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Challenges in Validation of Sustainable Products and Services in the Green Marketplace

Xue Wang Underwriters Laboratories LLC, xue.wang@ul.com
William F. Hoffman III Underwriters Laboratories LLC, bill.hoffman@ul.com
Gabrielle Gaustad Rochester Institute of Technology, gabrielle.gaustad@rit.edu
Angela Griffiths Underwriters Laboratories LLC, angela.griffiths@ul.com

Abstract. As consumer awareness of sustainability increases, companies are spending more time and money claiming their products or services are more environmentally friendly than other similar products on the market. However, a substantial number of those claims used for advertising and marketing purposes may be misleading or false. While there are organizations that currently provide environmental claim validation services to increase trust in the green marketplace, the challenges in validation of these environmental claims have not been comprehensively examined. This paper explores three major challenges in validating sustainable products and services: 1) the risk of validating erroneous environmental claims, 2) the difficulty of balancing the trade-offs in multi-attribute environmental claim validations, and 3) the challenge of developing protocols for innovative claims within a reasonable time frame. The authors use three real-world examples – evaluation of a longevity claim (and associated reduced environmental impacts) of a product, development of a multi-attribute standard, and construction of test procedures in the absence of an existing standard. Results demonstrate that validations and certifications by dedicated third parties may effectively improve perceptions of trust in greener product claims. These initial findings aim to inform a variety of policy decision-making and potentially help to lay the foundation for establishing rules and regulations for environmental claims in green markets.

Keywords: validation, environmental claim, sustainability, greenwashing, green labeling

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Introduction. As consumer awareness of sustainability has increased in the past decades, the demand for sustainable products and services has also increased significantly. A growing number of companies have integrated sustainable strategies into their business activities or product designs, motivated in part by customers' green purchasing decisions(ULE 2014, 2015). Green messaging such as environmental advertising claims, green names, and various labels are popular approaches taken by manufacturers to differentiate their products and services that have lower environmental impacts from traditional ones. According to research completed by TerraChoice, formerly a marketing and environmental consultancy based in Canada that was acquired by UL Environment[1] in 2010, the total number of "green" products in selected stores in the US, Canada, UK, and Australia increased by 79% from 1,018 in 2007 to 2,739 in 2009, and increased again to 4,744 in 2010 (Figure 1a).

TerraChoice found that the majority of environmental claims in the green marketplace are misleading, deceptive or vague at some level. In other words, most messages out in the market are committing at least one of Seven Sins of Greenwashing (i.e., hidden trade-off, no proof, vagueness, irrelevance, lesser of two evils, fibbing, and worshiping false labels) according to TerraChoice. In 2007, less than 0.1% of products claiming green were sin-free, and this number increased slightly to 1.1% in 2009, and to 4.5% in 2010 (see Figure 1b) (Marketing 2009).

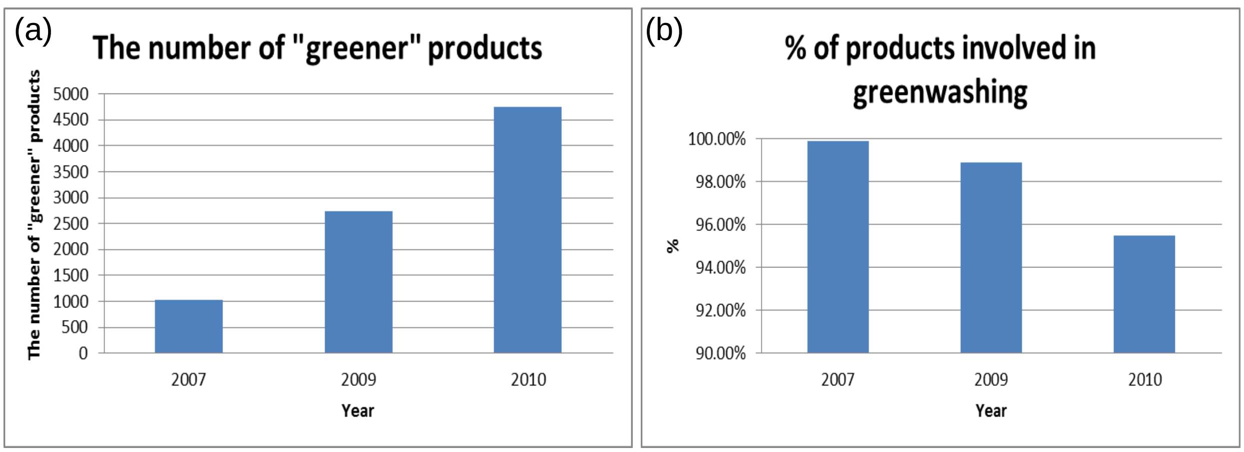

Figure 1a The number of "greener" products found in selected stores in 2007, 2009 and 2010, according to TerraChoice's research, **1b** the percentage of "greener" products involved in greenwashing.

The U.S. Federal Trade Commission (FTC) updated its Green Guides in 2012 to provide general principles to all environmental claims to help marketers avoid making deceptive claims.[2] Since the launch of the updated Guides, the FTC has taken actions against manufacturers and marketers on a host of claims, including on biodegradability, volatile organic compound (VOC) claims, and energy efficiency claims among others. For example, in 2013 the FTC announced enforcement actions against five companies (ECM Biofilms, American Plastic Manufacturing, Champ, Clear Choice Housewares, and Carnie Cap) for making false biodegradable plastics claims (FTC 2013).

To avoid greenwashing and increase marketplace trust in product claims, some companies engage third parties to endorse their environmental claims. Currently, a number of organizations provide environmental validation services, such as UL, Société Générale de Surveillance (SGS), the US Environmental Protection Agency (EPA), the National Sanitation Foundation

[1] UL Environment is a business unit of Underwriters Laboratories (UL).
[2] FTC's Green Guides are designed to help marketers avoid making environmental claims that mislead consumers.

(NSF) International, the Electronic Product Environmental Assessment Tool (EPEAT), member organizations of the Global Ecolabelling Network (GEN), and more. However, the challenges of practicing environmental claim validation remain unexamined. This study aims to explore these challenges by analyzing three business projects completed by UL Environment, and to discuss how third party validation and certification service can inform a more robust marketing system.

Methodology. Three major challenges facing environmental claim validation practitioners are: 1) the risks of validating erroneous environmental claims (avoiding Sins of Greenwashing for instance), 2) the difficulty of balancing the trade-offs in multi-attribute environmental claim validations, and 3) the challenge of developing protocols for innovative claims within a reasonable time frame. This paper uses three case study examples to explore these challenges and how UL Environment approaches them.

Challenge 1—the risk of validating erroneous environmental claims. In one case, a printed circuit board (PCB) manufacturer sought UL Environment's assistance in helping it make a credible, market-facing claim that a longer life PCB will provide lower environmental impacts by extending the lifespan of the product. However, since PCBs cannot be used stand-alone, their environmental impacts are highly dependent on the useful service life of specific electronic products in which PCBs are used. UL Environment can assist manufacturers that wish to make new sustainability-related product claims in the marketplace through its Innovative Claims offering. Through this offering, UL Environment begins by seeking to understand whether there is a testable claim to be made. Called a feasibility assessment, the first step is to conduct a comprehensive study to assess the feasibility of testing based on the environmental significance and relevance of the claim, as well as the technical and market requirements related to labeling with respect to regulator guidance such as the Green Guides. UL Environment identified two key issues for consideration related to this specific claim: potential causes for circuit board failure (requiring replacement), and the life span of electronic products.

Potential causes of PCB failures. PCBs, the board bases for mechanically supporting and electrically connecting electronic components, are widely used in almost all electronic products. In general, PCB failures fall into two main categories: failures that occur during the manufacturing process, and those that occur during the use phase of end-products in which they are a component part (i.e., electronic products such as laptop computers). UL Environment's feasibility assessment focused on the latter category of failure of the end-products in which the PCBs are a component part. Such failures include power component failure, discrete component failure, physical damage, and trace damage, as the most probable failures that might occur after the PCB has been delivered to the end user, and which critically affect the life expectancy of the PCB (Wu *et al.* 1993; Lim & Low 2002; Jenq *et al.* 2007).

UL Environment found that, during the use phase as a component within manufactured products, there are a variety of causes of PCB failure over time. These include excessive heat, thermal cycling, high voltage, humidity, severe shock, strong vibration, contamination, etc. (Lee *et al.* 2006). In short, thermal and mechanical stresses that are beyond what PCBs typically experience are the major factors contributing to low PCB life expectancy as a component part in other products.

A potential additional concern related to this claim is the identification of potential causes of PCB failures during the service lifetime of different types of electronic products.

Life span of electronic products. PCBs, as currently designed, are not reusable in another electronic device; therefore, their environmental impacts are highly dependent on the useful service life of specific electronic products in which PCBs are used. While PCBs with longer life expectancy have the potential to lower the environmental burden of electronic products over their life cycle, the durability of PCBs might not be the aspect that significantly affects an electronic product's useful life and therefore environmental impacts. In particular:

- The failure of other contained components is more likely to lead to malfunction of a certain product than the PCB. For example, accidently dropping a camera on a hard surface might not harm its PCB but might lead to a warping of the lens mount, a damaged anti-shake mechanism, or other severe damages that would require replacement versus repair.
- The typical service lifetime of a certain type of electronic product is shorter than the lifetime of PCBs. For example, the average service lifespan of smartphones has decreased to 21 months in 2011 (Entner 2011). In addition, users may replace smartphones with newer generation products after only a few months' use. Hypothetically, if the PCBs used in smartphones last 4 years on average, extending PCBs' life expectancy will not contribute to a reduction in the environmental impact of smartphones.

Consequently, to make this type of environmental claim, UL Environment determined that a series of tests should be performed at the board-level and/or the product-level to prove that improving the life expectancy of PCBs extends the service life time of the electronic products in which they are a component part. These tests are called Quantitative Accelerated Life Testing (QALT).

QALT. These tests are designed to provide data on product life expectancy under accelerated conditions to extrapolate the mean life expectancy of products as well as the probability of failure of products under normal use conditions. Two experimental options to achieve acceleration are shown in Table 1.

Table 1 Two experimental options for QALT.

Experimental Options	Application	Cases	Approach Options
Usage rate acceleration	For electronic products that are not intended to operate continuously	Microwave, televisions, cameras, etc.	Increasing usage (e.g., operating continuously, or increasing usage frequency) but keeping the same types of stresses and stress levels as those in the normal operation.
Overstress acceleration	For electronic products that are normally used continuously	Mobile phones, computers at work, computer servers, etc.	Using accelerated stresses, e.g., higher temperature, thermal cycle, humidity, vibration, and severe shocks, etc.

Auditing Requirements. UL Environment determined that, despite the likelihood that an extended life PCB could reduce certain waste as a standalone product, the fact that PCBs are never used as standalone product links the life of the PCB to the useful life and potential environmental benefits of the product. In fact, the life expectancy of PCBs might not be the aspect that significantly affects an electronic product's environmental impacts. Consequently, the only claims that might be feasible would be very application-specific. In these cases, the PCB manufacturer would need to first prove that the service lifetime of electronic products is longer than the current life expectancy of PCBs so that an extended life PCB provides a benefit. Table 2 summarizes the average service lifespan of several types of electrical and electronic products, many of which are too short for an extended lifespan to provide benefit. If the manufacturer wished to proceed, UL Environment would develop a formal validation protocol for appropriate type(s) of electronic product in which candidate PCBs are used. The validation process would involve a series of QALT at electronic product-level, including usage rate acceleration and overstress acceleration. Finally, the test reports as well as the PCB manufacturer's ability to maintain conformity over time, would be reviewed by UL Environment to receive a validated claim and permission to use UL Environment's ECV badge[3].

Table 2 Average service lifetime of several products.

Product Type	Average Service Lifetime (yrs)	References
Mobile phones	<3	(Yin *et al.* 2014)
Laptops	4	(Bakker *et al.* 2014)
Desktop computers	5.9	(Van Heddeghem *et al.* 2014)
Copiers	6.5	(Masahiro *et al.* 2006)
Printers	7.1	

Challenge 2—the difficulty of balancing the trade-offs in multi-attribute environmental claim validations. Environmental claims fall into two main categories: single-attribute and multi-attribute. Single-attribute claims generally focus on one critical aspect of a product, such as waste to landfill diversion rate, recyclability rate, halogen free electronics, etc. Multi-attribute claims cover multiple sustainable attributes and characterize the overall sustainability performance throughout a product's lifecycle. However, balancing the trade-offs among different assessment criteria in a multi-attribute environmental claim validation is challenging.

To discuss this challenge in more detail, we refer to our second example: the process UL Environment undertook to develop UL 110, Standard for Sustainability for Mobile Phones. This standard evaluates the environmental, economic and social benefits of a mobile phone's lifecycle.

UL Environment convened a cross-functional team of internal and external engineers, scientists, manufacturers, users, and policymakers to identify key sustainability factors. UL, as a credible third party, has resource and expertise to ensure standard technical panels that develop balance, transparency, and, unbiased procedures. These stakeholders' classified factors into eight impact categories, including mobile phone's materials, health and environment, manufacturing and operations, packaging, end-of-life management and life extension, and innovation (see Table 3). Among those attributes, eight criteria are required to be met by evaluated products to be certified against UL 110, as this stakeholder group identified them as critically important; the rest are optional. Points were assigned to the optional criteria based on the relative importance of each attribute as determined by stakeholders in the technical committee. In total, a maximum of 109 points are available (not including innovation points). The standard also includes innovation criteria to address new and emerging technologies and products may be awarded innovation points.

The standard development process (including criteria-selection and points-assignation) involved several rounds of discussion and voting to ensure the fairness and feasibility of the standard. The typical timeline is approximately 6-12 months. This process is continuing as the standard is developed into a full consensus based ANSI standard[4]. This illustrates the level of effort and time it takes to build multi-attribute evaluation frameworks – a process that is lengthy precisely because decisions about criteria and relative weight in an assessment process is challenging work.

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[3] The UL Environment ECV badge communicates to customers and prospects that products have been evaluated by a neutral third party and independently validated. ECV badges are custom made on a project by project basis.
[4] The American National Standards Institute (ANSI) is a private non-profit organization that oversees the development of voluntary consensus standards for products, services, processes, systems, and personnel in the United States (Shirey 2007).

Table 3 Assessment criteria (either optional or required) and available points in UL 110.

Category	Sub-category	Criteria	Required or Optional[a]
Materials	Supply chain management of materials	Conflict minerals restriction	1
		Compliance with the European REACH Directive (Regulation (EC) No 1907/2006)	5
	Sustainable use of raw materials—plastics	Post-consumer recycled plastic and/or bio-based plastic content in the housing of the mobile phone	≤ 5
		Post-consumer recycled plastic and/or bio-based plastic content in the housing of the external power supply	≤ 4
	Energy use requirements	Universal connector for external power supply output	2
		External power supply average efficiency and no-load power	≤ 20
		Universal connector for mobile phone	2
Health and Environment	Substances of concern	Compliance with the European RoHS Directive (2002/95/EC)	Required
		Extractable nickel	Required
		PVC restriction for mobile phone, external power supply, and accessories	≤ 3
		DEHP, DBP, and BBP[b] restriction for mobile phone	2
		Restriction of bromine and chlorine in mobile phone PCB	2
		Restriction of bromine and chlorine in all materials of mobile phone	3
		Restriction of beryllium in all materials of mobile phone	2
		Restriction of lead, cadmium, and mercury in the mobile phone battery cell	Required
		Textile and leather accessories	Required
	Dermal contact assessment	Dermal toxicological assessment of exterior surfaces of mobile phone	3
		Acceptable hazard profile for dermal toxicological assessment of exterior surfaces of mobile phone	5
	Life cycle assessment (LCA)	Product level LCA	3
		Independent peer review of product level LCA	2
		Major impacts of LCA included in the CS plan	2
End of Life Management and Extension of Useful Life	End of life (EOL) management	Mobile phone take-back and/or refurbishing program	2
		Mobile phone recyclability rate	≤ 5
		Availability of replacement parts	1
		Primary recyclers certified to R2, e-Stewards or equivalent	1
		Battery removability	Required
		Ease of removing external enclosure of mobile phone	1
		Use of similar or compatible plastic materials	1
		Feature to erase user data from mobile phone	1
Packaging	Packaging	Use of recyclable fiber based packaging materials	≤ 3
		Use of post-consumer recycled plastic packaging	≤ 2
		Expanded polystyrene packaging (EPS) restriction	Required
		Environmentally preferable paperboard packaging	≤ 3
		Heavy metal restrictions in packaging	Required
		Avoiding petroleum based inks in packaging	1
		Avoiding petroleum based adhesives in packaging	1
		Reduced packaging volume	≤ 3
Manufacturing and Operations	Corporate Sustainability (CS)	CS action plan	4
		Publishing of the CS report	2
		Third party review of the CS report	1
		CS action plan applied to contract manufacturers	2
	Environmental health and safety policies	Publicly available environmental health and safety policy	Required
		Formal environmental management system (EMS) program and certification	2
	Supply chain impacts	The electronic industry citizenship coalition code of conduct	5
		Manufacturing facilities certified to ISO 14001 or EMAS	2
Innovation	The intent is to award activities that exhibit exceptional performance above and beyond those required within these requirements as well as activities that are not covered by the criteria within these requirements.		≤ 10

[a] If a criteria is optional, the available point(s) is shown.
[b] Bis(2-ethyhexyl) phthalate (DEHP), benzyl butyl phthalate (BBP), and dibutyl phthalate (DBP).

Challenge 3—the challenge of developing protocols for innovative claims within a reasonable time frame. Companies wishing to take a sustainability leadership position are often more innovative than the market in general (GM 2014; Unilever 2015; Walmart 2015). As a result, these companies may develop new products or technologies for which there are no pre-existing standards. This is particularly true in fast moving sectors such as electronics. These companies may seek third party validation of their new products as a means of enhancing or supporting their market entry.

An alternative approach to development of a full multi-attribute standard – which takes significant time, as noted above – is the development of specific environmental claims protocols. However, the development of validation procedure for such new-to-market or innovative claims within the accelerated time frames required of innovation can be challenging.

To discuss this challenge in more detail, we'll take our third case: the development of an environmental claim validation procedure for a new type of power strip. In 2010, an advanced power strip (APS) manufacturer expected to launch its products to the green marketplace with a certified energy-saving label. Advanced Power Strips disconnect power from peripheral devices under a control of a master device or by sensing inactivity in the room. However, EnergyStar does not have a protocol for these products (EnergyStar 2015). UL Environment was asked to develop a new validation procedure for comparable energy efficiency marketing claims for APS products.

The process of UL Environment's Innovative Claim Validation includes three main stages. The first stage is to conduct a preliminary assessment, which usually takes two to four weeks. As noted under the first challenge, during this stage, the feasibility of the claims proposed by customers is analyzed based on their environmental significance and relevance, and technical and market requirements for the claim, including the possible required tests and supplemental documents. If the studied claim is determined feasible, UL Environment will suggest acceptable claim language based on its knowledge and experience with guidelines such as the FTC Green Guides. The second stage is protocol development, which could take one to several months depending on the specific case. At this stage, a validation protocol specifying the scope, boundaries, required testing and criteria, calculation methodologies, and validation procedure and requirements for the environmental claim will be established and reviewed by a group of technical experts. At the final stage, UL Environment will use the developed validation procedure to validate the environmental claims. The process might include a documentation review, desktop and/or on-site audits, and product testing, which usually takes between four and eight weeks to complete. This last stage is largely dependent on the manufacturer's readiness to supply requested evidence and schedule onsite visits.

This APS manufacturer eventually achieved this energy saving claim; however the whole validation process took much longer than they expected. While as a credible third party UL Environment has to go through all these three stages to ensure the credibility, reliability, and transparency of its standards/procedures and certification processes, how to shorten this process without reducing the quality is a challenging but imperative task faced by all certification organizations.

Conclusion. Due to the inaccuracy of a large number of self-declared environmental claims out in the green marketplace, an increasing number of companies engage third parties to endorse their environmental claims. While credible validation and certification bodies have resources and ability to ensure the accuracy and trustfulness of sustainability claims, they usually face challenges during the validation process. This paper analyzes three major challenges in validation of sustainable products and services using three business case studies. In addition, this study also demonstrates that green messaging validated by credible third parties may improve the communication in the green marketplace through offering benchmarks for assessment of environmental performance of products and services, sending transparent and unbiased information to the market, and promoting healthy competition among manufacturers. These results also inform a variety of policy decision-making and could potentially help to lay the foundation for establishing rules and regulations in the green marketplace. Our future research involves exploring the specific strategies to address those three major challenges.

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