Sustainable Personal Finance Dashboard

Capstone Project Final Report

Team Members: Venkatesh Ravi & Hayford Atim
Project Advisor: Professor AnnaLee Saxenian
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Abstract

This is a sustainable personal finance dashboard project designed to help users understand the environmental impact of their spending. By integrating with Plaid, the platform retrieves real-time bank transaction data and categorizes it using merchant and transaction metadata. Each transaction is analyzed using Claude's AI, which estimates CO_2e emissions based on spending categories and inferred consumption patterns. Users receive visual insights on their carbon footprint across time and categories, empowering informed decision-making. To go a step further, this project incorporates KlimAPI to enable carbon offsetting directly within the platform. After calculating their emissions, users can seamlessly offset their footprint through certified projects, making sustainability both actionable and personal.The platform also features an AI-powered assistant that offers personalized recommendations for reducing emissions and improving financial habits. Overall, this project bridges the gap between personal finance and climate responsibility, using data-driven tools to promote sustainable living.

1. Introduction

Climate change is one of the biggest challenges of our time, and more people are trying to live in ways that are better for the planet. However, even though many care about the environment, it's not always clear how their daily choices, especially financial ones affect it. What we buy and how we spend are directly tied to carbon emissions, but most people don't see that connection.

This project is a tool designed to help close that gap. It's a personal finance dashboard that turns everyday spending into clear environmental insights. The platform connects to users' bank accounts through the Plaid API, safely pulling in transaction data. It then groups each transaction based on details like where it was made and the type of purchase. From there, Claude, a large language model (LLM), analyzes the data to estimate how much carbon emissions (CO_2e) each purchase is likely to produce.

This project helps users see their carbon footprint in easy-to-understand charts, showing trends over time and by category. But it doesn't stop at awareness. The platform also connects with

KlimAPI, so users can take action by funding climate projects like tree planting or clean energy to offset their emissions.

To make the experience even more personal, this project includes an AI assistant. Users can chat with it to ask questions like, "How can I lower my travel emissions?" or "Which of my spending habits hurt the planet most?" The assistant gives smart, tailored answers using the user's own data.

2. Problem Statement

Climate change is pushing people and communities to adopt more sustainable habits. But even though many individuals want to reduce their impact on the environment, they often lack the tools to understand how their everyday spending affects the planet. Most banks and finance apps help with budgeting and saving but do not show the environmental cost of what people buy.

Some sustainability tools do exist, but they are either too basic or too complicated. The simple ones require users to enter information manually, while the advanced ones are made for businesses, not everyday people. Personal finance apps, on the other hand, help track expenses but rarely consider the environmental side of spending. Because of this, users cannot clearly see the link between their purchases and their carbon footprint.

Many people also don't have access to ways they can take action based on their spending data. They may want to change habits, set eco-friendly goals, or support climate projects, but without clear insights or easy options, these actions often don't happen.

There is a clear need for a tool that makes environmental data more personal and easier to act on. The project fills this gap by using Plaid to connect to bank data, Claude to estimate carbon emissions, and KlimAPI to offer carbon offset options. All of this is delivered in a simple dashboard that helps users track, understand, and improve the environmental impact of their financial choices.

3. Project Objective

The main goal of the project is to build a smart personal finance dashboard that helps people understand how their spending affects the environment. The tool is designed to help users monitor their carbon footprint, get helpful insights, and take real action toward more sustainable living.

This will be done through the following key goals:

- Connect to financial data using Plaid: The platform links to users' bank accounts to pull in real-time transaction data, with full security and user permission.

- Estimate CO_2 emissions using Claude: Each transaction is analyzed using a large language model to guess what was purchased and how much carbon it likely produced. This helps turn spending data into environmental impact data.

- Offer carbon offsetting with KlimAPI: Users can choose to support real climate projects, like planting trees or funding clean energy, to balance out their emissions.

- Provide helpful AI insights: The dashboard includes a chat assistant powered by Claude that gives users tips, answers their questions (like "How can I cut emissions from travel?"), and encourages eco-friendly choices.

- Display everything in a dashboard: Users can view graphs, charts, and summaries that show their spending and emissions over time. They can also track goals and see how they compare to others.

4. Literature Review

This literature review explores the connection between personal finance and sustainability, focusing on how everyday spending habits can contribute to carbon emissions and how digital tools can help individuals make more informed, climate-conscious decisions. It draws on existing research in financial behavior, carbon footprint estimation, sustainable consumption, open banking, carbon offsetting, and conversational AI. These areas form the foundation for the project, offering insights into the technical and behavioral elements that can influence how people track, understand, and improve their environmental impact through their financial choices.

Financial Behaviors and Personal Finance Trends

Managing personal finances has long been a focus of research in consumer behavior and economics. According to Goyal et al. (2021), factors such as age, income, education, social environment, psychological attitudes, and financial literacy all influence how people manage their money. These factors can shape outcomes like financial well-being, stress levels, and the ability to plan for the future.

In recent years, technology has become an essential part of how people handle their finances. Many consumers now use mobile apps or digital platforms to track spending, make payments, and invest. In the United States, data show that over 80% of adults who use the internet have used a financial app or website in the past year. On average, users rely on two to three different apps for various needs, including budgeting, banking, and money transfers (Statista, 2023). This trend reflects how digital tools have made it easier for people to monitor their finances in real time and across multiple accounts.

