Voluntary Offsets For Air-Travel Carbon Emissions

Evaluations and Recommendations of Voluntary Offset Companies

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Preface (last edited for revision 1.2)

This paper was written by the Tufts Climate Initiative and examines the rapidly growing market for voluntary carbon offsets. The report focuses specifically on how to evaluate offsets companies to offset air travel emissions.

Voluntary offsets are of limited value to solve the increasing threat of climate change. They should not be seen as a way to buy "environmental pardons." In most countries, jet fuel is currently not taxed. Yet to internalize some of the environmental cost and to more accurately reflect the true costs of air travel, such a tax is vital. In December 2006, the E.U. unveiled draft rules for capping airline emissions. The E.U. is proposing to regulate intercontinental flights that use European airports for takeoff or landing. Under these plans, there will be a cap on CO_2 emissions – airlines would get a certain number of pollution allowances each year. The U.S. is opposed to such legislation and is threatening legal action against the proposed rules on the grounds that such legislation would violate trade rules. (For a summary on European legislative action and links to several policy papers see: *European Climate Policy dossier* available at www.eel.nl/categorieen/index.asp?sub_categorie=168&c_nr=5&linktwee=ja)

To successfully avert the looming catastrophes that we are facing with global climate change, very strong and swift regulatory action is needed on the state, national and international level. No voluntary approach to reducing greenhouse gas emissions should be allowed to delay or replace a mandatory federal cap on carbon emissions or a worldwide tax on jet fuel.

Yet voluntary carbon offsets do have their place in spurring innovation and financing carbon-reducing projects that would otherwise not have happened. They are especially appropriate for individuals who have done their best to reduce their personal emissions but would like to neutralize some of the unavoidable emissions that they are responsible for. Air travel is a good example for this. First and foremost, we all should work on minimizing our air travel. But some flying might be unavoidable, for example for academics who need to attend professional conferences, for musicians who tour internationally or for expatriates who wish to visit their relatives.

As is to be expected with new business opportunities, the quality and standards of voluntary offset companies vary widely – or as one of our reviewers put it: "It's the Wild West!" Some offset companies are run by very seasoned carbon trading experts who are well versed in all the issues that surround carbon trading, others are much less experienced and are either using carbon offset to further promote their environmental or humanitarian missions or see the emerging market as a financial opportunity. Neither of these objectives is inherently bad, if the offsets that are sold meet high standards, yet unfortunately that is not always the case.

This report and the 2-page pamphlet '***Flying Green: How To Protect the Climate and Travel Responsibly***' offer guidelines for consumers wishing to offset their emissions. It takes a look at 13 companies and organizations that sell offsets to individuals. The report does not provide final answers but is meant as a think piece to raise the many questions that still need to be addressed in this newly emerging field. We hope that this paper, together with other reports that have recently been published[2] will help catalyze discussion and will ultimately help steer the market towards offering high quality carbon offsets to concerned citizens.

[1] We have received numerous comments since we first published our study. To keep this study as accurate as possible, we have incorporated many of the suggestions we received. Some of the offset companies have changed their practices since we published this study. We are not able to redo all the calculations, yet we have indicated their changes whenever possible. We have indicated each section that has been edited since the original version.

[2] For two other reports on this subject please read, ***A Consumers Guide to Retail Carbon Offset Providers***, a report published by Clean Air – Cool Planet in December 2006. It can be downloaded at www.cleanair-coolplanet.org/ConsumersGuidetoCarbonOffsets.pdf and ***The Carbon Trust three stage approach to developing a robust offsetting strategy***. Published in November 2006 by the carbon trust. It is available at http://www.carbontrust.co.uk/Publications/publicationdetail.htm?productid=CTC621

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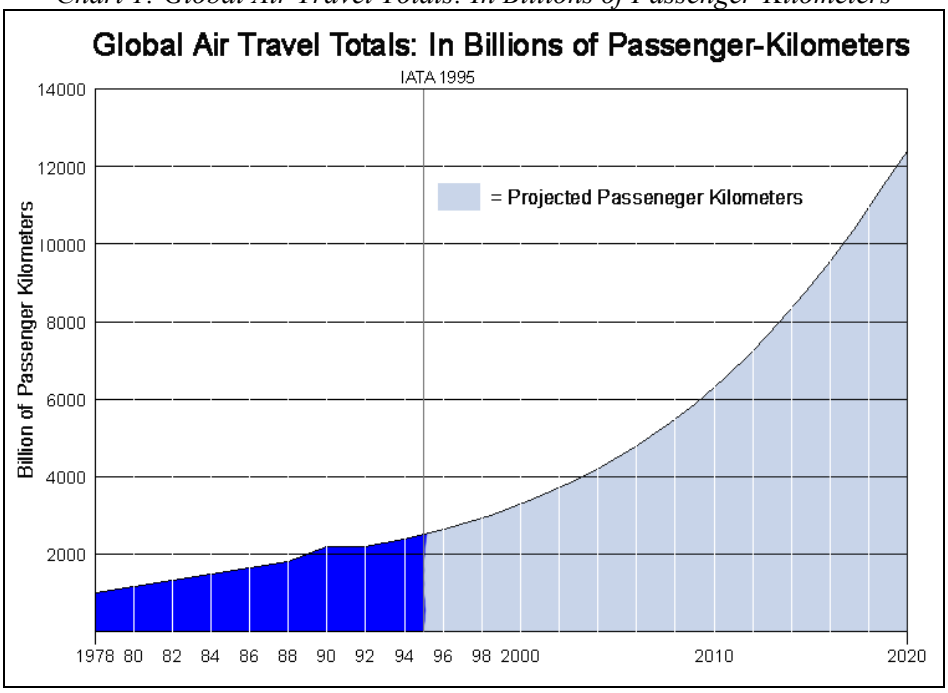
1. Introduction

Aviation is a large and continuously growing contributor of greenhouse gas emissions. In 1992, carbon dioxide emissions from aircraft comprised 2% of total anthropogenic CO_2 emissions (13% of CO_2 emissions from all transportation sources). The Intergovernmental Panel on Climate Change (IPCC) projects that the aviation sector will continue to grow and by 2050 its emissions may have reached 10 times the 1992 level (IPCC, 1999).

Chart 1: Global Air Travel Totals: In Billions of Passenger-Kilometers



Consumers who are concerned about the extent of their environmental impact but who cannot avoid flying completely, may wish to neutralize their travel emissions by purchasing carbon offsets. These voluntary offsets are generally inspired by a sense of responsibility about the personal impact on climate change. They also help educate consumers about the extent of their environmental impact. Recently, some large travel agencies have started giving their clients the option of purchasing offsets for their travel (e.g. Expedia and Travelocity, (MSNBC, 2006)). Also, non-governmental organizations (NGOs) and corporations have started to offset their employees' emissions from traveling. We can expect this trend to grow.

Voluntary offset companies offer organizations and individuals the opportunity to reduce their impact on global warming by purchasing carbon offsets. Individuals calculate the amount of carbon they are personally responsible for and then purchase an offset for that amount. The funds the offset company receives are then used to implement and manage projects that avoid, reduce or absorb greenhouse gases through renewable energy, energy efficiency, or forest and other bio-sequestration projects. Climate change is a non-localized global problem, which means that carbon reductions will have the same impact no matter where they are implemented (Hanson, 2004).

The number of companies that sell carbon offsets to individuals is continuously growing. Currently, there are over three dozen companies and organizations active in the voluntary offset markets. Different offset

companies operate with different consumers in mind. Of the thirteen companies[3] we considered in this paper, eleven offer programs to address the effects of air travel specifically, which is the subject of this paper. For example, their websites ask the user to enter the distance she is going to travel by air and then calculate the amount of carbon she will need to purchase in order to offset the emissions associated with the travel. Two more websites discussed below are primarily designed to offset the carbon gases emitted by cars, but they can also be used to offset air travel CO_2 emissions. These companies are **Cleanairpass** and **TerraPass**.

This paper gives a short overview of international climate change policies and the current carbon market. It examines the quality of the currently offered carbon offsets and the criteria that help ensure high quality carbon offsets are sold to the consumer. The following 13 offset companies were evaluated:

atmosfair (http://www.atmosfair.de/)
Atmosfair is a German offset non-profit company focusing on offsetting air travel. Atmosfair was initiated in 2003 as a joint project of ***forum anders reisen*** (http://www.atmosfair.de/index.php?id=11&L=0), a consortium of travel agencies, the NGO ***Germanwatch*** (www.germanwatch.org) and the for-profit carbon trading company ***500 PPM GmbH*** (http://www.500ppm.com/de/)[4].

Better World Club (http://www.betterworldclub.com/)
Better World Club (BWC) does not specialize in offsets but provides nationwide roadside assistance, insurance and travel services. For each flight booked, BWC donates $11 to the ***Tides Foundation*** which administers the funds. BWC is a for-profit company founded in 1996.

CarbonCounter.org (http://www.carboncounter.org/)
CarbonCounter.org is a collaborative non-profit project started in 2002 by The ***Climate Trust*** (http://www.climatetrust.org) and ***The Mercy Corporation*** to offer offsets to individuals. The ***Climate Trust*** provides offsets to power plants, regulators, businesses and individuals and ***Mercy Corps*** (http://www.mercycorps.org) is an international relief and development agency.

Carbonfund.org (http://www.carbonfund.org)
Carbonfund.org is a US nonprofit organization that sells carbon offsets to individuals, businesses and organizations. **Carbonfund.org** was founded in 2003.

The CarbonNeutral Company (http://www.carbonneutral.com/)
This UK for-profit company, originally known as Future Forests, was founded in 1997 focusing on providing carbon credits generated from forestry projects. The company has expanded its services and now offers offsets from a variety of projects (not exclusively forestry). It also offers marketing and consulting services.

Cleanairpass (https://www.cleanairpass.com/)
Cleanairpass is a non-profit Canadian offset company that focuses on providing offsets to individuals who want to offset their vehicle miles traveled. Cleanairpass was founded in 2005.

Climate Care (http://www.climatecare.org/)
Climate Care is a for-profit company that offers offsets to individuals and businesses. This UK company was founded in 1997.

[3] These companies where chosen by doing a web search on Google. They were chosen for the variety of approaches that they represent. Furthermore, they were the companies that showed up most frequently and were therefore assumed to be among the most popular. Because of time and funding constraints we were not able to include more companies but we are planning to evaluate another set of companies and add our findings to our offset webpage: www.tufts.edu/tci/offsets
[4] ***500 PPM GmbH*** currently collaborates with **myclimate**.

climate friendly (http://www.climatefriendly.com)
Climate friendly is a for-profit company that offers offsets to individuals and businesses. This Australian organization was founded in 2004.

myclimate
(Swiss site: **http://www.myclimate.org/?lang=en)** (US site: **http://www.my-climate.com/**)
Myclimate - The Climate Protection Partnership was started in 2002 as an international non-profit venture at the ***Eidgenoessischen Technischen Hochschule*** (ETH) in Switzerland. It sells offsets to businesses, organizations and individuals. To sell carbon offsets in the US **myclimate** has partnered with ***Sustainable Travel International*** (www.sustainabletravelinternational.org) a non-profit organization that specializes in ecotourism and sustainable travel programs. If not noted otherwise, we are referring to the Swiss site in this report.

NativeEnergy (http://www.nativeenergy.com/)
NativeEnergy is a privately held Native American energy for-profit company founded in 2000. NativeEnergy helps build Native American, farmer-owned, and charitable-purpose renewable energy projects.

Offsetters (http://www.offsetters.com/)
Offsetters is a Canadian non-profit company started in 2005 that sells offsets to individuals and businesses. It has also partnered with WestJet. When WestJet flights are booked through the Offsetter webpage funds go directly to Offsetter to invest in offset projects.

Solar Electric Light Fund (http://www.SELF.org/)
The Solar Electric Light Fund, Inc. (**SELF**) is a US non-profit organization founded in 1990 to promote, develop, and facilitate solar rural electrification and energy self-sufficiency in developing countries. It is not an offset company but offers a program where people can donate $10 per ton of CO_2 they emit.

TerraPass (http://www.terrapass.com/)
TerraPass is a for-profit US company that offers offsets to individuals and businesses.
TerraPass was initially created in 2005 as a project for the course "Problem Solving, Design, and System Improvement" taught at the Wharton School of Business at the University of Pennsylvania.

When we evaluated the 13 offset companies we looked at the following criteria:

Company Profile. This includes whether or not the company is non-profit and when and where it was founded. Many of these companies were founded in Europe, but American and Australian companies now also offer offset services. All companies are located in wealthy, industrialized countries.

Overhead. All companies use a percentage of their sales to cover their operating costs. It is clearly better when more money goes directly to emissions-reducing projects. Yet, in this newly emerging field, relatively high operating costs can be expected. They might even indicate that the company is more careful about evaluating their purchases. In our study we determined that non-profit companies usually dedicate more of their income directly to projects. Other companies give as little as 15% of their income to carbon-reducing projects. It is important to keep in mind that the overhead costs are all self-reported and it is unclear what is included or excluded by each company.

Quality of offsets. The most important criteria for evaluating an offset company is the quality of the offset projects it invests in. There are three main categories of off-set projects: emission-free energy generation, reduction of demand for energy, and sequestration. The first two categories avoid emissions, while sequestration projects aim to absorb emissions that have already occurred. Sequestration projects are the most controversial for a variety of reasons discussed below. Results of the projects must be considered in light of their ***additionality***, that is, by comparing the reductions they made against the counter-factual situation of what would have occurred otherwise.

Standards and Verification. Third party standards and verification are crucial to ensure the quality of the offset projects. Voluntary offset companies can currently choose from a variety of standards to judge the performance of their emissions reduction projects. The voluntary market could greatly improve its credibility by introducing a common standard for carbon offset quality. Several such standards are currently being developed. We discuss the most important ones.

Air Travel Emissions Calculator. Most companies have an air travel emissions calculator on their website, yet the parameters used for these calculators vary considerably. Some companies use sophisticated and accurate calculations to determine how much CO_2 a traveler has to offset, others are much less accurate.

Price per ton of carbon offset. We found large differences in price to the consumer per ton of carbon offset. There seems to be no clear correlation between price and other parameters (e.g. for-profit or non-profit or type of offset), except that companies that purchase offsets through the ***Clean Development Mechanism (CDM)*** tend to charge higher prices, which reflect the higher transaction costs associated with CDM projects.

Transparency. Some websites provide very detailed information about projects and the companies' policies, standards and verifications. Other sites have much more limited, or more generic information. Consumer education and transparency is vital in this newly emerging field.

Aspects not evaluated in this report

In this report we did not evaluate the usability or the security on the offset companies' website – e.g. what credit cards are accepted, what security certificates the sites use, and how easy is it to navigate through the sites. These are all important factors that would be worth evaluating, yet go beyond the scope of this paper. We encourage the reader to carefully check these factors before choosing an offset company.

A Note on Data

All of the information used in this study was self-reported by the companies in question on their websites or in the literature they distribute. With some of the companies we communicated by e-mail to clarify certain aspects. Yet often the information available to us was limited or ambiguous. It is also reasonable to believe that each company reaches its statistics in a slightly different manner so that the reported numbers might not be strictly comparable. Non-profit organizations are required to disclose certain types of financial information; while for-profit organizations are sometimes more hesitant to make their data public, so some information may be missing.

The U.S. standard for calculating emissions is in short tons[5]. All emissions in this paper are reported in those units. All currency has been converted into U.S. dollars as of July 3, 2006.

2. International and National Carbon Trading

The rise of voluntary emissions trading companies is taking shape against the backdrop of national and international legislative activity. Voluntary offset companies work within and outside of these legal frameworks. It is important to have a broad understanding of the legislation and policies that underlie the emerging carbon markets in order to better understand the impact voluntary offset companies will have on the carbon economy and climate change policies.

The ***Kyoto Protocol to the United Nations Framework Convention on Climate Change*** is an amendment to the international treaty on climate change. It is a 'cap and trade' system that imposes national caps on the emissions of ***Annex I*** [6] countries. On average, this cap requires countries which have ratified the protocol to

[5] A short ton is 2000 pounds. A metric tonne is 1000 kg or 2205 pounds.

[6] Governments are separated into two general categories: **Annex 1** countries are developed countries that have ratified the Kyoto protocol, and have legally binding greenhouse gas emission reduction obligations; **Non-Annex 1** countries are developing countries that currently have no greenhouse gas emission reduction obligations.

reduce their emissions 5.2% below their 1990 baseline over the period from 2008 to 2012. Although these caps are national-level commitments, in practice most countries will delegate their emissions targets to individual industrial entities, such as utilities and manufacturing companies.

Kyoto enables a group of several Annex I countries to join together and form a so-called 'bubble' that is given an overall emissions cap and is treated as a single entity for compliance purposes. The EU, with its 25 member states, formed such a 'bubble' and created the ***EU Emissions Trading Scheme (ETS)*** which came into force in 2005. Under this cap-and-trade scheme, emissions are limited and can then be traded. The European Trading Scheme (ETS) is the largest mandatory cap-and-trade scheme to date[7]. There are two ways carbon emissions are currently traded:

Allowance-based transactions: The buyer purchases emissions allowances created and allocated (or auctioned) by regulators under cap-and-trade regimes, such as Assigned Amount Units (AAUs) under the Kyoto Protocol, or EU Allowances (EUAs) under the ETS. To make cap-and-trade successful, it is vital that the cap is set stringently enough to facilitate large emissions cuts[8].

