International Journal of Sustainable Development and Planning
Vol. 21, No. 5, May, 2026, pp. 2009-2020
Journal homepage: http://iieta.org/journals/ijsdp

Perceived Energy Efficiency and Green Marketing Strategy in Coffee SMEs: Implications for Sustainable Branding, Customer Green Behaviour, and Competitive Advantage

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https://doi.org/10.18280/ijsdp.210507

Received: 8 January 2026
Revised: 21 May 2026
Accepted: 28 May 2026
Available online: 31 May 2026

Keywords:
customer green behaviour, perceived energy efficiency, green competitive advantage, green marketing strategy, Indonesia, sustainable branding

ABSTRACT

This study examines how perceived energy efficiency (PEE) and green marketing strategy (GMS) contribute to perceived green competitive advantage (GCA) in the case of Tangsi Wangi Coffee, a West Java cooperative coffee brand associated with community-managed micro-hydropower. Using a survey of 200 customers, the study tests an integrated model grounded in the Natural Resource-Based View (NRBV), Signalling Theory, and the Theory of Planned Behaviour (TPB). Data were analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM). The results show that PEE positively influences sustainable branding (SB), customer green behaviour (CGB), and GCA, with the strongest indirect effect occurring through CGB. GMS strengthens SB and GCA but has a significantly negative relationship with CGB, indicating a credibility risk when green marketing messages are not sufficiently connected to sustainability information that customers can recognise and trust. SB increases CGB but does not directly translate into GCA. The findings support a customer-perceived "proof-then-promotion" logic, showing that micro-hydropower-related sustainability information matters not as objectively measured technical proof, but as a perceived sustainability cue that must be translated into credible brand meaning and CGB.

1. INTRODUCTION

The coffee eco-sphere spans cultivation, processing, roasting, café operations, and downstream distribution. Energy use is embedded across these stages, from roasting and cooling to brewing and in-store services, making energy efficiency a central lever for reducing the environmental footprint of coffee offerings. Energy efficiency has often been conceptualised as a form of "first fuel" because it prioritises resource reduction before additional energy supply or market expansion is pursued [1]. In this study, however, energy efficiency is examined from the customer side as perceived energy efficiency (PEE), namely, customers' perception of energy-efficiency-related cues associated with the use of community-managed micro-hydropower in coffee production.

In many economies, sustainability pressures on coffee SMEs have moved from peripheral to mainstream, reshaping operational practices and market communication. Regulatory initiatives increasingly call for alignment between circular practices and green marketing and highlight the risk that environmental claims are not correlated with operational improvements [2]. On the demand side, firms are expected to disclose sustainability credentials more openly in response to rising ethical and environmental sensitivities, particularly among younger consumers who are more selective about evidence and transparency [3]. For coffee SMEs, these pressures coincide with rising energy costs and growing attention to carbon emissions from food and beverage services, positioning energy-efficiency-related information as both an operational issue and a potential basis for sustainability communication.

Studies on green marketing, sustainable branding (SB), and consumer-based brand equity have explained how eco-labels, packaging, and sustainability messages shape perceptions and purchase intentions, including the role of message design and interactivity [4]. However, most studies examine isolated links rather than tracing the full pathway from operational practices such as energy efficiency through brand authenticity and SB to customer green behaviour (CGB) and, ultimately, competitive advantage [3, 5-7]. This fragmentation is increasingly consequential for SMEs, including coffee shops, because greenwashing risks intensify when claims are not anchored in credible and observable evidence. Green image and market response may erode when customers perceive a gap between sustainability claims and operational practices, whereas credibility and authenticity can help reduce such risk [8-10]. The role of CGB as a mechanism connecting perceived operational sustainability cues and sustainability-oriented

branding to competitive outcomes remains underexplored in coffee SMEs.

This study addresses this gap through the empirical case of Tangsi Wangi Coffee, a coffee brand produced by a West Java cooperative whose production context is associated with community-managed micro-hydropower. The case is theoretically relevant because it shifts the discussion of green marketing from generic environmental communication to the translation of specific renewable-energy-related cues into information that customers can understand, evaluate, and trust. For SB theory, the case shows that brand credibility is not formed only through green messages, image, or claims, but through the perceived connection between brand communication and visible operational practices. In this context, the "proof-then-promotion" logic is treated as a customer-perception mechanism: micro-hydropower-related sustainability information becomes meaningful only when customers encounter it through accessible touchpoints such as product packaging, labels, social media content, cooperative storytelling, in-store communication, or product-related sustainability narratives. Therefore, the contribution of this study lies in clarifying how a renewable-energy coffee cooperative context extends green marketing and SB theory by showing that perceived operational cues must first be translated into credible brand meaning before they can stimulate CGB.

The central problem, therefore, is to clarify how energy efficiency and green marketing strategy (GMS) jointly support SB and CGB, and how these outcomes contribute to green competitive advantage (GCA) in coffee SMEs. To address this problem, the study develops and tests an integrated model linking PEE and GMS to SB, CGB, and GCA, grounded in the Natural Resource-Based View (NRBV) [10-13].

