Deliverable 1:

1. Problem Identification :

1.1 Problem/Opportunity Statement :

Different companies from different industries face increasing challenges in measuring, tracking or reducing their carbon footprint. These challenges come from multiple pressure points, which contribute to a complex environment in which businesses must navigate their sustainability efforts to remain competitive and compliant.

The several key pressure points:

1. **Regulatory Compliance:**
   Countries all over the world are putting in place stringent regulations aimed at curbing greenhouse gas(GHG) emissions. Most of these come with very heavy implications like getting fined through higher taxation or, in a worst-case scenario, losing operating licenses. Non-compliance with such increasingly stringent environmental criteria will expose a company to financial loss, legal implications as well as a disturbance to the operations. Global pressure to achieve, for example, net-zero emissions by 2050 only serves to pile on the demand that companies should be monitoring and controlling their carbon output.

   An example is the case presented by the "Green Deal" established in the European Union, where it seeks to have the entire region carbon-neutral by 2050. This applies stringent carbon emission regulations on energy production as well as industries of manufacturing and transport sectors.

2. **Cost Inefficiencies:**
   Many companies still use outdated machinery and processes that cause carbon emissions in great quantities. Indeed, this is evident in the manufacturing and transportation fields. Generally, the older machinery consumes more energy than up-to-date well-maintained machinery and is more carbonaceous. This raises the company’s carbon tax liability for the same emissions as would be generated by newer machinery, adding to operational costs in terms of increased energy use. Improving energy efficiency would, therefore, reduce emissions and operating costs by the same amount.

   Companies such as Ford have made significant investments in updating old plants to more energy-efficient ones, thereby reducing carbon emissions and overall energy costs.

3. **Stakeholder Pressure:**
   Governments, consumers and investors are increasingly demanding that companies start to operate sustainably. As this sensitivity to the environment in which companies do business wakes up, the pressure is on the company to operate with a sustainability angle. Ignoring these demands can result in reputational damage, loss of consumer trust and decreased access to green financing.

Amazon has come under constant scrutiny for its carbon emissions from its global supply chain. While the company has pledged to be carbon neutral by 2040 to meet stakeholder demands, the biggest challenge is accurately measuring emissions from its complex operations.

Statistics and Research Reports :

There are several entities dedicated to collect, analyze and forecast data regarding the performance of industries and greenhouse gasses (GHG) emissions, in order to propose solutions for an optimal transition towards low-carbon economy and more secure, affordable and sustainable energy systems. Among those entities, the International Energy Agency (IEA) is the most common one as it works with many international organizations to gather updated data all around the world.

- According to the “Emissions Database for Global Atmospheric Research” of the European Commission, as of 2023, China remains at the top of GHG emitting countries with 30% of global emissions followed by the United States and India with respectively 11 and 8% of global emissions.
- However, when comparing the GHG emissions per capita, many countries from the Middle east come at top followed by Australia, Canada and the United States, while China falls far behind due to its high population density.

Breakdown of Emissions by Domain:

- The global market and economy is driven by 5 major sectors: the energy sector responsible for electricity and heat, the industry sector regrouping the mining and different manufacturing sectors of metals, chemicals and oil & gas, the mobility including cars, trucks, aviation and freight, the building sector, and the farming and agriculture.

- Depending on the position of their operation along the product's value chain, each sector can have emissions classified as different emissions scope 1,2 or 3. Scope 1 emissions involve the emission released directly from sources that are owned or controlled. Scope 2 emissions relate to greenhouse gases emitted indirectly from purchased energy generation. Scope 3 is a category representing all the indirect emissions not covered under scope 2 emissions, which occur within the corporate value chain of the reporting

company. It covers both the upstream and the downstream emissions. Figure 1 reports a summary of these scopes with the corresponding sectors.