Project based transactions: Carbon emissions reductions are traded through newly created credits from projects that offset emissions through renewable energy production, energy efficiency or carbon sequestration. For project-based offsets it is especially important that they fulfill additionality requirements (see section 3.1). Project-based transactions can be conducted within the Kyoto framework or outside of it to meet voluntary emissions reduction targets. The following two project based mechanisms are part of the Kyoto Protocol:

Clean Development Mechanism (CDM) allows developed countries to gain emissions credits for financing projects based in developing countries (non-Annex 1 countries). CDM projects produce ***Certified Emission Reductions (CERs).***

Joint Implementation (JI) projects work similarly but between two developed countries (Annex 1 countries). JI projects produce ***Emission Reduction Units (ERUs).***

Outside of Kyoto compliant mechanisms, other actions taken to reduce greenhouse gas emissions are being verified and traded. Voluntary markets for emissions reductions that are not compliant with the Kyoto protocol are developing rapidly. Emission offsets in this latter category are verified by independent agents, but are not certified by a regulatory authority for use as a compliance instrument, and are commonly referred to as ***Verified Emission Reductions (VERs).*** VERs are not a standardized commodity (see 3.3.)

Several non-Kyoto carbon reduction regulatory schemes and carbon markets are already in existence, and these are likely to grow in importance and numbers in the coming years. These include the New ***South Wales Greenhouse Gas Abatement Scheme,*** a mandatory trading system that requires utilities to reduce their emissions, the cap-and-trade ***Regional Greenhouse Gas Initiative (RGGI)*** of several Eastern US states, the voluntary trading system of the ***Chicago Climate Exchange***, and ***California's Global Warming Solutions Act of 2006*** which caps California's greenhouse gas emissions at 1990 levels by 2020, and the commitment of 131 US mayors to adopt Kyoto targets for their cities.

All these initiatives form a series of linked markets, rather than one single carbon market. Most of them embrace market-based mechanisms to achieve emissions reductions. These varying schemes allow for each system to account for the regional differences in political structure, and economic makeup. It might be possible that carbon credits in one market may at some point be tradable in other schemes. This would streamline the market and could increase efficiency.

[7] Several countries have developed or are planning to develop their own internal carbon trading schemes: The UK established a voluntary scheme, which runs from 2002 through 2006. Canada and Japan will establish their own internal markets in 2008.

[8] Additionality (see section 3.1, p. 8) is less of an issue in cap and trade programs.

2.1 Policy Implications of Voluntary Offset Markets

Voluntary offsets projects could conceivably hamper future regulatory action. For example, if offsets are profitable for an energy producer, this producer will likely oppose regulatory action such as ***Renewable Energy Portfolio Standards (REPS)*** that would mandate all utility companies to have minimum of renewable produced energy in their mix because the provider could then no longer sell the ***Renewable Energy Credits (RECs)*** or the carbon benefits (see section 3.3.) It is likely that not only the utility but also the offset companies would oppose such standards because they would undermine their markets. Yet, the overall carbon benefits would be higher with REPS. Viewed at this macro scale, the offset market could potentially undermine stronger, more potent policy action.

Although the voluntary offset market is still young, such policy implications are worth considering, as examples in other industries well illustrate. For example, many of the recycling companies in Massachusetts are opposed to the expansion of the bottle bill, which would put a deposit on all soft drink bottles and cans. Under the expanded bottle bill, the recyclers would lose the revenue stream from recycling the bottles and cans that are currently not included in the existing bottle bill. Although the existing bottle bill has been very successful[9], all of the efforts that have been made to expand the bottle bill have been unsuccessful so far.

Policy implications of mandatory and voluntary carbon markets will have to be seriously examined. Market-based approaches to solving environmental problems have proven to be very successful in certain instances, yet they are no panacea to such large scale problems as climate change and can only be successful if regulated and implemented jointly with far reaching and smart policies such as federal carbon caps, carbon taxes, strict and well enforced building codes, and stringent efficiency standards for vehicles and appliances.

3. Carbon Offset Quality

Arguably the most important aspect of an offset company is the quality of its project portfolio. High quality carbon offsets must clearly demonstrate additionality, avoid double counting, have a realistically calculated baseline and emissions reduction projection, account for leakage and be permanent. In the following sections we explore each of these issues.

3.1 Additionality (this section was rewritten for revision 1.2)

The topic of 'additionality' is hotly debated. In theory, it answers a very simple question: Would the project have happened, holding everything else constant, if the carbon offsets from it could not be sold? Or more simply: Would the project have happened anyway? If the answer to that is yes, the project is not additional. Some argue that instead of debating additionality, it is more important that emissions trading mechanisms are put in place without being bogged down by too may details, such as additionality, and that these trading frameworks and mechanisms will change and adjust as they mature.

Although we agree that policies to avert climate change should be implemented swiftly, we disagree that additionality can be treated lightly. If I buy carbon offsets, I make the implicit claim that I forgo reducing my own emissions (i.e. I still fly) but in exchange I pay someone to reduce their emission in my stead. If I buy carbon offsets to "neutralize" the emissions I caused during air travel from someone who would have reduced their emissions anyway, regardless of my payment, I, in effect, have not only wasted my money, but I also have not neutralized my emissions. **It is not necessary that the project is happening solely because of the carbon credits it produces but the anticipated benefits of the carbon offsets have to be a decisive factor for pursuing the project.**

[9] 68% of the beverage containers covered by the law are recycled – only 39% of non-redeemable containers are recycled. Unclaimed deposits currently provide $34 million annually in state funding. Under the expansion, approximately $15 million in additional unclaimed deposit revenue could be generated. (http://www.massbottlebill.org/ubb/facts.htm, last accessed, 11/30/06)

What makes additionality so difficult an issue is not its theoretical definition, but its application in practice. In fact, there is no way to determine with absolute certainty if a project is additional or not. Instead, many different additionality tests and eligibility criteria have been developed to maximize the accuracy of additionality testing[10].

The following is a short selection of additionality tests that are commonly used:

Legal and Regulatory Additionality Test
If the project is implemented to fulfill official policies, regulations, or industry standards it cannot be considered additional. If the project goes beyond compliance, it might be additional but more tests are required to determine that. For example, an energy efficiency project might be implemented because of its cost savings and would in this case not be additional.

Financial Test
This test assumes that an offset project is additional if it would have a lower than acceptable rate of return without revenue from carbon offsets. In other words, the revenue from the carbon offsets is a decisive reason for implementing a project. In theory, the financial test measures additionality very well, but in reality there may be projects whose finances make them look non-additional Yet they may still be "additional" because of non-monetary barriers.

Barriers Test
This test looks at implementation barriers, such as local resistance, lack of know-how, institutional barriers, etc. If the project succeeds in overcoming significant non-financial barriers that the business-as-usual alternative would not have to face the project is considered additional.

Common Practice Test
If the project employs technologies that are very commonly used, it might not be additional because it is likely that the carbon offset benefits do not play a decisive role in making the project viable.

It is important to point out that there is no single test for additionality. Which test is best suited to validate additionality depends on the type of project. An additionality test for one type of project (e.g., a simple regulatory test for methane flaring, where there is no reason to do the project if not required by law) might not be sufficient for other kinds of projects (e.g., energy efficiency, where there could be plenty of reasons for doing a project besides complying with regulations).

Also, additionality tests are always to some extent subjective, because the assumptions that underlie even the strictest additionality test are determined by the objectives that the additionality test is trying to fulfill. These objectives cannot be scientifically determined or tested, because they are not technical but political in nature and must therefore be discussed and standardized by policy makers[11].

To illustrate this, here a simplified example: to apply a regulatory test on an energy-efficiency project, a third party verifying company determines the parameters for additionality based on their analysis of the situation. In some cases, an improvement of 10% over the statutory requirements may be considered additional, but in other cases, where, for example, the policy is considered very minimal (e.g. a building code with minimal energy-efficiency requirements), the project would need to exceed the minimum standards by at least 50%.

[10] The guidelines set by the CDM Executive Board for assessing additionality can be found at: http://cdm.unfccc.int/methodologies/PAmethodologies/AdditionalityTools/Additionality_tool.pdf

[11] For a more in-depth analysis, please see M. Trexler, D. Broekhoff, L. Kosloff (2006). 'A Stastistically-driven Approach to Offset-based GHG Additionality Determinations: What Can We Learn?' *SUSTAINABLE DEVELOPMENT LAW & POLICY, Vol 6, issue II.*

The discussion about additionality shows one of the weaknesses of project-based emissions reductions policies. Cap-and-trade systems, or purely regulatory action such as efficiency standards and carbon taxes, avoid the issue of additionality altogether. This is one reason we strongly advocate robust regulatory action and see value in the voluntary emissions trade market only insofar as it can spur innovation and carbon reductions even in a hostile political environment.

It is never possible to establish with certainty what would have happened in the absence of a particular project, and clearly there is potential for abuse. For example, there are strong financial incentives for the seller (project financier and implementer) as well as the offset buyer to overestimate the "business-as-usual" baselines and thus artificially inflate emission credits for improved performance. There is clearly a need for strict monitoring and third-party verification of carbon projects. Although the risks of "cheating" are real and substantial, it is also important to recognize that additionality rules that are too stringent can hamper project implementation.

The debate over additionality is especially fierce surrounding the issue of converting ***Renewable Energy Credits (RECs)*** to carbon offset credits. More details on this discussion can be found in section 3.3.

While all of these concerns are hard to address, voluntary offset companies must deal with them to some degree when choosing projects. It is usually the certification and verification organizations that ensure additionality (see section 3.4).

3.2 Double Counting (last edited for revision 1.3)

Unfortunately, it is all too easy to double count emissions reductions; that is, to have multiple stakeholders take credit for them. A hypothetical extreme example would be an electricity provider who builds a wind farm and then sells their power at a premium as 'green power' to local customers but also sells their carbon credits and their Renewable Energy Credits (RECs), and uses the wind farm to qualify for Renewable Portfolio Standards. In addition, if the wind farm was located in a state or country that has a legislated cap on carbon emissions or needs to reduce its emissions under the Kyoto protocol, the wind farm would also count toward that state's or country's emissions reductions goal. In this extreme example, the emissions reductions from the wind farm are counted 6 times!

Some of these double counting issues are easily addressed:

- Offset companies must retire their offsets once they sell them (i. e. they can only be sold once).
- Offset companies must ensure that carbon offsets from renewable energy projects are not also sold as Renewable Energy Credits.
- Utilities that sell RECs from Renewable Energy Projects are prohibited to use that project to qualify for Renewable Portfolio Standards.

Other double counting issues are more difficult to address: For example, if a US citizen were to buy offsets that are then are invested in a wind farm project in Canada, he will take credit for these emissions reductions. But Canada will also count the resulting reduction in carbon emissions from the new wind farm toward their emission reductions goals that they are required to meet as signatories of the Kyoto protocol.

This means, not only are the emissions double counted but the wind farm has effectively replaced another set of emissions reduction measures that Canada would have had to take in order to meet its Kyoto requirements. Viewed this way, it can be argued that the wind farm does not have any net carbon benefits. On the other hand, a valid counter argument can be made that such a wind farm project would stimulate the renewable energy industry in Canada and might therefore encourage further renewable energy projects and a move towards a low carbon economy.[12]

[12] More about how well country have succeeded in implementing climate mitigation policies and strategies see Germanwatch's report: *Climate Change Performance Index 2007* http://www.germanwatch.org/klima/ccpi.htm, accessed on 11/21/06)

It can also be argued that because of the uncertain future of the Kyoto agreement and because international environmental agreements are notorious for their unenforceability, it is unclear how seriously countries take their treaty obligations. In other words, in our hypothetical answer, Canada might not take any actions to reduce their carbon emissions and withdraw their commitment to Kyoto. In this case, the wind farm would be additional and paradoxically the double counting issues would be less serious. The same would hold true if the wind farm was build in the US, which has not ratified the Kyoto agreement.

These national double counting problems could be addressed if Annex 1 countries with emissions reduction obligations would retire AAU credits for all the VERs that are created through the voluntary market. We are unaware of any country that currently has such regulation in place.

Double counting issues also apply on a more local level: if a region, state, county or city has enacted a emissions reduction target – even if it is just a voluntary one – any emissions that are created in that area but then sold as VERs in the voluntary market must not also be counted in that jurisdiction's emissions inventory. Although double counting on a national level is currently not a problem in the US, but more localized double counting problems remain an issue.

For example, the Climate Trust buys offsets from the City of Portland for two of their building energy efficiency programs. Yet, in 1993, the city of Portland became the first U.S. city to adopt a strategy to reduce emissions of carbon dioxide (CO2). Their Local Action Plan on Global Warming calls for a reduction of carbon dioxide emissions to 10 percent below 1990 levels by 2010. According to their webpage:

> "Local greenhouse gas emissions are now less than 1 percent above 1990 levels – a key benchmark of the international Kyoto Protocol – and emissions have declined in each of the past four years."
>
> "On a per capita basis, Portland and Multnomah County emissions have fallen 12.5% since 1993, an achievement likely unequalled in any other major U.S. city."
> (http://www.portlandonline.com/osd/index.cfm?c=41896, last accessed 11/27/06)

The carbon offsets that the Climate Trust buys from the City of Portland are also counted in the cities' greenhouse gas inventory. The Climate Trust responded to our concern:

> The Climate Trust does allow entities who are a part of a voluntary reduction program to claim credit for the reductions that result from a given offset project. We do not, however, allow entities to claim credit if they are a part of a regulatory regime. Our position is that early-moving companies should be able to claim some economic benefit for their actions. The City of Portland has worked hard and their offset projects are of high quality. (e-mail communication, 2/14/07, CarbonCounter.org)

Additional legislation is needed to avoid double counting of voluntary offsets generated in Annex I countries (see section 5) and in areas that have sub-national emissions reductions obligations or goals (e.g. California or RGGI). An international registry for VERs (similar to that which exists for CERs created by CDM projects) is needed to minimize fraudulent double counting.

3.3 Types of Carbon Credits *(last edited for revision 1.3)*

Voluntary offset companies can operate either within or outside of the Kyoto framework. The advantage of working within Kyoto is that emissions reductions (***CERs or ERUs***) are verified under a unified regulatory framework. All CERs have to be verified by a Designated Operational Entity (DOE[13]). DOEs are liable for

[13] A Designated Operational Entity (DOE) is a company accredited by the CDM Executive Boards that checks whether projects are fulfilling CDM criteria. Each CDM project must be validated and verified.

Validation is done once before initial project approval. Verification is done periodically after the project has been approved or registered.

any emissions credits wrongly certified. If they overstate the savings, they are responsible for delivering the missiong emissions credits. Experience shows that this type of rigor squeezes out about 40% from the initially claimed tons in a CDM project. (Dietrich Brockhagen, e-mail communication 3-29-07)

Table 1: International Carbon Trading and Project Mechanisms

Mechanism	Unit	Type	Regulatory Framework
IET - International Emissions Trading	AAUs - Assigned Amount Units (Allowances[14])	Quota	Kyoto
JI - Joint Implementation	ERUs - Emission Reduction Units	Credit[15]	Kyoto
CDM - Clean Development Mechanism	CERs - Certified Emissions Reductions	Credit	Kyoto
Voluntary Carbon Trading	VERs - Verified Emissions Reductions	Credit	No unified regulatory framework

Yet the administrative burden for CDM projects is larger than in a more informal market. Projects that do not fall under the Kyoto mechanisms are more difficult to verify, since there are no clear guidelines and third party certification is done at the discretion of the offset company. That means that the quality of ***Verified Emissions Reductions (VERs)*** can greatly vary (see section 2.) This makes it harder for the consumer to be sure her emissions are truly offset by the VERs she buys.

Sometimes projects in developing countries are not registered as CDM projects because they are too small. **Myclimate** estimates that a carbon offset project must reduce at least 5,000 metric tons of CO2 per year in order justify the CDM transaction costs[16]. Such projects can still adhere to high standards, for example they can be implemented using the ***Gold Standard's*** new standards for VER generating projects — projects that are outside of the Kyoto Protocol (see section 3.4).

Validation
Based on the project design document (PDD), the DOE will evaluate and validate the proposed CDM project, confirming :
1 – Parties are voluntarily participating
2 – Stakeholders have been invited to comment
3 – Project participants have submitted documentation on environmental impacts to the DOE
4 – The project will result in greenhouse gas reductions that are additional
5 – A methodology has been adopted in accordance with CDM rules
6 – Provisions for monitoring, verification and reporting are in accordance with CDM rules
7 – The project complies with all other CDM rules

The DOE then issues a validation report, and requests registration of the project though the CDM Executive Board

Verification
CDM project are monitored or "verified" after the project has been approved or registered by the CDM Executive Board. After the project has been registered by the Executive Board, the DOE periodically checks (usually once a year) whether emission reduction have actually taken place. It will then request that the EB issue CER's accordingly, based on this verification report. It is only after verification that CER's are actually delivered.
(This footnote was modified from: http://www.cseindia.org/programme/geg/cdm_faq.htm#doe, accessed 4-2-07)

[14] Allowances are the unit of compliance that are traded in cap and trade programs.

[15] Credits (Offsets) are emission reductions that an emitter has achieved in excess of any required reductions. The excess amount is the credit and can be sold on the market.

[16] http://www.myclimate.org/index.php?lang=en&m=projects&um=standard&uum=ver, last accessed 11/30/06

Renewable Energy Credits (RECs) (last edited for revision 1.2)
One REC represents the delivery of one megawatt-hour of renewable power to the total energy infrastructure. RECs can be sold and traded independent of the electricity produced. RECs are traded both in mandatory and in voluntary markets. RECs are sold in the voluntary market based on the assumption that they represent the environmental benefits when electricity is generated from renewable resources instead of fossil fuels, like coal and natural gas. It is important to understand the difference between "mandatory" or "compliance" RECs and voluntary RECs. Because mandatory RECs are simply an instrument for meeting a quota, there is no concern or implication about their "environmental benefits." It's only in the voluntary markets, where RECs are sold solely because the buyer is interested in their environmental benefits, that their true environmental value needs to be evaluated, rated, and certified.

