Carbon Offsets

An Overview for Scientific Societies

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Version 1.2 June 24, 2018

Executive summary

Carbon offsets are mechanisms allowing individuals and organizations to "offset" activities (such as air travel) that emit carbon dioxide (CO_2) and other greenhouse gases by funding mitigating activities (such as landfill methane capture) elsewhere. For scientific societies, where air travel to conferences plays a central role in the organization's activities, carbon offsets offer an immediate response to the issue of climate change while longer-term, more comprehensive plans to reduce carbon emissions are being developed.

The world of carbon offsets—what kinds of offsets are available, what organizations offer them, how they are vetted and evaluated, which ones are considered good, how much they should cost, etc.—is rather complex, and there are arguments both in favor of and against purchasing them. This report is an attempt to summarize what we have learned about this world while developing recommendations for SIGPLAN, the Special Interest Group on Programming Languages of the Association for Computing Machinery, as part of a larger effort to evaluate potential ways for SIGPLAN to respond to the issue of climate change. Our conclusion is that, on the whole, purchasing carbon offsets is a good short-term strategy for mitigating climate effects of conferences.

Four basic criteria are commonly used to evaluate carbon offsets (*additionality, permanence, absence of leakage,* and *verification*), and several different *standards* (such as the *Verified Carbon Standard*, the *Gold Standard*, and the *Clean Development Mechanism*) are used by *vendors* (such as *atmosfair* and *Cool Effect*) to certify that particular carbon-offset *projects* satisfy these criteria to an acceptable degree. Types of offsetting projects range from renewable energy development and energy efficiency improvements to reducing carbon emissions from industrial and agricultural processes and to biosequestration (e.g., planting trees), to deploying technologies for carbon capture and storage. The Stockholm Environmental Institute (SEI) found that the types of projects most likely to deliver reliable greenhouse gas reduction while furthering (or at least not damaging) the United Nations Sustainable Development Goals (SDGs) were methane capture projects such as wastewater treatment, manure management, and landfill gas capture. Offsets also vary widely in cost (from less than $1 USD to more than $50 USD), depending on project type, vendor, certifying standard, geographical region, and

other factors. A typical cost for rigorously certified offsets from reputable vendors is around $9–$15 USD per ton of CO_2e ("CO_2-equivalent," the standard unit of measure for greenhouse gases).

Opinions vary about whether carbon offsets are a good idea at all. In particular, critics point out that the convenience and inexpensiveness of offsets may lead organizations to delay challenging conversations about how to actually reduce their emissions. On the other hand, offsetting is a concrete step that can reduce overall emissions significantly in the short term while more permanent solutions are being developed; it can thus be an effective stopgap measure, especially in large organizations where deeper changes require buy-in from many individuals. Moreover, offsetting may help develop a mindset of noticing and measuring emissions, in effect creating a self-imposed carbon tax. On balance, we agree with the proponents.

With all this in mind, we offer some specific recommendations:

- We recommend carbon offset purchases as a short-term or partial carbon strategy, while organizations or individuals pursue overall carbon emissions reductions.
- We recommend supporting projects that use the Gold Standard, the most demanding of the three common standards.
- We currently recommend purchasing offsets from either Cool Effect or atmosfair. Cool Effect offers a range of project types including some that seem to have a very high likelihood of reliable carbon reduction; works with a number of established organizations in science, technology, and the environment; and claims to donate an impressive 90.13% of funds collected to the sponsored projects. However, Cool Effect's Web site is somewhat U.S.-centric, only listing prices and taking payment in U.S. dollars. Atmosfair also works with project types with a high likelihood of reliable carbon reduction, has received consistently very good reviews, and is notable for exclusively sponsoring Gold Standard-certified or Gold Standard certification-pending projects. Its website works well with purchasers from multiple countries; however, its offsets are expensive compared to Cool Effect and other high-quality vendors.

Appendix A suggests further reading on carbon offsets. Appendix B compiles examples of non-profit organizations that have purchased carbon offsets or recommended purchases to their constituents. Appendix C is a quick-start for individuals wishing to purchase offsets.

Your comments on this report are greatly appreciated! The text is available as a live Google Doc, where you can add comments and suggestions directly.

What are Carbon Offsets?

