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Carbon Calculators' Shortcomings in Analyzing the Indirect Energy Use of Small Restaurants

An Interactive Qualifying Project Proposal

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by

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Abstract:

There are many residential carbon calculators available online, but little has been done to analyze their effectiveness. This project investigated the reliability of available calculators when applied to The People's Pint, a small restaurant in Greenfield, MA. We found that these calculators failed to take into account numerous indirect energy sources, thus making them ineffective at determining the carbon footprint of a small restaurant. We recommend carbon calculator metrics be made transparent and that sustainability efforts be tailored to businesses.

Table of Contents

1. Introduction

As climate change becomes an increasingly prevalent issue in our everyday lives, people have become more conscious of how their individual practices affect the planet. People have begun composting, using more efficient lighting in their homes, buying into solar energy, and even biking to work when feasible. Some companies have begun using more efficient toilets and lighting, as well as using less materials and energy in their manufacturing processes. Others design their buildings from the ground up to be as eco-friendly as possible. These collective practices, designed to maintain our current quality of life while reducing environmental impact, are referred to as sustainability.

Sustainability, as defined by the Brundtland Commission, is “development which meets the needs of current generations without compromising the ability of future generations to meet their own needs” (Bärlund, n.d.). Sustainability is a growing concern globally and, unlike other megatrends, it is essential to preserving the Earth as habitable for humans, thus prolonging our longevity as a species. Currently, we are consuming many more resources than the planet is able to replenish, and as we continue to do so resources become increasingly scarce. This goes beyond having luxury goods. As our population grows, resources vital to healthy living become ever scarcer. We need to start making changes if we are to save ourselves from a planet that can no longer sustain us.

Making the switch from conventional to sustainable practices is not easy. In order for us to reach a world where sustainability is the standard, we have to start small before we can go large. This is the approach that The People’s Pint, a small pub in Greenfield, MA chose to take in approaching the design and operation of their restaurant.

In 1997 Alden Booth, a sustainably-minded individual, opened The People’s Pint in order to set an example for his community by showing how a restaurant could adopt sustainable methods of operation and still be successful. Now, 19 years later, The People’s Pint operates their own brewery and continues to attract customers.

Our goal with this project was to determine the feasibility of making The People’s Pint even more sustainable. We first intended to analyze the energy use of The People’s Pint pub and associated brewery in an effort to utilize energy-use reductions to lower operating costs and decrease the business's energy footprint. To do this, we intended to perform an energy audit that would allow us to examine the pub and brewery’s energy usage patterns and determine how they can reduce their energy footprint by decreasing excess energy usage. However, after some consideration, we concluded that an energy audit would not be an efficient use of our time, so we shifted our focus to looking at indirect energy uses that affect their overall environmental impact. This included their choice of napkin material, their Bike to Live program, and an analysis of carbon calculators which were expected to reveal additional avenues for improvement.

Our goal was to quantify how some of The People’s Pint’s practices are environmentally friendly and examine the applicability of residential carbon calculators to small businesses.

2. Background

Sustainable development is an ever growing topic of concern as global climates change. Examples of sustainable development can be seen in select restaurants throughout the country. The City of Greenfield and The People's Pint have also promoted sustainable development through initiatives such as park renovations, bike/walk programs and asking questions about their indirect energy usage. To analyze indirect energy usage, carbon calculators were examined. With much of our project focusing on sustainable development, it is important to emphasize the importance of sustainability.

2.1 Importance of Sustainability

2.1.1 Climate Change

As oil production increases and more fossil fuels are used, global temperatures continue to rise (NASA, 2015). The fumes produced by the combustion of fuels, such as natural gas and gasoline, pollute the air and contribute to rising temperatures by trapping heat on Earth. This is referred to as the greenhouse effect (NASA, 2015). CO_2 emissions have been rising since they broke historical thresholds back in 1950; not only is the planet warming, but our atmosphere is changing, and this in turn has had an effect on our health. The National Institute of Environmental Health Sciences details how asthma, cancer, cardiovascular disease, mental health and stress-related disorders and heat-related morbidity and mortality, among others, negatively affect human health and development. Sustainable energy production would likely help to mitigate these issues. Moving away from combustible fuels towards sustainable methods of energy production may not be a cure-all for climate change and asthma, but it could prevent the problems.

2.1.2 Carbon Footprint

One way of evaluating sustainability is through use of a carbon footprint calculator, an assessment of carbon emissions in homes or businesses, many of which are available online. Information is input on a carbon footprint website about how much electricity used, for example, and the results give an estimate on the amount of CO_2 is produced. Merriam-Webster defines a carbon footprint as "the amount of greenhouse gases and specifically carbon dioxide emitted by something (as a person's activities or a product's manufacture and transport) during a given period" (Merriam-Webster, 2015). For the purpose of restaurants this typically includes all emissions from day to day operations such as food preparation, cooling and heating, and the transportation of the supplies. However, it can also be expanded to include all emissions, from those associated with the construction of the building to those relating to the disposal of waste. There are various carbon footprint calculators available online to help give individuals and businesses a sense of how much they are contributing to global climate change. These basic tests may also provide enough information to guide future projects by showing what categories are contributing the most to total carbon emissions.

2.2 Case Studies

Businesses are increasingly becoming concerned with sustainability leading to the creation of multiple certification options for those who want to display how environmentally friendly they are to consumers. One such certification is LEED. Leadership in Energy and Environmental Design (LEED) certification has four different levels that allow businesses to distinguish themselves in areas such as energy conservation, green building materials, and healthy in indoor environment (USGBC, n.d.). The Founding Farmers, a restaurant in Washington DC, has achieved Gold LEED certification, the second highest rank, in their efforts to demonstrate their commitment to environmental stewardship (The Founding Farmers Triple-Green Approach, n.d.).

There are also some restaurant specific certification programs in existence that are geared specifically towards the qualities unique to food establishments. Similar to LEED, the nonprofit Green Restaurant Association (GRA) has a four-tiered strategy to rate the sustainability of restaurants. What separates the GRA from LEED is that while they do look at green energy use and waste management they also specifically consider food waste disposal as well as examining the sourcing of a restaurant's food. Uncommon Ground in Chicago, Illinois, is a 4-Star Certified Green Restaurant by the GRA partially based on criteria not considered by LEED, such as a rooftop farm (Uncommon Ground Reclaims the Title of World's Greenest Restaurant, n.d.).

A common way for restaurants to reach higher levels of certification is to reduce their environmental footprint by decreasing their energy use. For example, The Founding Farmers repurposes their old fryer oil as biofuel for their cars to prevent it from being thrown away, and do their best to minimize the need for indoor lighting by maximizing the natural light they get (The Founding Farmers Triple-Green Approach, n.d.). Moreover, they buy as much of their produce as possible from local markets to reduce the distance traveled by their food and consequently reduce the amount of fossil fuels required for each meal they serve (The Founding Farmers Triple-Green Approach, n.d.). Similarly, Uncommon Ground, in addition to their rooftop garden, uses only LED, compact fluorescent, and T8 lamps to decrease energy consumption (Uncommon Ground Reclaims the Title of World's Greenest Restaurant, n.d.). They also work to offset their energy consumption by generating renewable energy on site (Uncommon Ground Reclaims the Title of World's Greenest Restaurant, n.d.). Likewise, The Original Oyster House in New Orleans, Louisiana produces some of their own electricity on site: they have a small wind turbine that they use to power lights for their playground as well as the Christmas lights that illuminate the restaurant (Original Oyster House Honored for its Environmental Stewardship, n.d.). They also have solar powered water heater that helps reduce their energy demand (Original Oyster House Honored for its Environmental Stewardship, n.d.).

Waste is another serious concern for restaurants when they consider their environmental footprint. Uncommon Ground diverts 95% of their waste from landfills through a combination of recycling, composting, and conscientious purchasing (Uncommon Ground Reclaims the title of World's Greenest Restaurant, n.d.). the Founding Farmers reduce their water waste by having flow regulators for their plumbing fixtures, including their urinals, and, like Uncommon Ground they try to keep as much waste from landfills as possible (The Founding Farmers Triple-Green

Approach, n.d.); when they were under construction, the Founding Farmers used recycled materials for their wood floors, carpets, and wall coverings. In total, about 75% of their building materials were diverted from landfills (The Founding Farmers Triple-Green Approach, n.d.).

2.3 Greenfield and The People's Pint

2.3.1 Greenfield

The town of Greenfield, Massachusetts, was incorporated in 1773 on a piece of land provided by the town of Deerfield. Due to the confluence of railroads and rivers, Greenfield quickly grew in size and prosperity and remained an industrial hub through the 1850s. Mills and factories sprang up along the river, and the construction of housing for the workers contributed to a residential feel that it retains to this day.

Large areas of Greenfield still remain purely residential making the town highly walkable. When Franklin County was established in 1811, Greenfield was named the official County Seat and is still the governmental, economic, and cultural center of the county (MA DCR, 2009). Financial success allowed business owners to invest in large commercial buildings in the downtown district that are still standing and provide the town with a strong historical feel. Maintaining this atmosphere is a priority for residents and leaders in the community.

In addition to have a close relationship with its past, Greenfield also has a track record of being environmentally conscious. In 1997 the town built Energy Park on the site of an old railroad yard and depot. The park was designed to combine "town history and contemporary environmental issues into a multifunctional park property" (Greenfield Recreation Department, n.d.). Today the park includes solar panels on display, signage identifying area plants and trees, gardens growing plants native to New England, a composting station, and an old train caboose serving as a museum of Greenfield history. The town has a recycling rate that is almost 7% higher than the national average; locals have also been working since 2013 to pass legislation banning plastic bags and single serve plastic water bottles thus illustrating their commitment to sustainable living (EPA, 2013; Greenfield MA, 2014; Fritz, 2015).

2.3.2 The People's Pint

Alden Booth opened The People's Pint on January 1, 1997**,** envisioning a business that would not only provide people locally sourced food and beer but would also encourage the community to adopt greener practices. Situated just off Main Street in downtown Greenfield the pub was optimally located to be accessible to walkers and bikers. Today Mr. Booth runs a business that serves customers meals made from ingredients grown on regional farms, and provides patrons with beer brewed just down the street. The brewery was originally underneath the pub but was moved to a newly renovated space a number of years ago. When first opened The People's Pint only served dinner but four years ago the decision was made to begin opening earlier and serving lunch as well. The restaurant doesn't spend money on advertising, relying instead on word of mouth, quality food, and a positive atmosphere to bring in new customers. It seems to be working for them as Alden reports that they serve upwards of 200 people a day, 150 of those coming in for dinner on an average night maxing out the capacity of their 65 seat dining room.

The People's Pint already employs a number of sustainable practices in their efforts to reduce their environmental impact. They compost the paper towels from the bathrooms as well as their food waste and provide the compost to some of the local farms that in turn help supply the kitchen. As much of their glass, paper, and plastic waste as possible is recycled and light emitting diode (LED) lights are used to reduce energy consumption. Additionally, The People's Pint also has a program that encourages customers to take their bike rather than their car.

In their efforts to decrease energy consumption, The People's Pint has primarily considered energy explicitly used by the buildings themselves, or direct energy use. Meaning there is likely more room for improvement with their indirect energy use, or the energy that is used in the production of materials used by the buildings but that are not produced on site. Indirect energy uses include production of paper napkins or beer bottles, or the transportation of recycling to the transfer station. The energy is required to run the business but is not directly consumed within the buildings' walls. This is where we hope to help by analyzing some indirect energy uses and offering suggestions for improvements.

2.4 Indirect Energy Usage at The People's Pint

2.4.1 Bike to Live Program

Bike to Live is a program run by The People's Pint that rewards people for taking their bikes instead of their cars. This is not a new concept. Patagonia's Drive-Less Program gives employees the opportunity to earn up to $500 per year in rewards if they commute by bike rather than car (Patagonia, n.d.). Chittenden Area Transportation Management Association's Bike/Walk to Work Program gives you a $15 gift certificate if you bike or walk to work 24 times within a 60-day period (CATMA, n.d.). Employees aren't the only ones who can benefit from such programs, Oregon Health and Science University allows employees and students to log their miles to earn rewards. These can take the form of cash, parking reimbursement, or transit credit (Landolfe, 2011).

Organizations who institute bike reward programs often say it is because it agrees with their values. For instance, Patagonia is focused on outdoor gear and fitness, and OHSU is a college with a specialty in health. Bike programs often yield long term benefits for the companies as well, as active employees tend to be healthier employees, and healthier employees typically require less medical attention. This lower demand for medical services saves companies money in healthcare costs creating a monetary incentive for companies to create such programs.

In an effort to encourage such programs, the federal government enacted The Bicycle Commuter Act of 2008 (132 (f) of the Internal Revenue Service Code (26 U.S.C. sec. 132(f))) allows employers to reimburse bike commuters up to $20 a month for bicycle related expenses, making it easier for businesses to start programs that encourage alternative forms of transportation (National Center for Biking and Walking, n.d.). However, there are very few programs that reward customers for biking. The most notable of those in existence is the Bicycle Benefits Program. This is a national organization that partners with a network of local businesses to encourage customers to bike to the various stores. Bikers purchase stickers for $5 to place on their helmets which if shown at participating businesses gives the patron a discount or reward at the discretion of the business owner (Bicycle Benefits, 2015). While operating on a slightly different premise, the Benefits Program has the same effect as rewarding people for logged miles: people utilize bikes rather than cars to get around.

Comparing such programs can be difficult. Not all programs publish the results of their programs, and some like the Bicycle Benefits Program don't track miles at all. Additionally, the size of the organization and the number of people who choose to participate greatly affect the number of miles biked. Patagonia has only around 2,000 employees eligible to participate in their Drive-Less program (Patagonia, n.d.). It's unclear how many of those employees chose to participate, but in 2014 those who did saved a total of 726,404 driven miles (Patagonia, Inc. 2014). In contrast, OHSU's Bike Program had more than 2,000 participants who biked a 1.1 million miles in 2011 (Landolfe, 2011).

2.4.2. Napkins

As we learn more about the far reaching effects our actions can have on the environment, people are looking for more ways to reduce their environmental impact. For The People's Pint, one of those ways is to determine whether paper or cloth napkins are more sustainable, and they are not the first to compare the environmental impacts of cloth napkins to those of paper napkins. ThinkStep (formerly PE International) and Exponent published a report comparing the environmental impacts of disposable and reusable napkins, each with Worst, Mid-Low, Mid-High, and Best categories to incorporate the large differences in manufacturing, processing, and washing that can occur (Exponent, 2014). They found that these differences made it difficult to definitively say whether cloth or paper were better; there are too many different factors that can drastically change the environmental impact of the product.

The Swedish Environmental Research Institute performed a similar study comparing paper and cloth napkins. They found results that resembled Exponent's and demonstrated how the environmental impact of the reusable napkin can be changed depending on the quality of the paper napkin or the type of cloth used. For example, the Swedes found that linen napkins have much smaller environmental footprints than cotton napkins (Jelse, 2011). The primary conclusion that can be drawn is that while it is difficult to make overarching statements about the superiority of a single napkin option, it is possible to determine the preferable napkin strategy in a specific situation. This is what we hope to be able to do for The People's Pint.

Simple Diaper is the cleaning service that washes the napkins belonging to The People's Pint. Instead of using chlorine to sanitize laundry, Simple Diaper uses an Aquawing Ozone Laundry system. Ozone is a better disinfectant than chlorine, and also has fewer negative environmental effects so it is considered a more sustainable option than traditional laundry systems (Magnanti et al, 2013).

Ozone laundry systems also help reduce energy and water use. The Gaston Memorial Hospital in Gastonia, North Carolina, found that their water usage was reduced almost 15%, and their electricity usage was reduced almost 14% (Magnanti et al, 2013). The facility also saw a 61% decrease in the amount of natural gas required to heat the water used to wash the laundry. Other studies have shown that businesses that transfer to ozone-based laundry systems can reduce water usage by 20-25% and decrease the amount of fuel required to heat the water by 70-80% (Shaw, 2004). Aquawing, the brand used by Simple Diaper, says that their system can shrink electricity bills up to 15% and reduce the fuel required to heat water by as much as 85% (Aquawing, n.d.).