RECs are frequently turned into carbon credits by multiplying them by a factor that accounts for the avoided CO_2 emissions. In theory, it does not matter if RECs are sold as RECs or as carbon credits as long as they are not double counted and are additional (see section 3.2). Yet in practice assuring additionality is very difficult. Voluntary market RECs generally do not have to adhere to the same strict additionality standards (see section 3.1) as carbon offsets (VERs.) Green-e certified RECs, for example, have to come from renewable energy plants that were built after 1997 and cannot be counted towards ***Renewable Portfolio Standards*** or any other legal requirements. Although these two requirements are important, they do not fully address additionality. Because of the economic benefits of many renewable energy projects, such as wind farms, it is especially difficult to determine additionality with RECs. Some companies clearly state that their RECs have to comply with the same additionality criteria as carbon offsets (VERs.) In this case, RECs are a credible alternative to VERs. Yet most companies do not make this distinction.

This is not to say that none of the available RECs are additional. Some developers explicitly state that the revenue from RECs played a decisive role making the project viable:

> *"In all 8 wind energy projects that CEI [Community Energy] has developed or helped to finance with Renewable Energy Credit (REC) marketing efforts, REC revenue streams were explicitly valued (based on voluntary market customer contracts or market projections) and vital to project feasibility. As the industry continues to evolve, reliable REC revenue steams will be even more critical to flipping the economics of wind energy in the positive direction."*
> Brent Beerley, Vice President, CEI
>
> Quote taken from: *How Voluntary Markets for Renewable Energy Support Meaningful Reductions in GHG Emissions* November 30, 2006, discussion draft, available at http://green-e.org/docs/RE_and_GHG_Q&A_v2.pdf (last accessed 1/26/2007)

Yet the issue remains that there is currently no standard and verification available that ensures RECs are additional.

To summarize, we would like to distinguish between the sale of RECs and the sale of RECs-converted-to-carbon-credits (RECscc). RECs do not need to fulfill additionality criteria because they do not claim to neutralize any carbon emissions. They just claim to be from renewable sources and therefore are almost completely pollution- and carbon-free. Yet RECscc do claim to offset carbon emissions. Therefore if RECscc are sold to someone who wants to offset their air travel emissions, additionality becomes vital to make such offsets credible. RECscc can only claim to do so if the benefits of the sale of the RECs were a decisive factor in pursuing the project. Because there are currently no clear guidelines available to ensure additionality in RECscc, we consider RECscc less desirable (lower quality) than CERs or VERs that fulfill strict additionality standards. ***Green-e***, the main certifying body of RECs in the US is currently developing new, stricter standards for RECscc (see section 3.4).

Forward Purchasing of Offsets (FPO) / Future offsets (last edited for revision 1.3)

Carbon offset companies can purchase carbon offsets that have already been achieved or that will happen in

the future. Forward Purchasing of Offsets (FPO) carries the risk of buying credits that might not happen if the project fails or underperforms. On the other hand, it is often the financial investments in such ***future offsets***[17] that will allow a project to actually be implemented – in other words, ***FPO*** can be an effective tool in reducing risks that otherwise could prevent the project from being implemented.

FPO does not guarantee additionality, but most additional projects need to secure upfront offset funding. It is much easier to implement financially additional projects if customers can be found who are willing to pay upfront than if the project needs to secure funding from lenders with the expectation that the debt will be paid off later by customers purchasing carbon reductions. (Conversely, non-additional projects by definition do not depend on any offset funding - so they can afford to go forward and wait for customers to pay for their "reductions" in the future.) Therefore, forward purchasing can be an incentive for additional projects, in other words, FPO does not guarantee additionality, but on balance will lead to more additional projects than a "pay-as-you-go" approach. Additionality needs to be substantiated regardless of whether one is purchasing forward credits or current year credits it's central to the claim about offsetting emissions.

A distinction needs to be made between **contracts of forward purchases** and **contracts of forward crediting**. With forward purchases, the buyer invests the money upfront but does not get the credits until they are actually produced. This is how most CDM projects are financed. Yet in the voluntary market, offset purchasers are often unwilling to make long-term commitments, especially in the context of offsetting air travel, where purchasers offset one flight at a time, or a year of flying at a time.

With forward crediting, the buyer pays and also gets the offsets credited upfront, despite the fact that they will only be produced in the future.

> Tom Stoddard from Native Energy:
>
> With such a contract, an offset marketer agrees to purchase the project's long-term offset output upfront, and then sells shares of that future output up front, with each share sized to produce an estimated quantity of carbon offsets over a specified period of time.
>
> ***The quantity of offsets may not be guaranteed.*** Marketers of offsets (and the projects for which the future offsets model is most useful), are typically not well enough capitalized to guarantee a project's future performance. In addition, insurance products insuring the volume of an offset project's future output are not available. This leaves most marketers of future offsets estimating rather than guaranteeing the future offset quantity. Marketers of future offsets should discount the expected future offset quantity, as a means to reduce the risk of project underperformance. Adequate discounting of the expected offset quantity can result in the projects enabled by future offsets performing as well or better than estimated, on average. (e-mail communication, 2-28-07)

Clearly, forward crediting carries the risk of claiming credits as real that may or may not happen in the future. Being conservative when calculating the estimated offsets and discounting them to allow for underperformance are legitimate tools to reduce the risk of these forward crediting mechanisms. Nevertheless, they can be a risky proposition and consumers should be encouraged to opt for companies that fully disclose both the risks and how those risks are mitigated by discounting.

Bundled offsets
Bundled offsets are emissions that do not come from one single project but are, similar to a Mutual Fund, a

[17] The phrase "future offset" was replaced with "forward purchases of offsets (FPO)" in revision 1.3 of this paper. This is to distinguish between forward purchasing and forward crediting. As explained in this chapter, we do recommend forward purchasing but are wary of forward crediting.

collection of offsets from various projects. If all the offsets in the bundle come from high quality emissions reductions projects, then bundling is a valuable approach to insure against risks, for example from future offsets, and to lower prices. For example, **MyClimate** offers two different offset portfolios to their clients. The more expensive one includes offsets that come with more external benefits (e.g. bringing new technologies and know-how to very remote areas), while the less expensive one includes projects that have lower implementation costs.

Bundling offsets is problematic if low quality emissions reductions are mixed into the portfolio. For example, the ***Chicago Climate Exchange*** (see section below) offers bundled offsets that include project based emissions as well as emissions reductions achieved by member corporations that went above their emissions reductions target. These emissions reductions, although laudable, are not the same as offset reductions created through offset projects alone. They raise issues of overabundancy, double counting, and transparency. This is especially true since CCX's standards and verifications procedures are proprietary (see more details below). **Because the voluntary carbon market is so young, we recommend consumers act as conservatively as possible and buy carbon offsets with highest standards of certification and verification, even if those currently carry higher transaction costs.**

3.4 Standards and Verification (last edited for revision 1.3)

To address concerns of additionality, monitoring and verification, companies often involve a third party and use internationally recognized criteria. Standards set criteria by which projects are chosen and evaluated. Such standards may include criteria for: type of project, impact on local communities, additionality and leakage[18]. These standards may be set by the offset company itself or a third party. These standards allow for better project comparison and evaluation.

Standards alone cannot ensure the quality of a project. It is only through the validation and verification of these standards that projects can reliably be evaluated. Verification consists of the periodic monitoring and review of ongoing projects in addition to an evaluation after the project period has ended. The monitoring ensures that the project is meeting goals and operating properly. For example, if a project involves installing stoves, monitoring allows for assurance that the stoves are working and are being used.

End-of-project verification ensures that the carbon emissions have been reduced by the amount intended. It is particularly important to have a third party involved at this point as there is an obvious incentive for project financers and offset buyers to see that projects have met their goals. Independent verification is crucial for the credibility of emission reduction projects. Below is a description of the most frequently used standards and verification procedures.

Clean Development Mechanism (CDM)

http://cdm.unfccc.int/

Used by: **atmosfair, myclimate and (update 1.3: The CarbonNeutral Company)**

As mentioned earlier, the CDM is part of the United Nations Framework Convention on Climate Change (UNFCCC). As the largest regulatory project-based mechanism, the CDM offers the public or private sector in developed nations the opportunity to purchase carbon credits from offset projects in developing nations. CDM is involved in setting standards and verifying projects. Certified Emissions Reductions (CERs) are verified and certified by authorized third parties ***(Designated Operational Entities.)*** CDM standards are stringent and robust, yet have high transaction costs so that usually only large projects are registered. CDM requires strict additionality for certification of carbon offset projects. (For validation and verification procedures, see footnote 15)

[18] Unintended release of CO2 as a result of the project (e.g. farmers move away from a now protected forest and start clear cutting an area that was previously untouched; or new compressed natural gas buses replace diesel buses but because of small gas leaks, the greenhouse gas balance is not improved as expected.)

Gold Standard and Voluntary Gold Standard

http://www.cdmgoldstandard.org/
Used for all their projects by: **atmosfair**, **myclimate, Climate friendly**

The Gold Standard was developed by a network of non-government organizations and sets higher standards than the CDM. It is endorsed by 42 NGOs worldwide. Gold Standard projects include renewable energy or energy efficiency technologies. (No sequestration projects are accepted.) The Gold Standard requires strict additionality for certification of the carbon offset projects. For a project to be selected, these standards must be met and are checked by a UNFCCC-accredited organization. Monitoring and verification is also done by these organizations to ensure the benefits are realized.

Gold Standard projects take into account differing environmental, social and economical factors to maximize the secondary benefits and to minimize the negative impacts of a project. It actively encourages local participation in project design, and seeks to maximize sustainable development benefits.
Gold Standard projects are usually CDM projects. Because of the high transaction costs of CDM/Gold Standard, the projects are usually large scale.

There are currently eight projects registered as Gold Standard projects. Information about them can be accessed at: http://www.cdmgoldstandard.org/projects.php

Voluntary Gold Standard

For smaller projects that are not CDM registered, a Voluntary Gold Standard (VGS) was released in spring of 2006. The aim was to simplify procedures and to reduce transaction costs for small scale projects while still maintaining high quality standards. VGS can only be used in non-Annex 1 countries.

The Gold Standard is the most rigorous standard available to date. Although adhering to the Gold Standard incurs higher transaction costs and can therefore lead to higher prices for consumers, we strongly recommend purchasing offsets that follow these strict guidelines.

The Voluntary Carbon Standard (VCS) (last edited for revision 1.3)

Used by: **The CarbonNeutral Company**

The Climate Group (TCG), the International Emissions Trading Association (IETA) and the World Economic Forum Global Greenhouse Register (WEF) jointly develop the ***Voluntary Carbon Standard (VCS)***. Version 1 of the Standard was published in 2006. The goal of the VCS is to provide "a certification tool that is designed to give users confidence that voluntary project-based GHG emission reductions are real, measurable, permanent, additional and independently verified" (The Climate Group)

Carbon offsets that are certified and verified through the VCS are called ***Voluntary Carbon Units (VCUs)***. VCUs are fungible, tradable and registered: VCS established an international registry for its VCUs which is sited at the Bank of New York.

The Voluntary Carbon Standard Version 2 is currently being developed. A draft of the VCS version 2 can be downloaded at http://theclimategroup.org/assets/Voluntary_Carbon_Standard_Version_2_final.pdf
http://www.v-c-s.org/

Chicago Climate Exchange (CCX) (last edited for revision 1.2)

http://www.chicagoclimatex.com/
Used by: **Carbonfund**, **Cleanairpass**, **TerraPass**

The Chicago Climate Exchange is a voluntary cap-and-trade emission trading system. CCX operates mainly in the US but also has members and affiliates in Canada and Mexico. Members commit to reduce their emissions by a certain amount each year, measured against their original baseline. Companies that achieve

reductions that go above the commitment can sell these emissions reductions as CCX's commodities called ***Carbon Financial Investments (CFIs.)*** Companies can also invest in external carbon projects which are implemented in the US, Canada, Mexico and Brazil. These projects involve mostly methane capture and carbon sequestration though forestry and no-till agriculture. The offset from these projects are also tradable as CFIs.

The CCX certification and verification process is proprietary. It is therefore difficult to evaluate the quality of CCX's carbon offsets. Several NGOs have criticized the CCX for its loopholes, lack of clearly defined additionality criteria and a general lack of transparency (Dale, 2006).

In addition, many of the member companies of CCX have over-complied with their commitments. This has led to an overabundancy of CFIs. In a cap-and-trade system, it is most important that the cap is set at a high enough level so the system produces meaningful reductions that go beyond business-as-usual. Additionality is not of concern because it is the cap on the emissions that helps achieve real reductions. To give an example: if the cap on a hypothetical cap-and-trade system is 1000 tons of CO_2 and I buy 100 tons and retire them, I have in effect created a scarcity of available credits. That means the price of the still available credits will likely go up and companies will have to work harder to create additional credits. If, on the other hand, there is an overabundancy of credits and I buy some of those credits, I have in effect just reduced some of the excess credits that are available.

CCX has certainly demonstrated a very innovative and valuable approach to carbon trading. Yet, because of a lack of transparency, the current overabundancy of CFIs, and to a lesser degree because of their focus on bio-sequestration in their external offset projects (see section 4.3), we advocate that consumers minimize purchasing voluntary offsets that were generated through CCX.

Green-e

http://www.green-e.org
Used by: **NativeEnergy, TerraPass, Carbonfund**

Green-e is run by the Center for Resource Solutions (CRS) (www.resource-solutions.org/index.htm), a US-based non-profit company that measures and verifies a range of renewable energy projects. Green-e both sets standards for US renewable energy projects and verifies the projects. Green-e certified ***Renewable Energy Credits (RECs)*** have to be generated by power plants that were built after 1997 and they cannot be used to also meet regulatory portfolio standards.

RECs can be sold and traded independent of the electricity produced both in mandatory and in voluntary markets. As mentioned earlier, RECs do not have to adhere to the same strict additionality standards (see section 3.1) as carbon offsets. Because of the economic benefits of many renewable energy projects, such as wind farms, it is especially difficult to determine additionality with RECs.

CRS is currently (as of January 2007) working on developing new, stricter standards for RECs that are converted to carbon offsets[19]. We strongly support efforts to develop clear, transparent and strict rules for selling RECs into the voluntary carbon market. Given how important renewable energy production will be in guiding us towards a low-carbon future, we support the financing of renewable energy projects though voluntary carbon offset companies, as long as the project are of high quality, fulfill strict additionality standards and are not double counted.

[19] The draft version of these guidelines are available at http://www.resource-solutions.org/mv/docs/DRAFT_Green-e_GHG_Product_Standard_for_Stakeholder_Comment.pdf Stakeholder comments accepted until January 31st, 2007 The comment form is available at: http://www.resource-solutions.org/mv/ghgstandard.html

4. Offset Project Types (last edited for revision 1.2)

Most companies invest in a variety of different carbon offset projects. Most projects can be broadly categorized into three main types: renewable energy, energy efficiency and sequestration projects. These three categories are discussed in more detail below.

Projects that do not easily fit into one of the three categories include projects that reduce non- CO_2 emissions, for example:

- Flaring of landfill gas, which is comprised of about 50% methane. Methane is about 21 times stronger as a greenhouse gas than CO_2. Flaring landfill gas reduces these methane emissions.
- Reducing emissions from industrial processes: for example, some very potent greenhouse gases are emitted during production of aluminum[20]. Altering production processes can reduce these emissions.

In this paper, we focus on the three main categories of renewable energy, energy efficiency and sequestration. We do not provide further analysis of projects that do not fit these categories. This is not a reflection of their quality but the result of the limits of this paper. Projects are implemented either internationally or domestically. We discuss below the implications of project location.

4.1 Renewable Energy

Numerous renewable energy technologies exist. Most offset projects focus on wind, biomass, and solar technologies. Examples of such projects include solar panels to create electricity for a home in a developing nation or the construction of a wind farm in the US.

Economic, geographic, social, and political factors all need to be considered to establish the feasibility of renewable energy projects. Many renewable energy projects have high up-front capital costs, although they may offer high rates of return (Martinot, 2000). Legislative hurdles and local opposition to a project can further complicate the implementation of such projects.

Projects that are implemented in poorer nations are often much more cost effective but such projects can easily be compromised by a lack of local capacity and the needed infrastructure to operate the new technology. Project staff may introduce the new technology and then leave the project site without creating a sustainable situation under which the new technology can be maintained and repaired (Martinot, 2000; Turkenburg, 2000).

Moving away from fossil fuel based electricity production to renewable energies is crucial for the long-term protection of the global climate. We therefore recommend offset projects that lead to the production of renewable energy.

4.2 Energy-Efficiency

Energy efficient products or systems use less energy to perform the same task. For example, if a new refrigerator of the same size replaces an old, less efficient one, energy is saved. If the electricity to power the refrigerator comes from a coal or oil power plant, the new refrigerator will not only use less energy but also produce less greenhouse gas emissions than the old one.

Examples of energy efficiency technologies include compact florescent lamps, energy efficient motors, and redesigned cooking stoves. Installing more efficient stoves in developing nations can reduce coal and wood consumption. Improving efficiency of wood use is particularly important in areas where wood harvesting contributes to deforestation. Establishing a baseline can be difficult, for example, reducing the amount of wood burned does not result in a net greenhouse gas reduction: the burning of wood is considered carbon

[20] Perfluorocarbons (PFCs) are 7000-9000 times more potent than CO_2

neutral since the carbon released is equal to the carbon the tree absorbed. Yet, if there is permanent deforestation as a result of fire wood use, more efficient stoves can reduce CO_2 emissions.