Carbon offsets are a “credit for negating or diminishing the impact of emitting a ton of carbon dioxide by paying someone else to absorb or avoid the release of a ton of CO_2 elsewhere.” Simply being alive entails that your individual effect on the planet is carbon-positive (because animals such as humans emit CO_2, if for no other reason), and this effect increases with the use of electricity from non-renewable sources, transportation involving fossil fuels (particularly air and car travel), and all the supporting industries and infrastructures that themselves are carbon positive (i.e., purchasing red meat, or indeed most products). However, by paying for the reduction of carbon emissions elsewhere, you can reduce the net effect of some or all of these activities so as to be carbon-neutral or even carbon-negative.

For example, you might purchase a carbon offset that funds a project that supplies more-efficient cookstoves in a developing nation. More-efficient cookstoves can mean significantly less fuel required for cooking, which in turn can result in fewer carbon emissions from burning wood or charcoal and less deforestation.

Criteria for Quality Carbon Offsets

Environmental experts have identified a number of criteria to look for in a carbon offset. Some of the most common criteria are Additionality, Permanence, absence of Leakage, and Verification.

Additionality refers to whether the carbon emissions reduction or mitigation would have happened without the offset. If, for instance, the carbon offset project pays a factory owner to install new, less-carbon-emitting equipment, but the factory owner had planned to install the equipment anyway (either because the equipment would pay for itself or because regulation compelled the owner to do so), the carbon offsets would not be additional.

Permanence refers to whether the carbon emissions reduction or mitigation continues for the stated life span. A simple example of this might be regarding a project to plant trees, forecasting that the trees will remove carbon from the atmosphere over a certain number of years. The project must guarantee that the trees will remain in place over the life of the project, instead of being cut down prematurely.

Absence of **Leakage** refers to whether the carbon emissions reduced or mitigated do not occur somewhere else. For instance, if a forest is prevented from being cut down, perhaps a logging company will just cut down a different forest, resulting in no net carbon decrease.

Verification refers to whether all of the above can be independently established by a credible authority.

Standards

Various organizations verify the quality of carbon offsets that are sold, under standards or guidelines that they publish.

The most commonly used standard (by carbon offsets sold under that standard) is the Verified Carbon Standard (VCS), followed by the Gold Standard and the Clean Development Mechanism (CDM). Other common standards are the Climate Action Reserve and American Carbon Registry. (Unlocking Potential: State of the Voluntary Carbon Markets 2017, 15.)

VCS is a standard founded in part by the International Emissions Trading Association, a consortium whose members include major energy and chemical companies, banks, and law firms. Unlike the Gold Standard or CDM, VCS has no requirement that its carbon offset project have additional social benefits, allowing for a wider range of projects.

The **Gold Standard,** founded by organizations that include the World Wildlife Fund, differentiates itself by requiring that carbon offset projects also meet various "sustainable development" goals—beyond offsetting emissions, also contributing to the economic and social welfare and development of the people where the project is taking place. It claims that "[t]he difference we make is to ensure that each dollar of funding goes further." The Gold Standard's sustainability requirements are more stringent than those of VCS or CDM. Perhaps as a result, the Gold Standard focuses on a narrower range of projects, including renewable energy, energy efficiency, waste management, and land use and forests.

CDM is a UN standard established under the Kyoto Protocol, and is to some extent the baseline standard against which other standards are compared. CDM allows for a wide range of projects, although not as wide as VCS (for one, CDM projects are exclusively in developing nations), and has sustainability requirements more stringent than VCS but less stringent than the Gold Standard. CDM has been criticized for backing projects that fail additionality requirements. (How additional is the Clean Development Mechanism?, 152).

Vendors

Voluntary carbon offsets are sold by a number of providers. Here are some that we have explored:

- **Cool Effect** is a U.S. nonprofit and a relatively new player in carbon offsets. Its partners and clients include Audubon, March for Science, Salesforce, and SXSW. Cool Effect touts its transparency, close involvement in project selection, and ability to send 90.13% of funds from carbon offset purchases to its projects.
- **atmosfair** is a German nonprofit. It focuses on mitigating the effects of air travel on climate change. Its projects are exclusively Gold Standard approved or pending approval.

