

Applications of Environmental Modeling in the Financial Services Sector

Addressing the gap between Americans' concern for climate change and action to reduce their personal footprints.

By Shannon Parker

Executive Summary

Currently, personal carbon footprints and environmental impact are not well understood in the United States. Existing solutions aimed at educating people about these topics are stagnant and lack personalized details to help enable meaningful action. Yet, there is a willingness among the public to live a more sustainable lifestyle. In 2020, there was a 4550% increase in Google keyword search terms for “how to live a sustainable lifestyle”⁵. Moreover, 80% of people have indicated they would be willing to change their lifestyle as much for climate change as they have for the COVID-19 pandemic²¹. This project aimed to explore the value and viability of addressing the gap between current levels of concern and action to address climate change, known as the value-action gap, by first exploring current perceptions of carbon footprinting and offsets here in the US and subsequently conducting a market sizing analysis to determine the environmental impact and market opportunity. Specifically, this project explores the application of a well-established carbon accounting method, EIO-LCA, within the financial services sector as a means of addressing the value-action gap. Findings included the potential for a 640 million MTCO₂E annual reduction within the United States and a recommended go-to-market strategy.

Note: It is important to acknowledge that the terms “carbon” and “green-house-gas (GHG)” are often used interchangeably, as they have been in this paper. When evaluating potential carbon impact, and discussing the outputs of EIO-LCA models, a “carbon intensity” is the metric ton of carbon dioxide equivalent (MTCO₂E). MTCO₂E accounts for additional GHGs and their relative impact converted to carbon equivalency.

Background

EIO-LCA Primer

This project sought to understand the value of applying an established corporate carbon accounting method, Economic Input Output-Life Cycle Assessment (EIO-LCA), to the personal carbon footprinting space. EIO-LCA “estimates the materials and energy resources required for, and the environmental emissions resulting from, activities in our economy”⁹. This means that carbon emissions, and other environmental impacts are mapped to the economic flows of a specific subset of industries. This generates relative carbon intensities of certain activities for each industry. The Environmental Protection Agency (EPA) utilizes EIO-LCA in its *US Environmentally Extended Modeling Framework*. EIO-LCA model outputs are GHG emissions intensities, and other environmental metrics, per dollar spent in an economy²⁴. This is in contrast to traditional lifecycle assessment (LCA) methods which aim to “quantify the environment impacts of a given product’ by developing relative inventories of process inputs required to produce a product¹⁷. The outputs of the model, a carbon intensity per dollar spent, makes it ideal for applications such as Scope 3 carbon accounting for corporations, because purchases can be directly evaluated by their dollar amount. Similarly, this is what made the method of particular interest for application to the financial service sector, as it could be used to directly evaluate consumer transactions. However, before discussing the potential application of EIO-LCA to the financial services sector, it is important to review how the method is currently being applied in corporate carbon accounting, and how corporate accounting solutions differ from personal carbon footprinting tools.

