

# Forget offsets: Examining the offer of carbon offsets when registering for the ASLA Annual Conference on Landscape Architecture

By Rob Kuper, PLA, ASLA

## INTRODUCTION

On April 2, 2019, the American Society of Landscape Architects (ASLA) posted an update in LAND, the online newsletter distributed to ASLA members, entitled “For ASLA, Addressing Climate Change is a Stewardship Obligation” (<https://www.asla.org/land/LandArticle.aspx?id=55255> Accessed April 9, 2019). In it, the ASLA states that it is “fully engaged in addressing climate change—both through bringing the profession’s expertise to bear on the issue and through reducing the organization’s own carbon footprint.” The newsletter briefly describes a policy initiative, participation in a summit, and purchase of 100% renewable energy for the ASLA headquarters in Washington DC. The ASLA also states that a 2019 goal is to “reduce the carbon footprint of the Society’s signature meeting, the ASLA Conference on Landscape Architecture.” Indeed, a long-term goal listed for governance and general oversight on the 2019 annual operating plan is to “position ASLA as a resource, leader, and role model organization on environmental stewardship and other key issues” (ASLA, 2019, p.8). As of now, as the announcement in LAND states, the ASLA plans to act on this goal by offering conference registrants the ability to offset the carbon associated with their travel. Additionally, the ASLA indicates interest in purchasing offsets for the carbon emitted as a result of the entire conference; has begun an “environmental impact” analysis of all

ASLA operations, and begun developing a “plan and a timeline for moving the Society toward fully carbon neutral operations.”

The annual Conference on Landscape Architecture (formerly the Annual Meeting and EXPO) probably makes a substantial annual contribution to the Society’s carbon footprint and requires the most immediate action. The first of many 2019 actions/goals related to the Annual Meeting (Conference) and EXPO is to “maintain the level of attendance at or above the five-year average of 5,900 total registrants and 2,800 total paid registrants in order to meet or exceed the registration/ticket revenue goal” (ASLA, 2019, p. 12). In a study that estimated the travel-related carbon emissions of 2018 ASLA Meeting educational session featured speakers, I found that about half of the 395 speakers likely traveled by air and each may have emitted, on average, about 0.40 metric tons (mt), or 881 lbs, of carbon into the atmosphere (Kuper, 2018). Thus, given the five-year averages the ASLA reports, one may estimate that if half of paid and total registrants traveled to the 2018 ASLA annual meeting by air, 560 to 1180 mt (1.2 million to 2.6 million lbs) of carbon, respectively, would have been emitted into the atmosphere. The carbon footprint of the annual conference must be immediately addressed if the ASLA wants to be a leader and model organization in efforts to arrest global climatic change. Should the ASLA offer conference registrants carbon offsets? Will carbon offsets meet Ethical Standard 1.1 of the ASLA Code of Environmental Ethics, which is to “support planning, design, and construction policies and regulations that will enhance air quality such as multi-modal transportation facilities and *measures to reduce* fugitive dust, *greenhouse gas emissions*, and volatile organic compounds” (emphasis mine) (ASLA Environmental code of Ethics, 2019)?

In what follows, I briefly review some literature regarding the effectiveness of carbon offsets, mostly from peer-reviewed academic journals. I have prioritized peer-reviewed literature

rather than newspaper or online articles because the former requires the review of usually two anonymous reviews by so-called experts in the field of study under examination. Although the refereed review process has flaws, it seeks to minimize or eliminate biases and encourages the creation and dissemination of rigorous, valid and reliable information using clearly articulated, replicable methodologies.

An important clarification is in order before examining the literature. To repeat, the ASLA states that a 2019 goal is to “reduce the carbon footprint of the Society’s signature meeting,” but then plans to offer carbon offsets for conference registrants. Reducing the carbon footprint of the annual conference differs from offsetting carbon emissions. A *reduction* entails the employment of methods to convene an annual conference that results in lower carbon emissions when compared to the typical operations involved in the annual conference.

Conversely, an *offset* implies that the annual conference is held as usual. All conference-related carbon enters the atmosphere with the expectation that a fee incurred by conference registrants or the ASLA will fund the implementation of a project somewhere else in the world that is intended to remove a quantity of carbon from the atmosphere that is equal to that emitted as a result of the conference, or prevent the same quantity from entering the atmosphere.