- **Carbon Footprint** is a UK-based for-profit corporation that supplies offsets to the UK government (among others).
- **Go Climate Neutral Now!** is a platform run by the United Nations Framework Convention on Climate Change that allows individuals to purchase carbon offsets from UN CDM projects.
- **NativeEnergy** is a U.S.-based certified B corporation. Its high-profile partners and clients include Ben & Jerry's, National Geographic, National Resources Defense Council (NRDC), and The Sierra Club.
- **TerraPass** describes itself as a "mission-driven business" and is a subsidiary of JustEnergy, a Canadian-based, publicly traded energy company. It offers carbon offsets exclusively for U.S.-based projects.

Types of Carbon Offset Projects

Carbon offset projects seek to avoid or absorb a specified amount of carbon emissions while selling credits for the resulting carbon reduction. Sometimes these are developed in close partnership with carbon offset vendors; other times the vendor has a more distant relationship. Projects are typically verified under a third-party standard.

The Carbon Offset Research and Education (CORE) Initiative outlines six main types of carbon offset projects:

- Renewable Energy—developing renewable energy production, such as solar, wind, hydro, or biomass power.
- Energy Efficiency—encouraging energy efficiency. Examples include distributing more efficient light bulbs or more efficient cooking stoves.
- Industrial Gases—capturing and/or destroying greenhouse gases produced in industrial processes, particularly those that have dramatically more warming effect compared to carbon dioxide, such as nitrous oxide (N2O) or HFC-23.
- Methane Capture—Methane's effect on climate change is between 21 and 72 times more severe than that of carbon dioxide. Thus capturing it and converting it to carbon dioxide can have a big impact on global warming. These projects capture the methane released from activities such as landfills, coal mining, wastewater treatment, etc., and either burn it off or use it as fuel.
- Biosequestration—broadly speaking, keeping carbon in plants by not killing them, or growing plants to absorb carbon. Projects include tree planting and avoiding deforestation.
- Carbon Capture and Storage—Capturing carbon from emissions sources and storing in geological formations.

(This set of categories is neither universally agreed upon nor exhaustive.)

The Stockholm Environmental Institute examined different types of offset projects and rated them on (1) confidence of environmental integrity (their likelihood of delivering the promised carbon offset) and (2) confidence in delivering additional sustainable development goals.

SEI found that projects most likely to deliver both were methane capture projects such as

- wastewater treatment,
- manure management, and
- landfill gas capture

(but not coal mining methane capture).

Projects that had only medium environmental integrity confidence but that were still likely to bring sustainable development benefits included

- household energy efficiency projects like cookstoves and lighting improvements,
- small renewable energy projects,
- municipal projects in solid waste management, and
- energy efficiency of public or commercial buildings, HVAC, or street lighting.

Pricing

Pricing of carbon offsets can vary wildly, for reasons that are far from transparent. This section discusses the range of carbon offsets prices and attempts to explain their variance. We also propose an alternate way of looking at pricing.

We examined carbon offset pricing from a number of carbon offset vendors[1] and found that the vast majority sell offsets to individuals at between $9 USD and $15 USD per ton. Notable outliers include, on the low end, Go Climate Neutral Now!, which as of January 2018 sold offsets at prices between $.38/ton and $8.50/ton, and, on the high end, atmosfair, which sold offsets at 23 EUR / ton (around $28 USD / ton).

In contrast, Ecosystem Marketplace's recent report on voluntary carbon markets found much lower prices for carbon offsets: the average price of carbon offsets in 2016 was $3 USD/ton, although prices paid ranged from little as < $0.5/ton to as much as > $50/ton. (See Unlocking Potential: State of the Voluntary Carbon Markets 2017, 8). Price points varied by standard:

- The average price of offsets sold under the Gold Standard was $4.6/ton.
- Ossets sold under VCS averaged $2.3/ton when not additionally covered by the Climate, Community and Biodiversity (CCB) Standards. Offsets sold under VCS + CCB averaged $3.9/ton.
- Offsets sold under CDM averaged $1.6/ton.

Questions about Pricing

Two questions are raised by these findings.

[1] atmosfair, Carbon Neutral Charitable Fund, Carbon Footprint, carbonfund.org, ClimateCare, Cool Effect, Go Climate Neutral Now!, NativeEnergy, Nature Conservancy, Stand for Trees, and TerraPass.

