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Millennial Consumers' Attitudes and Purchase Intentions Toward Electric Vehicles (EVs): The Role of Greenwashing in Shaping Perceptions

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Abstract

Electric vehicles (EVs) are central to ongoing decarbonisation strategies, yet marketing communications frequently emphasise operational benefits while omitting upstream lifecycle impacts associated with battery production, electricity sourcing, and end-of-life processing. Such selective disclosures, commonly labelled as greenwashing, operate as signals under conditions of information asymmetry and can shape consumer attitudes and purchase intentions. This study is positioned as a conceptual framework supported by preliminary pilot qualitative observation with an aim to synthesise the literature on greenwashing taxonomies, lifecycle assessment (LCA) evidence for EVs, signalling theory, and corrective research to develop an Integrated Signalling–Greenwashing Model (ISGM). The ISGM conceptualises greenwashed marketing as potentially deceptive low-cost signals and corrective LCA materials or documentary excerpts as higher-cost counter-signals. The pilot study provides an extended literature review, theoretical development, a detailed theoretical model with propositions and boundary conditions, and a discussion of implications for theory, policy and managerial practice in policy-active contexts such as the Australian Capital Territory (ACT).

Keywords: electric vehicles; greenwashing; signaling theory; signals; corrective counter-signals; consumer attitudes; purchase intention; Australia

1. Introduction

Transport electrification is widely regarded as a major area of climate mitigation strategies in advanced economies, and electric vehicles (EVs) are frequently promoted as a primary technological pathway to reduce greenhouse gas emissions from personal mobility [1,2]. EVs eliminate tailpipe emissions during operation and, when powered by low-carbon electricity, can deliver substantial lifecycle emission reductions relative to internal combustion engine vehicles; however, the net environmental benefit of EVs depends critically on upstream and downstream lifecycle stages, including raw material extraction for batteries, cell and pack manufacturing, and end-of-life treatment and recycling [3,4]. Policy instruments like subsidies, registration concessions, tax exemptions and investments in charging infrastructure have accelerated EV adoption in many jurisdictions, and the Australian Capital Territory (ACT) exemplifies a policy-active context that has implemented incentives and infrastructure to promote EV uptake as part of a net-zero-by-19418

Academic Editor: Manfred Max Bergman

Received: 2 April 2026

Revised: 8 July 2026

Accepted: 8 July 2026

Published: 10 July 2026

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agenda [3,5]. In such contexts, consumer perceptions of EV sustainability are consequential for both market diffusion and the realisation of public policy goals [1,6]. This paper presents a conceptual framework supported by preliminary pilot qualitative observation. Rather than reporting a completed empirical investigation, the study develops the Integrated Signalling–Greenwashing Model (ISGM) and demonstrates its conceptual utility through limited exploratory observations.

Despite the potential environmental benefits, EV sustainability claims in marketing often emphasise operational advantages like zero tailpipe emissions and lower running costs, while omitting or downplaying upstream lifecycle impacts, a selective presentation commonly described as greenwashing [7,8]. Greenwashing can take many forms, from vague or unsubstantiated claims to evocative imagery that implies broader environmental virtue than is supported by scientific observation [8,9]. Under conditions of information asymmetry, such selective claims function as signals from firms to consumers; when signals are low-cost or ambiguous, they risk misleading receivers about true product quality and environmental performance [7–9]. The strategic use of selective messaging can therefore distort consumer choice and undermine policy objectives that rely on informed consumer behaviour [9,10].

Millennial consumers (here defined as ages 14–44) are a strategically important cohort for studying EV adoption and greenwashing effects because they combine purchasing power, environmental concern and high digital engagement, increasing both their exposure to online green marketing and their potential influence on EV diffusion [2,11]. How millennials interpret green-oriented EV signals, if they treat such signals as credible, and whether corrective, science-based counter-signals can reshape their attitudes and purchase intentions remain understudied, particularly within policy-active contexts such as the ACT, where consumer choices intersect with climate goals [5,12]. Understanding these interpretive processes is, therefore, both theoretically important and practically urgent. Consistent with Pew Research Centre, millennials are defined as individuals born between 1981 and 1996. Accordingly, participants recruited for this study fall within this cohort [13].

Exploratory qualitative observation based on a preliminary pilot study helps develop a theoretical and conceptual foundation for investigating these issues by synthesising the literature on greenwashing taxonomies, EV lifecycle observation, signalling theory and corrective information, while integrating these strands into the Integrated Signalling–Greenwashing Model (ISGM). ISGM explicates mechanisms by which greenwashed marketing functions as deceptive signalling under information asymmetry, how receivers form credibility judgments, and how corrective counter-signals may restore or alter receiver inferences. This preliminary study hopes to conclude with propositions derived from ISGM while discussing theoretical, policy and managerial implications for markets where EV adoption is policy-sensitive [10,14,15].

Governments worldwide—including both developed and developing economies—are promoting vehicle electrification [13]. They are doing this not only to reduce greenhouse gas emissions and improve energy security but also to strengthen domestic manufacturing capabilities, secure strategic positions within global battery supply chains, and enhance industrial competitiveness. Consequently, EV adoption has become an environmental, economic and geopolitical priority simultaneously [1].

2. Literature Review

The literature review is organised into five parts: (1) greenwashing definitions, taxonomies and empirical patterns; (2) EV lifecycle observation and marketing challenges; (3) signalling theory and extensions relevant to deceptive environmental claims; (4) correc-

tive counter-signals and debiasing research; and (5) the consumer attitude formation and purchase intention literature that situate ISGM within consumer behaviour theory.

2.1. Greenwashing: Definitions, Taxonomies and Empirical Patterns

Greenwashing has evolved from a concept into a structured scholarly object with multiple taxonomies designed to operationalise deceptive environmental communication for empirical research [10]. De Freitas Netto et al. provide a systematic classification that distinguishes firm-level and product-level forms [10]. His research separates claim-based from executional greenwashing, enabling researchers to differentiate between explicit falsehoods and subtler executional strategies that create misleading impressions without overtly false statements [10]. Claim-based greenwashing involves explicit assertions (for example, “zero emissions”), whereas executional greenwashing relies on imagery, framing and selective disclosure to create an impression of environmental virtue without necessarily making false factual claims [7,9].