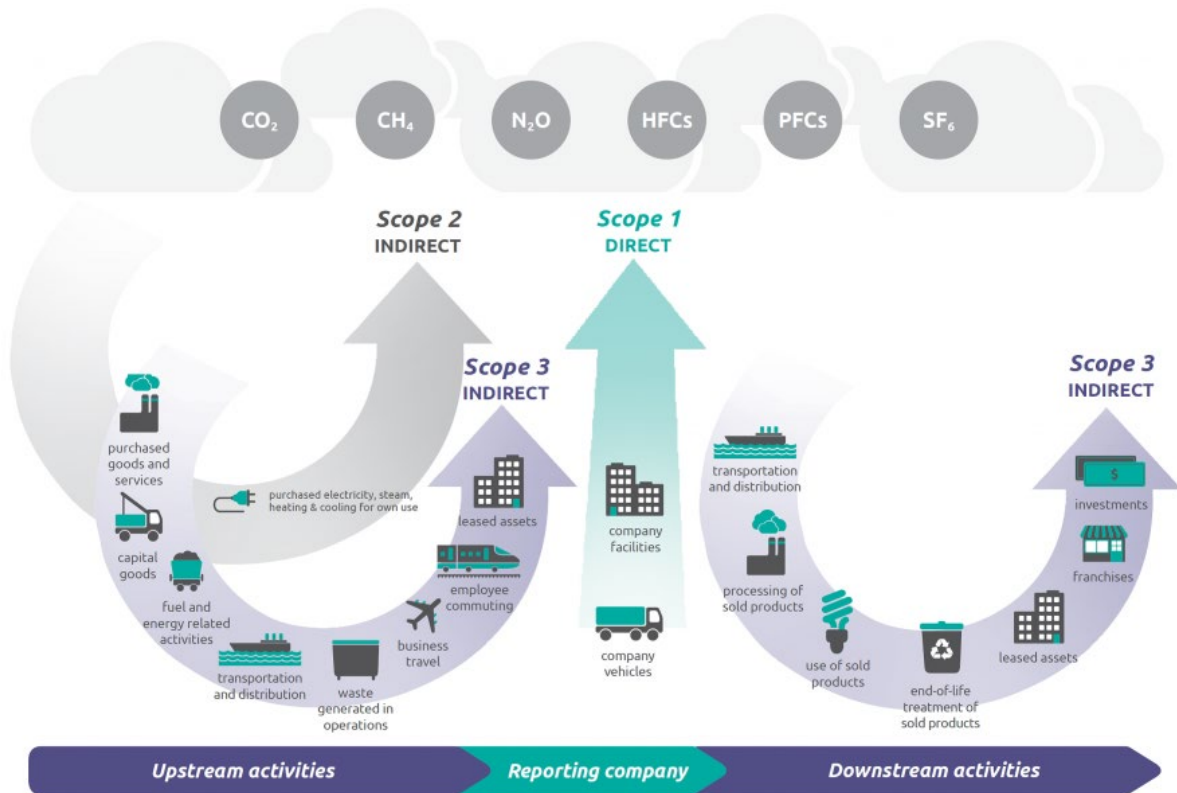
What is Carbon Accounting: Key Metrics, Corporate Accounting Methods, and Personal Footprinting

Corporate carbon accounting is the “process by which organizations quantify their GHG emissions”⁶. The corporate GHG accounting movement began approximately 20 years ago with the establishment of the GHG Protocol and the release of the first corporate standard in 2001². A growing number of organizations have since adopted the regularly revised standards as their framework for reporting GHG

emissions. Organizations such as the GHG Protocol and CDP (formerly the Carbon Disclosure Project) have become the preeminent authorities on corporate accounting and reporting, respectively. The process of carbon accounting and reporting, in accordance with the standards set by these organizations, helps companies determine their impact and set reduction targets that are ideally aligned with scientifically established carbon budgets⁶. As consumers continue to demand more sustainable solutions from brands, these standards will be critical in providing transparency on company performance in reducing environmental emissions³.

There are several methods and tools that help support companies as they establish their GHG inventories. Among the best known are Corporate Accounting and Reporting Standard and the scope-specific guidance published by the GHG Protocol. Inventories are developed by scope, one to three, to identify emissions coming from various sources of a company's operations (Figure 1). The GHG protocol states that it is uncommon for companies to directly measure their GHG emissions directly, in any scope. Most companies will instead use publicly available emissions factors that "relate to a proxy measure of activity", such as the carbon intensity per dollar spent in an industry. EIO-LCA, as a corporate carbon accounting method, provides an easy way to estimate the emissions associated with expenditures, making it an ideal candidate for evaluating Scope 3 emissions (emissions from a company's supply chain).

Figure 1: Scopes of Corporate Carbon Accounting



Source: GHG Protocol

Personal Carbon Accounting

Personal carbon footprint is similar to corporate accounting because it seeks to establish the carbon impact of actions of a single entity²⁵. Rather than this being an entire company and its supply chain however, it is the carbon footprint of a single individual or family unit. Applying a categorical evaluation, like the three scopes of corporate carbon emissions, is a useful framework for calculating carbon emissions. Historical personal carbon footprint tools tend to evaluate carbon impact across categories such as travel, home, food, and shopping²⁵. Unfortunately, existing solutions are highly manual and require significant amounts of time and data to complete. The average time to complete one of these evaluations is estimated to be 15-30 minutes, depending on the degree of data input required. One of the core questions this project sought to answer was whether the high level of effort required to

calculate one's carbon footprint was a contributing factor in the low levels of current understanding that are discussed in the next section.