## LITERATURE REVIEW

***Airline Carbon Offsets.*** A recent article in *Wired* presents two reasons why air travelers should “stop worrying about buying carbon offsets” for flights (Stewart, 2018). First, the author notes that online ticketing websites like Expedia allowed customers to purchase carbon offsets for flights about ten years ago, but are less available than they once were because the options may have confused travelers, and were less effective than if airlines purchased the

offsets for travelers. Airlines, such as Delta and jetBlue, have purchased *limited* quantities of carbon offsets for travelers. Delta estimated that it purchased 30,000 and 15,000 carbon offsets in April 2018 for patrons and employees, respectively (<https://news.delta.com/delta-offsets-carbon-emissions-170000-customers-thursday>. Accessed 21 November 2018). Since 2012, Delta has purchased more than 8 million offsets. If we assume that each offset is equal to one pound, Delta may have purchased offsets equal to 3,628 mt of carbon. jetBlue states on their website that they have purchased carbon offsets that amount to 2 billion pounds of carbon to date, which is equivalent to about 907,184 mt. According to the Air Transport Action Group (<https://www.atag.org/facts-figures.html> Accessed April 15, 2019), the airline industry emitted 859 million mt in 2017. Thus, Delta offset roughly  $4.22 \times 10^{-6}$  percent (or 0.000004.22 percent) of the worldwide global emissions in 2018, and jetBlue offset  $1.056 \times 10^{-3}$  percent (or 0.00106 percent) to date. The offsets may give travelers the impression that each company is addressing carbon emissions and global climatic changes, but the potential effect of the airlines' offsets on arresting global climatic change appear negligible.

According to Stewart (2018), the second reason why air travelers should stop worrying about purchasing carbon offsets is because of a 2018 agreement called the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), which currently has two limitations. First, CORSIA only requires airlines that fly *internationally* to cap carbon emissions at 2020 levels. It is unclear whether a cap on emissions exists for domestic flights, like those that many ASLA members would use to travel to the Annual Conference. Nonetheless, to implement CORSIA, airlines will improve the efficiency of operations and fuel use, as well as purchase carbon offsets. Warnecke, Schneider, Day, La Hoz Theuer, and Fearnough (2019, 218) state that the agreement may “constitute the single largest demand for offset credits after 2020.”

Second, the criteria needed to ensure that carbon emissions are reduced to 2020 levels have not been addressed by the International Civil Aviation Organization (ICAO) and incorporated into CORSIA. Warnecke et al. (2019) state that projects that supply offset credits for CORSIA must be created explicitly to address CORSIA and vulnerable to the loss of funds needed to implement and reduce carbon emissions. If these two criteria are not met, then CORSIA will not effectively contribute to reductions in carbon emissions.

***Carbon Offset Uncertainties.*** Stewart (2018) has made a flawed argument for avoiding the purchase of carbon offsets. However, numerous uncertainties that carbon offsets inherently possess should cause one to seriously question the purchase of carbon offsets altogether. Millard-Ball and Ortolano (2010, 533) write that carbon offsets, “by definition, do not exist in any tangible form. An offset can neither be measured directly nor observed in reality.” Moreover, they write that “the value of an offset is inevitably a fiction, and the precise storyline depends on the institutions and decision-makers writing the story” (Millard-Ball & Ortolano, 2010, 533). Millard-Ball and Ortolano (2010) interviewed 29 methodological panel reviewers who are responsible for evaluating and determining whether projects are implemented as part of the Clean Development Mechanism (CDM), the largest carbon offset program that was included in the Kyoto Protocol and allows developed countries to offset carbon emissions by “investing in climate change mitigation projects in developing countries” (Olsson, Grönkvist, Lind, & Yan, 2016). Warnecke et al. (2019) note that the last “commitment period of the Kyoto Protocol” related to the CDM ends in 2020. After this time, the CDM may or may not continue in its current state.

In all sectors of the CDM (forestry and agriculture, biogas/methane capture, renewable energy, energy efficiency, fugitive/industrial gases, transport, and “other”), the methods for

measuring and verifying the effectiveness of carbon offset projects have become increasingly complex, which may prevent project proposals from receiving approval and becoming implemented. Transportation CDM project proposals may serve as an example. In 2008, transportation accounted for 23 percent of “global energy-related greenhouse gas emissions,” yet only two transport CDM projects were registered out of 1792 in 2009 (Millard-Ball & Ortolano, 2010, 533). One reason why methodologies for transport projects, at least, have become increasingly complex is due to the number of uncertainties in quantifying carbon emissions, which all offset projects must account for. Following is a table of uncertainties directly from Millard-Ball and Ortolano (2010, 539).