Energy efficiency projects need to be carefully evaluated for their economic, environmental and social benefits. In developing nations, new technologies need to be introduced alongside building the necessary local capacity to make the projects sustainable (Martinot, 2000).

Many energy efficiency projects have higher transition costs than large centralized renewable energy production projects on a per unit of energy basis because they are small and decentralized (Martinot, 2000). Transition costs include planning, installation, operation and maintenance.

Because of the decentralized nature of energy-efficiency projects, monitoring and evaluating energy efficiency projects can be challenging. Establishing a baseline and estimating emissions reduction for small decentralized projects is difficult and labor intensive.

Despite the issues that can arise with energy efficiency projects, such projects have great potential in decreasing greenhouse gas emissions. Well implemented energy-efficiency projects are among the best offset projects.

4.3 Biological Sequestration[21]

Biological sequestration absorbs CO_2 emissions through the growth of vegetation. Bio-sequestration projects, usually called ***Land Use, Land Use Change and Forestry (LULUCF)*** projects, are the most controversial of the three main types of offset projects. (Brown, 2000; Osborne, 2005).

The amount of carbon sequestered by vegetation depends upon a number of factors including the age of the trees, their growth rate, local climatic conditions and soil conditions. Additionally, the carbon intake may be altered over time as temperatures and carbon dioxide concentrations in the atmosphere change with global warming. While greater concentrations of carbon dioxide may increase the growth of trees, greater cloud cover can reduce light and thus limit growth. Additionally, photosynthesis is reduced when temperatures are above optimal levels (Clark, 2003; Brown, 2000; Osborne, 2005).

If global warming is to be controlled, a transition away from fossil fuels is imperative. Therefore, carbon sequestration should not be seen as a long-term solution. Predictions state that only 10% of human emissions over the next 100 years can be offset by forests (Hamilton, 2002).

One of the largest challenges that arise with carbon sequestration is measurement. The carbon cycle in trees is complex. During the day, plants synthesize carbon dioxide yet at night and under stress situations (e.g. drought and heat) the process reverses and plants respire CO_2. Furthermore, the carbon cycle is altered by seasonal changes in temperature and precipitation (Hadley, 2002).

Additionally, leakage must be considered to properly measure project benefits. Leakage is the unanticipated loss of carbon reductions. For example, farmers may be moved off a given plot of land to allow a project to plant trees for sequestration, but the farmers may clear trees in another location to begin farming there. Thus the project may not be able to claim a net reduction in carbon emissions (Brown, 1999).

A final issue concerning measurement is permanence. For a LULUCF project to realize its full potential of sequestration, it must last. There are two main ways that the benefits could be negated. First, natural events

[21] Much research is currently done on geological sequestration – the underground injection of CO_2 emitted by fossil fuel power generation. At this point, geological sequestration is very costly and does not offer an alternative to the transition from fossil fuels to renewable carbon-free sources.

such as fires, pests, or diseases could destroy a forest. Second, the forest could be cut down by human activity. In either case, the intended sequestration would be negated (Brown, 1999).

Additionally, the age of the forest impacts carbon uptake; young forests absorb more carbon than older ones but mature forests store more carbon per acre in trees and soil and their biological value is also much higher. A tree plantation that is harvested at relatively short intervals and then replanted can have a high rate of carbon sequestration. Yet, while such a system of monoculture may have high carbon benefits, its ecological value is low, specifically in terms of biodiversity.

Ultimately, the exact tons of carbon sequestered might be less important than considering which projects help the transition to a low carbon economy. Both energy efficiency projects and renewable energy projects promote a more efficient, lower carbon economy, while LULUCF projects constitutes at best a stop gap measure that might ensure the protection of valuable biodiversity in old growth forests, at worst it can negatively impact biodiversity and also hamper the development opportunities of poor subsistence farmers in developing nations.

Clearly, land use management and reforestation projects are vitally important to protect and restore watersheds, ensure clean drinking water and protect biodiversity. Yet we feel that such projects should be implemented to secure exactly those benefits and not to achieve carbon sequestration. We do not mean to discredit all LULUCF projects. May of them are well planned and implemented.

But because of all the uncertainties involving bio-sequestration projects, and because of the vital importance that renewable energy and energy efficiency play in guiding us towards a low-carbon society, we do not recommend buying voluntary carbon offsets that are largely based on LULUCF projects.

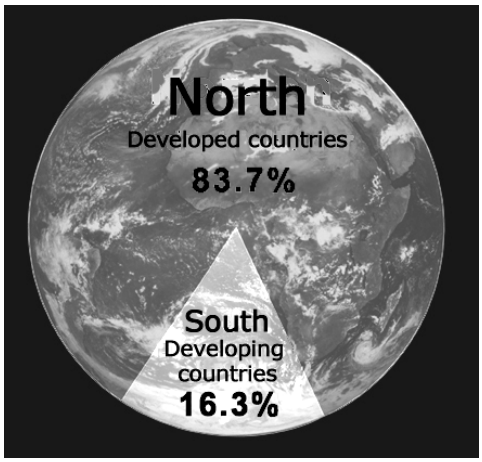
Added comment 1/27/2007:
We have received many reactions regarding the validity of bio-sequestration projects. Because of the importance and the complexity of the issue, we are currently developing a more in-depth analysis of bio-sequestration (in particular forestry). The result of this work will be available on-line in the spring of 2007.

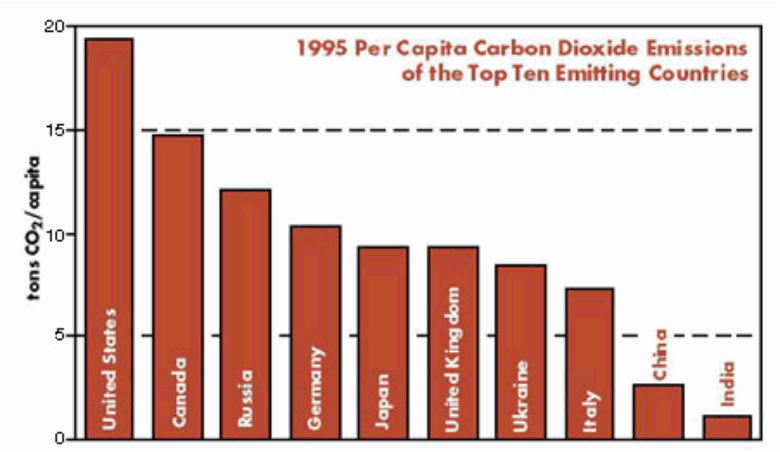
5. Offset Project Location

5.1. Developed Nations (Annex 1 Countries)

All countries have a responsibility to reduce their emissions, yet the weight of responsibility lies with the developed nations who are not only historically responsible for the largest part of emissions, but also have the highest per capita emissions (see graphs below and Annex A). It can therefore be argued that rich nations have a moral obligation to take the lead in cutting their domestic emissions. Furthermore, projects implemented in Annex 1 countries do not place developing countries at a disadvantage in terms of cost to reduce emission in the future as described below (Agarwal, 2002). Also, some clients may prefer domestic projects that support the domestic economy (Hanson, 2004).

Cumulative CO_2 Emissions from 1800-1988: The Ecological Debt of the North





(Source: Dr. Martin Storksdieck) **(Source: NRDC)**

Projects in the North are often not as cost-effective to implement as projects in developing countries. Additionally, those who feel a moral responsibility to help developing nations may not be satisfied with these projects. Large-scale domestic projects, such as wind farms, are susceptible to high upfront costs and political hurdles. However, technical know-how and verifiability of projects are easier to establish domestically than in a developing nation.

Yet there are also some drawbacks to domestic projects implemented in rich nations. Some of the issues involving double-counting and the risk that voluntary offset projects just replace other carbon mitigation measures which would have had to be implemented in order for the country to meet its Kyoto obligations discussed in *Section 3.2, p.9.*

Also, aside from large renewable energy projects, voluntary domestic carbon projects are often small-scale.[22] That means that the change they facilitate is marginal and does not facilitate more comprehensive policy change. On the contrary, the argument can be made that such projects hamper more forceful regulatory action *(see section 2.1)*.

5.2 Developing Nations (Non-Annex I countries).

International projects are usually implemented in developing nations because of their cost effectiveness (Hanson, 2004). The Clean Development Mechanism (CDM) of the Kyoto Protocol puts in place a framework to implement such projects. It allows industrialized countries with a greenhouse gas reduction commitment to invest in emission reducing projects in developing countries as an alternative to what is generally considered more costly emission reductions in their own countries. The CDM is supervised by the CDM Executive Board and is under the guidance of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC).

Clients may be attracted to projects in developing nations for moral reasons. Developed, rich countries are largely responsible for creating climate change which in turn will cause most harm in the poorest populations of developing nations. In a best-case scenario, international projects can bring resources, technology, infrastructure, and know-how to poorer nations and provide many additional benefits to the country (Edwards, 2003; Agarwal, 2002).

However, there are several criticisms of international projects. First, such projects allow developed countries to avoid domestic emissions reductions. Without strong domestic political action the dependence on carbon

[22] Michael Lazarus, Stockholm Environment Institute, phone conversation, 11-7-2006.

fuels in developed nations will continue to grow and renewable energy sources will not be sought. Therefore emissions will continue and the threat of climate change will increase (Agarwal, 2002).

Second, developed nations are placing others at a long-term disadvantage. When all the cheaper emissions reductions are made by foreigners, developing nations will later only be able to make the expensive changes. Additionally, as the Kyoto Protocol does not require developing nations to reduce their emissions during the first phase[23], they will not be credited for these reductions (Agarwal, 2002).

Finally, there are also monitoring and evaluation concerns. To be sure that emissions reductions do occur, projects must be adequately monitored and evaluated. First, an accurate baseline for emissions must be gathered and then the project must be monitored to assure proper functioning. After that, long term follow up is needed. These evaluative goals are particularly difficult to meet when the project occurs on a small scale and operates in a remote location (Meyers, 1999).

It is also worth pointing out that many carbon offset projects are somewhat experimental in nature, for example, introducing a new technology. The burden when such a project does not live up to expectation represents just a small cost for Northern institutions, but a failed solar power project in an Indian village can have far reaching negative consequences on that community. Apart from the primary problem – a lack of reliable power supply – unsuccessful projects hamper associated infrastructure development and opportunities to build capacity.

The advantages and disadvantages of projects in developing nations therefore depend very much on how projects are designed and implemented[24]. Because there are also major concerns with projects implemented domestically, we do not recommend one over the other but we stress the importance of projects that can prove clear additionality, sustainable development benefits, permanence, and contribute to the long-term goal of a carbon free, highly energy efficient economy. High standard and verification requirements such as the Gold Standard and the Voluntary Gold Standard help maximize the benefits of projects implemented in non-Annex 1 countries.

6. Company Profiles

6.1 Location and Date of Inception

Carbon offsets are an international business, which reflects the global nature of the problem they address. Even if a particular jet engine releases CO_2 over the North Atlantic or the state of Colorado, the environmental effects are cumulatively felt around the planet, and buying offsets from a London-based company for a project based in Brazil is a valid exchange. Four of the companies we evaluated are based in Europe, two of which are from the UK. Additionally, there is one company from Australia and two from Canada. The remaining six are from the US.

[23] The First Phase of the Kyoto Protocol ends in 2012.

[24] **Indigenous People See Harm from Kyoto Carbon Trading.**
By Alister Doyle and Gerard Wynn, Reuters, November 8, 2006.
"Indigenous peoples from the Amazon to Asia said on Wednesday that U.N.-backed clean energy projects meant to combat global warming were aggravating threats to their livelihoods. They said hydropower projects or plantations of fast-growing trees, prompted by a billion-dollar scheme under the U.N.'s Kyoto Protocol for limiting the planet's dependence on fossil fuels, were damaging nature. 'We are not only victims of climate change, we are now victims of the carbon market,' Jocelyn Therese, a spokesman for indigenous peoples of the Amazon basin, told a news conference on the fringes of U.N. talks on global warming. 'Efforts that are supposed to...retard climate change are having an equally disastrous effect,' said Ana Pinto, representing indigenous peoples in India."

The oldest companies, which began in 1997 and 1998, are both from the UK. The first US company was started in 2000. The number of offset companies is steadily growing on all three continents that were examined. Four of the companies in this paper began their operations in 2005 and all but 3 started selling offsets in 2002 or after.

6.2 For-Profit versus Non-Profit Companies

The offset companies function either as for-profit or a non-profit company. Seven of the companies are for-profit and six are non-profits. The distinction between non-profit and profit does not give an indication of the project and offset quality the company sells. In our study we did find though, that for profit companies where less forthcoming about their financial situation and tended to have higher overhead costs.

Table 2: Companies' year of inception, location, and status

Company	Year of Inception	Location	Company status
Solar Electric Light Fund	1990	US	Non-Profit
Better World Club	1996	US	For-profit
The CarbonNeutral Company	1997	Europe	For-profit
Climate Care	1998	Europe	For-profit
NativeEnergy	2000	US	For-profit
CarbonCounter	2002	US	Non-Profit
Myclimate	2002	Europe	Non-Profit
Carbonfund	2003	US	Non-Profit
climate friendly	2004	Australia	For-profit
Atmosfair	2005	Europe	Non-Profit
Cleanairpass	2005	Canada	For-profit
Offsetters	2005	Canada	Non-Profit
TerraPass	2005	US	For-profit

6.3 Overhead Costs (this section was rewritten for revision 1.3)

The percentage of offset sales that are reported to go directly to project implementation ranges quite significantly: from 25% (**Clean Air Pass**) to 90% (**CarbonCounter**) and 93% (**Carbonfund**) of sales going. (Chart 2) Five of the six non-profits provided answers on their website or replied via email, but the information was only available for four of the seven for-profit companies. (For **The CarbonNeutral Company please see footnote**[25])

As all of these numbers are self-reported, it is not clear how the companies arrive at these percentages. Some may include education, overhead and administration costs in project costs. Others may not include those expenses. The mean for non-profit companies is 81.6% and for for-profit companies 43.4%. Again, it is difficult to judge if that indicates that non-profits use a larger percentage of their funds for direct project implementation or if it indicates that non-profits tend to define "project implementation" more broadly.

Clearly it is very important that a company use their funds efficiently, yet because we cannot objectively evaluate the self reported numbers and because we did not have information for many of the companies, we removed overhead costs from our final analysis.

[25] We originally found a comment on **The CarbonNeutral Company**'s webpage that indicated that only 15-30% of offset sales go towards direct project implementation. They have since reported to us that these numbers are incorrect: "As a very broad average, we state that on average 60% of money 'goes to a project' and it can be up to 80% in specific contracts." (e-mail communication 3/22/07) We have adjusted that reported number in our final assessment and removed the numbers from chart 2 (also see footnote 1).

Chart 2: Percent of Funds Invested in Projects

Company	For or non-profit	% of money to projects
Carbonfund.org	Non	93%
CarbonCounter.org	Non	90%
Atmosfair	Non	80%
Myclimate	Non	80%
Climate friendly	For	66%
Offsetters	Non	65%
Climate Care	For	60%
Cleanairpass	For	25%
The CarbonNeutral Company	For	See footnote[25]
Better World Club	For	N/A
NativeEnergy	For	N/A
Solar Electric Light Fund	Non	N/A
TerraPass	For	N/A

7. Air Travel Emissions Calculators *(last changed for revision 1.3)*

Calculators have to fulfill three requirements: they have to educate the consumer, be user friendly and accurate. Nine of the offset companies do not provide their customers with detailed information about the complexities of calculating air travel emissions. The four companies that do are: **atmosfair**, **climate friendly**, **NativeEnergy** and **myclimate**. These companies also link to the IPCC's and other reports on this topic. **Climate Care** features a link to a paper they commissioned from Oxford University.[26] The other 9 companies do not discuss these complex issues on their webpage.

Since this study has been done CarbonCounter.org has overhauled its website. For updated information, see footnote[27]

[26] Jardine, Christian N. (2005). Part 1: Calculating the Environmental Impact of Aviation Emissions.,Environmental Change Institute: Oxford University Centre for the Environment. Available online at: http://www.climatecare.org/_media/documents/pdf/Aviation_Emissions_&_Offsets.pdf Last accessed on 7/7/06.

[27] **CarbonCounter.org** has done a major overhaul of its webpage in early 2007 and now has much more detailed information about its calculator. It now also includes a factor of 2 to account for full radiative forcing. The customer can choose between an emissions estimate, by entering approximate number of hours flown, or calculate the exact emissions by entering the number of miles flown. **CarbonCounter.org** does not provide a link to an external site for customers to calculate the number of miles flown. The carbon emissions in our two examples would now be 0.36 /3.21 tons of CO2 respectively. That means that according to the criteria in this study, they no longer underestimate emissions from air travel. We did not update the numeric tables or graphs. We also did not update the pricing information. We did change the information in the final calculator evaluation graph and in the company profile in chapter 9

7.1 User friendliness of calculator

There are three basic ways customers can calculate emissions from their air travel:

A. Entering the total miles flown.

CarbonCounter[27] and **Carbonfund.org** require customers to enter the mileage they would like to offset. It is assumed that users can find this information for themselves. There are other websites (such as http://www.webflyer.com) which compute the distance between major airports. None of the offset companies that ask for mileage have links to such sites. Adding such links would increase the user friendliness of these sites.

B. Entering origin and destination of the trip

atmosfair, **Climate Care**, **The CarbonNeutral Company, climate friendly**, and **Offsetters** have calculators that let customers enter their airport of origin and their destination. Multiple flights may be calculated using this method and then offset simultaneously. **Myclimate** and **NativeEnergy** offer a choice between entering mileage and entering the origin and destination of the flight.

C. Offsetting a fixed amount without calculating the precise emissions.

A number of the offset companies offer a simpler alternative to calculating emissions.
The CarbonNeutral Company offer in addition to their point to point calculator the option of choosing a short, medium and long haul flight, instead of calculating the precise emissions.