Seele and Gatti’s typology further isolates vague labelling, hidden trade-offs, false certifications and evocative imagery as core mechanisms through which firms mislead stakeholders [9]. Their research offers a practical framework for coding and analysing real advertising stimuli [9]. Parguel et al. demonstrate empirically that executional cues like evoking nature or using emotive framing can mislead consumers even when explicit claims are factually accurate [7]. The potency of non-verbal and aesthetic elements in shaping perceptions and the need to consider executional features in greenwashing analyses is highlighted [7]. Empirical research on greenwashing reveals consistent correlates and consequences: perceived greenwashing reduces consumer trust and can provoke negative attitudinal and behavioural responses, with outcomes that vary in context and exposure dynamics [8,16]. Nyilasy et al. show that green advertising combined with weak corporate environmental performance produces stronger backlash than advertising alone, indicating interactive effects between message content and corporate reputation [16]. Testa et al. and Lyon & Montgomery find that reputational penalties often materialise principally when deception is publicly exposed, suggesting a payoff-penalty for firms that weigh immediate marketing gains against potential long-term reputational costs [8].

Beyond taxonomy and measurement, the literature interrogates motives and institutional drivers of greenwashing. Firms may engage in selective disclosure to capture early market share, to align with shifting consumer norms, or to pre-empt regulatory scrutiny. Where disclosure requirements are weak and third-party verification is costly or unavailable, low-cost executional signals proliferate; conversely, robust institutional frameworks (mandatory disclosure, standardised labels, credible third-party audits) raise the cost of deception and can restore signal reliability [6,10].

2.2. EV Lifecycle Observation and Marketing Challenges

The lifecycle assessment (LCA) literature demonstrates that EV environmental performance is context-dependent and sensitive to majorly upstream and downstream stages of the product lifecycle [3,4]. While EVs eliminate tailpipe emissions during operation, upstream activities like mining and refining battery raw materials, cell and pack manufacturing, and the carbon intensity of electricity used during operation can constitute a substantial share of total lifecycle emissions, particularly where supply chains are carbon-intensive or recycling infrastructure is weak [3,4]. LCAs reveal heterogeneity across battery chemistries (for example, nickel–manganese–cobalt (NMC) versus lithium–iron–phosphate (LFP)), manufacturing geographies (China versus Europe) and electricity mixes (coal-dominated versus renewable-rich grids), complicating simple “EV = green” narratives and underscoring the need for nuanced disclosure [17,18].

Automotive marketing frequently asserts operational benefits like zero tailpipe emissions, lower running costs and uses cues such as nature imagery and lifestyle positioning to convey environmental virtue while omitting upstream lifecycle challenges [7,9]. Such selective framing fits several greenwashing categories (hidden trade-offs; executional greenwashing), where marketers assert one credible attribute to imply broader sustainability that is not substantiated by lifecycle observation [7,10,12,19]. The result is an information environment where consumers receive emotionally compelling but incomplete signals about the environmental merits of EV purchases, increasing the risk of misinformed decisions and policy leakage where incentives are tied to perceived rather than actual lifecycle performance [2,5].

EV adoption research has predominantly emphasised instrumental barriers (cost, range anxiety, charging infrastructure) and psychological drivers (attitudes, perceived behavioural control, social norms), treating environmental messaging as one input among many rather than as a potentially deceptive signal with independent causal effects on attitudes and purchase intentions [2]. This omission is consequential: in policy-active jurisdictions such as the ACT, incentives amplify marketing visibility and the potential influence of misleading signals on short-term purchase decisions; if greenwashed claims shape uptake decisions in such contexts, they can distort policy outcomes and consumer welfare [7,10]. A further complication arises from the multi-actor nature of EV supply chains: battery raw materials are often sourced from geographically dispersed and environmentally heterogeneous contexts; cell manufacturing may occur in regions with different energy mixes; and end-of-life treatment depends on nascent recycling infrastructures [17,18]. These distributed responsibilities dilute accountability and complicate consumer verification, meaning that marketing which emphasises local operational benefits without disclosing upstream impacts exploits informational opacity; the policy implication is that disclosure regimes and certification standards must address supply-chain transparency rather than focusing solely on operational emissions [6,10].

2.3. Signalling Theory: From Credible Separation to Deceptive Signals

Signalling theory explains how senders communicate unobservable qualities to receivers under information asymmetry; a signal's value depends on its correlation with true quality and its costliness to imitate, enabling separating equilibria where high-quality senders signal and low-quality senders do not [14,19]. In markets for credence attributes, such as environmental performance, signals include warranties, third-party certifications and transparent lifecycle disclosures that are costly to obtain and therefore credible indicators of underlying quality [14]. However, green markets often violate signalling theory's ideal conditions: many green claims are low-cost, simple advertising (ad) copy, imagery, vague labels that are easy for low-quality senders to mimic, undermining the costliness condition and enabling deceptive or "noisy" signals that obscure true product quality [12,14].

Steigenberger argues for conceptual extensions that account for deceptive signalling dynamics and proposes remedies for restoring signal credibility (auditability, third-party verification, regulatory enforcement) [4]. Drover et al. emphasise cognitive mechanisms (attention allocation, signal set interpretation) that mediate receiver inferences, suggesting signalling analyses must integrate psychological constructs to explain consumer responses [4]. Receiver cognition is central to understanding how signals operate: dual-process models of information processing distinguish heuristic (fast, affective) and systematic (slow, deliberative) modes; under heuristic processing—common when consumers face cognitive load or low motivation—executional cues (nature imagery, emotive music) and simple heuristics (for example, "green imagery = green product") dominate, increasing susceptibility to low-cost deceptive signals [4]. Under systematic processing, when motivation and ability are higher, consumers seek observation, evaluate claims and demand

corroboration, reducing susceptibility to executional greenwashing but increasing sensitivity to the presence or absence of lifecycle disclosures [4,9].