**Table 3**  
 Classification of methodological uncertainties.

Category	Source of uncertainty	Example
<b>Leakage uncertainty (market)</b>	Fossil fuel price effect	If a CDM project reduces demand for fossil fuels, the price falls and increases consumption elsewhere
	Rebound effects	Reduction in vehicle travel from a CDM project is offset as individuals make more trips in response to lower generalized cost
	Crowding out	If a CDM project shifts freight to barges, these barges may no longer be available for other customers who may then shift back to trucks if supply is not sufficiently elastic
	Outward-shifting supply curve (sometimes termed “suppressed demand” by Meth Panel)	CDM project increases electricity generation or transportation capacity, shifting the supply curve outward and thus increasing demand
<b>Leakage uncertainty (non-market)</b>	Upstream emissions	Emissions from cement or steel production to build the BRT system or hydroelectric facility
	Other leakages	Generally specific to project types, e.g. fugitive emissions from industrial processes
<b>Baseline uncertainty</b>	Identification of a reasonable counterfactual without-project scenario	Would the local government have built a Metro, expanded roads or done nothing if BRT had not been an option?
	Quantification of emissions under that baseline scenario	What would emissions have been in the presence of the Metro or expanded roads?
<b>Additionality uncertainty</b>	Additionality (related to identification of baseline)	Would the project have been undertaken in the absence of the CDM?
<b>Monitoring uncertainty</b>	Ability to measure actual emissions within the project boundary	Measurement of fuel consumption by BRT vehicles
<b>Implementation uncertainty</b>	DOE <sup>a</sup> (auditor) competence	Does the DOE have enough time, expertise and incentives to ensure that all the rules and procedures are being followed, and to verify the integrity of data?

<sup>a</sup> A designated operational entity (DOE) is accredited by the executive board, and contracted by the project owner to validate ex ante the project (certify that CDM requirements and applicability conditions are met) and verify ex post that emission reductions are achieved.

As the preceding table from Millard-Ball and Ortolano (2010) describes, rebound effects and carbon leakages are two uncertainties that are difficult to measure and may contribute to the failure of a project to reach carbon offset emission targets. Wang-Helmreich and Kreilbich (2019, 457) define carbon leakage as the “temporal or geographic dislocation of emissions outside the scope of the mitigation activity.” Wang-Helmreich and Kreilbich (2019, 457) define the rebound effect as the “situation in which the implementation of a mitigation activity leads to a reduction of GHG emissions associated to a specific activity, which are, however, countered by changes in behaviour and consumption.” For example, if one purchases carbon offsets for air travel to the ASLA conference, or elsewhere, one may then use carbon offsets to justify flying (and emitting greenhouse gases) more. See the following box from Olsson, Grönkvist, Lind, and Yan (2016) for more specific information.

**Box 1.** Brief descriptions of the measurement uncertainties affecting the various CDM project categories.

**Afforestation and reforestation:** Forest may be harvested and used for wood products and paper production and thus lead to new businesses and stimulate the economy. Other potential revenue-generating products from A/R projects mentioned in the project design documents (PDDs) for CDM projects are medical plants, timber and fruit production (UNFCCC, 2014e). However, since the income-bringing activities may replace previous agricultural activities they probably have little rebound effect. If degraded lands are afforested or reforested, the revenues from the project activity are likely to be small due to the low fertility of such land. It is important to point out that A/R projects can have a positive impact on biodiversity (Gold Standard, 2014), i.e. give positive externalities that are not manifested in direct income to the project and therefore have little economic rebound effect. Local variations are important to consider and the feasibility of some A/R projects may be totally dependent on the income from tree crops with little incentive given by the CERs (Djanibekov et al., 2012).

**Renewables:** Although this category involves high measurement precision of direct emissions, the rebound effects are probably also very high. The direct rebound effect of increasing the installed capacity in a growing economy is that electricity is adding to the supply rather than substituting fossil fuel power production. If substitution occurs, the fuel saved will affect the market price, thus increasing the use of the fuel elsewhere. If the electricity market is liberalised to some degree, the added capacity may decrease electricity prices, leading to higher use of electricity. The availability of renewable electricity could lead to new uses for electricity, e.g. in off-grid applications, and it could also lead to higher stability (or instability) in the electrical grid, and this may have a transformational effect.