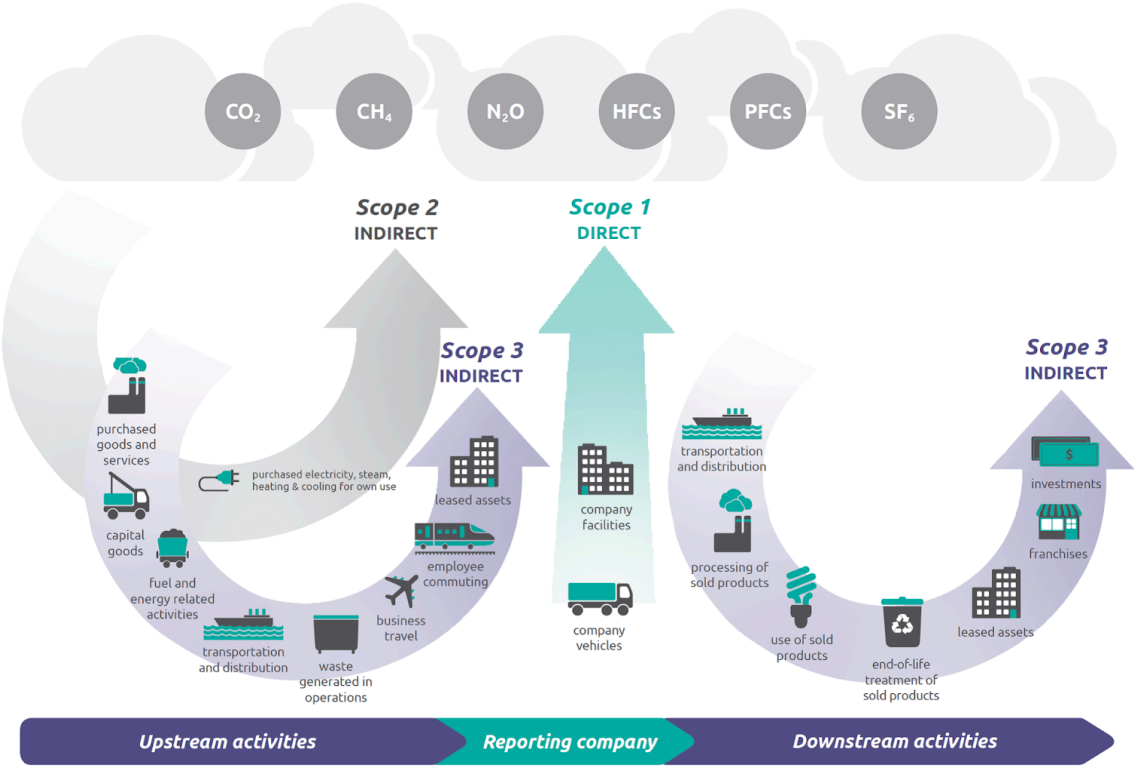


Figure 1 : GHG Emission Scopes, an overview. (Source)

According to the latest analysis from IEA, the energy and electricity sectors account for approximately 44% of total emission as of 2022. followed by transport and industries with respectively around 24 and 17% of global emissions.

Description of Significance:

With the effects of climate change evident in the world today, there is a growing trend among corporate undertakings of measuring and monitoring their daily operational carbon emissions. It is not only to help you meet laws but also numerous operational, financial and marketing benefits.

1. **Meeting Environmental Targets:**
   Through the carbon footprint calculation, companies can meet their targets for eco-sustainability including the Paris Agreement. To minimize carbon emissions,

companies create and control emission sources. This is aimed at fighting climate change at both national and international levels.

Example: Among the largest corporations in the world, Microsoft and Apple plan to go carbon-neutral by 2030 and thus for these companies initiatives to introduce advanced carbon measurement and other systems have emerged.

2. **Impact on Decision-Making:**
   Such accurate tracking of emissions assists in critical business functions such as the supply chain management, resource deployments and operational efficiency. Such as, tracing emissions across vendors allows companies to discover their energy inefficient suppliers or processes and helps management. This results in reduced emissions and possibly reduced costs due to better resource use and control of energy in Philadelphia.