Current Understanding of Carbon Footprints and Purchasing of Offsets

In addition to understanding how EIO-LCA is applied at corporations and the current state of personal carbon footprint solutions, it was vital to understand Americans' current perception of climate change and associated solutions. While Americans concern over climate change is increasing, with nearly 54% of Americans indicating they are "alarmed" or "concerned" about climate change, most Americans do not have a fundamental understanding of what an average personal carbon footprint is¹⁵. As few as 27% of Americans correctly estimated a carbon footprint of about 17 MTCO₂E per annum. Just as many (27%) of Americans also think the average American footprint was only 2 MTCO₂E¹⁸.

On top of the gap between those that are concerned about climate change and those that understand their carbon footprint, there is a gap between those that understand the scale of their carbon footprint and those taking action to reduce it, through carbon offsetting. This gap between consumers expressed preferences (their concern over climate change) and their demonstrated preferences (their action to address it) is known as the value-action gap. Carbon offsetting is best defined as the purchasing of a credit from a GHG emissions reduction project as a means of compensating for emissions elsewhere¹⁷. Markets for carbon offsets can be divided into compliance driven and voluntary carbon offsets, with the latter being the appropriate market for personal consumption. The total volume of voluntary offsets purchased has been increasing rapidly with McKinsey estimating that purchase volumes have nearly doubled between 2017 and 2020¹. Furthermore, the same study estimates that offset purchasing levels could increase 15-fold by 2030, based on 2020 levels.

Even when people do understand their carbon footprint and the actions to reduce, such as switching to a vegetarian diet, it is not possible for people to eliminate their carbon footprint. The Nature

Conservancy states that in order to limit the global temperature rise to below 2 degrees Celsius, the average individual carbon footprint needs to be lower than 2 MTCO₂E per annum²⁵. This represents a 90% reduction in the average American carbon footprint, estimated at 20 MTCO₂E by MIT in 2007⁷. One existing technology solution found they could achieve a 10% improvement in footprints with improved education and personal action, which still leaves a significant gap in the current trajectory and the reductions necessary to limit global temperature rise according to the Paris Accord¹³.

This presents an opportunity for carbon offsetting solutions to make a difference over a short period of time. Currently, only 12% of Americans have ever purchased a carbon offset, yet 51% have indicated interest in doing so¹⁸. Offset programs have been criticized for several reasons, including their role in allowing polluters to continue their degradation of the environment and their negative impact on indigenous populations⁸. However, despite these criticisms, they may remain a piece of the solution to climate change because of the sheer scale of carbon emissions reduction necessary to meet the Paris Climate Accord targets²⁰.

Improving carbon offsetting rates to meet the Paris Climate Accord targets requires addressing known barriers of carbon offsetting. It is hypothesized that overall usage of personal carbon footprinting calculators are low because of the burden place on the consumer. A consumer survey was therefore conducted to better understand the barriers to consumers understanding their own carbon footprints and the perception of existing carbon offset solutions.

Consumer Survey

Between 16 February 2020 and 12 April 2020, a survey was conducted with 96 respondents from the United States. Due to the broader topic of investigation in this project, whether applying EIO-LCA methods to the financial services sector would be *viable* and *valuable*, the survey aimed to learn more about people's current usage of financial services platforms, what is the current understanding of their

personal carbon footprint, what carbon offset solutions are, and their willingness to pay (WTP) for improved solutions. This survey was conducted via Google Forms and distributed through the authors networks. No compensation was provided to survey respondents for their time. The results can be divided into both quantitative analyses, paired t-tests, as well as qualitative feedback. The full list of survey questions and response type can be found in the Exhibit 1.

Profile of Respondents

As concern over climate change and willingness to purchase carbon offsets differs by age and other demographic traits, respondent's demographic information was collected¹⁸. Overall, the age of respondents ranged from 19 to 96 with an average age of 36 and a median age of 29. 33 (34.4%) of respondents identified as male while 62 (64.5%) identified as female, with one respondent choosing not to disclose. The majority of respondents (77%; n=74) self-identified as White. 10% of respondents (n=10) identified as Asian, 4% (n=4) identified as Hispanic or Latinx. Black and African American as well as Middle Eastern perspectives were underrepresented with only 1% of respondents each. The remainder of respondents (5%, n=5) identified as two or more races and one respondent chose note to disclose.