**Demand-side energy efficiency:** This category is the classic example of rebound effects. Energy efficiency may lead to increased use of the service that will eat up some of the potential energy savings. Efficiency improvements such as improved insulation in residential buildings may lead to increased indoor temperature instead of reduced energy use. On the other hand, if service use does not increase the economic savings may lead to an income effect that increases the use of other energy-demanding services. Market-wide rebound effects are also present, as for all measures that affect the use of tradable energy carriers. A transformational effect is present when the reduction in product energy use makes new products and new applications of old products possible.

**CH<sub>4</sub> reduction and cement and coal mine/bed:** This category includes a large range of projects, such as composting, waste incineration and biogas production. Rebound effects may be low, e.g. in composting projects where landfill waste is reduced and CH<sub>4</sub> emissions are avoided. However, some projects, such as large-scale biogas projects, will undoubtedly lead to rebound effects since new power production is installed.

**Fuel switch:** In fuel switch projects, one fossil fuel is substituted by another fossil fuel, e.g. coal by natural gas. Typically this leads to an increase in energy efficiency as well but otherwise this category could have low direct rebound effects. However, market-wide effects are likely to be present affecting both the new and the substituted energy carrier. Rosendahl and Strand (2009) found that the more local the fossil fuel market is, the stronger the rebound effect, and for some qualities of coal, the market is relatively local. The transformational effect could also be considerable in this category since new processes and applications may become possible.

**Supply-side energy efficiency:** Supply-side EE includes projects dealing with industrial internal waste gas utilisation for power production, reduction of losses in transmission of electricity and heat, and energy efficiency in heat and power production facilities. All of these projects have obvious direct and indirect rebound effects.

**HFCs, PFCs, SF<sub>6</sub> and N<sub>2</sub>O reduction:** This is probably the category with the smallest rebound effects since the sole purpose of the projects is GHG destruction. Thus, the projects will not affect energy carriers or the economy significantly and there is little difficulty proving additionality (Cormier and Bellassen, 2013). The only possibility may be that there is a perverse incentive to produce more GHGs for destruction since this would generate more CERs.

**Transport:** This category, much like A/R, is under-represented within CDM. Notably, Millard-Ball and Ortolano (2010) found that the reasons given by the CDM EB for excluding transport projects are rebound effects as well as insufficient accuracy in the measurements used in the models and projections underlying transport baselines.

Olsson et al. (2016) presents the intended carbon reduction values for three hypothetical carbon offset projects, along with the outcomes that incorporate different measurement uncertainties. In each case, the intended carbon reductions of 100 mt of carbon for the hypothetical solar power, reforestation, and soil carbon sequestration projects presented vary greatly depending on the measurement of uncertainty used, but range from 0 to 94. Moreover, the authors present and suggest using conservativeness factors and rebound factors, which range from 0.73 to 0.94 and 0 to 0.96, respectively, for each category of CDM projects to account for uncertainties. In other words, carbon offset projects in each of the eight CDM categories *do not* meet their targeted carbon reduction values.

Although afforestation/reforestation projects may have a conservativeness factor of 0.73 (Olsson et al., 2016) (meaning that a target of removing 100 mt may only result in the removal of 73 mt), van Kooten (2017, 88) concludes that “forest carbon offsets are a poor tool in the climate mitigation arsenal” due to problems with governance. There are many potential differences in incentive and motivation between landowners and land users/tenants/peasants, contractors and landowners, sellers or contractors and aggregators, and buyers and sellers. Olsson et al. (2016) also examined leakages within the CDM program. The authors suggest that the small percentage (0.8 percent) of afforestation and reforestation offset CDM projects in 2012 were due to the issue of permanence, or lack thereof. Forest fires, unincorporated harvests, pests, and natural disasters are always possible and decrease the likelihood that an afforestation or reforestation project is permanent and achieves the targeted goal of carbon sequestration.

Carbon offset projects may also *not* meet the criteria of additionality. A project that is intended to offset the carbon emissions from one activity must be implemented explicitly for that purpose. If the project already exists, it cannot be used to reduce carbon emissions of an activity

that calls for an offset. For instance, the adolescent forest outside my door cannot remove the 80 to 118 mt of carbon emitted into the atmosphere by featured educational session speakers' travel to and from the 2018 ASLA Annual Meeting and EXPO (Kuper, 2018). A project that aims to produce and plant between 3,300 and 4,900 three-inch caliper sugar maples (Kuper, 2018), or their equivalent, to remove the carbon that resulted from the featured speakers' travel would meet the criteria of additionality. For perspective, Wang-Helmreich and Kreibich (2019, 457), cited an analysis of randomly sampled CDM projects that found "about 85% of the projects have a low likelihood of their emission reductions being additional." In other words, the projects included in the analysis may *not* have been implemented to explicitly reduce carbon emissions for a particular project and are *likely not* reducing the carbon emissions that the project was intended to reduce or sequester.