PEE is positioned as a customer-perceived sustainability cue associated with the cooperative's micro-hydropower-based production context, while GMS is positioned as a market-facing capability that communicates environmental value through product, packaging, labels, and sustainability messages. SB and CGB function as value-realisation mechanisms that convert perceived sustainability cues and market-facing communication into customer-facing credibility and behavioural responses. To explain the behavioural pathway at the customer level, this study draws on TPB as a complementary mechanism lens linking sustainability-related perceptions to CGB. Specifically, this study aims to:

1) Examine the effects of PEE and GMS on SB and CGB in the Tangsi Wangi Coffee case,
2) Assess how SB and CGB contribute to GCA, and
3) Test the mediating roles of SB and CGB in linking PEE and GMS to GCA.

2. THEORETICAL FRAMEWORK AND RESEARCH HYPOTHESIS

2.1 Coffee value chain and energy efficiency as "first fuel"

The coffee value chain links cultivation, processing, roasting, cafe operations, and distribution, with value creation accompanied by increasing embedded energy use and emissions. Coffee processing and roasting are energy-relevant stages because they involve drying, roasting, cooling, grinding, packaging, and related operational activities that may contribute to the environmental footprint of coffee products [14, 15]. Evidence also indicates that roasting and downstream processes are key energy hotspots and that instant coffee requires substantially more energy than ground coffee [14, 15]. These patterns position energy efficiency as a relevant operational issue for coffee businesses seeking to reduce resource intensity while maintaining product quality and economic viability.

Energy efficiency has also been framed as the "first fuel" because it prioritises reducing energy demand before expanding energy supply. Policy and analytical reports associated with energy transitions emphasise efficiency as a pathway for reducing emissions, lowering costs, and improving resource productivity [16, 17]. Broader reviews also underline efficiency improvements as a crucial step in reducing carbon emissions and supporting sustainable development [18, 19]. In this study, however, energy efficiency is not measured through objective operational indicators such as energy use per production unit, energy cost reduction, or carbon reduction. Instead, the study examines PEE, defined as customers' perception of energy-efficiency-related cues associated with the community-managed micro-hydropower context of Tangsi Wangi Coffee. Therefore, the "first fuel" concept is used as a contextual foundation for understanding how customers interpret energy-related sustainability information, not as direct evidence that technical energy efficiency has been objectively measured.

Building on this framing, the Tangsi Wangi Coffee case provides a specific empirical context for examining how renewable-energy-related information may be interpreted by customers. The use of community-managed micro-hydropower may offer a more concrete basis for sustainability communication than generic environmental claims when customers can observe, understand, or trust the information. However, such information only becomes meaningful at the customer level when it is communicated through accessible touchpoints such as packaging, labels, product narratives, social media, cooperative storytelling, or in-store communication [20-23]. Accordingly, PEE is positioned as a customer-perceived cue through which the Tangsi Wangi micro-hydropower context may enter SB and CGB mechanisms.

2.2 Natural Resource-Based View and green capabilities

The NRBV argues that environmental capabilities can contribute to competitive advantage when they are valuable, difficult to imitate, and embedded in organisational routines. NRBV highlights capabilities such as pollution prevention, product stewardship, and sustainable development as strategic resources that reduce ecological impacts while enabling market differentiation [24]. Prior studies also link environmental proactivity, eco-innovation, and lean-green practices with stronger environmental and market performance, often through reputation, stakeholder trust, and improved organisational responsiveness [25, 26]. In this study, GCA is specified as a perceived strategic outcome that reflects customers' evaluation of whether sustainability-related practices strengthen the brand's market position.

Within the NRBV lens, actual energy efficiency can be understood as an operational environmental capability. However, this study captures its customer-perceived manifestation through PEE. Thus, PEE is treated not as direct technical evidence of reduced energy intensity, but as the perceived market-facing relevance of Tangsi Wangi Coffee's

micro-hydropower-related practice. This distinction allows the study to connect NRBV with a customer-side model, where the value of an environmental practice depends not only on its operational existence but also on whether it can be recognised and interpreted by the market.

GMS, by contrast, is treated as a market-facing green capability that communicates environmental value through product attributes, packaging, labels, and sustainability messages. Green dynamic capabilities and green marketing orientation have been associated with stronger translation of environmental investments into market outcomes under regulatory and consumer pressures [10, 12, 27]. Accordingly, PEE and GMS are positioned as complementary antecedents: PEE reflects the perceived market-facing manifestation of an underlying operational practice, while GMS reflects the communication and market-orchestration process through which such practice is framed for customers. SB and CGB then operate as interfaces through which perceived environmental relevance and marketing communication are translated into brand meaning and behavioural responses [6, 10, 28, 29].

2.3 Signalling theory and credibility of sustainability cues

Signalling theory, originally formalised by Spence [30], explains how one party reduces information asymmetry by sending observable cues that allow others to infer unobservable quality. In sustainability contexts, customers often cannot directly verify whether a firm's environmental claims are supported by substantive operational practices. As a result, they rely on signals that help them distinguish substantive sustainability practices from symbolic green messaging.

At the signalling level, the underlying micro-hydropower practice may represent a more concrete sustainability basis than generic green claims. However, because this study measures customers' perceptions, PEE is better understood as a perceived credibility cue rather than a hard operational signal. Its signalling value depends on whether customers regard the renewable-energy-related information as specific, consistent, and connected to real production practices [31]. GMS often operates as a softer signal because it shapes customer interpretation through claims, narratives, and positioning. When green claims are not supported by sufficiently available evidence, customers may perceive a claim-evidence gap, which can trigger scepticism, perceived greenwashing, and weaker behavioural responses [32, 33]. SB is therefore positioned as the brand-level consolidation of sustainability cues into perceived authenticity and coherent green brand meaning. When customers perceive that marketing messages are consistent with sustainability-related information, the brand is more likely to be evaluated as credible and authentic [34]. Accordingly, signalling theory provides the credibility mechanism linking PEE and GMS to SB and, indirectly, to CGB. It also explains why green marketing messages may fail to stimulate behaviour when promotional claims appear stronger than the evidence available to customers.

