



Carbon Clicker

An Engaging Learning Tool about Greenwashing in the Tech Sector

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Abstract

This project introduces Carbon Clicker, a browser-based educational clicker game created to raise awareness of green-washing methods in the tech sector. Inspired by games such as Cookie Clicker, it puts players in control of a growing technology company where they must manage revenue, pollution, and public perception at the same time. Through this gameplay, players encounter both misleading sustainability actions and more genuine alternatives, based on real-world examples from the software and technology industry. The game is aimed mainly at software engineers and computer science students, with the goal of helping them recognize how greenwashing works in practice within their industry. By combining satire with simple resource-management mechanics and short educational prompts, the project explores whether this topic can be presented in a more engaging and accessible way. Due to the limited timeframe of the project, the game was evaluated through scenario-based analysis rather than large-scale user testing. Even with this limitation, the project suggests that Carbon Clicker has potential as an introductory learning tool for sustainability awareness in software engineering. Future work could focus on user testing, expanding the gameplay, and adding social features to increase engagement.

1 Introduction

As Software Engineers, we are all too aware of the complexities of the systems we interact with on a daily basis. Much like working in software, tackling climate change (and the analysis thereof) involves dealing with vast and deeply complex systems which can have vastly different outcomes based on even incredibly minor alterations. With this in mind, it is evident why "Greenwashing" has become so prevalent within the Tech Sector. Through some 'creative' data interpretation and lies by omission, many companies are recording record energy consumption yet their sustainability metrics have never looked better. However, most software engineers are blissfully unaware of the green-washing taking place on a global scale. Tech companies have a tendency to present themselves as sustainability oriented while building data centers that consume as much electricity per year as 15,000 to 75,000 homes [14]. With the newer generations of software engineers becoming more aware of sustainability, the topic of green-washing remains relatively undiscussed. Most engineers are likely unable to recognize that the company they work for is green-washing, possibly leading them to contribute to pollution unknowingly. One simply cannot account for what they do not know, which is the problem that "Carbon Clicker", an educational game about green-washing, aims to solve.

There are few to no educational tools on green-washing. Most articles introduce the topic and hand out a list of red flags to look out for, while rarely actually showing the signs

in context. This project aims to put users in an environment where they actively choose to commit to green-washing, and how.

In section 2, the related work about educational games and green-washing is explained. Subsequently, in section 3, the gameplay loop, the implementation, and the design choices of the "Carbon Clicker" are described. From the implementation, the game was validated using a set of scenarios which can be found in section 4. After the design and implementation, the dissemination and social impacts of the game are explained in section 5. Lastly, section 6 highlights the most important conclusions that can be drawn from the design and development process.

2 Related Work

2.1 Educational Games and Gamification

Gamification has been shown to have increased positive effects on cognitive, motivational, and behavioral learning outcomes[11]. These findings support the idea of incorporating a game-based design for educational purposes, particularly when game fiction and social interaction are incorporated into the design. Within the genre of idle clicker and incremental games, a taxonomy was developed by analyzing 66 games, which identified key features such as strategy, decision-making, progression systems, and internal economies that drive player engagement [1]. Further analysis of similar clicker games like Universal Paperclips and Cookie Clicker argued that these games make the player "think like the machine" and serves as a vehicle for ethical and philosophy critique[12]. Universal Paperclips serves as a strong precedent for our game Carbon Clicker, which uses clicker mechanics to deliver commentary on AI ethics, much as our game does for greenwashing. Research into games designed to promote awareness regarding pro-environmental behavior has established that gamification is a recognized and studied approach for environmental education[10].

2.2 Greenwashing Perception

A systematic review of the literature regarding greenwashing proposes a classification into firm-level versus product-level and executional versus claim-based greenwashing[2]. This taxonomy can help in framing the different types of deceptive practices represented in our game's upgrade system. Especially in the tech sector where a critical analysis of the 2023 sustainability reports of Amazon, Apple, Google, Meta, and Microsoft found a lack of transparency and skewed measurement frameworks that allow misleading environmental claims[15]. "Machine washing" is also an extension of greenwashing which claims about misleading ethical AI algorithmic systems, showing that misleading practices are evolving within the tech industry[13]. Greenwashing research can be divided into three stages, from misleading advertisements to strategic corporate behavior to forward-looking climate pledges such as net-zero commitments [7], which are exactly the kind of claims our game satirizes.