Young adults, especially those from Generation Z and Millennials, are even more likely to engage with money matters through mobile apps and social platforms. For example, some use social media for peer-to-peer payments, financial education, or advice from online communities (Chawla & Joshi, 2021). While these behaviors introduce risks such as misinformation or privacy concerns, they also highlight a growing demand for accessible and engaging financial tools that fit naturally into people's daily lives.

Despite these digital advancements, many households still face serious financial challenges. Surveys from 2022 and 2023 show that about half of Americans feel stuck financially and struggle to cover basic expenses due to inflation and rising costs (FINRA, 2023). At the same time, fewer than half of the respondents report feeling optimistic about their financial future. These findings suggest that managing money effectively is just as important as income level when it comes to financial stability.

Given these patterns, there is a clear need for tools that help people better understand and control their financial lives. This project builds on this trend by offering a platform that not only helps users track spending but also brings in an environmental perspective. By adding sustainability insights to familiar finance tasks, the project aims to make the connection between money and climate impact more understandable and relevant for everyday users.

Estimating Carbon Emissions from Financial Transactions

A central part of this project is estimating how much carbon is tied to each purchase a user makes. Many recent tools and studies have shown that it's possible to use financial data to calculate rough estimates of carbon emissions. One common method is to use Merchant Category Codes (MCCs), which are standard labels that describe the type of store or service involved in a transaction. For example, MCC 5411 refers to grocery stores. Each category can be matched with an average emission factor of how much CO_2 is typically produced for every dollar spent based on public datasets and life cycle studies of products. This method has already been used by real financial institutions. Vancity introduced a Carbon Counter that calculates emissions for each transaction using MCC-based averages. Mastercard also partnered with Doconomy to create a similar tool that gives users a monthly overview of their carbon footprint from spending. These tools work automatically in the background and require no input from the user, making them simple and scalable (Mastercard, 2022). They help users make the link between what they buy and their climate impact, even if only at a high level.

However, this approach has limits. MCCs are meant for payment systems, not environmental analysis, so they are often too broad. Two people might shop at the same grocery store but buy very different things; one may buy local vegetables, while another buys imported meat. Yet the system will treat their transactions the same. Some startups are now improving accuracy by identifying specific merchants or subcategories, or by asking users follow-up questions. While these refinements help, the current research shows that even basic estimates can still be valuable for raising awareness as long as users know that the results are averages and not exact figures (Wenz et al., 2021). This project uses this MCC-based approach as a foundation, translating users' spending into carbon insights with clarity and transparency.

Sustainable Consumption and Carbon Footprint Tracking

Sustainable consumption means making choices that reduce harm to the environment. Many people care about climate change, but they don't always know how their daily choices affect it. Without good data, it's hard to tell which habits make the biggest difference. This is where carbon footprint tracking tools come in. These tools measure emissions from everyday activities like food, travel, and shopping, giving people a clearer picture of how their actions contribute to climate change (Ivanova et al., 2020).

Recent research shows that when people receive personal carbon feedback, they often change their behavior. In one study from 2024, users of carbon tracking apps lowered their emissions by an average of 23%, with the biggest changes seen in home energy use and daily purchases. Even smaller categories like transportation saw meaningful improvements (Smith & Chen, 2024). These tools help people move from vague concerns to specific actions by showing progress, comparing habits over time, and offering tips on what to improve.

However, keeping users engaged over time can be difficult. Many people reduce their emissions right after getting feedback, but that effect tends to fade without regular reminders. To make the impact last, research suggests that tools should include goal-setting, progress tracking, or even small rewards (Otto et al., 2019). Surveys also show that most people want better information to make sustainable choices over 60% say they would change their behavior if they had clear data (Deloitte, 2023). This project builds on these insights by helping users track their emissions over time and showing them how their spending choices shape their environmental footprint.

Climate Change and the Role of Personal-Level Interventions

Addressing climate change requires both global efforts and personal responsibility. While government policies and clean technologies play a major role, the everyday choices people make also matter. Research shows that personal consumption patterns like how we travel, what we eat, and the products we use account for a large share of global emissions. The United Nations Environment Programme estimates that lifestyles contribute to about two-thirds of greenhouse gas emissions globally (UNEP, 2021). This means individuals have real power to reduce emissions through thoughtful decisions.

Some actions are much more impactful than others. A well-known study by Wynes and Nicholas (2017) found that avoiding air travel, living without a personal vehicle, and eating a plant-based diet are among the most effective ways to cut emissions. For example, choosing not to drive can save around 2.4 metric tons of carbon dioxide each year, and shifting to a vegetarian diet can save nearly 0.8 metric tons. These savings are much larger than those from commonly promoted actions like recycling or switching light bulbs. The key takeaway is that high-impact lifestyle changes can make a meaningful difference if they are widely adopted.

When many people take small steps, the overall effect is significant. A study by Dietz et al. (2009) found that basic household actions could cut United States emissions by 7 to 10 percent in just ten years. While these changes work best alongside supportive infrastructure and public

policies, they show that individuals do not need to wait for large systems to change before acting. Tools that provide people with clear feedback about their own behavior, especially when compared to community norms or personal goals, can encourage long-term change. This supports the idea behind this project to help people make smarter, more sustainable choices by linking spending habits to environmental impact.