2.4 Theory of Planned Behavior and customer green behaviour

The Theory of Planned Behaviour (TPB) explains how beliefs translate into behaviour through attitudes, subjective norms, and perceived behavioural control, with intentions predicting behaviour [35]. TPB research in green consumption consistently shows that attitudes and social norms shape intentions, while perceived behavioural control becomes critical when behaviours require additional effort or resources [36]. In this study, TPB provides the behavioural lens for explaining how sustainability-related perceptions are internalised by customers and materialise as CGB in a coffee consumption context.

In the proposed model, GMS and SB primarily shape customers' attitudinal and normative evaluations by communicating environmental value and creating a coherent green brand meaning. Consistent green messages and branding cues can strengthen favourable evaluations and perceived social endorsement toward choosing greener coffee products or outlets [37, 38]. At the same time, communicated PEE-related cues may strengthen customers' perceived behavioural control by increasing their confidence that choosing Tangsi Wangi Coffee is connected to a meaningful sustainability practice. These mechanisms explain how perceived environmental relevance may move from cognitive evaluation to behavioural response.

Accordingly, CGB is specified as the behavioural outlet linking perceived sustainability cues and branding mechanisms to demand-side outcomes, including repeat patronage, willingness to recommend, preference for greener products, and advocacy through interpersonal or digital communication [35, 39-42]. In this study, CGB is therefore not treated merely as an attitude, but as the behavioural mechanism through which perceived sustainability value may accumulate into GCA.

2.5 Research model and hypotheses development

This study integrates three complementary lenses to ground the proposed relationships. NRBV provides the capability-based logic, explaining how environmentally oriented capabilities may support advantage when they are valuable, embedded, and difficult to imitate. TPB provides the behavioural logic, explaining how customer beliefs translate into green behaviour through attitudes, subjective norms, and perceived behavioural control. Signalling theory provides the credibility mechanism, explaining how customers interpret sustainability-related cues under information asymmetry and how such interpretations shape the pathway from marketing activities to behavioural outcomes [43].

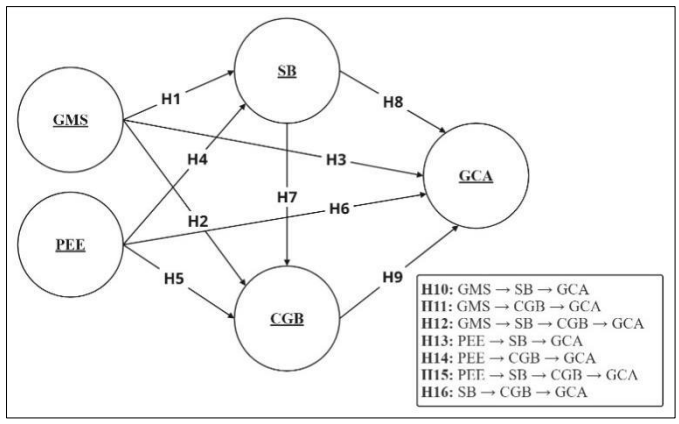

Figure 1. Structural model proposed
Note: PEE = Perceived Energy Efficiency; GMS = Green Marketing Strategy; SB = Sustainable Branding; CGB = Customer Green Behaviour; GCA = Perceived Green Competitive Advantage.

In this model (see Figure 1), PEE is positioned as customers' perception of micro-hydropower-related sustainability cues in the Tangsi Wangi Coffee case. GMS is positioned as a market-facing capability that communicates environmental value through product attributes, packaging, labels, and sustainability messages. SB captures the consolidation of sustainability-related cues into coherent green brand meaning and perceived authenticity. CGB reflects downstream behavioural responses shaped through TPB belief structures, while GCA is specified as a perceived strategic outcome resulting from customer recognition of sustainability-related value.

From an NRBV perspective, GMS is a market-facing green capability that aligns product, price, place, and promotion with environmental goals to create sustainability-oriented value [24, 44]. When marketing activities are linked to credible sustainability-related information, they can strengthen SB by consolidating green brand image and perceived authenticity [6, 9]. Prior studies in services and SMEs generally associate GMS with stronger green brand image and performance outcomes [10, 12, 27]. In signalling terms, GMS strengthens SB when customers perceive that green claims are consistent with available sustainability cues. Accordingly, this study hypothesises that:

H_1: GMS positively influences SB.

TPB suggests that marketing strategies shape behaviour via attitudes, subjective norms, and perceived behavioural control [35]. In green consumption contexts, credible claims and practice-based cues embedded in GMS can strengthen favourable evaluations, perceived social approval, and confidence that green choices are feasible, thereby supporting CGB [37, 38]. Evidence in retail, foodservice, and hospitality links green marketing activities to green purchase intention, loyalty, and positive word-of-mouth, with CGB functioning as a behavioural bridge to performance [37, 39]. However, signalling theory also implies a boundary condition: when customers perceive a claim-evidence gap, green messages can trigger scepticism and greenwashing perceptions, weakening favourable attitudes and behavioural responses even under consistent messaging [45, 46]. Based on this reasoning, the following hypothesis is proposed:

H_2: GMS positively influences CGB.