2.5 Carbon Calculators

Carbon calculators have been used for the past decade to evaluate the carbon footprints of individuals and businesses alike. They have a large handicap however: their inconsistency. There exist no standards for carbon calculators and no homogeneity; each calculator uses different equations and metrics, much of which are not comparable. When entered into multiple calculators, the same data can yield results that vary by thousands of pounds of CO_2. Additionally, there is no proper way to gauge the accuracy of each calculator because the majority of them don't have metrics publically available. If one were to use a variety of carbon footprint calculators to measure the same exact information, one would expect to get similar results each time. This is unfortunately not the case.

A study performed by Paul Padgett and his colleagues titled "A comparison of carbon calculators" describes the overall lack of consistency among the carbon calculators. In their study they compared 10 individual CO_2 calculators, focusing particularly on the CO_2 emissions from the use of household fuel oil, electricity, natural gas, and propane. They also examined personal vehicle and air travel CO_2 emissions and discussed the measures required to offset the CO_2 emissions for both of these vehicles and household emissions. Table 2.1 shows the values that "A comparison of carbon calculators" used as inputs.

Table 2.1: Individual profile of behaviors used in carbon calculator comparison

Household energy	Average annual use
Electricity	12 000 kWh
Natural gas	92 160 ft^3
Fuel oil	651 gal
Propane	488 gal
Kerosene	100 gal
Wood	1 cord
Transportation	
Vehicle miles	11 700 miles
Vehicle efficiency	22 mpg

Table 2.1, gathered by "A comparison of carbon calculators" shows they input information about electricity, natural gas, fuel oil, propane, kerosene, and wood burning as a way to calculate individual usage. The 'Average annual use' values used in this profile were taken from EPA's

calculator when possible. In the event that EPA did not account for a behavior, averages provided by other calculators were used" (Padgett, 2008). Their results are shown in Table 2.2.

Table 2.2: A comparison of carbon calculators, Results

Calculator	Pounds of CO_2 per Year
American Forests	34,890
Be Green	18,260
BEF	24,003
CarbonCounter.org	31,940
Chuck Wright	24,460
Clear Water	16,200
The Conservation Fund	22,860
EPA	16,440
Safe Climate	22,308
TerraPass	22,996

"A comparison of carbon calculators" noted how the inconsistencies could have been caused by many factors including methodologies, behavioral estimates, or conversion factors:

> "Notably, these results reveal a lack of uniformity among calculators. These variations may be a result of different conversion factors employed or distinct methodologies utilized to calculate these estimates of CO_2 emissions. Although these differences may appear small in some cases, when compounded in calculations, they can produce considerable variation in results." (Padgett, 2008)

Their conclusion pointed to the need for carbon calculators to become more consistent and transparent in order to analyze the discrepancies in the results.

3. Methodology
3.1 Carbon Calculators

Out of the 11 carbon calculators examined in “A comparison of carbon calculators” only 6 were still active: Chuck Wright, American Forests, Conservation Fund, EPA, and TerraPass. Those that are available were scrutinized to find their biases. It is important to understand biases as they can reveal the motives behind the creation of the calculators and potentially explain skewed results.

American Forests is an environmental organization whose mission is to “restore threatened forest ecosystems and inspire people to value and protect urban and woodland forests” (American Forests: Mission and Vision, n.d.). They run programs that facilitate the location and protection of large trees, enlist volunteers to plant trees in deforested areas, and educate the public on the benefits and services provided by urban and rural forests. As the “oldest national nonprofit conservation organization in the country” they have a long history of working with the federal government to create sustainable forest policy (American Forest: Mission and Vision, n.d.).

Chuck Wright is an independent individual who has a history of environmental stewardship and computer programing (Chuck Wright, n.d.). This combination apparently led him to create his own carbon footprint calculator without the endorsement of any other organization. Due to the lack of information it is difficult to say what biases his calculator may or may not have.

The Conservation Fund is a national organization dedicated to “practic[ing] conservation to achieve environmental and economic outcomes” (Conservation Fund, n.d.). They partner with local and federal governments, businesses, Non-Governmental Organizations, and private landowners to reduce carbon emissions, promote green infrastructure, and promote the growth of sustainable business practices. They have also provided more than $130 million in loans to help organizations protect threatened locations with historical and environmental importance (Conservation Fund, n.d.).

The EPA is the US governmental organization in charge of protecting human and environmental health by regulating the consumption and pollution of natural resources. To do this, they create and enforce regulations regarding humans and the environment, provide grants to organizations to fund a variety of environmental initiatives, and educate the public through campaigns and publications (EPA, 2015).

TerraPass is a business that sells carbon offsets to businesses and individuals who are interested in reducing their carbon footprints but are either unable or unwilling to make changes to their daily lives or are interested in doing even more to reduce their carbon emissions (TerraPass, n.d.). They also help businesses to do detailed carbon footprint analyses to show them places where they could reduce their carbon emissions, and then assist them in developing plans to institute those reductions. Because this business is based on companies needing to offset their carbon use, it would be expected that the results from their calculator would be on the higher end of the spectrum. The higher the results, the more carbon offsets the company can sell.

With the biases in mind, we began our methods by gathering information for the carbon calculators. The X’s in Tables 4.1, 4.2, and 4.3 show what information is requested by the calculator. Table 3 looks at transportation, Table 4 looks at home energy, and Table 5 looks at waste and recycling inputs.

Table 3.1: Transportation inputs allowed for each calculator

	American Forests	Chuck Wright	The Conservation Fund	EPA	TerraPass
Auto Transportation	X	X	X	X	X
Number of vehicles	X		X	X	X
Vehicle type	X			X	X
Vehicle maintenance				X	
Fuel type	X				X
Reduce number of miles driven				X	
Replace a vehicle with higher mpg				X	
Air Transportation	X	X	X		X
Miles flown	X	X	X		X
Length of flight					X
Refractive Forcing Index					X
Employees traveled annually					X
Short haul flight					X
Medium haul flight					X
Long haul flight					X
Commute					X
Car, Train, Bus, Taxi, Ferry commuting					X
Shipping					X
Air Cargo, Truck, Train shipping					X

Table 3.2: Energy inputs allowable for each calculator

	American Forests	Chuck Wright	The Conservation Fund	EPA	TerraPass
Energy	X	X	X	X	X
Oil	X	X	X	X	X
Natural gas	X		X	X	X
Source of natural gas		X			
Propane			X	X	X
Computer server					X
Turn up A/C during summer				X	
Turn down heating during winter nights				X	
Replacing incandescent light bulbs				X	
Power management feature on computers				X	
Green power usage				X	
Wash clothes in cold water				X	
Clothes line instead of drying rack				X	
Replacing refrigerators, furnace or boiler, or windows				X	

Table 3.3: Waste and Recycling inputs allowable for each calculator

	American Forests	Chuck Wright	The Conservation Fund	EPA	TerraPass
Food waste	X				
Waste	X		X		
Garbage	X				
Recycling	X		X	X	

Next we gathered The People's Pint data to input into the calculator in order to compare our results to those of "A comparison of carbon calculators". The information used to evaluate The People's Pint's CO_2 footprint was obtained via a phone interview with our sponsor, Alden Booth, and from the restaurant's energy bills reviewed during an onsite visit (see Appendix A). In each calculator, a value of 200 was entered for the amount of people in the household since The People's Pint serves around 200 customers per day. 78351.6 was entered for the amount of kilowatt hours of electricity per year, 6674.4therms for natural gas per year, and 11860.8 miles a year driven at 22 miles per gallon. The average miles driven per year used the information gathered from the second interview with Alden where he said that they distributed beer in restaurant owned vehicles weekly to Springfield and bi-weekly to Boston. Additionally, a '0' was used for oil and air transportation information since The People's Pint does not burn oil for energy nor does it use air transportation. See Table 3.4 for a summary of the inputs used in each calculator.

Equation 3.1: Miles traveled per week

$$Miles\ per\ Week = (Mile\ to\ Springfield \times Trips\ per\ Week) + (Miles\ to\ Boston \times Trips\ per\ Week)$$

Equation 3.2: Miles traveled per year

$$Miles\ per\ Year = Miles\ per\ Week \times 52\ Weeks\ per\ Year$$

Equation 3.3: Average kilo-Watts per year

$$kilo - Watts\ per\ year: ((6076 + 2883.2 + 1873.8 + 5676 + 6360 + 6389 + 8285 + 8970 + 10753 + 8986 + 8748 + 6586 + 6429 + 4075 + 5188 + 3105.6 + 4487 + 5205 + 5912 + 6227 + 3932 + 7909 + 9985 + 9352 + 9841) per \frac{month}{25} months) \times 12\ months\ per\ year = 78351.6\ kWh/year$$

Equation 3.4: Average therms per year

$$Therms\ per\ year: ((492.1 + 535.7 + 570.6 + 578.8 + 588.4 + 711.9 + 699.4 + 689.8 + 637.2 + 664.3 + 239.9 + 641.7 + 258.4 + 658.1 + 573.2 + 582.2 + 729.1 + 707.6 + 672.2 + 486 + 587.1 + 574.8 + 552.9 + 503.5 + 527) per \frac{month}{26} months) \times 12\ months\ per\ year = 6674.4\ therms/year$$

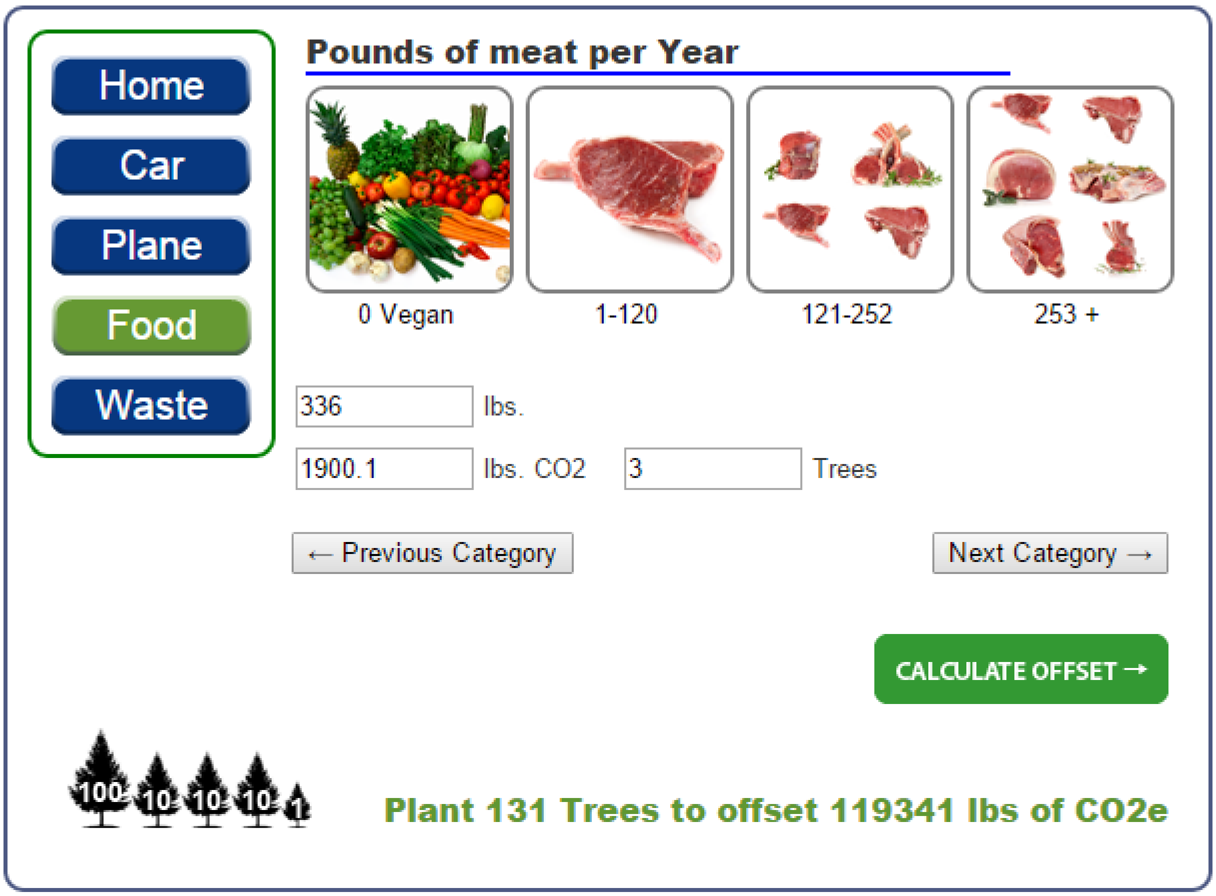
Table 3.4: Inputs to be used for all calculators

	American Forests	Chuck Wright	The Conservation Fund	EPA	TerraPass
People per day	0	0	200	200	200
Electricity (kWh)	78351.6	78351.6 (East Coal)	78351.6	78351.6	78351.6
Oil	0	0	0	0	0
Natural Gas (therms)	6674.4	6674.4	6674.4	6674.4	6674.4
Propane	0	0	0	0	0
Auto Transportation (miles)	11860.8	11860.8	11860.8	11860.8	11861
Miles per gallon of gasoline	22	22	22	22	22
Air Transportation (miles)	0	0	0	0	0

As the previous Tables 3.1, 3.2, and 3.3 show, each calculator uses different inputs to calculate the user's CO_2 output. Therefore, after we input the data from Table 3.4, we went into detail on what additional information the calculator asked. Moreover, all inputs that were not previously collected were given a value of 0.

For the American Forests Calculator there was an option for pounds of garbage, recycling, and pounds of meat per year. There were three options for pounds of meat per year, 253+ pounds being the highest one. Therefore, we assumed that The People's Pint would use 253+ pounds of meat per year since they are a restaurant that serves meat regularly. When that option was selected, the calculator automatically filled in a meat consumption value of 366 pounds per year.