First, why is there so much variance in the price of carbon offsets? Theoretically, carbon offsets could function as commodities, with every metric ton of CO_2e being fungible; in a free market, prices should then converge. But instead, the voluntary purchase of carbon offsets seems to resemble buying real estate, in that "even if two houses have an identical size and make, there are an infinite number of factors that might affect the selling price." (Unlocking Potential: State of the Voluntary Carbon Markets 2017, 8). Perhaps as a result of the relative lack of regulation and the resulting diversity (and varying quality) of carbon offsets, as well as the public-relations aspect of buying offsets for some purchasers (for instance, as part of a corporate social responsibility initiative), demand for offsets is less about the most efficient way of offsetting emissions, and more about considering a number of factors that might interest the purchaser. Some of these factors could include project type, location of project, which standard verified the project, etc. Additionally, different carbon offsets vendors might have different pricing strategies or overhead: one enterprise might set a certain profit margin or discount poorly-selling offsets; another might conduct particularly thorough and expensive reviews of its projects and pass those costs on to the consumer.

Second, what is the "right" price for carbon offsets? We don't fully understand why the vendors we've investigated sell carbon offsets for $9 to $15/ton while the average price in voluntary carbon markets overall (according to Ecosystem Marketplace) is merely $3/ton. Some possible explanations and data points:

- Many carbon offsets sold on the voluntary market are purchased in bulk, which may drive down the price (either because of purchasers' being more sensitive to price or economies of scale / bulk discounting) relative to the prices available to individuals that we found on vendors' websites.
- Some portion of the price difference may be vendor overhead or profit.
- Some portion of the price difference could be attributed to the types of projects being selected. We looked at vendors that were relatively well-known or had good reputations. These vendors are more likely to pick projects that are reliable, credible, uncontroversial, third-party verified, and have additional social benefits. These characteristics might all carry a premium relative to the average price of carbon.
- Some portion of the price difference may be attributable to the cost of measuring and verification. More direct involvement by monitors, particularly more direct involvement by the vendor itself, could increase the cost of the offset.
- California's current price for carbon (March 29, 2018) is $15.10 / ton for industry. While this is a compliance market, quite separate from the voluntary carbon offset market, this may be a reasonable upper bound for offsets purchased in voluntary markets. Carbon Offset Research and Education (CORE) notes that because voluntary markets have less demand as compared to compliance markets, the price for carbon is often lower in voluntary markets.
- The *social cost of carbon*, meant to fully capture the damage done by emitting carbon into the atmosphere, is estimated at approximately $40/ton by the U.S. Government Interagency Working Group on Social Cost of Carbon. Theoretically, policies that spend

up to $40/ton to avoid or offset carbon emissions would still be “worth it.” (Note that the social cost of carbon is calculated to increase over time.)

Thus, while $9 to $15 differs from $3/ton, this price doesn’t seem wholly unjustifiable.

The opacity of pricing remains concerning. It would be a good idea to do further research on this topic, including getting price and cost breakdowns directly from vendors.

An Alternate View on Pricing

Finally, we suggest that there may be an alternate way of viewing carbon offset pricing. Rather than attempting to get the best value in paying for offsets—quality balanced against price—and viewing the number of offsets purchased as a function of emissions, an organization (or individual) could measure their carbon emissions and calculate the *social cost* of carbon for those emissions—the amount needed to redress all of the economic harms done by the emitted carbon—then use that money to purchase as many high-quality carbon offsets as possible.

For example, if an organization emits 100 metric tons of carbon, rather than looking to purchase 100 metric tons of offsets and wondering how to get the best value for its money, the organization could instead calculate that 100 metric tons $40/ton *should* cost it $4000, and thus purchase $4000 worth of carbon offsets at whatever price per ton is being offered for offsets that the organization considers high quality.

In this scenario, the organization is arguably pricing carbon more accurately. This may better align incentives—the organization charges itself the actual cost of its emissions, and thus people within the organization are incentivized to decrease those emissions, rather than being encouraged to continue carbon-emitting behavior by the relatively low actual cost of carbon offsets.

What Are the Main Concerns with Carbon Offsets?