Open Banking and Financial Data Aggregation

To make the link between finances and sustainability easier to track, the project uses open banking to collect users' transaction data. Open banking allows users to share their financial information with third-party applications through secure APIs. Instead of being locked within a single bank, account and transaction data can now be gathered in one place with user permission. In Europe, this movement has been supported by regulations like PSD2, which require banks to provide API access (Zetzsche et al., 2020). In the United States, open banking has grown through private companies like Plaid, Finicity, and Yodlee. These firms connect to thousands of banks and financial institutions and give users the option to pull all their financial activity into one dashboard.

Plaid, which plays a central role in this project, connects to over 12,000 institutions worldwide. By linking their accounts, users can automatically share real-time bank and credit card data with apps like this project. This approach avoids the need for manual data entry or uploading statements. The literature shows that financial aggregation helps users make better decisions by offering a clearer view of their money across all platforms (Chen et al., 2022). When users can see all their spending in one place, it becomes easier to identify wasteful habits or track meaningful trends. For a tool focused on sustainability, having access to this full picture is essential. It means that emissions can be estimated not just from one card or bank account, but across a user's full financial life.

While open banking brings many benefits, it also requires strong attention to privacy and security. Financial APIs are built with encryption, multi-factor authentication, and user consent at the core. Users can revoke access at any time, and upcoming regulation in the United States under Section 1033 of the Dodd-Frank Act is expected to standardize protections even further (Consumer Financial Protection Bureau, 2023). For this project, the advantage is that we do not need to build integrations with each bank individually. Instead, we rely on a trusted provider like Plaid to serve as the bridge, giving the project more time to focus on how to use that data to help users make informed, sustainable choices.

Carbon Offsetting Mechanisms

While reducing personal emissions is the ideal goal, some emissions are difficult to avoid. In those cases, carbon offsetting becomes a practical tool. Offsetting means investing in environmental projects that remove or prevent emissions elsewhere. These projects include tree planting, renewable energy, methane capture, and direct air carbon removal. Individuals or companies buy carbon credits, each typically representing one metric ton of CO_2 removed from the atmosphere (Kollmuss, Zink, & Polycarp, 2008). The voluntary carbon market, where these

credits are sold, has seen rapid growth. Analysts from Morgan Stanley estimate that this market could grow from $2 billion in 2022 to $100 billion by 2030, driven by more people and organizations aiming to reach net-zero emissions (Morgan Stanley, 2022).

To make offsetting easier for everyday users, services like KlimAPI provide ready-to-use APIs that calculate and offset carbon emissions directly within apps. With KlimAPI, developers can estimate the emissions tied to a transaction or activity and then let users fund certified offset projects through the same platform. For example, this project allows users to see their monthly emissions and choose to offset them through KlimAPI in just a few clicks. KlimAPI also provides proof of each offset in the form of a certificate and guarantees that the projects are verified. Similar services, such as Cloverly and Patch, offer the same kind of automation, but KlimAPI was chosen for its focus on transparency and flexibility for small applications.

It is important, however, to be careful with offsets. Research shows that many available carbon credits may not deliver the environmental benefits they promise. For offsets to work, the funded projects must be additional (meaning they wouldn't happen without the purchase), verifiable, and permanent. Trencher et al. (2024) found that 87% of carbon offsets used by major companies were linked to projects at high risk of not delivering real emissions reductions. Low-quality credits, like those tied to avoided deforestation or outdated renewable projects, often fail to meet high standards. Because of this, this project uses KlimAPI in a limited and transparent way. Offsetting is offered as an optional last step, only after users have seen their emissions and explored ways to reduce them. Any offsets purchased are from certified providers such as Gold Standard or Verra. This ensures users can act on their impact in a responsible and informed way.

Large Language Models (LLMs) for Enhanced Engagement and Personalized Insights

One of the innovative components of the project is the use of large language models (LLMs) to help users make sense of their financial and environmental data. These models can analyze information, answer questions, and generate human-like responses, making them well suited for providing guidance in a user-friendly format. Instead of static charts or summaries, the system offers a conversational interface where users can ask questions like "How can I reduce my travel emissions?" or "What did I spend the most on last month?" and receive tailored, understandable answers. In personal finance applications, LLMs can play the role of an intelligent assistant by interpreting patterns in spending and suggesting practical actions. This type of interaction builds on research that shows users are more likely to engage with systems that provide feedback in plain, conversational language (Weizenbaum, 1966; Binns et al., 2018).

Studies in human-computer interaction have found that people feel more supported and informed when advice comes from systems that mimic natural conversation. In educational settings, for example, chatbot tutors have been shown to boost learner engagement and comprehension by personalizing explanations (Wollny et al., 2021). In finance, emerging apps already use GPT-style assistants to help users with budgeting or investment questions, showing that people value guidance that is fast, relevant, and easy to understand. For this project, Claude is the LLM used to power these features. Claude processes the user's transaction data,

including their spending categories and estimated emissions, and turns that information into personalized tips. For instance, it might point out an increase in fuel spending and suggest alternatives like biking or carpooling, based on the user's habits.