   For example, Walmart's suppliers' carbon footprint data are examined to formulate plans to press the suppliers under its provide chain on Project Gigaton that aims at cutting down one billion metric tons of emissions by 2030.

3. **Reputation Management:**
   If one fails to mitigate carbon emissions, there could be adverse consequences of a reputational nature. The conviction of people in a modern company is related to its concern for the environment or to these at least allegations. Though companies may not be solely focused on carbon management, failure to do so would pose a threat in terms of customer and investor attrition, while those who integrate carbon management systems stand to benefit from better brand reputation and competitive advantage.

   Example: The loyal client bases that and the goodwill garnered by media hype have been associated with the sustainability strategy of this company, and this is easy to understand considering the brand's promise of zero-sum management of waste. The organization has worked hard to measure and disclose its carbon footprint as part of being a good corporate.

4. **Long-Term Risk Mitigation:**
   As regulatory constraints are becoming intense, any business that neglects carbon management is likely to face major consequences. Non-compliance may attract penalties, potential litigation, or even elimination from coat tailing markets. Furthermore, given that an increasing number of sectors and countries are moving towards net zero industries, those companies that are behind the trend may gradually be out of the game due to more sustainable competitors capturing the markets.

   Example: In the energy business, one thing that has happened is that companies such as BP and Shell are in the race of advanced technologies in renewable energy and carbon sequestration as they want to be compliant with regulations and avoid the health risks of carbon-based operations in the future.

5. **Consequences of Ignoring Carbon Footprint:**
   As the regulatory climate becomes strayer and strayer, it is apparent that any company that wishes to ignore carbon management will be courting major risks. Non-compliance is encumbered with several ramifications, including but not limited to paying of fines, litigation in courts, or even being boxed out of very profitable markets. Additionally, these encumbering forces will increase as more industries and nations commit to net zero carbon emissions. Those who do not abide may find themselves at the bottom of the line, losing market shoppers to sustainable alternatives, which will be the case as more businesses push towards the transition target.

   Example: In the energy sector, examples include oil companies like BP and Shell that have adopted renewable energy strategy and initiated investment in carbon capture technologies for risk mitigation due to emissions regulations.

6. **Benefits of Monitoring Carbon Footprint:**
   Carbon emissions monitoring advantages include cost savings, informed decision-making, incentives, and unleashing of customers and institutional investors. A business may find operational and process inefficiencies, which would again provide an avenue for investment in energy-saving technologies with a twin benefit of reducing both emissions and costs related to operations. This way, governments are also encouraging companies to take advantage of tax breaks, subsidies, and other inducements, such as lower interest rates, that are being offered for firms showing progress on their carbon footprint.

   For instance, IKEA attracts green financing and appeals to the increasing population of ecologically conscious consumers with its carbon footprint reduction policies to build a strong leadership brand in sustainability.

1.2 Stakeholder Analysis

Identification of the key stakeholders involves different players in the field of carbon footprint monitoring who are either directly or indirectly affected or benefit from the process. Each stakeholder has a different role, either driving or responding to such change with regulatory, financial, or social pressures. Some of the key stakeholders include :

1. **Government and Regulating Bodies:**
   Role: To develop, implement and enforce laws relating to carbon emission and prescribe the standard of compliance, ensuring that industries also adhere to other environmental laws.

   Why They Care: It is because, by putting controls on companies to reduce their carbon footprint, the governments can reduce the overall national carbon emissions and prevent

environmental degradation. Following the rules and being able to monitor require attention to carbon footprints.

2. **Businesses and Corporations: manufacturing, retail, logistics**
   Role: The company emitting carbon through its operations, supply chains, manufacturing, and transportation. Because of the demands of regulations and pressure from customers, they are expected to take full responsibility for monitoring and reducing those emissions.

   Why They Care: It reduces their carbon footprint, which in turn reduces operating costs. Besides, avoiding potential penalties and enhancing brand reputation are key concerns. Firms also attempt to appeal to a greener consumer base and attract investment interested in this area.

3. **Consumers and Customers:**
   This would also mean a call for sustainable products and services; therefore, being more willing to support eco-friendly businesses.
   Why They Care:: People in this day and age are increasingly conscious of the state of the environment and would always favor products from a business that is seen to be serious about reducing its carbon footprint.

4. **Investors and Financial Institutions:**
   Role: This will be about financing businesses and projects, investing in sustainable development for long-term benefits in most instances.

   Why They Care: Green finance is on the rise; investors want to make sure they support those companies that have clear goals in terms of sustainability and reduce the risk associated with climate change-related regulations or reputational damage.

5. **Suppliers and Partners:**
   Role: To provide raw materials, services, and logistics valuable to a company's carbon footprint. They can also be directly involved in the achievement of sustainability goals set by businesses they are involved with.

   Why They Care: Suppliers have to be in line with the corporate sustainability standards for their business continuity at competitive levels and to avoid penalties that relate to supply chain emissions.

6. **NGOs & Environmental Groups :**
   Interests: The calls from these groups for carbon reporting and corporate ambition on sustainability goals.
   Concerns: Companies might report less than actual emissions, or the rate of their implementation is lagging behind, which slows down climate action.

7. **Employees and Workforce:**
   Role: Applications of sustainability principles are done within their companies, ranging from everyday operations to the planning of corporate strategies.

   Why They Care: Employees want to work for companies that reflect their values, one of which involves taking care of the environment. The reinforcing effect of sustainable practices at work is improved morale and engagement level.

Table 1 : Stakeholder Map

Stakeholder	Rôle	Interest in Carbon Footprint Monitoring	Concerns
Government & Regulatory Bodies	Create regulations, enforce compliance	National climate targets, pollution reduction	Enforcement difficulties, delayed compliance
Businesses & Corporations	Operate in various industries	Cost savings, brand image, regulatory compliance	Enforcement difficulties, delayed compliance
Consumers & Customers	Purchase goods/services	Prefer sustainable brands, transparency in carbon footprint	Enforcement difficulties, delayed compliance
Investors & Financial Institutions	Provide funding for companies	Green financing, ESG investments	Investing in non-compliant or unsustainable businesses
Suppliers & Partners	Provide raw materials, logistics	Alignment with sustainability targets, securing contracts	Difficulty in reducing emissions, technology upgrades
NGOs & Environmental Groups	Monitor and advocate for stronger climate action	Corporate transparency, climate action	Corporate inaction, slow emission reductions
Employees & Workforce	Implement and work under corporate sustainability	Pride in working for sustainable businesses	Lack of corporate commitment to sustainability

1.3 Relevance to Software Solution

Explanation of How Software Can Address the Problem:

Software solutions play a vital role in helping businesses monitor and reduce their carbon footprint. These tools offer several key benefits:

1. Automated data collection: Software can integrate with various systems, such as energy meters, transportation logs, and supply chain management tools. This integration allows for automatic gathering of data on carbon-emitting activities, reducing manual effort and potential errors.

2. Real-time tracking: Businesses can monitor their carbon emissions as they happen. This immediate visibility allows companies to quickly identify problem areas or unexpected increases in emissions, enabling faster responses to environmental challenges.

3. Predictive analytics: By analyzing historical data and patterns, Our solution can forecast future emissions. This foresight allows businesses to implement preemptive measures, potentially avoiding excess emissions before they occur.

4. Reporting and visualization: These tools transform complex data into easy-to-understand dashboards and reports. By presenting information clearly and visually, they facilitate better decision-making across all levels of an organization.

5. Goal setting and progress tracking: Our Software helps businesses set realistic carbon reduction targets and monitor progress towards these objectives. This feature keeps companies accountable and motivated in their sustainability efforts.

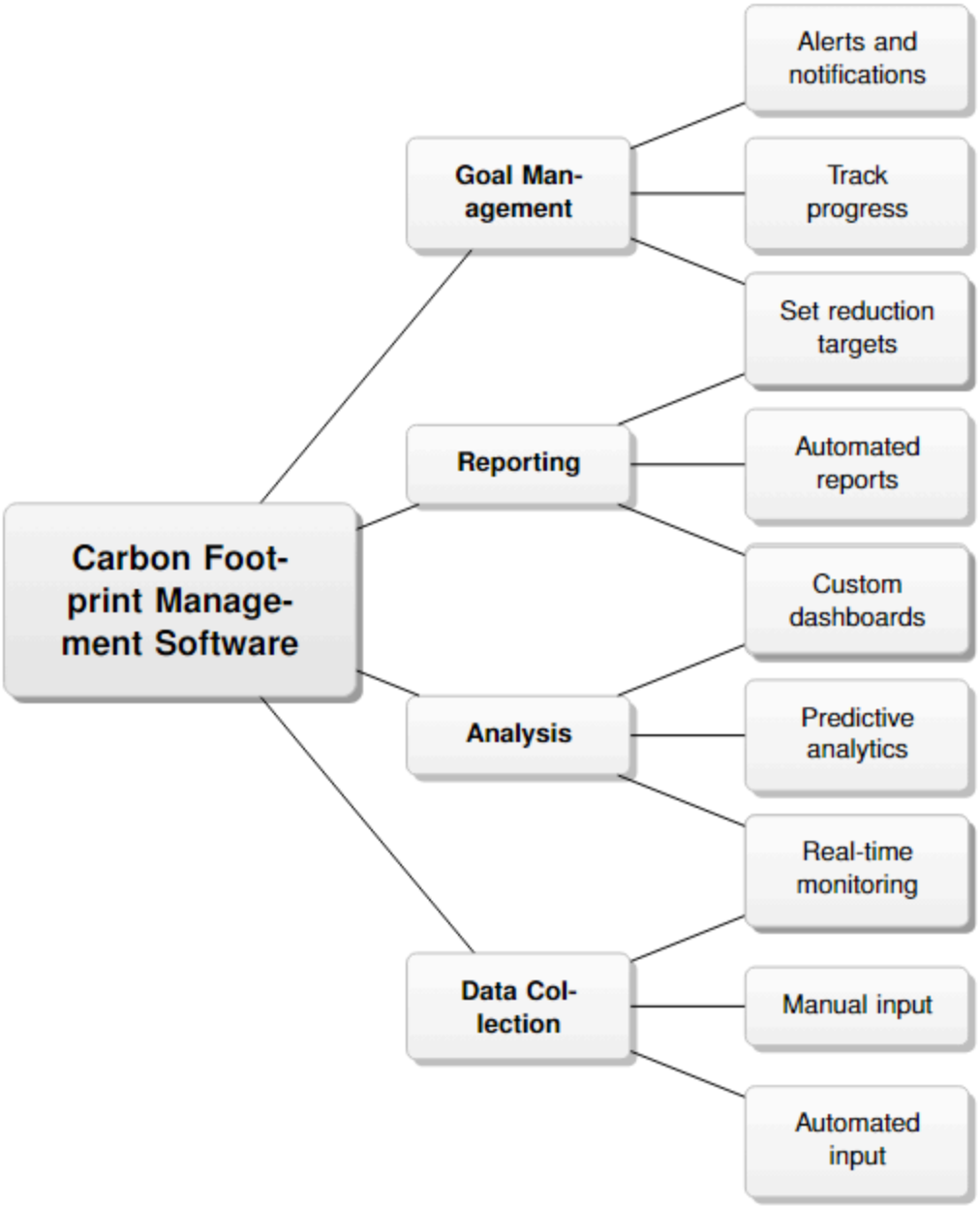
By leveraging these software solution properties, We can help businesses take a more systematic, data-driven approach to reducing their environmental impact. This not only helps in the fight against climate change but can also lead to increased efficiency and cost savings. This in fact demonstrates that environmental responsibility and business success can go hand in hand through our solution.

- **Initial Scope of the Software Solution** :

Our software solution addresses the carbon footprint challenge. This is done by providing companies with the resources they need to precisely measure, thoroughly examine, efficiently report their carbon emissions.It goes beyond simple tracking to provide useful insights and support well-informed decision-making throughout the enterprise.

In line with the growing emphasis on Scope 3 emissions in corporate sustainability goals. Our solution's scope takes into account not only direct emissions but also the entire supply chain. Businesses can adopt a proactive approach to carbon management by incorporating predictive capabilities and scenario modeling, which has the potential to result in considerable cost savings and enhanced environmental performance. Moreover, the inclusion of user management features ensures that the solution can be effectively implemented across different levels of the organization, promoting a culture of sustainability and shared responsibility for carbon reduction.

1. Data Collection and Integration Module:
    - Automated data import from various sources (e.g., energy meters, fleet management systems)
    - Manual data entry interface for non-automated sources
    - API integrations with third-party systems (e.g., supplier databases, utility providers)
2. Carbon Footprint Calculation Engine:
    - Real-time calculation of carbon emissions based on collected data
    - Support for Scope 1, 2, and 3 emissions calculations
    - Customizable emission factors database
3. Analytics and Reporting Dashboard:
    - Real-time monitoring of carbon emissions
    - Customizable dashboards for different user roles
    - Automated report generation (daily, weekly, monthly, annual)
    - Export functionality for various file formats (PDF, CSV, Excel)
4. Goal Setting and Tracking:
    - Functionality to set carbon reduction targets
    - Progress tracking against set goals
    - Alerts and notifications for deviations from targets
5. Scenario Modeling and Forecasting:
    - What-if analysis tools for different carbon reduction strategies
    - Predictive modeling for future emissions based on historical data and planned activities



The Above figure is a mind map to our project.

For reproducibility we are able to provide a latex code.

2. Market Analysis

2.1 Target Audience Identification

Many countries are realizing the long-term effects of carbon emissions and are now imposing carbon laws that businesses and industries are required to follow in an effort to reduce carbon emissions. Thus, monitoring and regulating carbon emissions become imperative for an organization, especially for industries that contribute the most towards carbon emission. It not only helps an organization to stay on track with the laws, but can also help reduce the overall manufacturing cost by reducing the overall fuel consumption.

- **Target Audience for the Software Solution**

  Agriculture sector: In Canada, the Agriculture sector was the fifth largest greenhouse gas emitter and accounted for 10% of total national emissions in terms of Carbon dioxide equivalent in 2022. This percentage has been increasing since 1990 and between 2005 and 2022 there was a 7% increase.

  Transportation sector: In 2022, the Transportation industry was the second largest emitter of carbon by products and accounted for 22% of total national emissions. Similar to the agriculture industry, these emissions have been constantly increasing since 1990.

  Oil and gas sector: It was the largest source of carbon emissions that accounted for 31% of the total national emissions and there has been an 83% increase from 1990 to 2022.

  Compliance officer: They ensure that the organization follows the government and environmental requirements and regulations. One of their roles entail monitoring and accounting the carbon emissions and introducing new carbon sustainability policies to further reduce the carbon emissions.

  Corporate Social Responsibility Department and Sustainability managers: They have a more direct impact on carbon footprint management in an organization. Their main goal is to ensure their organization is reducing its impact on the environment in terms of greenhouse and carbon emissions.

  Overall, even on a global scale, agriculture and forestry contribute around 15% of carbon emissions as of 2022 and a similar trend can be observed for the above sectors. Other sectors include, manufacturing, power, construction and food retail industry. In short, a reliable carbon footprint tracker is a necessary to make long term plans to reduce their carbon footprint and enhance sustainability,

- **Demographic and Psychographic Characteristics**:

Sectors: It includes any organization or individual who is environmentally conscious and has to adhere to the carbon laws set up by the government. They also include individuals who are responsible to make business decisions related to environmental impact and sustainability. Some of the roles in an organization who come under the demographic are Sustainability Managers, Corporate Social Responsibility managers, Compliance officers and Operations managers.

Geographic location: In general, developed countries have strict carbon laws in terms of high carbon tax per ton of carbon emissions, thus tracking emissions accurately and effectively becomes imperative. Poorer countries account for a relatively small percentage of emissions of carbon by products, thus, their government does not impose strict carbon laws. Thus, they are the primary target region. Countries such as Sweden and Norway have one of the highest carbon taxes. European countries on the whole have stricter carbon laws and are working on achieving net zero emissions like in Austria and Finland. The United Kingdom also plans to cut greenhouse gas emissions by 68% in terms of carbon equivalents by 2030. Canada also plans to achieve net zero emissions by 2050 and was regulated by the government by The Canadian Net-Zero Emissions Accountability Act which is in effect from 2021. Further, a few developing countries like Senegal have implemented carbon laws and this trend is expected to grow as awareness on global carbon emissions are increasing each year due to growth in sectors like agriculture.

Business scale: Small and medium scale organizations may not produce heavy carbon emissions compared to larger businesses thus, tracking carbon emissions may not be of high concern. However, in some cases they may require economical and affordable solutions to monitor carbon emissions. On the other hand, large organizations require a robust and comprehensive solution to track carbon emissions and to ensure that they are regulated and adhere to laws imposed by the government.

Psychographic characteristics:

Nowadays, more consumers have become environmentally conscious and are willing to pay more for a product that takes actions to reduce carbon footprint. Thus, companies that do not monitor and make efforts to reduce their carbon emissions are alienated from the market and are sometimes heavily criticized. Sometimes, marketing a product in terms of its reduction of carbon footprint, can give an edge over other competitors as it makes them stand out.

2.2 Competitor Analysis

- **Identification and Analysis of Competitors**:
  A **detailed competitor analysis** that explains competitors' business models, target audiences, and approaches to solving the problem, with examples of their software solutions.

Competitor Analysis for Carbon Footprint Monitoring Solutions

1. SAP Sustainability Solutions

- **Target Audience:** Large enterprises focused on integrating carbon tracking into their business processes.
- **Approach:** Tracks emissions across operations and ensures compliance with sustainability goals.

2. EcoStruxure Resource Advisor (Schneider Electric)

- **Target Audience:** Medium to large companies in energy-heavy industries.
- **Approach:** Provides real-time tracking of energy use and carbon emissions to boost efficiency..

3. Planetly

- **Target Audience:** Startups and medium-sized companies focused on simple carbon management.
- **Approach:** Automates carbon footprint tracking and provides tools to reduce and offset emissions.

4. Carbon Trust Footprint Calculator

- **Target Audience:** Small and medium businesses looking for simple carbon assessments.
- **Approach:** A free tool that helps calculate carbon emissions and suggests improvements.

5. Uplight

- **Target Audience:** Utilities and energy providers engaging customers in sustainability.
- **Approach:** Tracks energy usage and carbon impact, offering insights to reduce emissions.

Competitor SWOT Analysis :

Conduct a detailed analysis (Strengths, Weaknesses, Opportunities, and Threats), offering actionable insights that can influence your product features, marketing strategy, and positioning.

Competitor	Strengths	Weaknesses	Opportunities	Threats
SAP Sustainability Solutions	Comprehensive enterprise integration, trusted brand	High cost, complex implementation	Expansion into SMBs, partnerships in emerging markets	Competition from lower-cost cloud solutions, demand for simplicity
EcoStruxure Resource Advisor (Schneider Electric)	Real-time tracking, strong in energy-heavy industries	Steep learning curve, energy sector focus	Broaden to more industries, enhance data analytics	Rise of cloud-native solutions, multi-sector demand
Planetly	Simple interface, automated tracking, startup-friendly	Limited scalability for large firms, lacks advanced reporting	Scale with enterprise features, develop sophisticated analytics	Scale with enterprise features, develop sophisticated analytics
Carbon Trust Footprint Calculator	Free, easy to use for small businesses	Basic functionality, lacks real-time tracking	Premium version with advanced features, expand through partnerships	Competitors with better reporting and visualizations
Uplight	Utility-focused, strong customer engagement tools	Limited to utilities sector, relies on third-party integrations	Expand beyond utilities, enhance customer engagement features	Competitors offering holistic multi-sector platforms

A comparison matrix showing how your solution stacks up against competitors, with clear areas where it outperforms or falls short.