GMS may also contribute directly to GCA when environmental communication supports differentiation, reputation, and customer preference. From an NRBV perspective, market-facing green capabilities can help firms convert environmental orientation into competitive outcomes when such capabilities are recognised by the market [24, 44]. Therefore, this study hypothesises that:

H_3: GMS positively influences GCA.

SB provides the interpretive frame through which customers internalise sustainability claims. SB translates GMS into coherent identity cues and touchpoint experiences that shape meaning and authenticity perceptions [47, 48]. When supported by practice-based sustainability information, SB can reinforce green brand image and brand closeness, which in turn promote green purchase, loyalty, and advocacy [6, 49]. Therefore, this study proposes the following mediation hypotheses:

H_{10}: SB mediates the relationship between GMS and GCA.

H_{11}: CGB mediates the relationship between GMS and GCA.

H_{12}: SB and CGB sequentially mediate the relationship between GMS and GCA.

2.5.1 Perceived energy efficiency and its effects on sustainable branding, customer green behaviour, and green competitive advantage

Energy efficiency is increasingly recognised as an operational capability that raises resource productivity and reduces environmental burdens at the process level [1]. Under NRBV, actual energy efficiency can be treated as a valuable and embedded environmental capability when supported by routines such as energy management systems, monitoring, and operational improvement [24, 50]. However, this study does not measure technical energy efficiency through objective indicators. It examines PEE, namely, customers' perception of energy-efficiency-related information associated with Tangsi Wangi Coffee's community-managed micro-hydropower context.

From a signalling perspective, the underlying micro-hydropower-related practice may provide a more concrete sustainability basis than generic environmental claims. Its branding value, however, depends on whether customers perceive the information as specific, credible, and connected to real production practices [9, 30, 31]. When such perceived cues are integrated into brand communications and customer touchpoints, PEE is expected to reinforce SB and contribute to GCA through perceived reputation, differentiation, and sustainability relevance [6, 25]. Based on this logic, this study hypothesises that:

H_4: PEE positively influences SB.

H_5: PEE positively influences CGB.

H_6: PEE positively influences GCA.

TPB provides a behavioural pathway through which PEE may influence CGB. Customers do not need to calculate actual energy savings, but they may respond behaviourally when renewable-energy-related information increases their confidence that choosing Tangsi Wangi Coffee is connected to a meaningful sustainability practice [35, 36]. In coffee ecosystems, communicating tangible energy-related practices can reinforce customers' beliefs that green choices are feasible and compatible with functional expectations [37, 39]. These mechanisms suggest that PEE can foster CGB, including purchase preference, willingness to recommend, advocacy, and repeat patronage, which may support GCA through loyalty and positive word-of-mouth [40, 42]. Therefore, this study proposes the following mediation hypotheses:

H_{13}: SB mediates the relationship between PEE and GCA.

H_{14}: CGB mediates the relationship between PEE and GCA.

H_{15}: SB and CGB sequentially mediate the relationship between PEE and GCA.

2.5.2 Sustainable branding, customer green behaviour, and green competitive advantage

SB functions as a brand-level mechanism that translates sustainability-related cues into market-relevant meaning. Consistent disclosure of sustainability information can reduce information asymmetry and strengthen inferences of brand authenticity [51], favourable attitudes and perceived social approval toward green choices [9, 30, 52]. Within TPB, credible signals strengthen attitudes and subjective norms and, when supported by sustainability-related information, reinforce perceived behavioural control [32, 45]. In coffee ecosystems, brands that align identity with practice-based sustainability cues tend to stimulate CGB, including eco-conscious purchase and advocacy through e-WOM [6, 34, 38, 42, 48]. Based on this reasoning, this study hypothesises that:

H_7: SB positively influences CGB.

Under NRBV, SB represents the market-facing expression of green capabilities and resources that are valuable and difficult to imitate [24, 28]. By crystallising these capabilities into recognisable green brand meaning and perceived authenticity, SB can support GCA through enhanced reputation, differentiation, and stakeholder preference [10, 26]. CGB then operates as the behavioural channel that converts brand meaning into strategic outcomes, including patronage, willingness to pay, and word-of-mouth [37, 40, 41]. Accordingly, the following hypotheses are advanced:

H_8: SB positively influences GCA.

H_9: CGB positively influences GCA.

Overall, the model implies a sequential pathway in which SB consolidates sustainability-related cues into brand meaning, which then strengthens CGB and contributes to GCA [6, 35, 39]. As these behaviours accumulate, demand-side responses may translate into loyalty, e-WOM, and more resilient demand, consolidating GCA consistent with NRBV expectations [53]. Hence, the following hypothesis is advanced:

H_{16}: CGB mediates the relationship between SB and GCA.

3. RESEARCH METHODOLOGY

Tangsi Wangi Coffee is produced by Koperasi Produsen Rimba Lestari Gununghalu (Tangsi Jaya, West Java), where coffee processing operations are associated with community-managed micro-hydroelectricity (PLTMH). This renewable-energy setting provides a relevant empirical context for examining how micro-hydropower-related sustainability information is interpreted by customers and translated into perceived branding, behaviour, and competitive advantage. The study is therefore designed as a case-based customer perception study, rather than as a general survey of coffee SMEs.