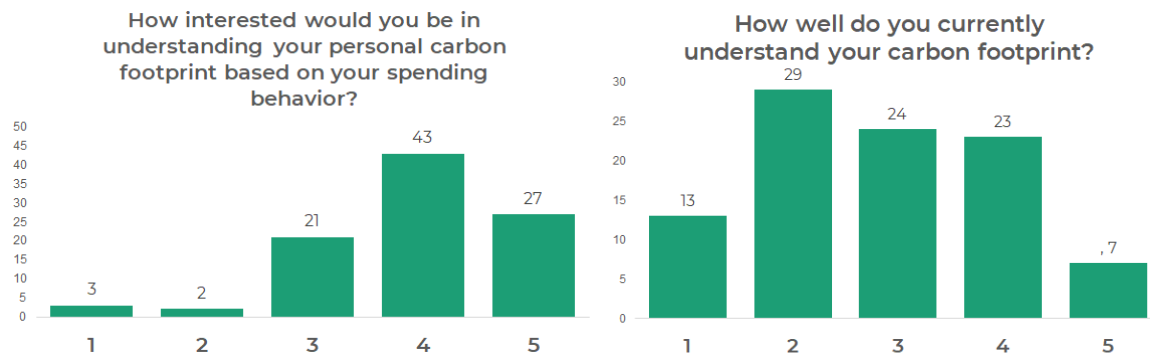
Respondent's geographical residence was varied with the highest proportion (30%) residing in the South Atlantic region (regions were defined by the current US Census regions²⁴). A high number of respondents also came from the Mountain, Pacific, and New England regions (Exhibit 2). While the primary aim of this study was to understand the perceptions of carbon footprint and offsets here in the United States, three respondents indicated they were currently residing outside of the US, however, their responses were not excluded from this analysis.

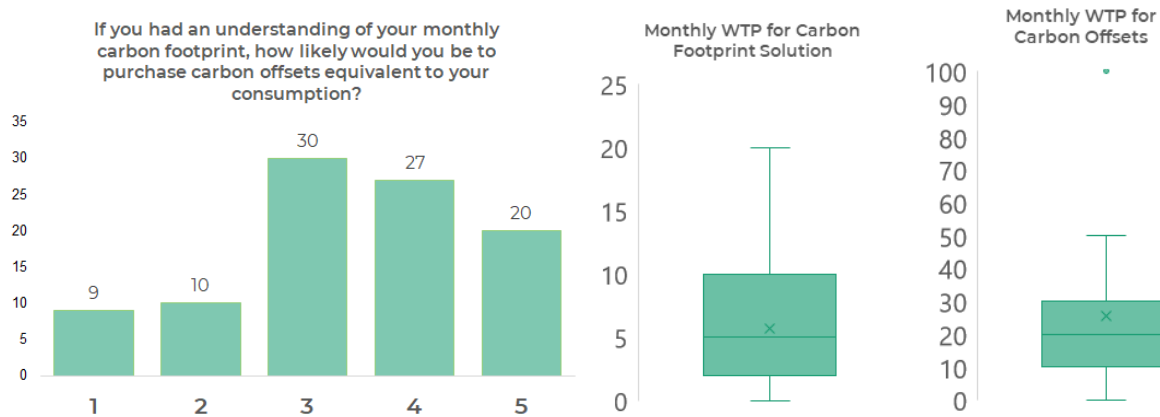
Selected Results

On average, the respondents indicated a 2.8 (SD=1.2) on a five-point scale when answering how well they currently understood their carbon footprint. There was no significant difference based on gender for current level of understanding of their carbon footprint, $t(95) = -0.4, p = 0.34$. This is in contrast with an average of 3.9 when they were asked about their interest in understanding their carbon footprint based on their spending behavior. These results are significant using a paired t-test at a 95% confidence interval, indicating that respondents were truly interested in understanding their carbon footprint at a higher level than they currently do.

When respondents were asked about their willingness to pay (WTP) for a solution that simplified carbon offsets, they indicated a wide range [0,20] per month with an average WTP of \$5.69 (SD=4.71). When asked about their WTP for carbon offsets, the range was even more significant [0,100] with a mean of \$25.40 (SD=27.64).