Signalling theory, therefore, benefits from integration with the cognitive and behavioural literature. The Integrated Signalling–Greenwashing Model (ISGM) adopts this integrative stance by treating signals not as monolithic but as heterogeneous in cost and content, and by modelling receiver processing modes and moderators (environmental concern, knowledge, trust) that shape interpretation. The model also recognises temporal dynamics: deceptive signals may yield short-term adoption benefits but expose firms to reputational penalties when deception is revealed, creating dynamic strategic considerations for firms and regulators [12,14].

ISGM seeks to bridge various literature flows that have largely developed in parallel. Traditional signalling theory focuses on how firms communicate underlying quality under conditions of information asymmetry and the conditions under which signals remain credible, whereas greenwashing research examines the consequences of misleading or weakly substantiated environmental claims. However, these perspectives provide only limited explanation of how consumers interpret and respond to competing sustainability messages. The reason being consumers' interpretations vary in credibility and evidential support. ISGM addresses this limitation by conceptualising greenwashing not as a phenomenon external to signalling processes, but as a form of low-cost signalling that competes with more credible signals for consumer attention and interpretation. The model further extends sustainability communication research by incorporating cognitive processing mechanisms, individual-level moderators and corrective counter-signals into a single explanatory framework. In doing so, ISGM shifts attention from the transmission of sustainability claims alone to the broader process through which signals are received, interpreted, challenged and revised, providing a process-oriented account of how environmental claims influence attitudes and purchase intentions and how those effects may change following exposure to corrective information.

2.4. Corrective Counter-Signals and Debiasing

Corrective interventions operate across regulatory, institutional and communicative channels. Institutional measures like audits, mandatory disclosures and certification schemes raise the cost of deception and provide systemic corrective pressures [9,10]. Communicative counter-signals include third-party certifications, consumer-facing LCAs, documentary exposures and investigative media that reveal omitted lifecycle impacts and contextualise corporate claims [17,18,20]. The experimental and correction literature indicate that the effectiveness of counter-signals depends on source credibility, message clarity, framing (numerical versus narrative) and the cognitive state of the receiver during exposure [15].

Research on misinformation and correction provides useful analogies: corrections can reduce belief in false claims, but their efficacy is bounded—corrections are more effective when they come from trusted sources, when they provide an alternative causal explanation, and when they are timely and salient [15]. Corrections can also backfire under certain conditions if they threaten identity-linked beliefs or are perceived as ideologically motivated, leading to entrenchment rather than updating [15]. Translating these insights to greenwashing suggests that corrective counter-signals must be credible, accessible and framed to minimise defensive processing; numeric LCA summaries may be effective for numerate, motivated receivers, whereas narrative documentary excerpts may be more persuasive for affectively engaged audiences [15,20]. In the EV domain, direct observation using real advertising stimuli followed by succinct LCA counter-signals is limited; much prior work relies on vignettes, hypothetical claims or between-group experi-

ments that reduce ecological validity, indicating a need for process-oriented within-participant designs that trace interpretive updating in ecologically valid settings [3,7,8].

2.5. Consumer Attitude Formation and Purchase Intention

Consumer perception encompasses the processes by which individuals select, organise and interpret sensory stimuli into meaningful messages about products or brands [4,7,9]. In sustainable consumption, perception extends to how consumers evaluate environmental claims, interpret eco-labels and construct beliefs about the social and ecological consequences of their purchase decisions; attitudes are defined as enduring evaluations of an object along dimensions of favourability that emerge from both cognitive appraisals of product attributes and affective responses to marketing stimuli [3,9]. Purchase intention refers to a consumer's self-reported likelihood to buy a product and serves as a proximate predictor of actual behaviour [7,9]. In sustainable consumption, purchase intention is shaped by perceived product attributes, social norms, perceived behavioural control and trust in environmental claims [7,9]. Trust functions as a critical antecedent: when consumers doubt the veracity of environmental claims, positive attitudes may not translate into purchase intentions; conversely, credible signals that reduce uncertainty can strengthen the attitude–intention link [10,15].

Consumer decision-making is also characterised by uncertainty and perceived risk because many environmental attributes represent credence qualities that cannot be directly verified before or after purchase. Under such conditions, consumers rely on available/accessible informational cues and institutional assurances to evaluate competing claims and reduce decision uncertainty. Research in consumer behaviour suggests that perceived risk—whether financial, functional or environmental—can weaken purchase intentions even when attitudes toward a product are favourable, contributing to the frequently observed attitude–behaviour gap in sustainable consumption [21]. Trust, therefore, serves not only as an outcome of credible signalling but also as a mechanism through which uncertainty is reduced and behavioural intentions are strengthened [21]. Conversely, perceptions of greenwashing increase uncertainty regarding both product performance and corporate motives, potentially undermining trust and reducing willingness to purchase despite positive environmental attitudes. These insights suggest that consumer responses to sustainability claims depend not only on the content of signals themselves but also on how those signals shape perceptions of credibility, risk and uncertainty during the decision-making process.

Integrating these literature suggests that greenwashing operates by altering the informational environment in which attitudes form. Executional signals can produce favourable affective responses that elevate attitudes in the short term, but if credibility is later undermined, trust erosion can reverse attitudinal gains and depress purchase intentions. Corrective counter-signals aim to restore informational completeness and recalibrate credibility assessments; their success depends on cognitive, affective and institutional boundary conditions, including environmental concern, numeracy and source credibility [15,20].

3. Primary Research Questions

- A. How do greenwashed electric vehicle (EV) marketing advertisements influence perceived credibility, trust, attitudes, and purchase intentions among millennials in the Australian Capital Territory (ACT)?
- B. To what extent does exposure to corrective, scientifically validated information (for example, lifecycle-based summaries or documentary excerpts) influence perceived credibility, trust, attitudes, and purchase intentions following exposure to greenwashed EV advertisements? [15,20]

4. Theoretical Framework: Integrated Signalling–Greenwashing Model (ISGM)

This section develops the Integrated Signalling–Greenwashing Model (ISGM), synthesising greenwashing taxonomies, LCA observation and signalling theory to explain how greenwashed marketing influences consumer attitudes and purchase intentions and how corrective counter-signals may recalibrate those effects.