Better World Club's system is not based on a careful calculation. Instead, they use a loose approximation of one ton per flight, for which they donate $11 to the Tides Foundation as an offset.

Solar Electric Light Fund (SELF) does not offer calculators on its website, but has links to calculators to determine the amount of carbon emitted per flight and offers a program (**SELF**'s Carbon Neutral Club) where people can donate $10 per ton of CO_2 they emit.

7.2 Calculator Accuracy

Measuring greenhouse gas emissions from aircrafts is a complicated issue as a number of effects must be considered such as contrails, cirrus clouds and additional greenhouse gases (Bows, 2005; IPCC, 1999)[28].

7.2.1 Radiative Forcing (last changed for revision 1.3)

Calculating the CO_2 emissions from jet fuel burned on flights is relatively simple but the overall warming impacts of air travel are much more complex and difficult to calculate. Therefore, and to allow comparisons of varying types of emissions, the concept of *radiative forcing* is used. Radiative forcing measures the rate at which a given atmospheric gas alters radiation that is entering the atmosphere. A positive value denotes warming; a negative number signifies cooling (IPCC, 1999).

The main greenhouse gases emitted from aircraft are carbon dioxide (CO_2), water vapor, nitrogen oxides (NO_x), and methane (CH_4). Aircraft travel at altitudes of 9 to 13 kilometers (approximately 5.6 to 8 miles). At these altitudes, the effect of the emitted gases is considerably different than on the ground level and in many cases still incompletely understood[29]. Aircraft also emit water vapor during flight. When emitted in the stratosphere, H_2O can cause the formation of ice clouds, called contrails. Where contrails persist, cirrus clouds begin to form which have an additional impact on global warming. Clouds can have a double effect on

[28] For an excellent paper on the effects of air travel on climate change please see Lee (2004).
[29] For example, NO_x emissions have a stronger global warming impact in the lower troposphere. When NO_x is emitted in the troposphere, ozone levels increase, causing the earth to warm because ground level ozone is a greenhouse gas (IPCC, 1999).

radiation: they warm the earth by reducing the amount of radiation from the earth that escapes into space but also cool the earth by reflecting the sun's rays back into space. However, contrails lead to a net warming (William, Noland and Toumi, 2002; IPCC, 1999).

The IPCC has estimated total radiative forcing of air travel to be 1-5 times larger in the stratosphere than in the troposphere and calculated the average for full radiative forcing to be a factor of approximately 2.7 (IPCC, 1999.) Therefore to estimate the impact of an airplane trip a multiplier should be used on the CO_2 emissions from jet fuel to account for full radiative forcing.

Unless the growth of the air travel industry is slowed[30], it is estimated that by 2050 air travel will be contributing at least 6% of the total radiative forcing from human activities (RCEP, 2003; Bows, 2005).

The impact of NOx, water, and hydrocarbons at high altitude are poorly understood. It is possible that the forcing of water vapor is being underestimated by as much as a factor of 10 (see: Workshop on the Impacts of Aviation on Climate Change June 7-9, 2006, Boston, MA) [31]

Although more research is needed to fully understand the chemical processes in the stratosphere, the research used by the IPCC is robust. We therefore recommend using a calculator that includes a multiplier for the increased radiative forcing in its carbon calculations. Only five of the evaluated offset companies use a multiplier to account for radiative forcing: **atmosfair**, **Climate Care**, **climate friendly**, **myclimate**, and **NativeEnergy**. (**CarbonCounter.org** has recently added a multiplier to their calculator, see footnote 27)

7.2.2 Flight Distance (last changed for revision 1.3)

The rate at which fuel is burned is proportional to the drag which is the force of resistance that must be countered by the force of the engine's propulsion. During the take-off and landing, the engine is at full thrust and more fuel is consumed during take-off and climbing. Shorter flights therefore have a lower overall fuel efficiency; ie. use more fuel per mile than long-distance flights (RCEP, 2003). As the aircraft climbs and

[30] Increasing efficiency of new aircraft could potentially contribute to a slowing of emissions growth of air-travel.

CO2 production is directly related to aircraft efficiency, and to some degree how the aircraft is flown. Increasing aircraft efficiency has four components:
1. increasing the lift of the wing,
2. decreasing the drag,
3. increasing the thrust per pound of fuel burned (called thrust specific fuel consumption), and
4. decreasing the weight of the aircraft.

Aircraft are not as efficient during climb, but it has been shown that the overall greatest flight efficiency occurs when an aircraft climbs fast and spends more time in cruise. It might be that overall efficiency can be increased by sacrificing climb efficiency in order to spend more time in cruise.

There are new strategies being worked on to make descent more efficient. Currently during a conventional stairstep descent, the engine revs up and down – causing high emissions. So-called "continuous descent approach" that is much more environmentally friendly is currently being worked on. (e-mail communication, Prof. Rich Wlezien, Tufts University)

[31] The atmospheric chemistry of air plane emissions at high altitude is very complex. To delve into detail goes beyond this paper. We recommend the following list of readings:

Workshop on the Impacts of Aviation on Climate Change June 7-9, 2006, Boston, MA
http://web.mit.edu/aeroastro/partner/reports/climatewrksp-rpt-0806.pdf

IPCC (1999) Aviation and the Global Atmosphere: 6.2.3. Alternative Indexing of Aviation's Climate Impact-RF Index [online]. Available from: http://www.grida.no/climate/ipcc/aviation/071.htm#623

Sausen, R. et al. (2005) Aviation radiative forcing in 2000: An update on IPCC (1999) Meteorologische Zeitschrift 14: 555-561 - available from: http://folk.uio.no/gunnarmy/paper/sausen_mz05.pdf

Forster et al. (2006) It is premature to include non-CO2 effects of aviation in emission trading schemes. Atmospheric Environment 40:1117-1121

begins to cruise - that is, above the altitude of 3000 feet - drag and therefore rate of fuel use decreases (IPCC, 1999). On longer flights (those over approximately 994 miles) the amount of fuel used during take-off is less significant compared to the whole. This efficiency gain is partly offset on long distance flights by the added weight of the fuel that an airplane needs to carry on such long trips (RCEP, 2003). On the other hand, cirrus clouds from contrails only develop at higher altitude. On short-haul flights the percentage of time the plane will spend at high altitude is less than on long-distance flights. That means the increased warming effect from cirrus clouds is less strong on short haul flights. In other words, the factor to account for full radiative forcing is likely lower for short haul flights than for long haul flights.

To more accurately calculate emissions, some of the companies' carbon offset calculators distinguish between short, medium or long flights. **Atmosfair**, **myclimate**, **The CarbonNeutral Company**, and **NativeEnergy** account for fuel efficiency differences between long and short flights. **NativeEnergy**, for example, uses a calculator that asks for place of origin and destination or mileage flown to be entered. The data entry points are then divided into three categories: short, medium and long haul flights and CO_2 emissions factor of 0.64, 0.44 or 0.40 lbs of CO_2 per passenger mile, are applied respectively.

Often, airplanes do not take the most direct route and having to change airplanes is very common. This leads to additional inefficiencies. **Atmosfair** accounts for route and layover.

7.2.3 Occupancy Efficiency

At full occupancy an aircraft will fly at maximum efficiency. Therefore a flight that is at maximum payload burns less fuel per passenger than a flight that is at less than its maximum payload. On average, international flights fly at 78% of maximum payload and domestic flights at around 65% (RCEP, 2003).

The **atmosfair** emissions calculator addresses the different seat occupancy rates by applying a common average of 80% for charter flights. For scheduled flights the seat occupancy rates are also differentiated according to the flight region: for Germany 60%, EU 62%, intercontinental traffic 75%. If the flight type is not known, an average of 75% is applied[32].

7.2.4 Business vs. Economy (last changed for revision 1.3)

Business and first class seats are larger and take up more room. Therefore, a passenger traveling in business or first class is responsible for more emissions because they have effectively excluded additional people from traveling on that same flight (IPCC, 1999). Further research has shown that first class travel on long haul flights could have an impact 6 times as large as an economy traveler.

Atmosfair calculates that business class seats require 1.4-times as much space as the economy seats. For fuel consumption this means that economy passengers consume 10% less than the average for all seats, while business passengers consume 40% more.

myclimate allows customers to enter whether they fly business or economy class. A passenger traveling business class is charged 1.5 times the emissions of a traveler in economy class.

[32] The Atmosfair Emissions Calculator, pdf, www.atmosfair.de/fileadmin/user_upload/image4/atmosfair_calculator_04.pdf , accessed last on 10/31/06

7.2.5 Type of Plane

Type of plane also effects efficiency. The size, number of seats, engine types and other characteristics all influence the emissions of a flight. In general, older airplanes are less efficient than newer models. Most calculators use an average based upon all planes or choose just one typical commercial plane (IPCC, 1999).

Atmosfair allows customers to enter information about the type of airplane. **Climate Care** uses the fuel efficiency of 737s for short haul flights and 747s and the Airbus A340 for long distance flights.

7.2.6 Accuracy versus Ease of Use

The air travel emissions calculators do not vary widely in terms of overall ease of use. All that is required for any calculator is the entry of mileage or airports. Additional information, may be entered but is not required. Therefore a trade-off between accuracy and ease of use is not necessary.

7.3 Sample Calculations (last changed for revision 1.3)

To better compare how offset companies calculate and price their emissions offsets we have calculated for two sample flights:

- A short domestic flight: Boston - Washington, DC - Boston
- A long-distance, transatlantic flight: Boston - Frankfurt, Germany - Boston

The following three companies were not included:

Solar Electric Fund does not have its own calculator but has a link to http://www.earthfuture.com/climate/calculators/ which lists many available calculators. For air travel, the recommended calculator is http://chooseclimate.org/flying/ . The consumer has to click on an interactive map to choose departure and destination point. The consumer can also enter occupancy rate and choose between economy and business class. For the international flight, this calculator estimates a trip length of 4370 miles and 5.3 tons of CO_2 emissions per person. This calculator seems to underestimate trip length. The calculated CO_2 emissions are very high. The site gives detailed information about how the numbers are calculated. It would go beyond the purpose of this report to analyze this calculator in more detail but it seems that the CO_2 emissions are possibly overestimated on this site.

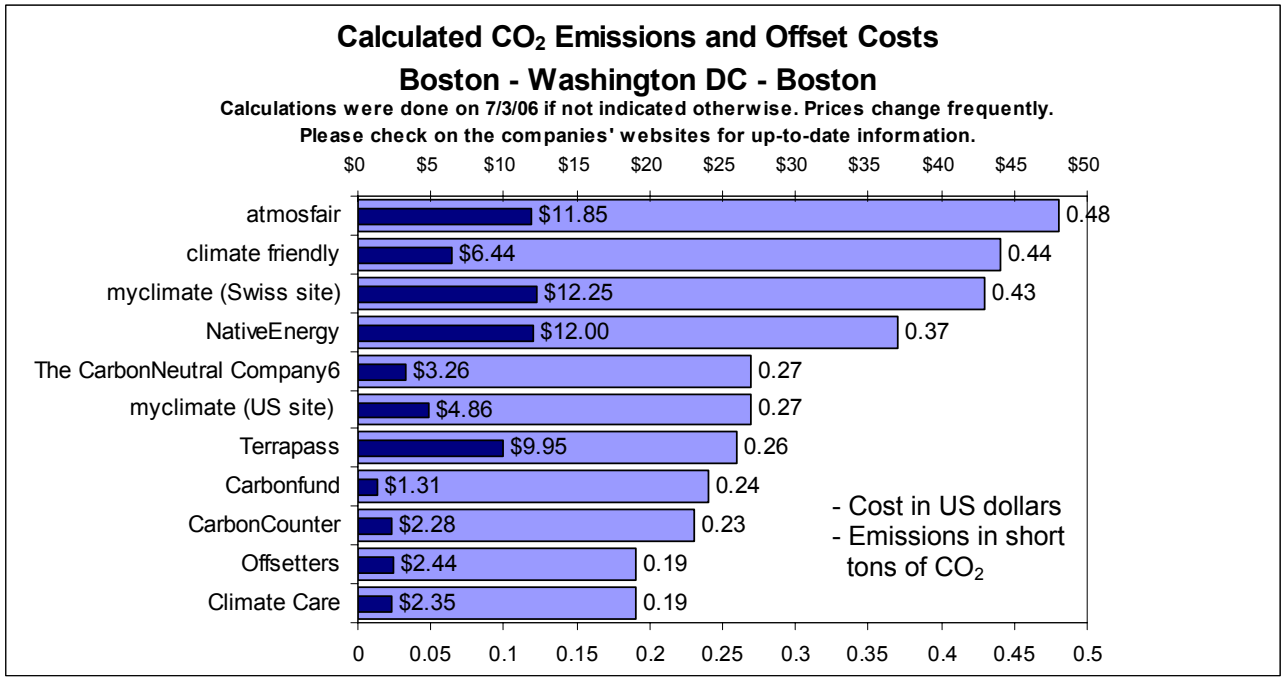
Better World Club does not have a carbon calculator on its site but also has a link to http://www.earthfuture.com/climate/calculators/ . For each flight booked through BWC, BWC donates $11 to the ***Tides Foundation*** which administers the funds.

Cleanairpass focuses on offsets from vehicle emissions. The site offers no easy way to purchase carbon to offset air travel. It was therefore not included in this example.

Table 3: Domestic Flight: Boston - Washington, D.C. – Boston. Sorted by Emissions

Company	***Distance (miles)***	***Emissions (tons)***	***Cost to offset***
atmosfair	889	.48	$11.85
climate friendly	797	.44	$6.44
myclimate (Swiss site)	824	.43	$12.25
NativeEnergy[2]	*822*	.37	$12.00
myclimate (US site)	NA[3]	.27	$4.86
The CarbonNeutral Company[6]	824	.27	$2.79 to $3.66
Terrapass	824	.26	$9.95[4]
Carbonfund[1]	*822*	.24	$1.31
CarbonCounter[1] (see footnote 27)	*822*	.23	$2.28
Climate Care[1]	*822*	.19	$2.35
Offsetters	824	.19	$2.44

Chart 3: Domestic Flight: Boston - Washington, D.C. – Boston. Sorted by Emissions



Notes:

Calculations and currency conversions made on 7/3/06 and on 10/31/06 (for myclimate), using online converter found at: http://www.xe.com/ucc/

Italic numbers indicate that the information was taken from a separate webpage:

[1] These companies either required the customer to enter mileage flown or did not offer the distance after the calculation was made. Therefore the distance of 822 miles for the domestic flight and 7320 miles for the international flight were used. These estimates were provided by an airport mileage calculator found at: http://www.webflyer.com/travel/milemarker/

[2] These companies only sell offsets on a per ton basis. Therefore the cost used is to offset one ton of carbon.

[3] The US site for **myclimate** does not display the number of miles traveled.

[4] This is the price for the *TerraPass Puddle Jumper* which offsets 2,500 lbs of CO_2 emissions

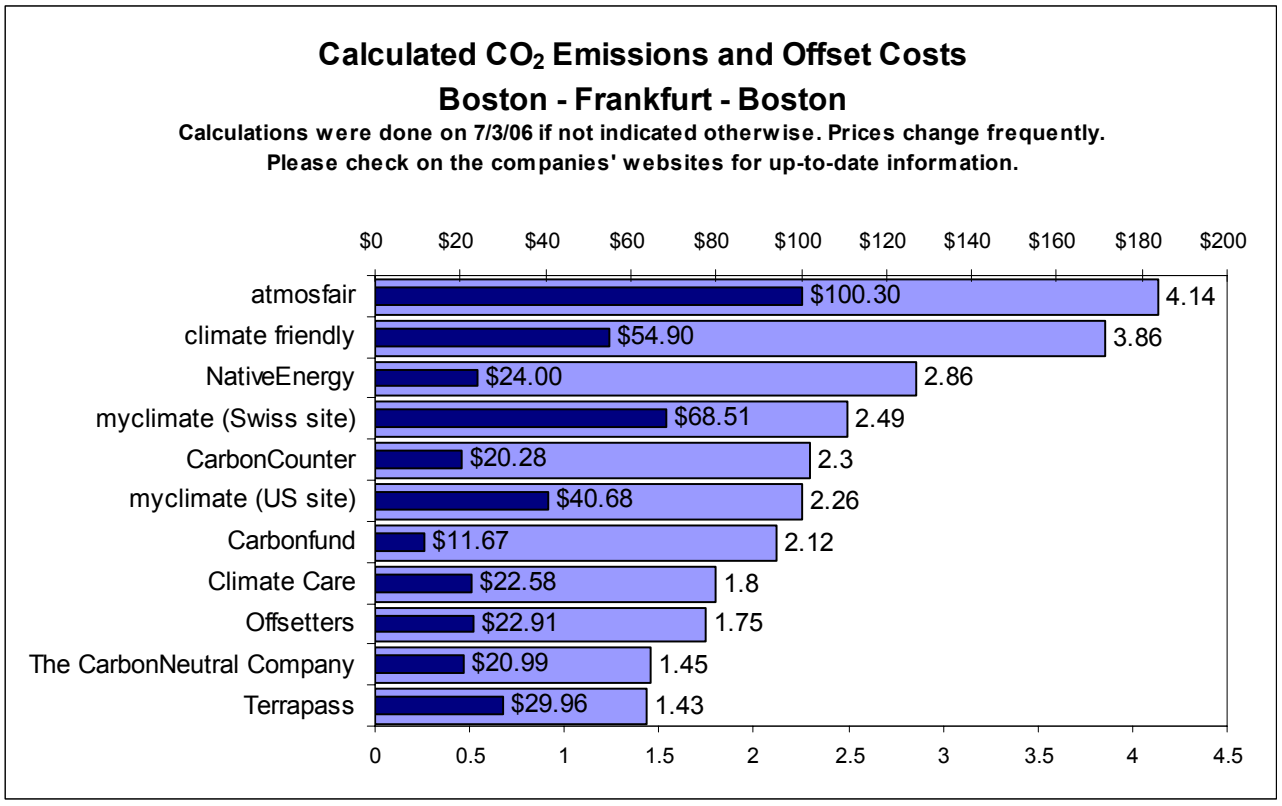
[5] This is the price for the *TerraPass Intercontinental* which offsets 7,500 lbs of CO_2 emissions

[6] The CarbonNeutral Company reported to us that they do not only sell on a per ton basis (e-mail communication 3/2/07). They offer currently three different portfolios ranging from $2.79 to $3.66 for the short-haul flight and from $18.14 to $23.83 for the long distance flight. Their prices also include 17.5% UK VAT. The tables and charts were adjusted on 3/31/07 for the charts, the average prices were chosen.