Image 3.1: Meat consumption question from the American Forests Calculator



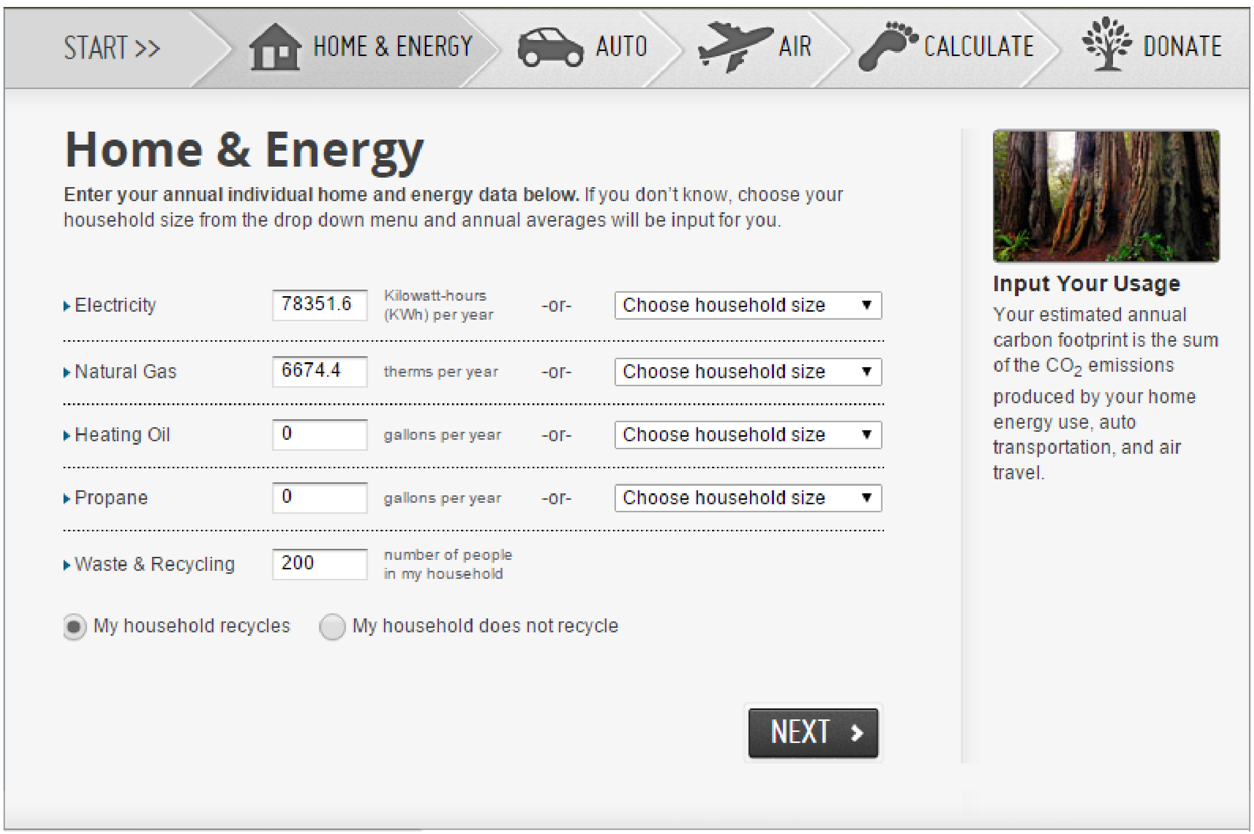
* See Appendix B for screenshots of all the calculators

Information received from our phone interview with Alden Booth provided us with estimates on the amount of waste and recycling produced per year (See Appendix A). Using Greenfield's Materials and Pricing Guide, we found that the reported average of $150 per month spent on waste removal by Alden Booth divided by 4 weeks, divided by $3 per bag used on waste removal, multiplied by 52 weeks per year equals 650 bags per year. Looking at the FAQs page on Greenfield's website on the Pay-As-You-Throw trash bags used in Greenfield describes how sturdy the bags are: "The bags are 1.5 millimeters thick - almost twice as thick as a regular kitchen garbage (PAYT, n.d.). According to UPS, a regular duty 56 gallon trash bag can hold up to 40 pounds of dry weight (US Packaging and Wrapping, LLC, n.d.). Thus a 30 gallon trash bag can hold about 21 pounds of dry weight. 650 bags per year multiplied with 21 pounds per bag equals 13,928.6 pounds per year. Due to recycling costing $0 dollars, The People's Pint collected no data on how much they recycle, however, since The People's Pint is a big proponent of recycling and recycles all paper and metal products possible, the highest value of 701+ was chosen (Greenfield DPW, 2014).

The Chuck Wright calculator had a drop-down menu of the source of power for the power plant. Since we do not know where their source of power for their power plant comes from, the automatic available option of Eastern Coal was selected.

The Conservation Fund allowed input of waste & recycling, in terms of people in the household. A value of 200 people was used since that was average number of customers per day at The People's Pint. Additionally, the calculator had an option for either 'My household recycles' or 'My household does not recycle'. The People's Pint recycles so the former option was chosen.

Image 3.2: Recycling questions from the Conservation Fund calculator



The EPA calculator also allowed input for the number of people in the household, unfortunately, there was a two-digit limit. The number 20 was chosen and thus all calculations returned that were based on this number were multiplied by 10. Zip code was also asked and 01301 was entered for The People's Pint.

Image 3.3: Zip Code question from the EPA calculator

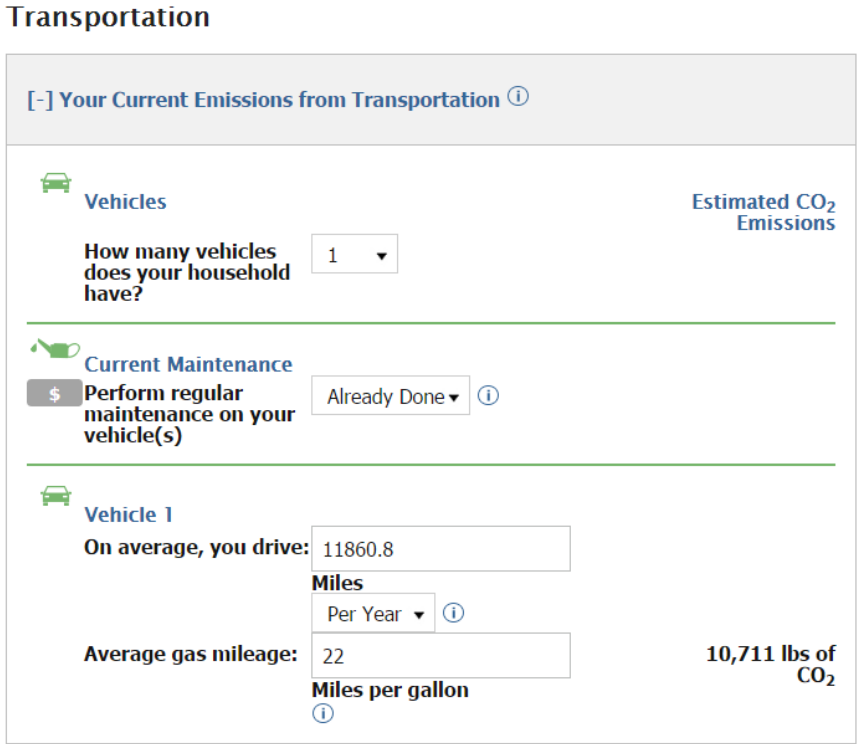
The EPA calculator first asked for the primary heating source; converting from therms to kWh provided us with an answer.

Equation 3.5: Therms to Kilo Watt Hours (ConvertUnits, 2016)

$$kWh = Therms(29.3)$$
$$kWh = 6861.3(29.3)$$
$$kWh = 201{,}036.9$$

It was calculated that 6,861.3 therms was 201,036.9, which was more than 78351.6 kWh, and since electricity and natural gas were the only sources of energy, it was clear that natural gas was the primary source of heat (Visit #2 in Appendix A). Power and settings on computers, washing clothes in cold water, using clothesline or drying rack, refrigerator, furnace or boiler, and windows had options associated with them. No information was gathered so no input was given. Current vehicle maintenance was asked and we assumed that the vehicles were receiving maintenance regularly.

Image 3.4: auto questions from the EPA calculator



Further, the EPA calculator asked whether or not the household recycled aluminum and steel cans, plastic, glass, newspaper and magazines. Specific information about recycling was not gathered but due to the restaurant's heavy emphasis on recycling and composting as conveyed by Booth, this paper makes the assumption that The People's Pint recycles all recyclable materials (Booth, 2015).

The TerraPass calculator had an option of calculating carbon footprints for businesses or individuals. We used the businesses calculator since The People's Pint is a business. The TerraPass calculator, similar to the EPA calculator, asked for the number of customers (100-999 was chosen since 200 is the average amount of customers per night). Moreover, no input for therms was allowed, therefore we used a convertor found on Birkeshiregas.com to convert from therms to CCF.

3.2 Bike to Live Program

To analyze the impact of The People's Pint's Bike Program we started by obtaining the number of miles that have been reported by bikers. We also calculated the average miles per gallon of the cars on the road during that time using data from the Bureau of Transportation Statistics. With that information, it was possible to calculate the number of gallons of gasoline saved by using the Equation 3.6.

Equation 3.6: Gallons saved

$$Gallons\ Saved = \frac{Miles\ Biked}{Average\ MPG}$$

The next step was to calculate how many pounds of CO_2 this kept out of the atmosphere. The US Energy Information Administration provides data on how many pounds of CO_2 on average are produced from every gallon of gasoline burned. With this new data and the information previously calculated it was possible to find the total amount of CO_2 that The People's Pint's bike program saved using Equation 3.7.

Equation 3.7: Pounds of CO_2 Saved

$$Lbs\ CO_2\ Saved = Gallons\ Saved\ \times Lbs\ CO_2\ per\ Gallon$$

Finally, to determine how many pounds of CO_2 were saved on average every year the number calculated from the previous equation was divided by the number of years the program has been operating (Equation 3.8).

Equation 3.8: Pounds of CO_2 Saved per Year

$$Lbs\ CO_2\ Saved\ per\ Year = \frac{Lbs\ CO_2\ Saved}{Years\ of\ Operation}$$

3.3 Napkin

Average water, electricity, and heat fuel usage by standard laundry systems were calculated by averaging the use patterns from all four levels, Worst, Mid-Low, Mid-High, and Best. The average resource usage reduction found when switching from a standard laundry system to an ozone laundry system was also calculated by averaging the reduction recorded by Gaston Memorial Hospital and Aquawing. With these numbers it was then possible to calculate the predicted average energy usage of an ozone laundry system using Equation 3.9.

Equation 3.9: Average resource use by ozone laundry systems

$$Ozone\ Laundry\ Usage = Standard\ Laundry\ Usage \times Reduction\ \%$$

After calculating the water, electricity, and heat fuel used by an ozone laundry system, it was possible to compare The People's Pint's cloth napkin usage with the paper napkins profiled in ThinkStep/Exponent paper by comparing the various resource usages. It was then possible to draw conclusions about which napkin option was more environmentally friendly for The People's Pint.

4. Results

4.1 Carbon Calculators

After putting all of the data into the carbon calculators as specified in the methods chapter each calculator provided an estimate as to the yearly carbon production associated with The People's Pint. Our results from our inputs into the calculators and 'A comparison of carbon calculators' are shown in Table 4.1. This table shows a decrease in pounds of CO_2 per year for "A comparison of carbon calculators" as you move down the table and an increase for The People's Pint, with the exception of TerraPass. Unfortunately, due to the lack of accessible methodologies online, why this occurs can only be speculated.

Table 4.1: Pounds of CO_2 per year comparison

Calculators	Pounds of CO_2 per year: The People's Pint	Pounds of CO_2 per year: A comparison of carbon calculators
American Forests	133,917	34,890
Chuck Wright	248,600	24,460
The Conservation Fund	322,640	22,860
EPA	16,399,150	16,440
TerraPass	125,663	22,996

4.2 Bike to Live Program

Bike to Live is a program run by The People's Pint that rewards customers when they use their bikes instead of their cars. Participants record the miles that they bike rather than take their car. This does not include recreational biking, only miles that would be driven in a car. After the first 100 miles the participant can take their record sheet into The People's Pint and receive a $25 gift card. After that, the reward is $1 for every 20 miles recorded (Booth, 2015).

Alden Booth reported that participants in the Bike to Live program logged more than 87,000 miles between 2002 when the program started and 2015. To determine how many gallons of gas this is equivalent to it was necessary to obtain the average miles per gallon of the cars on US roads. Using data from the US Department of Transportation, we found that the average fuel efficiency for light duty cars on the road between 2002 and 2013(the most recent data available) was 22.88 MPG. We selected light duty vehicles because that classification includes passenger vehicles and some smaller trucks.

Table 4.2: Average MPG of all light duty vehicles on the road by year.

Average Fuel Efficiency of U.S. Light Duty Vehicles												
Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Light-duty vehicle	22.0	22.2	22.5	22.1	22.5	22.9	23.7	23.5	23.3	23.2	23.3	23.4
								Average(MPG):			22.88	

Source: Bureau of Transportation Statistics

With this information it is possible to calculate how many gallons of gas the Bike to Live program saved using Equation 3.6.

Equation 3.6: Gallons saved

$$Gallons\ Saved = \frac{Miles\ Biked}{Average\ MPG}$$

$$Gallons\ Saved = \frac{87{,}000\ miles}{22.88\ MPG}$$

$$Gallons\ Saved = 3802.45\ Gallons$$

According to the United States Energy Information Administration burning one gallon of ethanol free gasoline releases approximately 19.64lbs of CO_2 into the atmosphere (US Energy Information Administration). Knowing this it is possible to calculate how many pounds of CO_2 were kept out of the atmosphere by saving 3,802.45 gallons of gas using Equation 3.7.

Equation 3.7: Pounds of CO_2 Saved

$$Lbs\ CO_2\ Saved = Gallons\ Saved\ \times Lbs\ CO_2\ per\ Gallon$$

$$Lbs\ CO_2\ Saved = 3802.45\ Gallons\ \times\ 19.64\ Lbs\ CO_2\ per\ Gallon$$

$$Lbs\ CO_2\ Saved =\ 74{,}680.12\ Lbs\ CO_2$$

The People's Pint Bike to Live Program has prevented approximately 74,680 pounds of CO_2 from being released into the atmosphere.

Using that information, it is possible to calculate how many pounds of CO_2 per year have been saved using Equation 3.8.

Equation 3.8: Pounds of CO_2 Saved per Year

$$Lbs\ CO_2\ Saved\ per\ Year = \frac{Lbs\ CO_2\ Saved}{Years\ of\ Operation}$$

$$Lbs\ CO_2\ Saved\ per\ Year = \frac{74{,}680\ Lbs}{13\ Years}$$

$$Lbs\ CO_2\ Saved\ per\ Year = 5{,}744\ Lbs\ per\ Year$$

4.3 Napkins

Based on the information gained from previous studies, the following calculations were completed using the averages of the three resource reductions commonly seen when switching from a regular laundry system to an ozone laundry system.

Table 4.3: Average Reduction per Item

Item	**Average Reduction**
Water	19%
Electricity	15%
Heat Fuel	74%

Based on the numbers reported by Exponent and ThinkStep, the average resource usage by standard laundry systems are as follows in Table 4.4. (See Appendix XX for complete tables)

Table 4.4: Average resource usage by standard laundry systems

Parameter	**Average Use**
Water (gal)	1.38
Electricity (Btu)	2,369.75
Heat Fuel (Btu)	443.56

Using the numbers from Tables 4.3 and 4.4, it is possible to determine the average usage by an ozone laundry system using Equation 3.9. Results are shown in Table 4.5.

Table 4.5: Average resource use per pound of laundry

Parameter	**Standard System**	**% Decrease**	**Ozone System**
Water (gal)	1.38	19	1.12
Electricity(Btu)	443.56	15	377.03
Heat Fuel (Btu)	2,369.75	74	616.14

5. Findings

5.1 Carbon Calculators

Due to how widely cited "A comparison of carbon calculators" was and the need to compare our findings to some sort of other data, we used the carbon calculators presented in their study. However, being that the paper delved into individual consumption and ours looked at business consumption our results were significantly different than theirs. Nevertheless, the primary finding of this IQP is that there exists no standard for carbon calculators and no homogeneity; each calculator uses different metrics, many of which are not comparable. This lack of homogeneity yields noticeably different results from each calculator. The variations in pounds of CO_2 released can vary by thousands of pounds, and there is no proper way to gauge the accuracy of each calculator because, for the majority of them, the metrics aren't publically available for review. If one were to use a variety of carbon footprint calculators to measure the same exact information, one would expect to get the same results each time. This is unfortunately not the case.

The results of our study are similar to those of "A comparison of carbon calculators", in that they reflect the lack of congruity amongst the metrics of carbon calculators. In the report, averages were determined using the EPA calculator, as it is backed by government provided emissions information. These values were reported previously in Table 2.1.

Notably, there is no average value for public transportation, only transportation. While this would be valuable information, it is understandably hard to quantify, as the average person doesn't record their average travel times or fuel usage. For example, it is possible that many people don't consider how often they take public transportation, nor do they necessarily have access to the fuel economy of, say, a public bus. Beyond public transportation, there are several emerging car technologies that relate directly to sustainability and a car's fuel economy. For example, the emergence of electric vehicles and other cars running on alternative fuel sources obscures the environmental cost of transportation.

It is worth noting that none of the calculators take into account any extraneous sources of carbon contribution or mitigation. This information could serve to help adjust the results provided by the calculators, providing a more realistic idea of an individual or business' carbon contribution. Table 2.2 shows the discrepancies between the calculators' results when provided with the same information. While all of the values fall within a range between 16,000 lbsCO_2/year, and 34,900 lbsCO_2/year, and it might seem like a reasonable range, it in fact isn't. For the same information to be fed into calculators and the difference between values be in the tens of thousands instead of in the hundreds (or ideally, in the decimals) clearly demonstrates that the metrics and algorithms by which the individual calculators arrive at their solutions are different. This can be even more directly inferred by comparing the inputs of each calculator while using them. For example, the EPA and TerraPass calculators require the most information, in many cases covering energy usage that the other calculators omitted entirely.

