Introduction to EcoPersona AI: Generative Consumer Personas Based on Carbon-Footprint Sensitivity

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Abstract
Consumers today encounter a growing volume of sustainability-related marketing information, including carbon footprint labels, eco-scores, and product transparency dashboards. Yet, despite the global emphasis on sustainability, the behavioral impact of such information remains inconsistent. Many consumers acknowledge environmental issues but vary widely in how deeply they process, trust, or act on sustainability claims. This inconsistency highlights the need for a segmentation approach that goes beyond traditional demographic or psychographic boundaries.
This paper introduces EcoPersona AI - designed to classify consumers by their Carbon-Footprint Sensitivity (CFS)—a measure of how individuals perceive and respond to product-level sustainability data. The model uses verified environmental metrics such as ISO 14067-based product carbon footprints, coupled with behavioral interaction signals, to develop adaptive personas that guide message framing, creative design, and communication strategy.
Grounded in the Value-Belief-Norm (VBN) theory, the Theory of Planned Behavior (TPB), and Construal Level Theory (CLT), EcoPersona AI seeks to humanize the use of artificial intelligence in marketing by connecting behavioral science with measurable sustainability outcomes. The model aims to help mid-sized and large product-based businesses translate verified impact data into effective and credible communication strategies that increase comprehension, trust, and green product adoption.

Keywords: *Green marketing, consumer behavior, carbon labeling, ISO 14067, AI personalization, sustainability communication*

Introduction

Green marketing has evolved from niche branding to a strategic necessity across industries. Governments, regulators, and consumers are increasingly demanding environmental transparency through standardized measures such as carbon labeling, product life-cycle assessment (LCA), and sustainability disclosures. Yet, while the data supporting these initiatives has become more robust, the behavioral response from consumers remains fragmented.
A consistent pattern in recent empirical studies suggests that simply displaying sustainability information—such as a carbon footprint or recycled-content percentage—does not guarantee behavioral change. For instance, Edenbrandt (2025) and Imran (2025) observed that while carbon labels can influence purchase intention, the effect size depends heavily on consumer awareness, prior values, and the design of the information interface. This underscores the fact that the same sustainability message can have vastly different effects on different people.
EcoPersona AI addresses this communication asymmetry by proposing a structured, theory-driven model that categorizes consumers according to their Carbon-Footprint Sensitivity (CFS). The concept recognizes that consumers are not homogeneous in their cognitive or motivational responses to sustainability messages. Rather than assuming a uniform "green audience," EcoPersona AI enables marketers to tailor the complexity, tone, and evidence depth of sustainability communication based on how individuals interpret and act upon environmental information.

2. Theoretical Foundations

The conceptual foundation of EcoPersona AI draws from three complementary behavioral theories that explain why consumers vary in their pro-environmental engagement.

2.1 Value-Belief-Norm (VBN) Theory

Proposed by Stern et al. (1999), the VBN model posits a causal sequence in which personal values shape environmental beliefs, which then activate moral norms leading to pro-environmental behavior. Individuals with strong biospheric or altruistic values experience a moral obligation to act sustainably once they perceive environmental consequences. Applying this model to consumer marketing, EcoPersona AI interprets user interactions—such as voluntarily expanding sustainability information or viewing methodology details—as indicators of activated moral

norms. These behavioral signals can be quantified to estimate each user's CFS level.

2.2 Theory of Planned Behavior (TPB)

Ajzen's (1991) TPB states that intention to perform a behavior is driven by attitude toward the behavior, subjective norms, and perceived behavioral control. In sustainability contexts, attitude reflects the perceived benefits of green products; norms refer to social influence and peer expectations; control denotes whether consumers feel capable of making an eco-friendly choice. EcoPersona AI maps these constructs to observable signals: for example, engagement with "peer choices" or "eco-savings" cues suggests norm-driven behavior, while clicks on "learn more" links may reflect high perceived control and positive attitude.

2.3 Construal Level Theory (CLT)

According to Trope and Liberman (2010), individuals interpret information differently depending on psychological distance. When issues feel abstract or distant, people process them conceptually; when issues feel close or immediate, they process them concretely. In sustainability marketing, high-involvement consumers (high-CFS) are comfortable with concrete, numeric data such as kilograms of CO_2e per product. Low-involvement consumers (low-CFS) respond better to simple, emotionally resonant messages like "Cleaner choice for tomorrow." EcoPersona AI integrates CLT principles by matching the level of message abstraction to the consumer's inferred psychological distance from environmental issues.

Together, these theories provide a rigorous conceptual backbone. They justify that consumers' sustainability responsiveness can be inferred through behavior and that communication effectiveness improves when aligned with corresponding cognitive and motivational profiles.

3. Problem Context

Despite progress in sustainability metrics, marketing practice often treats environmental communication as uniform. Many brands adopt generic sustainability claims ("eco-friendly," "low impact") without differentiating between audiences that demand technical evidence and those that prefer intuitive cues. This "one-message-fits-all" approach results in weak comprehension and limited behavioral shift, as supported by meta-analyses on green labeling effectiveness (Lenk et al., 2025).

Furthermore, marketers rarely connect verified product data with psychological segmentation. Existing marketing automation platforms can personalize by purchase history or demographics, but they cannot adjust the depth and framing of sustainability information according to consumers' sensitivity or interest level.

EcoPersona AI directly addresses this operational gap by using AI to merge verified environmental metrics with behavioral signal analysis, thereby producing dynamic personas that inform creative and channel decisions.

4. Conceptual model of EcoPersona AI

4.1 Definition of Carbon-Footprint Sensitivity (CFS)

CFS represents the extent to which an individual notices, interprets, and acts upon carbon-related information in a product context. It reflects both cognitive engagement (attention to details) and affective engagement (concern or motivation). In practice, CFS can be inferred from digital behaviors such as expanding "learn more" tabs, viewing methodological notes, or comparing carbon data between variants.

4.2 Persona Typology

Initial deployments may classify users into four broad persona categories:

1.Technical Seekers: High-CFS individuals who value numeric transparency and life-cycle details.

2.Utility Pragmatists: Moderate-CFS users who connect sustainability with practical or financial benefits (e.g., "uses less energy").

3.Social Responders: Norm-driven individuals influenced by peer adoption and collective outcomes.

4.Minimalists: Low-CFS users who prefer concise, visual messages with minimal cognitive load.

Each persona reflects distinct combinations of the constructs from VBN (value orientation), TPB (norms and control), and CLT (construal level). The purpose is not to stereotype consumers but to enable adaptive communication design.

4.3 Architecture

The EcoPersona AI system operates through four conceptual layers:

1.Data Layer: Aggregates verified product metrics (carbon footprint, recycled content, durability) based on ISO 14067 or equivalent LCA standards, along with behavioral data such as interaction time or expansion clicks.

2.Signal Layer: Translates raw data into interpretable psychological signals (interest depth, norm responsiveness, concreteness preference).

3.Persona Layer: Applies clustering algorithms to generate CFS personas; uses language models to articulate each persona's narrative ("who they are," "how they perceive green claims").

4.Activation Layer: Deploys tailored message variants across creative assets and channels, continuously testing and refining based on observed response metrics.

Although AI aids automation and pattern recognition, decision rules remain transparent and interpretable to marketing teams, ensuring accountability.

5. Implementation Strategy

EcoPersona AI is structured for gradual adoption. Mid-sized businesses can implement the model without heavy infrastructure by following a phased approach.

In the initial phase, a company selects one or two product categories with existing carbon data—such as appliances or packaged goods. A simple carbon information card is embedded on product pages, presenting verified CO_2e values and a link to methodology. User interactions with this card generate behavioral signals used for persona inference.

Next, marketers create three to four message templates aligned with the identified personas. For example, a "Technical Seeker" receives precise data—"1.8 kg CO_2e per item, verified by ISO 14067"—while a "Utility Pragmatist" sees a combined functional frame—"Saves 25% energy, cutting CO_2 emissions by 28%." These variations are distributed through A/B testing across web pages, advertisements, or e-mails.

Over time, aggregated responses refine the persona definitions and improve model accuracy. Importantly, the system remains modular: companies can expand it across products and regions as data maturity increases.

Such an approach keeps implementation accessible, aligns with current marketing analytics practices, and avoids dependence on large-scale AI infrastructure.

6. Expected Outcomes

From a behavioral standpoint, the EcoPersona AI model leads to several empirically testable outcomes.

Improved Comprehension and Credibility.

Messages aligned with CFS personas will enhance consumer comprehension of environmental information and perceived trustworthiness of claims. This prediction follows from VBN and TPB, as aligned values and norms improve message relevance and reduce skepticism.

Increased Adoption of Low-Carbon Alternatives.

Consumers receiving persona-tailored communication will exhibit a higher probability of selecting lower-carbon products compared to those receiving uniform messages. Prior experimental findings on carbon labels (Beyer et al., 2024; Schulze-Tilling, 2025) support this expectation.

Communication Efficiency.

Adaptive messaging will maintain or improve conversion rates while reducing unnecessary cognitive or media load. Low-CFS segments receive concise information, minimizing resource use and attention fatigue.

Empirical validation can involve field experiments or controlled online tests comparing baseline communication with persona-adapted messaging, using dependent variables such as click-through rate, trust score, time spent on label, and conversion to greener variants.

7. Practical Relevance and Governance

EcoPersona AI aligns with the broader movement toward data-verified sustainability communication. The use of ISO 14067 for product carbon footprints ensures methodological rigor and comparability, while privacy-respecting behavioral data collection adheres to ethical marketing standards.

Importantly, the model discourages manipulative personalization. Persona inference is based on anonymous event data rather than personal identifiers, maintaining compliance with data-protection regulations. Every sustainability claim remains linked to auditable evidence ("see method" or "source" links).

For organizations, adopting this system strengthens both compliance and consumer trust. It also enables measurable reporting of communication effectiveness—an aspect increasingly required in environmental, social, and governance (ESG) disclosures.

8. Discussion

EcoPersona AI operationalizes long-standing behavioral theories in a contemporary digital context. It translates abstract psychological constructs—values, norms, perceived control, construal distance—into quantifiable engagement patterns that inform marketing practice. In doing so, it reframes AI not as a creative replacement but as an analytical partner for responsible communication design.

From a sustainability perspective, the model connects marketing directly to measurable environmental outcomes. By fostering uptake of verified low-carbon products, EcoPersona AI contributes indirectly to emissions reduction while strengthening the credibility of corporate sustainability initiatives.

The model also encourages collaboration between product teams, data analysts, and marketers. Material scientists who calculate product impacts provide the verified data; marketers translate it through AI-supported segmentation; data analysts maintain the learning loop. This interdisciplinary integration exemplifies the spirit of "AI and Materials for Sustainability," the theme of AIMS 2025.

9. Limitations and Future Research

While conceptually strong, EcoPersona AI requires validation through longitudinal studies across sectors. Initial persona clustering may misclassify users due to limited behavioral data, necessitating iterative refinement. Additionally, not all markets have

standardized carbon data for all products, which could constrain scope in the short term.

Future research could explore integrating emotional or cultural variables—such as regional environmental concern indices or cultural distance—to enhance persona fidelity. Cross-national replication would test how cultural values influence the predictive power of CFS. Another avenue involves integrating life-cycle data from digital product passports (as envisioned under the EU Ecodesign Regulation) to enhance transparency and automation.

10. Conclusion

EcoPersona AI provides a structured pathway for connecting verified environmental data with human behavioral diversity. It addresses a critical bottleneck in green marketing: the assumption that all consumers interpret sustainability information similarly. By classifying consumers according to their Carbon-Footprint Sensitivity and adapting message framing accordingly, the model aligns marketing effectiveness with scientific credibility and ethical transparency.

For businesses, it offers a scalable yet accessible method to enhance sustainability communication without excessive complexity. For academia, it demonstrates how classic behavioral theories can inform AI-enabled marketing design grounded in environmental data. Ultimately, EcoPersona AI moves green marketing toward a more evidence-based, human-centered, and accountable practice—one that not only informs but empowers consumers to act sustainably.

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