Although LLMs offer strong potential, they must be used carefully. These models can generate incorrect or misleading statements if not guided properly. A recent study found that ChatGPT produced responses in line with expert climate data about 70 - 80 percent of the time, but accuracy varied across topics (Hartmann et al., 2023). To manage this, the project ensures that any sustainability advice from Claude is based on real transaction data and verified calculations. The AI assistant does not guess it builds its responses using the same estimates shown in the dashboard. This approach combines the reliability of data-driven insights with the accessibility of natural conversation. As a result, users not only see how their choices affect the environment but also receive helpful suggestions in real time, increasing their motivation to adopt more sustainable habits.

This literature review has explored how personal finance, climate change, open banking, carbon offsetting, and AI technologies intersect in ways that support the goals of the project. Consumers are increasingly using digital tools to manage their finances, but they often lack awareness of how their purchases affect the environment. Several studies and real-world applications show that financial transactions can be used to estimate personal carbon footprints, especially when supported by reliable merchant data and emission factors (Gössling et al., 2020; Vancity, 2021). Although these estimates are imperfect, they provide users with a starting point to reflect on their impact and consider more sustainable choices.

Tools that track emissions based on spending can influence behavior when combined with personalized feedback and opportunities for action. Many users are willing to make changes when presented with accurate and relevant data (Dietz et al., 2009; Wynes & Nicholas, 2017). Open banking makes it easier to collect this data across accounts, and offsetting platforms like KlimAPI allow users to take additional steps to reduce their footprint. Large language models, such as Claude, further enhance engagement by providing explanations, summaries, and advice in a conversational format, turning complex data into actionable insights.

The research supports the development of a tool that helps individuals align their financial behaviors with environmental goals. By building on established methods and addressing known limitations, the project aims to create a system that informs and empowers users. The literature highlights the importance of clarity, transparency, and user control. As digital finance and climate awareness continue to grow.

5. **Methodology**

System Architecture

The project is built as a web-based dashboard that brings together personal finance management and sustainability insights. It adopts a modular client-server architecture, where a Python-based backend handles data logic and API communication, while a JavaScript-based frontend presents interactive features to the user. The platform uses external APIs to gather bank transaction data, estimate carbon emissions, provide AI-generated insights, and facilitate voluntary carbon offsets.

Architecture Components

The system consists of the following core modules:

- Backend (Flask/Python): The server processes requests, manages user sessions, analyzes data, and integrates with APIs for Plaid, Claude, and KlimAPI.

- Frontend (HTML, CSS, JavaScript): A lightweight interface allows users to navigate dashboards, view emissions insights, and interact with AI features. Data visualizations are rendered using Chart.js.

- External APIs:

  - Plaid API is used to retrieve bank transaction data (simulated in this demo).

  - Claude (Anthropic) is used to estimate CO_2e emissions and power the AI assistant.

  - KlimAPI allows users to offset their emissions through certified carbon credit projects.

Plaid Integration for Financial Data Aggregation

In this project, Plaid serves as the secure data aggregator that enables users to connect their financial institutions and share transactional data with the system. This data forms the foundation for estimating carbon emissions linked to personal spending patterns. By utilizing Plaid's robust API infrastructure, we ensured a seamless integration with our U.S. banks while maintaining compliance with modern data privacy standards.

1. User Authentication and Consent Flow

The Plaid integration begins with the user initiating a connection to their bank account through Plaid Link, a front-end module designed to securely handle user authentication. The process is structured in four key steps:

- Link Token Creation: The backend generates a *link_token*, which is passed to the client and initializes the Plaid Link flow.

- User Bank Login: The user selects their bank, logs in securely, and grants explicit consent for this project to access their financial data. OAuth is used where supported for enhanced security.

- Token Exchange: Upon successful login, Plaid returns a temporary *public_token*. This token is sent to the backend, where it is exchanged via the */item/public_token/exchange* endpoint for a permanent *access_token* and a unique *item_id*.

- Persistent Access: The *access_token* is stored securely and used for subsequent requests to retrieve transaction and account data. This flow is designed to respect user permissions and allows revocation at any time.
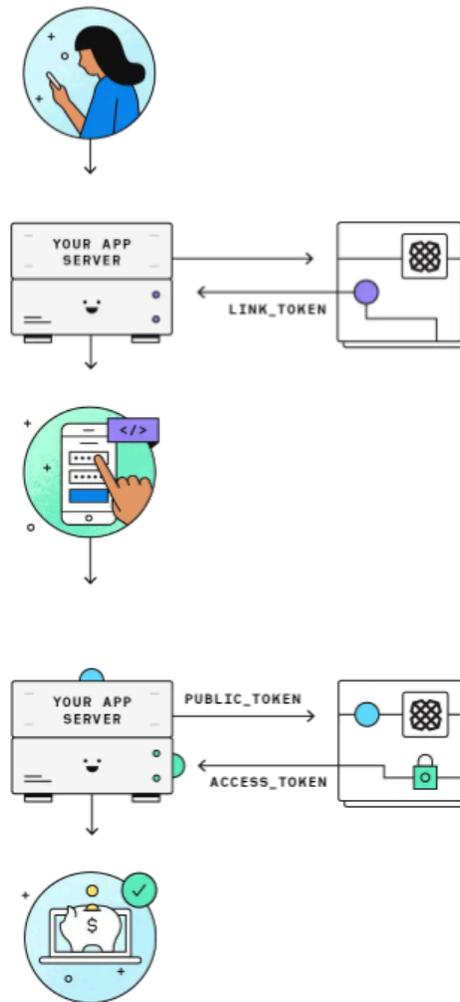

Fig 1 - How Plaid works

Transaction Data Retrieval

With authentication established, we used Plaid's */transactions/get* endpoint to fetch itemized financial activity. Each transaction includes:

- Merchant Name and Description

- Transaction Date and Amount

- Plaid-Inferred Categories (e.g., "Fast Food," "Air Travel")

- Geolocation and Payment Channel (POS or Online)

- Merchant Category Code (MCC)

Plaid's proprietary categorization engine maps transactions to predefined category groups using internal heuristics and MCC metadata. This structured data enables scalable analysis across various user profiles.