Concerns with carbon offsets can be broken down into several categories:

1. Concerns with the quality of the offsets—that they are fraudulent or in some way don’t deliver the promised reduction in emissions
2. Concerns that carbon offsets don’t do enough or make things worse—that they avoid or even hinder more substantive personal or policy choices necessary to reduce emissions. For instance, purchasers might avoid taking steps to reduce their own emissions by buying their way out, in the process propping up older, fossil-fuel-based infrastructure. In a worst-case scenario, carbon offsets arguably could result in more carbon emissions, as purchasers actually over-emit due to having purchased offsets (a “rebound” effect).
3. Concerns with fairness—that they are a means to shift emissions reductions from the developed world to the developing world, or that in some cases (some fraudulent, but not necessarily so), they end up paying polluters.

4. Concerns with unanticipated side effects—that carbon offsets might perversely incentivize behavior that increases carbon emissions (such as building a nitrous-emitting plant, then selling off carbon offsets to capture the nitrous before it's released into the air); that carbon offset projects might have unintended environmental or economic effects or might be simply be unconcerned with such effects; or that carbon offset policies could be used to justify (and fund) land grabs or similarly exploitative actions
5. Concerns with moral hazards—the "buying indulgences" issue (this is related to #2). Specifically, the concern is that carbon offsets are a way to avoid the "sinful" behavior of emitting carbon while paying others to avoid emissions for you, and that this avoids taking real responsibility for one's own emissions. Proponents of this argument might characterize purchasing offsets as inherently wrong or misguided, in addition to being harmful for the planet long-term.

What are the Arguments for Carbon Offsets?

Properly chosen, carbon offsets should reduce an organization or individual's carbon footprint, enabling them to limit their contribution to climate change and global warming. Issues of quality, fairness, and unanticipated side effects should be able to be limited (if not wholly eliminated) by carefully choosing projects and vendors.

Carbon offset projects can also have additional positive social benefits, such as promoting a transition to renewable fuel sources, improving economic development or health, or promoting the advancement of women. For instance, projects approved by the Gold Standard must meet at least two United Nations Sustainable Development Goals (SDGs), in addition to addressing climate change (SDG #13). These additional social benefits can mitigate the fairness concern that the developed world is paying off the developing world to reduce emissions instead of doing so itself. In a best-case scenario, developed world funding helps poorer countries leapfrog to a renewable energy infrastructure and carbon neutral economy, while perhaps even enjoying other social benefits.

In addition, purchasing carbon offsets can function as a sort of voluntary carbon tax, creating a way for a individual or organization to experience to some extent the social cost of carbon, thus disincentivizing carbon-emitting behavior. For organizations, this can also be a way to start to plan for a more-regulated future, where we might anticipate there *is* a carbon tax or similar externally-imposed cost for carbon emissions.

There is some risk of a "rebound" effect—that given the chance to purchase carbon offsets, an individual or organization might increase carbon-emitting behavior. Research on this is mixed. Some researchers have found that, given a chance to purchase "green energy" for household use, participants did not increase their energy use, while in a similar study another researcher found evidence of a rebound effect of 1%–3% of increased electricity use.

In either instance, concern about a rebound effect with respect to carbon emissions could be mitigated by measuring overall carbon emissions before offsets and ensuring that these stay fixed or are reduced. Ideally, to the extent that purchasing carbon offsets can encourage greater awareness and measurement of carbon-emitting behavior, doing so could serve as a gateway to an overall carbon strategy that leads to changes in that behavior.

While carbon offset purchases are sometimes criticized as "buying indulgences," the analogy falls apart under scrutiny:

- "Buying indulgences" implies someone is buying their way out of an act that is itself *inherently* bad, rather than avoiding the bad behavior. But the act of emitting carbon isn't inherently bad; if all carbon emissions could somehow be offset, there would be no climate change and no reason to assign a moral value to emitting carbon. (In fact, before the industrial era, all carbon emissions of animals were offset by carbon sequestration by plants.)
- In addition, if carbon offsets become popular, the price of offsets should go up as cheaper or more desirable projects become more scarce. Carbon offsets should then become expensive, and deeper emissions cuts should become more economically desirable. Or, renewable energy technology or other technology advances should make it cheaper to continue offsetting—in which case emissions reductions continue not to be a better option. Arguably, if we can continue to affordably offset carbon emissions, then we all should continue to do so—if it actually works, then we are in fact mitigating the effects of climate change.
- Finally, concerns about failing to decrease emissions can be mitigated by pairing carbon offsets with a longer-term emissions-reduction strategy.