Table 4: International Flight: Boston - Frankfurt – Boston. Sorted by Emissions

Company	***Distance (miles)***	***Emissions (tons)***	***Cost to offset***
atmosfair	7384	4.14	$100.30
climate friendly	7317	3.86	$54.90
NativeEnergy[1, 3]	*7320*	2.86	$24.00
myclimate (Swiss site)	7312	2.49	$68.51
CarbonCounter[1] (see footnote 27)	*7320*	2.30	$20.28
myclimate (US site)	NA[3]	2.26	$40.68
Carbonfund[1]	*7320*	2.12	$11.67
Climate Care[1]	*7320*	1.80	$22.58
Offsetters[4]	7152	1.75	$22.91
The CarbonNeutral Company[6]	7318	1.45	$18.14 to $23.83
Terrapass	7310	1.43	$29.95[5]

Chart 4: International Flight: Boston – Frankfurt -- Boston. Sorted by Emissions



For notes see previous page.

The calculated distance between the place of origin and destination is relatively similar across the different calculators. The difference in tons of carbon emitted is more significant. For the domestic flight it ranges between 0.19 to 0.44 tons; for the international flight between 1.45 to 4.43 tons. The companies that calculate the highest emissions for the domestic and international flights all use a multiplier to account for full radiative forcing (**atmosfair, climate friendly**, **NativeEnergy** and **myclimate**). **atmosfair, NativeEnergy** and **myclimate** account for fuel efficiency differences depending on flight distance. These companies all use the airport method to calculate emissions (as opposed to the mileage method.) Also, **atmosfair** and **myclimate** include additional factors in their calculations.

Myclimate has two separate sites, one for its European customers and one for its American customers. These sites use separate calculators and the results are noticeably different in their carbon calculations as well as their pricing[33]. In the evaluation of the calculators we have focused on the Swiss site (www.myclimate.org).

Two of the companies with the lowest calculations (**Offsetters** and **CarbonCounter, see footnote 27**) do not clearly explain the assumptions under which their calculators operate. Interestingly, **Climate Care** accounts for radiative forcing, uses the airport method of calculation and accounts for airplane type and still has one of the lowest estimates for these flight examples. It is not clear why this calculator varies in this way.

7.4 Calculator Evaluation

Table 5: Comparison of Calculators

Company	Information sources for emissions calculators	Multiplier for full Radiative Forcing	Flight Distance	Occupancy Efficiency	Business versus Economy	Airplane Type	Additional Variables
atmosfair	German Federal Environment Ministry, EU, UN, German Aerospace Center, and IPCC	2.7	X	X	X	X	X
Better World Club	*No air travel emissions calculator*	NA					
CarbonCounter.org (see footnote 27)	*Source not listed on webpage*	**2 (see footnote 27)**					
Carbonfund	www.ghgprotocol.org, a joint project of the *World Resources Institute* and the *World Business Council for Sustainable Development*	None					
The CarbonNeutral Company	UK Department for Environment, Food and Rural Affairs	None	X				
Cleanairpass	*No air travel emissions calculator*	NA					
Climate Care	UK Dep. for Env., Food & Rural Affairs	2				X	
climate friendly	IPCC and the Greenhouse Gas Protocol	2.7					
myclimate (CH)	IPCC	2	X		X		
NativeEnergy	www.ghgprotocol.org	2	X				
Offsetters	*Source not listed on webpage*	None					
SELF	*No air travel emissions calculator*	NA					
TerraPass	www.ghgprotocol.org	None					

[33] According to an e-mail communication with R. Heuberger from **myclimate** on 2/14/06, the price difference is a result of different projects: US customers automatically fund projects of their 'balance' portfolio, whereas Swiss customers fund projects of their 'sustainable' portfolio, which is more expensive (see section 9, p.30.)

Because of all the variables and uncertainties involved in calculating the climate impacts of air travel it is difficult to say with certainty which is the most accurate calculation. Yet calculators that take into account a greater number of air travel factors seem to be the most accurate. For example, it is safe to assume that those calculators that do not include a multiplier for full radiative forcing are underestimating the impact of air travel (RCEP, 2003).

As the table above illustrates, in our evaluation, **atmosfair** has the most detailed and best documented calculator. When we rated the calculators, we considered the following amounts most accurate: Domestic flight: minimum 0.35 tons per passenger; international flight: minimum 3 tons per passenger. We rated as acceptably accurate: Domestic flight: minimum 0.25 – 0.35 tons per passenger; international flight: 2.5 - 3 tons per passenger.

Table 6: Rating of Calculators

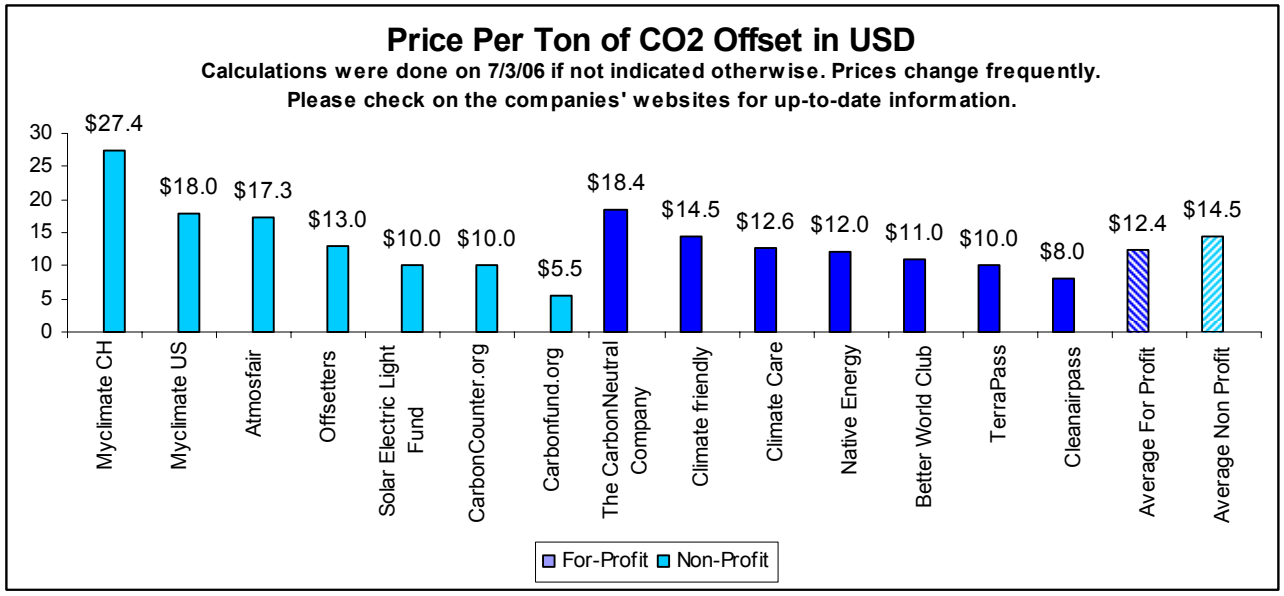
Company	***Calculator accuracy***
atmosfair	Excellent
climate friendly	Excellent
myclimate (Swiss site)	Very good
NativeEnergy	Very good
myclimate (US site)	Acceptable but emissions likely underestimated
CarbonCounter.org	Updated 3/24/07: Very good, see footnote 27
Carbonfund	Emission calculations too low
The CarbonNeutral Company	Emission calculations too low
Climate Care	Emission calculations too low
Offsetters	Emission calculations too low
Terrapass	Emission calculations too low
Better World Club	No air travel emissions calculator
Cleanairpass	No air travel emissions calculator
Solar Electric Light Fund	No air travel emissions calculator

With the voluntary carbon market expected to grow, it would be helpful if emissions calculations for air travel would be standardized by an independent third party. Such standardized emissions parameters would streamline the calculations and lend greater credibility to the offset companies much in the same way verifications standards are used to guarantee the quality of offset projects (see section 3).

8. Price per ton of carbon offset

8.1 Comparing carbon prices among the offset companies *(this section was last edited for revision 1.3)*

Chart 5. Price per ton of CO_2 offset



Notes:
The Carbon Neutral Company 's price includes 17.5% UK VAT.

The price to offset one ton of CO_2 varies substantially.[34] The prices for the companies in this study range from $5.50 (**Carbonfund**) to $27.40 per ton (**myclimate,** Swiss site), eight of the thirteen companies have prices within $10 to $15. The price differences do not seem to coincide with the percent of overhead each company charges (see section 6.3). There also does not seem to be a clear correlation between price and for-profit versus non-profit companies. Excluding **myclimate** (CH)'s very high price, non-profit companies and for-profit companies charge the same average price per ton ($12.35).

Some companies purchase offsets on the international market through institutions such as the ***Clean Development Mechanism (CDM)***. CDM offsets are more expensive than VERs. Therefore it is not surprising that two of the three highest priced offsets are sold by companies that purchase carbon offsets through the CDM (**atmosfair** and **myclimate**).

[34] All tons have been converted into short tons.

Table 7: Companies Sorted by Cost per ton of CO_2

Company	Cost per ton of CO_2	For or non-profit	Short or metric tons[3]
Carbonfund	$5.50	Non	Metric tonnes
Cleanairpass	$7.98[2]	For	Metric tonnes
CarbonCounter	$10.00	Non [1]	Short tons
Solar Electric Light Fund	$10.00	Non	NA
TerraPass	$10.00	For	Short tons
Better World Club	$11.00	For	Short tons
NativeEnergy	$12.00	For	Short tons
Climate Care	$12.57	For	Metric tons
Offsetters	$13.03	Non	Metric tonnes
climate friendly	$14.50	For	Metric tonnes
atmosfair	$17.30	Non	Metric tonnes
myclimate (US)	$18.00	Non	Metric tonnes
The CarbonNeutral Company	$18.40 (inc. 17.5% VAT)	For	Metric tonnes
myclimate (CH)	$27.40	Non	Metric tonnes

Note:
All currency conversions made on 7/3/06 using online converter found at: http://www.xe.com/ucc/
[1]CarbonCounter is a project of two non-profit companies.
[2]Cost based on calculated average. Actual cost varies by ton of carbon emitted. e.g to offset 1 ton costs $19.95 Canadian Dollars, to offset 40 tons costs $195.95 Canadian Dollars, which is $4.9 Canadian Dollars per ton.
[3]It is not obvious on every website if the company refers to short tons or metric tons. The right hand column indicates what we assumed. Because we did not know for sure if metric or short tons are quoted, we did not convert prices.

High-cost carbon offsets might be cost prohibitive for consumers and low priced carbon offsets might be an indication of lower quality offsets.Yet there does not necessarily have to be a correlation between price and offset quality. A very successful company will find lower cost ways to reduce emissions so its price might be low. On the other hand, such low costs may reflect low quality projects just as for any product in the market place. There is no readily available metric to evaluate these issues.

Even though cost will clearly play a part in a consumer's decision making process, the quality of the offset projects and not cost should be the determining factor. It is more important to invest in high quality offsets than to buy as many offsets as possible.

8.2 Comparing Carbon Prices to the European Trading Scheme (ETS)

The European Trading Scheme (ETS) came into force in 2005 and covers heavy industry and power generation. It is mandatory and includes 12,000 sites across all the 25 European Union member states. Each participating country proposes a National Allocation Plan (NAP) including caps on greenhouse gas emissions for power plants and other high emitting industries. The NAP must subsequently be approved by the European Commission.

Since the start of the European Trading Scheme (ETS) the price per ton of CO_2 has fluctuated between $12 and $34[35]. When making these price comparisons, it has to be taken into account that ETS is a cap and trade system whereas voluntary offsets are mostly created by project based transactions. Also, ETA is not yet a mature market (Henrik Hasselknippe, 2006) and the voluntary offset business too is a very new trade. Yet it is interesting to note that the prices per ton of CO_2 offsets are more or less in the same range. Comparing the offset companies' prices with ETS, however, shows that the offset companies tend to charge less for offsets than what their value would be on the ETS market – over half the offset companies charge $12 or less per ton of CO_2 offset. This might indicate that carbon prices on the voluntary carbon market are currently under valued.

[35] In its first year, 399 million tons of CO_2 were traded on the ETS market for a total of $9.2 billion. The price of allowances increased more or less steadily to its peak level in April 2006 of ca. $34 per ton CO_2, but came crashing down in May 2006 to under $12/ton when it became clear that many countries had given their industries such generous emission caps that there was no need for them to reduce emissions. Consequently, NGO's have accused national governments of abusing the system under industry pressure, and have urged for far stricter caps in the second phase (2008-2012). (Henrik Hasselknippe, 2006; http://www.emissierechten.nl/marktanalyse.htm)

9. Recommendations and Ratings

This section was last edited for revision 1.3; Although we added information for accuracy and clarification, we did not change any of the original ratings. Some of the companies might get a different rating if we redid the study at this point, but because we would have to reevaluate all companies to re-rate companies fairly and accurately, we decided to keep the original ratings until we have time for a larger study.

As illustrated above, there are a number of ways in which carbon offset companies can be compared, reflecting the diversity in approaches to addressing issues of climate change. TCI has chosen the following criteria as most important in evaluating an offset company:

Calculator: The air travel emissions calculator should be accurate, include a multiplier for radiative forcing and account for flight variables.

Project Type: Project portfolios should have little or no bio-sequestration projects; rather they should be mainly or entirely renewable energy and energy efficiency projects.

Project Location: The advantages and disadvantages of projects in developing nations depend very much on how projects are designed and implemented. Because there are also major concerns with projects implemented domestically, we do not recommend one over the other.

Project/Offset Quality: Projects should ideally be additional, permanent, account for leakage and contribute to the long-term goal of a carbon free, highly energy efficient economy. They should be planned and implemented with excellent standards and verification. Additional benefits such as capacity building or protected biodiversity are a plus. High standard and verification requirements such as the Gold Standard and the Voluntary Gold Standard help maximize the benefits of projects implemented in non-Annex 1 countries.

Transparency: The company should clearly state all their procedures, verification schemes, financial arrangements and partnerships.

We chose to group the evaluated companies in three groups:

1. **Recommend** (atmosfair, climate friendly, Myclimate, NativeEnergy)
2. **Recommended with Reservation** (CarbonCounter, Carbonfund, CarbonNeutral, Climate Care, Offsetters, TerraPass)
3. **Not Recommended** (Better World Club, Cleanairpass, Solar Electric Light Fund)

Within each category, the companies are listed alphabetically.

Table 8: Summary & Ratings of Companies

Company	Calculator accuracy	Standards & Verification	Project Location	Project Type	Price per ton of CO_2 offset	For or non-profit	Overall Recommendation
atmosfair	Excellent	CDM, Gold Standard	International	Renewable, Energy Efficiency	$17.30	Non	**Yes**
climate friendly	Excellent	Green Power, Gold Standard	International, Domestic	Renewable	$14.50	For	**Yes**
Myclimate	Very good (Swiss site) Acceptable but emissions likely underestimated (US site)	Gold Standard	International	Renewable, Energy Efficiency	$18.00 (US site) $27.40 (CH site)	Non	**Yes**
NativeEnergy	Very good	Green-e, Climate Neutral Network	Domestic	Renewable	$12.00	For	**Yes**
CarbonCounter (see footnote 27)	Very good	Climate Trust	International, Domestic	Renewable, Energy Efficiency, Sequestration	$10.00	Non	**With Reservations**
Carbonfund	Emission calculations too low	CCX, Green-e, ERT	International, Domestic	Renewable, Energy Efficiency, Sequestration	$5.50	Non	**With Reservations**
The CarbonNeutral Company	Emission calculations too low	Voluntary Carbon Standard version 1	International, Domestic	Renewable, Energy Efficiency, Sequestration Methane Capture	$18.40 (inc. 17.5% VAT)	For	**With Reservations**
Climate Care	Emission calculations too low	NA	International	Renewable, Energy Efficiency, Sequestration	$12.57	For	**With Reservations**
Offsetters	Emission calculations too low	NA	International	Energy Efficiency, Sequestration	$13.03	Non	**With Reservations**
TerraPass	Emission calculations too low	Green-e, CCX, CRS	Domestic	Renewable, Energy Efficiency	$10.00	For	**With Reservations**
Better World Club	No air travel emissions calculator	N/A	Domestic	Energy Efficiency	$11.00	For	**No**
Cleanairpass	No air travel emissions calculator	CCX	International, Domestic	Renewable, Energy Efficiency, Sequestration	$7.98[2]	For	**No**
Solar Electric Light Fund	No air travel emissions calculator	N/A	International	Renewable	$10.00	Non	**No**

Recommended:

Atmosfair

http://www.atmosfair.de

Atmosfair is a German offset non-profit company focusing on offsetting air travel. Atmosfair was initiated in 2003 as a joint project of ***forum anders reisen*** (http://www.atmosfair.de/index.php?id=11&L=0), a consortium of travel agencies, the NGO ***Germanwatch*** (www.germanwatch.org) and the for-profit carbon trading company ***500 PPM GmbH*** (http://www.500ppm.com/de/)[36].