Claude Integration

Claude serves as the intelligent assistant that helps users interpret their financial behavior through a sustainability lens. Rather than passively presenting carbon emissions data, Claude enables interactive, personalized conversations that turn raw numbers into meaningful insights. The goal is to encourage behavior change through natural language guidance tailored to each user's financial and environmental footprint.

Claude is used to deliver two primary functionalities within this project:

- Personalized Sustainability Insights
  Claude analyzes categorized transaction data (fetched via Plaid) to identify patterns in spending and associated carbon emissions. Based on this analysis, Claude offers users contextual suggestions, such as reducing ride-hailing trips, shopping more locally, or adjusting food purchases to lower-impact alternatives.
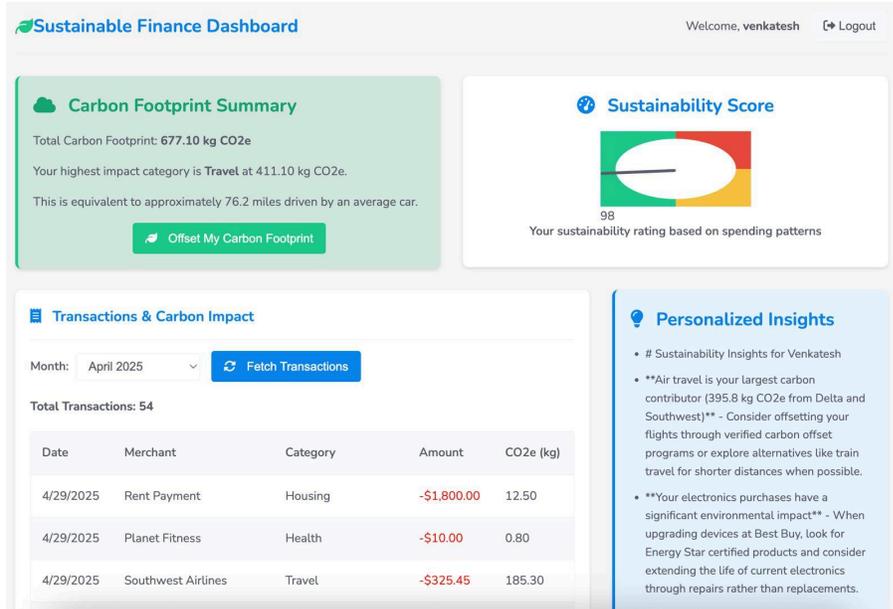
Fig 2: Personalized Insights

- Conversational Interface
  Users can ask questions like "How much CO₂ did I emit last month from travel?" or "What are some eco-friendly ways to reduce fuel spending?" Claude interprets the queries and generates responses based on user-specific data.
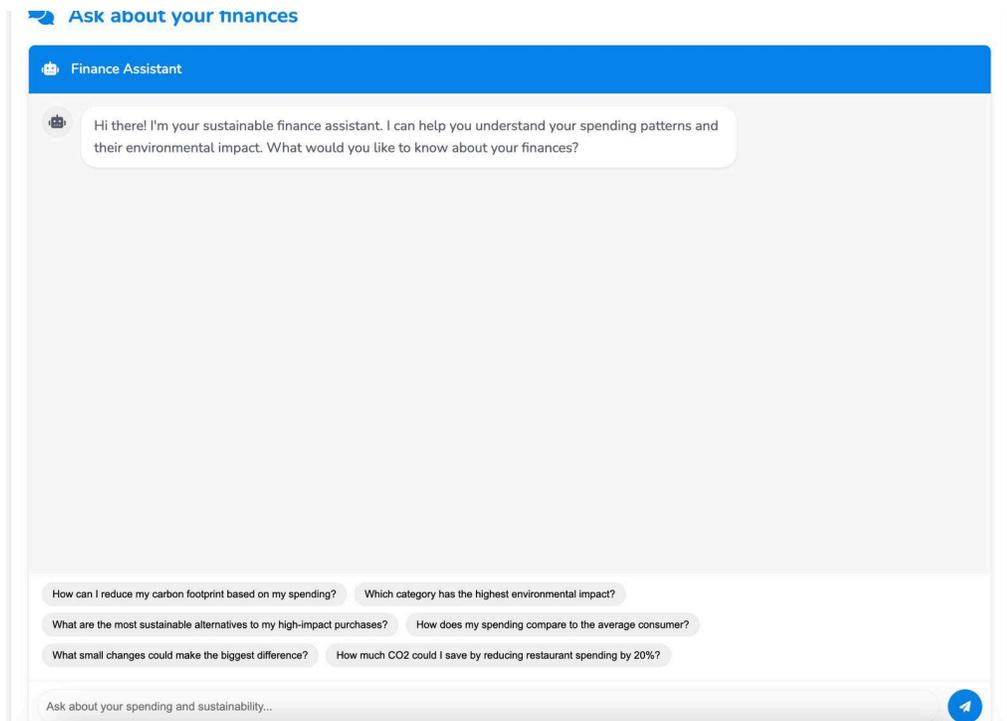

Fig 3: conversational tool

KlimAPI Integration

KlimAPI is integrated into the system to give users a tangible way to act on their carbon footprint by funding certified offset projects. While the dashboard helps users understand their financial and environmental impact, KlimAPI extends this by enabling real-time carbon offsetting transforming awareness into meaningful climate action.