In sum, a limited review of existing refereed literature pertaining to carbon offsets suggests that past efforts to allow passengers to purchase offsets for themselves proved ineffective. Airlines that have instead purchased offsets for passengers likely fail to adequately offset emissions that have been generated from air travel. CORSIA appears only to address emissions from international travel, rather than domestic. The largest carbon offset program in the world (CDM) is nearing the end of the agreed commitment period. Eighty-five percent of CDM projects may not meet the criteria of additionality. Uncertainties in carbon offset methodologies such as the rebound effect and leakages decrease the likelihood that carbon offset projects achieve targeted emission reductions. Methodological complexities prevent carbon offset projects in the transport sector from receiving approval and implementation. Governance—oversight of the various layers and people involved—in afforestation and forestry projects make them ineffective carbon offset projects, as do several natural or human-caused

events that compromise the potential permanence of the projects. Overall, carbon offsets may not display the appropriate level of action needed to reduce carbon emissions and arrest global climatic change. Moreover, carbon offsets may be "worse than doing nothing," as Kevin Anderson, chair of energy and climate change in the School of Mechanical, Aerospace and Civil Engineering (MACE) at the University of Manchester, writes in *Nature* (2012). He goes on to say that carbon offsets are "without scientific legitimacy, [are] dangerously misleading and almost certainly contributes to a net increase in the absolute rate of global emissions growth."

Samples of existing refereed literature that focus on carbon offsets appear to support his claim.

**Thus, the ASLA should not offer carbon offsets to registrants of the Annual Conference on Landscape Architecture.** Offering carbon offsets to ASLA conference registrants may mislead ASLA members into thinking carbon offsets effectively prevent carbon emissions from entering the atmosphere that are equal to the emissions that conference registrants will be personally responsible for, or remove the same quantity, when evidence from refereed literature indicates that such offsets may not perform this function.

***Don't Airplanes Always Fly Full?*** Without carbon offsets, a landscape architect may grapple with whether or not to travel by air to attend the Annual Conference on Landscape Architecture. One attempt to rationalize air travel is to suppose that an airplane will fly from a point of origin to a destination with or without you given the existing demand for air travel. If one opts to fly, that passenger becomes responsible for a portion of the carbon emissions resulting from the flight. If one opts not to fly, two scenarios exist. In the first, the seat on the airplane that one could have occupied will remain vacant. Frontier Airlines boasts that lightweight seats made of recycled leather save 214 gallons of jet fuel per seat per year, which may reduce the release of 1.90 mt (4190 lbs) of carbon into the atmosphere

(<https://www.flyfrontier.com/about-us/why-fly-frontier>. Accessed 29 November 2018). A vacant seat is lighter than a seat occupied by a person, who may also have luggage. Thus, by opting out of air travel, one reduces fuel use by decreasing the weight of an airplane, reduces carbon emissions, and reduces the demand for air travel. If demand decreases enough, the number of planes in the air may decrease too.

In the second scenario, the seat on the airplane that a landscape architect could have occupied, but decided not to, becomes occupied instead by another passenger who (hopefully) may not be a landscape architect. If one assumes that the weight of the replacement passenger approximately equals the weight of a landscape architect, along with her or his luggage, the weight of the airplane, fuel use, and carbon emissions are equal, regardless of the passenger. However, the landscape architect, which may believe that stewardship is an obligation (defined in my desk American Heritage College Dictionary as “a social, legal, or moral requirement that compels one to follow or *avoid* a particular course of action” [emphasis mine]), is not responsible for the carbon emissions and may exemplify leadership in climate action. Additionally, demand for air travel still decreases if the landscape architect opts not to fly then, or at any other time thereafter. If enough landscape architects stay grounded, demand for air travel will obviously be more significant. Imagine if half of paid and total 2018 ASLA meeting attendees who traveled by air to the conference did not fly; instead they traveled by train or not at all. Consequently, between 1400 and 2950 landscape architects would not have flown, which is equivalent to between six and 21 full Boeing 737 Max airplanes. We can make a difference!