Figure 3: Selected Results from Consumer Survey

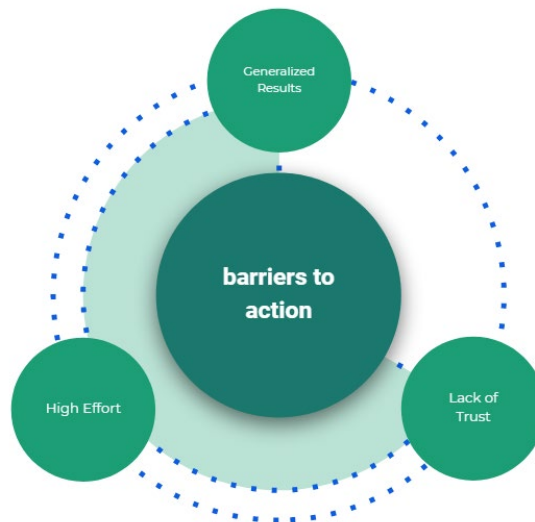




Qualitative Feedback

In addition to the quantitative results from the consumer survey, respondents also shared qualitative data regarding their perceived barriers to both understanding and offsetting their carbon footprint. These qualitative statements were classified into different categories of barriers with the three primary barriers being reflected in Figure 3.

Figure 4: Triad of Barriers to Action



Respondents stated the amount of effort that was required by existing solutions, both in the form of data aggregation and input, as a barrier to their current utilization of existing tools. Furthermore,

respondents indicated a frustration with generalized responses that resulted from these tools, even when an effort was made to provide specific data. Finally, in part due to the lack of specificity of the results, respondents indicated that they did not trust the results of current carbon footprint calculators. Trust was also the barrier that was most frequently mentioned when respondents were asked what they saw as the greatest barrier to purchasing carbon offsets, however, this was a lack of trust around the carbon offset providers, rather than the metrics themselves.

Survey Limitations

This survey had clear limitations including the small number of respondents, and a lack of racial diversity and geographic diversity. It is possible that this is the result of network effects driven by the distribution of the survey through authors networks, rather than a randomized survey platform. Because of these limitations, it is difficult to generalize the findings to the broader US population as it may not be representative of the underlying population.

Environmental Impact Analysis

Based on the consumer survey findings, there is both a significant interest and an adequate WTP for improved carbon accounting and offsetting solutions among end consumers. Current market conditions show it would cost between \$80-\$200 to offset the average American's carbon footprint. Extrapolating respondents WTP average *monthly* WTP for carbon offsets of \$25.40 to an *annual* value (\$304.80), respondents WTP was more than adequate to completely offset their footprints. In fact, respondents in the lowest quartile, with a monthly WTP between \$2 and \$5 would still be able to offset 12-30% of their carbon footprint, when using a conservative estimate for annual offset costs (\$200). Though respondents were not asked if they currently purchase offsets, any uncaptured WTP represents both an opportunity for both positive environmental impact and a business opportunity.

Market Sizing

To understand the value of capturing this WTP, a market sizing analysis was conducted to determine the total carbon mitigation that could be reasonably achieved from mobilizing additional individuals to address their carbon footprint. To do so, the total addressable market was calculated at approximately 88 million people or 27% of the US population. This subset of the population was chosen based on their age (ranging from 25-54) and their income (>\$70,000) as previous studies have shown these demographics to be among the most interested in purchasing offsets¹¹. From here, the serviceable available market of 64 million adults was determined by applying a 73% consumer adoption rate, as determined from the proportion of survey respondents who both had a high interest (4 or 5 out of 5) and WTP high enough to offset the average annual American carbon footprint. Finally, the serviceable obtainable market (SOM) of 32 million people was determined by applying a potential bias factor of 50%, to conservatively account for any bias that may have been introduced by the survey, including those discussed in the limitations section. This SOM is aligned with current research which demonstrates that while currently, only 12% of Americans have purchased a current offset, over 50% are interested in doing so¹¹. Actual carbon offset purchases will likely increase greater than 12%, however, the value-action gap phenomenon, means it is unlikely all those expressing interest in carbon offset solutions will follow through.

Figure 5: Market Sizing Summary



Environmental Impact

Using the SOM figure of 32 million Americans, a potential carbon mitigation opportunity of 640 million MTCO₂E annually was calculated by multiplying this market size by the average American carbon footprint, roughly 20 MTCO₂E. This scale of avoided emissions is approximately equivalent to the removal of 139.1 million cars from the road annually, according to the US EPA Greenhouse Gas Equivalency Calculator ²².