Understanding the inconsistency, the next step would be to try to reverse engineer the algorithms and analyze the metrics each calculator used. Unfortunately, the lack of consistent math makes it difficult to determine how the calculators returned the results they did, ultimately making a comparison between the calculators an intractable and intrinsically flawed endeavor. In fact, it is impossible to further research some of these calculators: out of the 11 carbon calculators examined in the paper, only 6 are still active; Chuck Wright, American Forests, Conservation Fund, EPA, and TerraPass. We also cannot reverse engineer the algorithms used to compute the results for each calculator because, as stated, the metrics are largely obscured.

The EPA calculator was the most transparent calculator available for review. One particularly useful aspect of this calculator is that the total carbon output generated by the user can be compared to their sub-region's annual CO_2 output as well as to their energy service provider's annual CO_2 output. The EPA calculator also includes information about specific energy providers' CO_2 output in pounds per megawatt hour (lb/MWh) as well as emissions factors. The emission factors used in this calculator are also measured in pounds per megawatt hour and correlate with specific sub-regions. For example, NPCC New England, the eGRID sub-region that corresponds to New England (of which Massachusetts is a part) has an equivalent total output emission rate of 834.281 lb./MWh. This gives the user an idea as to what percentage of their region's total CO_2 output directly relates to them.

5.2 Bike to Live Program

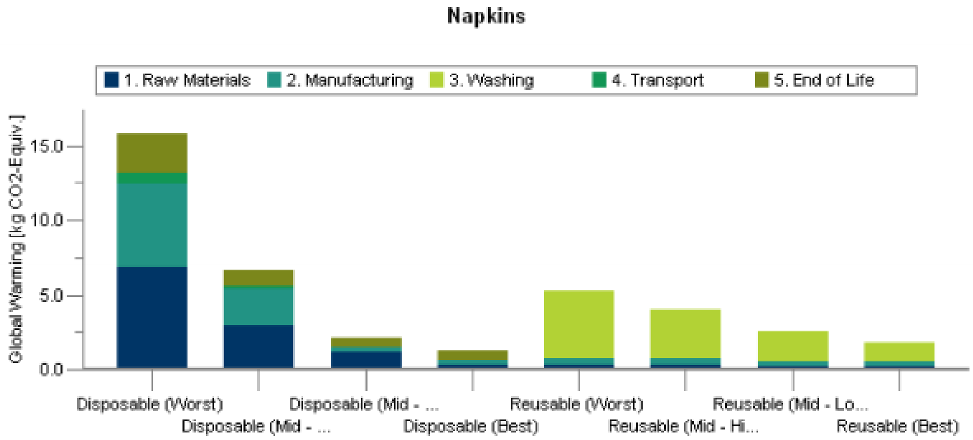
An analysis of the Bike to Live program found that there has been significant carbon savings resulting from patrons taking their bikes rather than their cars, nearly 75,000 pounds. Every year, The People's Pint Bike Program did the work of 120 trees by keeping 5,745lbs of CO_2 from the atmosphere (American Forests).

While this is a significant amount, traditional residential carbon calculators have no way of taking this information into account. Without a carbon calculator designed for small businesses it is impossible to tell what portion of The People's Pint's annual emissions 5,745lbs of CO_2 represents.

5.3 Napkins

With the limited data available it is difficult to directly compare the resource consumption between paper napkins and cloth napkins cleaned using an ozone laundry system. In examining the results from comparison between disposable napkins and reusable ones done by Exponent it became clear that the primary factor in determining the environmental impact was the amount of water wasted (See Appendix C for additional tables). The environmental impact was quantified as the global warming potential (GWP) of the napkin's lifecycle and is shown in Table 5.1.

Table 5.1: Results from the LCA of Disposable and Reusable Napkins (Exponent, 2014)



The graph shows the total GWP for each of the different napkin scenarios, with the contributions color coded to the various stages of the napkins life: Raw Materials, Manufacturing, Washing, Transportation, and End of Life. The four reusable napkin scenarios to the right of the graph clearly display that the largest differences in total GWP can be attributed to the washing phase. To determine what contributes to the differences between the various scenarios, it was necessary to examine the different factors that were considered in that stage, shown in Table 5.2.

Table 5.2: Inputs and Outputs for napkin washing (Exponent, 2014)

Wiper		Worst	Mid-High	Mid-Low	Best
Electricity	[Btu / lb laundry]	614.16	443.56	443.56	272.96
Natural gas	[Btu / lb laundry]	3471.00	2185.00	2185.00	1638.00
Water	[gal / lb laundry]	2.23	1.25	1.25	0.78
Wash chemistry	[lbs / lb laundry]	0.01	0.01	0.00	0.01
Waste water	[gal / lb laundry]	1.60	1.58	1.45	1.48
Sodium hydroxide	[mg / L wastewater]	**0.79**	0.79	0.79	0.79
Detergent	[mg / L wastewater]	**0.87**	0.87	0.87	0.87
Softener/souring agent	[mg / L wastewater]	**0.07**	0.07	0.07	0.07
Mildewcide	[mg / L wastewater]	**0.04**	0.04	0.04	0.04

By examining this data, it is apparent that the only difference between the mid-low and mid-high categories is the amount and contamination of the waste water. Because the ozone laundry system used by Angie's Diaper releases wastewater that is much less contaminated than the traditional laundry systems profiled by Exponent it can be assumed that the ozone laundry system falls at or below the levels of the Mid-Low scenario.

Because The People's Pint washes their napkins 350 to 400 times whereas the study cited assumes only 100 uses, the resource use associated with the raw materials (dark blue) and production (teal) of the napkins would be decreased by ⅓ to ¼. Furthermore, the calculated water and electricity use of the ozone laundry system place it between the Reusable (Mid-Low) and Reusable (Best) categories, automatically making it more efficient than all but the most efficient disposable napkins. Finally, the fact that the ozone laundry system uses just 38% of the heating fuel required by even the Best Reusable napkin reduces each napkins environmental impact below that of every single disposable alternative (Exponent, 2014).

5.4 Conclusions

Through our results and our findings, we have several conclusions. First and foremost, The People's Pint incorporates many environmentally friendly practices into their business from buying certain napkins that use less water to the Bike to Live program that rewards those who use bikes to reduce their carbon footprint. Moreover, our study found that the carbon calculators are not, at this point in time, a good measurement of a restaurant's carbon footprint. This was due to the carbon calculators' lack of transparency and consistency as reported by "A comparison of carbon calculators".

6. Recommendations

The main recommendations drawn from this IQP are for any individual who creates an online carbon calculator for small businesses. Our focus on the carbon calculators for our recommendations is because an overarching sustainability calculator, while valuable, would be much more cumbersome due to the large number of factors that would have to be considered. There are already carbon calculators available which build a framework that a business calculator could be based on.

Many restaurants work on reducing indirect carbon emissions in ways that are not reflected in current online carbon calculators. For example, The People's Pint's Bike to Live program and napkin washing habits are not examined in any of the residential calculators we evaluated. The challenge facing anyone who decides to design a carbon calculator for a restaurant is considering all the factors that are unique to restaurants, such as taking into account the distance the patrons travel to dine at the restaurant or how they deal with their waste. Such a device would have to be scalable, with a baseline of inputs that small businesses all share and then different inputs that help to specialize and scale the calculator to suit the needs of the business. As The People's Pint was the focus of our IQP, we will focus on restaurants for our recommendations.

An important factor when considering a restaurant's indirect energy usage is the distance the restaurant's patrons travel to eat there. If an establishment uses primarily local produce but is forced to draw in clientele from miles around to stay open, it could be argued that the carbon emissions offset by the usage of local food are being negated by how far customers have to drive. If the restaurant owner doesn't have an estimate of how far their customers travel, this could perhaps be calculated using a combination of demographics information surrounding the restaurant's zip code which could be asked for by the calculator. If the surrounding area has a better support for local restaurants, then the residents would not need to travel far, reducing the amount of CO_2 emissions. However, if the restaurant draws customers in from farther away, the increased distance creates more CO_2 emissions. Several of the calculators already ask for the zip code (see Appendix B for pictures of the calculators) but, as explained in the findings, how that information was used was either too convoluted to understand or not available online for public access.

Similar to the distance the patrons would go to get to a restaurant, there would have to be more questions regarding meat and seafood consumption. Land and sea animals are environmentally costly to raise, process, and distribute across the county (Walsh, 2013). Therefore, information about what kinds of meat and seafood are served, what portion of the menu is composed of meat or seafood-containing items, and what size the portions are is important. When added up over the course of a year and hundreds of customers the difference in carbon outputs between an 8 oz. steak and a 6 oz. steak can be considerate. The region where the meat is from is also important to consider as transportation of anything releases lots of carbon into the atmosphere.

While residential calculators do ask about garbage and recycling, for restaurants, there would have to be much more information needed on composting and recycling. Questions asking about the amount of pounds of food waste and recycling that were diverted, how far the food waste and recycling went before being composted or recycled would be needed in the calculator. With the amount of food waste that restaurants deal with on a daily, let alone monthly or yearly, composting is a huge factor in determining carbon footprints (Santa Barbara County Resource Recovery & Waste Management Division, n.d.; Decker, n.d.)

Water usage would also be an important category of inquiry. Because of the large volume of dishes that restaurants do, the efficiency of the dishwashers would be very important to know. Additional questions would have to be asked about how often the dishwasher is run and whether it is run only when it's full or when it's only have full. Questions about dual flush toilets and other water conserving strategies would have to be asked.

As shown with The People's Pint, laundry is a surprisingly complex topic. It would be important to ask about what kind of napkins the restaurant uses, disposable or reusable. If the answer is reusable napkins then it would be very important to know how they are washed, as well as how often they are used before being discarded. Whether or not the restaurant uses table cloths and how often they are washed would also be valuable pieces of information to get.

Finally, it would be interesting if a calculator was developed and administered by a consulting company that specializes in calculating direct energy usage. There would be an option for "Other Practices" with it which would require a consultant to determine energy usage on an case-by-case basis. For example, do they have a solar hot water heater or solar panels? Do they, like The People's Pint, have some sort of rewards program for customers who opt out of driving? As the consultation company works with more restaurants, they can add these options to the calculator to more specifically tailor it to each business. Implementing such a system would make carbon calculators a much more reliable tool, and would be a big step towards increased sustainability in restaurants and small businesses.

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Appendix A: Terminology and General Project information

Phone Interview
September 24, 2015.
Approximately 11:00 AM
Discussion between:

- Alden Booth, owner of The People's Pint pub and brewery in Greenfield MA,
- WPI project group Sarah Campos, Mervyn Larrier, and Kaija Roy with
- Faculty advisor Suzanne LePage

The following record is a synthesis of the information gathered in two sets of notes, combined and refined for clarity and to insure that all information is present.

General Information

Greenfield:

- Hugely residential, originally a mill town and the owners built houses in town for workers, making it easily bound together by walking and biking.

Alden Booth:

- English major, involved in music.

The People's Pint

Background:

- Open for 18 years in same location.
- The brewery was originally under the pub but moved down the street to a newly renovated building approx ¼ mile away a few years ago.
- Alden does not own the building; Jane Realty LLC owns the building.
- Began opening at 4 and just served dinner/after dinner. 4 years ago began serving lunch as well.
- Founding focus: Triple bottom line.
    - Financial
    - Community
    - Lower env impact.
- Food was merely a platform for encouraging sustainability. More important than making money.
    - "What can I do as a business owner to influence the community to use less fossil fuels?"

Current:

- Seat 65 in their dining room, would be happy to double that in their existing location.
- Traffic:
    - Serve ~200 people a day.
    - 150 is a good night.
    - 250 is a VERY good night.

    - Could possibly expand lunch/late evening traffic as most customers come in around dinner time and they are usually full during this period. But this is not a priority.
- Don't spend much on advertising relying instead on returning customers and word of mouth to bring in new customers.
- Brewery sells beer across the state.
- They don't buy wholesale/individually wrapped things to minimize non-compostable waste.
- Bike Program:
    - Encourages people to bike, offers gift cards as rewards.
    - Also involved with Mass Bike to facilitate biking by making roads safer.

Potential Project Focuses

Key Concerns:

- What can we do from our vantage point?
- What can we do from Worcester?
- What would we like to do?
- Suggestions/advice may be difficult from a distance.
- Not interested in an advertising campaign.

Environmental Footprint: Are they as sustainable as desired?

- What impact the bike program has.
- Analyze practices and find alternatives.
    - Eg. paper vs. cloth napkins
- Discovering ways to reduce their energy consumption.

Community Involvement: How can they encourage others to go green?

- Want to promote what they do to lower their environmental impact and why it is important.
- Trying to promote bicycling.
- Social impact events: workshops, discussions, coalitions, about environmental sustainability
    - Is a business a good platform for this kind of change?
    - Does this benefit the business?
    - Does it work in your community?
        - Has to start Greenfield specific, then expand. Effects radiate.

Data and Details Discussed

Energy Used on Site:

- Use gas for the ovens and the brewery.
- Use lots of hot water, want to reduce that.

Composting:

- Generate 20-35 gallon buckets of organic waste a week, or ~500 lbs a week, which is either composted or fed to chickens or pigs on local farms. 216 tons of organic matter has been kept out of the waste stream this way.
- Brewery waste is fed to goats on a farm ~8 miles away.
- $120 per month to take away organic waste vs. $150 per month to remove regular waste. Have saved ~$30,000 by composting.
- Question posed: How does this help landfills?

<u>Free Air System</u>

- Pulls in cold air from the outside during the winter into the walk in coolers. Automatically shuts off compressors and pulls in outdoor air when it gets cold enough.
- It was expensive, more than $10,000 in install, but there were incentives from the energy company Western Massachusetts Electric(now Eversource).
    - Western MA Electric provided The People's Pint with a loan to cover the cost of the system and the install. Payments are taken out of the pub's electric bill, which hasn't been reduced to reflect the energy saved by the system, thus allowing them to pay it off without adding a separate bill. Once the loan has been paid off the electric bill will begin to reflect the savings.
- Because it is cold enough to trip the system ~6 months a year the system has reduced energy used by ~30%, saving ~$5,400 per year.

<u>Visit #2 Notes</u>

During the visit, Kaija and I sat down and asked Alden our questions. We also went through energy bills and took pictures of them and measured the dimensions of the building.

All information is based on the People's Pint Pub, not the associated brewery.

- Heating Source:
    - Natural gas
    - Blown air furnace
- Vehicles:
    - Pickup truck: used to move compost, have someone else that comes and picks most of it up now.
    - Truck: 6 cyl Chevy express.a
        - Once a week for beer in Greenfield and Springfield.
        - Biweekly to Boston on Rte 2.
        - Self distribute beer.
        - 22/23 MPG
- Don't own the building.
    - Looked into photovoltaic cells but there were problems with the grid on that block.

        - Double grid that makes returning unused solar E difficult.
- Purchasing:
    - Buy in bulk to reduce wasted packaging.
    - Don’t have go to different distributer, most sell both bulk and portioned, you just have to specify which you want.
    - Don’t buy saran wrap.
- Napkins:
    - Washed by Simply Diaper, in Holyoke.
        - Contact Person: Angie
        - Promote reusable diapers, TPP has run promotions with them in the past.
            - Sign up for SD, get a TPP gift card.
        - Use non-chlorine based cleaners.
    - When they did research, found that at 50 washes the cloth napkin becomes more efficient than a paper napkin.
        - Can get most napkins to last 300-400 washes.
- Bike Program:
    - More than 100,000 miles biked so far.
    - All over the country.
        - eg. Woman in Oregon records miles and then takes brother out to dinner when she visits.
- Wood:
    - Built the bar.
    - Stools with built with local wood.
    - The booths were reclaimed.
- Brewery was moved from Boston.
- Whenever possible, they buy used/reclaimed items to reduce resource consumption.