The primary function of KlimAPI in this project is to facilitate carbon offset transactions. After Plaid retrieves the user's transaction history and CO_2e emissions are estimated through Claude-based logic, KlimAPI provides an avenue for users to voluntarily neutralize a portion or all of their emissions. This feature bridges the gap between environmental insight and actionable behavior, helping users close the loop on their sustainability journey.

Workflow and Integration Logic

The integration follows a structured data pipeline that allows offsets to be both automated and user-driven.

- Triggering the Offset Process
  KlimAPI can be invoked in two ways:

  - Automatically after emissions are calculated (e.g., in a monthly summary).

  - Manually by the user through a dashboard feature (e.g., "Offset my emissions").

- Preparing Emission Data
  Once the system computes total emissions for a given period (e.g., 78.2 kg CO_2e for the current month), it prepares a payload formatted for KlimAPI. This includes total emissions to offset, type or source of emissions (e.g., fuel, general lifestyle) and optional metadata like user ID or session tag for logging

- Sending the Request to KlimAPI
  A secure POST request is made to KlimAPI's *offsets* endpoint, transmitting the payload. KlimAPI then processes the request and returns a list of matching offset projects, or automatically assigns one that fits the user's footprint.

- Receiving and Displaying Offset Options
  The response from KlimAPI typically includes project name and description, certification details, location and type (e.g., reforestation, renewable energy).

- User Engagement and Confirmation
  On the frontend, users are presented with offsetting options and can choose a preferred project. Payment is facilitated via an integrated payment processor. After confirmation, KlimAPI finalizes the transaction and returns a receipt or transaction ID.

📨 **Offset Your Carbon Footprint**   ← Back to Dashboard

✓

Your Carbon Offset Was Successful!

Project Funded

Quilleco Hydroelectric Power Plant

Location: Chile

Status: In operation

Quilleco is a run-of-river power plant with an effective installed capacity of 70 MW that uses the waters of the Laja River basin to supply the national power grid with energy equivalent to the consumption of more than 162,000 people.

Carbon Offset Certificate

Order ID: CA-B720-50FACF88   **Status:** processed

Fig 4: certificate of carbon offset

Key Features and Implementation

Carbon Footprint Analysis

For each transaction, a CO_2e value is estimated. The estimation process relies on the merchant category (e.g., groceries, fuel), spending amount, and occasionally merchant name. Claude is prompted with this contextual data and returns an approximate CO_2-equivalent emission value in kilograms. This allows the system to infer the environmental impact of financial habits without requiring manual input from the user.

Sustainability Scoring

To help users understand how "green" their spending is, a sustainability score is computed between 0 and 100. This score weights two key factors:

- Carbon Efficiency (70%) – Measured as kg CO_2e per dollar spent. Lower ratios indicate more sustainable behavior.

- Spending Categories (30%) – Certain high-impact categories (like gas stations or airlines) reduce the score, while low-impact categories (like books or education) preserve it.

The goal is to provide a clear and intuitive summary of environmental performance based on financial behavior.

Detailed Calculation Process

Carbon Efficiency Score:

This component measures the carbon emissions (CO2e) per dollar spent: CO2e per Dollar = Total CO2e (kg) / Total Spending ($)

A lower CO2e per dollar indicates more carbon-efficient spending patterns. This value is then converted to a score using:

Carbon Efficiency Score = max(0, 100 - (CO2e per Dollar × 20))

The multiplier of 20 scales the CO2e per dollar value to create a meaningful score range:

- Approximately 0-1 kg CO2e per dollar → Score of 80-100

- Approximately 1-3 kg CO2e per dollar → Score of 40-80

- Approximately 3-5 kg CO2e per dollar → Score of 0-40

High-Impact Category Analysis:

This component evaluates what percentage of spending occurs in environmentally intensive categories:

High-Impact Categories = [

'Air Travel', 'Flights', 'Airlines', 'Gas', 'Automotive',

'Fast Food', 'Meat', 'Beef', 'Fast Fashion']

The score is calculated as:

Category Score = max(0, 100 - (High-Impact Spending Percentage × 100))

For example:

- 0% spending in high-impact categories → Score of 100

- 50% spending in high-impact categories → Score of 50

- 100% spending in high-impact categories → Score of 0

Combined Final Score:

The final sustainability score is a weighted average of the two components: Sustainability Score = (Carbon Efficiency Score × 0.7) + (Category Score × 0.3)

This weighting:

- Prioritizes actual carbon footprint (70%)

- While still accounting for category choices (30%)

The final score is clamped to ensure it stays within the 0-100 range.