Discussion & Recommendations

The findings from the consumer survey and the market sizing analysis suggest innovative solutions to address the value-action gap demonstrated by Americans would be both *viable* and *valuable*. This finding is further validated by the emergence of and investment in new technologies in the carbon accounting and offset cleantech niche within the past five years (Figure 6).

Figure 6: Recent Cleantech Innovation in Carbon Accounting and Offsetting

Company	Founding Year	Maturity	Funding Raised	Business Model	Notable Partners & Investors	Primary Location
Doconomy	2018	Growth	Undisclosed	B2B & B2C*	Mastercard	Stockholm, Sweden
Meniga	2009**	Mature	51.19M	B2B		London, UK
Ecolytiq	2019	Seed	Undisclosed	B2B	Visa	Berlin, Germany
Greenly	2019	Pre-Seed	0.05M	B2B & B2C		Paris, France
Joro	2018	Seed	3.3M	B2C	Sequoia	Oakland, CA, USA
Patch	2019	Seed	5.7M	B2B		San Francisco, CA, USA
Wren	2019	Seed	1.65M	B2C	Climate Capital	San Francisco, CA, USA

* Doconomy initially launched with a B2C carbon footprint credit card and expanded offerings into the B2B space in 2020

** Meniga is a fintech and mobile banking company who recently started offering carbon footprint as a service in 2020

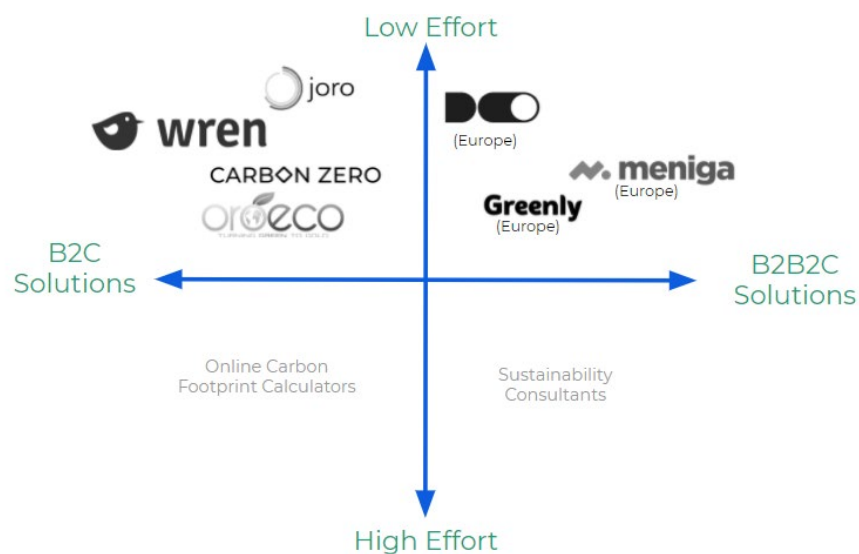
Solution Parameters

These solutions will only prove valuable if they are able to address the true pain points behind the current carbon footprinting process, as discussed in the *Qualitative Findings* of the Consumer Survey section. These pain points can be summarized by five parameters. Any solution successful in addressing the barriers to action from Figure 4 must be *easy, personalized, responsive, accurate* and *actionable*. For a solution to be easy, it must eliminate all additional effort encountered by the end consumer by eliminating manual data gathering and entry requirements. In addition to ease of use, any markedly improved solution must also be *personalized*, with results tailored to the consumers specifically lifestyle and consumption habits. These results must also be *responsive* to changes in an individual’s carbon footprint, therefore reflecting a noticeable change in a consumer’s footprint as they adapt their lifestyle to be more sustainable. A solution must also be *accurate*, incorporating the latest climate science and carbon accounting standards. Finally, any recommendations that the solution provides must be immediately *actionable* by the consumer, rather than requiring significant time or money.