Appendix B: Carbon Calculator Images

Image A.1: American Forests' electricity consumption

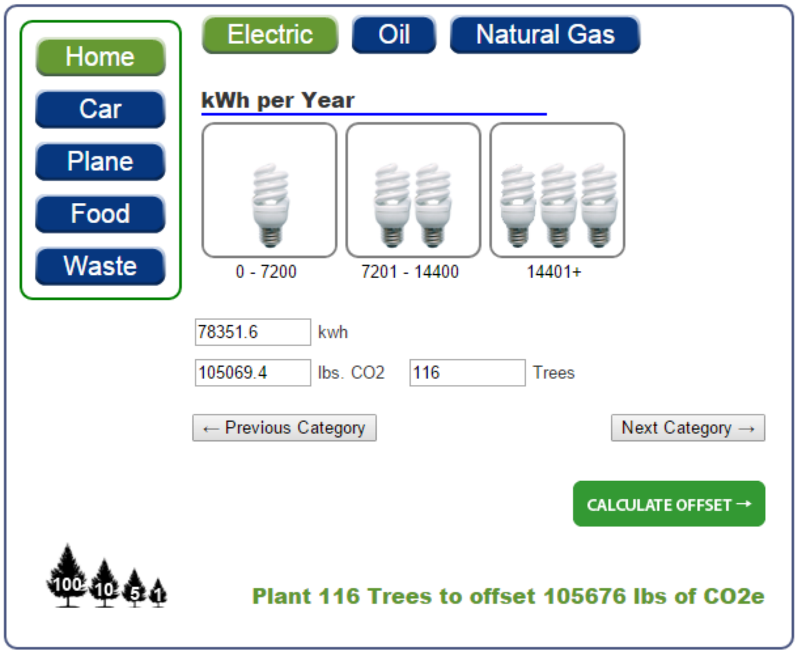


Image A.2: American Forests' oil consumption

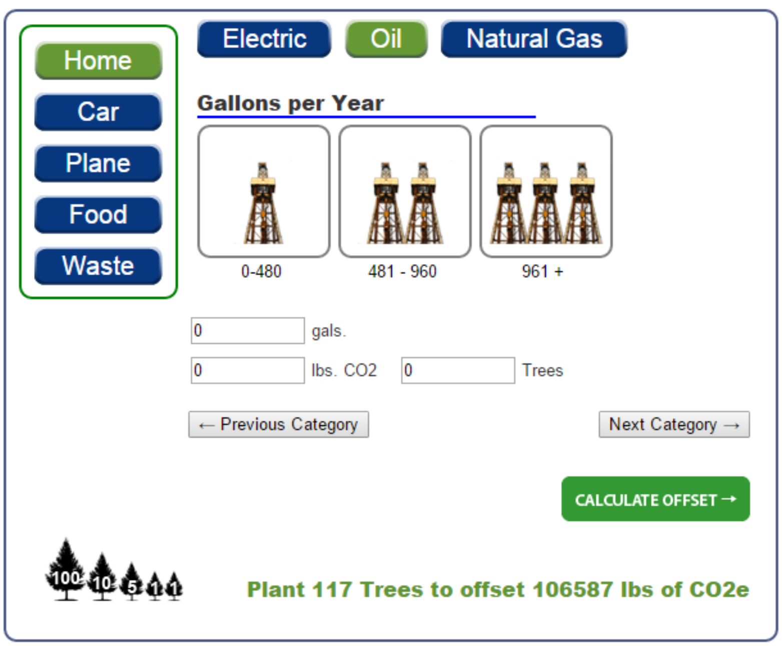


Image A.3: American Forests' natural gas consumption

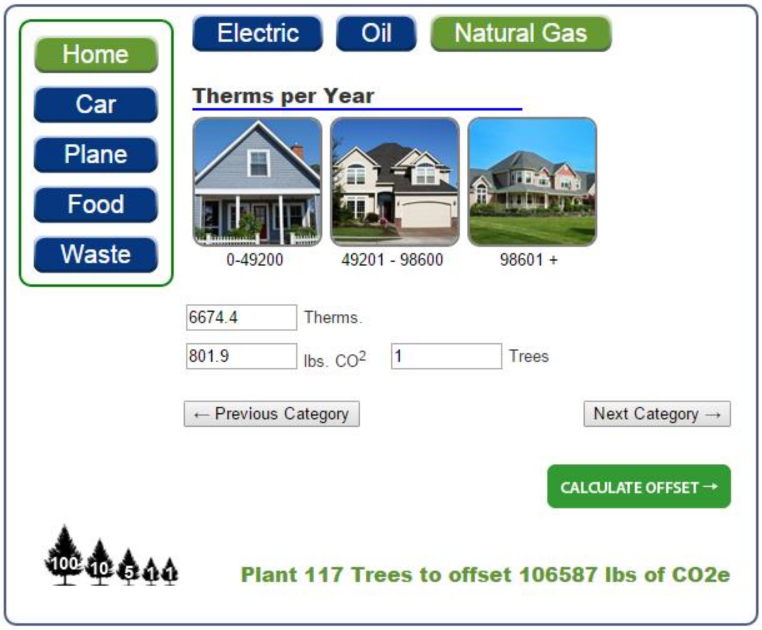


Image A.4: American Forests' vehicle travel

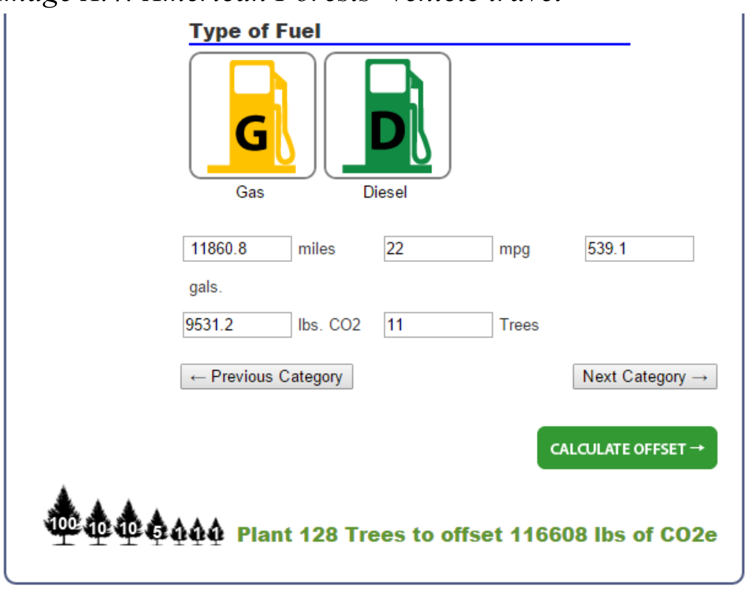


Image A.5: American Forests' air travel

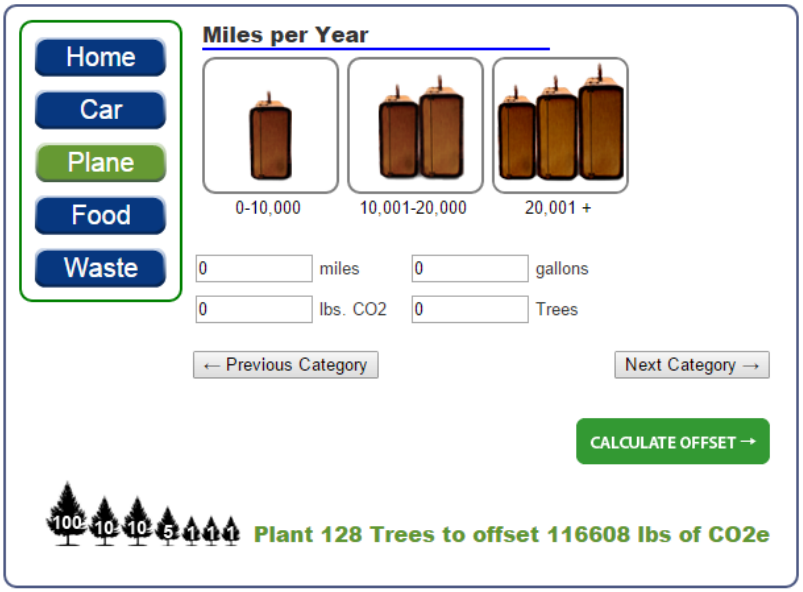


Image A.6: American Forests' meat consumption

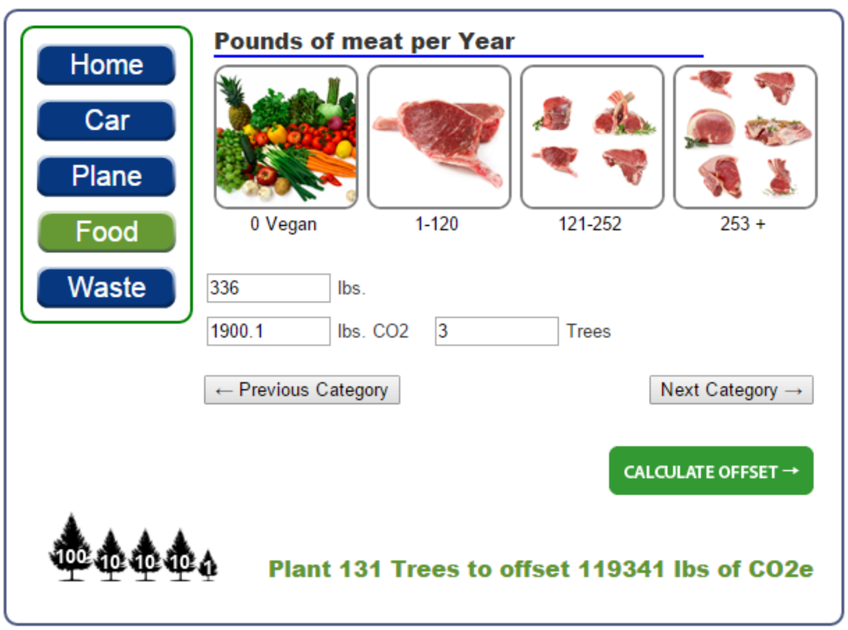


Image A.7: American Forests' waste

Image A.8: American Forests' recycling and carbon footprint

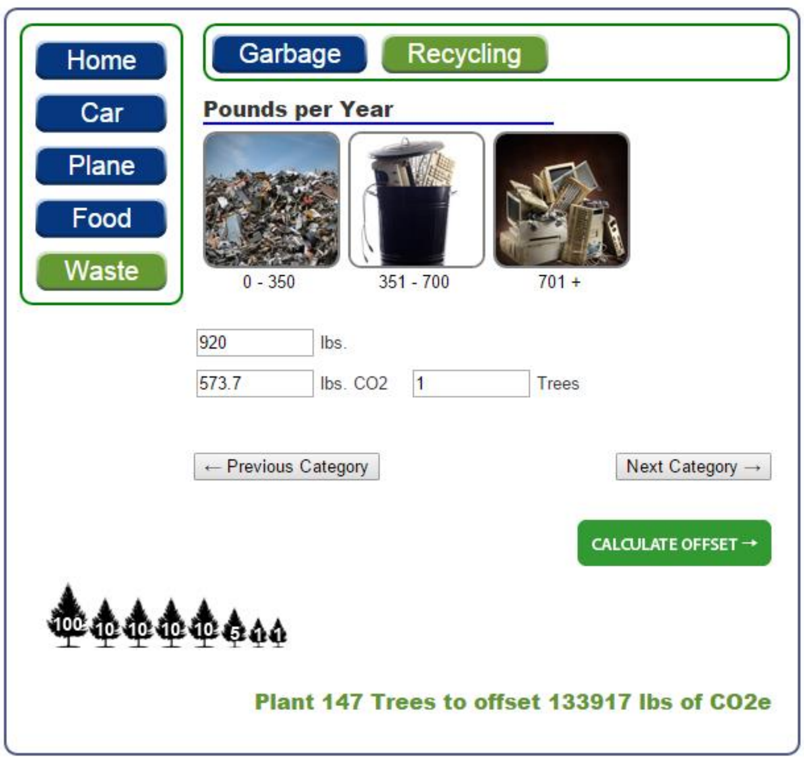


Image B.1: Chuck Wright calculator

Auto Transportation:	Air Transportation:	Home Electric Usage:	Home Natural Gas Usage:	Home Fuel Oil Usage:
Yearly ▼ travel of 11860.8 miles, at 22 miles per gallon, burns 539.1 gallons of gasoline annually, putting 3235 pounds of carbon (about 5 lbs/gal) into our air.	Monthly ▼ travel of 0 miles via commercial airline puts about 0 pounds of carbon into our air annually.	Yearly ▼ use of 78351.6 kilowatt-hours of electricity, if your power plant generates power from Eastern Coal ▼ puts 42740 pounds of carbon into our air each year.	Yearly ▼ use of 6674.4 Therms (Or ccf - hundred cubic feet) of Natural Gas contributes 21830 pounds of carbon to our air each year.	Monthly ▼ use of 0 gallons of Fuel Oil adds 0 pounds of carbon to our air each year.

YOUR TOTAL CONTRIBUTION

Your total atmospheric carbon contribution is approximately 67810 pounds per year. That's 248600 pounds of Carbon Dioxide (CO_2). In different terms, this amounts to 7.74 pounds of carbon **per hour**, 249.8 cubic feet of CO_2 **per hour**, or 4.163 cubic feet of CO_2 **per minute**. Of course, this ignores all of the energy spent to produce all of the goods that you buy...you might want to double these numbers!