Score Interpretation

Score Range	Classification	Description
80 - 100	Excellent	Your spending patterns reflect very low carbon intensity. You primarily spend in sustainable categories with minimal environmental impact.
60 - 79	Good	Your spending has a lower than average carbon impact. There are some opportunities for improvement, but you're on the right track.
40 - 59	Average	Your carbon footprint is typical. There are multiple areas where you could make more sustainable choices.
0 - 39	Needs Improvement	Your spending has a significant environmental impact. Review high-carbon categories to find substantial improvement opportunities.

Dashboard Visualizations

The frontend uses Chart.js to display personalized data in a visually engaging format. Key charts include: spending by category , emissions by category, daily emissions over time, sustainability score gauge, etc

6. Limitations and Challenges

Limited Detail in Financial Data from Plaid

One of the main challenges of the project lies in the limited detail provided by Plaid's financial data. While Plaid offers useful information such as the merchant name, transaction amount, and date, it does not show the exact items a user purchased. This means the platform must estimate carbon emissions based on general spending categories, rather than on specific products. For example, a $50 transaction at a grocery store might include mostly vegetables, which have a low carbon footprint, or mostly meat, which has a higher footprint. However, the system will apply an average emissions factor across all grocery purchases, which may not reflect the actual environmental impact. This issue becomes more complicated when transaction data is misclassified or mislabeled. If a purchase is incorrectly tagged as a convenience store instead of a supermarket, the emissions estimate could be inaccurate. Without access to item-level data, the platform can only provide rough estimates, which limits the precision of its carbon tracking features.

Challenges in Estimating Emissions from Spending

Estimating carbon emissions from monetary values introduces another layer of complexity. The platform uses emissions factors averaged values that estimate how much CO_2 is released per dollar spent in each category. However, these averages often do not account for specific regional differences, supplier practices, or product types. For instance, a locally made product and an imported product may have the same price but very different carbon footprints. The same applies to services like electricity, where the emissions can vary widely depending on the energy source used in a particular location. In some cases, price is not a good indicator of emissions at all. Gasoline, for example, emits the same amount of carbon per gallon regardless of where it is sold, but the price can vary significantly. Using price alone to estimate emissions may therefore overstate or understate a user's carbon impact depending on local costs. These challenges highlight the difficulty of translating financial data into environmental insights with a high degree of accuracy.

Dependence on External APIs

The system relies heavily on external APIs, which introduces several risks. It uses Plaid to fetch banking data, Claude for AI-powered recommendations, and KlimAPI to support carbon offsetting. These services are essential to the platform's functionality, but they are controlled by outside providers. If one of these services experiences downtime, changes its API structure, or imposes new restrictions, the platform may stop working correctly or require urgent updates. These dependencies also raise concerns about cost, as many APIs have usage limits or tiered pricing models that could affect performance as the user base grows. Because the platform depends on these services for key functions, it must stay updated on changes, manage usage carefully, and be ready to adapt if any third-party service changes its policies or structure.

Concerns Around Carbon Offsetting

Adding a carbon offset feature introduces ethical and technical challenges. Carbon offsets are only effective if they fund projects that lead to real, measurable, and lasting emissions reductions. It is difficult to verify whether a reforestation project, for example, will actually store carbon for decades or if it would have happened without the offset funding. The platform must trust that KlimAPI offers high-quality, certified projects. Any doubt about the quality or integrity of these projects could make users question the effectiveness of their offsets. Moreover, not all users may be interested in offsetting their emissions. Some may see offsets as expensive or unnecessary, while others may view them as an excuse to continue polluting. The platform must therefore work to educate users on what carbon offsets are, how they work, and why they matter. Clear explanations, user-friendly design, and visible impact such as certificates or progress indicators can help users see value in the feature.

Keeping Users Engaged Over Time

Maintaining user engagement over the long term is another major challenge. Many apps experience strong initial interest that fades as users lose motivation or become overwhelmed. In the case of sustainability tracking, some users may become discouraged if the data shows consistently high emissions or if the recommended changes feel out of reach. Others may stop using the app if they do not see quick improvements or if the feedback feels repetitive. To address this, the platform must use effective strategies such as goal setting, regular tips, and positive reinforcement. Features like badges, reminders, and personalized messages can help maintain interest. Most importantly, the platform must make the experience feel encouraging rather than judgmental. Sustained engagement depends not just on good data, but also on thoughtful design that motivates users to keep improving.

Data Privacy and Security Requirements

Because the platform handles sensitive financial and personal data, privacy and security are critical. Users are sharing bank transaction records and sustainability insights, which requires strong protection and trust. Regulations such as the General Data Protection Regulation (GDPR) in Europe and the California Consumer Privacy Act (CCPA) in the U.S. set clear rules about how this data must be handled. The platform must follow these laws by gaining user consent, allowing users to delete their data, and being transparent about how information is used. In addition, using external services like Plaid and Claude increases the risk, as data is passed through third-party systems. Even if those services have strong security, the overall safety of user data depends on how well the platform protects it. Best practices like encrypted data storage, strict access control, and secure transmission protocols are essential. Users also need to trust that their data will not be used for advertising or sold to other companies. If the platform fails to meet these expectations, users may stop using it. Building trust through transparent policies and responsible design is key to the platform's long-term success.