Atmosfair has an excellent air travel emissions calculator and detailed information on the underlying assumptions. Atmosfair has excellent on-line documentation of its projects. All of its projects have to meet the Gold Standard. Atmosfair's project portfolio includes four renewable energy and energy efficiency projects planned and/or implemented in India, Thailand, Brazil and South Africa. Atmosfair does not invest in domestic projects or sequestrations projects. All projects are third party verified by TÜV[37]. All verification reports can be downloaded directly from the website.

The projects in India (large scale solar cookers) and the project in Thailand (sewage treatment plant at palm oil factory to reduce methane emissions) are currently in the operations phase. The projects in Brazil and South Africa are still in the planning stage and it is unclear when and if they will be realized. Atmosfair is unusually honest in its project descriptions, as the following example of the project in Brazil shows:

> "At present the validation of the project according to the GoldStandard is unsure. The partner for this project, the local NGO South-SouthNorth, announced in November 2005 to get the approval for the Gold Standard. But the ongoing delays casts doubt of that plan. The newly patented technology is still tested, thus the local impacts on the environment cannot be determined finally. Taking into account previous delays atmosfair only sees a limited chance of success for this project. No funds have been paid for the project so far since atmosfair retains the right to only pay for the contracted volume of emission reductions when the project fulfills the Gold Standard." (http://www.atmosfair.de/index.php?id=174&L=3, last accessed: 11/21/2006)

Atmosfair is one of the more expensive companies we evaluated. They charge $17.30 per ton of CO2 offset. The high prices might be due to the fact that all their projects are implemented within the Kyoto Mechanisms.

Despite the high cost, we give this company a high rating for its excellent documentations, good projects and strict verification procedures.

[36] ***500 PPM GmbH*** currently collaborates with **myclimate**.

[37] TÜV Industrie Service GmbH TÜV SÜD Group Carbon Management Service
http://www.tuev-sued.de/industrial_services/environmental_services/climate_change

Climate friendly
http://www.climatefriendly.com/

Climate friendly is a for-profit company that offers offsets to individuals and businesses. This Australian organization was founded in 2004. Climate friendly has an excellent air travel emissions calculator. Climate friendly charges $14.50 per ton of CO2 offset. Climate friendly's project portfolio consists of two wind power projects. Both sites were built after 2001:

- The 52.5MW Challicum Hills wind farm in Victoria was completed in 2003.
- The 90.75 MW Te Apiti wind farm is located on the north island of New Zealand. The carbon credits generated from Te Apiti are Kyoto Compliant Joint Implementation (JI) Voluntary Emissions Reduction (VERs).

Although Climate friendly currently has only wind power in their portfolio they are seeking new renewable energy projects including wind, solar electric (PV), solar thermal, micro hydro (low-impact), geothermal, ecologically sound biomass and biogas. They do not fund bio-sequestration, geo-sequestration, or landfill gas projects. All projects are accredited through two standards: The Gold Standard and Green Power accreditation.

Although Climate friendly is currently a small company, their high standards, transparency and excellent carbon calculator make them a good choice for offsetting air travel emissions.

myclimate
Swiss site: http://www.myclimate.org/?lang=en,
US site: http://www.my-climate.com/

myclimate - The Climate Protection Partnership was started in 2002 as an international non-profit venture at the ***Eidgenoessischen Technischen Hochschule*** (ETH) in Switzerland. It sells offsets to businesses, organizations and individuals. To sell carbon offsets in the US **myclimate** has partnered with ***Sustainable Travel International*** (www.sustainabletravelinternational.org) a non-profit organization that specializes in ecotourism and sustainable travel programs.

The air travel emissions calculator on the Swiss site is very good. The calculator on the US site is acceptable but emissions are likely underestimated. Myclimate offers CDM projects and VER projects in its portfolio and does not support sequestration projects. For individual customers, myclimate offers two different project portfolios:

> **Portfolio Sustainability**
> This portfolio consists of small-scale and micro-scale projects. All projects have clear additional sustainability benefits. Favorably, these projects are situated in economically disadvantaged areas. For example in Ladakh, a remote area in the Indian Himalaya, that faces very harsh conditions due to the high altitude. In building 500 passive solar greenhouses and 20 micro hydropower systems, myclimate helps the local rural population to generate income activities in order to improve their conditions of living.
>
> **Portfolio Balance**
> This portfolio includes cost effective and attractive certificates. It consists of small-scale projects, which generate VERs/ CERs.
>
> (pdf, myclimate Carbon Offsetting Services, General Information Zurich, 01.02.2006)

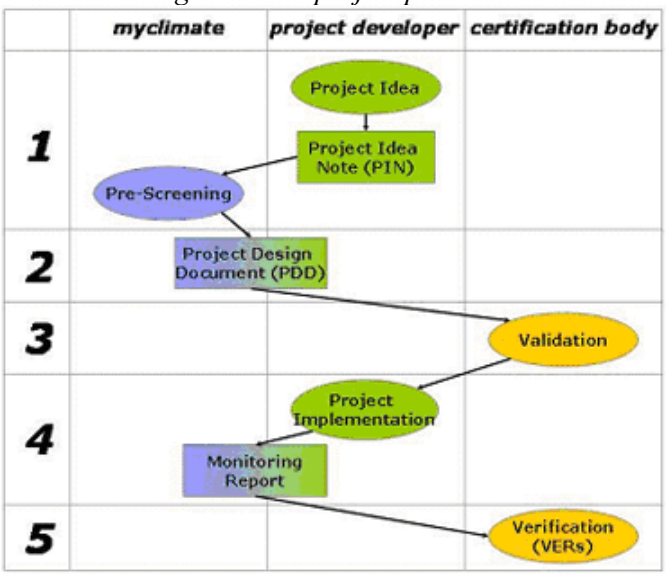
The offsets from myclimate are quite expensive at $18.00 (US site) $27.40 (CH site). Although it is not made explicit on the websites, the US site quotes offsets for "Portfolio Balance", the Swiss site quotes offsets for "Portfolio Sustainability" [38]

Myclimate carbon offset projects are certified by independent organizations. Depending on the project size and type, validation may take place either through CDM accredited certification institutes such as the SGS, TÜV and DNV or by a board of experts from Swiss universities.

All myclimate projects, CDM and VER, have to adhere to the Gold Standard. The project descriptions on the website are very good. They all indicate how much the project is expected to offset and if it is a CDM or VER project. Unfortunately, project description information is hard to find on the US site.[39]

We are including the following graph from myclimate's Swiss site because it nicely illustrates the process VER projects go though from inception to implementation.

Diagram: VER project procedure.



(http://www.myclimate.org/index.php?lang=en&m=projects&um=standard&uum=ver&uuum=vercycle, last accessed 11/30/06)

Despite the high price of their offsets, myclimate's high project standards, its transparency and good calculator makes it an excellent choice for offsetting air travel emissions.

[38] E-mail communication with R. Heuberger from myclimate on 2/14/06.
[39] http://www.sustainabletravelinternational.org/documents/op_carbonoffsets_projects.html, last accessed 11/30/06

NativeEnergy

http://www.nativeenergy.com/

NativeEnergy is a privately held Native American energy for-profit company founded in 2000. NativeEnergy helps build Native American, farmer-owned, and charitable purpose renewable energy projects.

NativeEnergy has a very good air travel emissions calculator that uses a factor of two to account for full radiative forcing. NativeEnergy charges $12 per ton of CO_2 offset.

NativeEnergy develops renewable energy projects on Native American lands and farmer-owned wind, solar, and methane projects throughout the country. NativeEnergy offers offsets to individuals and businesses. Their programs include household energy consumption (*Cool*Home[sm]), driving (*Cool* Driver[sm]), Climate Neutral Travel, climate neutral events and conferences**,** a *Cool*Business[sm] program, and general consulting services.

NativeEnergy has a very extensive website that gives answers to many of the technical questions: e.g. what is additionality or what is the difference between a REC and a carbon offset. They also have short project descriptions of eight of their already implemented projects and 4 currently planned projects (see http://www.nativeenergy.com/projects.html, last accessed 12/14/06.)

NativeEnergy clearly distinguishes between RECs, carbon credits and future credits and explains the issue of additionality to their customers:

> […] The fact is, however, that with almost all renewable energy projects, that certainty comes with the virtual certainty that each and every one of your RECs or offsets would have been generated regardless of your (or anyone else's) purchase.
> Most renewable energy projects have high installation costs and little or no operating/fuel costs. As a result, once they're built there's little chance that running will be more expensive than not running. Most of their return on investment, by far, comes from the revenues and tax benefits from generating and selling their underlying "generic" power. RECs sales bring them additional revenues, which may have been counted on when the investment decision was made, but typically do not cause them to be "turned on" when they would otherwise be "turned off." Notable exceptions include a limited number of existing biomass, small hydro, fuel switching and similar projects that have high operating costs and require additional revenues to operate.
> http://www.nativeenergy.com/risks_benefits.html (last accessed 12/14/06)

They state the additionality benefits of their futures (which they call "help build Recs") and also the risks associated with buying credits that will be created in the future and therefore need to be estimated.

On the other hand, it is not clear how they choose their projects or how the carbon offsets are verified. They do not list a third party verification process or company.

NativeEnergy's strict distinction between type and quality of offset is laudable. We would like to see more transparency in terms of financing and project verification. We recommend NativeEnergy as a provider of voluntary carbon offsets.

Recommended with Reservation:

Carbonfund (last edited for revision 1.2)

http://www.carbonfund.org

Carbonfund.org is a US nonprofit organization that sells carbon offsets to individuals, businesses and organizations. **Carbonfund.org** was founded in 2003.

Carbonfund.org's air travel emissions calculator does not account for full radiative forcing and underestimates emissions from air travel. Their price of $5.50 per ton of CO_2 offset is very low. Carbonfund.org invests in renewable energy and energy efficiency as well as sequestration projects. All the projects are located in the US.

Carbonfund.org's renewable energy offsets are primarily certified by either ***Green-e*** or ***ERT*** (non-wind related renewable energy offsets). Carbonfund.org purchases its Energy Efficiency VERs from ***Chicago Climate Exchange (CCX).*** The sequestration carbon offset credits are audited by ***ERT*** (www.ert.net/). ***ERT*** also audit Carbonfund's offset results to insure that purchase and retirement of offsets matches the contributions they receive.

Carbonfund.org has good on-line documentation of many of its projects. Some of the certification documents can be downloaded directly from the website.

We feel that Carbonfund.org makes a good effort to be transparent, efficient and competitively priced. Yet we are concerned about the quality of the offsets that Carbonfund.org sells: namely RECs (no guaranteed additionality), CCX offsets (overabundancy) and sequestration offsets.

We recommend Carbonfund.org to offset air travel emissions with the above mentioned reservations.

CarbonCounter / Climate Trust

http://www.carboncounter.org/ Last updated for version 1.3

CarbonCounter.org is a collaborative non-profit project started in 2002 by The ***Climate Trust*** (http://www.climatetrust.org) and ***The Mercy Corporation*** to offers offsets to individuals. The ***Climate Trust*** provides offsets to power plants, regulators, businesses and individuals and ***Mercy Corps*** (http://www.mercycorps.org) is an international relief and development agency.

At the time of this study, CarbonCounter.org's emissions calculator underestimated the emissions from air travel. And they did not list any of their sources on the underlying assumptions. Yet they have since overhauled their website. They now use for a multiplier of 2 to account for radiative forcing and have a list with detailed information about their calculator assumption. Their price is $12 per ton of CO2 offset.

CarbonCounter.org has overhauled its website and now has detailed information on many of the projects. Additional information can be found on The Climate Trust's website (http://www.climatetrust.org):

> "The Climate Trust's current portfolio will offset 1.9 million metric tons of carbon dioxide from $4.9 million invested in offset project contracts-- making us one of the largest and most experienced offset buyers in the U.S. and world markets." (http://www.climatetrust.org/offset_projects.php, last accessed 11/27/06)

Climate Trust invests in domestic and international efficiency, renewable energy and sequestration projects. According to their 2-page project standards summary[40] available on their website: "The Trust requires state-

[40] http://www.climatetrust.org/pdfs/CT%20offset%20criteria.pdf, last accessed 11/28/06.

of-the-art monitoring and verification of its offset projects." The Climate Trust does not use any outside certifiers. They do state that they use third-party verification of all their projects, although no information on that is available on their current site. All of their projects produce VERs. They do not sell carbon credits that originated as REC because of additionality concerns. They are currently working on a document that spells out their additionality guidelines. The details are not yet publicly available. For a discussion on how some of their projects might have double counting issues, please see section 3.2.

Climate Trust is one of the largest offset businesses. Although we cannot comment on their main carbon and consulting projects, we recommend them for offsetting individual air travel emissions with the above mentioned reservations.

The CarbonNeutral Company (last updated for version 1.3)

http://www.carbonneutral.com/

This UK for-profit company, originally known as *Future Forests,* was founded in 1997 focusing on providing carbon credits generated from forestry projects. The company has expanded its services and now offers offsets from a variety of projects (not exclusively forestry). It also offers marketing and consulting services.

From December 2004 through June 2006 TCNC sold 378,423 tonnes of CO2. About 93% of their sales are through corporate clients and about 7% of their sales come from individual consumers. During that period about 70% of their offsets came from 'technology-based' projects (energy efficiency, renewable energy and methane mitigation) and 25% from afforestation and reforestation projects. (Source: KPMG's verification report accessed on 3/24/07 from http://www.carbonneutral.com/pages/carbonstrategy.asp.)

TCNC's emissions calculator underestimates the emissions from airtravel. Their price is $18.40 per ton of CO2 offset. (This price includes 17.5% UK VAT).

The CarbonNeutral Company invests in renewable energy, energy efficiency, methane sequestration and forestry projects in developed as well as developing nations (e.g. US, Germany, India, Mexico, etc.). One page PDF document summaries are available on their webpage.[41] Some issues remain about double counting of projects that are implemented in Annex 1 countries. This is a problem that many offsets companies in Annex 1 countries with Kyoto obligations face: clients demand projects that are locally implemented but until now, there is no mechanism in place to retire these VERs so that there are not also counted in the country's national inventory (see section 3.2).

TCNC is quite aware of this issue and tries to address it as best as possible:

> UK forestry projects are all accounted for on an ex-ante basis (99 years), so any overlap with Kyoto only covers 5 years out of those 99. Secondly as the UK has committed not to sell AAU's, there can be no double-selling of this carbon anyway. In the case of technology projects, we have very few Annex 1 based projects, but where we do, we are totally committed to ensuring that there is no double counting. Examples of this are a small-hydro project in Bulgaria where the Bulgarian government has committed to subtract the credits generated by this project from their national registry. A second example is an agricultural methane capture project in Germany, where we have only bought the pre-2008 vintage credits (no double-counting with Kyoto) and have only counted the methane mitigation element of the project (not the grid-based fossil fuel displacement element of the project), so there is no double-counting with the EU-ETS.
> (e-mail communication, 3/30/07)

[41] http://www.carbonneutral.com/pages/projectlocations.asp last accessed 11/29/06

Until recently, TCNC has invested in projects outside the Kyoto Mechanisms - which generate Verified Emissions Reductions (VER's). The company has now added Certified Emissions Reductions (CER's) to their portfolio. For their VERs they have developed their own quality standards (see http://www.carbonneutral.com/pages/carbonstrategy.asp for 'The CarbonNeutral Protocol'.) They also sell offsets from projects that were implemented under the Voluntary Carbon Standard version 1.

The CarbonNeutral Company is a large consulting, marketing and offset business. Although we cannot comment on their other carbon and consulting projects, we recommend them for offsetting individual air travel emissions with the above mentioned reservations.

Climate Care

http://www.climatecare.org/

Climate Care is a for-profit company that offers offsets to individuals and businesses. This UK company was founded in 1997.

Climate Cares's air travel emissions calculator does use a factor of 2 to account for full radiative forcing and yet in our examples, their calculator underestimated emissions from air travel. The price per tone of CO_2 offset is of $12.60.

In 2005, 80% of Climate Care's offsets came from energy projects and 20% from sequestration projects. All projects are implemented in developing countries. Climate Care explicitly states that this is to avoid double counting emissions reductions in Annex 1 countries. Climate Care does not clearly state which standards and verifications they employ. They mention that a baseline report is written by a third party for each project. On their webpage and in their 2005 annual report, we find the following statements:

> "We will only fund a project if we can be confident that it would not have gone ahead without our assistance." (http://www.climatecare.org/projects/index.cfm?content_id=E17E5E13-0AFA-DB60-5640550B1039396A, last accessed 11/30/06)
>
> "Climate Care is scrutinised by our Environmental Steering Committee, which includes eminent environmentalists and NGOs, including WWF and Forum for the Future. To ensure that our projects achieve the CO2 emissions that we claim, our committee requires us to meet three criteria for each project. These are:
>
> - that a third party report be obtained
> - that the CO2 reductions be monitored on an ongoing basis
> - that any shortfall is made up in other projects."
>
> (http://www.climatecare.org/_media/documents/pdf/Climate_Care_Annual_Report_2005.pdf, last accessed 11/27/06)

Although they contributed to the development of the voluntary Gold Standard, they do not currently offer Gold Standard certified offsets, but expect to do so in the future. All their listed projects tend to be small scale and decentralized.