4.1. Conceptual Foundations

ISGM rests on three theoretical building blocks. First, greenwashing taxonomies provide content categories and executional features that constitute signals (claim type, imagery, omission patterns) and guide stimulus coding for empirical work [9,10]. Second, LCA observation supplies the substantive content that counter-signals must convey to correct incomplete impressions (upstream emissions, battery supply-chain impacts, recycling constraints) [17,18]. Third, signalling theory supplies the mechanism: signals convey information under information asymmetry; their informativeness depends on correlation with true quality and costliness to imitate; and receivers use heuristics and credibility cues to infer quality [14,19].

ISGM integrates these blocks by conceptualising greenwashed marketing as a set of sender signals that vary in informational content and costliness. Executional cues (nature imagery, emotive narratives) are low-cost and easily mimicked; explicit lifecycle disclosures and third-party certifications are higher-cost and harder to fake. Receivers interpret signals through cognitive filters like attention, heuristics, and motivated reasoning and form credibility judgments that mediate attitude formation and purchase intention. Counter-signals (concise LCAs, documentary excerpts, third-party audits) function as corrective signals that increase perceived information completeness and reduce the credibility of initial greenwashed messages when they are perceived as credible and accessible [14,15].

4.2. Model Structure and Pathways

ISGM specifies the following constructs and pathways:

- Signaller: EV manufacturers, dealers and marketers who craft messages [14].
- Signal: Marketing messages and executional features (claim type, imagery, omission patterns) that convey environmental attributes [7,9].
- Receiver interpretation: Perceived credibility, perceived costliness of the signal, and inferred environmental benefit [4,14].
- Mediator: Attitude toward the EV (cognitive and affective components) [22].
- Outcome: Purchase intention (self-reported likelihood to consider or buy) [23].
- Counter-signal: Corrective information (LCA summaries, documentary excerpts, third-party audits) that provides upstream lifecycle context [15,18].
- Moderator: Environmental concern and related individual differences (knowledge, motivation to process) [2,15].

The primary causal pathway is: Signal exposure → Receiver interpretation (credibility, perceived costliness) → Attitude formation → Purchase intention. Counter-signals intervene after initial exposure to alter receiver interpretation and downstream outcomes. Moderators such as environmental concern influence both initial interpretation and corrective responsiveness [2,15].

4.3. Micro-Mechanisms

ISGM identifies several micro-mechanisms that mediate or moderate the pathways.

Heuristic processing: Under low motivation or cognitive load, receivers rely on executional cues and simple heuristics, increasing susceptibility to low-cost deceptive signals [9].

Systematic processing: Under high motivation or environmental concern, receivers seek observation and evaluate signal content more critically, reducing susceptibility to executional greenwashing but increasing sensitivity to lifecycle disclosures [4,9].

Credibility inference: Receivers infer signal credibility from perceived costliness (presence of third-party certification, numerical LCA data), source reputation and consistency with prior beliefs; low perceived costliness reduces credibility and attenuates positive attitude formation [14,15].

Counter-signal updating: Credible counter-signals provide corrective information that increases perceived information completeness and reduces the credibility of initial greenwashed messages; the effectiveness of updating depends on source credibility, message clarity and cognitive accessibility [2,15].

Temporal dynamics: Initial market gains from selective messaging may precede reputational penalties that occur when deception is exposed; corrective effects may be immediate but decay without reinforcement or institutional corroboration (labels, regulation) [6,8].

4.4. Signal Typology and Ecology

ISGM distinguishes three analytically useful signal classes that differ in informational content, observability and imitation cost.

Executional signals: Imagery, music and lifestyle framing; low in direct informational content about lifecycle impacts, highly observable and low-cost to produce. Their persuasive power derives from affective resonance and heuristic shortcuts [7].

Claim-based signals: Explicit textual or numeric claims (for example, “zero tailpipe emissions,” “X km per kWh”); verifiability varies with specificity and availability of corroborating observation [9,14].

Substantive signals: Third-party certifications, standardised LCA disclosures and audited supply-chain reports; high in informational content and costly to obtain, and therefore more robust separators [8,18].

Consumers process a portfolio of concurrent signals (advertising, labels, dealer claims, media coverage), and the relative mix determines overall inference quality. A market saturated with executional signals but lacking substantive signals will produce noisy inferences and higher greenwashing risk [8,12].

5. Methodology

This study adopts a qualitative within-participant pre-post exposure design to explore how individuals interpret and update their understanding of environmental advertising signals in the context of electric vehicles (EVs). The design follows the Integrated Signalling–Greenwashing Model, which proposes that consumers interpret corporate environmental claims through competing signals (advertising) and counter-signals (corrective information). By capturing participants’ interpretations before and after exposure to corrective information, the design allows observation of immediate interpretive change within the same participant, thereby isolating how perceptions shift when potentially misleading environmental signals are challenged.

Participants are first asked to respond to a set of real advertising signals related to EV sustainability claims. Following this baseline discussion, they are exposed to corrective counter-signals, such as factual information or critical perspectives that question or contextualise the original claims. Participants are then asked to reflect again on the same themes, enabling the study to trace within-person changes in interpretation, trust, and perceived credibility of the signals.

5.1. Sample and Recruitment

The broader study is designed to recruit 15–20 millennial participants (aged 29–44) residing in the Australian Capital Territory (ACT). Consistent with Pew Research Centre, millennials are defined as individuals born between 1981 and 1996 [13]. Accordingly, participants recruited for this study fall within this cohort. Participants will be recruited through purposive sampling to ensure variation across key characteristics likely to shape environmental interpretations, including gender, vehicle ownership and use, environmental concern, and prior exposure to electric vehicles. The sample size is chosen to reach thematic saturation for in-depth qualitative analysis [24].

This preliminary (pilot) study is based on 2 pre and post-interviews. Although the proposed qualitative sample is relatively small, it is consistent with qualitative exploratory research and expert interview studies where the objective is analytical depth rather than statistical generalisation. Previous studies investigating emerging policy and sustainability issues have similarly employed relatively small purposive samples to generate rich contextual insights.