Image C.1: EPA's zip code

Image C.2: EPA's energy consumption

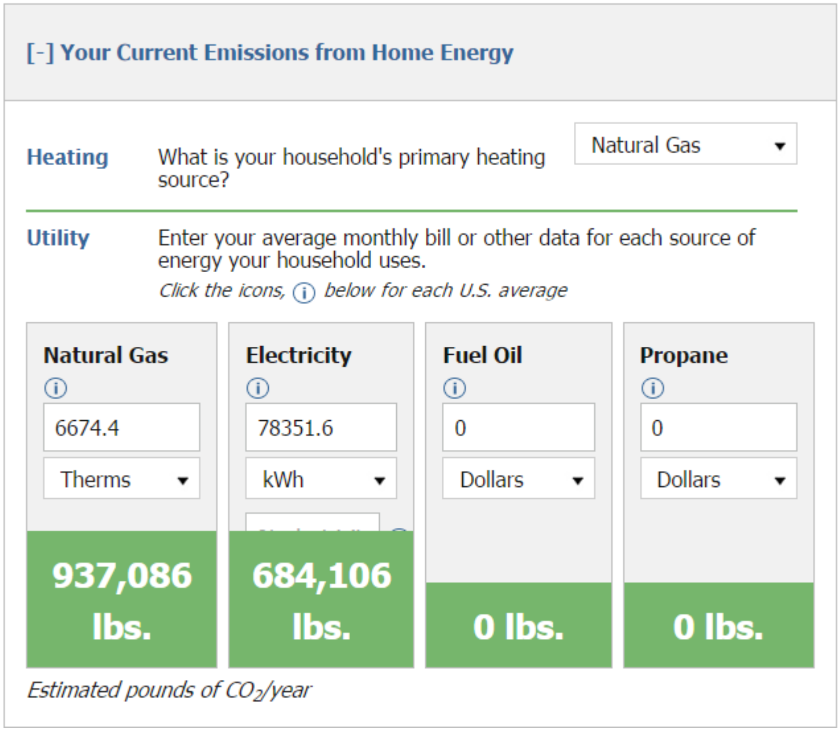


Image C.3: EPA's heating, cooling, lighting, and power source settings

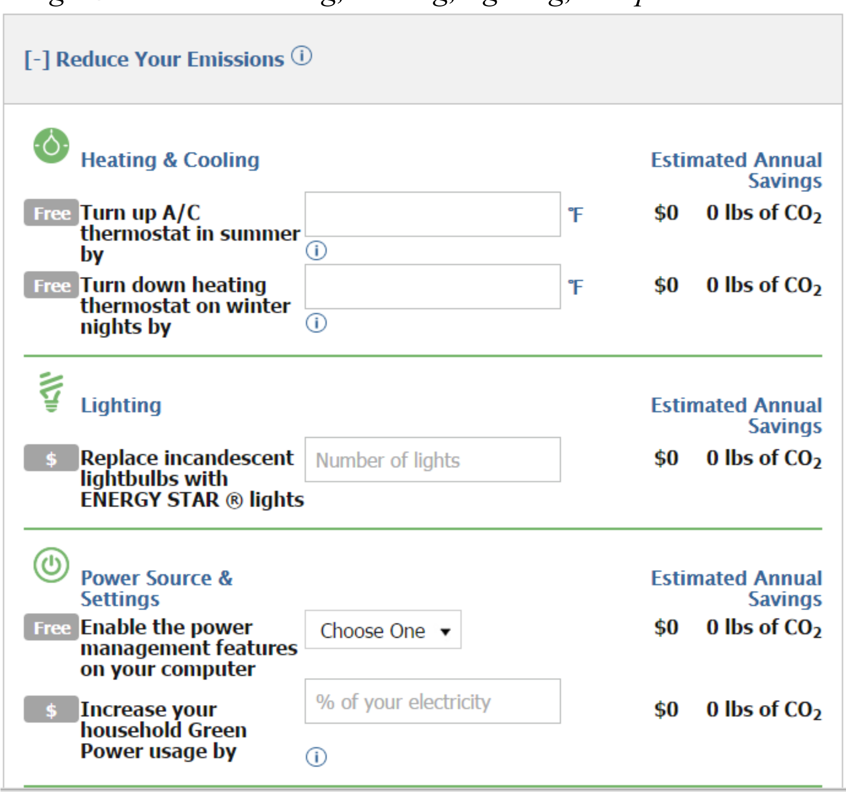


Image C.4: EPA's washing, drying, and ENERGY STAR products

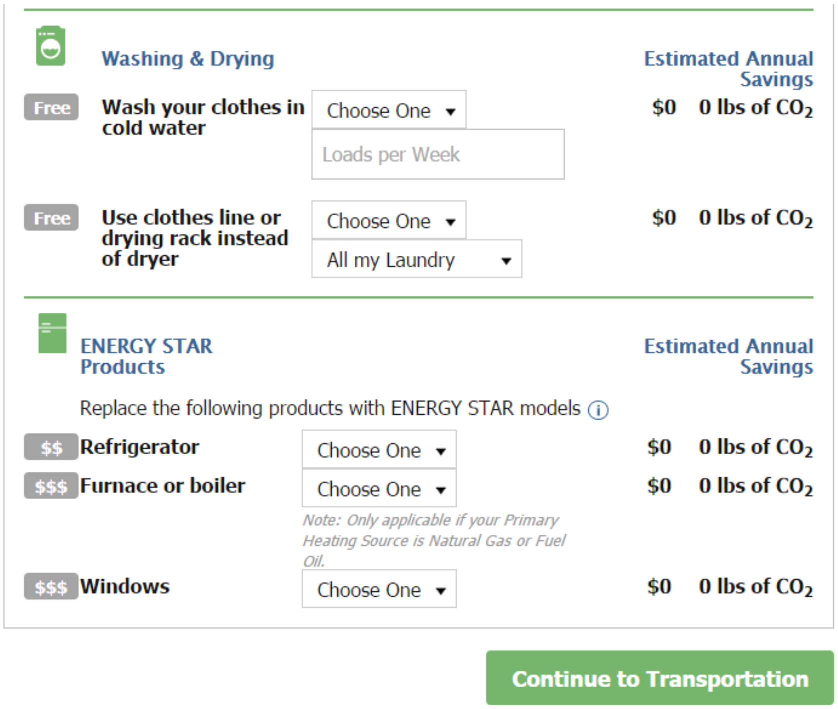


Image C.5: EPA's transportation

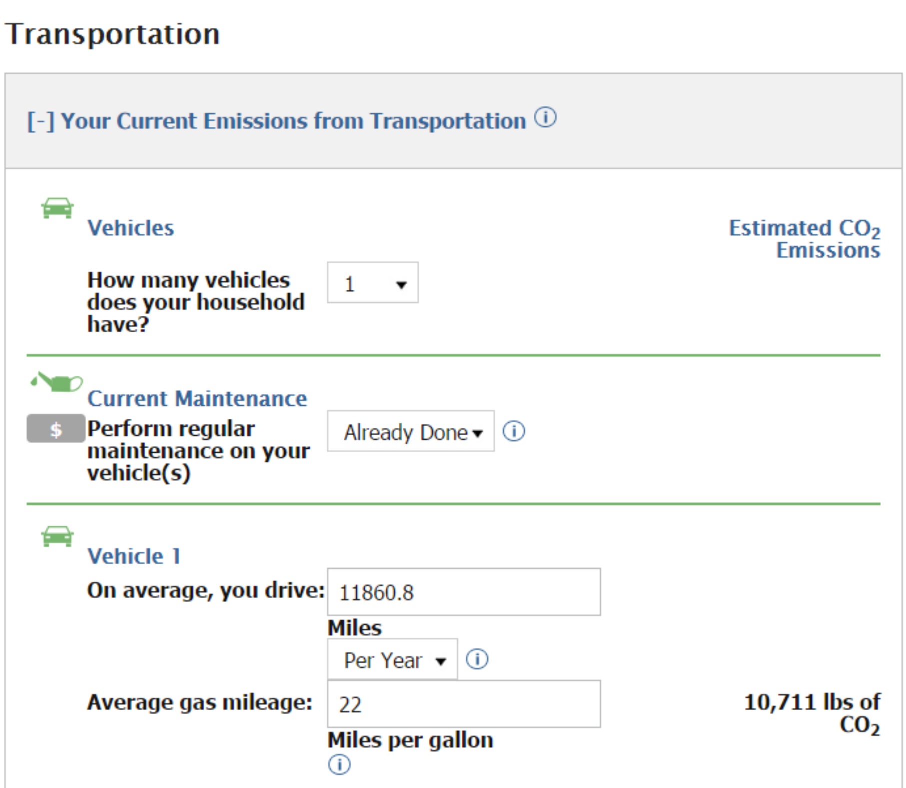


Image C.6: EPA's waste and recycling

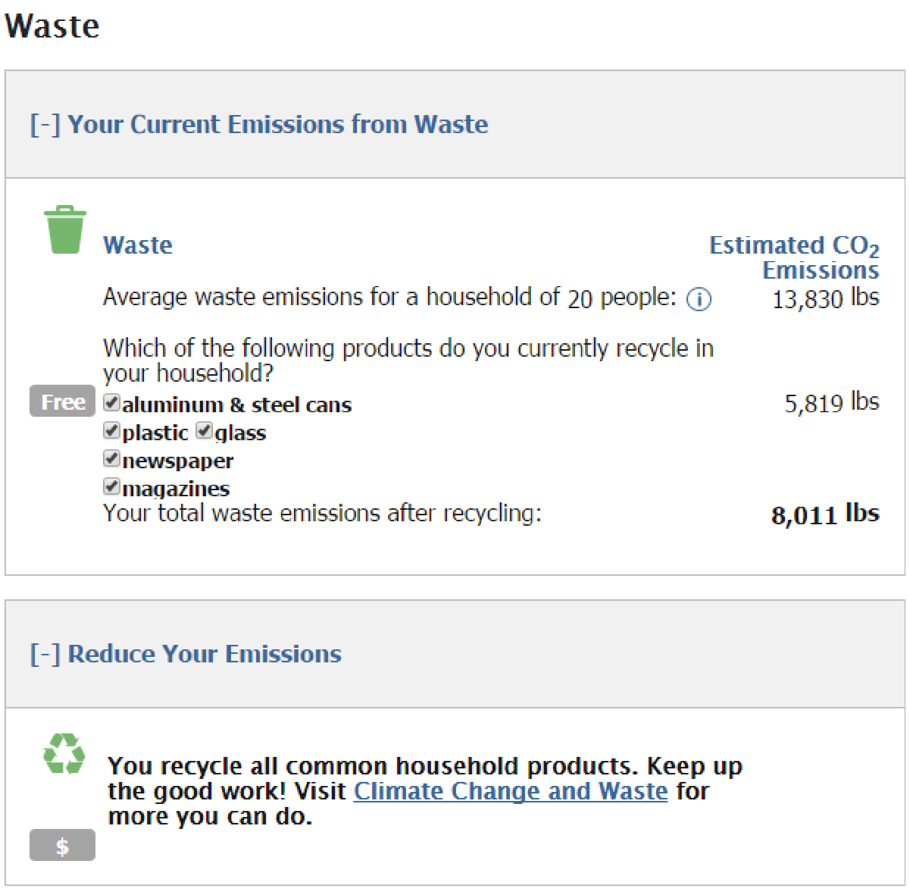


Image C.7: EPA's carbon footprint

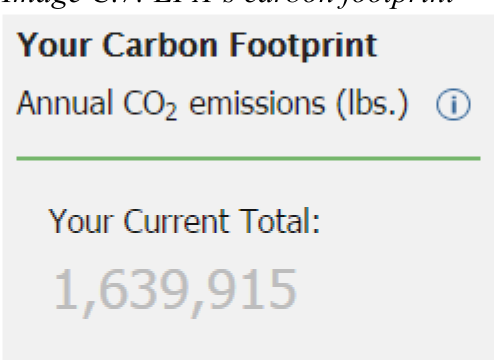


Image D.1: TerraPass' number of employees

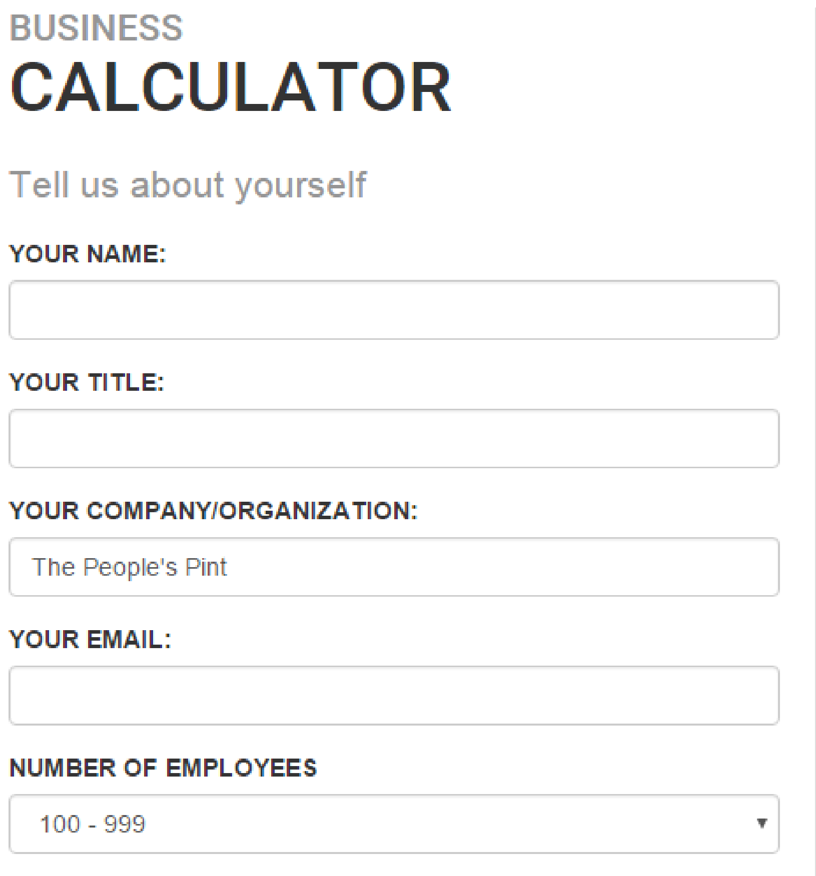


Image D.2: TerraPass' zip code

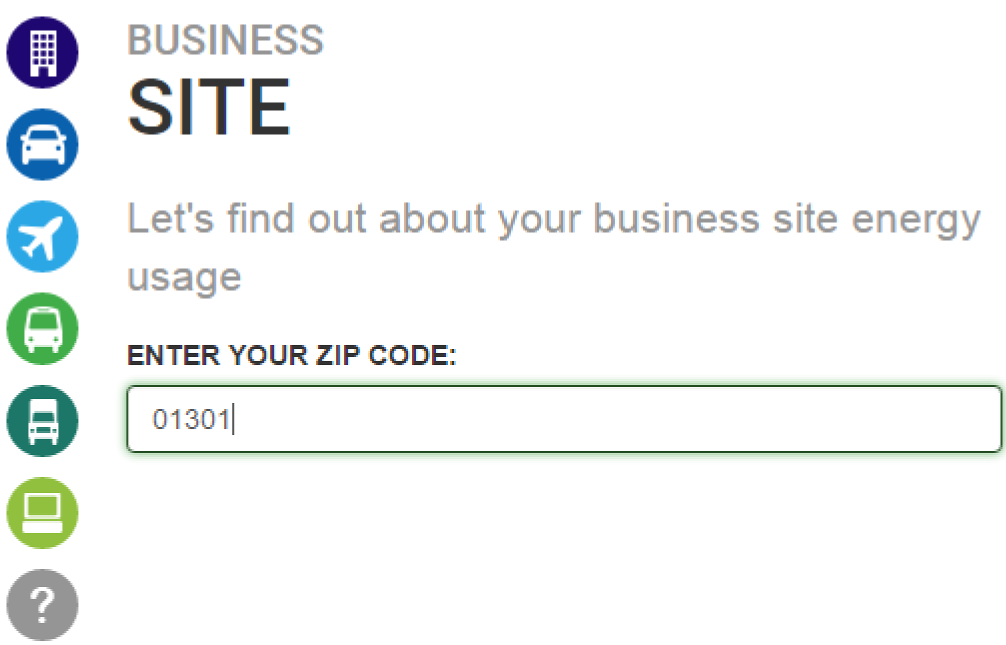


Image D.3: TerraPass' energy usage

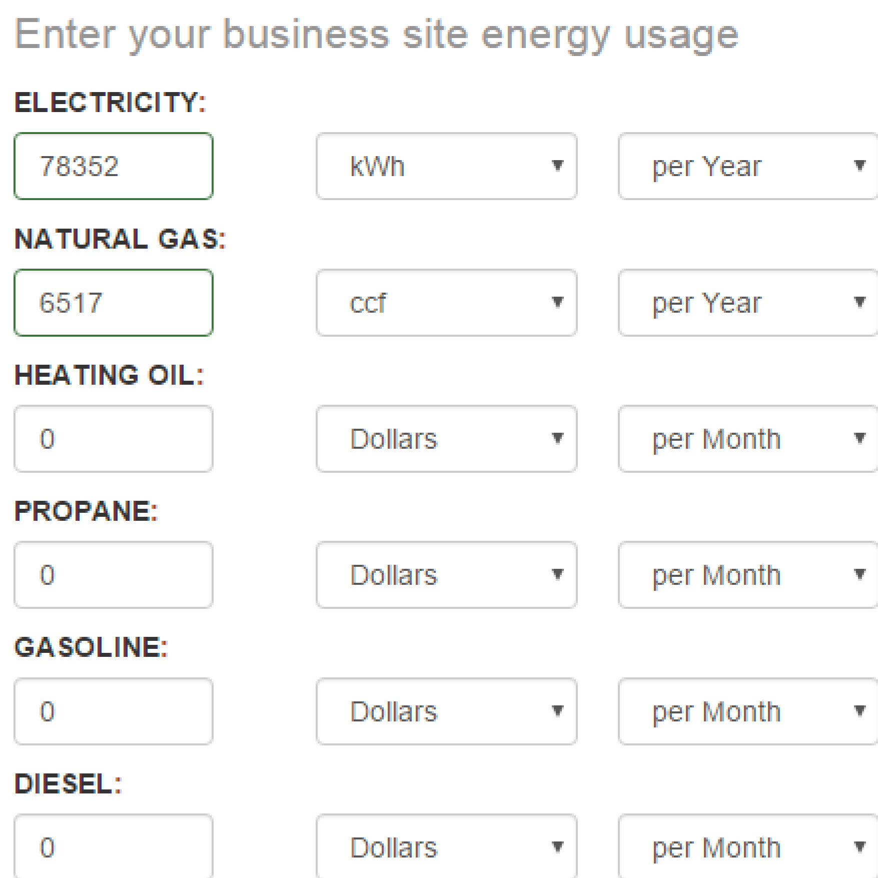


Image D.4: TerraPass' vehicle type

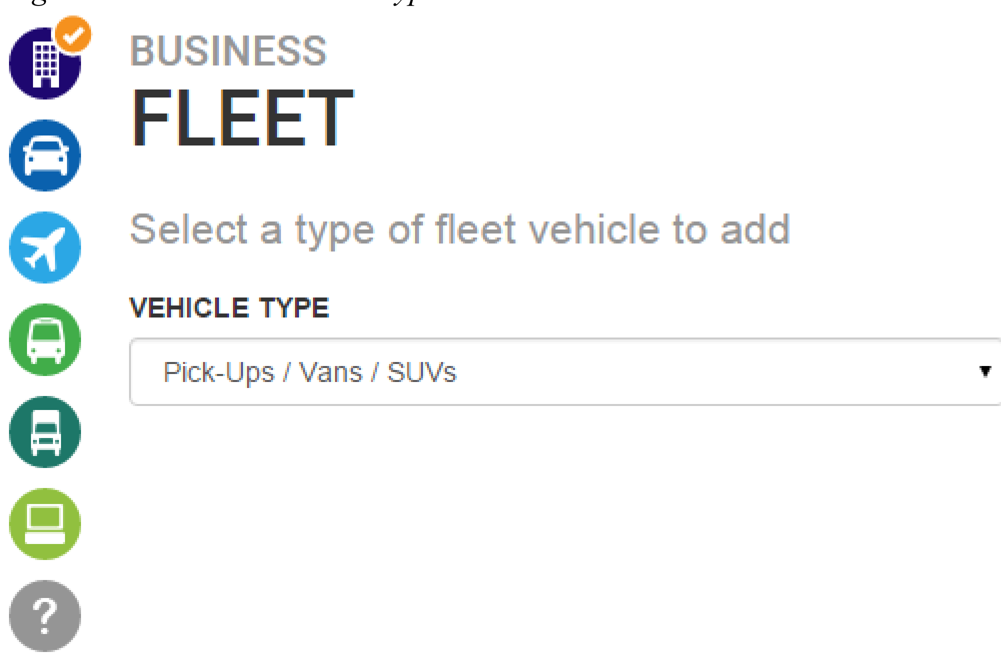


Image D.5: TerraPass' vehicle fuel type and annual mileage