Comparison Matrix

Feature/ Competitor	SAP Sustainability	EcoStruxure	Planetly	Carbon Trust	Uplight	Proposed Solution
Automated Data Collection	Yes	Yes	Yes	No	Yes	Yes
Manual Data Entry	Yes	No	Yes	Yes	No	Yes
API Integrations	Yes	Yes	Yes	No	No	Yes
Real-Time Monitoring	Yes	Yes	No	No	Yes	Yes
Scope 1, 2, 3 Emissions	Yes	Yes (1, 2)	Yes(1, 2)	Yes(1, 2)	Yes(1, 2)	Yes
Custom Dashboards	No	Yes	Yes	Yes	Yes	Yes
Scenario Modeling	Yes	No	No	No	No	Yes
Affordability	High	Medium	Affordable	Free	Medium	Affordable

2.3 Business Values

- **Unique Selling Points (USPs)** :

1.**Comprehensive Scope Coverage**:

Our software solution offers real-time monitoring and calculations for Scope 1, 2, and 3 emissions, in contrast to many competitors. This enables companies to thoroughly monitor all emissions from the supply chain, including direct and indirect emissions, ensuring that no part of the carbon output is missed.

2. **Scenario Modeling and Predictive Analytics**:

   We provide sophisticated tools for scenario modeling so that companies can model various approaches to reducing carbon emissions. This special feature aids in the prediction of future emissions and the selection of the most practical course of action to achieve sustainability objectives.

3. **Affordability with Advanced Features**:

   While competing with SAP Sustainability Solutions, our product is more reasonably priced and still provides enterprise-level features like API integrations, automated data collection, and customizable dashboards. Because of this, it is available to both large and medium-sized businesses.

4. **User-Friendly Interface with Real-Time Monitoring**:The solution provides a seamless and intuitive user experience with real-time tracking and visualization of carbon emissions. This ensures that users at all levels, from sustainability managers to corporate executives, can easily interpret data and take action.

- **Value Proposition for Potential Users:**
  Our software offers a significant value proposition to businesses that are navigating complex sustainability requirements:

  1. **Cost Reduction**: By identifying carbon inefficiencies, companies can lower operational costs through optimized resource usage and reduced energy consumption.
  2. **Regulatory Compliance**: The platform ensures businesses remain compliant with rapidly evolving global carbon emission regulations, avoiding fines and legal risks.
  3. **Improved Brand Image**: Companies that demonstrate commitment to reducing their carbon footprint gain a competitive advantage, attracting environmentally conscious consumers and investors.
  4. **Scalable Across Industries**: From agriculture to transportation and oil & gas, the software is versatile and scalable across multiple industries with varying carbon emission needs.

- **Challenging Component:**
  One of the most challenging components of our value proposition is integrating comprehensive Scope 3 emissions tracking into the supply chain. However, the long-term benefits of this feature are significant:

  1. **Sustainability Leadership**: Businesses that effectively track and reduce their full carbon footprint, including Scope 3 emissions, position themselves as leaders in sustainability, gaining trust from stakeholders and partners.
  2. **Long-Term Cost Savings**: By using predictive analytics and scenario modeling, companies can make informed decisions that lead to long-term savings on energy and operational costs.

3. **Enhanced Market Position**: As regulations tighten and consumers become more eco-conscious, companies that adopt our solution will stand out in the marketplace as proactive, responsible, and future-focused.

    - An example of this is **Walmart's Project Gigaton**, where the company worked closely with suppliers to track and reduce emissions, leading to significant sustainability improvements while cutting costs.