Ease of Use

It appears that recent innovations within the industry are seeking to address the first two, by leveraging methods similar to EIO-LCA and applying them to financial transactions. The degree to which each of these solutions is “easy” though depends on their level of integration with existing systems in consumers lifestyle. For example, a B2C solution requiring an end consumer to sign up for a new app or account is higher effort than a solution which integrates directly with a customer’s existing bank service. This leads to the primary recommendation that services seeking to improve carbon footprinting and offsetting must integrate with systems that already capture the user’s attention. Naturally, this might mean developing a B2B service that integrates with existing banking and financial services platforms to carbon impact information automatically. In Figure 7, examples of these recent innovations were mapped on a 2 by 2 matrix according to their current business model and perceived level of effort for the end consumer. While some solutions (Doconomy, Meniga, and Greenly) are exceling in providing low-effort, integrated solutions, these solutions are currently operating in Europe, suggesting there is still an opportunity for similar innovation with the US.

Figure 7: Landscape of New-Age Carbon Footprint Solutions



* B2B = Business to Business, B2C = Business to Consumer

Personalization, Accuracy, and Responsiveness

The degree of personalization, accuracy, and responsiveness of each solution is dependent on how much data is incorporated and how frequently that data is updated. A solution which incorporates more of a consumer's transactions and specific lifestyle parameters is more personalized and accurate. Given that the average American has 2.69 credit cards, and 75% of Americans prefer paying with credit or debit cards, partnering with individual credit or debit card providers would be insufficient to represent an individual's carbon footprint in a personalized or accurate manner^{12,14}. Solutions should therefore aim to holistically evaluate consumers carbon footprints specifically through partnerships with institutions that have access to multiple credit cards, such as Mint or You Need a Budget (YNAB). In addition to incorporating as much data as possible, accuracy is aligned with how responsive the solution is, any solution that is outdated, for instance by providing carbon footprints based on older transaction data, would be neither accurate nor responsive. Instead, a solution which presents an updated carbon footprint to consumers at a more frequent cadence would be considered more responsive.

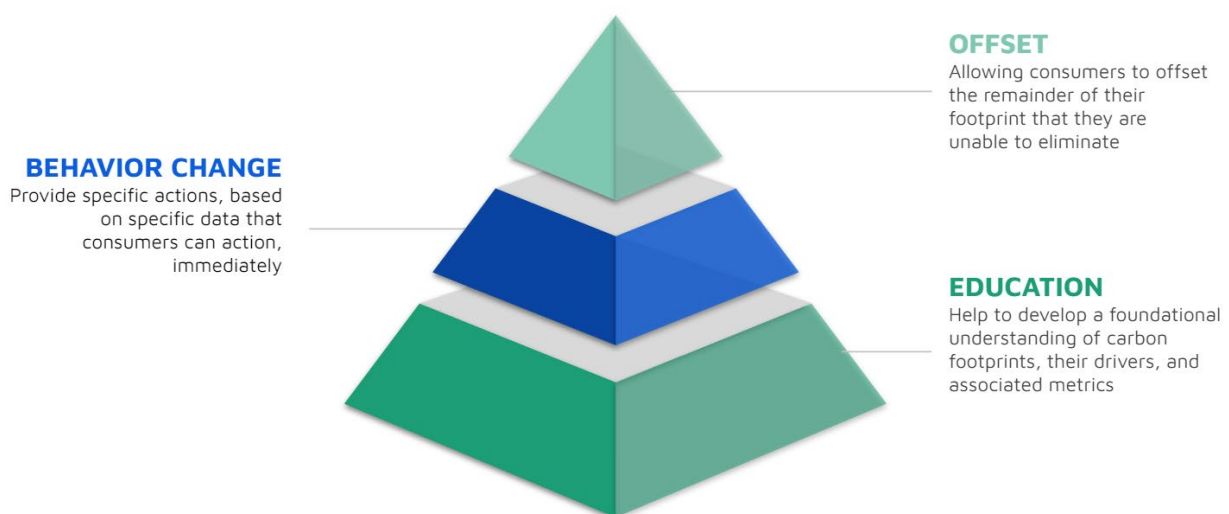
However, the frequency of an update is limited by the availability of new consumer information in the form of a new transaction, a lifestyle change, or updated science behind the carbon impact calculations. This leads to the third recommendation, that solutions should update consumers carbon footprints at the time a new transaction is received, a lifestyle habit is updated, or the climate science is changed.