5.1.1. Stimuli

- Greenwashed signals: 2–3 real EV advertisements selected and coded using de Freitas Netto et al. and Seele & Gatti taxonomies (executional cues, hidden trade-offs, claim specificity).
- Corrective counter-signals: Concise, source-attributed short documentary excerpts that foreground upstream emissions, battery supply-chain impacts and end-of-life constraints.

5.1.2. Procedure (Single Session, 25–30 min)

1. Pre-exposure session (8–10 min): Participants view advertisements (randomised) and answer semi-structured questions on recall, perceived credibility, affect and purchase intention.
2. Corrective exposure session (8–10 min): Participants view concise LCA summaries and documentary excerpts.
3. Post-exposure session (9–10 min): Parallel semi-structured questions capture revised credibility judgments, attitude shifts, intended information-seeking and purchase intention. Sessions conducted in person or via secure video conferencing; all sessions audio-recorded and transcribed verbatim.

5.1.3. Measures and Instruments

An interview guide was provided to probe [EE1.1] signal salience, credibility cues (source, specificity, perceived costliness), affective reactions, trust, and stated purchase likelihood.

5.1.4. Data Analysis

Interview transcripts will be analysed using six-phase thematic analysis [25]. Initial open coding will be undertaken independently, followed by iterative refinement into higher-order themes aligned with the ISGM constructs [25,26]. Pre- and post-exposure responses are compared within each participant to identify shifts in credibility, trust, attitudes and purchase intentions. Coding decisions were documented to enhance transparency and dependability. At the time of writing, two semi-structured interviews and three informal discussions have been completed as part of the initial data collection phase, with further interviews planned in line with the recruitment strategy outlined above. The completed interview functions as an exploratory case within the intended design and provides

preliminary insights that help refine interview prompts and analytical focus prior to full data collection.

Early informal conversations assisted the researchers in refining the interview guide during the conceptual development stage; however, these conversations were not recorded, analysed, or treated as empirical data and therefore do not contribute to the study's findings.

Notes were recorded immediately after these discussions to capture recurring themes, such as scepticism toward corporate sustainability messaging, confusion about lifecycle emissions of EVs, and the influence of peer conversations on technology perceptions. While these discussions are not included as primary empirical data, they helped formulate the development of interview prompts and further refine the signal–counter-signal framing used in the formal interview protocol. Together, the preliminary interviews, exploratory discussions, and literature review form the groundwork for the ongoing qualitative data collection planned in the full study design that follows.

Table 1 below summarises the whole process and definitions used:

Table 1. Constructs and Definitions.

Construct	Operational Definition	Interview Question	Indicators	Analysis
Demographic Profile	Basic socio-demographic characteristics used to contextualise participant responses	“Do you identify as male, female or other? What is your highest educational qualification? Which sector are you employed in?”	Gender identity, education level, employment sector	Descriptive coding to profile sample characteristics
EV Familiarity & Experience	Participant's prior exposure to electric vehicles through ownership, consideration, or general awareness	“Can you tell me a bit about your current vehicle if it is an EV or your thoughts on EVs in general?”	EV ownership, familiarity level, attitudes toward EVs	Thematic coding
Advertising Re-call & Exposure	Ability of participants to re-remember and describe EV advertisements encountered in media	“Can you recall any advertisements on electric vehicles that you have come across recently? Did they arouse your interest in EVs? How?”	Ad recall, message salience, interest generation	Content analysis of recall strength and emotional engagement
Greenwashing Perception (Pre-exposure stimulus)	Perception that marketing selectively highlights environmental benefits while omitting key environmental costs	“Are there any outstanding messages or themes that you recall from these advertisements?” (after viewing EV ads)	Perceived exaggeration, selective claims, missing lifecycle information	Thematic analysis using greenwashing coding framework
Purchase Influence (Marketing Impact)	Extent to which advertising messages affect intention or decision-making for EV purchase	“Would the messages in these EV advertisements influence your decision-making in any way when purchasing an EV in the future? Why or why not?”	Purchase intention, persuasion strength, attitude change	Thematic coding linked to Theory of Planned Behaviour constructs
Environmental Knowledge Awareness	Awareness of scientific or factual information related to EV environmental impacts	“Are you aware of any scientific or environmental information about EVs—for example, battery production or disposal?”	Knowledge depth, accuracy of awareness, uncertainty	Knowledge gap analysis (misconceptions vs. informed understanding)
Information Credibility (Post-exposure documentary)	Perceived trustworthiness and reliability of environmental information sources after exposure to credible content	“Were you surprised with any of the information about EVs in these documentaries?”	Surprise, belief revision, cognitive dissonance	Narrative thematic analysis (belief change patterns)

Information Source Trust	Preference and trust in different information channels when making purchase decisions	“If you were doing some research prior to purchasing an EV, where would you look for trustworthy information—government sources, independent reviews, environmental groups, or elsewhere?”	Source preference, trust hierarchy, authority perception	Comparative coding of trust structures across sources
Greenwashing Sensitivity/Ethical Perception	Reaction to discovering misleading or incomplete marketing claims about EVs	“If you discovered that some marketing claims about EVs were exaggerated or omitted important information, how would this affect your likelihood of purchasing one?”	Trust loss, purchase hesitation, ethical judgement	Thematic analysis of trust erosion and behavioural change
Information Transparency Expectation	Expectation regarding availability and openness of EV-related environmental information	“Do you think more information should be readily available about EVs and their impact?”	Demand for transparency, perceived information gaps	Thematic coding (transparency expectations and policy suggestions)

6. Discussion: Theoretical, Policy and Managerial Implications

This section discusses the theoretical, policy, and managerial implications of the proposed Integrated Signalling–Greenwashing Model (ISGM), drawing primarily on the conceptual framework and literature synthesis developed in this paper. The pilot observations serve only as illustrative examples. The following discussion summarises key implications and highlights avenues for scholarly development and practical action arising from this limited yet very pointed study.