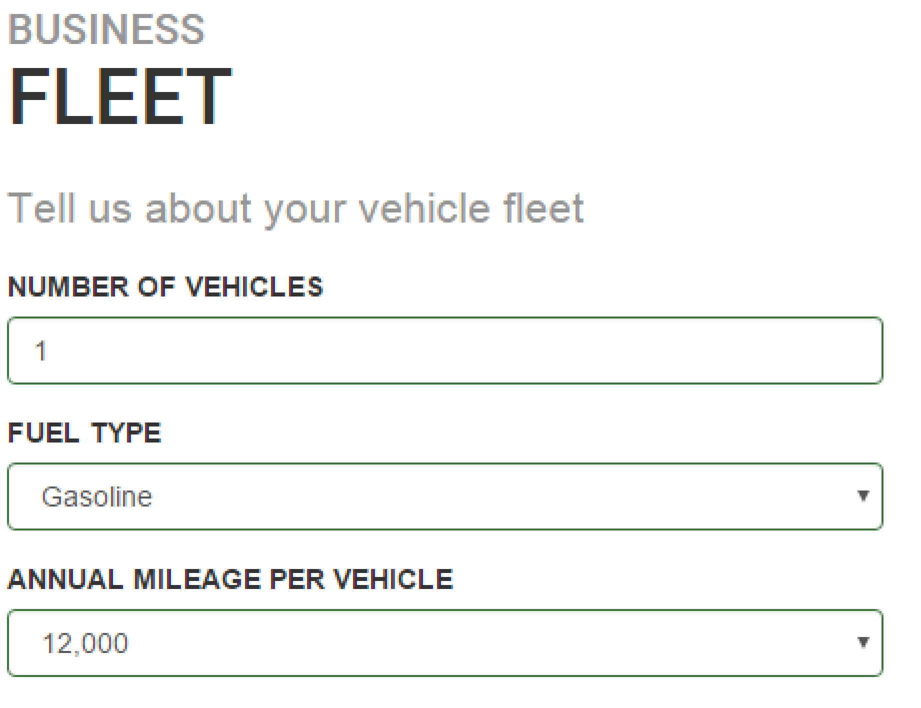


Image D.6: TerraPass' air travel

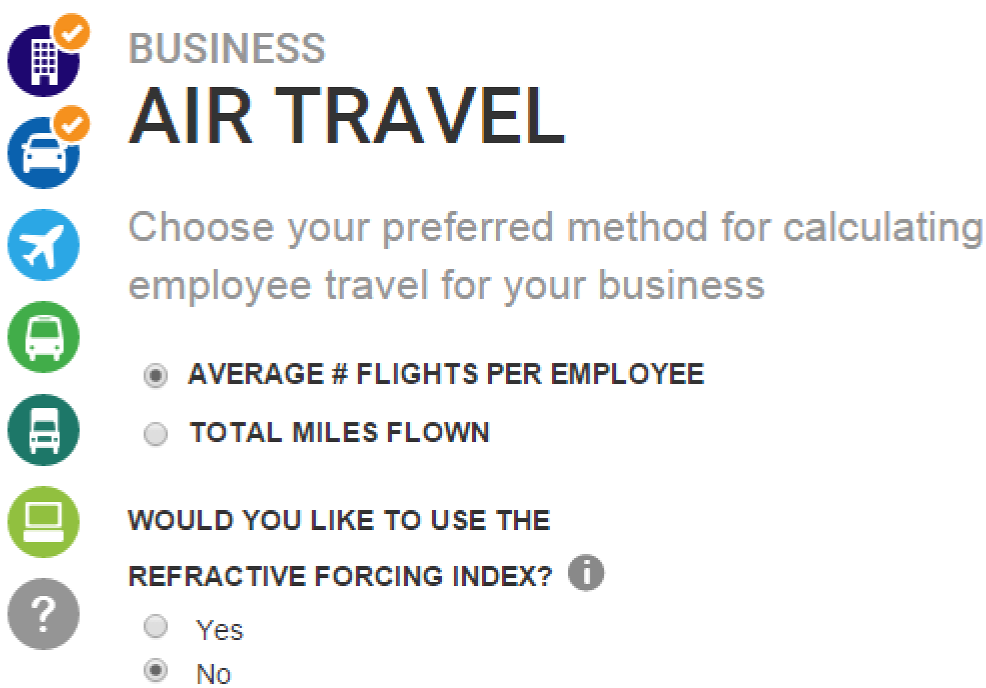


Image D.7: TerraPass' employee travel


Tell us how many employees fly and describe their average annual travel.

HOW MANY EMPLOYEES TRAVEL ANNUALLY?

0

AVERAGE NUMBER OF SHORT HAUL FLIGHTS PER EMPLOYEE (< 2 HOURS)

0

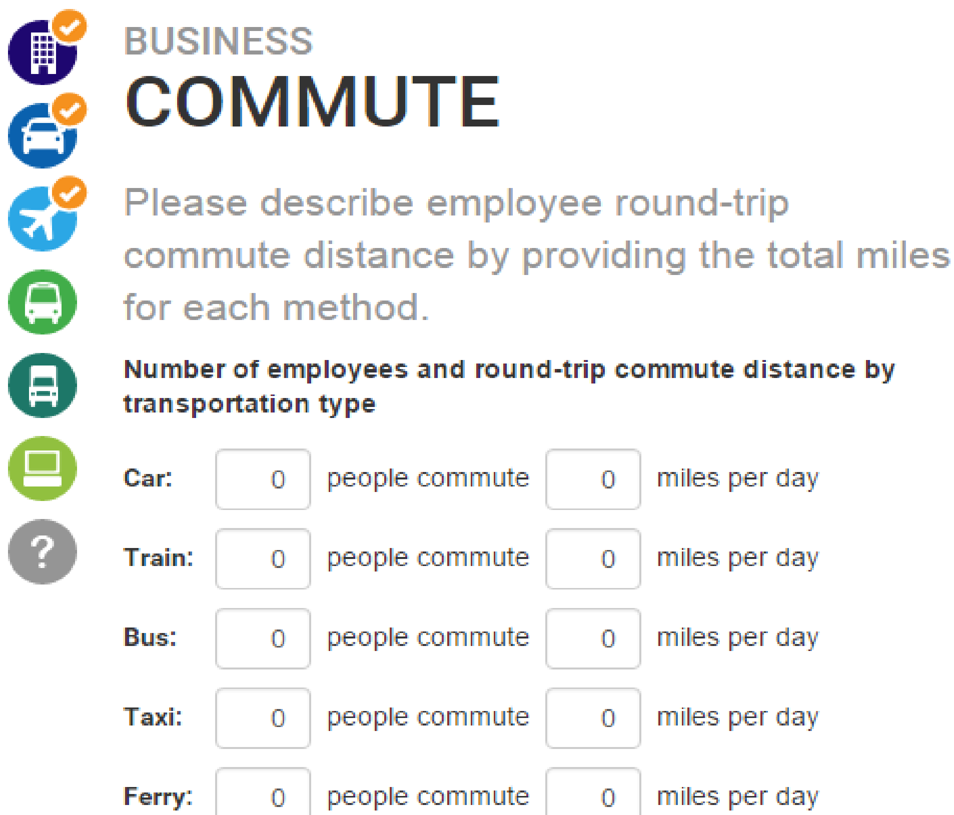
AVERAGE NUMBER OF MEDIUM HAUL FLIGHTS PER EMPLOYEE (2-4 HOURS)

0

AVERAGE NUMBER OF LONG HAUL FLIGHTS PER EMPLOYEE (> 4 HOURS)

0

Image D.8: TerraPass'


BUSINESS

COMMUTE

Please describe employee round-trip commute distance by providing the total miles for each method.

Number of employees and round-trip commute distance by transportation type

Car:	0	people commute	0	miles per day
Train:	0	people commute	0	miles per day
Bus:	0	people commute	0	miles per day
Taxi:	0	people commute	0	miles per day
Ferry:	0	people commute	0	miles per day