Given current technology, holding conferences at all is guaranteed to generate significant emissions. Carbon offsets appear to be the only viable short-term means of *fully* addressing the impact of conferences short of simply cancelling them. The uncertainty associated with carbon offsets is unsatisfying, but, given the urgency of climate change, we favor action over inaction—and concrete action now over hypothetical action later. Dissatisfaction with carbon offsets can be a goad for developing other ways of reducing emissions.

Furthermore, given the outsize role that air travel plays in the carbon emissions generated by conferences—arguably as high as 70% of a conference's emissions—failing to address air travel through carbon offsets or other mechanisms means that any other efforts to address carbon emissions will be dwarfed by what's being neglected. A conference has no chance of getting to carbon neutral unless it can deal with air travel, and the only currently effective ay to do this is buying carbon offsets. On the other hand, once those air travel emissions are being offset, any further emissions reductions make a much larger proportional difference.

Conclusions

Ultimately we agree with the UN and environmental organizations and NGOs such as NRDC and The Nature Conservancy, who conclude that, when used as part of an overall emissions reduction strategy and carefully chosen, carbon offsets are a useful tool for reducing the carbon impact of individual and group activities. Moreover, carbon offsets can be applied quickly, reducing the net carbon footprint of human activities almost immediately as large, slow-moving organizations like scientific societies gradually change course.

We recommend projects that use the Gold Standard rather than CDM or VCS alone, as these standards have fewer safeguards, and we are skeptical of bio-sequestration (forest) projects, because of the difficulties with ensuring additionality, permanence, and no leakage.

While the variability in offset pricing remains a concern, we submit that it is not critical to identify a "correct" price for offsets in the first instance. Rather, organizations that want to offset should choose a respected vendor, accept whatever price they are charging, and focus their energy on working to establish the principle and practice of purchasing offsets to mitigate emissions. Once these norms are established, there will be time for longer discussions about which are the best offsets and what is the best price to pay for them. Conversely, because the offset market is still developing fairly rapidly, the details of how an organization purchases offsets should be reviewed and adjusted periodically.

At this time, **we suggest purchasing carbon offsets from Cool Effect or atmosfair**.

We like **Cool Effect** for a number of reasons:

- Cool Effect's carbon offset projects seem carefully chosen. In particular, the developing world biogas and cookstove projects, all of which meet Gold Standard certification, provide significant social benefits in addition to carbon offsetting and are of project types that are likely to deliver the promised offset while also providing social benefits.
- Cool Effect claims that an impressive (and remarkably precise) 90.13% of funds raised for carbon offsets goes directly to the funded projects. At the same time, prices for Cool Effect offsets were among the cheaper of the vendors we examined, at $6.04 to $13.18/ton, depending on project.
- Cool Effect can boast a number of high-profile clients, including Salesforce and March for Science.
- Cool Effect operates as a U.S. non-profit/charitable organization, not as a commercial endeavor.
- Cool Effect has an impressive level of transparency regarding its projects, important given the asymmetrical information possessed by sellers vs. buyers in the voluntary carbon offset market. Cool Effect posts copious project reports and details for each

project it sponsors. We appreciated also that Cool Effect posts a summary of each project that outlines project challenges as well as benefits.

We also had some concerns with Cool Effect:

- Cool Effect's Web site is a bit U.S.-centric, quoting prices only in U.S. dollars. However, they can accept payments from non-U.S. addresses, with either PayPal or one's credit card handling the currency conversion. They are also able to work with organizations to build customized "landing pages."
- Cool Effect's projects are not exclusively verified by the Gold Standard, and they include bio-sequestration (forest) and wind projects, for which the promised carbon offset can be difficult to accurately verify/quantify.

We recommend purchasing carbon offsets in Cool Effect's projects in biogas and cookstoves (Honduras, Malawi, Peru, Uganda) in the developing world, all of which are certified by the Gold Standard. **We do not recommend its U.S.-based projects, due to their limited additional social benefits, or its projects in forest conversation or wind turbines, due to verification/quantification concerns with biosequestration and wind projects.** Also, Cool Effect's U.S.-based and forest projects are not certified by the Gold Standard.