According to Climate Care's 2005 annual report:

> "This year [2005], the first Clean Development Mechanism (CDM) projects were registered, enabling emission reductions to be bought from projects in the developing world to help developed countries to meet their Kyoto targets. However, to date the high costs and restrictions of setting up a project to sell emission reductions to this regulatory market have tended to prohibit smaller-scale community based projects that have wider sustainable development benefits.

> In contrast, the voluntary market can provide finance for projects of this type that have multiple health and economic benefits to communities, alongside the greenhouse gas reductions. So far, the voluntary carbon offset market has been able to reach areas where the regulatory market cannot – developing appropriate technology solutions for some of the poorest communities."
> (http://www.climatecare.org/_media/documents/pdf/Climate_Care_Annual_Report_2005.pdf, p. 6, last accessed 11/27/06)

It is true that the regulatory burden is larger for CDM projects than for projects that produce VERs. As pointed out earlier VER producing projects, even if they are very small, can still be implemented adhering to the Gold Standard principles, especially since the release of the Voluntary Gold Standard in spring of 2006. Smaller decentralized projects in developing countries are very difficult to plan, implement and supervise. We would therefore argue that with such projects it is especially important that additional verification (such as required with the Gold Standard) takes place.

We recommend Climate Care for offsetting individual air travel emissions with the above mentioned reservations.

Offsetters

http://www.offsetters.com/

Offsetters is a Canadian non-profit company started in 2005 that sells offsets to individuals and businesses. It has also partnered with WestJet. WestJet flights that are booked through the Offsetter webpage are made carbon neutral though offset projects.

Offsetters air travel calculator underestimates the carbon emissions. The price per ton of CO2 offset is approximately $13.

Projects funded by offsets purchased through Offsetters are provided in collaboration with **Climate Care**, reviewed earlier. It is unclear if Offsetters offsets are produced with Gold Standard projects. On the webpage they state Offsetters supports the Gold Standard yet since Climate Care does not currently use the Gold Standard, we assume that is true for Offsetter projects also.

We recommend Offsetters for offsetting individual air travel emissions with the reservations mentioned for Climate Care.

TerraPass (last edited for revision 1.2)

TerraPass (http://www.terrapass.com/)

TerraPass is a for-profit US company that offers offsets to individuals and businesses. TerraPass was initially created in 2005 as a project for the course "Problem Solving, Design, and System Improvement" taught at the Wharton School of Business at the University of Pennsylvania.

Terrapass' air travel emissions calculator does not account for full radiative forcing and underestimates emissions from air travel. Their price of $10 per ton of CO_2 offset is relatively low.

TerraPass funds renewable energy and energy efficiency projects that produce a combination of RECs and CFIs from CCX. All projects are implemented in the US. On their webpage, Terrapass lists eight projects: Three wind facilities, three biomass projects and two energy efficiency projects. TerraPass does not purchase bundled CFIs from CCX. Instead, they support specific projects, structure those contracts, and then take them to the CCX to register the trade. Such transaction are known as bilateral contracts. TerraPass comments:

> We believe that bilateral contracts offer us the best of both worlds: complete control over project selection, coupled with the transparency and security of the CCX trading platform.
> (e-mail communication, 1/16/07)

We agree that such direct project contract can potentially help to increase transparency and quality of product.

Because of additionality concerns with RECs that we stated earlier, and because of concerns that have been raised about the methodologies that CCX uses for some of their project evaluations and baseline calculations we recommend TerraPass for offsetting individual air travel emissions with reservations.

Currently Not Recommended:

Better World Club

http://www.betterworldclub.com/links/offsets.htm

Better World Club's system is not based on a careful calculation. Instead, they use a loose approximation of one ton per flight, for which they donate $11 to the Tides Foundation as an offset. Better World Club (BWC) does not specialize in offsets but provides nationwide roadside assistance, insurance and travel services. BWC sees itself as a more sustainable alternative to AAA (the largest American automobile association). For each flight booked through BWC, BWC donates $11 to the ***Tides Foundation*** which administers the funds. There is no information available on the BWC nor in the Tides Foundation website on the type of projects that are funded.

We welcome this kind of one-stop-shopping, where customers can purchase offsets at the same time they buy their airline tickets. More travelers are likely to buy offsets when procedures are simplified in that way. (Yet the BWC offsite webpage (http://www.betterworldclub.com/links/offsets.htm) is hard to locate on their website. It is not accessible from the homepage and also not listed on their site map.)

Better World Club does not have a carbon calculator on its site but has a link to http://www.earthfuture.com/climate/calculators/ which lists many available calculators.

Although we applaud the mission of BWC and also welcome any organization that sensitizes the public about their carbon footprint, we recommend using offset companies that are more accurate in their calculations and their emissions offset. For emissions offsets to gain credibility and to be verifiable, they have to be calculated accurately and offset as exactly as possible.

We do not recommend the Better World Club for buying offsets.

Solar Electric Light Fund

http://www.SELF.org/

The Solar Electric Light Fund, Inc. (**SELF**) is a US non-profit organization founded in 1990 to promote, develop, and facilitate solar rural electrification and energy self-sufficiency in developing countries. It is not an offset company but offers a program where people can donate $10 per ton of CO_2 they emit.

SELF's website does not have its own carbon calculators, however, they have link to www.earthfuture.com/climate/calculators with a list of about 25 calculators.
SELF charges $10 per ton of CO_2 offset.

SELF's project portfolio is composed of solar energy projects which include electrification of public buildings, including health clinics, schools, houses of worship and streetlights, household electrification and solar water pumps for efficient irrigation. For each project, the partner institution is clearly identified. Procedure for applying for external subsidizes and funding is mentioned but not listed, ie they talk about getting seed money from the World Bank to start certain projects.

There are no third party verifications for the projects SELF invests in. SELF states that it maintains a certain level of internal standards including ensuring social, economic and environmentally sound project outcomes. But it is unclear what their standards are.

Neither Better World Club nor SELF are offset companies in the strict sense. They were included in this report to show the diversity of offset programs that exist. Although we applaud the creativity of these two organizations and also welcome any organization that sensitizes the public about their carbon footprint, we recommend using offset companies that are more accurate in their calculations and more rigorous in ensuring additionality and permanence of their projects.

Cleanairpass

https://www.cleanairpass.com/

Cleanairpass is a non-profit Canadian offset company that focuses on providing offsets to individuals who want to offset their vehicle miles traveled. Cleanairpass was founded in 2005.

Cleanairpass does not have an air travel calculator because of their focus on vehicle emissions. The price per ton of CO2 offset is approximately $8. Currently Cleanairpass does not seem to have concrete projects. According to its webpage:

> "We purchase carbon emission offsets from qualified projects that have initiated emission reduction measures. Projects may include renewable energy technologies, energy efficiency and conservation initiatives, emission capture or sequestration, and other measures which reduce or prevent emissions from reaching the atmosphere and/or eliminate the need for energy generated from coal, oil, natural gas, and other fossil fuels." (https://www.cleanairpass.com/cap/project.jsf, last accessed 11/27/06)

> "We intend to source emission offsets from local sources as they become available and anticipate the initiation of a Canadian emissions trading system late 2006. Currently cleanairpass is in the process of purchasing our first emission offsets. Be one of the first to get a cleanairpass! Return to this page to review the projects cleanairpass supports." (https://www.cleanairpass.com/cap/offsetSources.jsf, last accessed 11/27/06)

Since Cleanairpass is a very young company that does not have any concrete projects listed and since they do not have a air travel carbon calculator, we do not recommend the Cleanairpass for buying offsets to offset air travel.

10. Conclusions

The debate over the ethical validity of buying voluntary offsets to reduce ones personal carbon emissions is far from over – a recent Economist article compared offsetting to buying pardons in the Medieval Catholic Church (The Economist, 2006)[42].

Moreover, while it reduces carbon emissions at the margins, when just a few enlightened people choose to offset their carbon footprint, it clearly would not be possible to offset all air travel related carbon emissions, either now or much less in the future, given the rapid growth or air travel.

There is much validity to the argument that offsetting simply helps us assuage our guilt, whilst we continue to fail to change out lifestyles towards patterns that are more truly sustainable. Avoiding having to fly to far-away places is still the most effective way to reduce one's personal air travel emissions[43].

Voluntary approaches to reducing greenhouse gas emissions do not capture sufficient emission sources. No voluntary approach to reducing greenhouse gas emissions should be allowed to delay or replace a mandatory federal cap on carbon emissions or a worldwide tax on jet fuel.

Reducing travel miles and living a less energy-intense lifestyle in general – e.g. living in an apartment close to work and using public transportation –and voting officials into office who enact legislation that effectively addresses the threats of climate change will ultimately be more important than buying carbon offsets.

On the other hand, carbon offsetting can genuinely reduce emissions. Even more importantly, it can help provide funds now to kick start the development of low carbon technologies, which will be vital in the more fundamental transition to low carbon societies.

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[42] Also see *Carbon Trading: A Critical Conversation on Climate Change, Privatisation and Power* Published in April 2006. The book can be downloaded at www.dhf.uu.se/press_release_carbon.html

[43] The argument that the air plane will fly anyway, has only limited validity, as the effects of Y2K and 9/11 on the air travel industry showed.

References

Agarwal, Anil. (2002). 'A Southern Perspective on Curbing Global Climate Change.' *Climate Change Policy.* Schneider, Stephen; Rosencranz, Armin and Niles, John eds. Island Press: Washington, DC.

Bows, Alice; Upham, Paul and Anderson, Kevin. (2005). 'Growth Scenarios for EU & UK Aviation: Contradictions with Climate Policy.' Available online at: http://www.foe.co.uk/resource/reports/aviation_tyndall_research.pdf Last accessed on 7/1/06.

Brown, S.; Burnham M.; Delaney, M.; Vaca, R.; Powell, M. and Moreno, A. (2000) 'Issues and Challenges for Forest-Based Carbon-Offset Projects: A Case Study of the Noel Kempff Climate Action Project in Bolivia.' *Mitigation and Adaptation Strategies for Global Climate Change 5*, 99-121.

Brown, Sandra. (1999). 'Guidelines for Inventorying and Monitoring Carbon Offsets in Forest-Based Projects.' Winrock International. Available online at: http://v1.winrock.org/reep/guidelines.html

Bryner, Gary C. (2004). 'Carbon Markets: Reducing Greenhouse Gas Emissions Through Emissions Trading.' *Tulane Environmental Law Journal, 17*(267).

Chomitz, Kenneth M. 'Evaluating Carbon Offsets from Forestry and Energy Projects: How do they compare?' World Bank. Available online at: http://wbln0018.worldbank.org/Research/workpapers.nsf/0/d92de72e3c60be77852568f9004b40e3/$FILE/wps2357.pdf Last accessed on 7/7/06.

Clark, D.A.; Piper, S.C.; Keeling, C.D. and Clark, D.B. (2003). 'Tropical Rain Forest Tree Growth and Atmospheric Carbon Dynamics Linked to Interannual Temperature Variation During 1984-2000.' *Proceedings of the National Academy of Sciences of the United States of America*, 100:10, 5852-5857.

The Climate Group. (2006) The Voluntary Carbon Standard (VCS). Available online at: http://theclimategroup.org/preview.php?pid=858. Last accessed on 11/21/06.

Dale S. Bryk. (2006). 'States and Cities Should Not Join the Chicago Climate Exchange.' *Natural Resources Defense Council*

The Economist. (2006) 'Sins of emission.' Print Editions Aug 3rd 2006. Available online at http://www.economist.com/opinion/displaystory.cfm?story_id=7252897. Last accessed on 11/2/06.

Edwards, Rufus D.; Smith, Kirk R.; Zhang, Junfeng and Ma, Yuqing. (2003). 'Models to Predict Emissions of Health-Damaging Pollutants and Global Warming Contributions of Residential Fuel/Stove Combinations in China.' *Chemospere 50* (2), 201 â€“ 215.

Hadley, J.L. and Schedlebauer, J.L. (2002) 'Carbon Exchange of an Old-Growth Eastern Hemlock (*Tsuga canadensis*) Forest in Central New England.' *Tree Physiology*, 22, 1079-1092.

Hamilton, J.G.; DeLucia, E.H.; George, K.; Naidu, S.L.; Finzi, A.C. and Schlesinger, W.H. (2002). 'Forest Carbon Balance Under Elevated CO_2.' *Oecologia*, 131, 250-260.

Hanson, Donald and Laitner, John A. 'Skip.' (2004). 'An Integrated Analysis of Policies that Increase Investments in Advanced Energy-Efficient/Low-Carbon Technologies.' *Energy Economics 26* (4), 739-755.

Henrik Hasselknippe, Kjetil Røine. (2006).'Towards a truly global market of carbon funds." *Point Carbon 2006*

Intergovernmental Panel on Climate Change (IPCC). (1999). *Aviation and the Global Atmosphere.* Available online at: http://www.grida.no/climate/ipcc/aviation/index.htm Last accessed on 6/29/06.

Lee D.(2004). 'The Impacts of Aviation on Climate' *Issues in Environmental Science and Technology, No. 20 Transport and the Environment*, The Royal Society of Chemistry

Martinot, Eric and McDoom, Omar. (2000). 'Promoting Energy Efficiency and Renewable Energy: GEF Climate Change Projects and Impacts.' Global Environment Facility. Available online at: http://www.martinot.info/Martinot_McDoom_GEF.pdf Last accessed on 7/7/06.

Meyers, Steven. (1999). 'Additionality of Emissions Reductions From Clean Development Mechanism Projects: Issues and Options for Project-Level Assessment.' Available online at: http://eetd.lbl.gov/ea/IES/iespubs/43704.pdf Last accessed on 7/7/06.

MSNBC. (2006). 'Warming Guilt? Travel Sites Aim to Ease: For a Price, Travelers Can Offset Carbon Impact of Flying, Driving.' Available online at: http://www.msnbc.msn.com/id/14572998/ Last accessed on 9/16/06.

Osborne, Tracey and Kiker, Clyde. (2005). 'Carbon Offsets as an Economic Alternative to Large-Scale Logging: A Case Study in Guyana.' *Ecological Economics, 52*(4), 481-496.

Royal Commission on Environmental Protection (RCEP). (2003). *The Environmental Effects of Civil Aviation in Flight.* Available online at: http://www.rcep.org.uk/aviation/av12-txt.pdf Last accessed on 6/29/06.

Turkenburg, Wim C. (2000). 'Chapter 7: Renewable Energy Technologies.' *World Energy Assessment: Energy and the Challenge of Sustainability.'* Draft. Available online at: http://www.lged-rein.org/publication/WEA-RETs.pdf Last accessed on 7/7/06.

Williams, V.; Noland, R. B.; & Toumi, R. (2002). 'Reducing the Climate Change Impacts of Aviation by Restricting Cruise Altitudes.' Available online at: http://www.cts.cv.imperial.ac.uk/documents/publications/iccts00186.pdf Last accessed on 6/30/06.

Companies

atmosfair. Available online at: http://www.atmosfair.de/index.php?id=9&L=3 Last accessed on 12/12/06.

Better World Club. Available online at: www.betterworldclub.com/links/offsets.htm and http://www.betterworldclub.com/ Last accessed on 12/12/06.

CarbonCounter. Available online at: http://www.carboncounter.org/index.php Last accessed on 12/12/06.

Carbonfund. Available online at: http://www.carbonfund.org Last accessed on 12/12/06.

Clean Air Pass. Available online at: https://www.cleanairpass.com/cap/home.jsf Last accessed on 12/12/06.

Climate Care. Available online at: http://www.climatecare.org Last accessed on 12/12/06.

climate friendly. Available online at: http://www.climatefriendly.com Last accessed on 12/12/06.

myclimate (Swiss site). Available online at: http://www.myclimate.org/index.php?lang=en Last accessed on 12/12/06.
myclimate (US site). Available online at: http://www.my-climate.com/ Last accessed on 12/12/06.

NativeEnergy. Available online at: www.nativeenergy.com Last accessed on 12/12/06.

Offsetters. Available online at: http://www.offsetters.ca Last accessed on 12/12/06.

Solar Electric Light Fund. Available online at: http://www.**SELF**.org/cnc.asp and http://www.**SELF**.org Last accessed on 12/12/06.

TerraPass. Available online at: http://www.terrapass.com/ Last accessed on 12/12/06.

ANNEX A: THE TOP 20 CARBON DIOXIDE EMITTERS

Country	*Total emissions* (1000 tons of CO2)	*Per capita emissions* (tons of CO2/capita)	*Total emissions* (rank)	*Growth* (in %, 1990-96)
United States	5,304,849.0	19.7	-1	-9.9
Peoples Rep. of China	3,365,989.0	2.8	-18	40
Russia Federation	1,580,663.3	10.7	-6	-19.2 (since 1992)
Japan	1,168,515.3	9.3	-9	9.1
India	998,110.7	1.1	-20	47.7
Germany	861,850.0	10.5	-7	-12.2
United Kingdom	557,388.3	9.5	-8	-1.1
Canada	409,651.0	13.8	-4	-0.1
South Korea	408,356.7	9.0	-11	69.2
Italy	403,524.0	7.0	-13	1.1
Ukraine	397,580.3	7.7	-12	-37 (since 1992)
France	362,083.3	6.2	-15	2.4
Poland	357,041.7	9.2	-10	2.6
Mexico	348,359.0	3.7	-17	18
Australia	306,856.0	17.0	-2	15.3
South Africa	292,959.3	6.9	-14	0.6
Brazil	273,570.0	1.7	-19	34.9
Saudi Arabia	268,026.0	14.2	-3	51.2
Iran	266,856.3	3.8	-16	25.6
North Korea	254,510.7	11.3	-5	4

Source: Marland, G., T.A. Boden, R. J. Andres. 2000. Global, Regional, and National CO2 Emissions. In Trends: A Compendium of Data on Global Change. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. (available online at http://cdiac.esd.ornl.gov/trends/emis/tre_coun.htm)