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Sustainable Tourism Innovation and Destination Competitiveness: Assessing the Economic Value of Low-Carbon Tourism Practices

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Green Price Premium,
Decoupling

Abstract

Destinations are under growing pressure to reduce the carbon footprint of tourism, yet decisions to adopt low-carbon practices are usually judged on environmental grounds alone, and the economic case is rarely set out in a form that managers, investors, and destination agencies can use. This study develops an evidence based framework for assessing the economic value of low-carbon tourism practices and for asking whether they strengthen destination competitiveness. It synthesizes peer reviewed work on tourism emissions, destination competitiveness, hospitality energy economics, green demand, eco-efficiency, climate risk, and governance. The evidence shows that low-carbon operations in accommodation can lower unit costs, that stated preference studies often find a willingness to pay for green attributes that is limited by an attitude behaviour gap, and that emissions are dominated by travel to the destination, which operators cannot control. Direct evidence that links low-carbon practices to destination level competitiveness outcomes is thin. The paper therefore proposes a five stream value model (cost savings, price and demand premium, mix and yield, resilience, and valued externalities), derives a marginal abatement cost, a break even price premium, a market level eco-efficiency identity, and a decoupling condition, and introduces a Low-Carbon Destination Competitiveness Index (LCDCI) that aggregates four pillars with a geometric mean. Illustrations with assumed parameters show that some practices pay for themselves while a full programme needs a premium or a carbon value, that source market mix can change eco-efficiency more than property level measures, and that efficiency alone does not stop emissions from rising when arrivals grow quickly. The central implication is that low-carbon tourism practices raise destination competitiveness when they are bundled, verified, and paired with a value-over-volume market strategy.

1. Introduction

Tourism is both an engine of economic activity and a significant source of greenhouse gas emissions. A multi-region input-output assessment by Lenzen et al. (2018) places the global carbon footprint of tourism at roughly eight percent of world emissions, with transport, food, and shopping among the largest contributors, and the UNWTO (2019) reports that tourism related transport alone accounts for about five percent of global carbon dioxide emissions. Destinations therefore face two linked pressures: to reduce emissions in line with national and corporate targets, and to remain attractive and profitable in a market where rivals, visitors, and investors are changing their expectations. The literature on sustainable tourism has long argued that environmental management and competitiveness can support each other (Mihalič, 2000; Hassan, 2000; Ritchie and Crouch, 2003), but it has also documented a gap between what the sector says and what it does (Gössling and Scott, 2018; Buckley, 2012).

A practical difficulty is that the economic value of low-carbon practices is spread across different actors and different time horizons. A hotel that installs heat pumps captures a lower energy bill. A destination agency that attracts lower-emission, higher-spending visitors captures yield. A community that avoids climate damage captures a benefit that no balance sheet records. When these values are not counted together, low-carbon practices can look like a pure cost, and when they are counted loosely, they can look like a free lunch. Both readings are unsafe. The marginal abatement cost literature shows that abatement options differ widely in cost and that some have negative cost while others are expensive (Kesicki and Strachan, 2011), and the eco-efficiency literature shows that value created per unit of emissions differs strongly across tourism segments (Gössling et al., 2005, 2015).

This paper asks: *What is the economic value of low-carbon tourism practices, and under what conditions do they strengthen destination competitiveness?* It breaks the question into four research questions.

RQ1 Which value streams do low-carbon practices create for operators and destinations, and how can they be measured?

RQ2 Which practices pay for themselves, and what price premium or carbon value is needed to justify the rest?

RQ3 How does source market mix shape the eco-efficiency of a destination and the condition under which emissions fall as value grows?

RQ4 How can the capability of a destination to turn low-carbon practice into competitive advantage be measured?

The paper makes five contributions. First, it treats low-carbon practice as tourism innovation (Hjalager, 2010; Hall and Williams, 2008) and links it to destination competitiveness through five value streams. Second, it supplies property level tools, a marginal abatement cost and a break even price premium, that translate engineering and market information into one decision rule. Third, it supplies destination level tools, an eco-efficiency identity, a carbon-adjusted value measure, and a decoupling condition, that show why source market mix matters. Fourth, it proposes a Low-Carbon Destination Competitiveness Index that penalizes weak pillars through a geometric mean. Fifth, it states testable hypotheses and a research design for future work with operator panels, choice experiments, and destination emissions accounts.

The evidence boundary is 31 December 2021: publications from 2022 onward are not used as evidence. The paper proceeds as follows. Section 2 reviews the literature. Section 3 develops the framework. Section 4 describes methodology and measurement. Section 5 synthesizes the evidence and illustrates the framework with assumed numbers. Section 6 discusses implications, Section 7 sets out limitations and a research agenda, and Section 8 concludes. Figure 1 summarizes the framework.

2. Literature Review

2.1 Tourism Emissions and the Decarbonization Problem

Estimates of tourism's climate impact depend on the boundary chosen, but they agree that transport is central. Gössling (2002) reviewed the global environmental consequences of tourism early on, and Gössling and Peeters (2015) assessed tourism's environmental impact over a long horizon and showed that growth in travel can overwhelm technological improvement. Becken et al. (2003) compared energy use across travel choices and found that the mode and distance of travel dominate

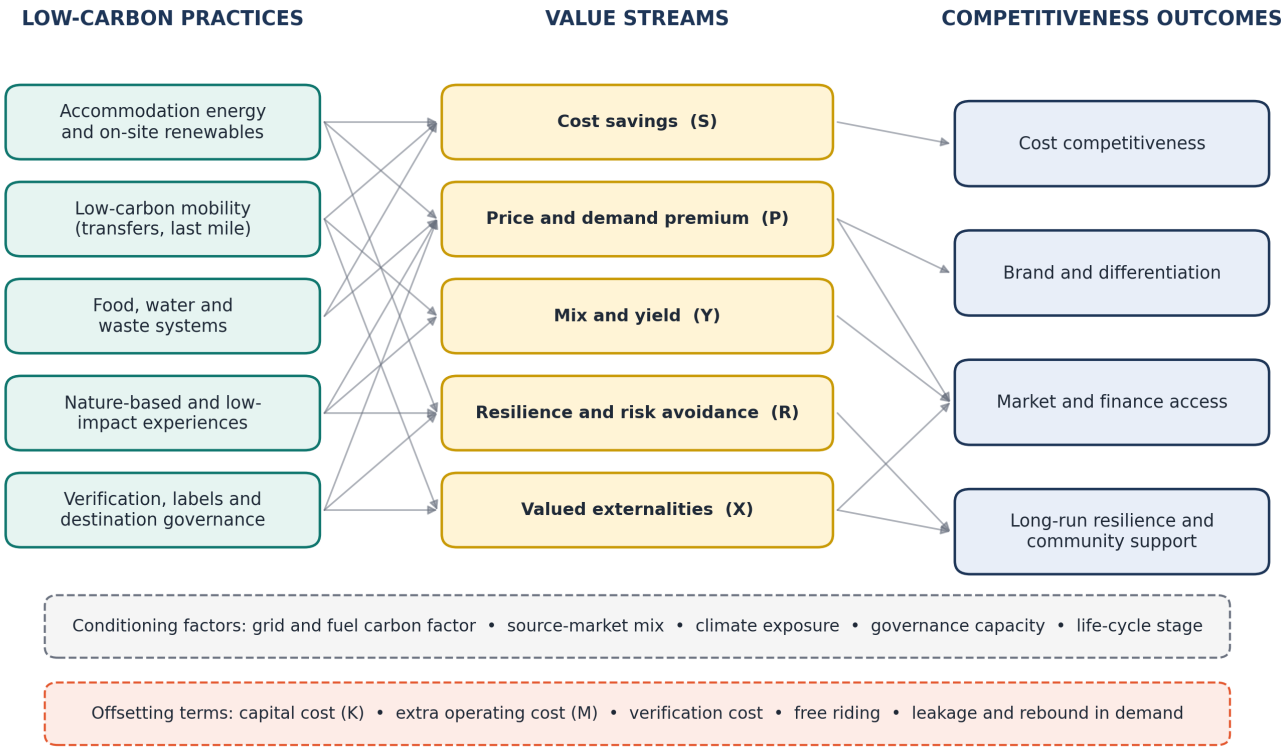

Figure 1. Value framework linking low-carbon tourism practices to destination competitiveness through five value streams.

energy use per trip. Dwyer et al. (2010) estimated the carbon footprint of Australian tourism with an accounting approach that attributes emissions to the sector's demand, and Lenzen et al. (2018) extended such accounting to the global supply chain. Together these studies imply that a destination that counts only the energy used inside hotels will see a small share of the footprint associated with its visitors.

Mitigation has proved difficult. Gössling and Scott (2018) surveyed tourism leaders and described an impasse between recognition of climate change and willingness to adopt measures that limit growth in demand, and Peeters and Dubois (2010) showed that tourism travel under climate mitigation constraints would require changes in the structure of travel as well as in technology. Gössling et al. (2012) discuss transition management as a way to implement sustainable tourism scenarios. Buckley (2012) reviewed the research and described a persistent gap between research and practice, which leaves the economics of mitigation at the level of the destination thinly evidenced.

2.2 Destination Competitiveness and Environmental Quality

Models of destination competitiveness have placed environmental resources and their management among the determinants of success. Ritchie and Crouch (2003) frame competitiveness as the ability to deliver greater well-being than rivals while preserving resources for future generations, and Dwyer and Kim (2003) integrate determinants and indicators into a general model. Mihalič (2000) argued that environmental management and quality are factors of tourism competitiveness, and Hassan (2000) proposed determinants of market competitiveness in an environmentally sustainable industry. Huybers and Bennett (2003) examined how environmental management relates to the competitiveness of nature-based destinations. Empirical measurement has taken a quantitative turn, for example with the indicator approach of Enright and Newton (2004), the weighting of attributes by Crouch (2011), and the study of small island destinations by Croes (2011). The life cycle perspective of Butler (1980) is a reminder that competitiveness is dynamic and that environmental degradation can shorten the life of a destination. Despite this lineage, the competitiveness models treat environmental quality in general terms and say little about carbon specifically.

2.3 The Economics of Low-Carbon Operations in Accommodation

Hospitality is the best documented setting for the economics of operational decarbonization. Benchmarking studies measure energy use intensity in hotels in several climates (Deng and Burnett, 2000; Priyadarsini et al., 2009) and identify determinants of resource use such as climate, size, and category (Bohdanowicz and Martinac, 2007). Bohdanowicz (2006) surveyed environmental awareness and initiatives in hotels in two countries and found variation by country and ownership. Life-cycle approaches to hotel carbon footprints (Filimonau et al., 2011) and analysis of food systems (Gössling et al., 2011) show that emissions arise beyond the building envelope. The strand is informative about where energy is used but less so about realized financial returns, and the economic analysis of adoption has to draw on general work on abatement cost curves (Kesicki and Strachan, 2011) and on cost-benefit methods (Boardman et al., 2018). Strategy research on whether environmental performance pays is mixed: Porter and van der Linde (1995) argued that well designed environmental regulation can spur innovation that offsets costs, while Palmer et al. (1995) cautioned that the no-cost paradigm is not general. In the hotel sector, Kang et al. (2010) associated corporate social responsibility activities with company performance, and the sign of the association depended on the type of activity.

2.4 Demand Side: Green Premiums and the Attitude-Behaviour Gap

Stated preference and survey studies show that many guests value green attributes. Han et al. (2010) applied the theory of planned behavior to green hotel choice, Kang et al. (2012) examined willingness to pay for hotel green initiatives, Millar and Baloglu (2011) studied guest preferences for green guest room attributes, and Manaktola and Jauhari (2007) examined attitudes and behavior toward green practices in lodging in India. The same literature contains a caution: Juvan and Dolnicar (2014) review the attitude-behaviour gap in sustainable tourism and show that pro-environmental attitudes often fail to translate into holiday behavior, and Hares et al. (2010) and Higham et al. (2016) report that tourists are reluctant to reduce flying even when concerned about climate change. Font et al. (2012) document a gap between what firms disclose and how they perform, which weakens the signal that a premium depends on. A stated premium is therefore not a realized premium, and the economics of green pricing should rest on revealed outcomes as well as stated intentions.

2.5 Market Mix, Eco-Efficiency, and Decoupling

Gössling et al. (2005) introduced eco-efficiency to tourism as the economic value created per unit of environmental impact and showed that it varies considerably across tourism segments. Gössling et al. (2015) extended the logic to source markets and showed that carbon emission

intensities per unit of revenue differ greatly between markets, which suggests that destination marketing is a carbon management tool. The decoupling literature supplies a vocabulary for the relationship between growth and impact: Tapio (2005) defined degrees of decoupling through the elasticity of an environmental pressure with respect to economic growth. These strands have not been combined with property level economics, and no common framework tracks both the cost side at the operator and the mix side at the destination.

2.6 Valuing Externalities and Climate Risk

Low-carbon practice produces benefits that accrue outside the firm. The social cost of carbon is the standard device for valuing them: Stern (2007) argued that the costs of inaction exceed the costs of action, Nordhaus (2017) revisited the social cost of carbon; published estimates span a wide range, and the value used in any appraisal is a choice that should be tested. Tourism is also exposed to climate impacts: Becken and Hay (2007) describe risks and opportunities, and Scott et al. (2019) assess the vulnerability of destinations worldwide and find it unevenly distributed. For a destination, avoided climate risk is therefore a source of value that is poorly captured in private accounts.

2.7 Governance, Verification, and Innovation

Whether practices spread depends on governance. Bramwell and Lane (2011) review critical research on governance of tourism and sustainability, Hall (2011) analyzes policy learning and policy failure, and Hall (2019) questions whether the sustainability agenda is compatible with growth oriented tourism management. Font and McCabe (2017) discuss the paradoxes of sustainability marketing. In the language of innovation research, low-carbon practice combines product, process, organizational, and market innovation (Hjalager, 2010), and its diffusion depends on the capability of the firms and agencies involved (Hall and Williams, 2008). Mihalič (2016) calls for responsible and sustainable tourism that is implemented rather than merely stated. Cvelbar and Dwyer (2013) show that managers' views of sustainability factors vary in importance and performance, which supports a differentiated approach.

2.8 Research Gap

Five gaps are identified. First, competitiveness models mention environmental quality but do not value carbon specifically. Second, hospitality studies describe energy use but seldom report realized returns together with abatement. Third, demand studies rely on stated willingness to pay and rarely link it to the cost of the practice. Fourth, eco-efficiency work at the source market level is not connected to the operator level economics that determine adoption. Fifth, there is no measure of destination capability that treats the weakest pillar as a binding constraint. This study addresses these gaps with a five stream value model. Table 1 sets out, question by question, what the literature settles and what it leaves open.

3. Theoretical Framework

3.1 Low-Carbon Practice as Tourism Innovation

A low-carbon practice is any change in the way a tourism product is designed, produced, delivered, or marketed that lowers emissions per unit of tourism activity. Following innovation research, such practices can be product innovations (a car-free itinerary), process innovations (heat pumps, solar generation, waste reduction), organizational innovations (an energy team with accountable owners), and market innovations (targeting lower-emission, higher-yield source markets) (Hjalager, 2010). The framework treats these as an investment portfolio whose returns are spread across several value streams and whose costs are borne mainly by operators.

3.2 Five Value Streams

The framework identifies five value streams (Table 2). Cost savings (S) are reductions in energy, water, and waste costs. The price and demand premium (P) is the additional revenue from higher room rates, longer stays, or higher occupancy that guests grant to verified low-carbon products. Mix and yield (Y) is the additional value from shifting arrivals toward source markets that generate more value per tonne of emissions. Resilience (R) is the expected reduction in losses from climate impacts, energy price shocks, and regulatory change. Valued externalities (X) are avoided climate damages priced at an internal or social carbon value. Offsetting these are the annualized capital cost of the practice, extra operating cost, verification cost, and leakage.

3.3 Property Level Value Model

Consider an operator that adopts a portfolio of practices $j = 1, \ldots, J$. Practice j requires capital K_j with service life T_j, adds operating cost M_j per year, saves S_j per year in operating cost, and avoids A_j tonnes of carbon dioxide equivalent per year. With a discount rate r the annuity factor is $a_j = r/\big(1-(1+r)^{-T_j}\big)$. The annual net economic value of the practice is

$$\mathrm{NEV}_j = S_j + P_j + Y_j + R_j + X_j - a_j K_j - M_j, \tag{1}$$

where P_j, Y_j, R_j, and X_j are the annual values of the premium, mix and yield, resilience, and externality streams. The private value omits X_j. The marginal abatement cost of the practice, which does not depend on the revenue streams, is

$$\mathrm{MAC}_j = \frac{a_j K_j + M_j - S_j}{A_j}. \tag{2}$$

A negative MAC_j means that the practice pays for itself in operating savings, and a positive value is the carbon price at which the practice breaks even on cost alone (Kesicki and Strachan, 2011). Ranking practices by MAC_j gives the abatement cost curve. For a bundle of practices with total annualized net cost $\Gamma = \sum_j (a_j K_j + M_j - S_j)$ and total abatement $A = \sum_j A_j$, a property with baseline room revenue R_0 that earns a proportional premium π and is credited a carbon value τ per tonne breaks even when $\pi R_0 + \tau A \geq \Gamma$, so the break even premium is

$$\pi^* = \frac{\Gamma - \tau A}{R_0}. \tag{3}$$

A negative π^* means that the bundle pays without any premium. The carbon value at which no premium is needed is $\tau_0 = \Gamma/A$ when $\Gamma > 0$. Equation (3) turns the question "is it worth it?" into a comparison of two observable quantities, the required premium and the premium that guests actually pay.

3.4 Destination Level Eco-Efficiency

Let source market m send N_m visits with average stay L_m nights, value added y_m per night, travel emissions e_m^T per visit, and on-site emissions e_m^S per night. Destination value added and emissions are

$$V = \sum_m N_m L_m y_m, \qquad E = \sum_m N_m \big(e_m^T + L_m e_m^S\big). \tag{4}$$

Eco-efficiency is the ratio of value to emissions (Gössling et al., 2005). It can be written as an emission-weighted average of market eco-efficiencies $\varepsilon_m = L_m y_m / (e_m^T + L_m e_m^S)$:

$$\mathrm{DEE} = \frac{V}{E} = \sum_m w_m \varepsilon_m, \qquad w_m = \frac{E_m}{E}. \tag{5}$$

Writing $V = N\bar{v}$ and $E = N\bar{e}$ with N total visits, value per visit $\bar{v}$, and emissions per visit $\bar{e}$ shows that $\mathrm{DEE} = \bar{v}/\bar{e}$: eco-efficiency is unaffected by the number of visits and depends only on value and emissions per visit. A change in eco-efficiency between two periods B and A can be split exactly into a market mix effect and a within-market effect with the log mean Divisia index (Ang and Liu, 2001; Ang, 2005). With $a_m = w_m \varepsilon_m$ and the logarithmic mean $\ell(x,z) = (x-z)/(\ln x - \ln z)$,

$$\Delta\mathrm{DEE} = \underbrace{\sum_m \ell\big(a_m^A, a_m^B\big) \ln \frac{w_m^A}{w_m^B}}_{\text{market mix}} + \underbrace{\sum_m \ell\big(a_m^A, a_m^B\big) \ln \frac{\varepsilon_m^A}{\varepsilon_m^B}}_{\text{within market}}. \tag{6}$$

The within market term captures property level practices that raise value per tonne for a given market, and the mix term captures marketing and access policy. A related measure accounts for the carbon externality

Table 1. Evidence Ledger by Research Question: What the Pre 2022 Literature Settles and What It Leaves Open

Research question	Reasonably settled	Still open
RQ1 Value streams and their measurement	Tourism emissions are large and dominated by travel to the destination (Lenzen et al., 2018; UNWTO, 2019; Becken et al., 2003). Resource use in hotels follows measurable determinants such as climate, size, and category (Bohdanowicz and Martinac, 2007; Deng and Burnett, 2000). Climate risk is unevenly spread across destinations (Scott et al., 2019).	Realized financial returns from low-carbon practice, as opposed to energy benchmarks, are seldom reported; no common accounting joins cost, price, mix, risk, and externality values in one frame.
RQ2 Cost of abatement and the premium needed	Abatement options differ widely in cost, and some pay for themselves (Kesicki and Strachan, 2011). Guests state a willingness to pay for green attributes that varies across people (Kang et al., 2012; Millar and Baloglu, 2011; Han et al., 2010).	Stated premiums are not realized premiums because of the attitude-behaviour gap and the disclosure-performance gap (Juvan and Dolnicar, 2014; Font et al., 2012); hedonic evidence on label premiums is scarce.
RQ3 Market mix, eco-efficiency, and decoupling	Eco-efficiency and emission intensity per unit of revenue differ strongly by segment and by source market (Gössling et al., 2005, 2015). Growth in travel can overwhelm technical gains (Gössling and Peeters, 2015).	How far destination marketing can shift the mix without losing value; how return and origin-side travel emissions should be bounded for market comparisons.
RQ4 Destination capability and governance	Environmental management is treated as a determinant of competitiveness (Mihalič, 2000; Hassan, 2000; Huybers and Bennett, 2003); governance gaps and policy failure slow action (Gössling and Scott, 2018; Hall, 2011).	No measure treats the weakest capability as a binding constraint; links from governance quality to realized competitiveness outcomes are rarely tested with data.

Table 2. Five Value Streams, Their Measurement, and Typical Beneficiaries

Stream	Definition	Measurement indicator	Main beneficiary	Principal risk
Cost savings (S)	Lower energy, water, and waste costs per occupied room-night	Cost per occupied room-night; kWh and m^3 per room-night	Operator	Rebound in use; poor installation
Premium (P)	Higher rate, stay length, or occupancy attributable to verified practice	Hedonic rate premium; revealed occupancy change	Operator, destination	Attitude-behaviour gap; weak verification
Mix and yield (Y)	Value per tonne gained by shifting source markets	Eco-efficiency by market; carbon-adjusted value	Destination, community	Loss of volume; market access limits
Resilience (R)	Avoided expected losses from climate, energy price, and regulation	Expected loss avoided; insurance and finance terms	Operator, community	Hard to observe; long horizon
Externalities (X)	Avoided climate damage valued at a carbon price	Tonnes avoided × carbon value	Society	Contested valuation

directly. The carbon-adjusted value added of a visit from market m at carbon value τ is

$$\mathrm{CAVA}_m = L_m y_m - \tau\left(e_m^T + L_m e_m^S\right). \tag{7}$$

A market with negative CAVA_m destroys value once the carbon cost is counted. Figure 2 shows how a destination's emissions divide between sources and how much of each is within local reach, and Figure 3 shows the eco-efficiency map of markets.

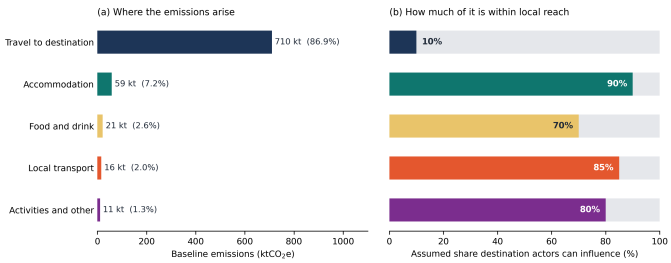

Figure 2. Aanatomy of destination emissions (a) by source and (b) by the assumed share that destination actors can influence.

3.5 Decoupling Condition

Let arrivals grow by g, let emissions per visit fall by a proportion ρ, and let value per visit change by ν. Then $1+\Delta V/V = (1+g)(1+\nu)$ and $1+\Delta E/E = (1+g)(1-\rho)$. Following Tapio (2005), the decoupling elasticity is

$$\eta = \frac{\Delta E/E}{\Delta V/V}, \tag{8}$$

and strong decoupling occurs when value grows while emissions fall, which implies $\eta < 0$. Emissions do not rise if and only if

$$g \le g^* = \frac{\rho}{1-\rho}. \tag{9}$$

The condition shows why value per visit matters: a destination that grows value mainly through ν rather than g can satisfy Equation (9) with a smaller ρ. If the target is to raise value by a factor $1+\Gamma_V$ while holding emissions constant, the required growth in value per visit is $\nu = (1+\Gamma_V)/(1+g) - 1$ and the required cut in emissions per visit is $\rho \ge g/(1+g)$.

3.6 Value Capture and Governance

Who captures the value matters for support and durability. Operators capture cost savings and premiums, employees and local suppliers capture value only if practices change purchasing and employment, public bodies capture levy revenue, and society captures avoided damage.

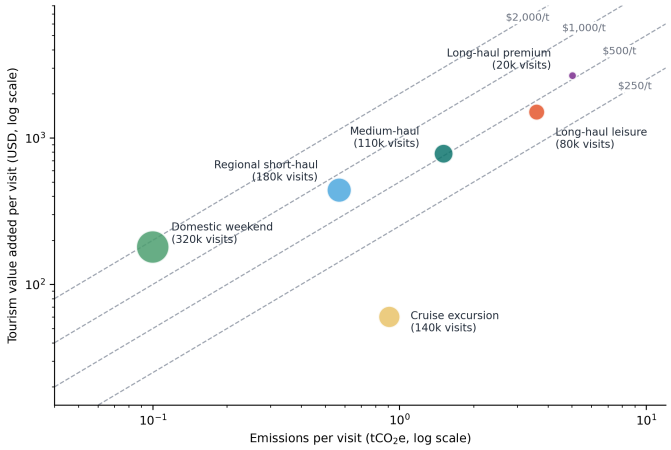

Figure 3. Eco-efficiency map of six hypothetical source markets.

Governance arrangements that range from voluntary labels to mandatory standards and levies reinvested in a destination fund distribute value differently (Bramwell and Lane, 2011; Hall, 2011). The framework expects that arrangements that return part of the value to the community broaden support and sustain participation.

3.7 Moderators and Boundary Conditions

Four moderators condition the pathway: the carbon intensity of the energy supply, the source market mix, the credibility of verification, and institutional coordination. Boundary conditions include climate exposure, life-cycle stage (Butler, 1980), capital availability, and the strength of competition from rival destinations with lower costs.

4. