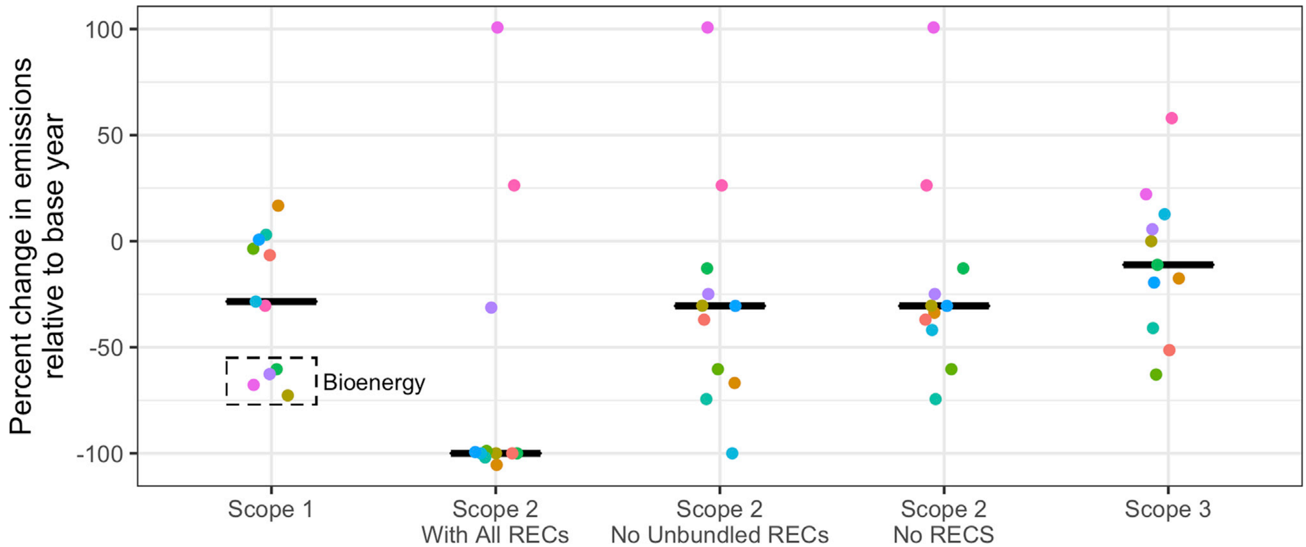

Figure 2. Reductions by scope for each carbon-neutral HEI before offsets

Reductions (as percentages) from baseline year are shown below zero; increases in emissions are shown above zero. Colored dots represent the same institution across scopes, and bars are the median. Scope 1 represents on-site combustion, Scope 2 purchased electricity, and Scope 3 institution-funded air travel and employee commuting. In this figure, we treat bioenergy (HEIs in the dotted box) as carbon neutral, consistent with reporting guidelines. Scope 2 emissions are shown including all RECs purchased (bundled and unbundled), only counting RECs tied to a power purchase agreement (no unbundled RECs), and before accounting for RECs (no RECs, i.e., gross changes in Scope 2 based on electricity consumption and grid intensity). One school had a significant increase in local grid intensity since the baseline year.

approaches. First, roughly half of institutions achieved meaningful reductions in their Scope 1 on-site fossil-fuel emissions between their baseline year (the year against which they measure reductions, ranging between 2007 and 2012) and neutrality year. The median reduction in fossil-fuel-based Scope 1 emissions for these institutions was 28%, but three institutions actually saw their gross Scope 1 emissions increase from the baseline year to the carbon-neutrality year. Schools generally achieved Scope 1 reductions through building and transportation efficiency measures or by switching heating fuels, for example, to bioenergy. The four institutions with the largest reductions in reported Scope 1 emissions all deployed bioenergy strategies (box in Figure 2), which we discuss in more detail below.

Approaches to reducing Scope 2 emissions varied. Many schools installed some amount of on-site solar generation to reduce purchased electricity emissions, while most (nine) schools purchased renewable energy certificates (RECs) to "cover" Scope 2 emissions (Figure 2). RECs represent the environmental attributes of renewable energy generated elsewhere; "bundled" RECs are associated with new power purchase agreements (PPAs) for renewable electricity, while unbundled RECs are purchased from voluntary markets without associated electricity contracts (see below). All institutions reduced Scope 2 emissions simply due to the fact that the carbon intensity of their electricity grid improved from the baseline year to the year of neutrality. For example, the reported carbon intensity of the New York State electricity grid decreased by nearly half from 2007 to 2017.[15] Without accounting for REC purchases, the median reduction in Scope 2 emissions was 31%. With all RECs, the median reduction was 100%.

Finally, these institutions reduced Scope 3 emissions covered by the commitment (primarily institution-funded airline travel and employee commuting) through on-campus incentive programs. The median reduction was 11%, but reductions varied widely. Some schools reduced Scope 3 emissions by over 50%, whereas four schools saw their Scope 3 emissions increase from their baseline year to their neutrality year (Figure 2). It is important to note that changes in other Scope 3 emissions, such as embodied carbon in the supply chain from purchased goods (e.g., food and building materials), are not required to be reported under the Carbon Commitment. This is particularly relevant for natural gas, as schools substituting natural gas for other fuels are "shifting" some emissions outside of their neutrality commitments, moving them from Scope 1 (combustion) to Scope 3 (upstream leakage from natural gas infrastructure).[16]

No institution achieved net neutrality without significant use of accounting-based instruments (Figure 3). The majority of all claimed emissions reductions come from purchased offsets (payment to a third party for avoided emissions or sequestration) and unbundled RECs rather than direct emission reductions by the institution (Figure 2). The median use of offsets and unbundled RECs as a share of emission reductions at the time of neutrality was 63% (46%–107%). The purchased carbon offsets came primarily from landfill methane and forestry practices (Figure 4). When bioenergy is included, the median use of these three accounting-based measures rose to 81% (53%–107%) (see discussion). In aggregate, these three measures were 77% of total reductions.

Finally, two institutions relied considerably on carbon sequestration from college-owned land (Figure 1; Notes S6 and S10). In this case, the annual carbon sequestered in institution-owned forests was considered as a reduction in emissions (a "credit" against gross emissions). Current guidance discourages schools from counting institution-owned land sequestration without a

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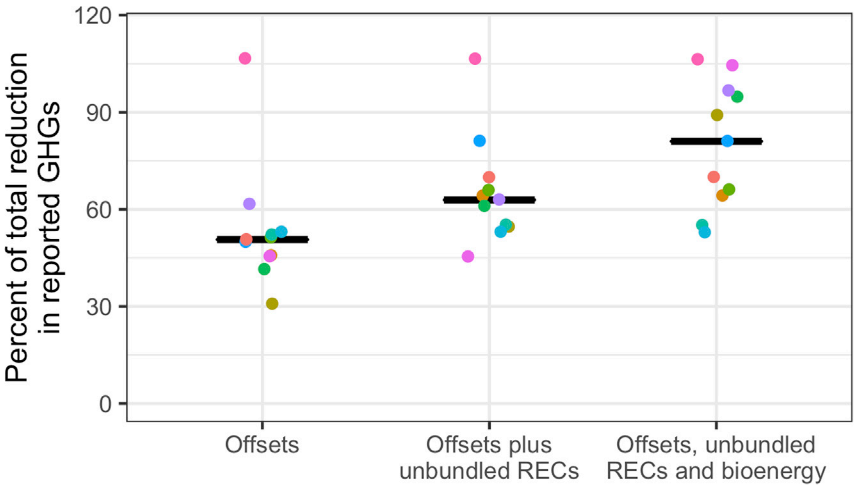

Figure 3. Share of reductions in HEI GHG emissions coming from three accounting-based strategies
Dark bar represents the median.

demonstration of additionality (i.e., proof that all of the reductions represent genuine reductions relative to the status quo).[17] These institutions effectively treat the carbon sequestered on their forest land as additional relative to the regional landscape of forest management in their areas. In other words, by conserving the forest, the institution is sequestering more carbon than it would in a world in which the forest land was not owned by the institution. One institution has highlighted that this would make their institution-owned land eligible for offsets under California's Forest Management Compliance Offsets Program, which considers carbon sequestered from activities that are not "common practice" to be additional. However, a more conservative approach to assessing additionality at the project level would find that a forest stewardship plan that has been largely unchanged since the baseline year is unlikely to result in additional carbon sequestration relative to business as usual.

Our discussions with these institutions highlight ongoing challenges in additionality assessments that are playing out beyond U.S. HEIs.[18] While differences in analyses of additionality frequently turn on differing approaches to counterfactuals, we have discussed the land sequestration approaches with these institutions and remain unconvinced that this sequestration, although associated with positive land-management practices, is additional in a way that should be counted toward neutrality at the institution. At the same time, it is critical for institutions to model good land-management practices for a climate-constrained world, and both institutions who chose to count sequestration from institution-owned land highlighted the attention to sustainable practices involved in their decisions (and the risks associated with institutions ignoring land-management emissions).

THE POTENTIAL BENEFITS OF A NEUTRALITY-FIRST APPROACH

Early target dates for net carbon neutrality are designed to recognize the urgency of reducing emissions and that every ton of GHG emissions reduced today reduces future climate damages. These benefits accrue whether they come from on-site shifts away from fossil fuels, improvements in energy efficiency, or high-quality off-site reductions (but only under the strong assumption that all of those reductions are real, permanent, and additional). In theory, ambitious neutrality commitments should lead schools to reduce emissions faster than those without. (We do note that current practice has not resulted in large reductions in reported Scope 1 emissions for these HEIs, other than those that adopted bioenergy strategies [Figures 1 and 2]. Given the small number of carbon-neutral HEIs and the quality of the self-reported data, we cannot quantitatively test here whether, for example, on-site emissions fell faster at the neutrality-first institutions relative to others with later commitments.) Second, neutrality commitments have catalyzed infrastructure changes, motivating institutions to update heating technology, deploy energy-efficiency measures, and build on-site renewable generation (see Notes S1–S11 for school profiles). Finally, aggressively pursuing carbon neutrality has led to cultural changes at several institutions, putting in place institutional structures for advancing sustainability that will continue into the future. Sustainability directors at these institutions report that achieving carbon neutrality "early" relative to other institutions mainstreamed climate-focused thinking throughout institutional decision-making processes (K. Payson and J. Pumilio, personal communications). Several institutions also note that they are actively continuing to pursue emission reductions even after meeting neutrality, for example by expanding agreements for renewable energy,[19,20] suggesting that achieving neutrality was a catalyst for further action at these institutions. At the same time, the benefits of a focus specifically on neutrality in the near term must be weighed against the notable challenges with the dominant strategies usually required to meet these goals quickly, as we describe in more detail below.

ACCOUNTING-BASED EMISSION-REDUCTION STRATEGIES

Our analysis shows that the majority of emission reductions at neutrality-first HEIs have come from accounting-based strategies (Figure 3). We underscore that these strategies are widely used and are standard under the guidelines used to administer the Second Nature Carbon Commitment. Given that HEIs are among the first large sectors to adopt carbon-neutrality goals and thus serve as a highly visible model for pathways to carbon neutrality, it is worthwhile to assess these institutions' strategies in detail. In the next sections, we discuss three salient strategies used by carbon-neutral HEIs: (1) the use of unbundled RECs to reduce Scope 2 emissions; (2) the use of bioenergy sources to reduce Scope 1 emissions; and (3) the use of purchased carbon offsets.

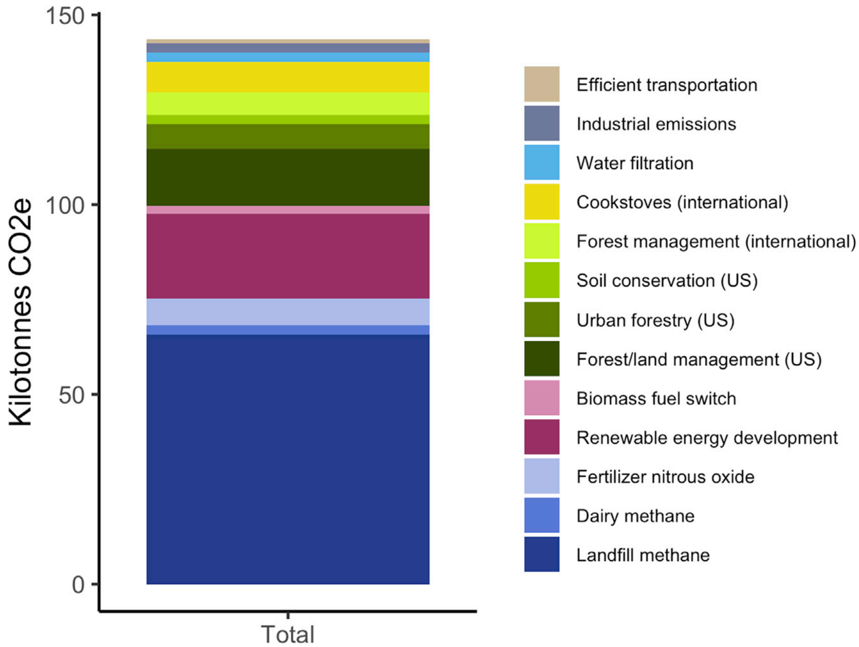

Figure 4. Types of offsets purchased by the 11 HEIs to declare carbon neutrality
See also Figure S3.

Unbundled renewable energy certificates

Claiming emissions reductions from off-site renewable sources that enter the electrical grid requires an accounting-based approach because one cannot track specific electrical energy from generation source to outlet. RECs were created as a means to track quantities of electricity (not emissions) associated with the generation of renewable energy such as wind and solar. RECs are accounting instruments that are typically used to track compliance with state renewable portfolio standards that have specified targets for the percentage of electricity sales from renewable energy sources each year. However, RECs are also sold in voluntary markets and purchased by institutions or other entities who want to demonstrate their green credentials. (Unlike utilities, these institutions are not required to hold RECs.) Thus, RECs are treated as the "environmental attributes" of renewable generation, and the holder of an REC has the right to claim credit for the renewable power generated. In most GHG accounting systems, including the Carbon Commitment under Second Nature, the REC holder can claim the number of kilowatt-hours represented by the RECs as zero-carbon electricity in their Scope 2 emissions.