We also recommend **atmosfair** for a number of reasons:

- atmosfair's carbon offset projects meet high standards. All atmosfair projects are CDM-approved and are *also* either Gold Standard approved or pending approval. While atmosfair includes some project types for which verification/quantification is often uncertain, such as wind power or biomass projects, many of its projects are of types that are more easily verified and deliver social benefits, such as biogas/manure management, cookstoves,
- atmosfair avoids tree-planting projects, for which meeting additionality, permanence, and no leakage requirements are hard to ensure.
- atmosfair's website is friendly to non-US purchasers, unlike Cool Effect, accommodating addresses from a large range of countries (although only taking payment in euros).
- atmosfair's project description pages were transparent and detailed, with links to detailed, official documentation.
- atmosfair's website provides a lot of useful information about its carbon policies and its stance on carbon-offset-related issues. The information seemed relatively straightforward, clear, and fact- and evidence-based, without much attempt to cover uncomfortable facts with marketing.
- atmosfair is a German nonprofit organization, not a commercial endeavor
- atmosfair is highly regarded in multiple comparisons of carbon offset vendors. While we were unable to find any published comparisons of carbon offset vendors within the last 8 years, atmosfair is top-ranked or nearly top-ranked in studies in 2009 (tied for second place), 2007 (recommended), and 2006 (top-tier).

We also had some concerns with atmosfair:

- atmosfair's carbon offsets are significantly more expensive than those of other vendors—at $28/ton, more than twice the cost of Cool Effect's, and well outside the typical range we saw of $9/ton to $15/ton. We've attempted to contact atmosfair to get an explanation of their pricing. Their responses so far have not been terribly illuminating.
- While atmosfair's projects are all Gold Standard-approved and a significant portion are of types that often deliver promised carbon offsets (cookstoves, biogas), a number are of types for which verification/quantification is often uncertain, such as wind power or biomass projects.
- A 2007 Tufts Climate Initiative study (note that this is not terribly current) found that atmosfair directs about 80% of its offset sales toward carbon offset projects. This was about average for nonprofits, but a few organizations can claim a higher percentage. (Cool Effect, for example, claims over 90%.)

Ultimately, carbon offsets are not a guarantee of reduced emissions. In many ways, they're more like an investment, with some degree of calculated risk. The surer way to reduce one's carbon footprint is to reduce emissions at the outset. Even so, we believe that carbon offsets can be a reasonable way to take immediate action in the short-term, as each scientific society develops a longer-term, more comprehensive strategy.

Appendix A: Further reading

We recommend the following articles and reports for more information.

- General-interest articles
  - "Aviation: The Dirty, Not-So-Little Secret of Internet Governance" (2017)
  - "Carbon Offsetting: Buyers' Guide 1.0" (2017)
  - "Offsetting Green Guilt" (2009)
  - "Should You Buy Carbon Offsets?" (2016)
  - "Carbon Offsets 101" (2018 Webinar)

- In-depth reports
  - "Overview of Carbon Offset Programs: Similarities and Differences" (2015)
  - "Supply and sustainability of carbon offsets and alternative fuels for international aviation" (2016)
  - "Purchasing Carbon Offsets: A Guide for Canadian Consumers, Businesses, and Organizations" (2009)
  - "Unlocking Potential: State of the Voluntary Carbon Markets 2017" (2017)

Appendix B: Who Purchases Carbon Offsets?

Here are some examples of organizations in the academic and non-profit sphere that have purchased carbon offsets or recommended doing so to their constituents:

Scientific Organizations

- American Astronomical Society (AAS). AAS collected carbon offset donations of behalf of its members for its 2017 annual meeting, and continues to offer carbon offset donations at registration for future meetings. They have a sustainability committee.
- American Meteorological Society (AMS). AMS recommends attendees either take personal steps to reduce carbon emissions to offset the carbon cost of traveling to its events, or purchase carbon offsets. They have a statement on climate change.
- European Geological Union (EGU). EGU gave attendees the option to offset their emissions at registration for their April 2018 meeting. (Specifically, they calculated the carbon footprint of travelling to EGU for participants and an offset was included in their registration fee which they could opt out of if they wanted to.) EGU purchased its offsets from carbonfootprint.com.
- Ecological Society of America (ESA). ESA donated over $22,000 to a forestry program for "environmental offsets" to "offset the environmental costs of travel" to the society's 2017 annual meeting.
- Society for Conservation Biology (SCB). To offset emissions associated with SCB's July 2017 meeting, SCB funded specific carbon offset projects, for which 80% of the money came from members and 20% from SCB itself. (Sustainability Report, 19)