Image D.9: TerraPass' shipping

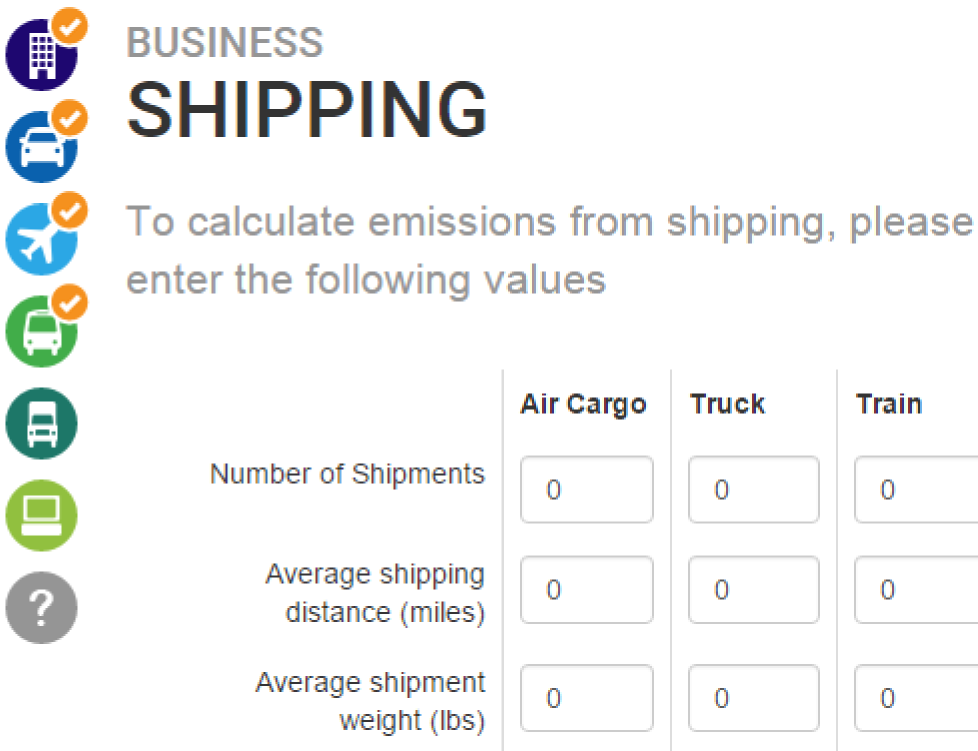


Image D.10: TerraPass' server

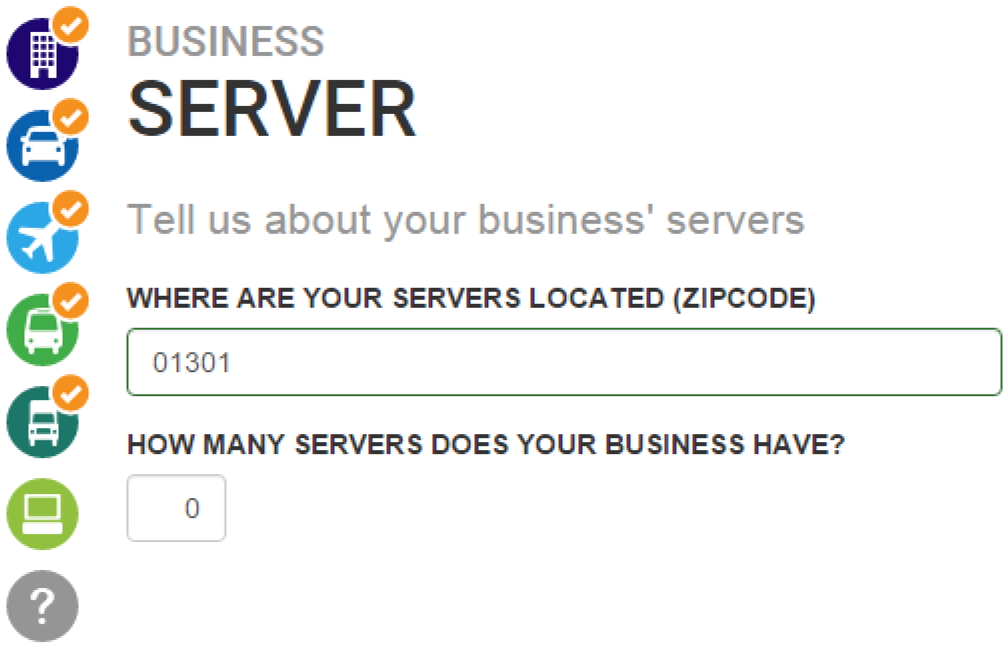


Image D.11: TerraPass' carbon footprint

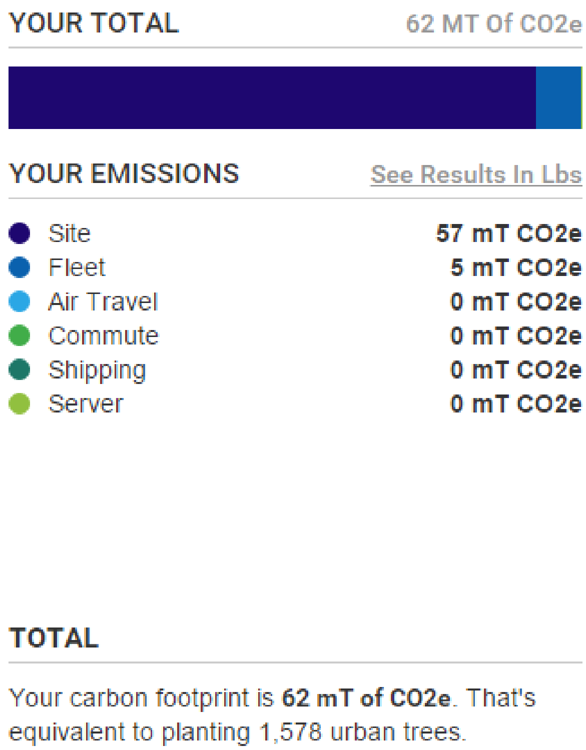


Image E.1: The Conservation Fund's home and energy consumption

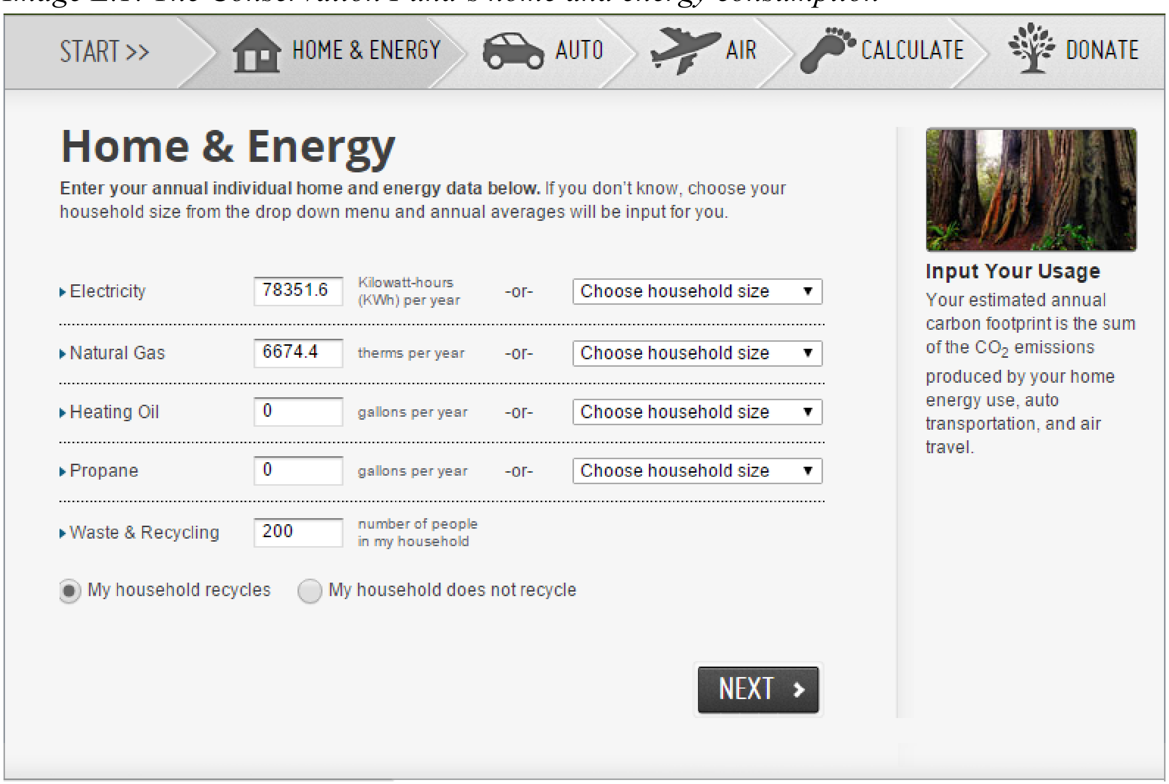


Image E.2: The Conservation Fund's auto information

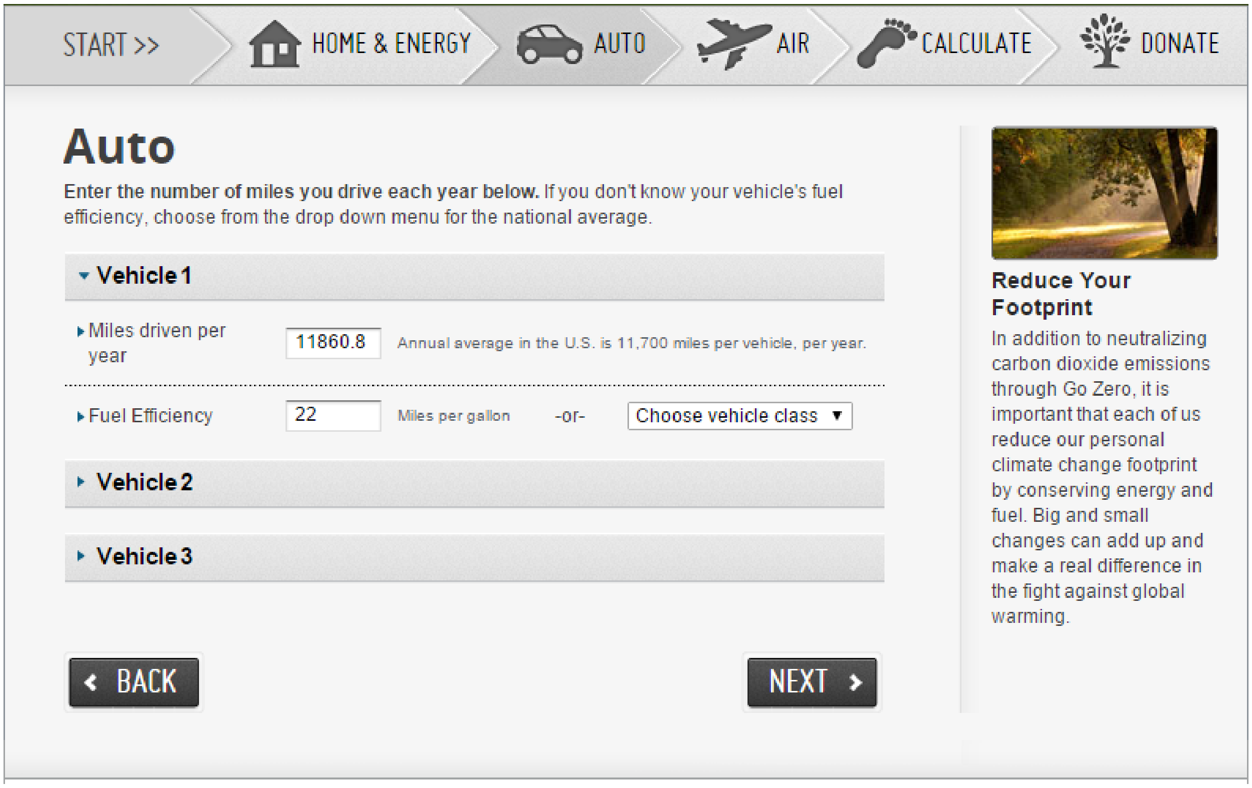


Image E.3: The Conservation Fund's air travel

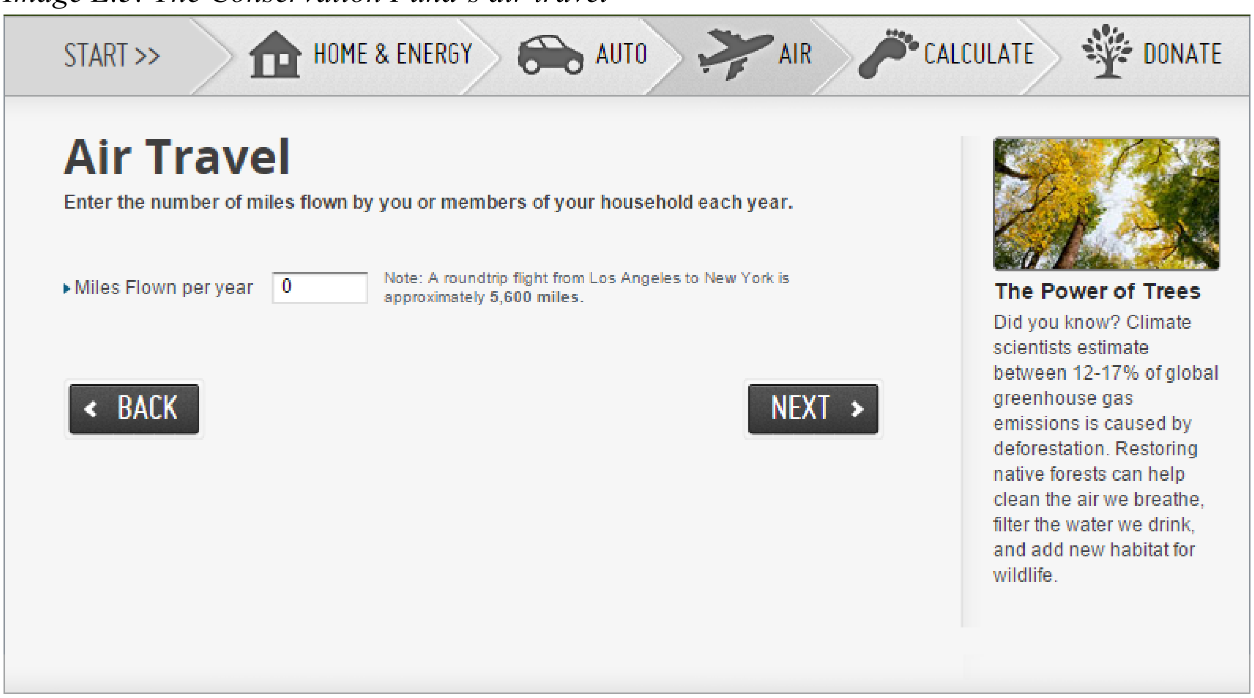
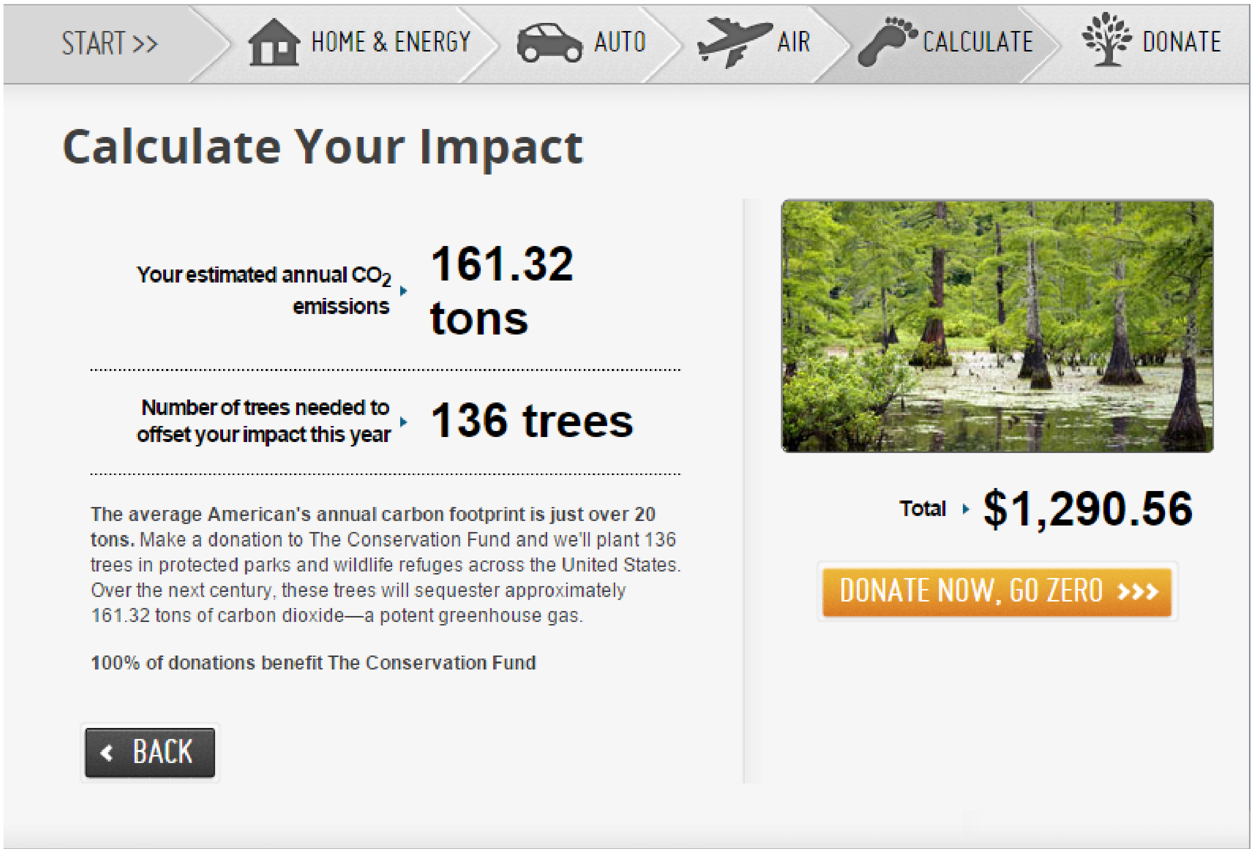


Image E.4: The Conservation Fund's carbon footprint



Appendix C: Exponent Napkin Charts

Image F.1: LCI results for the napkin systems

Table 3-11. LCI results (kg of each material) for the napkin systems

Type	Flow	Disposable (Worst)	Disposable (Mid–High)	Disposable (Mid–Low)	Disposable (Best)	Reusable (Worst)	Reusable (Mid–High)	Reusable (Mid–Low)	Reusable (Best)
Resources									
	Crude oil	0.498985	0.165358	0.017408	0.015198	0.147737	0.12197	0.074116	0.062826
	Hard coal	0.031565	0.012838	0.035356	0.037381	0.5524028	0.437773	0.270805	0.203645
	Lignite	0.036491	0.015617	0.00719	0.007603	0.1362179	0.112027	0.069142	0.056105
	Natural gas	0.290342	0.121954	0.018278	0.01913	1.2865901	0.941588	0.593181	0.412984
	Uranium	0.000224	9.67E-05	1.39E-05	1.47E-05	7.40E-05	5.59E-05	3.41E-05	2.46E-05
Emissions to Air			1.69E-07	5.42E-08	9.00E-07	9.52E-07	1.18E-05	9.00E-06	5.54E-06
	Carbon dioxide	5.947407	2.435907	0.290152	0.298647	4.9998296	3.767585	2.353802	1.695704
	Carbon monoxide	0.061234	0.026043	0.002245	0.00235	0.0025153	0.001888	0.001159	0.000841
	Nitrogen dioxide	2.09E-07	8.95E-08	3.56E-08	3.77E-08	2.39E-06	1.75E-06	1.05E-06	6.99E-07
	Nitrogen oxides	0.000121	5.21E-05	1.98E-06	2.10E-06	3.20E-05	2.40E-05	1.52E-05	1.33E-05
	Sulphur hexafluoride	7.33E-13	3.12E-13	2.33E-13	2.46E-13	2.98E-12	2.29E-12	1.40E-12	1.01E-12
	Dust (PM2.5–PM10)	0.001916	0.000825	0.000235	0.000249	0.0003217	0.000237	0.00015	0.000101
Emissions to Water			1.35E-06	5.71E-07	3.12E-07	3.30E-07	3.91E-05	3.78E-05	2.37E-05
	Ammonia	0.011935	0.005142	0.000216	0.000227	1.65E-03	0.001148	0.000697	0.000493
	Nitrate	3.63E-05	1.57E-05	5.65E-06	5.99E-06	1.56E-04	0.000101	5.81E-05	2.85E-05
	Phosphorus	0.498985	0.165358	0.017408	0.015198	0.147737	0.12197	0.074116	0.062826

Image F.2: LCA results for the napkin systems

Table 3. Napkin LCA results

	Units	Disposable (Best)	Disposable (Mid–Low)	Disposable (Mid–High)	Disposable (Worst)	Reusable (Best)	Reusable (Mid–Low)	Reusable (Mid–High)	Reusable (Worst)
Acidification	kg SO_2 eq.	0.199672	0.393618	2.192283	5.097829	0.29866	0.375982	0.603508	0.750186
Eutrophication	kg Nitrogen eq.	6.21E-04	6.21E-04	6.08E-03	1.41E-02	1.18E-03	1.58E-03	2.60E-03	3.39E-03
Global Warming	kg CO_2 eq.	1.30249	2.098093	6.685911	15.79989	1.793988	2.486705	3.980989	5.283447
Ozone Depletion	kg CFC-11 eq.	7.30E-09	1.57E-08	3.87E-08	8.96E-08	1.34E-09	1.49E-09	2.38E-09	2.64E-09
Primary Energy	MJ	10.03332	20.29294	122.9092	289.3114	30.34069	41.50548	66.30406	87.69368
Smog Creation	kg O_3 eq.	0.050612	0.07826	0.434996	1.013536	0.071859	0.093807	0.150755	0.192318