RECs can be contracted with their corresponding electricity at the time when new renewable generation is financed. These RECs are considered "bundled RECs" because the REC is purchased in a "bundle" with the rights to the electricity in a PPA. Holders of bundled RECs note that this approach provides capital to put new renewable energy on the grid and can force utilities to build additional renewable energy to comply with state renewable mandates (because a bundled project does not allow the RECs from that new renewable project to be used for utility compliance), with the result that PPAs are increasingly being adopted as best practice.[8,21] Potential pitfalls include the fact that new renewables in states with binding cap and trade programs do not reduce the overall capped emissions,[22] and that the actual impact of any renewable generation depends on the electricity it displaces and the precise details of the policies and incentives involved.[23]

Unbundled RECs, on the other hand, are sold through secondary markets separately from the purchase of the power itself, and they can derive from existing renewable generation that is likely to run regardless of the sale of the REC. Modeling of REC purchases suggests that, in some cases, they are unlikely to increase the amount of renewable energy on the electricity grid, and as such these purchases may lead to little or no actual change in emissions.[23–28]

Most RECs used by the U.S. HEIs in our data are not bundled (Figure 1). Of the nine schools that purchased RECs to achieve Scope 2 emission-reduction goals, seven purchased only unbundled RECs. From conversations with HEI sustainability practitioners, most in the field regard bundled RECs as "higher quality," and at least three institutions have pursued PPAs with bundled RECs in subsequent years (Notes S3, S5, and S10).

In the absence of more evidence that unbundled RECs are having an impact on the amount of new renewable energy generation, these credits may represent a "dead end" as a systems solution—providing the appearance of action but de minimis systems or climate impact. Bundled RECs with a PPA offer a move in the right direction, but even here more research is needed to understand their impacts on electricity markets and emissions. Ultimately, most HEIs cannot escape the fact that they depend on the larger overall grid and policy-induced shifts in generation, transmission, and storage to achieve meaningful decarbonization of purchased electricity.

Bioenergy

In the northeastern U.S., home to many of the HEIs leading carbon-neutrality efforts, bioenergy has been a popular option for carbon mitigation, but one that is complicated by the scientific uncertainty and lack of a broader U.S. policy strategy. Five of 11 institutions deployed biomass or biomass-derived fuels for on-site use as part of their neutrality strategy. Many current accounting practices (including those in higher education) effectively treat bioenergy as carbon neutral[29] by assuming that carbon uptake during post-harvest regrowth of forests offsets carbon emitted to the atmosphere through biomass combustion. The U.S. Congress has directed the Environmental Protection Agency (EPA) to treat biomass this way via a budget rider,[30] and various European governments view biomass similarly (but with a range of sustainability and carbon-neutrality criteria).[31]

However, treating all bioenergy as carbon neutral is not supported by the best available science. A 2012 report by EPA's

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Science Advisory Board[32] concluded: "Carbon neutrality cannot be assumed for all biomass energy a priori. There are circumstances in which biomass is grown, harvested, and combusted in a carbon-neutral fashion, but carbon neutrality is not an appropriate a priori assumption; it is a conclusion that should be reached only after considering a particular feedstock's production and consumption cycle."

Bioenergy accounting is complicated by the fact that analyses in the peer-reviewed literature still reach widely divergent conclusions, with some studies claiming that wood pellets offer lower emissions relative to coal within a few years in the United Kingdom[33] and others suggesting that the use of biomass increases net emissions for decades.[34] Recent work suggested that even relative to coal (most institutions are displacing less carbon-intensive natural gas), carbon payback periods for northeastern forests were likely to range from 50 to 100 years.[35] Significantly, even if the "carbon debts" are short, front loading of emissions to be offset by later sequestration (i.e., net carbon neutrality over time) still may not be climate neutral. System lags mean that the early pulse of CO_2 will increase the heat trapped in the climate system for years after the pulse has been offset by sequestration, and this short-term warming may push the climate system into feedback loops that accelerate warming.[36–38]

Several institutions took substantial steps to locate bioenergy with the best possible environmental profile. This meant sourcing biomass from thinning or waste, from within a particular radius to reduce transport, and/or from forests that were registered as sustainable working forests so that the land was likely to experience regrowth. While bioenergy use at these institutions represents an optimistic scenario whereby "sustainably" harvested biomass from forested regions is used in high-efficiency cogeneration of heat and electricity,[39] current certifications around forest practices are not by themselves capable of ensuring a short-term neutral climate impact. The supply of "sustainable" biomass which is actually near neutral[31] may place constraints on the availability of these solutions to scale,[39] limiting the ability of HEIs that utilize bioenergy to model approaches for scalable change.

Particularly important from a systems perspective is the global impact that large-scale bioenergy production could have on land use and air quality in a climate-constrained world. The most recent Intergovernmental Panel on Climate Change special report on climate change and land concluded that while bioenergy can contribute to mitigation, it could also have negative impacts on food security, desertification, and land degradation if best practices are not followed to limit bioenergy production to marginal lands or abandoned cropland.[40] Conversely, economists project that economic uses for forest products could slow the rate of land conversion by making it economic to maintain ownership of forests and intensify management for more biomass,[41] a dynamic that will be very sensitive to markets and local conditions.[42]

The neutrality-first HEIs that switched to bioenergy reported substantial reductions in Scope 1 emissions when they counted it as carbon neutral. If they treated the biogenic CO_2 as emissions (with zero offsetting land uptake), most would have seen an increase in emissions (Figure S2). The truth likely lies somewhere in between. It is beyond the scope of this perspective to resolve the debates around bioenergy's neutrality or detail best practices to account for biomass resources. Instead, we highlight the fact that current accounting for carbon neutrality typically treats bioenergy as carbon neutral even though the scientific literature does not support that categorical treatment, as well as the significant challenges of ensuring good climate outcomes in the absence of broader state or national policy.

Offsets

Although the carbon-management hierarchy generally urges that offsets be used as a last resort to cover difficult-to-reduce emissions such as air travel, purchased offsets are the single largest source of reductions for nine of the 11 schools that have announced carbon neutrality (Figure 3)—well in excess of what is needed to offset air travel (5%–31% of emissions). One institution achieved carbon neutrality with essentially no net on-site reductions, entirely through the purchase of offsets (Note S12).

In theory, offsets represent a way for actors to reduce emissions at the lowest cost possible, finance reductions in other countries, and address sectors that might not otherwise be covered by a carbon pricing program (e.g., land-use emissions, biogenic methane) by paying a third party for real, permanent, and verifiable emission reductions. In practice, offsets have been a controversial policy tool. Early implementation of offsets under the Kyoto Protocol and the Clean Development Mechanism led to some high-profile failures, including perverse incentives to generate more fluorinated GHG emissions.[43–45] Ensuring that offset projects are truly additional and that they are permanent (i.e., the carbon sequestered through an offset project is not later lost to the atmosphere) is extremely challenging,[46–49] even for best-in-class programs such as California's regulatory Compliance Offset Program.[18]

Voluntary (non-regulatory) carbon offset markets[50]—those most available to HEIs—are a special challenge because the lack of government oversight can mean that transparency and quality enforcement suffer.[51] "High-quality" voluntary market offsets should meet "PAVER" requirements (Permanent, Additional, Verifiable, Enforceable, and Real). However, the relatively small amount of academic literature on offsets[18,49,52] in comparison with their complexity and policy relevance creates real challenges for institutions looking to achieve neutrality. Nonetheless, offsets are widely and frequently purchased by firms, institutions, and individuals; the voluntary offset market represents ~$300 million each year.[53]

The use of carbon offsets to achieve emission-reduction goals also raises potential equity and justice concerns. Environmental justice groups and researchers point out that if neutrality is achieved primarily through offsets, conventional air pollution from fossil energy sources (potentially including those on campuses) may continue to impact vulnerable and marginalized populations.[54] In the U.S., local air pollution from fossil-fuel combustion disproportionately impacts communities of color.[55] The 2019 New York Climate Leadership and Community Protection Act requires that offset projects have local co-benefits and limits their use to settings where on-site reductions are not feasible, demonstrating some policy-makers' concern that offsets are being overused to achieve neutrality.[56]

These concerns about offsets are not lost on neutrality-first institutions. The prevalence of landfill methane offsets among neutral HEIs (Figure S3) is consistent with a focus on quality, as these offsets can have lower additionality and reversal

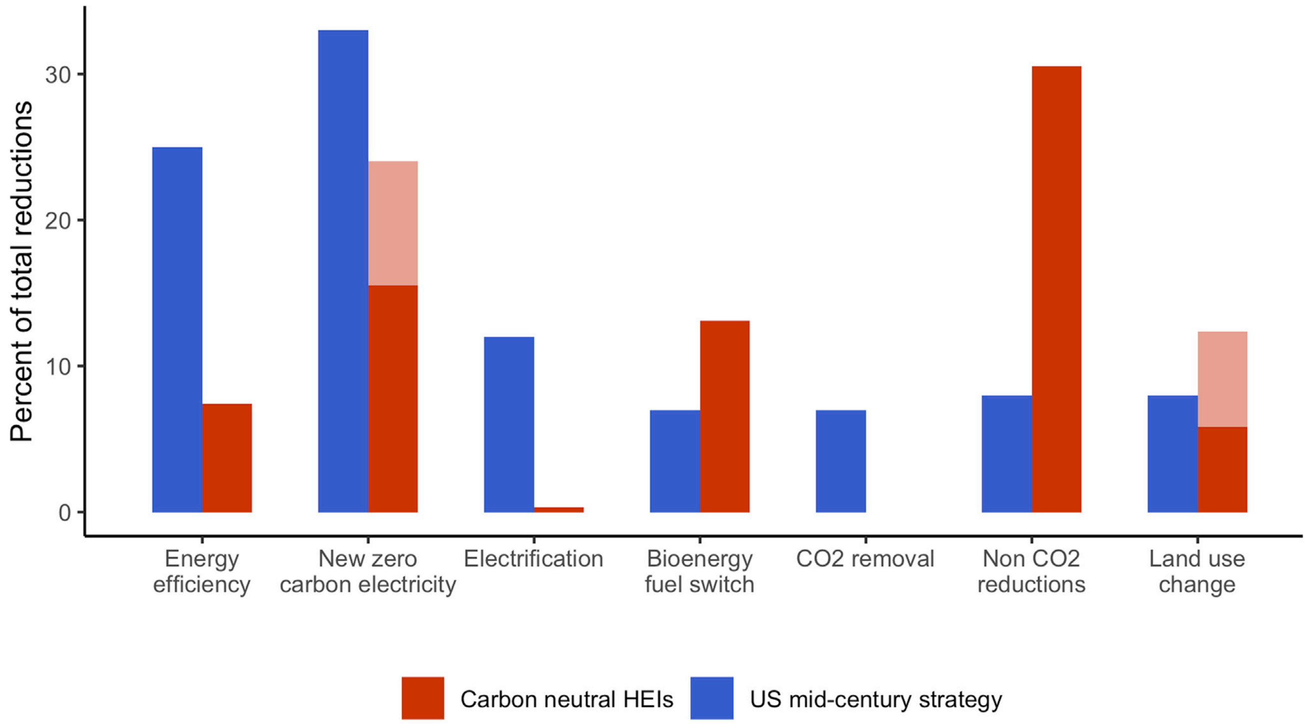

Figure 5. Share of emissions reductions by strategy for the U.S. deep decarbonization study versus HEI strategies
Emission reductions by type under the Obama Administration's U.S. Mid-Century Strategy and under current carbon-neutral U.S. HEIs. HEI reductions do not sum to 100 because we do not assume here that unbundled REC purchases lead to changes in emissions. Renewable energy from offsets and college-owned land sequestration are shown in lighter red. The percentages shown are meant to illustrate patterns rather than provide exact numerical information.

concerns. Nearly all of the carbon-neutral schools have adopted policies guiding their procurement of offsets to promote offset quality and to align with other environmental and social concerns. Colby College, for example, adopted a policy that all offset projects must advance the UN Sustainable Development Goals.[57] We note that there is an emerging practice of offsetting historical emissions[58] or pursuing "climate positivity," whereby risks around additionality are less critical because these purchases are not "displacing" emission reductions elsewhere and can form an important source of finance.

Ultimately, while the best offsets represent a potential mechanism to obtain urgently needed GHG reductions and finance of neglected sectors, we suggest that there are limitations to voluntary market offsets as a tool to support societal decarbonization. Cost pressures may push institutions to seek lower-cost (and therefore potentially lower-quality) offsets, a concern raised even by offset developers.[53] At worst, supporting voluntary markets can risk strengthening incumbents who might lobby against regulation of those sources[18] (for example, landfill methane could also be reduced by regulations) or for weaker offset provisions in a federal program (as happened in 2009).[59]

DISCUSSION

Scalability of current U.S. HEI approaches to neutrality

The original ACUPCC is a strong framework for working toward system-scale change with leverage greater than the quantity of emissions reduced.[60] An analysis of a subset of schools under the ACUPCC found that schools participating in the commitment had 47% lower purchased electricity emissions and 27% less energy use (both on a per-square-foot basis) compared with non-signatories.[61] There is evidence that carbon-neutrality commitments, combined with the associated reporting, planning, and implementation, have played an important role in driving education and real GHG emission reductions.

However, a firm quantitative metric for carbon neutrality risks falling victim to Goodhart's law, which states that metrics quickly lose effectiveness as individuals and firms optimize to the metric rather than its intent.[62] Strict adherence to by-the-book neutrality goals has the potential to introduce behaviors that look more like regulatory compliance than true climate leadership and innovation. As described above, a few of the schools announcing carbon neutrality relied substantially on offsets and/or unbundled RECs to "achieve" carbon neutrality (Figure S4).[63,64] Despite emerging best practices and norms to ensure high-quality emission reductions for these strategies, unbundled RECs and a high reliance on offsets does not demonstrate an approach that can be widely adopted to achieve broad-scale climate goals.

Reliance on off-site reductions cannot scale to the larger U.S. economy; we cannot achieve urgent climate goals (e.g., 50%–52% emission reductions by 2030) without direct decarbonization of electricity, transport, industry, and buildings. Collectively compiled, the strategies of these schools differ significantly from the mix of strategies that large-scale studies of decarbonization predict for the U.S. as a whole (Figure 5). Relative to the U.S. Government's 2016 Mid-Century Strategy (MCS) for Deep Decarbonization,[65] which characterized reductions needed to offset growth and reduce emissions 80% by 2050, the HEIs we analyze here have underinvested in energy efficiency, new zero-carbon electricity, and electrification (which make up 71% of total reductions in the MCS) in favor of bioenergy and methane reductions. While this is an imperfect comparison between national and institutional strategies (we cannot estimate how much energy efficiency offset growth for HEIs) and short- versus long-term approaches, the relatively small shares of new clean energy, CO_2 removal, and electrification suggest that HEIs may be missing opportunities to catalyze progress in these critical approaches. Bowdoin College was the only school in our dataset that we are aware is moving rapidly from "neutrality" under the terms of the ACUPCC toward a detailed decarbonization plan that will electrify campus heat and provide 100% renewable energy via PPAs. A focus solely on achieving neutrality first risks over-reliance on accounting mechanisms, potentially delaying necessarily infrastructure (and policy) changes critical to societal decarbonization.

From institutional neutrality to a systems approach

Given the increasingly widespread adoption of neutrality targets across the world and the concomitant concerns about the accounting-based reduction strategies highlighted above, we envision a "systems" rather than a "compliance" approach that focuses on the aspects of neutrality that can help contribute to the policy and market shifts needed at larger scales. Importantly, a systems approach can work in tandem with a carbon-neutrality target. In this approach, a neutrality target is an optional milestone rather than an end goal and should be considered one component of the broader system-wide decarbonization that can be led by HEIs. A few HEIs in our study displayed aspects of a systems approach to decarbonization (with neutrality as a milestone), but this type of approach is not yet codified or established as general practice in HEI carbon accounting (or most other sectors).

What does a systems approach to climate action look like for HEIs? Robinson et al.[66] discuss the strengths of HEIs as change agents, noting that they have "agency to change structures," "agency to pursue novel practices," and "agency to link novel practices to structures."

Changing structures (i.e., decarbonizing systems) should include transforming the campus heating and transportation infrastructure to run on zero-carbon electricity (e.g., heat pumps). While not easy, reframing a goal around decarbonization is essential, as it is clear that the neutrality commitments for these HEIs did not uniformly lead to reductions in on-site GHG reductions. Separating decarbonization from negative-emission technologies and offsets can reduce risks associated with technology lock-in and excessive offsetting[67,68] and can build regional technical capacity.

Novel practices (i.e., innovation) would include piloting new experimental technologies, decision-making tools, or policy approaches. Innovation includes ongoing research, development, and deployment of carbon capture and storage, direct air capture, new energy-efficiency approaches, and other new technologies. Rather than neglect most Scope 3 emissions outside the current ACUPCC framework, HEIs should actively address them. HEIs can use their purchasing power to create further market pressure to account for and reduce emissions in their supply chains. HEI dining services can continue to explore ways to shift norms and purchases toward more climate-friendly diets.[69,70] Given the likely continued use of some offsets on the pathway to decarbonization, the potential for research by HEIs to innovate in this space is underutilized. Recent guidelines from the Offset Network—a group of HEIs implementing their own offset projects—encourage more innovation and attention to co-benefits.[71] The University of California (UC) recently released a "Request for Ideas" to catalyze new UC-led offset projects.[72] More institutions could harness their research capacity to implement innovative projects that support campus research and education goals, investigate the quality of existing offset projects, develop new frameworks and approaches to support the reduction of these emissions (including new ways to finance them), and identify those projects that provide benefit to local communities and vulnerable populations to ensure climate justice. However, given the increasing focus on concerns about current offsetting practices[73] in the broader policy landscape, we suggest that climate action leadership at HEIs means shifting the focus from a heavy reliance on offsets as a compliance mechanism toward a focus on the broader systems and flows of finance required to reduce emissions from sectors such as land use.

Linking novel practices to structures (i.e., scale) could include partnering with local governments to deploy transportation strategies or district heating. These kinds of measures produce knowledge than can be transferred outside the institution to help drive technical and policy innovation. For example, the UC has created a working group combining facilities and academic expertise across campuses and have focused on areas that could scale and create significant learning spillovers, including energy efficiency and electrification.[74] More research that evaluates whether sustainable forest management actually produces net carbon gains across all pools in the long term and whether bioenergy demand can successfully alter regional economics to increase net forest carbon would also be especially useful.

Finally, to incorporate the systems approach into their climate actions, institutions that announce a "neutrality" milestone should pair it with a clear deadline for decarbonization of Scope 1 and Scope 2 emissions. This commitment can ensure that schools resist the temptation to "coast" on offsets instead of continuing to work diligently on campus emissions. Given the Biden-Harris administration's commitment to net zero by no later than 2050, leading U.S. institutions should have targets well before that date.

CONCLUSIONS

Our analysis demonstrates strengths and limitations of non-state action to reduce GHG emissions. It mirrors conversations in the business sector about whether a firm can be considered responsible in the climate space if it is individually carbon neutral but fails to use its full leverage for policy changes at the state, national, or international level.[75] It also shows how institutional actions can be undermined by the lack of strong standards and broad-scale policies for electricity, land use, bioenergy, and transportation. While virtually any climate action was likely to be constructive when HEI carbon-neutrality efforts began, institutions now need to think carefully about how to take action that charts an appropriately ambitious pathway toward decarbonization for society. As we note above, neutrality commitments have served as an important collective frame, a catalyst for institutional change, and an action-forcing deadline for these HEIs. However, it is not clear from our analysis that net carbon neutrality alone focuses HEIs (or any institution) on where they can have the most impact or that it drives decarbonization at the needed pace.

As resources are limited in the wake of the COVID-19 pandemic, it will be more important than ever for all institutions to prioritize the many rapid system-scale changes needed to avoid the worst impacts of the climate crisis. One lesson is that, even if the substantial risks and uncertainty associated with some accounting instruments are addressed through careful consideration and study, institutions cannot neglect the need to eliminate on-site GHG emissions and to pay more attention to their full supply-chain emissions. A second lesson is that climate leadership is best represented by those institutions that have used their push for neutrality to help catalyze broader efforts to decarbonize. Finally, these lessons highlight the need for global "rebranding" of institutional neutrality commitments as an optional milestone that can catalyze further action toward societal decarbonization rather than the end goal of institutional climate initiatives. While it is critical for institutions to take responsibility for reducing their own emissions as quickly as possible, we should be evaluating their actions in the context of our social responsibility to reduce emissions globally.

EXPERIMENTAL PROCEDURES

Methods

U.S. HEIs that have achieved carbon neutrality were assembled by reviewing press reports and consulting with staff at Second Nature, which manages the Presidents' Climate Leadership Commitments (previously the ACUPCC). Eleven schools that achieved neutrality under the terms of the "Carbon Commitment" were identified as of December 31, 2020 (see supplemental experimental procedures for additional details).

Information on schools with neutrality commitments were obtained from the Second Nature reporting portal. Gaps in reporting were supplemented with data from the Association for the Advancement of Sustainability in Higher Education, schools' emissions inventory spreadsheets, and correspondence with the sustainability staff of the institutions. To ensure equivalent comparison across HEIs (despite differing amounts of time since neutrality) and reflect the terms of the ACUPCC, all reductions are represented for the year in which the school announced neutrality (subject to minor adjustments as described in supplemental experimental procedures). Post-neutrality plans and measures we are aware of are described in Notes S1–S11 for each HEI. Emission Scopes 1, 2, and 3 (typically only commuting and air travel for Scope 3, no other purchasing or upstream methane leakage, etc.) are all included in the institutions' gross baseline and carbon-neutral year emissions. A number of adjustments, documented in the available R code and in supplemental experimental procedures, were needed to ensure uniform and representative comparisons across the self-reported data.

To give a rough comparison of the relative mix of strategies across schools, we compared the breakdown of aggregate emission reductions from HEIs to the Obama Administration's MCS for Deep Decarbonization[65] by making a few simplifying assumptions (see supplemental experimental procedures). This is an imperfect comparison, as the MCS reductions are for 2050 and are measured against a baseline with considerable growth rather than relative to a historical baseline year. These combined assumptions mean that the figure only roughly approximates the attribution of sources of reductions.

Resource availability

Lead contact

Further information and requests for resources should be directed to and will be fulfilled by the lead contact, Alex Barron (abarron@smith.edu)

Materials availability

This study did not generate new unique materials.

Data and code availability

- Reported emissions data are available through Second Nature (https://reporting.secondnature.org/). Compiled institutional emissions data used here have been deposited at Zenodo under https://doi.org/10.5281/zenodo.5217590 and are publicly available as of the date of publication. All other data reported in this paper will be shared by the lead contact upon request.
- All original code (R v4.0.0, R Studio v1.3.1056) has been deposited at Zenodo under https://doi.org/10.5281/zenodo.5217590 and is publicly available as of the date of publication.
- Any additional information required to reanalyze the data reported in this paper is available from the lead contact upon request.

SUPPLEMENTAL INFORMATION

Supplemental information can be found online at https://doi.org/10.1016/j.oneear.2021.08.014.

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AUTHOR CONTRIBUTIONS

Conceptualization and methodology, A.R.B. and A.L.S.; investigation, A.R.B., A.L.S., M.D., and L.E.M.; data curation, A.R.B., A.L.S., M.D., and L.E.M.; software, L.E.M.; visualization, A.R.B., A.L.S., and L.E.M.; writing, A.R.B., A.L.S., L.C.D., M.D., and L.E.M.; supervision, A.R.B. and A.L.S.

DECLARATION OF INTERESTS

The authors declare no competing interests. For transparency, we note that A.R.B. has consulted in the past for Environmental Defense Fund and the Center for Applied Environmental Law and Policy on topics unrelated to this study, A.R.B. has received funding from the Hopewell Fund for unrelated research, and his spouse works for Clean Energy Works.

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