## Conclusions and Suggestions

The ASLA should not offer carbon offsets to registrants of the Annual Conference on Landscape Architecture. Furthermore, the ASLA should educate ASLA members about the uncertainties related to carbon offsets, and discourage ASLA members from purchasing offsets to rationalize carbon-intensive actions like air travel. The ASLA should encourage members to reduce carbon emissions by flying less and eventually not at all, among other actions.

While all carbon reductions are welcome, dramatic reductions are immediately necessary given the potential ecological, economic, and social peril associated with climatic change that is presented in the Special Report on Global Warming of 1.5° C prepared by the Intergovernmental Panel on Climate Change (IPCC). On the whole, the ASLA must reimagine the Annual Conference so that conference-related emissions are reduced by 50% before 2030 and completely eliminated by 2050, as the IPCC recommends. Efforts to actually lead climate action as a professional organization wherein “stewardship is an obligation” will require reducing and ultimately eliminating conference-related emissions faster and sooner than the IPCC recommends. A petition to the ASLA regarding this issue exists and has been circulating among members, albeit slowly

[https://docs.google.com/document/d/12LKjss38S4LsurNz81omTW6kPZ2I-Fit3IQg\\_LbIhiM/edit?usp=sharing](https://docs.google.com/document/d/12LKjss38S4LsurNz81omTW6kPZ2I-Fit3IQg_LbIhiM/edit?usp=sharing)). But I suspect that you all already knew that!

To achieve the goal of *reducing* the carbon footprint of the Annual Conference, and leading climate action as an organization, the ASLA should set a goal to make the 2025 Annual Conference on Landscape Architecture completely virtual. Between now and then, experiment and implement measures to achieve that goal. Quantify and compare the carbon footprints of past conferences (three to five, perhaps), the 2019 Conference on Landscape Architecture in San Diego, and future conferences that implement measures to reduce air travel. See my study that

estimated travel-related emissions of featured speakers at the 2018 ASLA meeting and EXPO for more information (Kuper, 2018).

## References

- American Society of Landscape Architects (ASLA). 2019. Annual Operating Plan. ([https://www.asla.org/uploadedFiles/CMS/AboutJoin/Leadership/Leadership\\_Handbook/FY%202019%20Annual%20Operating%20Plan.pdf](https://www.asla.org/uploadedFiles/CMS/AboutJoin/Leadership/Leadership_Handbook/FY%202019%20Annual%20Operating%20Plan.pdf) Accessed April 18, 2019).
- ASLA. 2019. Code of Environmental Ethics. (<https://www.asla.org/ContentDetail.aspx?id=4308> Accessed April 18, 2019).
- Anderson. K. 2012. The inconvenient truth of carbon offsets. *Nature* 484 (7392): 7. (<https://www.nature.com/news/the-inconvenient-truth-of-carbon-offsets-1.10373>. Accessed January 11, 2019).
- Intergovernmental Panel on Climate Change. 2018. *Global Warming of 1.5° C*. Chapters 1, 2, and 3. (<http://www.ipcc.ch/report/sr15/>, Accessed 29 November 2018).
- Kuper, R. (2018). Carbon Count: 2018 ASLA Annual Meeting. Unpublished manuscript. Please contact the author at [rkuper@temple.edu](mailto:rkuper@temple.edu) for a PDF.
- Millard-Ball, A., and Ortolano, L. (2010). Constructing carbon offsets: The obstacles to quantifying emission reductions. *Energy Policy* 38: 533–546.
- Olsson, A., Grönkvist, S., Lind, M., and Yan, J. (2016). The elephant in the room – A comparative study of uncertainties in carbon offsets. *Environmental Science & Policy* 56: 32–38.

Stewart, J. 2018. “Stop worrying about buying carbon offsets for your flights.” *Wired*.

(<https://www.wired.com/story/airline-emissions-carbon-offsets-travel/> Accessed April 15, 2019).

van Kooten, G. C. (2017). Forest carbon offsets and carbon emissions trading: Problems of contracting. *Forest Policy and Economics* 75: 83–88.

Wang-Helmreich, H., and Kreibich, N. (2019). The potential impacts of a domestic offset component in a carbon tax on mitigation of national emissions. *Renewable and Sustainable Energy Reviews* 101: 453–460.

Warnecke, C., Schneider, L., Day, T., La Hoz Theuer, S., and Fearnough, H. (2019). Robust eligibility criteria essential for new global scheme to offset aviation emissions. *Nature Climate Change* 9 (March): 218–221.