A judgment sampling technique was employed, namely a non-probability approach in which respondents are deliberately selected based on pre-defined criteria [54]. The sampling frame comprised individuals who had purchased, seen, or consumed Tangsi Wangi Coffee within the last six months. Screening questions at the beginning of the survey ensured that only qualified respondents continued. The unit of analysis was the individual customer. Although the sample included end consumers, cooperative members, and agents or resellers, all respondents were retained because they had direct exposure to the brand. This composition is acknowledged because these groups may interpret sustainability-related information differently.

Data were collected using a self-administered questionnaire with items measured on a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The format was selected because it is simple, user-friendly, and helps reduce respondent errors [55]. A total of 200 respondents participated, satisfying sample adequacy guidelines for Partial Least Squares Structural Equation Modelling (PLS-SEM). As shown in Table 1, the sample was dominated by respondents from West Java (84%) and end consumers (92%), which is consistent with the brand's local cooperative base. Smaller proportions of agents or distributors (5%) and cooperative members (4%) were also included. This suggests that the findings mainly reflect customer-side perceptions, while generalisation beyond this single brand context should be made cautiously.

The questionnaire captured how respondents perceived sustainability-related information associated with Tangsi Wangi Coffee. In this study, customer exposure to such information was reflected through items on renewable-energy information, recyclable materials, product labels, and sustainability communication. These touchpoints are important because the proposed mechanism depends on whether customers can recognise and trust the brand's renewable-energy-related information.

In total, 15 items were adapted from established literature to capture the exogenous and endogenous variables. GMS was assessed using three items reflecting product packaging and sustainability communication, including clarity of renewable-energy information, use of recyclable materials, and ease of understanding product labels. These items were adapted from [4, 5, 7].

Table 1. Demographic profile

Demographic (N = 200)					
Gender	Freq.	%	*Education*	Freq.	%
Male	114	57	High school or below	107	54
Female	86	43	Bachelor's degree	60	30
			Master's degree or above	33	17
Age (years)	Freq.	%	*Locations*	Freq.	%
< 20	25	13	Bali	1	1
20-29	71	36	West Java	168	84
30-39	33	17	DKI Jakarta	14	7
40-49	32	16	Kalimantan	3	2
≥ 50	39	20	Maluku	2	1
			Sumatra	12	6
*Average Spending on Tangsi Wangi Coffee**	Freq.	%	*Duration of familiarity with Tangsi Wangi Coffee*	Freq.	%
Less than USD 7	131	66	Less than 6 months	133	67
USD 7–31	56	28	6–12 months	38	19
USD 32–320	6	3	1–5 years	20	10
More than USD 320	7	4	More than 5 years	9	5
Status	Freq.	%			
Agent/Distributor	9	5			
Cooperative Members	8	4			
Consumer	183	92			

* Exchange rate based on Wise's mid-market rate on September 23rd 2025: 1 USD ≈ IDR 16,650.

PEE was measured using three items capturing awareness of micro-hydro renewable energy in production, perceived cost or resource efficiency, and perceived eco-efficiency. These items were informed by energy-efficiency indicators [1], but were operationalised as customer perceptions rather than objective operational measurements. Accordingly, PEE should be interpreted as a perception-based construct, not as direct evidence of energy use per production unit, energy cost reduction, or carbon reduction.

SB was assessed using three items tapping brand credibility, consistency in portraying environmental concern, and emotional closeness to the brand [7, 6, 9].

CGB was evaluated with three items focusing on willingness to recommend Tangsi Wangi Coffee, preference for green-labelled coffee, and advocacy through social media or peer sharing [7].

GCA was operationalised using three items reflecting perceived superiority over competitors, loyalty associated with environmental reputation, and increased market appeal derived from sustainability commitments. These items were adapted from [5, 6].

Because all constructs were collected from the same respondents using a self-administered questionnaire at one point in time, common method bias was assessed using Harman's single-factor test and full collinearity diagnostics, as reported in the findings section.

4. RESULTS AND DISCUSSION

4.1 Measurement model

PLS-SEM using SmartPLS 4 was employed to estimate and test the research model. PLS-SEM identifies predictive linear relationships in the data and assesses relationships among latent variables, with an emphasis on maximising the explained variance of endogenous constructs [56].

Table 2. Structural equation modelling (SEM) analysis results

Indicator	Loading Factor	Cronbach's Alpha	rho_A	AVE
CGB1	0.895			
CGB2	0.945	0.911	0.912	0.851
CGB3	0.924			
PEE1	0.868			
PEE2	0.827	0.815	0.825	0.728
PEE3	0.865			
GCA1	0.925			
GCA2	0.940	0.924	0.926	0.867
GCA3	0.929			
GMS1	0.911			
GMS2	0.848	0.847	0.863	0.766
GMS3	0.864			
SB1	0.867			
SB2	0.894	0.851	0.851	0.771
SB3	0.872			

Source: Author's own creation.
Note: PEE = Perceived Energy Efficiency; GMS = Green Marketing Strategy; SB = Sustainable Branding; CGB = Customer Green Behaviour; GCA = Perceived Green Competitive Advantage.

The reflective measurement model was first assessed. Indicators showed substantial loadings on their intended constructs (CGB = 0.895–0.945, PEE = 0.827–0.868, GCA = 0.925–0.940, GMS = 0.848–0.911, SB = 0.867–0.894), supporting convergent validity. Cronbach's alpha and rho_A for all constructs exceeded 0.70, and AVE values were above 0.50, confirming satisfactory reliability and convergent validity [57]. Table 2 presents the reflective measurement model results.

For discriminant validity, three checks were applied (Table 3). First, the Fornell–Larcker criterion was satisfied: for every construct, the square root of AVE exceeded its inter-construct correlations. Second, cross-loadings showed that each indicator loaded highest on its own construct and lower on others. Third, all HTMT values were at or below 0.90 (range ≈ 0.549–0.900), with the largest pair, CGB–GCA = 0.900, which is at the commonly accepted upper threshold, suggesting acceptable but relatively close discriminant validity for this construct pair [58].

Table 3. Discriminant validity results

Fornell- Larcker Criteria					
	CGB	PEE	GCA	GMS	SB
CGB	**0.922**				
PEE	0.707	**0.853**			
GCA	0.828	0.738	**0.931**		
GMS	0.484	0.678	0.616	**0.875**	
SB	0.670	0.727	0.685	0.727	**0.878**
Heterotrait-Monotrait Ratio of Correlations (HTMT)					
CGB	—				
PEE	0.812	—			
GCA	0.900	0.841	—		
GMS	0.549	0.811	0.691	—	
SB	0.761	0.869	0.772	0.847	—

Source: Author's own creation.
Note: PEE = Perceived Energy Efficiency; GMS = Green Marketing Strategy; SB = Sustainable Branding; CGB = Customer Green Behaviour; GCA = Perceived Green Competitive Advantage.

4.2 Common method bias

Common method bias was assessed using Harman's single-factor test and full collinearity diagnostics. The first unrotated factor explained 59.69% of the total variance, exceeding the commonly used 50% threshold and suggesting potential common method variance [59]. However, because Harman's single-factor test has limited diagnostic sensitivity, full collinearity VIF was also examined. The VIF values ranged from 2.49 to 4.04, remaining below the 5.0 threshold for serious collinearity problems, although some values exceeded the more conservative 3.3 criterion [60]. Thus, common method bias cannot be completely ruled out, but severe collinearity-based inflation is not indicated. Therefore, the findings should be interpreted with caution, especially because the study relies on cross-sectional self-reported data.

4.3 Hypothesis test

The structural model showed no severe multicollinearity among predictor constructs, with all VIF values below 5. Explanatory power was moderate to substantial (adjusted R^2: SB = 0.626, CGB = 0.558, GCA = 0.750). Effect sizes indicated that the CGB → GCA path made a large contribution ($f^2 = 0.650$), whereas PEE → CGB, PEE → SB, and GMS → SB were of medium magnitude; other paths were small or non-significant, including SB → GCA. Q^2 values for SB (0.479), CGB (0.472), and GCA (0.644) were positive, indicating predictive relevance.

Path significance was evaluated using bootstrapping at α =

5% with t > 1.96. The results indicate that PEE → CGB is the strongest predictor of CGB, while CGB → GCA is the strongest predictor of GCA. GMS → CGB is statistically significant but negative, meaning that H2 is not supported in the hypothesised positive direction. This result suggests a potential credibility-risk mechanism in which green marketing messages may not directly stimulate CGB when customers perceive insufficient evidence behind the claims. By contrast, SB → GCA is not significant, indicating that SB does not directly translate into competitive advantage without customer behavioural response.

The mediation results further show that CGB is the main behavioural pathway linking sustainability-related perceptions and branding mechanisms to GCA. The PEE → CGB → GCA path shows the strongest indirect effect, followed by the SB → CGB → GCA path. For GMS, the GMS → SB → CGB → GCA path is positive, whereas the GMS → CGB → GCA path is statistically significant but negative. Therefore, the negative indirect path should be interpreted as significant but contrary to the hypothesised positive direction, not as hypothesis support. Table 4 reports the direct and indirect hypothesis testing results. Figure 2 illustrates the PLS-SEM structural model and path strengths.

Table 4. Hypothesis test results

Direct & Indirect Relationship	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Conclusion
H1: GMS → SB	0.434	0.434	0.064	6.812	0.000	Supported
H2: GMS → CGB	-0.172	-0.176	0.076	2.269	0.023	Not supported
H3: GMS → GCA	0.202	0.200	0.065	3.115	0.002	Supported
H4: PEE → SB	0.433	0.430	0.070	6.137	0.000	Supported
H5: PEE → CGB	0.521	0.519	0.084	6.172	0.000	Supported
H6: PEE → GCA	0.163	0.165	0.061	2.681	0.007	Supported
H7: SB → CGB	0.417	0.425	0.097	4.304	0.000	Supported
H8: SB → GCA	0.015	0.019	0.079	0.190	0.850	Not supported
H9: CGB → GCA	0.605	0.600	0.053	11.414	0.000	Supported
H10: GMS → SB → GCA	0.006	0.008	0.035	0.188	0.851	Not supported
H11: GMS → CGB → GCA	-0.104	-0.105	0.047	2.235	0.025	Not supported
H12: GMS → SB → CGB → GCA	0.109	0.111	0.031	3.489	0.000	Supported
H13: PEE → SB → GCA	0.006	0.008	0.035	0.187	0.852	Not supported
H14: PEE → CGB → GCA	0.315	0.311	0.057	5.560	0.000	Supported
H15: PEE → SB → CGB → GCA	0.109	0.109	0.032	3.450	0.001	Supported
H16: SB → CGB → GCA	0.252	0.254	0.060	4.213	0.000	Supported

Significance was assessed at $p < 0.05$.

Note: PEE = Perceived Energy Efficiency; GMS = Green Marketing Strategy; SB = Sustainable Branding; CGB = Customer Green Behaviour; GCA = Perceived Green Competitive Advantage.

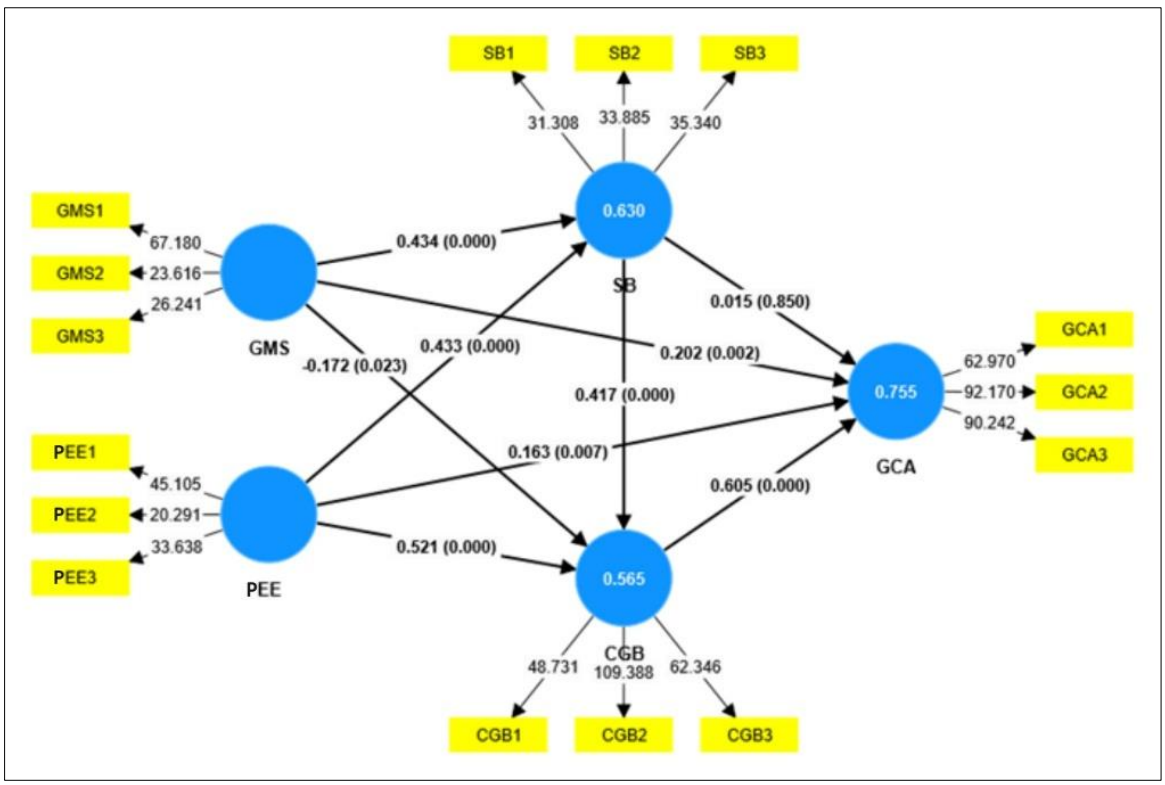

Figure 2. Partial Least Squares Structural Equation Modelling (PLS-SEM) structural model and path strengths

Source: SmartPLS 4, 2025.

Note: PEE = Perceived Energy Efficiency; GMS = Green Marketing Strategy; SB = Sustainable Branding; CGB = Customer Green Behaviour; GCA = Perceived Green Competitive Advantage.

The results support H_1 and H_3, indicating that GMS positively affects SB and GCA. This suggests that green marketing activities can strengthen SB and perceived competitive advantage when product, packaging, labelling, and sustainability communication are perceived as coherent with environmental value [44]. This aligns with NRBV because market-facing green capabilities may help firms translate environmental orientation into brand-level differentiation and competitive positioning [24]. Related service-sector evidence also suggests that the orchestration of green capabilities may strengthen reputation, preference, and loyalty linked to GCA [12].

However, H_2 is not supported because the GMS → CGB coefficient is negative and significant. This result indicates that green marketing does not automatically stimulate CGB. Instead, it may create a credibility risk when customers perceive insufficient evidence behind sustainability claims. In such cases, customers may infer greenwashing or become sceptical, weakening behavioural responses [9, 61, 62]. Therefore, the negative GMS → CGB path is statistically significant, but contrary to the hypothesised positive direction.

The PEE-related direct paths show a different pattern. H_4, H_5, and H_6 are supported, indicating that customers' perception of Tangsi Wangi Coffee's micro-hydropower-related sustainability information positively affects SB, CGB, and GCA. Among these paths, PEE → CGB is the strongest, suggesting that perceived renewable-energy-related information is most influential when it shapes customer behaviour. This result should not be interpreted as evidence that technical energy efficiency was objectively measured. Rather, it shows that customers' perception of renewable-energy-related information can support brand meaning, green behaviour, and perceived competitive advantage when the information is meaningful and connected to the product context [1, 35].

The downstream paths further clarify the role of branding and behaviour. H_7 is supported, showing that SB positively affects CGB. This means that SB can encourage customers' willingness to recommend, prefer, or advocate for green-labelled coffee. However, H_8 is not supported because SB does not directly affect GCA. This indicates that sustainable brand meaning alone is insufficient to generate perceived competitive advantage unless it is translated into customer behaviour [6, 48, 63]. H9 is supported and shows the strongest effect: CGB is the main conduit through which value becomes competitive advantage, via repeat purchasing, loyalty, and positive word of mouth [37-39].

The mediation results reinforce this behavioural mechanism. For GMS, H_{10} is not supported because the GMS → SB → GCA path is not significant. This means that SB does not directly transmit the effect of GMS to GCA. H_{11} is also not supported in the hypothesised positive direction because the GMS → CGB → GCA path is significant but negative. This negative indirect effect suggests that when green marketing weakens CGB, it may also weaken the behavioural route to GCA. By contrast, H_{12} is supported, showing that GMS can positively contribute to GCA through the sequential pathway of SB and CGB. This finding indicates that GMS becomes more effective when it first strengthens sustainable brand meaning and then stimulates CGB [6, 47, 49].

For PEE, H_{13} is not supported because the PEE → SB → GCA path is not significant. This confirms that SB alone does not directly convert PEE into GCA. However, H_{14} is supported and represents the strongest indirect pathway, indicating that PEE contributes to GCA primarily through CGB. H_{15} is also supported, showing that PEE can strengthen GCA through the sequential mechanism of SB and CGB. These results suggest that customers' perceived sustainability cue needs to move beyond brand meaning and become a behavioural response before it contributes to perceived competitive advantage [64, 65].

Finally, H_{16} is supported, confirming that CGB mediates the relationship between SB and GCA. This result explains why H_7 is supported, but H_8 is not: SB strengthens CGB, but its contribution to competitive advantage occurs indirectly through customer action. Prior studies also suggest that CGB is reinforced by e-WOM and information quality, where relevance and credibility matter more than message volume [39, 42, 66], and by perceived value and issue knowledge, which help address intention–behaviour gaps [67-70].

Taken together, the findings support a customer-perceived version of the proof-then-promotion logic. In the Tangsi Wangi Coffee case, micro-hydropower-related information matters not as objectively measured technical proof, but as a perceived sustainability cue that must be translated into SB and CGB. This case-based interpretation clarifies the study's contribution: green marketing becomes more effective when promotional messages are grounded in sustainability information that customers can recognise, understand, and connect to the brand.

5. CONCLUSION

This study examined how PEE and GMS shape SB, CGB, and GCA in the Tangsi Wangi Coffee case. The findings show that PEE positively affects SB, CGB, and GCA, with the strongest indirect effect occurring through CGB. This indicates that customers' perception of micro-hydropower-related sustainability information is most relevant when it is translated into behavioural responses such as recommendation, preference, advocacy, and repeat patronage. However, this result should not be interpreted as evidence of objectively measured technical energy efficiency. The study captures customer-perceived sustainability cues rather than operational indicators such as energy use per production unit, energy cost reduction, carbon reduction, or documented micro-hydropower output.

The findings also show that GMS strengthens SB and GCA but has a significant and negative effect on CGB. This result suggests that green marketing does not automatically stimulate green behaviour when customers perceive insufficient evidence behind sustainability claims. Therefore, the study supports a customer-perceived version of the "proof-then-promotion" logic: renewable-energy-related information must first be recognisable, understandable, and connected to the product context before it can strengthen sustainable brand meaning and CGB. For renewable-energy coffee cooperatives and similar coffee SMEs, this implies that sustainability communication should not rely only on broad environmental claims. Managers need to link sustainability information to customer-facing touchpoints such as packaging, labels, product narratives, social media content, cooperative storytelling, and direct communication.

The theoretical contribution of this study lies in clarifying how a renewable-energy coffee cooperative context can extend green marketing and SB theory. NRBV explains how environmental and market-facing capabilities may contribute

to perceived competitive advantage when customers recognise their sustainability value. Signalling theory explains how micro-hydropower-related information may function as a perceived credibility cue when customers regard it as specific, consistent, and connected to real production practices. TPB explains how such perceived cues are translated into CGB. The findings, therefore, position CGB as the key behavioural mechanism linking PEE, GMS, and SB to GCA.

This study has several limitations. First, its cross-sectional design limits causal interpretation. Second, the study is based on 200 respondents from one coffee brand, so the findings should not be generalised directly to all coffee SMEs. Third, although the sample was dominated by end consumers, it also included cooperative members and agents or distributors, who may interpret sustainability-related information differently. Fourth, the study relies on customer perceptions rather than objective operational indicators. Fifth, common method bias cannot be completely ruled out because all variables were collected from the same respondents using a self-administered questionnaire at one point in time. Future research should test the model across multiple coffee brands or cooperatives, separate respondent groups more clearly, and combine perception-based data with objective sustainability indicators. Longitudinal, experimental, and multilevel designs are also recommended to examine how renewable-energy-related information moves from customer perception to branding, behaviour, and competitive advantage.

ACKNOWLEDGEMENT

This research was funded by the Ministry of Research, Technology, and Higher Education of the Republic of Indonesia, Fundamental Research Grant Scheme (FRGS): under Contract No. 124/C3/DT.05.00/PL/2025; 0969/LL3/AL.04/2025; 003/SSP.PEN/LPPM/UNSADA/VI/2025.

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