7. Future Work and Recommendations

There are two main ways we would like to expand the project and make it even more useful: building a mobile version of the platform and adding features that help users benefit from tax incentives when they make eco-friendly choices. These additions would improve access, boost user involvement, and give people more reasons to stick with sustainable habits.

Developing a Mobile App

To make this project more accessible and convenient, especially for people who prefer using their phones, creating a mobile app is an important next step. This app would include the main features of the web version but be designed specifically for mobile use.

A good way to build this is by using tools like React Native or Flutter. These platforms allow developers to create one app that works on both iPhones and Android phones, which saves time and resources. The mobile interface would be simple and easy to navigate, using tabs and swipes to help users move between screens. Important features like spending summaries, carbon tracking, the AI chat tool, and tips for greener choices would be easy to find and use. It would also be helpful to let users view some information even when they're offline and receive notifications. For example, a reminder to check their carbon footprint or a suggestion to take public transit instead of driving could encourage better habits over time.

Adding Tax Incentive Features for Sustainable Behavior

Another way to improve this project is by helping users save money through tax incentives. Many governments, including the United States, offer tax credits and deductions for people who take steps to reduce their carbon footprint. The project could help users track and report these actions so they can claim financial benefits during tax season.

This would involve researching tax policies and linking user behavior to the right tax codes. For example, if someone chooses public transportation instead of driving, or buys products that are better for the environment, the system would log these actions. The app could then check if they qualify for tax credits like those listed in IRS forms related to clean energy or sustainability. To make this easier for users, this project could also prepare downloadable reports that show their carbon-reducing behavior. These reports could be used directly for filing taxes or imported into tax software like TurboTax or H&R Block.

By building these new features, the project can offer even more value making sustainable living easier, more rewarding, and financially beneficial.

References

Goyal, K., Kumar, S., & Xiao, J. J. (2021). Antecedents and consequences of personal financial management behavior: A systematic literature review and future research agenda. *International Journal of Bank Marketing, 39*(7), 1166–1207. https://doi.org/10.1108/IJBM-12-2020-0612

Wynes, S., & Nicholas, K. A. (2017). The climate mitigation gap: Education and government recommendations miss the most effective individual actions. *Environmental Research Letters, 12*(7), 074024. https://doi.org/10.1088/1748-9326/aa7541

Dietz, T., Gardner, G. T., Gilligan, J., Stern, P. C., & Vandenbergh, M. P. (2009). Household actions can provide a behavioral wedge to rapidly reduce U.S. carbon emissions. *Proceedings of the National Academy of Sciences, 106*(44), 18452–18456. https://doi.org/10.1073/pnas.0908738106

Trencher, G., Nick, S., Carlson, J., & Johnson, M. (2024). Demand for low-quality offsets by major companies undermines climate integrity of the voluntary carbon market. *Nature Communications, 15*, Article 6863. https://doi.org/10.1038/s41467-024-51151-w

Tapix. (2025, March 26). *How Raiffeisen Bank displays transactional carbon footprint to 1M+ clients*. Retrieved from https://www.tapix.io/resources/post/raiffeisen-bank-carbon-footprint-eco-track

Vancity. (2022). *Carbon Counter FAQ*. Retrieved from https://support.vancity.com/vancity-carbon-counter/

S&P Global Market Intelligence. (2024, August 7). *One-third of Americans use three or more financial apps*. Retrieved from https://www.spglobal.com/market-intelligence/en/news-insights/research/one-third-of-americans-use-three-or-more-financial-apps

The Commons. (2024, April 25). *Carbon footprint tracking: An easy habit for sustainable living*. Retrieved from https://www.thecommons.earth/blog/carbon-footprint-tracking-an-easy-habit-for-sustainable-living

Plaid. (2025, April 1). *What is open banking? A guide to the future of finance*. Retrieved from https://plaid.com/resources/banking/what-is-open-banking/

KlimAPI. (2023). *Calculate & offset CO_2 emissions – via API*. Retrieved from https://klimapi.com/

Strabo. (2023, October 28). *How to use ChatGPT as your personal finance assistant*. Retrieved from https://www.strabo.app/content/how-to-use-chat-gpt-as-your-personal-finance-assistant

Williams, T. (2024, May 2). *Should chatbots chime in on climate change?* [Press release]. *Virginia Tech News*. Retrieved from
https://news.vt.edu/articles/2024/05/research-ai-climatechangeliteracy.html

Akoya. (2024). *The rise of secure data sharing: APIs vs. screen scraping*. Retrieved from
https://akoya.com/blog/securedatasharing

Empowered Systems. (2023). *Understanding the challenges and risks of carbon accounting*. Retrieved from
https://empoweredsystems.com/blog/understanding-the-challenges-and-risks-of-carbon-accounting-implications-for-organizations/

Irrational Labs. (2023). *Designing for sustainable user engagement*. Retrieved from
https://irrationallabs.com/blog/putting-back-users-to-the-forefront-sustainable-engagement-tips-from-behavioral-science/

Plaid. (2022). *Sync: A new paradigm for building on transaction data*. Retrieved from
https://plaid.com/blog/transactions-sync/

Tracex. (2023). *Carbon offset verification: Ensuring transparency*. Retrieved from
https://tracextech.com/carbon-offset-verification/

Venminder. (2023). *How to mitigate third-party API risk*. Retrieved from
https://www.venminder.com/blog/how-mitigate-third-party-api-risk