The Development of Actionable Solutions for Consumers

The final solution parameter derived from the consumer survey is itself a recommendation. Any advice that is provided to the consumer, alongside the analytics of transactions, must be actionable. Existing solutions do not properly address this challenge; however, it is arguably more valuable than continuing to build out the case for carbon offsets. Carbon offsets have several challenges, as described in the background of this paper, that make them a less than ideal solution for reducing carbon footprints. In

fact, “scientists argue that companies’ first priority should be to cut actual emissions wherever possible, and only rely on offsets for the emissions that cannot be cut”, suggesting that the solution be a last resort ⁴. If similar logic is applied to the personal carbon footprinting and reduction space, it means that solutions encouraging behavior changes which prevent emissions from ever occurring, should be more highly prioritized than new offset solutions. While offsets may still play a role in climate change mitigation, they should not be relied upon by businesses, including those innovating to help end consumers. Instead, innovations to support behavior change must be developed and invested in.

Figure 8: Pyramid of proposed solutions to close the value-action gap



Future Opportunities

In addition to the potential for improved behavior change solutions in the market, there are additional opportunities to expand this type of environmental consciousness and rigor to another environmental metric. The impacts of climate change cascade into other areas of environmental science, such as water management, air quality, and biodiversity loss ¹⁰. As the effects of climate change becoming increasingly material, addressing these issues with as much vigor as has been applied to the carbon management

space will be even more critical. One benefit of EIO-LCA methodologies is that the results of these models often include metrics beyond carbon intensities. This means a new metric, such as land use or water use, could be incorporated in new innovations in a similar framework discussed in this paper.

In addition to the expansion of metrics, there is also opportunity to expand markets. Based the current landscape of solutions (Figure 7), the European market is the most mature. This paper discusses the application of EIO-LCA and the value specifically in the US, however, there remain several untapped markets where similar solutions should be investigated. Here, market entry should be prioritized both by consumer demand and potential for environmental impact, based on nationally determined contributions of carbon emissions¹⁹.

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Appendix

Exhibit 1: Consumer Survey Questions

#	Question	Response Type	Response Options
1	What is your age?	Numeric	
2	What is your gender?	Multiple Choice	Male Female Prefer Not to Say
3	What is your race?	Checkbox	American Indian or Alaska Native Asian Black or African American Native Hawaiian or Pacific Islander White Other (fill-in)
4	Where do you live?	Multiple Choice	Midwest: East North Central Midwest: East South Central Midwest: West North Central Midwest: West South Central Northeast: Middle Atlantic Northeast: New England Outside of the US South: East South Central South: South Atlantic South: West South Central West: Mountain West: Pacific
5	Do you use any financial data aggregators services?	Yes/No	Yes No
6	Which financial information aggregators, or budgeting platforms, do you use?	Checkbox	Mint Quicken Albert EveryDollar ClarityMoney Personal Capital YNAB Wally Other
7	How many times (per month) do you use or interact with the platform of your choice?	Numeric	
8	How well do you currently understand your personal carbon footprint?	5 Point Scale	1 – 5, whole numbers
9	What do you see as the biggest limitation to understanding your current footprint?	Short Answer	
10	How interested would you be in understanding your personal carbon footprint based on your spending behavior?	5 Point Scale	1 – 5, whole numbers

11	What is your maximum willingness to pay (per month) for a service that helps you understand your carbon footprint?	Numeric	
12	If you had an understanding of your monthly carbon footprint, how likely would you be to purchase carbon offsets equivalent to your consumption?	5 Point Scale	1 – 5, whole numbers
13	What do you see as the largest barrier to purchasing carbon offsets?	Short Answer	
14	What is your maximum willingness to pay (per month) to offset your carbon footprint?	Numeric	
15	Are you willing to have a further conversation regarding your responses?	Yes/No	Yes No

Exhibit 2: Consumer Survey Geographic Profile

Region	N	Mean
Midwest: East North Central	5	3.0
Midwest: East South Central	1	2.0
Midwest: West North Central	2	2.0
Midwest: West South Central	1	2.0
Northeast: Middle Atlantic	7	3.4
Northeast: New England	11	2.7
Outside of the US	3	3.3
South: East South Central	7	2.0
South: South Atlantic	29	2.8
South: West South Central	4	3.0
West: Mountain	11	2.5
West: Pacific	15	3.3