2.3 Sustainability education in Software Engineering

Despite the growing awareness of sustainability and sustainable practices, the education regarding that in the software engineering field remains limited. A study across 28 organizations found that 96% of industry professionals received no training on sustainability in software development[4]. Similarly, a survey of 464 practitioners at major firms revealed that while developers care about energy consumption and sustainable practices, they lack the knowledge and tools to act on it[5]. A systematic review of gamification for climate change engagement produced a user-centered design framework that supports using game-based approaches to engage people with environmental topics[3].

While educational games, greenwashing research, and sustainability education in software engineering each have growing bodies of literature, no existing tool combines all three by using game mechanics to teach software engineers specifically about greenwashing in the tech sector. Carbon Clicker aims to fill this gap.

3 Methodology and Design

The solution we have opted for is "Carbon Clicker", a game that raises awareness of different greenwashing concepts through a similar system used in the popular game "Cookie Clicker" [9].

3.1 Main Gameplay Loop

Players start off with a new company, which they can name, and 0 dollars to their name. Once the game is started, the player receives 1 dollar per game tick. Additionally, as shown in Figure 1 once a player has accrued enough money, they are able to buy upgrades to their company.

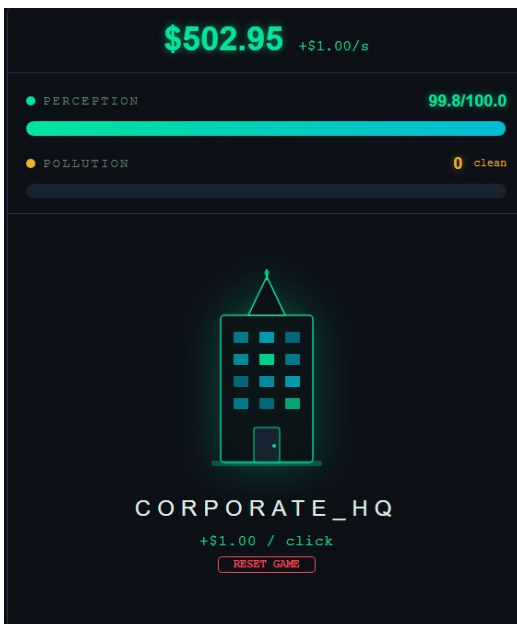


Figure 1: The main gameplay screen of Carbon Clicker.

These upgrades are divided in three categories as shown in Figure 2

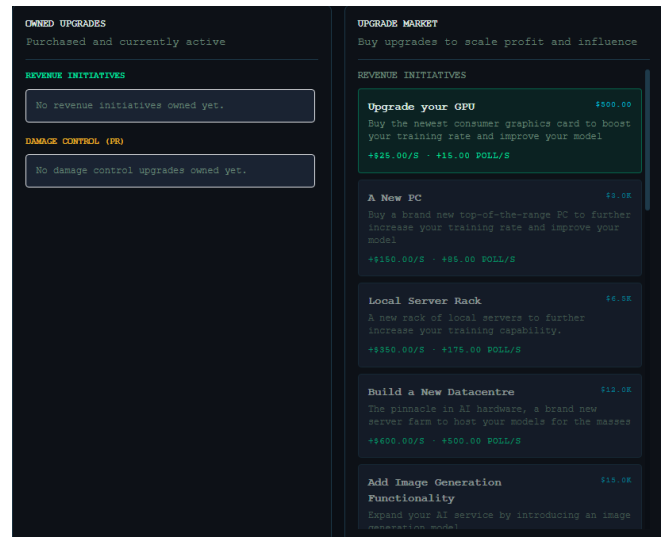


Figure 2: The upgrades panel displaying Revenue Initiatives (production upgrades) and Damage Control (perception upgrades), each showing their cost and impact.

- Production upgrades. These upgrades provide an overall increase to the production of your company. Gameplay wise, this means boosting your money earned per tick. However, these upgrades also increase the pollution your company produces. This pollution is also on a tick basis. An example of production upgrade can be an AI datacenter expansion, giving 25 dollar and 15 pollution per tick.
- 'Bad' Perception (Greenwashing) upgrades. These upgrades increase the perception of the company, while not providing to the pollution or monetary gains. Just like in the real world, they portray your company as sustainable while not actually contributing to anything.
- 'Good' Perception upgrades. These upgrades function similarly to their 'bad' counterparts but are instead based of positive real-world sustainability actions. The have a steeper upfront cost but are worth it in the long term

The chosen perception upgrades are related to real life events and, along with their interaction with gameplay, will be further discussed in section. 3.2

A player goes back and forth between making money and upgrades while keeping in mind the companies reputation and pollution. Over time, and as pollution increases, the companies reputation decreases faster. This forces the player to remain active and actively engage with the game and by extension, greenwashing. Once the pollution of the company exceeds a certain threshold, or the perception of the company depletes to 0, the player will lose. Upon losing a loss screen with the game statistics is shown to the player, along with the option of starting a new game(Figure 3).

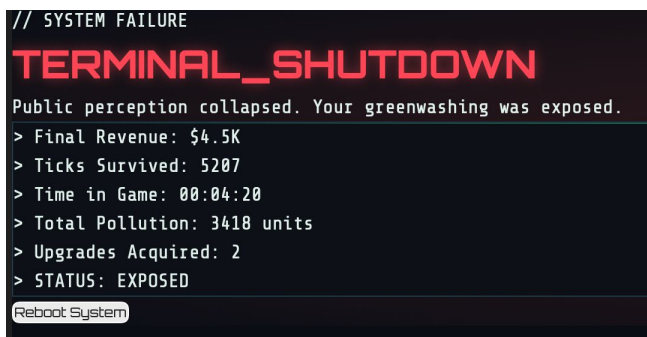


Figure 3: End screen: player wasn't able to successfully hide their actions

3.2 Design choices

Greenwashing upgrades

The upgrades system is the most fundamental component of the app as it serves as the basis for the sustainability awareness aspect of the project. The upgrades system went through a number of iterations before arriving at the final design. Initially, the upgrades were split into two categories, *production* and *perception*.

Production upgrades increase the players per second income but also produce a set amount of pollution which will degrade their public perception score over time. *Perception* upgrades allow the player to improve their public perception score by performing acts of greenwashing with each upgrade linking to a real world greenwashing act. While this worked, further refinement of the system was needed as the existing setup did not completely satisfy the project brief as the app did not specifically target Software Engineers nor specifically focus on sustainability in the software engineering industry/community.

The final implementation, as discussed previously, split the upgrades into three categories: *production* (which operates the same as the previous iteration), *'bad' perception*, and *'good' perception*. The *'bad'* upgrades are similar to the original perception upgrade but with a focus on the tech industry in particular. This refines our scope to better align with the project brief. This is further highlighted with the *'good'* upgrades which also improves the player's public perception score but are based instead on real positive steps that companies use. The *'good'* upgrades are more expensive upfront but offer better long term benefits compared to their *'bad'* counterparts. Tying our narrative into the primary gameplay loop like this further increases the game's effectiveness as a learning tool [6]. It also allows us to discuss the potential solutions to as well the problems with greenwashing in the tech sector.

For example the production upgrades range from buying a new GPU(\$500, +25 income, +15 pollution per tick) to building an entire data centre(\$12,000, +600 income, +500 pollution per tick), reflecting the typical scale in which tech infrastructure grows and its environmental cost[14].

'Bad' upgrades are each tied to a documented greenwashing case. For example, "Misleading Progress Narrative" upgrade allows the player to show decreased level of emissions with the help of some creative accounting. This is in rela-

tion to Google's 2025 Sustainability Report, which reported falsely 17% reduction in data centre emissions despite a 23% increase in total electricity usage, made possible through emissions intensity metrics rather than absolute figures. Another example, "Unsubstantiated AI Climate Claims," reflects on the fact that only 26% of the AI climate claims cite any valid source. Each 'bad' upgrade links the player to the real-world source, reinforcing the educational message(Figure 4).

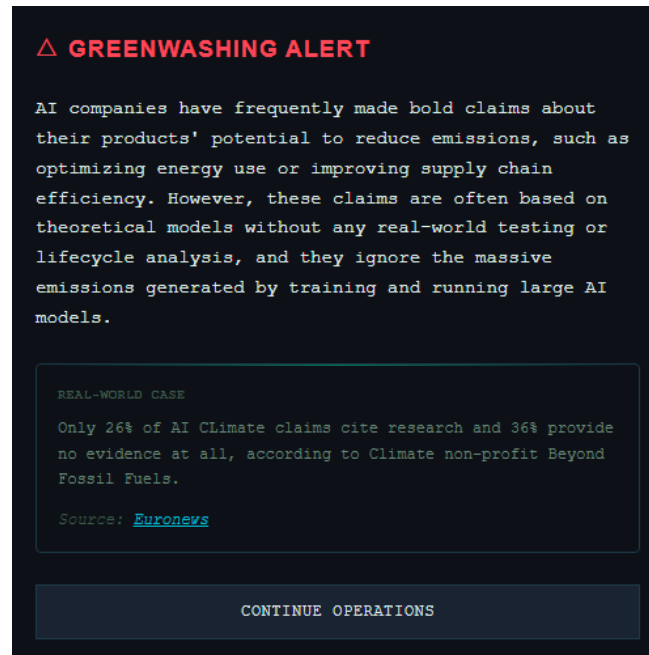


Figure 4: The Greenwashing Alert popup displayed after purchasing a 'bad' perception upgrade, showing the educational message, real-world evidence, and a link to the original source.

'Good' perception upgrades present genuine efforts made to promote sustainability. For example, "Model Distillation" references DistilBERT, which retains 97% of BERT's performance while being 40% smaller and 60% faster. "Cloud-Powered Radiators" (\$12,000) is based on real initiatives such as the Tallaght District Heating Scheme in Ireland, which repurposes waste heat from an AWS data centre to heat nearby homes. These upgrades cost more upfront but provide greater long-term perception benefits, teaching players that genuine sustainability requires real investment but pays off over time.

Perception degradation

During a run of Carbon Clicker, one of the main success factors is the public's perception of the player's company. Over time, the company's perception meter decreases, decreasing faster as more time passes. Not only time is a factor for degradation though, as the level of pollution the company also influences the perception meter. The more pollution, the faster the perception decreases. The meter exists to keep the players engaged and playing actively, as the only way to refill the perception is to buy upgrades, and ensure that players don't just sit back and let the game run endlessly without interacting with it, as when the perception bar reaches 0, the player loses the game.

3.3 Practical implementation

Perception degradation

As explained, the perception of the player's company reduces slightly over time. This is done using a mapping function that maps the tick count to a factor in the range of $[0, 0.05]$. The mapping function is as follows:

$$\text{map}(\text{value}, \text{inMin}, \text{inMax}, \text{outMin}, \text{outMax}) = \frac{(\text{value} - \text{inMin}) * (\text{outMax} - \text{outMin})}{(\text{inMax} - \text{inMin})} + \text{outMin} \quad (1)$$

In this equation, the current tick (value), which can fall between 0 and 100.000 (100.000 chosen as an upper bound for the degradation factor, meaning it degrades the fastest past tick 100.000) is converted to the degradation factor, which falls between 0 and 0.05, representing a maximum 5% perception meter degradation per second. This is the first part of the degradation, as we have only taken the amount of ticks the player has been active into account. The other factor that should influence the rate at which perception decreases is pollution.

To calculate the additional rate of pollution degradation, we use the same mapping equation 1 from before. This time, however, the pollution can be mapped to the range of 0 to 0.1. The pollution should become a more pressing issue for the reputation as the pollution increases, for the intention is to keep the player aware of the fact that pollution is a negative trait. Once both the pollution and ticks have reached a value of 100.000, the degradation per second reaches a maximum of 15%.

4 Scenario Based Evaluation

Once the design had been finalized and implemented, next began a phase of validation and refinement. Due to the time constraints of the project, there was insufficient time to complete a worthwhile testing period with human users. Instead, validation mainly focused on creating scenarios; a set of persona with differing levels of expertise and understanding of the topic through which we will critically assess our project. This feedback can also be used to suggest extensions of the current app (discussed below).

For the purpose of this analysis, we will say that all our users have received a link to the game from a colleague and they are playing about with it for the first time on their work/university PC. This is obviously the most important interaction our users will have with the app as in both the viral social media and gaming spaces, the importance of the "hook" is paramount to success [8].

4.1 Scenarios

- Mid-20s Environmentally Conscious Software Engineer: This persona would be our ideal user. They sit right in our target demographic in terms of age and would respond proactively to the information provided. They do, however, highlight some missing features that

would turn this satisfied user into free advertisement. Most notably, the app is missing the functionality to share scores to social media which would bring in more users through word of mouth and encouraging competition.

- Experienced Full Stack Engineer with Little Interest in Sustainability: This persona is more challenging. The systematic optimization of our clicker gameplay would no doubt be appealing to a degree. However, it would not be enough of a draw to get the user to engage long term or to research very far outside of the app. The solution here, however, would be quite straightforward; increase the complexity. Our current iteration is modeled after clicker games which are marketed towards a general audience. If we want to capture our software engineer market to the fullest, the game should lean more into these optimization elements by, perhaps introducing mechanics that introduce exponential values and add a recursive element to the upgrades system.
- University CS Students looking to pursue a career in Software Engineering: These users are incredibly important from a greenwashing awareness perspective as they are ideal point in their lives to become aware of this shady techniques before they choose where to use their skills long term. The previous pain points discussed for the other persona apply here also with an even bigger emphasis on competition as the game would most likely be played in a social context with scores passed between users in groupchats. A global/weekly leaderboard system would further reinforce this and improve the overall virality of the app.

5 Dissemination and Social Impact

Beyond the design and implementation of Carbon Clicker, ensuring the game reaches its target audience and creates meaningful impact is essential. This section discusses our distribution strategy and the broader social implications of our project.

5.1 Dissemination

Just as vital as the quality of the app is having an effective distribution method. Our implementation is deployed via Netlify and accessible [here](#), providing reliable hosting with a clean URL for distribution. The game is also open-source, with the full codebase publicly available on GitHub, welcoming contributions from the community. Being browser-based with no installation required, the barrier to entry is minimal. To further improve the virality of the app (and thus increase its effectiveness), a major improvement would be the introduction of social media sharing features. Additional features like cloud saves and global leaderboards would further increase online traction for the app and allow it to further spread the intended message.

5.2 Social Impact

Carbon clicker has the potential to create meaningful social impact through the following methods.

Firstly, by placing the player in the shoes of the company executive making the greenwashing decisions, the game provides an experiential learning environment. Rather than being a passive participant reading about the tactics the player gets to experience the implementation of these tactics first hand by purchasing upgrade such as misleading carbon offset claims or selective sustainability reporting. This first-person engagement with these misleading practices makes the players more aware of these tactics when they encounter them in the real world[12], as the experience of having personally deployed them will create a lasting mental framework for identification.

Secondly, the satirical tone of the game serves a deliberate purpose. Discussions regarding environment reservation and climate change often trigger a defensive response from the general public, particularly by the people working in the industries being criticized. By injecting these misleading methods into a humorous and exaggerated clicker game, Carbon Clicker lowers this barrier, allowing the players to engage with the subject without feeling personally attacked. This approach aligns with research showing that gamification can positively influence both attitudes and behavior towards environmental topics [10].

Thirdly, Carbon Clicker is particularly well-positioned to reach software engineering students and early-career developers. As noted by [4], the vast majority of software professionals receive no sustainability training. By targeting this demographic through an accessible browser-based game that can be easily shared among peers, Carbon Clicker addresses this gap at a critical point, before these individuals enter the workforce and begin making decisions that affect the environmental footprint of the systems they build.

Finally, Carbon clicker is deployed on Netlify, ensuring reliable and permanent hosting. This ensures that the barrier to entry is minimal as it's a browser based application. The accessibility maximizes the potential reach of the game and allows it to be adopted as an educational tool in university courses or workplace training sessions focused on sustainability awareness. The source code remains publicly available on Github welcoming contributions and further developments from the community.

6 Conclusion

In this paper, we presented Carbon Clicker, a fun way to spread awareness about greenwashing methods in the tech sector among software engineers and computer science students. Through our scenario-based validation, we identified that the game introduces various greenwashing concepts in an accessible and non-confrontational manner. The satirical tone lowers the defensive barriers typically associated with discussions around climate change, while the core mechanic of balancing perception against pollution mirrors the real resource allocation dilemmas faced by tech companies.

However, the project is not without limitations, as due to the time constraints, we couldn't conduct real user testing and instead had to rely on persona-based scenarios. Additionally, features like social media sharing and global leaderboards, which would increase the virality remains unimplemented.

Future work should focus on conducting user studies to assess the quality of the game and how well it serves its purpose(raise awareness in a non-confrontational manner), adding more complex upgrades, and introducing social features to expand the virality of the game. With these improvements, Carbon Clicker has the potential to become a widely-used educational tool that helps the next generation of software engineers recognize and challenge greenwashing in the industry.

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