Sustainable Finance Company Wikipedia Page using Large Language Models

Pong Yi Zhen
2302010497
Peking University Yuanpei College Exchange Student

Abstract

Large language models (LLMs) play a pivotal role in various Natural Language Processing (NLP) tasks. This study focuses on the application of LLMs in the realm of sustainable finance, specifically framing the task as closed-domain question answering. Leveraging on Retrieval-Augmented Generation (RAG) with top-k retrieval, this paper introduces an innovative approach that combines RAG with insights from Table of Contents (ToC), denoted as *RAG + ToC*. This method effectively addresses the problem of long inputs, under the assumption of structured data as inputs where ToC acts as an optimised filter for handling our query. In handling extensive outputs, we employ a conventional method of generating an outline, but tailored using RAG + ToC with chain of thought prompting. A new phenomenon of *Structure bias* of LLMs was also introduced in our analysis of outputs.

1. Introduction

With the escalating significance of Environmental, Social, and Governance (ESG) factors in the business landscape, there is a pressing need and large demand for consolidated material information. Information is material, as defined in the IFRS S1 General Requirements for Disclosure of Sustainability-related Financial Information[1], if omitting, misstating or obscuring that information could reasonably be expected to influence decisions that primary users of general purpose financial reports make on the basis of those reports. Despite the existence of Wikipedia pages for corresponding corporations, closer examination reveals a lack of specificity, particularly in the absence of dedicated sections addressing sustainability. This gap becomes increasingly glaring given the growing prominence of sustainability in the corporate sector.

Furthermore, despite the availability of quantitative ESG metrics such as MSCI, Morningstar, Moody's, and previously S&P, qualitative evaluations are gaining more traction. S&P for instance pioneered the removal of ESG quantitative metrics. While the direct verification by S&P remains unconfirmed, industry momentum suggests a broader shift toward qualitative sustainability assessments[2]. Hence, this paper aims to leverage on LLMs to aid companies and the public in ESG evaluation by generating consolidated sources, such as Wikipedia, from credible sources like sustainability reports.

[1] https://www.ifrs.org/content/dam/ifrs/publications/pdf-standards-issb/english/2023/issued/part-a/issb-2023-a-ifrs-s1-general-requirements-for-disclosure-of-sustainability-related-financial-information.pdf?bypass=on
[2] https://www.anthesisgroup.com/esg-ratings-is-this-the-beginning-of-the-end/

2. Background

In our exclusive focus on sustainable finance, we define our task as a closed-domain Question Answering (QA). LLMs have demonstrated considerable success in closed-domain QA. Retrieval-Augmented Generation (RAG) enhances the performance of a large language model by consulting an authoritative knowledge base external to its training data sources before generating a response.

LLMs, trained on extensive datasets with billions of parameters, excel in generating original output for various tasks such as answering questions, translating languages, and completing sentences. RAG builds upon the robust capabilities of LLMs, tailoring them to specific domains or an organization's internal knowledge base without necessitating model retraining. This cost-effective approach ensures that LLM output remains relevant, accurate, and useful across diverse contexts.

However, it is crucial to be mindful of the limitations inherent in LLMs, including their susceptibility to hallucinations. Consequently, the product positioning is Wikipedia, where users can typically leverage it for a high-level overview rather than directly referencing it as a credible source.

3. Experiment

The primary LLM employed in this study is the Mistral 7B model, featuring a sliding context window of 4K tokens. The technological stack utilised in the code comprises the Langchain LLM framework, OllamaEmbeddings for embeddings, and Chroma for Vector store, with the LLM hosted on Ollama.

For enhanced adaptability, the code can be readily modified to implement Yarn Mistral[3], which extends the context size up to 128K tokens, suitable for scenarios requiring a longer context window.

Throughout the content generation process, the LLM model's temperature is systematically adjusted, ranging from the default value of 0.8 to 2. This temperature adjustment facilitates the generation of more creative and varied output.

3.1 Information Retrieval and Filtering

To initiate the experiment, we utilized Nasdaq screeners[4] to select specific stocks. Subsequently, we manually extracted links to sustainability reports, a process that could have been optimised with web scraping. However, web scraping posed challenges, such as encountering multiple nomenclatures for sustainability reports, including Corporate Social Responsibility (CSR), ESG, and Health for Humanity reports. Google search API may be employed to overcome this in the future. Some of the selected stocks are listed in Table 1.

[3] https://ollama.ai/library/yarn-mistral
[4] https://www.nasdaq.com/market-activity/stocks/screener

Symbol	Name
AAPL	Apple Inc. Common Stock
JNJ	Johnson & Johnson Common Stock
PG	Procter & Gamble Company (The) Common Stock
BAC	Bank of America Corporation Common Stock
KO	Coca-Cola Company (The) Common Stock
BIDU	Baidu Inc. ADS
BABA	Alibaba Group Holding Limited American Depositary Shares each representing eight Ordinary share

Table 1: Selected Nasdaq stocks

It might be useful to note that not all companies may have dedicated sustainability reports and ESG reporting on Nasdaq remains on a voluntary basis[5]. Given the absence of such reports, conducting a meaningful ESG evaluation for those companies becomes questionable as sustainability reports serve as a minimal indicator of a company's stance toward its sustainability responsibilities. Therefore, there will be no need to generate their sustainability Wikipedia pages.

Given the valuable nature of such sustainability reports as standalone inputs, noise reduction in input dataset via extensive filtering or other methods is not employed. Nonetheless, more care can be employed on the choice of the PDF loader as it can affect the retention of information for images and tables.

3.2 Content generation

Utilising sustainability reports as inputs, we attempt to generate the corresponding Wikipedia page for the stock code. The Wikipedia page we expect would constitute of three sections: General Company Information, ESG Overview, ESG Approach as seen in Table 2.

Section	Name
Part A General Company Information	Company name, ISIN Code, Headquarters, founded in, founded by, Important People, website, Sustainability Report Name
Part B ESG Overview	Summary of ESG commitments, achievements
Part C ESG Approach	Policies, Material topics

Table 2: Expected structure of Wikipedia page

Naïve RAG Approach and Ideal Content Generation Pipeline In addressing the challenges posed by lengthy inputs and outputs, the naïve approach involves employing the RAG model to retrieve the top-k documents and generate content based on an outline. The RAG process

[5] https://www.nasdaq.com/ESG-Guide#:~:text=Nasdaq%20does%20not%20require%20the,strive%20to%20meet%20disclosure%20obligations.

comprises two key steps: the initial phase involves loading, splitting, and storing vectors in a dedicated vector store, while the subsequent step entails retrieving and generating content.

As our baseline method, for each stock code, we load the corresponding sustainability report into the vector store. Segmenting our target Wikipedia page into three distinct sections, as outlined in Table 2, we formulate specific queries for Part A, Part B, and Part C, respectively. Recognizing that Part C contains the most substantial content, we intentionally craft an outline before initiating the generation process. Furthermore, to ensure a seamless transition between sections, Part B is strategically designed to include a line providing a concise overview of Part C. For each query, we will retrieve the top 10 relevant documents and parse them into our LLM for further processing.

Since Part B requires content generated by Part C, the content generation pipeline, outlined in Figure 1, unfolds in the following sequence: Part A, Part C(i) outlining the ESG approach, Part C for each point in the outline, and finally, Part B offering an overview of the company's ESG approach. Specifically, Part A requires responses for eight fields: "Company name," "ISIN Code," "Headquarters," "Founded in," "Founded by," "Important People," "Website," and "Sustainability Report Name." Part B anticipates a summary of the company's commitments and achievements, along with a concluding line that encapsulates the essence of Part C.

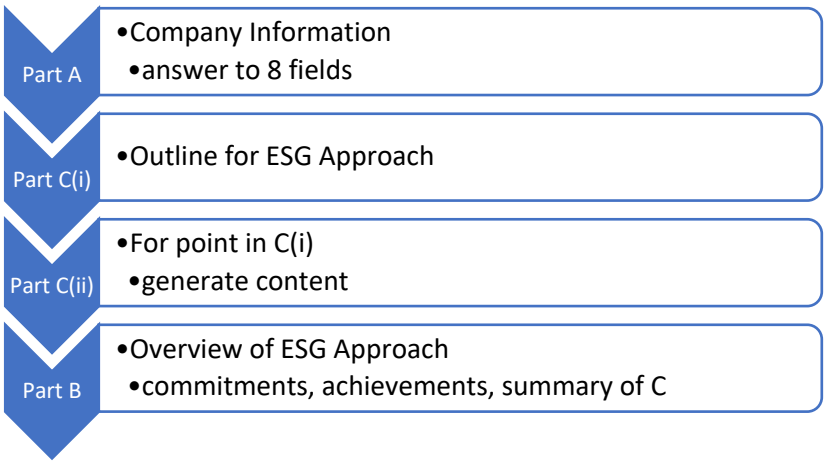


Figure 1: Content Generation Pipeline for every stock code

RAG + ToC Approach Building upon the base RAG approach, our objective is to enhance the customization of outlines in Part C(i), recognizing its pivotal role in generating a high-quality sustainable finance Wikipedia page tailored to the unique ESG approaches of each company. The fundamental concept behind the RAG + ToC approach involves acquiring an optimized filter, specifically the Table of Contents (ToC), directly from extensive inputs and subsequently delivering a high-level overview of desired outputs.

It is essential to highlight that this approach operates under the assumption that the high-level overview inputs are sufficient to generate desired responses and are, in fact, clearer than conventional methods of consolidating key themes in inputs. To clarify, while the ToC of sustainability reports might be adequate for producing the sustainable finance Wikipedia page, this may not hold true for the ToC of annual reports, for example. Hence, proper use cases should be defined on a case-by-case basis.

The ToC pipeline initiates with the first three pages of the report, followed by the extraction of ToC. Subsequently, non-material topics are removed as cleaned headers of ToC, and the

remaining material topics are ranked and prioritized, leading to the generation of a material topic list, as depicted in Figure 2. This pipeline leverages a chain of thought prompting[6], where the thought sequence is defined as the cognitive process guiding the extraction and prioritization of material topics. The chain of thought prompting involved in this pipeline allows the LLM to engage in longer contemplation, enhancing the output quality.

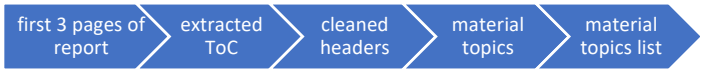


Figure 2: ToC pipeline with Chain-of-thought prompting

It is also crucial to highlight that we employed two LLMs for this process—one initialised to handle structured content, especially at the start and end of the ToC pipeline, and the other initialized to generate more creative content in the middle of the ToC pipeline. Detailed system prompts can be observed in Figure 3.

```
llm1:
“You are an expert at creating structured data"

llm2:
"""You are an expert at sustainable finance, ESG evaluation,
and a critical thinker that can quickly filter out irrelevant
information and pinpoint key ideas""", temperature = 2
```

Figure 3: LLM system prompts

Dealing with long inputs: ToC as an optimised filter A key assumption of our approach is that we are dealing with structured data, specifically PDF documents, wherein a ToC is consistently present at the beginning of the report. These PDFs represent highly valuable and inherently structured inputs, it is generally reliable to assume the presence of a ToC within the initial three pages of the report, especially a corporate report.

In our method, we leverage this assumption and instruct the LLM to extract the ToC from the first three pages of the report. This strategic choice not only saves valuable time that would be spent sifting through the inputs to gather key themes but also serves as a readily available, clean filter for the inputs. This is a crucial step, given that relying solely on a pure RAG can yield suboptimal results.

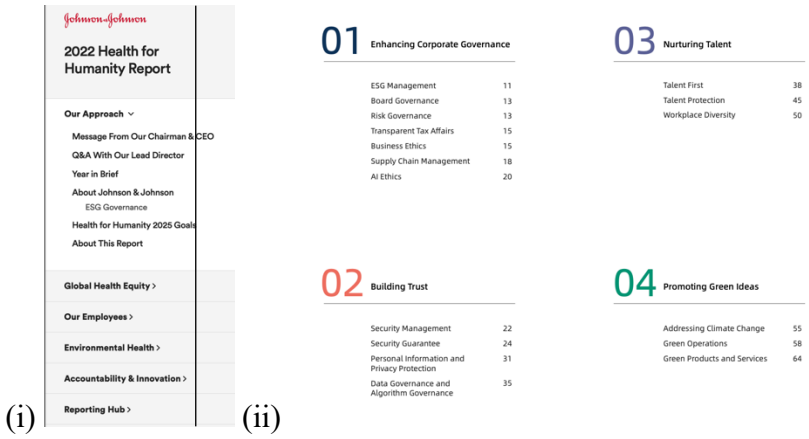
As illustrated in Figure 4, the pure RAG outline identified regions as key themes related to ESG Approaches, a categorization that is clearly inaccurate. This example underscores the necessity of integrating the ToC as a filtering mechanism to enhance the accuracy and reliability of the content generation process.

[6] https://arxiv.org/pdf/2201.11903.pdf

```
Gender representation in workforce
 Asia Pacific: 49.4%
 Europe
 Middle East & Africa: 50.7%
 Latin America: 54.6%
 North America: 47.5%
 EH&S compliances and fines
 Number of certified sites to ISO 14001: 87. ```
```

Figure 4: JNJ ESG Approach outline via Naïve RAG method

Nonetheless, challenges arise with the assumption that the ToC is consistently positioned within the initial three pages. Primarily, the complete ToC might not be found in the initial pages due to document structure, as illustrated in Figure 5i. Secondly, the ToC may be ordered differently, impacting the accuracy of its extraction, as demonstrated in Figure 5ii. Thirdly, in cases where reports incorporate images instead of text, the selection of the PDF loader becomes vital.



(i) (ii)

Figure 5: Examples of Contents page that may be problematic

After conducting multiple experiments, we determined that the most accurate method for ToC retrieval involves explicitly using the term 'extract' to ensure precision. Additionally, there is no requirement to utilise the retriever for obtaining the top k documents, as we are directly referencing the first three pages. Interestingly, referencing the top k documents appeared to result in less satisfactory outcomes.

Dealing with long outputs: Improved customised outline After obtaining high-level inputs, we instructed the LLM to eliminate rows in the ToC that do not align with material topics. Material topics, in this context, denote topics that signify an organisation's most significant impacts on the economy, environment, and people, including impacts on their human rights. In simpler terms, material topics constitute overarching themes that encapsulate the Environmental, Social, and Governance (ESG) approach of a company.

Following this step, we directed the LLM to reorder the material topics based on their importance. This chain of thought process is guided by the methodology outlined in the

guidance published by the Global Reporting Initiative (GRI) for determining material topics, as depicted in Figure 6.

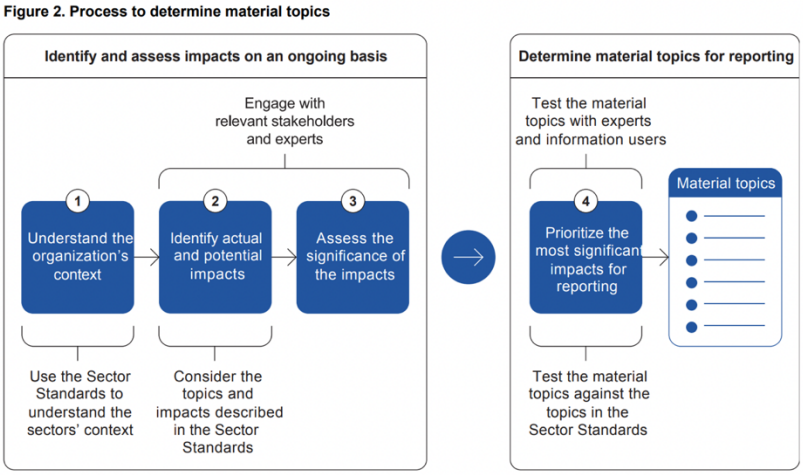


Figure 6: GRI guidance for identifying material topics[7]

Finally, we prompted the llm to generate the list. The decision to include an extra step and not directly rely on structured or list-format output parsers in the previous step was deliberate. Our experimentation revealed that leveraging different LLMs, especially those with a more creative inclination, tended to yield suboptimal results. By following this approach, we have successfully obtained an enhanced outline for Part C(i)

4. Discussion and Evaluation

A combination of human evaluation and automated evaluation metrics was employed to assess the performance of our approach. The evaluation process was divided into utilising human evaluation for Part A with retrieved ground truths, and automated evaluation metrics for Parts B and C.

For the assessment of Part A, we utilised Google search to extract the ground truth for each stock code. Subsequently, we compared the contents of the 8 fields generated by the LLM with the ground truth. Each field received a binary evaluation, with a score of 1 indicating factual correctness. No credit was given for fields that were partially correct, such as instances where the surname was incorrect in the 'Important People' field. We further categorized the fields into absolute or relative truth. Absolute truth denotes information that is typically static, where any two people would arrive at the same answer, for example, ISIN code. Relative truth pertains to information that is debatable, such as the field 'important people,' where determining the extent of importance is subjective. Lastly, we provided reasons for the binary evaluation, with 'NA' applied to absolute fields or fields marked as correct. The structure of the evaluation is depicted in Figure 7, and the scores are presented in Table 3. It is important to note that ISIN codes, intentionally not present in the sustainability report, were included to assess if the LLM would hallucinate or generate incorrect information. Most results in this field were incorrect though some credit would be given for the LLM's ability to understand the structure of ISIN codes as 12-character alphanumeric codes.

[7] https://www.sustainalytics.com/material-esg-issues-resource-center

```
{Stock code 1:
    "Field 1": {
        "Eval": 0 or 1
        "Type": "Absolute / Relative"
        "Reason": NA / Any long text},
… ,
    "Field n": {…}
},
…,
{Stock code m: …}
```

Figure 7: Part A Evaluation structure

Symbol	Score out of 8	Fields wrong
AAPL	8	-
JNJ	7	['ISIN Code']
PG	5	['ISIN Code', 'founded by', 'Important People']
BAC	6	['ISIN Code', 'Sustainability Report Name']
KO	6	['founded by', 'Sustainability Report Name']
BIDU	7	['ISIN Code']
BABA	3	['Company name', 'ISIN Code', 'founded by', 'Important People', 'Sustainability Report Name']

Table 3: Score for Part A Evaluation

For evaluating Parts B and C, we primarily utilised two tools: the Automated Readability Index (ARI) for assessing readability scores and the LanguageTool in Python for grammar analysis. ARI is a metric designed to gauge the readability of text, providing insights into the complexity of the language used. It's important to note that ARI always rounds up to the nearest whole number. Additionally, the LanguageTool checks for grammar issues across various domains, including but not limited to typos, style, redundancy, nonstandard phrases, typography, miscellaneous errors, and grammar.

The summary of scores from these evaluations is presented in Table 4. It is worth noting that the most outstanding error identified was typos, though upon closer examination, it became apparent that the tool also flagged instances such as last names as errors. The ARI scores for all the Wikipedia page section B and C are relatively high, indicating that the text caters to college graduates in the age group ranging from 24 to 100 years old. While this suggests that the text might be challenging to read, it's crucial to consider that the presence of technical terms inherent in sustainable finance could contribute to the observed challenges in readability.

Symbol	Part	ARI score	Number of words	Number of language errors
AAPL	B	16	1787	2

	C	19	59693	43
JNJ	B	17	1471	0
	C	20	64741	131
PG	B	20	2127	0
	C	19	13974	21
BAC	B	18	2321	9
	C	21	22442	22
KO	B	20	2388	5
	C	13	135388	93
BIDU	B	22	2218	1
	C	21	9039	5
BABA	B	22	2367	2
	C	21	72983	77

Table 4: Part B and C Evaluation

Structure bias – a new phenomenon observed in LLMs An insightful revelation from our analysis of outputs is how LLMs face challenges in restructuring information. This challenge is characterized by a notable inclination to retain the information in the same structure as initially inputted. In this paper, we propose the term "*structure bias*" to encapsulate this new phenomenon. Several key observations highlight the manifestations of structure bias:

Observation	Simple Example to illustrate
Directly splitting the ToC and outputting it as two dictionaries for the material topics	ToC: {A, B, C, D, E, F, G} Desired material topics: {A,B,D,F} Output: [{A, B, C}, {D, E, F, G}]
Unable to group clear themes together	Item to categorise: {Dog A, Dog B, Cat A, Cat B} Desired output: [Dog, Cat] Output: [Dog A, Dog B, Cat A, Cat B]
Returning information in the prompt but not in retrieved documents	Prompt = #some reporting framework keywords eg GRI, IFRS, etc Desired output: Framework A, B used that is in the sustainability report Output: GRI, IFRS

Table 5: Examples of Structure bias

While this is possibly attributed to the choice of a low parameter LLM, further investigation is warranted. Intriguingly, we exploit structure bias to our advantage in generating Part Ci from ToC and directing our search in Part Cii. However, recognising the broader implications of this phenomenon, we assert its significance for further investigation where emphasis can be driven on imparting models the ability to forget, not just to remember. This also prompts an inquiry into whether structure bias persists as a challenge across LLMs with higher parameters and when subjected to different prompts.

5. Future work

There are two key areas of future work to explore. One is the scalability of the project and the other is new developments.

The scalability of the project holds promising avenues for expansion, in three main areas: content-wise, minor features, major features. Firstly, for content, an ESG news section may be incorporated catering to the demand for timely information in ESG evaluations. Additionally, updating with past-year reports becomes imperative to observe improvements and changes in ESG approaches, and access if companies are setting optimal targets or relatively easy bars for themselves. Secondly, minor features that can contribute to project efficiency. This includes the implementation of web scraping for report URLs to expedite the process, introducing a source-based retriever, exploring additional evaluation methods such as the Google Search API[8] for quicker accuracy checks, evaluating the impact of different vector stores on the system, investigating the influence of the PDF loader are all areas worth delving into. Lastly, in terms of major features, the integration of a tree of thoughts implementation is a significant avenue for exploration. Addressing the challenge of reducing hallucinations further, as proposed by external resources such as the project on Wikichat[9], could also significantly enhance the model's performance.

Areas that warrant in-depth study include the phenomenon of structure bias. Exploring whether this bias is applicable to high-parameter models and considering approaches to teach models to forget, rather than just remember, present intriguing research directions. Moreover, the Rag+ToC approach, which has proven effective in handling long inputs, prompts further investigation to identify other use cases where the ToC serves as an optimal filter for queries. This could unveil new dimensions and applications for the RAG + ToC methodology.

6. Conclusion

In conclusion, this study delved into the transformative application of LLMs and introduced a pioneering approach RAG + ToC, which assumes a structured data input scenario where ToC operates as a refined filter for query resolution and is complemented by chain-of-thought prompting. Furthermore, our analysis uncovered a noteworthy phenomenon termed "Structure Bias" inherent in LLMs, where these models exhibit a proclivity to retain input structures in their outputs.

[8] https://serpapi.com/search-api
[9] https://github.com/stanford-oval/WikiChat

Appendix A: Wikipedia page content outputs

All code is available at https://github.com/yizhenpong/Sustainable-Finance-Company-Wiki-page-with-Langchain/.

Wikipedia page for each <stock code> in Table 1 is stored in:

`output_ToC/<stock_code>/Company_info.json`
`output_ToC/<stock_code>/ESG_overview.txt`
`output_ToC/<stock_code>/ESG_approach.txt`

Only one example will be featured here. Please refer to the link above for the Wikipedia pages generated for all stocks listed in Table 1.

Stock code: AAPL

Section	Generated Content
Part A General Company Info	{"Company name": "Apple Inc.", "ISIN Code": "US0378331005", "Headquarters": "Cupertino, California, United States", "founded in": "April 1, 1976", "founded by": "Steve Jobs, Steve Wozniak, and Ronald Wayne", "Important People": "Tim Cook (CEO)", "Website": "https://www.apple.com/", "Sustainability Report Name": "Apple's Environmental Progress Report"}
Part B ESG Overview	Apple is a technology company with a strong commitment to sustainable practices and reducing its environmental footprint. The company's Environmental Progress Report for 2023 outlines its efforts to address climate change, smarter chemistry, and resources. (1) In the area of climate change, Apple has continued to make significant progress in reducing its emissions. In 2022, the company avoided over 28 million metric tons of emissions across all scopes through initiatives like sourcing 100% renewable electricity for facilities and transitioning suppliers to renewable energy. Apple is aiming for net zero carbon emissions by 2030 and carbon neutrality by 2050. (6, 7) Regarding smarter chemistry, Apple has set goals to eliminate plastics from its packaging by 2025 and is working on developing intelligent disassembly technology to improve material recovery. (5, 8) When it comes to resources, Apple reported using 1,527 million gallons of water worldwide in occupied properties, with 679 million gallons of that being water discharge. The company also disposed of 15,086 metric tonnes of trash in landfill and 1,261 metric tonnes of hazardous waste. However, Apple also recycled 35,583 metric tonnes of material and composted 3,958 metric tonnes of material. (2) Additionally, Apple is taking steps to address water use in its manufacturing processes and aims to eliminate water use in production entirely by 2030. The company also aims to eliminate all other waste from its operations and products by the same year. (3)

Apple's sustainable commitments and achievements are aligned with themes such as climate change, goals and progress, our approach, direct emissions abatement, carbon removal, clean electricity, materials, water, and zero waste.

Part C ESG Approach

Sub header: "1. Climate Change

Title: Apple's Commitment to Sustainable Finance and Climate Change Solutions

Apple is a leading technology company that not only recognizes the impact of climate change but also actively promotes solutions that significantly reduce emissions. In their 2023 Environmental Progress Report, Apple expresses their confidence in the public and advocacy for equitable and just climate policies (Apple, 2023). They believe both corporate and regulatory action are crucial to prevent the worst impacts of climate change.

Apple acknowledges renewable energy as a versatile energy carrier used for household, industrial, and transportation purposes. The report also highlights their investments in carbon removal projects, aiming for over 75 percent emissions reduction (Apple, 2023). To address nonelectricity emissions, Apple's Restore Fund is focused on sustainably managed forests, creating revenue from timber while generating high-quality carbon credits.

Supportive of a just climate transition, Apple advocates for policies that enable cost-effective and accessible renewable energy. They collaborate with RE100, an initiative that aims to bring the world's most influential businesses towards using 100 percent renewable electricity. Furthermore, they cofounded the Asia Clean Energy Coalition to enact critical policy shifts in Asia, enabling a variety of corporate procurement options for renewable energy.

Apple emphasizes increasing access to clean energy globally. In South Africa, Apple's projects provide access to electricity for families to cook and children to do homework at night. The company also offers over 1670 EV charging stations and 3200 ports across their U.S.-based campuses (Apple, 2023). In Japan, new renewable energy options have the potential to scale access to renewable energy in the market.

Together with their suppliers, Apple has more than tripled the amount of renewable electricity online in their supply chain within the last two years (Apple, 2023). Over 85 percent of Apple's direct spend for materials, manufacturing, and assembly of products worldwide is now committed to using renewable electricity.

Apple has actively taken part in various advocacy efforts to encourage rapid integration of renewable energy to the transmission grid and support EPA's authority to regulate greenhouse gases from power plants (Apple, 2023). Their proactive stance on climate change initiatives showcases their dedication to driving positive change for a more sustainable future.

Sub header: Goals and progress

PACE, or Apple's Political Advocacy and Government Relations team, plays a pivotal role in driving the tech giant's environmental goals by engaging key global events and stakeholders across governments, the private sector, and civil society. Their initiatives focus on circular economy policies and improving industry engagement towards more sustainable practices (1).

One of PACE's significant areas of focus is enhancing packaging recyclability. Apple has implemented new design guidelines that call for the use of fiber-based materials in their packaging to increase its overall recyclability (2). By using materials that can be broken down to pulp as part of mixed-paper recycling streams, Apple intends to implement these changes across all its products, with the ultimate goal of eliminating plastics from their packaging.

Apple has recognized that obtaining complete traceability information for all its materials might be challenging since not all suppliers provide details about their sourcing practices. As they work on scaling up the use of high-quality recycled or renewable materials, they aim to ensure a transparent supply chain (3). Moreover, regulatory barriers such as international shipping regulations can pose challenges in effectively recovering and redistributing materials to optimal refining facilities, inhibiting circular production processes (4).

The tech giant is taking measures to address these issues by evaluating the positions of U.S. federal trade associations on climate policy, engaging them in discussions, and advocating for policy changes that promote a circular economy and sustainable manufacturing (5). In line with this approach, they have significantly reduced their reliance on non-renewable energy sources, focusing instead on renewables such as solar, wind, hydroelectric, and biogas.

Furthermore, Apple has taken a proactive stance in social responsibility by addressing issues of labor and human rights, health and safety, and environmental stewardship throughout their supply chain (6). In an ongoing commitment to sustainability and inclusivity, they continuously explore ways to dismantle systemic barriers that create opportunities for underrepresented communities and work towards achieving a more equitable society.

Sub header: Our approach

Apple's approach to supply chain management is driven by a commitment to health and environmental risks, with a focus on effective collaboration and the promotion of smarter chemistry across the industry. Apple uses its Regulated Substance Specification (RSS) to evaluate the potential risks of chemicals used in its products and manufacturing processes. This strategy informs product design by driving internal teams and supply chain partners to select materials that meet Apple's requirements.

Manufacturing is a key focus area for Apple, with the company requiring suppliers to manage materials and chemicals and helping them switch to safer alternatives. By encouraging the use of safer chemistries, Apple is creating a market for better alternatives, and lending its expertise to support supplier efforts to prioritize safer materials. This approach not only supports circular economies but also promotes safer work environments for people across the supply chain.

Apple's commitment to renewable energy is another important aspect of its smarter chemistry strategy. Through various programs such as renewable energy pilots and expert guidance, Apple helps suppliers transition to 100% renewable electricity. Apple also supports the creation and growth of renewable energy industry associations for its suppliers. These efforts encourage suppliers to prioritize safer materials, fostering partnerships and shared progress towards a more sustainable industry.

Apple collects detailed chemical information on its products, with 93% collected on average for all iPhone, iPad, and Mac products released in 2022. This comprehensive understanding of the materials in Apple's products allows for informed decisions when it comes to health and environmental risks. Apple also practices transparency by storing over 47,000 validated materials in its comprehensive materials library and making this information available to regulatory bodies.

Collaboration is an essential part of Apple's approach, with the company engaging industry leaders and stakeholders on key global events and environmental policy. Through its engagement in China and other initiatives, Apple influences change through policy advocacy and direct engagement, helping drive progress towards circular economies and smarter chemistry.

Sub header: Direct emissions abatement

Title: Direct Emissions Abatement and Smarter Chemistry Initiatives by PACE

PACE, a leading company in sustainable finance and Environmental, Social, and Governance (ESG) evaluation, has been actively engaging in various initiatives to reduce direct emissions and promote smarter chemistry within its operations and across the industry. These efforts not only contribute to the company's own environmental goals but also create market trends that prioritize safer alternatives and encourage the elimination of harmful substances and practices.

One of PACE's primary strategies is encouraging the use of safer chemicals in their products and processes. By working closely with suppliers and providing expertise on alternative chemistries, PACE drives change within the industry. Their commitment to phasing out harmful chemicals also incentivizes other companies to follow suit. This not only benefits human health by minimizing exposure to hazardous substances but also helps minimize environmental risks and contributes to circular economy initiatives.

PACE's initiatives extend beyond its immediate supply chain as well. For instance, they aim to eliminate plastics from their packaging by 2025 through partnership with the Ellen MacArthur Foundation. This ambitious goal will contribute significantly towards reducing waste and supporting a circular economy. Moreover, PACE collaborates with organizations like Conservation International to create business models and approaches for ecosystem protection, emphasizing the importance of environmental stewardship in meeting global climate goals.

Another crucial area where PACE demonstrates leadership is through energy innovation and transitioning to renewable resources. They recognize the potential benefits of various forms of renewable energy, such as biomass, solar, and wind energy, which serve not only as versatile fuel sources for households, industry, and transportation but also contribute towards reducing greenhouse gas emissions.

Furthermore, PACE prioritizes equity and justice in climate solutions, believing that policies supporting the new green economy should create job opportunities centered around advancing clean innovation. Additionally, they recognize communities that have been disproportionately impacted by climate change as key stakeholders who should benefit from the economic opportunities of potential solutions.

By advocating for smarter chemistry and renewable energy, PACE is fostering partnerships and shared efforts to create a more sustainable future, promoting public policies to reduce greenhouse gas emissions, and addressing the human health and environmental risks associated with chemicals through their materials library and regulatory requirements. Through these initiatives and engagement at key global events, they are making a significant impact in achieving collective environmental goals while prioritizing equity and social responsibility.

Sub header: Carbon removal,

2. Smarter Chemistry

Title: Smarter Chemistry and Carbon Removal at Apple: A Commitment to Safer Materials and Processes

Apple's Smarter Chemistry initiative is a crucial aspect of the tech giant's sustainable finance and Environmental, Social, and Governance (ESG) efforts. By focusing on safer chemicals in their products and manufacturing processes, Apple aims to minimize both human health risks and environmental impacts (1).

Since 2018, Apple has proactively influenced its supply chain by providing a list of approved cleaners and degreasers that are free from harmful substances (2). This initiative not only makes workplaces safer for people but also allows them to identify over 19,000 unique materials used in the manufacturing process. Through these efforts, Apple contributes to a healthier work environment for individuals throughout its supply chain (3).

In an ongoing mission to reduce potentially hazardous substances like Per- and Polyfluoroalkyl Substances (PFAS) in their products, Apple is committed to eliminating these chemicals entirely from their manufacturing processes. By lending their expertise on safer chemistries, Apple helps encourage their suppliers to adopt alternative materials, driving the demand for smarter alternatives within the industry (4).

Apple's commitment extends beyond its own product line. They assess potential human health and environmental risks of chemicals to evaluate compliance with regulatory requirements and inform product design (5). Furthermore, they collaborate with standard-setting bodies, trade associations, and NGOs to create stricter guidelines and push for the identification and adoption of smarter chemicals throughout their supply chain (6).

In the past decade, Apple has made significant progress towards avoiding harmful substances in its products. They have performed toxicological assessments on over 1300 materials to evaluate and eliminate potentially hazardous substances (7). Apple also led an industry standard group that developed and published a new standard for the use of safer cleaners in electronics manufacturing in 2022.

Moreover, Apple has integrated over 47,000 validated materials into their comprehensive material library (8) and collects detailed chemical information on these materials, as well as how they're used by their suppliers (9). By achieving such milestones, Apple sets an example for other tech companies in driving the integration of smarter chemistry innovation and comprehensive reporting of chemicals used within their supply chains.

Through initiatives like Smarter Chemistry and Carbon Removal, Apple demonstrates its unwavering commitment to minimizing human health risks and environmental impacts in manufacturing. By focusing on cleaner processes and alternative materials, the tech giant leads by example, promoting a greener future for the electronics industry.

Sub header: Goals and progress

Paragraph 1: Apple's commitment to environmental goals extends beyond its operations, emphasizing the importance of community engagement and global collaboration. The company participates in key events through PACE (Politics, Activism & Civic Engagement), serving as a crucial platform for advancing circular economy solutions across various sectors, including governments, private enterprises, and civil society. More details about Apple's stance on circular economy policy can be found on page 47.

Paragraph 2: Apple is also working towards improving the recyclability of its packaging, implementing guidelines that call for fiber-based materials, such as cereal boxes, to support mixed-paper recycling streams. The use of overprint varnish instead of plastic lamination helps reduce plastic in the company's packaging. While eliminating plastics is a goal, Apple continues monitoring international packaging standards and innovations to ensure continued progress.

Paragraph 3: Traceability of materials can be a challenge for large organizations like Apple due to limited available information regarding their sources – mined, recycled, or renewable. Scaling up the use of high-quality recycled or renewable materials poses another challenge given the potential exponential increase in effort required. Furthermore, regulatory barriers, such as transboundary movement regulations, can restrict the recovery and reuse of materials for best-in-class recyclers or refiners. Apple is an advocate for policies that support circular supply chains while improving social and environmental protections.

Paragraph 4: Engaging with industry partners is another essential aspect of Apple's sustainability efforts. The company works with trade associations in the U.S., evaluating their climate positions, identifying misalignments, and working to reduce these gaps. By engaging with partners, Apple can help push for progress on critical environmental issues like climate change.

Paragraph 5: Apple is committed to dismantling systemic barriers to opportunity and addressing injustices faced by communities of color across its global supply chain. The company upholds the highest standards of labor and human rights, health and safety, and environmental stewardship while promoting a sustainable future for all. Additional details on these initiatives can be found in Apple's People and Environment in Our Supply Chain annual progress report.

Sub header: Our approach

Apple's approach to sustainable finance and environmental, social, and governance (ESG) considerations in its supply chain is centered around smarter chemistry and collaboration. The company uses a Regulated Substance Specification to guide both internal teams and supply chain partners in selecting materials that meet Apple's requirements, aiming for safer alternatives.

Product design is informed by assessing potential human health and environmental risks of chemicals to ensure compliance with the company's specifications. Apple engages its industry partners to promote safer chemistries through collaboration, helping drive change towards eliminating harmful substances in their products and manufacturing processes. This progress contributes to building responsible circular economies at scale.

In addition to product design, Apple focuses on manufacturing processes by requiring suppliers to manage materials and chemicals more safely. Recycling initiatives aim to recover safer materials for use in new products. The company's commitment to smarter chemistry matters at every stage of the product life cycle.

Moreover, Apple is an active participant in industry engagement, particularly in China where it leads environmental protection and energy efficiency working groups. By sharing its expertise on renewable energy and engaging with policy makers and other companies, Apple creates opportunities for change and drives growth towards more sustainable practices within industries and the wider society.

Apple also supports suppliers through initiatives such as providing training resources, renewable energy advocacy networks, and expert-led trainings on safer chemistries to encourage priority on safer alternatives. The company is actively reducing chemicals of concern by phasing out those that don't meet their specifications. In addition, Apple has donated resources for a public training platform accessible to businesses across different industries, providing guidance to companies on implementing renewable energy solutions and access to advocacy networks.

These programs and the Regulated Substance Specification allow Apple to engage in ongoing training with suppliers and foster partnerships promoting smarter chemistry in their products and processes. As of 2023, over 47,000 validated materials are stored in Apple's comprehensive materials library, with detailed chemical information collected for most products. Through its various initiatives, Apple is not only improving the safety and sustainability within its supply chain but also creating opportunities for widespread change across industries.

Sub header: Assessment and management,

3. Resources

Title: Assessment and Management of Sustainability in Apple's Supply Chain: Resources and Waste Reduction

Apple, a pioneering technology company, demonstrates its commitment to sustainable finance through rigorous assessment and management practices in its supply chain. One significant aspect of this dedication is resource efficiency and waste reduction. Let's delve into some examples from Apple's 2023 Environmental Progress Report.

First, Apple integrates extensive testing for rugged device components, applying processes at scale to ensure their durability under a variety of conditions. These tests simulate extreme temperatures, high altitude, vibration, and other environmental stressors, contributing to the longevity and value retention of Apple products (BankMyCell, 2021-2022's Phone Depreciation Report). This strategy reduces the need for consumers to replace their devices frequently and, by extension, decreases the demand for new resources.

Furthermore, Apple aims to enhance its circular economy efforts by enabling more efficient repair programs and increasing the recovery of recyclable materials from older devices. With the expansion of its Self Service Repair program to Europe (Apple, 2022), customers can perform repairs on select iPhone models, MacBooks, and displays themselves, reducing overall e-waste generation. Simultaneously, Apple invests in technologies such as robotics and machine learning for more accurate material recovery (Apple, 2023).

Lastly, the company strives to divert waste from landfills through its Zero Waste Program. Over 150 of Apple's supplier facilities are now zero-waste verified, diverting an impressive 2.5 million metric tons of waste (Apple, 2023). Such achievements significantly minimize the environmental impact of manufacturing processes while fostering a more sustainable supply chain overall.

References:

1. BankMyCell (2021-2022). Phone Depreciation Report. Retrieved from https://www.bankmycell.com/reports
2. Apple (2022, December 9). Apple Self Service Repair Program Expands to Europe. Retrieved from https://www.apple.com/newsroom/2022/12/apple-self-service-repair-program-expands-to-europe
3. Apple (2023, February 8). 2023 Environmental Progress Report: Climate Change, Smarter Chemistry, Engagement and Advocacy. Retrieved from https://reportshq.apple.com/environment-reports/climate/2023/en/
4. Apple (n.d.). People and Environment in Our Supply Chain Progress Report. Retrieved from https://www.apple.com/supplier-responsibility
5. Apple (n.d.). Conflict Minerals Report. Retrieved from https://www.apple.com/supplier-responsibility/conflict-minerals
6. Apex Companies, LLC (2023). Independent Assurance Statement for Apple Inc.'s Supplier Energy Efficiency Program. Retrieved from https://www.apple.com/supplier-responsibility

Sub header: Goals and progress

PACE, or Apple's Political Advocacy and Corporate Engagement team, plays a crucial role in achieving the tech giant's environmental goals. Through participation in international events and forums, PACE fosters dialogue between governments, the private sector, and civil society to pursue sustainable solutions (1).

Apple is taking significant steps towards improving the recyclability of their packaging. The company's packaging design guidelines mandate the use of fiber-based materials, which are compatible with mixed-paper recycling streams (2). By adhering to these guidelines, Apple aims to eliminate plastics from its packaging entirely (3). This approach has the potential to reduce Apple's overall plastic usage across their product line.

However, achieving such ambitious targets comes with challenges. The traceability of raw materials and their origins might not be readily available for Apple. In some cases, materials for a single component could originate from hundreds of different suppliers (4). Additionally, regulatory barriers can hinder the movement and recovery of materials across international borders. Transboundary regulations are essential for protecting communities and environments, but they can sometimes inhibit the efficient flow of recycled materials between best-in-class recyclers and refiners (5).

Despite these hurdles, Apple is committed to implementing more eco-friendly packaging solutions while adhering to evolving international packaging standards. Their innovations range from overprint varnish as a replacement for plastic laminates to alternative materials that maintain their functionality while being easier to recycle (3).

Apple's dedication extends beyond just their packaging. The company has also made strides in reducing the carbon footprints of its products through the use of renewable energy sources such as solar, wind, and biogas fuel cells (6-8). However, despite these advancements, challenges remain. The mining, production, and disposal of raw materials can have a significant impact on communities and the environment. Apple aims to uphold high standards of labor and human rights, health and safety, and environmental stewardship across its global supply chain while dismantling systemic barriers to opportunity and combating injustices faced by underrepresented communities (9).

In conclusion, PACE's work on Apple's sustainability efforts encompasses various aspects such as the promotion of circular economy policies, improvement of recyclable packaging, adherence to evolving international standards, and engagement with relevant stakeholders. Though challenges exist, Apple remains committed to working towards more sustainable practices while continually improving their products and processes.

Sub header: Our approach

Apple's approach to sustainable finance and Environmental, Social, and Governance (ESG) evaluation, specifically regarding supply chain and the use of chemicals, is characterized by transparency, collaboration, and a commitment to driving change within the industry. Apple utilizes its Regulated Substance Specification to ensure that both internal teams and supply chain partners select materials that meet the company's stringent requirements.

The importance of assessing human health and environmental risks associated with chemicals is a core component of Apple's smarter chemistry strategy. Through ongoing engagement with suppliers, Apple fosters partnerships and promotes the use of safer materials, creating a market for alternatives and encouraging industry-wide progress towards building circular economies. Apple also invests in renewable energy initiatives to reduce reliance on harmful chemicals and support the growth of the renewable energy industry.

In China, Apple takes an active role in leading environmental protection and energy efficiency working groups, engaging with other companies and policy makers to comply with new regulations and future standards. By sharing expertise and experiences, Apple strives to realize common goals related to climate, resources, and smarter chemistry.

Moreover, Apple's comprehensive materials library holds over 47,000 validated materials, providing detailed chemical information for a significant portion of their products. The company aims to reduce the use of chemicals that don't meet its specifications and prioritize safer alternatives to create a sustainable supply chain. In addition, Apple works with suppliers to implement renewable energy projects, reducing reliance on potentially harmful chemicals while also contributing to cleaner work environments across the industry.

Through ongoing training programs, supplier partnerships, and the expansion of renewable energy initiatives, Apple fosters collaboration, knowledge sharing, and change within its industry. This collective effort helps build a more sustainable future for all involved, creating a market for smarter chemistry and circular economies at scale.

Sub header: Materials

Title: Materials and Energy Management in Apple's Sustainability Efforts

Apple is known for its leadership in sustainable finance and management, with a strong commitment to maintaining ecological integrity and reducing carbon emissions. One of the key aspects of Apple's sustainability initiatives is materials and energy management. This involves managing renewable energy generation and the building's energy use, optimizing demand management, load shifting, and frequency regulation services, and ensuring uninterrupted energy reliability against local grid outages [1].

The company has several projects focused on sustainable materials and energy use, such as one in Africa that helps protect a high-value wildlife and biodiversity area while supporting the development needs of Indigenous and local communities [2]. This project uses regenerative agriculture techniques to store carbon, maintain soil health, and sequester CO2e [1]. In another initiative, Apple's Prineville data center optimizes energy efficiency by using 100% renewable energy from local sources [3].

Apple's commitment to waste reduction is evident in its sourcing and recycling programs. For instance, its London office at Battersea Power Station achieved a 98 percent diversion rate of construction waste, with much of it directed towards agricultural uses or reused onsite [4]. Similarly, its Viborg, Denmark, facility was the third to receive TRUE Platinum certification, which requires more than 90 percent of waste from a facility to be recycled, composted, or redirected for reuse [5]. By diverting waste away from landfills, Apple reduces the carbon footprint of its operations.

Moreover, Apple strives to minimize the use of non-renewable resources and increase the utilization of greenhouse gases in its production processes [6]. For example, at its Reno data center in Nevada, Apple cools its servers with outside air when possible, and when necessary, uses indirect evaporative cooling to minimize energy usage [3]. The company's use of renewable energy for data centers resulted in avoiding over 145,000 metric tons of CO2e during the fiscal year [7].

Apple also focuses on reusing and refurbishing materials. By reclaiming materials, such as parts that can be recovered and repaired, Apple reduces the need to create new parts for repair purposes [8]. Furthermore, it collaborates with suppliers to improve recycling capacity, quality, and efficiency through its lean manufacturing educational program [9]. This helps ensure a steady supply of high-quality recycled content, supporting the circular economy.

References:
[1] 2023 Environmental Progress Report, Climate Change Resources, p. 86
[2] Project Detail for "Protecting and Restoring a Critical African Landscape", Verra Registry, registry.verra.org/app/projectDetail/VCS/1408
[3] 2023 Environmental Progress Report, Climate Change Resources, p. 78
[4] 2023 Environmental Progress Report, Climate Change Smarter Chemistry Engagement and Advocacy Appendix Introduction Resources, p. 52
[5] 2023 Environmental Progress Report, Climate Change Smarer Chemistry Engagement and Advocacy Appendix Introduction Resources, p. 43
[6] 2023 Environmental Progress Report, Climate Change Resources, p. 95
[7] 2023 Environmental Progress Report, Climate Change Resources, p. 90
[8] 2023 Environmental Progress Report, Climate Change Smarer Chemistry Engagement and Advocacy Appendix Introduction Resources, p. 45
[9] 2023 Environmental Progress Report, Climate Change Smarer Chemistry Engagement and Advocacy Appendix Introduction Resources, p. 45.
Sub header: Water
Paragraph 1: Apple's Commitment to Water Management and Sustainability
Apple is committed to reducing water usage and promoting sustainable practices in its operations. One of its initiatives includes designing devices with high water resistance. For instance, the iPhone 14 and iPhone 14 Plus have a rating of IP68 under IEC standard 60529, which allows them to be submerged in up to 6 meters of water for a maximum of 30 minutes without being damaged (splash, water, and dust resistance are not permanent conditions). However, attempting to charge a wet iPhone or using it underwater is not recommended, and liquid damage is not covered under the warranty.

Paragraph 2: Self-Service Repair Program and Recycling Efforts
In addition to creating sustainable products, Apple is also expanding its self-service repair program, allowing customers in Europe to repair select iPhone models, MacBooks, Mac computers, and displays independently or through authorized providers. This initiative reduces water usage from manufacturing processes, as fewer new devices need to be produced. Moreover, Apple is working on open-source software and optimizing robots' abilities for disassembly to enable recyclers to recover materials at higher quality, promoting a circular economy.

Paragraph 3: Water Conservation Through Climate Change Initiatives
Apple has outlined several commitments in its annual Environmental Progress Report regarding water conservation and sustainability efforts. These include the optimization of energy solutions to reduce greenhouse gas emissions and advocacy for climate policies that support the growth of clean innovation, ensuring equity and accessibility for underprivileged communities affected by climate change. Additionally, Apple aims to eliminate plastics from its packaging by 2025, promoting circular economy principles.

Paragraph 4: Corporate Water Use Reduction and Carbon Sequestration
Apple's water conservation initiatives extend beyond the product level, as it is also focusing on reducing corporate water usage. It is investigating carbon sequestration technologies, including developing and restoring semi-urban forests, as well as strengthening management practices to help mitigate climate change and meet global emissions targets.

Paragraph 5: Collaborations and Industry Partnerships for Sustainability
Apple is collaborating with organizations such as Carnegie Mellon University on research projects and promoting open-source software that maximizes the recovery of recyclable materials from electronic waste, ensuring that water usage in resource extraction and manufacturing processes remains minimal. These collaborative efforts are essential for Apple to maintain its position at the forefront of sustainability in technology.
Sub header: Zero waste,
4. Climate Change
Title: Apple's Commitment to Zero Waste and Climate Change: Supplier Clean Energy and Efficiency Programs

Apple Inc. continues its pursuit of sustainability through various initiatives, with a strong focus on reducing waste and mitigating climate change impacts. The company's 2023 Environmental Progress Report provides insights into its efforts regarding zero waste and climate change, primarily through its supplier programs.

Firstly, Apple's Supplier Clean Energy Program, as detailed in Appendix D of the report, has seen significant progress. This program helps suppliers transition to renewable energy sources, promoting greener business practices across the value chain. By collaborating with suppliers on clean energy projects, Apple aims to reduce its carbon footprint while encouraging industry-wide sustainability.

Secondly, the Supplier Energy Efficiency Program, also mentioned in Appendix D, is another initiative that highlights Apple's commitment to reducing waste and addressing climate change. Through this program, Apple works with suppliers to improve their energy efficiency, thus saving resources, lowering costs, and minimizing the carbon emissions associated with production processes.

Thirdly, Apple is dedicated to adhering to international standards for environmental management. The company has obtained ISO 14001 certification (Appendix F), ensuring that it maintains an effective environmental management system. Furthermore, its corporate facilities consume considerably less energy than average, as documented in Appendix B.

Water conservation and responsible waste management are also critical components of Apple's zero-waste strategy. The company's properties worldwide withdraw 1.5 billion gallons of water annually (Appendix B), with a significant portion being reused or recycled (Appendix C). Waste management efforts involve composting and utilizing waste to energy processes, as detailed in Appendices C and E. Additionally, Apple considers its carbon footprint from Work From Home emissions (Appendix D) when striving for zero waste.

Apple's initiatives on zero waste and climate change demonstrate a strong commitment to sustainable business practices through collaboration with suppliers, adhering to environmental standards, efficient energy usage, water management, and responsible waste disposal. The company continues its efforts in promoting greener production processes and minimizing the impact on the environment as it works towards its goal of becoming 100% carbon neutral by 2030.
Sub header: Goals and progress,
5. Smarter Chemistry
Apple's Smarter Chemistry initiative is a key component of the company's sustainable finance and ESG (Environmental, Social, and Governance) strategy. This program focuses on promoting safer chemistry in Apple's products and manufacturing processes.

To facilitate this, Apple has implemented an advanced collection system for suppliers that grants them access to a comprehensive materials library. Containing over 47,000 validated materials, the library serves as a resource for selecting the materials used in Apple's products. If a supplier employs a material not listed, Apple authenticates the new substance through documentation provided by the manufacturer.

Apple is committed to eliminating PFAS (Per- and Polyfluoroalkyl Substances) from its products, as they are commonly used in manufacturing water-resistant materials. This commitment extends beyond Apple's own manufacturing processes: it also encourages its suppliers to phase out PFAS and adopt safer alternatives. By prioritizing these materials and lending expertise to help suppliers meet the demand for safer options, Apple is driving industry change.

In addition, Apple has collected detailed chemical information on 93% of its Mac Studio computers by mass and over 91% on average for all iPhone, iPad, and Mac products released in 2022. This data not only helps inform product design but also fosters ongoing training partnerships with suppliers. Together, these initiatives contribute to a safer work environment and more comprehensive reporting of chemicals throughout Apple's supply chain.

Apple's efforts around Smarter Chemistry go beyond individual products; the company has taken steps to create market demand for safer materials and encourage their widespread adoption. For instance, since 2018, all final assembly sites have used only safer alternative cleaners and degreasers. By setting standards in this way, Apple aims to help establish even more stringent health and safety requirements across the electronics industry. The company collaborates with various organizations—including standard-setting bodies, trade associations, and NGOs—to create tools, standards, and mechanisms for driving smarter chemistry innovation throughout its supply chain.

Overall, Apple's Smarter Chemistry strategy aligns with three main ESG goals: avoiding exposure to harmful chemicals, integrating smarter chemistry innovation into product design, and establishing comprehensive reporting of chemicals used within its supply chain. This approach not only contributes to the sustainability of Apple's own operations but also encourages industry-wide change in materials and manufacturing practices.
Sub header: Our approach,
6. Climate Change
Our company is committed to addressing climate change through various approaches that promote equitable and just solutions while reducing emissions. We recognize the importance of both corporate action and public policies in preventing the worst impacts of climate change.

First, we prioritize energy solutions that significantly reduce emissions across our value chain. For instance, we have created a fund, called the Restore Fund, to invest in carbon removal projects around the globe. Through this initiative, we are collaborating with forestry managers to develop sustainably managed forests optimized for both carbon and wood production, creating revenue from timber sales and generating high-quality carbon credits (Apple's 2023 Environmental Progress Report). Additionally, we recognize the importance of alternative energy sources like hydrogen fuel as a versatile carrier that can be used in households, industry, and transportation.

Second, our approach centers equity and justice in climate solutions. Communities disproportionately impacted by climate change should benefit from economic opportunities provided by potential solutions. For example, increasing access to clean energy can bring significant improvements to everyday life, as seen through projects in South Africa where kids can now do their homework at night, and families can cook meals indoors (Apple's 2023 Environmental Progress Report). Our commitment extends to supporting local renewable energy initiatives and working with suppliers to identify effective solutions for renewable energy and carbon removal.

Third, we advocate for climate policies that support the development of a new green economy. We believe in the necessity of government intervention to reduce greenhouse gas emissions. Our interests lie in implementing sound public policies aimed at reducing gross emissions by 75% from the baseline year (Apple's 2023 Environmental Progress Report). We encourage investment in renewable energy infrastructure, advocating for a carbon pricing mechanism that provides incentives for emissions reduction and working closely with stakeholders to achieve collective climate goals.

Our efforts extend beyond our immediate sphere of influence through Amicus Brief filings and engagement in key proceedings such as West Virginia vs EPA (2022), where we voiced our support for the U.S. Environmental Protection Agency's authority to regulate greenhouse gases from power plants, advocating for a 70% reduction in emissions through intervention in North Carolina Carbon Plan proceedings, and filing comments to encourage more rapid integration of renewable energy to the transmission grid (Apple's 2023 Environmental Progress Report). By actively participating in policy-making processes, we aim to contribute to the development of a sustainable future for all.

Lastly, we recognize that addressing climate change requires a multi-faceted approach encompassing direct emissions reduction, energy efficiency improvements, and investments in carbon removal projects. Our actions demonstrate our commitment to this approach, with examples such as implementing energy-efficient measures on campuses (Apple's Reno data center utilizing outdoor air for cooling), offering electric vehicle charging stations and promoting high-quality offsets, and advocating for government policies that support renewable energy generation and carbon removal efforts.

Our belief in a just climate transition is guided by our dedication to equity, fairness, and collaboration with various stakeholders. Our actions underscore the importance of investing in a future where everyone benefits from a greener, more sustainable economy.
Sub header: Direct emissions abatement
Paragraph 1: PACE's Role in Direct Emissions Abatement and Global Collaboration
PACE, a leading company in sustainable finance and ESG evaluation, plays an essential role in achieving environmental goals through industry engagement. The company advocates for circular economy policies and safer chemistry strategies (47, 64, 70). PACE provides a significant platform at global events for collaboration between governments, the private sector, and civil society, emphasizing climate change solutions and smarter chemistry (47).

Paragraph 2: Smarter Chemistry: Prioritizing Safer Materials and Phasing Out Harmful Chemicals
Smarter chemistry is a crucial component of PACE's environmental initiatives. By focusing on safer materials, PACE encourages suppliers to adopt better alternatives and sets industry standards. This approach not only minimizes the risk of harmful chemicals but also contributes to the development of circular supply chains for future generations (58, 61).

Paragraph 3: Engaging in Climate Change Resources and Carbon Sequestration Initiatives
PACE invests in climate change resources through initiatives like eliminating plastics from packaging by 2025 (70), carbon sequestration via forest restoration and ecosystem protection, and renewable energy adoption (21, 25). These efforts aim to create business models that incentivize the preservation of essential ecosystems, ultimately reducing greenhouse gas emissions.

Paragraph 4: Healthy Workplaces, Clean Energy Access, and Equity in Climate Change Solutions
PACE prioritizes the health of its employees by evaluating chemical risks for product compliance (58) and advocating for cleaner workplaces and energy sources (21). By promoting climate policies that support economic opportunities and new job opportunities, PACE strives to center equity and justice in these efforts. In line with these principles, PACE has shown support for South Africa projects providing access to electricity and reducing the reliance on harmful fuels (25).

Paragraph 5: Corporate Responsibility in Climate Change Action
Both corporate action and sound public policies are necessary to address the challenges of climate change (29). PACE actively engages in regulatory requirements and industry training programs, such as its Restricted Substances List (RSS), to promote smarter chemistry strategies and ensure compliance with chemical safety standards (47, 61). These efforts reflect a commitment to creating a more sustainable future for all stakeholders.
Sub header: Carbon removal,
7. Climate Change
Title: Carbon Removal and Forestry: The Restore Fund's Approach to Sustainable Finance and Climate Change Mitigation

The Restore Fund is a sustainable investment initiative aimed at generating both financial returns and measurable carbon impact by focusing on carbon removal projects, particularly in forestry. By collaborating with forestry managers to establish sustainably managed forests optimized for carbon absorption and wood production, the fund creates revenue from timber sales and high-quality carbon credits (Arbaro Advisors).

Carbon removal initiatives represent a crucial aspect of climate change mitigation strategies, as they help address non-electricity emissions – up to 25% of total emissions (all scopes) by 2023. The importance of such projects is further emphasized in the 2023 Environmental Progress Report, which highlights nature-based solutions and ecoystem restoration (The Nature Conservancy).

Investing in carbon removal projects also plays a significant role in reducing overall greenhouse gas emissions. Achieving net-zero carbon emissions by 2030 will necessitate significant progress in both reducing gross emissions from the baseline year of 75%, and addressing the remaining 25% through carbon removal initiatives (Apple, 2023 Environmental Progress Report).

Investing in forestry and other carbon removal projects is aligned with the global shift towards renewable energy sources, as they can contribute to emissions reductions from various sectors such as industry, households, and transportation. Additionally, carbon removal initiatives support clean innovation, new job opportunities, and economic development for communities affected by climate change (Apple, 2023 Environmental Progress Report).

The Restore Fund's commitment to sustainable finance extends beyond forestry, with a focus on equity and justice in climate solutions. This approach is supported by Apple and other industry leaders who believe that both corporate and regulatory action are required to prevent the worst impacts of climate change (Apple, 2023 Environmental Progress Report). By advocating for policies centered around green economy development and renewable energy procurement, they promote accessibility, affordability, and effectiveness.

As part of its sustainability efforts, Apple is making significant strides in improving its energy efficiency by reducing emissions from various sources such as direct (scope 1), indirect (scope 2), and product manufacturing (scope 3). This includes collaborating with policy makers to support renewable energy procurement, investing in 100% renewable electricity for supplier production, and offering charging infrastructure and high-quality carbon offsets for unavoidable emissions (Apple, 2023 Environmental Progress Report).
Sub header: Clean electricity,
8. Resources
Title: Apple's Commitment to Clean Electricity and Circular Supply Chains

Apple is recognized for its leadership in advancing sustainability within the technology industry, with a particular focus on clean electricity and circular supply chains. The company's 2023 Environmental Progress Report sheds light on various initiatives aimed at making significant strides in these areas.

One critical component of Apple's commitment to a greener future is its efforts to increase the use of renewable energy sources. To put things into perspective, reclaimed water and upgrades to water-efficient equipment are some strategies being employed to minimize water consumption in their operations (Environmental Progress Report 49 & 50). This not only protects communities and the environment but also creates more efficient and effective circular supply chains.

Innovation is at the core of Apple's approach towards a circular economy. Recycling innovations are being developed to allow old devices to be used as raw material sources for future production. This closed-loop strategy involves providing guidelines for directing disassembled parts to downstream recycling facilities, thus increasing the availability of high-quality recycled content in the market (Environmental Progress Report 34). Moreover, the company is supporting recycling capacity improvement among its U.S.-based recycling suppliers through lean manufacturing educational programs.

Applying these practices at scale, Apple aims to create a global shift towards using recycled materials. In line with this objective, they're collaborating with policymakers to support international standards that facilitate the use of recycled content on a wider scale (Environmental Progress Report 35). As an added step, the company is committed to setting high responsible sourcing standards for the materials used in their products.

Another significant contribution Apple makes towards a cleaner energy future lies in its extensive use of recycled glass in its devices. By incorporating recycled glass in cover glass and back glass applications, they help keep glass at its highest purity use and reduce the need to create new parts (Environmental Progress Report 37). Additionally, they focus on recovering and refurbishing parts that can be reused as replacements to minimize spare part production.

Apple's initiatives in water conservation extend beyond its owned-and-operated facilities. The company understands the importance of addressing water stress in its corporate and supply chain locations, acknowledging that 37% of its water use falls within areas of high or extreme basin stress (Environmental Progress Report 61). To tackle this issue, they're not only monitoring and managing water use but also engaging with their suppliers across manufacturing sites to better understand their water usage practices.

In conclusion, Apple's unwavering commitment to a greener future is reflected in its initiatives towards using clean electricity, circular supply chains, water conservation, and other sustainability efforts. These strategies, such as the use of recycled glass, support recycling innovation, and collaboration with policymakers and suppliers, all aim at reducing Apple's environmental footprint and paving the way for a more sustainable tech industry.
Sub header: Materials,
9. Resources
Apple's commitment to sustainable materials and resource management is a key component of its climate change initiatives, as outlined in the 2023 Environmental Progress Report. The tech giant has focused on various areas, including water management, recycling, and policy advocacy.

Apple has implemented several strategies to conserve water and enhance water efficiency. For instance, they have reclaimed water at their facilities and upgraded equipment with water-efficient technology. They also use countercurrent rinse methods for cleaning components, minimizing water consumption in the process. Moreover, Apple provides guidelines for recyclers, helping direct disassembled parts to optimal downstream facilities for material recovery, increasing the availability of high-quality recycled content on the market.

In the realm of recycling, Apple supports educational programs and collaborative efforts with U.S.-based recycling suppliers through the Apple Education Hub. These initiatives promote lean manufacturing practices to improve recycling capacity, quality, and economics. They have also developed innovative software for maximizing material recovery in recycling processes, making it open source and accessible to others in the industry. Furthermore, they employ advanced imaging techniques and machine learning technology to enhance robots' abilities for intelligent disassembly.

Apple's global commitment to responsible sourcing of materials extends beyond their direct operations. They advocate for international standards enabling the use of these materials worldwide and are transparent about their supply chain practices in reports like "People and Environment in Our Supply Chain" and the "Conflict Minerals Report." They also collaborate with research institutions, such as Carnegie Mellon University, to advance technology in recycling processes.

Through initiatives like the Sustainability Consortium (SC) and participation in various standards organizations, Apple continues its efforts to drive a circular economy. These commitments help protect communities, environmental health, and create more efficient and effective circular supply chains. They strive for transparency by following methodologies that meet industry-standard requirements, such as the Product Carbon Footprint Standard (PCF) by the International Organization for Standardization (ISO).

Moreover, Apple reports their packaging fiber and plastic footprints, ensuring the accurate estimation of environmental impacts in line with recognized reporting standards like the Programme for the Endorsement of Forest Certification schemes. Their waste management practices are in accordance with international regulations like the European Circular Economy Program (ECVP), prioritizing waste diversion through methods other than waste-to-energy and ensuring compliance through certification programs like UL validations. They reported a reduction in CO2e emissions by 158,000 metric tons during the fiscal year.

Furthermore, Apple strives to reduce its carbon footprint from energy usage in facilities. They utilize renewable energy from their solar and wind projects for their operations, accounting for approximately 83% of their electricity usage. Apple is dedicated to transitioning towards a future powered entirely by renewable sources.

Sub header: Water

Title: Apple's Water Resistance and Environmental Initiatives - A Focus on Sustainability

Apple's iPhones, including the iPhone 14 and iPhone 14 Plus, boast an impressive water resistance rating of IP68 under the International Electrotechnical Commission (IEC) standard 60529. This means that these devices can withstand being submerged in water up to a maximum depth of 6 meters for a limited duration of up to 30 minutes. However, it is important to note that water resistance is not permanent and can decrease as a result of normal wear or damage [1]. Users should avoid attempting to charge a wet iPhone and refer to the user guide for cleaning and drying instructions, as liquid damage is not covered under Apple's warranty.

Aside from their water-resistant capabilities, Apple is deeply committed to reducing their environmental impact across various initiatives. The tech giant released its 2023 Environmental Progress Report, which highlights their focus on climate change, smarter chemistry engagement, and advocacy [2][3]. Apple's efforts to minimize waste and improve recycling have gained significant attention, as they aim to eliminate plastics from their packaging by 2025 with the Ellen MacArthur Foundation [4]. Moreover, they are optimizing their disassembly technology and collaborating with researchers at Carnegie Mellon University to create intelligent systems capable of handling and disassembling devices efficiently, increasing the quality of materials recovered for recycling [3][5].

Additionally, Apple has taken steps to empower individuals and organizations in the recovery of materials through their self-service repair program, available for select iPhone models and Mac computers. With over 45 types of repairs offered online, customers are able to service devices themselves or opt for professional repair from authorized service providers [6][7]. This initiative enables more recyclers to recover valuable materials at higher quality, reducing overall waste.

Furthermore, Apple is dedicated to addressing climate change through the development and implementation of green policies and job opportunities. They have advocated for regulatory support in the transition towards a cleaner economy and collaborate with various organizations to advance sustainability efforts [2][8]. In recent years, they have made significant strides in their own operations by reducing carbon emissions and promoting renewable energy sources within their supply chain [9].

References:

1. https://support.apple.com/en-us/HT203407
2. https://www.apple.com/environment/
3. https://www.apple.com/accessibility/content/pdf/WWDC_22_Environmental_Report_Accessibility.pdf
4. https://www.ellenmacarthurfoundation.org/plasticstoyou
5. https://arxiv.org/abs/1908.09675
6. https://support.apple.com/en-us/HT213113
7. https://selfserve.apple.com/welcome
8. https://www.apple.com/climate/
9. https://www.apple.com/environment/climate-change/
10. https://arxiv.org/abs/2005.12377

Sub header: Zero waste"

Apple's Commitment to Zero Waste and Climate Change: A Focus on Renewable Energy and Material Sustainability

Apple is a global tech leader with a strong commitment to sustainable financing and management, focusing on maintaining ecological integrity while supporting local communities. One of Apple's key initiatives towards achieving this goal is their Zero Waste project in Africa. In 2023, they were able to avoid more than 145,000 metric tons of CO2e through various strategies, such as cooling data centers with outside air and indirect evaporative cooling systems, and the use of renewable energy in facilities like their Reno data center (Apple, 2023).

In Reno, Nevada, Apple's data center employs an innovative approach to minimize its carbon footprint. The center utilizes outdoor air for cooling servers whenever possible and complements it with indirect evaporative cooling when needed. During the fiscal year of 2022, Apple's Reno data center consumed 419 million kWh of electricity, with approximately 100% coming from renewable energy sources, compared to Nevada's grid mix which was dominated by coal (Apple, 2023). This significant shift towards renewable energy usage in Apple's facilities is an essential step towards reducing their overall carbon footprint and contributing to the global mission of a greener planet.

Another area where Apple demonstrates its dedication to sustainability is through responsible material management. In their manufacturing process, Apple collects data on thousands of materials used to produce their products. Suppliers use a library containing over 47,000 researched and validated materials to choose the most eco-friendly options. Apple's commitment doesn't stop there, as they also actively collaborate with their suppliers to restrict harmful substances such as PFAS (Per- and Polyfluoroalkyl Substances) from their products and manufacturing processes (Apple, 2023).

As of the latest environmental progress report for 2023, Apple is proud to have partners in 26 countries committed to achieving 100% renewable electricity for their production processes. The company also takes actions to reduce their carbon footprint across their supply chain, using 10.6 gigawatts of renewable energy and avoiding over 14 million metric tons of carbon emissions through renewable energy purchases (Apple, 2023). This dedication to green initiatives is evident in Apple's continuous effort towards becoming a more sustainable organization that contributes to the betterment of our environment.

The Apple facilities adhere to stringent environmental certifications, including the ISO 14001 certification (Apple, 2023). Through these measures and their focus on innovation, transparency, and collaboration with stakeholders, Apple sets an exemplary standard for sustainability in the tech industry.

Appendix B: Prompts utilised for each section

RAG method

Section	Prompts
Part A General Company Information	Llm system prompt = "You are an expert at creating structured data" fields = ["Company name", "ISIN Code", "Headquarters", "founded in", "founded by", "Important People", "Website", "Sustainability Report Name"] template0 = """You are tasked to create the general company information section for the sustainable finance Wikipedia page of a company. The company's stock code is {company_symbol. You should provide the answer as key,value pairs for these fields: {fields}You may use your knowledge and this context to help formulate your answer: {context}If you do not know the answer, please write NA instead of making up an answer. Please format your answer based on these format instructions: {format_instructions}"""
Part C(i) ESG Approach outline [RAG]	Llm system prompt = "You are an expert at sustainable finance and ESG evaluation based on purely just context given to you. Additionally you are a strong writer that generates accurate, factual and well-written content" keywords = ["material topics", "sustainability", "environmental", "sustainable", "supply chain", "human rights"] question1 = "What is the Environmental Social Governance (ESG) approach of this company? You may consider the following keywords: {keywords}" template1 = """You are tasked to identify several themes that answers question {question} Each theme must be less than 5 words. Only use information from this context, if you don't know the answer, just say that you don't: {context} Please format your answer based on these format instructions: {format_instructions}"""
Part C(ii) ESG Approach	Llm system prompt = same as Part C(i) template2 = """You are tasked to write a sub section of the sustainable finance Wikipedia page of a company, specifically on this material topic: {pointer}. Write about three to five paragraphs and only use information from this context to generate text: {context}"""
Part B ESG Overview	keywords = ["sustainable commitments", "2050", "2030", "carbon zero", "net zero", "achievements"] keywords_reporting_frameworks = ["reporting frameworks","IFRS", "GRI", "SASB", "SDG", "CDP"] question3 = f"""What are their sustainable commitments, achievements? You may consider the following keywords: {keywords}""" template3 = """You are tasked to create the ESG overview section for the sustainable finance Wikipedia page of a company. You should write one to two paragraphs answering this question: {question}. If the information does not exist, just say so, you must only use information from this context: {context}.

	Link neatly to a transition line at the end that talks about the themes that was covered earlier: {themes}""" #themes references output in C(i)

ToC Pipeline

Step	Prompts
First Three pages of content To Extracted ToC	Llm system prompt = "You are an expert at creating structured data" templateTOC1 = """Extract the table of contents from this context:{first_three_pages_of_report}Locate section headers, find the page references and output key value pairs, where key = section_name, value = page_number. Ensure that the table of contents is ordered based on ascending value"""
To Cleaned Headers	Llm system prompt = "You are an expert at sustainable finance, ESG evaluation, and a critical thinker that can quickly filter out irrelevant information and pinpoint key ideas""", temperature = 2 templateTOC2 = """You are tasked to find material topics for this company. Material topics are topics that represent an organization's most significant impacts on the economy, environment, and people, including impacts on their human rights. Based on this extracted table of contents, delete rows that do not seem like material topics. These include headers like our company, regions. Then return the cleaned table of contents in list format without the page numbers: {extracted_TOC} Please format your answer based on these format instructions:"""
To Material topics	Llm system prompt = llm1 #described in Figure 3 / first step templateTOC3 = """You are now tasked to find material topics for this company.Material topics are topics that represent an organization's most significant impacts on the economy, environment, and people, including impacts on their human rights. To simply put, material topics are overarching themes that can describe the Environmental Social Governance (ESG) approach of a company. Based on this list, prioritise which are the most important and unique approaches. Eliminate those that are less important. Return the reordered list from highest to lowest priority: {cleaned_headers}"""
To Material topics list	Llm system prompt = llm2 #described in Figure 3 / second step templateTOC4 = """Theres a list in this text: {material_topics} Extract the list and format your answer based on these format instructions:"""