

Identifying and Mitigating Greenwashing of Carbon Utilization Products

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Abstract

This study explores strategies for identifying and mitigating greenwashing of carbon capture and utilization (CCU) technologies. A literature review was conducted to determine the most common forms of greenwashing, and the ‘seven sins’ (hidden trade-off, no proof, vagueness, worshiping false labels, irrelevance, lesser of two evils, and fibbing) along with the notion of executional greenwashing are explored in the context of CCU. A list of questions is provided to help stakeholders such as consumers, investors, non-governmental organizations, and employees uncover potential instances of greenwashing. The article concludes by exploring ways to disincentivize greenwashing of CCU products along with future areas of research.

Graphical Abstract

<u>Relevant Types of Greenwashing</u>	<u>Application to Carbon Utilization</u>	<u>Mitigation Strategies</u>
<ul style="list-style-type: none">• Hidden trade-offs• No proof• Vagueness• Worshiping false labels• Irrelevance• Lesser of two evils• Fibbing• Executional	<ul style="list-style-type: none">• Environmental burden shifting• Lack of rigorous life cycle assessment• Unsubstantiated use of broad terms like “sustainable” and “green”• Implication of carbon neutral/negative label• Non-disclosure of source of carbon in “carbon-utilizing” product• Advocating carbon reduction pathway when there are carbon neutral or negative alternatives• False claims about technologies, especially ones that violate laws of physics• Excessive use of natural imagery in advertising of carbon-utilizing product	<ul style="list-style-type: none">• Customer, investor, and employee self-education• Stricter FTC regulation• Culture of reputationally punishing greenwashers• Wider awareness of proper life cycle assessment and carbon accounting methodologies• Further research and public communication about greenwashing

Keywords

Greenwashing, carbon utilization, CCU, green marketing

INTRODUCTION

Environmentalist Jay Westerveld coined the term ‘greenwashing’ in 1986 to describe organizations that devote more resources to appearing environmentally friendly than actually engaging in sustainable practices (Orange & Cohen, 2010). Westerveld’s initial example of greenwashing was hotel chains that encourage customers to reuse towels to conserve water when the primary objective is really the reduction of laundry costs paired with the appearance of being ‘green.’ Since the inception of greenwashing, it has been used to describe deceptive green marketing practices in a wide variety of industries ranging from automobiles to home appliances to oil and gas (Furlow, 2010).

Greenwashing is perceived negatively for various reasons. Deceptive green marketing erodes the credibility of environmental claims in the marketplace, making it more difficult for companies and products that actually have lower environmental impacts to differentiate themselves. Discovering instances of greenwashing can also induce an environmental epistemological crisis for consumers (‘how can I actually know anything about the environmental attributes of products?’), which further weakens their ability and will to effect change through purchasing decisions. Others claim that a pattern of greenwashing on the part of some companies can be part of a larger political project meant to weaken the perceived need for further environmental regulation (Dahl, 2010). Simply put, greenwashing makes it more difficult to achieve environmental goals by interfering with the market for products with superior environmental attributes.

Given the pressing need to decarbonize society to meet emissions goals set out in the Paris Agreement (2015), greenwashing of climate-related products is especially concerning. While there are many kinds of products that will help mitigate climate change ranging from renewable power systems to electric vehicles (EVs), this article focuses on a specific class of climate-related products that utilize carbon dioxide captured either from industrial point sources or from the atmosphere directly. This category is often termed carbon capture and utilization (CCU). When this article uses the phrases ‘carbon utilization’ or ‘carbon-utilizing,’ it is specifically referring to products manufactured with captured carbon. Examples of carbon utilization pathways include chemical products, reagents, mineralization, inerting agents,

carbonates, enhanced fuel recovery, supercritical applications, refrigerants, fire suppressors, and biological conversion (Gulzar et al., 2020). Bioenergy with carbon capture and storage, biochar soil amendments, and the use of wood products are examples of ‘natural’ CCU pathways that leverage photosynthetic capture of carbon dioxide from the atmosphere.

Carbon utilization is an interesting technological paradigm for several reasons. In the ideal case for the mitigation of climate change, large reserves of fossil fuel will become unextractable (Welsby et al., 2021), implying that carbon dioxide captured either from point sources or the atmosphere (through either biological or engineered means) will be required for the manufacture of carbon-containing products. Continued use of these products in a defossilized manner will require utilization of carbon. Correspondingly, the sale of captured carbon dioxide to be used as a feedstock in products such as chemicals and concrete can help offset the costs of carbon capture either in hard-to-abate sectors such as cement production or from the atmosphere directly. Due to various innovations in carbon capture technology paired with government incentives, it may ultimately be cheaper to use captured CO₂ as opposed to CO₂ from geological sources. This would create economic benefits from carbon-utilizing processes (Valluri et al., 2022). CCU using carbon captured from the atmosphere directly could also allow for circular economies for various chemicals and fuels (Huang et al., 2021), many of which currently rely on fossil feedstocks and thus involve a unidirectional flow of carbon from the geosphere into the atmosphere. Certain products may also feature enhanced properties enabled by the utilization of captured carbon; vodka (CNBC, 2019) and concrete (Ravikumar et al., 2021) are two examples of these kinds of products. Finally, the use of carbon captured from the atmosphere could allow for relatively distributed, decentralized, and modular manufacturing of chemicals and other products, potentially allowing for the decreases in capital costs arising from a higher degree of cumulative production (Wright, 1936) and the distribution of the political power associated with control over production.

There has been rapid growth in the publication and citation of scholarly articles about carbon utilization (Wong et al., 2021) as well as an increase in the number of and funding for companies in the space

(Circular Carbon Network, 2020). Various economic, scientific, and political factors have contributed to the seemingly exponential increase in need, attention, and resources for CCU (Sick, 2021). As CCU products begin to reach full commercialization and penetrate consumer markets, ensuring the legitimacy of claims made about the environmental benefits of these products will be vital to enable further scaling and impact. To complement this effort, this article discusses common types of greenwashing and how they might affect CCU products with the goal of identifying strategies to mitigate this behavior.

MATERIALS AND METHODS

A review was conducted to establish a basic typology describing the most common manifestations of greenwashing. Greenwashing can take many forms, and not all may necessarily be understood or acknowledged at the time of writing. The practice can either be intentional or inadvertent. There are firms that actively seek financial gain through misleading customers and other stakeholders, and there are others that greenwash due to a lack of awareness of the actual environmental attributes of their products or even miscommunications between internal departments.

Firms are the primary entities that engage in greenwashing, and it can occur either on the firm level or on the product level (Delmas & Burbano, 2011). With the former, firms may attempt to portray the entire company as conscious of the environmental impact of their operations or as having environmentalism as a primary value, possibly through using specific claims or general advertising campaigns. Firms can also market individual products as 'green' without necessarily implying that the business overall is environmentally sustainable. Product- and firm-level greenwashing are not mutually exclusive; individual greenwashed products could be used as part of a broader campaign to make the company's brand appear more environmentally sustainable.

Scholars have identified various classifications of greenwashing. Parguel et al. describe a dichotomy of claim-based and executional greenwashing (2015). Claim-based greenwashing involves vague, misleading, or outright false assertions about a firm or a product, whereas executional greenwashing involves 'nature-evoking elements in the ad execution

[that] may induce false perceptions of a brand's greenness' (Parguel et al., 2015). Executional greenwashing often involves natural imagery, green and blue color schemes, or animals. These features do not communicate any specific environmental facts about the firm or the product, but they associate the brand with environmental sustainability in the viewers' minds. If the firm cannot be classified as 'sustainable,' this can be a natural example of decoupling—one of the forms of misleading behavior—in which the internal activities of firms are decoupled from how they present themselves to the world (Lyon & Montgomery, 2015). Similar to product- and firm-level greenwashing, claim-based and executional greenwashing are not mutually exclusive. It is easy to imagine products and firms that shroud themselves in natural imagery while simultaneously making misleading environmental claims.

As most greenwashing scholarship has focused on product-level, claim-based greenwashing (de Freitas Netto et al., 2020), this type has more corresponding sub-categories. Kangun et al. offer three categories for claim-based greenwashing: (a) vague, ambiguous, or broad; (b) omits important information necessary to determine truthfulness; or (c) false/outright lie (1991). In a follow-up article, the same authors extended this classification scheme to include the possibility of a combination of any of these elements (Carlson et al., 1993). These themes were further developed by TerraChoice, since acquired by United Laboratories (UL), with the 'seven sins' of greenwashing (de Freitas Netto et al., 2020). The sins include hidden trade-offs, no proof, vagueness, worshiping false labels, irrelevance, the lesser of two evils, and fibbing (TerraChoice & UL, 2007). As these 'seven sins' are heavily cited throughout most of the literature and other resources on greenwashing reviewed for this article, they will be explored in depth and applied to carbon utilization products and companies in the next section.

As described by de Freitas Netto et al., there have been several additions to the list of greenwashing sins by other scholars (2020). In Scanlan's analysis of the risk of greenwashing in the oil and gas industry, he proposes additional sins including: (a) spreading false hopes about technologies to clean up the industry; (b) fearmongering over not accepting fracking; (c) breaking promises related to the safety and

sustainability; (d) covering up the environmental injustice created by projects; (e) lying about and covering up hazardous impacts on society; and (f) pursuing profits relentlessly over people and the environment (2017). As these sins primarily pertain to the oil and gas industry and derive partly from a history of cover-ups and damaging activities, they will not be applied to the fledgling and diverse carbon utilization industry.

While this article focuses primarily on product-level greenwashing, there are several firm-level greenwashing strategies worthy of consideration. Contreras-Pacheco and Claasen identify five primary strategies, or ‘transgressions,’ used by firms engaged in firm-level greenwashing, including (a) dirty business; (b) ad bluster; (c) political spin; (d) ‘It’s the law, stupid!’; and (e) fuzzy reporting (2017). The first four of these strategies originate from Greenpeace (Demmerling, 2014), and the fifth was added by Berrone (2016). In the first strategy, inherently unsustainable organizations that fundamentally depend on destructive practices promote individual ‘green’ products or practices that are not representative of overall practices. Ad bluster involves the use of advertising to divert attention from primary sustainability issues and is in some sense the execution of the previous strategy. An example of this could be ExxonMobil’s advertising of work on malaria (2021); while malaria is certainly a very pressing issue, this promotional material distracts from their fundamentally unsustainable practices and extensive public influence and lobbying activities (Beder, 2014). Political spin occurs when firms leverage their standing in society as providers of jobs or tax revenue to negatively influence regulations relating to sustainability. The ‘It’s the law, stupid!’ transgression is similar to the sin of irrelevance, as it involves promoting positive environmental attributes about products that are already required by law. Fuzzy reporting involves the use of sustainability reports and other one-way communications to distort the reality of the company’s environmental practices. Many companies focused solely on carbon utilization are too young to have the standing or resources to engage in many of these practices, and many carbon-utilizing technologies themselves are too new to be effectively deployed for strategies like dirty business and fuzzy reporting. However, as the industry develops, the risk of firm-level greenwashing on the part of companies selling carbon-utilizing products

will likely increase. Future research could explore how larger and more established firms might use carbon capture, utilization, and storage to divert attention from unsustainable practices or engage in other firm-level greenwashing strategies. The scope of this article, however, is on product-level greenwashing of CCU products, which poses a more immediate concern as these products enter the market.

Finally, to supplement the sins of greenwashing, the company Futerra has identified 10 signs of greenwashing that can alert stakeholders to its presence. These signs include fluffy language, green products made by a dirty company, suggestive ‘green’ pictures, irrelevant claims, claiming to be best in class in a harmful category (similar to the sin of the lesser of two evils), unbelievable claims, ‘gobbledygook’ or overuse of jargon, hinting at false labels, a lack of proof, and outright lying (2015). There is heavy overlap between these signs of greenwashing and the aforementioned sins, providing more support that the sins offer a rather comprehensive description of how greenwashing manifests. The use of suggestive pictures to imply sustainable operations is also quite similar to the concept of executional greenwashing.

RESULTS

With the increased sale of products utilizing captured carbon dioxide, there will be a corresponding increase in the marketing of such products. It is highly unlikely that all this marketing will accurately portray the products’ true environmental attributes, whether intentionally or not. Miscommunication between departments or a desire to deceive customers, investors, and other stakeholders will drive greenwashing of carbon-utilizing products. This section explores how the various sins of greenwashing as described by TerraChoice/UL could potentially apply to various CCU products and how the industry may be able to mitigate this issue. It concludes by offering a few questions for each sin that stakeholders can ask about particular marketing examples that could help uncover whether a particular greenwashing sin is being committed.

Hidden Trade-Off

Companies may commit the sin of the hidden trade-off when marketing carbon-utilizing products if they emphasize the climate benefits of the products but fail to disclose other adverse environmental impacts from

manufacturing or use. The existence of such trade-offs is known as environmental burden shifting, and it is a somewhat common issue in the field of life cycle assessment (LCA) (Jackson & Brander, 2019; Yu et al., 2015). Burdens can be shifted between impact categories or between life cycle stages. A hypothetical example of the former could be a novel carbon-utilizing chemical manufacturing technique that emits less greenhouse gas than the conventional technique but uses significantly more water. The environmental burden would shift in this case from the climate impact of the process to water depletion. Shifting between life cycle stages can occur within the same impact category. One example of this could be upfront mineral carbonation of concrete. Cement carbonates throughout its life cycle, which is often ignored in studies of carbon flows (Xi et al., 2016). Upfront carbonation of the concrete can reduce attributable emissions in the manufacturing phase, but it could potentially offset mineral carbonation that would have otherwise occurred throughout the material's use and end-of-life phases given that there is a limited amount of calcium oxide that can be carbonated. Thus, upfront carbonation may shift an emissions burden from manufacturing to the use and end-of-life phases. A failure to study or disclose this effect could be an instance of hidden trade-offs.

Full life cycle assessment, inclusive of many different impact categories, is required to understand the full extent to which the production and use of a carbon-utilizing product could be complicit in environmental burden shifting. The results of such assessments can help technology developers and companies communicate the overall impact of their products as well as focus on further research that may help mitigate environmental trade-offs. Without major technological breakthroughs, dominating technologies that are superior in every environmental attribute will likely be rare. Given this, anyone on the receiving end of green marketing of carbon-utilizing products should remain cautious about potential environmental trade-offs.

No Proof

The sin of no proof occurs when claims about a product or firm are made for which there is a lack of evidence. For carbon-utilizing products, this might occur when there is an intuitive, but potentially

unfounded, reason to think that the products are superior in some environmental attribute relative to their conventional counterparts. An individual or company may be tempted to claim that a product is 'green' solely due to its use of carbon dioxide captured from an industrial source or from the atmosphere. A simple counterexample to such a claim is a life cycle assessment that demonstrates various scenarios in which manufacturing of synthetic methane via the Sabatier reaction with CO₂ captured from the atmosphere actually increases carbon emissions (Deutz & Bardow 2021).

While LCA may not have perfect predictive abilities, it is the default method for assessing the current and expected environmental impacts of a given product or process. Without some form of an LCA—even just a series of back-of-the-envelope calculations—there will likely be little to no proof of the environmental impacts of a particular product. Further verification of LCA results, such as through critical peer review or certification of environmental product declarations, can further increase confidence and mitigate the potential for the sin of no proof.

Vagueness

There are numerous vague words and phrases used to signal the alleged sustainability of a product. Common examples include 'eco-friendly,' 'natural,' 'organic,' 'non-toxic,' and 'sustainable' (Alexander, 2020). While these terms all have dictionary definitions, their meanings in advertising are much less clear. It is imaginable that such vague language can and will be used at both the product- and firm-level. A cursory review of websites for companies selling carbon-utilizing products yielded some of these terms and others such as 'green,' 'reducing carbon,' 'climate-positive,' and 'carbon recycling.' The phrase 'carbon negative' also appears frequently. Concepts like 'carbon recycling' and 'carbon negative' do have specific definitions according to the International Carbon Capture and Utilization Assessment Harmonization Group's glossary,¹ but it is uncertain whether the companies were aware of these definitions when creating the marketing materials.

Arguably, the use of these phrases is greenwashing only if they are either intentionally deployed to mislead or inadvertently used without a logical basis.

¹ <https://assessccus.globalco2initiative.org/glossaries/>

If those making the claims have defensible evidence that the product or company does actually reduce greenhouse gas emissions or does actually recycle carbon, then use of terms like ‘reducing carbon’ and ‘carbon recycling’ seems warranted. The definitions that do exist for these terms were created in part for the purpose of clearly communicating these concepts to stakeholders. Regardless, consumers, investors, scholars, and others evaluating the meaning of these claims should give careful thought to what vague phrases actually imply and if there is or could be proof for those implications.

Worshipping False Labels

According to UL, the sin of worshipping false labels pertains to a ‘product that, through either words or images, gives the impression of third-party endorsement where no such endorsement exists; fake labels, in other words’ (TerraChoice & UL, 2007). This sin generally applies to consumer products that are sold with labels on their packaging. Examples of false or fake labels could include green badges with wording such as ‘Eco-friendly’ or ‘100% natural’ that attempt to emulate claims made by more legitimate labels such as USDA Organic and Fair Trade Certified. As many CCU products are commodities that will ultimately be sold business-to-business before reaching end consumers, there is likely not a very high risk of false labels as they are traditionally understood. However, with the increasing number of labels related to the carbon footprints of products (Carbon Trust, 2020; Climate Neutral, 2021; CO2logic, 2021; Ecolabel Index, 2021), there may be a risk of some companies creating their own labels to suggest endorsement or measurement by one of these third parties. Customers and investors should be wary of any kind of promotional claim for CCU products that takes the form of a label, and carbon labeling organizations should remain vigilant about misuse of their labels. If such a label is used, stakeholders should seek proof for the claim being made or inquire about its potential vagueness.

Irrelevance

Irrelevant claims are those that are true but not important or relevant for assessing the environmental attributes of the product. A simple example is ‘recyclable garbage bags’; the fact that the garbage bags are recyclable might be true, but it is irrelevant as garbage bags are necessarily thrown away when fulfilling their primary function. Irrelevance can also

occur when a product’s advertising denotes that it has a certain environmental quality that is required by law anyway. For example, the insecticide DDT was banned in the United States in 1972, so any claim that a given product is ‘DDT free’ would be irrelevant. For carbon-utilizing products, claims about the use of carbon in the products run the risk of being irrelevant. Ethylene (C₂H₄) is a chemical that contains carbon, so claims about the mere presence of carbon in ethylene sold by a given company would be irrelevant without further qualifiers about the carbon’s source. A more likely example might be a carbon-utilizing food company that captures carbon dioxide from the atmosphere for use in the manufacturing of synthetic protein. While such a process technically utilizes captured carbon, claims about the extent of carbon recycling relative to conventional food products would likely be irrelevant given that the vast majority of such products also use carbon dioxide captured from the atmosphere through photosynthesis.

The CCU process may in fact reduce emissions relative to the conventional products, but this would need to be proven and communicated separately. Identifying such irrelevant claims is difficult given that it requires a high degree of knowledge about regulations, manufacturing techniques for conventional products, and so on. Those on the receiving end of the marketing need to apply a degree of cleverness to deduce whether a given claim is actually communicating a unique and incremental environmental benefit. Parsing claims to understand what the product or firm offers ‘above and beyond’ the status quo is a helpful method for determining relevance.

Lesser of Two Evils

Companies commit the sin of the lesser of two evils when branding themselves or their products as better than the competition without acknowledging or addressing the negative environmental impacts of the broader category. Fuel-efficient sport utility vehicles (SUVs) are an example of this; while a fuel-efficient SUV will certainly emit less than a non-fuel-efficient SUV *ceteris paribus*, SUVs as larger vehicles will generally emit far more per passenger mile than smaller vehicles, public transportation, biking, or walking (Ritchie, 2020). In certain cases, the CCU pathway may itself be the lesser of two evils. For example, there are processes that can convert carbon dioxide to gasoline for use in vehicles (Wei et al., 2017). While manufacturing and combusting gasoline

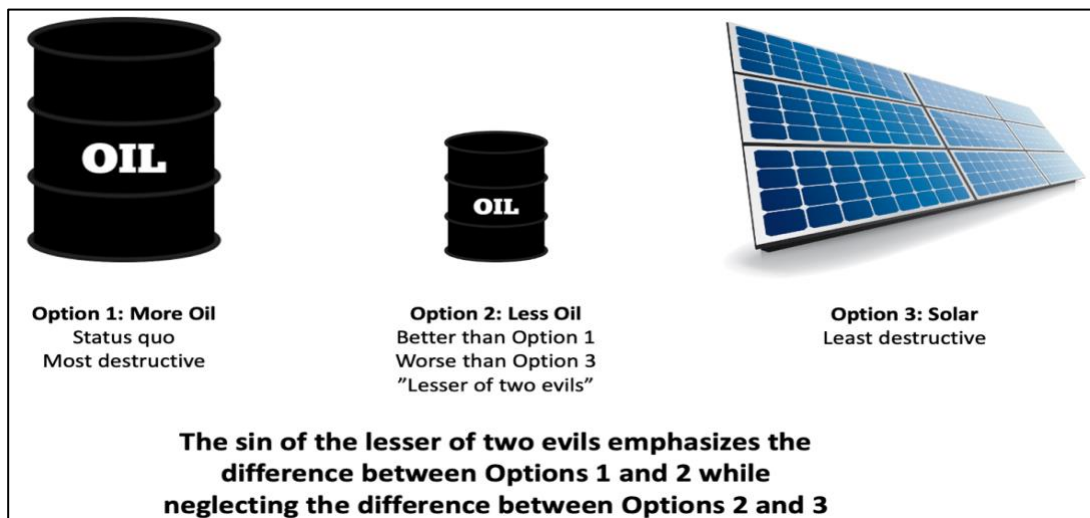


Figure 1. Simple example of how the sin of the lesser of two evils could manifest

made from CO₂ captured from the atmosphere would allow for a circular economy, it is difficult to imagine that such a system would be more efficient or lower in terms of emissions than using the renewable energy required for the CO₂ conversion process to instead power an electric vehicle directly. Better is not necessarily optimal as **Figure 1** demonstrates.

There is a degree of subjectivity in assessing whether a particular product represents the optimal environmental choice or is merely the lesser of two evils. This assessment depends on how realistic one believes the alternatives are. In some sense, a CCU product could represent the most realistic, lower-emissions alternative to some conventional product but could also be inferior in terms of emissions to either not using the product at all or using an entirely different product. However, there are certain cases, such as the EV one explained above, where it seems rather clear that CCU gasoline is a step backwards from the generally accepted method for decarbonization of automobiles. Assessing whether this is the case for any particular claim will require a holistic understanding of the functions of the products, other products in the marketplace, and other potential strategies for emissions reduction. This information will help determine whether a particular CCU product is merely the lesser of two evils or whether it truly is a significant and worthwhile solution.

Fibbing

The sin of fibbing involves outright deception and false claims. For a carbon-utilizing product, this could occur with the company making claims about the product that are simply untrue or falsifying or fraudulently reporting the results of a life cycle assessment. In some cases, fibbing could manifest through claims that suggest a violation of the laws of physics, especially the laws of thermodynamics. In the United States, making outright false claims in advertisements is illegal and punishable by significant fines based on guidance from the Federal Trade Commission (2021a). Despite such laws, false advertising abounds (Rhodes & Wilson, 2018), partly due to limited regulatory enforcement.

As the CCU business community is small relative to many other industries, there are higher reputational costs to fibbing. A loss in reputation from peddling a fraudulent technology could create a serious hindrance to gaining further resources from a limited investor and talent pool. However, the lack of experience and technical knowledge on the part of investors, employees, and customers could also create an environment ripe for false claims. The primary recommendation to reduce the risk of fibbing is for the community to educate itself on both the technologies as well as corresponding assessment methods. Another helpful strategy to reduce this risk is to increase the reputational costs of making false claims

Questions to Help Uncover Forms of Greenwashing

- **Hidden trade-off**
 - Does the product involve trade-offs between climate change and other environmental or social impacts, such as water use or toxicity?
 - How are emissions impacted at each stage in the product's life cycle when using a CCU product over a conventional one?
 - Is there enough information about the product to determine if there are trade-offs, and if not, where could one get this information?
- **No proof**
 - What evidence is provided about the sustainability of the product? Are there life cycle assessments, testimonies, reports, etc.?
 - Is any evidence that is provided sufficient to justify the environmental claims made about the product?
- **Vagueness**
 - What is the precise claim being made about the product?
 - What are the definitions of terms and phrases used to describe the product, such as "climate-positive" or "green"?
 - For the use of phrases that do have specific definitions such as "carbon negative": in what way and to what extent? What are the system boundaries (life cycle stages) used in the study?
- **Worshipping false labels**
 - Is there any kind of label used to communicate about the product?
 - Are any labels that are used issued by a third party, or are they made by the company itself?
 - If there is a label, what is it saying? What is the proof that the product meets the standards implied by the label, if there are any?
- **Irrelevance**
 - What is the incremental environmental benefit of the CCU product over the conventional product, if any? How is this communicated?
 - Are there any claims about meeting regulatory requirements that have to be met anyhow?
- **Lesser of two evils**
 - Is there a non-CCU product, technology, or intervention that would offer even more of an environmental benefit relative to the conventional product? How viable are such alternatives, and what is communicated about them?
 - What would the ideal case for the environment be? How close does the CCU product get to this?
- **Fibbing**
 - If the claims made about a product were false, how would one know?
 - What is the reputation of the entity making the claims? Is there any other reason to believe the claims could be false?
- **Executorial**
 - Is there significant use of natural imagery, green and blue color schemes, plants, animals, etc. in the promotional material for the product?
 - Is any use of natural imagery paired with claims about the environmental sustainability of the product? Are the claims justified?

Figure 2. List of questions to help stakeholders uncover potential instances of different types of greenwashing

by refusing to work with, buy from, or invest in companies that have a record of making such claims. However, due diligence and corresponding assessments are ultimately required to reveal potential fibbing.

Executorial Greenwashing

Executorial greenwashing—the use of natural imagery to imply a product's environmental friendliness—was identified in the literature review as its own category of greenwashing, distinct from the claim-based strategies described by the sins. For companies making products that utilize carbon, it is difficult to quickly determine if any use of natural imagery in their promotional materials is necessarily deceptive. It may be the case that the products actually do emit less and yield other environmental benefits, in which case it seems that the use of natural or 'green' imagery seems warranted. Regardless, anyone engaging with such promotional materials should attempt to focus on the claims and corresponding evidence rather than allow themselves to be influenced by natural imagery that may or may not have any relation to the actual product. This is easier in theory than in practice, but any serious evaluation

of the product's environmental merits should focus exclusively on the claims made about the product. Excessive use of natural imagery in a company's messaging could be a signal that the company is attempting to conceal something and might serve as a sign of executorial greenwashing.

Questions

A list of relevant questions is provided here to offer a structured approach to uncovering instances of greenwashing. Depending on the question, they can be posed either to oneself when engaging with promotional material or to firms directly. The answers, or lack of answers, can: (a) provide evidence of greenwashing; (b) reveal additional information that justifies the claims or the branding; or, (c) in cases of inadvertent greenwashing, prompt companies to re-evaluate their green marketing strategy. The questions are not necessarily comprehensive but should help reveal potential greenwashing based on the interpretation offered in this study. **Figure 2** provides a list of these questions for each of the identified sins of greenwashing along with executorial greenwashing.

DISCUSSION

As described in this article, there are many ways that firms might inadvertently or intentionally greenwash carbon-utilizing products. There are also many different questions that stakeholders can ask to help uncover these strategies and understand if the firms have taken the proper steps to assert their environmental claims. While equipping customers, investors, employees, non-governmental organizations, and business partners with the appropriate tools and knowledge may help mitigate greenwashing, there is still an open question surrounding how to incentivize firms to avoid greenwashing before they ever engage in it.

A simple approach to creating an incentive to not greenwash could involve strengthening and clarifying rules and enforcement mechanisms surrounding false advertising. In the U.S., the Federal Trade Commission has published the Guides for the Use of Environmental Marketing Claims to help inform marketers about best practices in honest, green marketing (2012b). These guides cover multiple categories ranging from carbon offsets to non-toxic claims, and they were informed by a high degree of public inputs from companies and customers. While they are not direct rules or regulations, 'they describe the types of environmental claims the FTC may or may not find deceptive under Section 5 of the FTC Act. Under Section 5, the agency can take enforcement action against deceptive claims, which ultimately can lead to Commission orders prohibiting deceptive advertising and marketing and fines if those orders are later violated' (Federal Trade Commission, 2012a). Combining more particular language about greenwashing of CCU products along with more stringent enforcement could help disincentivize would-be greenwashers. There are comparable competition and consumer protection agencies in nearly every country in the world (Federal Trade Commission, 2021b) that could theoretically enforce similar rules against greenwashing internationally.

However, policy alone cannot solve greenwashing. Even with perfect rules and enforcement, there are certain sins that fall outside of what can be reasonably regulated. For example, the sin of the lesser of two evils can be committed using truthful claims alone. While CCU fuel made with renewable energy may not be as beneficial for the climate as direct electrification of transportation, it can still be better than

conventional fossil fuel combustion. Advertising the latter fact is greenwashing but might not necessarily be deceptive, so subsequent regulations might be impossible to draft or vulnerable to selective enforcement. Executional greenwashing would also be difficult to regulate; it could be absurd to set an arbitrary standard for the extent of natural imagery that a company can use in advertising. Thus, if the burden to disincentivize greenwashing cannot fall on governments alone, then other stakeholders need to play a role too.

By educating themselves and not falling victim to greenwashing, consumers can directly make the practice less beneficial to those who might engage in it. The same can be said of employees, investors, and business partners. Stakeholders who want to engage with companies that are working on environmentally-beneficial products cannot meet their goals with false or misleading information. Naturally, these parties will negatively judge firms that deceive them about this. Investors and fund managers charged with investing in sustainable companies are coming under increasing scrutiny to prove that the companies they invest in are actually creating environmental and social benefits (Quinson, 2021). Creating a culture of identifying and punishing greenwashers can help mitigate intentionally deceptive green marketing schemes.

Mitigating inadvertent greenwashing will likely require additional strategies. Unintentional greenwashing can occur through miscommunications between engineers and marketers within a company, but it can also occur if those promoting a product are simply unaware of methodologies such as life cycle assessment and commonly accepted definitions of terms such as carbon negative and carbon neutral. Thus, promoting the awareness and use of methodologies like carbon accounting and LCA will help all different stakeholders remain vigilant about misleading claims and other forms of greenwashing.

Further research and discussion about greenwashing generally will also be helpful for uncovering and mitigating its role in the business ecosystem. There will be a place for more investigation of firm-level strategies and mitigation tactics as carbon utilization companies become more established and incumbent companies begin either acquiring CCU startups or launching their own CCU product lines. The

questioning approach outlined in this study could also be expanded with more specific questions and coverage of new sins. Others may want to explore further signs of greenwashing, particularly as more specific examples are revealed. Furthermore, general guidance on how to responsibly market attributes of more sustainable products could be useful to companies who might otherwise engage in inadvertent greenwashing. Finally, while this study focuses on greenwashing of CCU products, there are other emerging climate technologies—such as carbon removal, cultured meat, and novel manufacturing techniques for industrial products—that could also benefit from a similar analysis. If society hopes to use markets to help mitigate and reverse climate change, then it must work on ensuring accurate and transparent communication about climate-related products.

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