6.1. Theoretical Implications

Unlike traditional signalling theory, which focuses primarily on the credibility of individual signals, ISGM explicitly integrates deceptive environmental signalling, corrective counter-signals, consumer cognitive processing, and institutional conditions into a single process model. Consequently, ISGM explains not only how signals are transmitted but also how competing sustainability claims are interpreted, challenged, and revised. ISGM extends signalling theory by operationalising greenwashing as deceptive low-cost signalling and by integrating receiver cognitive processes into the signalling framework [9,14,19]. It highlights the heterogeneity of signals (executional versus substantive) and the importance of institutional context in shaping signal costliness, thereby inviting theoretical work on signal ecology—how sets of signals (advertising, certification, media coverage) interact—and on temporal dynamics of payoff-penalty equilibria in green markets [12,14,26]. Integrating dual-process cognitive models with signalling theory opens avenues for richer micro-foundations of consumer inference in credence markets and suggests new hypotheses about when and why corrective counter-signals succeed or fail [4,15].

ISGM further suggests that signalling equilibria in green markets are dynamic and endogenous to institutional design. When substantive signals are costly or unavailable, executional signals proliferate and noisy equilibria emerge; conversely, when institutions lower verification costs or mandate disclosure, separating equilibria become more attainable. This perspective reframes greenwashing not merely as firm misbehaviour but as an emergent property of market and regulatory structures, implying that theoretical accounts must incorporate institutional constraints and incentives to fully explain signalling outcomes [8,15]. ISGM further suggests that signalling equilibria in green markets are dynamic and endogenous to institutional design. When substantive signals are costly or unavailable, executional signals proliferate and noisy equilibria emerge; conversely, when institutions lower verification costs or mandate disclosure, separating equilibria become more attainable. This perspective reframes greenwashing not merely as firm misbehav-

ious but as an emergent property of market and regulatory structures, implying that theoretical accounts must incorporate institutional constraints and incentives to fully explain signalling outcomes [6,10]. Drawing on Spence [19], Connelly et al. [26], and Kirmani and Rao [24], the model treats these cues as market signals that stand in for hidden product qualities. However, consistent with the greenwashing literature and Steigenberger's work [27] on deceptive signalling, the model rejects the assumption that all salient signals are costly or credibly tied to underlying environmental performance. Instead, it distinguishes between higher-quality signals, which are more constrained by observation and verifiability, and lower-quality signals, which are relatively cheap to produce and more weakly anchored to lifecycle realities. Greenwashing occurs when low-cost signals generate broad inferences of environmental virtue that exceed what can reasonably be supported by the product's full environmental profile.

At the receiver side, the model emphasises interpretation rather than passive exposure. Consumers process EV signals through prior beliefs, environmental concern, category knowledge, trust orientations, and practical constraints related to cost and usability [4,22]. These interpretive filters shape perceived credibility, perceived environmental benefit, perceived completeness of the claim, and moral appraisal of the product. These perceptions then inform attitudinal evaluation and purchase intention. The model also introduces corrective information as a counter-signal. Counter-signals are conceived as observation-based interventions that challenge the informational sufficiency of the original marketing message by surfacing omitted lifecycle trade-offs or inconsistencies. When effective, they do not simply add facts; they alter the meaning of the original signal by reducing ambiguity and changing its perceived credibility. Figure 1 summarises this process, showing how greenwashed EV signals and corrective counter-signals move through interpretation to shape consumer responses. The model also specifies several boundary conditions. It is most applicable in markets characterised by high information asymmetry, low direct verifiability of environmental performance, and strong symbolic competition over sustainability meaning. EV marketing fits these conditions because most consumers cannot independently assess lifecycle emissions, mineral sourcing, or battery disposal implications at the point of exposure. The model may be less applicable where environmental quality is readily observable or where robust third-party certification substantially reduces ambiguity. By identifying these boundary conditions, the thesis clarifies that deceptive signalling is not a universal feature of all green markets, but a heightened risk in categories where complex technical realities are routinely translated into simple moral narratives.

The model further assumes that signal effects are moderated by receiver-side and contextual factors rather than operating uniformly. Environmental knowledge, prior EV familiarity, trust in public institutions, scepticism toward corporate communication, and perceived feasibility of EV ownership may all shape how the same signal is interpreted. In addition, the broader legitimacy environment of the ACT—where policy support for EVs is visible—may amplify initial openness to pro-EV claims while also making corrective information especially consequential when it appears to come from credible, non-commercial sources. These moderators do not weaken the model; they strengthen it by making interpretive heterogeneity a core expectation rather than a methodological nuisance. Figure 1 should therefore be read as a dynamic framework that accommodates variation in both signal uptake and counter-signal effectiveness.

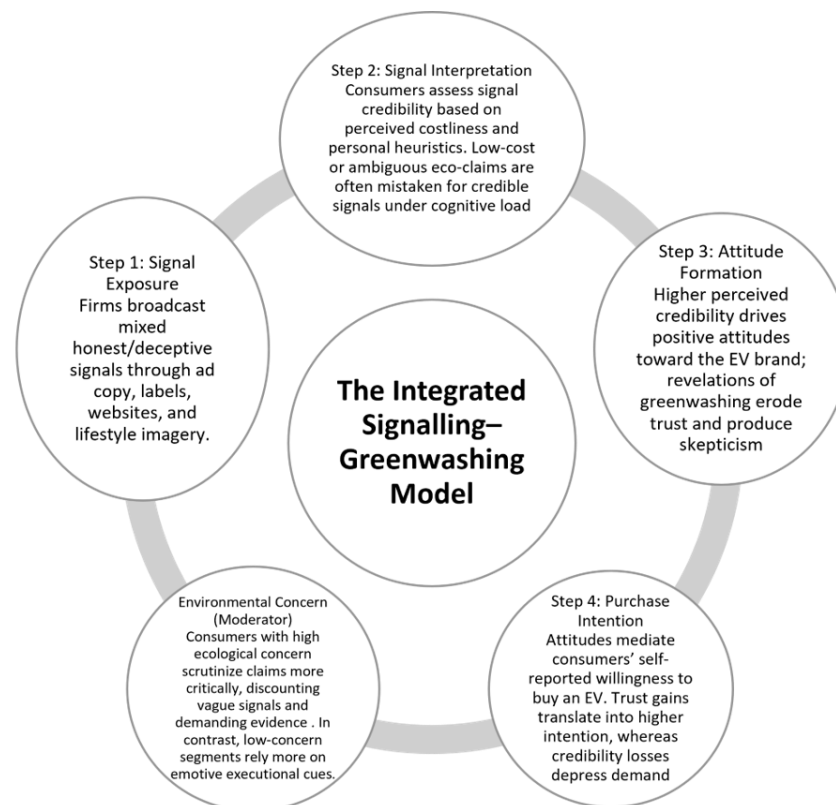


Figure 1. Theoretical Framework from EV Greenwashing Signals to Consumer Purchase Intentions.

A further advantage of this model is that it does not assume that corrective information must produce rejection of the product to count as effective. A participant may remain favourable toward EV ownership while becoming more critical of how EV sustainability is marketed. This distinction allows the model to capture nuanced outcomes such as reduced trust in a specific signal, increased demand for substantiation, or a shift toward more conditional support. Such outcomes are analytically important because they show that counter-signals can improve judgement quality even when purchase interest remains partly intact.

Recent EV consumer research also helps specify what is at stake in the model's outcome pathway. Studies on green perceived value and green trust indicate that consumers often rely on environmental claims as cognitive shortcuts that reduce uncertainty and increase perceived moral fit between the product and the self [28,29]. Within the present framework, this means that greenwashed signals may be effective not because they provide robust observation, but because they simplify evaluative work for the receiver. Counter-signals become important precisely because they disrupt this shortcut by reintroducing complexity and forcing a reassessment of what kind of observation is needed before a sustainability claim feels credible.

6.2. Policy Implications

The policy implications discussed below are derived from the conceptual synthesis of the existing literature and the proposed ISGM framework rather than from the preliminary pilot observations. For policymakers, ISGM highlights the limits of voluntary disclosure and the potential role of institutional interventions to raise the cost of deceptive signalling [10,16]. Mandatory lifecycle disclosure standards, standardised LCA reporting formats and third-party verification can increase signal costliness and reduce the scope for executional greenwashing; in policy-active jurisdictions such as the ACT, aligning incentive schemes with disclosure requirements can help ensure that subsidies and conces-

sions reward genuinely lower lifecycle impacts rather than marketing impressions [3,5]. Regulatory design should consider proportionality and implementation feasibility: standardised disclosure templates that present lifecycle information in accessible visual formats (benchmarks, traffic-light scales) can reduce cognitive barriers for consumers and improve comparability across models [10,15].

6.3. Managerial Implications

The managerial implications presented below arise from the conceptual framework and literature synthesis developed in this study, with the pilot observations serving only as illustrative examples rather than empirical evidence. For marketers and manufacturers, ISGM underscores the reputational risks of selective sustainability messaging and the long-term benefits of transparent lifecycle communication [7,14]. Investment in third-party verification, clear numeric disclosures and supply-chain traceability can enhance long-term credibility and reduce the risk of reputational penalties that follow exposure of deceptive practices [18,22,30]. Consumer-facing communications should prioritise clarity and avoid executional cues that imply broader sustainability without substantiation; where substantive improvements exist (for example, low-carbon supply chains or recycling commitments), firms should foreground verifiable observation and third-party endorsements [7,10,31].

Firms should also consider segmentation strategies: consumers differ in environmental concern, numeracy and trust; communications tailored to these segments like detailed LCA summaries for high-concern, high-knowledge consumers and simplified interpretive aids for broader audiences can improve message effectiveness while reducing the temptation to rely on low-cost executional signals [2,15]. Industry associations and consumer protection bodies can collaborate to develop standardised disclosure templates and audit mechanisms that reduce compliance costs and level the playing field; voluntary industry codes that pre-commit firms to transparent LCA methodologies may serve as transitional mechanisms toward mandatory disclosure [6,10].

7. Initial Findings

This paper presents a conceptual framework supported by preliminary pilot qualitative observations. The conceptual propositions and theoretical implications are primarily derived from the synthesis of the existing literature, while the pilot interviews serve only as illustrative observation demonstrating the preliminary applicability of the proposed framework. Accordingly, the observations reported in this study should not be interpreted as generalisable empirical findings but rather as preliminary insights informing the design of future empirical investigation. The following observations are presented solely to illustrate the preliminary applicability of the proposed conceptual framework. They are not intended to represent generalisable empirical findings. Interviews with two millennial participants in the ACT were conducted and three informal discussions were carried out. The interviews reveal consistent scepticism toward EV advertising and a strong demand for lifecycle transparency. Both respondents recalled nature-centric imagery and “zero emissions” claims that generated initial interest but were judged insufficient for purchase decisions without corroborating data. Participants reported prior awareness of lifecycle issues like battery manufacturing emissions, mineral sourcing, grid carbon intensity and recycling limitation and said that the advertisements rarely addressed these concerns. After viewing the documentary materials, both expressed increased clarity about upstream impacts and the conditional nature of EV environmental benefits, noting that manufacturing location and electricity mix materially affect lifecycle outcomes. Each interviewee indicated they would consult independent sources like government reports, peer-reviewed LCAs, accredited third-party certifications and reputable

consumer tests rather than rely on marketing. Discovery of exaggerated or omitted claims would reduce trust in the offending brand and likely alter attitude and purchase intent, though not necessarily preclude EV adoption. Both participants recommended standardised, consumer-facing lifecycle disclosures (for example, concise labels or traffic-light summaries) to improve comparability and accountability. Overall, the interviews underscore the need for transparent, verifiable information to translate positive affect from advertising into informed purchase intentions. Policymakers and industry should prioritise disclosure formats and independent verification to support informed consumer choices.

Emergent Themes

- Affective hook, cognitive gap: Nature imagery and “zero emissions” claims generate immediate positive affect and interest, but these executional cues do not supply the lifecycle information participants need to make confident purchase decisions.
- Prior awareness of lifecycle complexity: Even in early fieldwork and informal conversations, millennials referenced battery manufacturing emissions, mineral sourcing and grid carbon intensity as salient concerns that advertisements rarely address.
- Scepticism and conditional trust: When omissions or exaggerations are discovered, brand trust declines and participants report they would consult independent sources (government reports, peer-reviewed LCAs, accredited third-party certifications) before purchasing.
- Corrective information clarifies and reframes: In the pilot interview, concise LCA material increased clarity about the *conditional* nature of EV environmental benefits (dependent on manufacturing location and electricity mix). Corrective exposure tended to reframe decision criteria toward verifiability and lifecycle performance rather than uniformly eliminating purchase intent.
- Demand for standardised disclosures: Participants recommended concise, comparable labels (traffic-light or benchmarked LCA summaries) to reduce cognitive effort and enable cross-model comparisons.

Synthesis: these preliminary findings align with the literature: low-cost executional signals produce affective responses but leave lifecycle gaps that credible counter-signals can partially fill; responsiveness is heterogeneous and moderated by prior knowledge and motivation to process.

8. Limitations, Boundary Conditions and Future Research

ISGM is a conceptual model with strengths and limitations. This section outlines key boundary conditions, ethical considerations and a detailed research agenda to refine and test the model.

8.1. Limitations and Boundary Conditions

ISGM is developed with EV markets and policy-active jurisdictions (for example, the ACT) in mind; generalisability to other product categories or institutional contexts requires empirical validation [5,10]. The model highlights environmental concern and knowledge as moderators but cannot exhaustively capture all individual differences (for example, cultural values, political ideology) that shape processing; cross-cultural variation in trust and media ecosystems may alter both baseline susceptibility to executional signals and corrective responsiveness [4,15]. ISGM emphasises immediate interpretive processes and corrective updating; long-term dynamics (habit formation, repeated exposures, brand loyalty) require longitudinal elaboration to assess persistence of corrective effects and the conditions under which initial corrections translate into durable behavioural change [8,15].

Firms may adapt to disclosure regimes in unanticipated ways (for example, sophisticated green claims that exploit methodological complexity); regulatory design must anticipate strategic adaptation and include mechanisms for methodological standardisation and auditability [6,12]. The model also assumes that credible substantive signals are available or can be developed; in some supply chains, data gaps and proprietary constraints may limit the feasibility of robust LCA disclosure. In such contexts, policymakers and industry must invest in data infrastructure, standardised methodologies and third-party capacity to enable meaningful substantive signalling [10,18].

8.2. Ethical Considerations

Determining what constitutes deceptive emphasis versus legitimate persuasive framing involves normative judgements; policymakers must balance commercial speech rights with consumer protection and consider proportional enforcement mechanisms that deter deception without unduly burdening legitimate marketing practices [6,10]. Disclosure regimes that rely on numeracy or digital access may disadvantage less literate or digitally excluded consumers; inclusive design and interpretive aids (visual scales, benchmarks) are essential to avoid exacerbating information inequality [12]. Stricter disclosure and verification may impose compliance costs that disproportionately affect smaller firms; policy design should consider proportionality, transitional support and capacity building to avoid unintended market concentration effects [6].

Ethical communication also requires attention to unintended consequences: overly technical disclosures may create information overload and reduce trust, whereas oversimplified labels may obscure nuance; ethical frameworks should prioritise transparency, interpretability and fairness [15].

8.3. Future Research Directions

Priority research directions to refine and test ISGM include:

- Experimental tests of ISGM propositions: Manipulate signal features (executional intensity, claim specificity, presence of substantive signals) and counter-signal formats (numeric LCA summaries versus narrative documentary excerpts) to identify causal effects on credibility, attitude and intention [7,15].
- Longitudinal studies: Assess the durability of corrective effects and the temporal dynamics of reputational penalties following exposure to greenwashing revelations, including whether initial corrections persist or decay without reinforcement [8,15].
- Heterogeneity analyses: Examine moderators such as environmental knowledge, numeracy, institutional trust, political ideology and prior EV experience to map boundary conditions and segment-specific effects [2,4].
- Cross-national comparisons: Evaluate how regulatory regimes, media ecosystems and cultural norms shape signal credibility and corrective efficacy, and whether institutional interventions have differential impacts across jurisdictions [6,10].
- Market-level modelling: Use agent-based or system dynamics models to simulate how deceptive signalling and corrective interventions affect adoption trajectories, market welfare and policy outcomes under alternative disclosure regimes and enforcement scenarios [12,14].
- Normative and legal analysis: Clarify normative thresholds for deception, design proportional enforcement mechanisms and explore the legal implications of lifecycle disclosure mandates and third-party certification regimes [6].
- Methodological development: Develop reproducible stimulus coding protocols for real advertising materials using established taxonomies and validate coding reliability across coders and contexts [9,10].

These research avenues will refine ISGM, test its propositions and inform observation-based policy and managerial practice in EV markets.

9. Conclusions

This preliminary study based on a pilot study, a comprehensive literature review and informal discussions synthesises the literature on greenwashing, EV lifecycle complexity, signalling theory and corrective interventions to develop the Integrated Signalling–Greenwashing Model (ISGM). ISGM conceptualises greenwashed marketing as potentially deceptive low-cost signals and corrective LCA materials or documentary excerpts as higher-cost counter-signals that can recalibrate receiver inferences. By integrating signal content, receiver cognition and institutional levers, ISGM explains how signals shape attitudes and purchase intentions and identifies boundary conditions for corrective efficacy. The model extends signalling theory into the environmental communication domain and provides a structured agenda for empirical and normative research. In policy-active contexts such as the ACT, ISGM highlights the importance of disclosure standards, third-party verification and consumer education to ensure that marketing signals align with lifecycle realities and support informed consumer choice [5,10,14,15].

Author Contributions: Conceptualization, R.G. and M.C.; methodology, R.G. and M.C.; formal analysis, R.G.; investigation, R.G.; data curation, R.G.; writing—original draft preparation, R.G.; writing—review and editing, R.R.; visualization, R.G. and R.R.; M.C. and R.R.; project administration, M.C. and R.R. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Ethics approval for this study has been obtained from the relevant institutional HDR Ethics committee (63_2025), and all data collection procedures were conducted in accordance with approved ethical guidelines.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author due to privacy reasons.

Acknowledgments: The author thanks supervisory colleagues for feedback on earlier drafts. This study is a theoretical and conceptual contribution prepared prior to empirical implementation.

Conflicts of Interest: The authors declare no conflicts of interest.

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