Other Professional Organizations

- American Association of Law Libraries (AALL). Encouraged members to purchase carbon offsets to offset travel to their July 2017 conference.
- RIMS (Risk Management Society). Encouraged members to purchase carbon offsets to offset their emissions from their 2017 conference as a checkbox at registration.
- Society for Music Theory (SMT). Encourages members to purchase carbon offsets to offset their travel to SMT meetings.
- Unitarian Universalist Association (UUA). In 2015, they moved from making carbon offsets an optional purchase for attendees to their annual General Assembly to including it as part of the registration fee, offsetting 100% of emissions.
- Association for the Advancement of Sustainability in Higher Education (AASHE). They solicited contributions in 2014 and had 225 people pay $14 to cover offsets through Native Energy. In 2015 they asked attendees to contribute $10 to help offset the conference. The response was not significant (158 people), so the Conference Team decided to ask a carbon offset vendor (Native Energy) to donate (i.e., retire) some offsets. In 2016 they gave TerraPass a Gold sponsorship and retired 1350 metric tons. TerraPass also retired 262 Water Restoration Certificates which was equivalent to the 262k gallons of water the conference attendees used over the course of the four days. In 2017 Duke/Offset Network and Urban Offsets received a Gold sponsorship to provide enough offsets to make the conference carbon neutral. They retired 2,000 metric tons of offsets. They plan to continue this arrangement in 2018.

Universities

- Duke University. Duke Carbon Offsets Initiative both purchases carbon offsets and designs its own carbon offset projects.
- University of California, Los Angeles. Sustainable Transportation Plan, 25. UCLA deducts a Carbon Mitigation Fee from travel reimbursements for domestic [$9.00] and International [$25.00] airfare if a non-restricted fund is used to refund a travel reimbursement. The new fees started in Jan 2018. More details here.
- University of Colorado. Carbon Offsets and RECs.
- University of Maryland. Carbon Neutral Air Travel Initiative. UMD's Carbon Neutral Air Travel Initiative aims to "completely and permanently eliminate the university air travel carbon footprint, likely through the purchase of carbon offsets at a cost of approximately $5 for each domestic round-trip." A detailed plan is under development, due to roll out sometime in the second half of 2018.
- Yale University. Yale's Community Carbon Fund allows Yale community members to offset their personal or departmental carbon emissions by donation to a Yale fund that works with local non-profits to offset emissions. Interestingly, Yale appears to calculate the offset prices based on a social cost of carbon of $36/ton CO2e, as opposed to the current market cost of the offset.

Appendix C: How Do I Purchase Carbon Offsets?

For an individual, the process is relatively simple:

1) If you don't know how much carbon emissions you'd like to offset, start by calculating the carbon footprint. Carbon Footprint provides an easy-to-use calculator, but its calculations for flights seem surprisingly low compared to other sources. For flights, we recommend atmosfair's calculator, which takes into account the fuel efficiency of the particular airline you're using. Whichever calculator you use, the end result will be an estimate of your emissions in metric tons of CO2e (carbon dioxide equivalent).
2) Identify a carbon offset vendor. We recommend Cool Effect or atmosfair.
3) Purchase the amount of emissions you would like to offset, in metric tons of CO2e. Most vendors sell only by the metric ton, so you may end up offsetting a little more carbon than your calculation. Expect to pay between $9 and $15 USD per ton, although this could go as high as $28 USD/ton for atmosfair.
4) Alternately, you could multiply the social cost of carbon (c. $40/ton) against your amount of emissions and simply buy as many carbon offsets as you can with that "budget." This has the advantage of more accurately aligning your incentives. So if you are offsetting 1.6 tons of carbon, you would purchase $64 worth of carbon offsets.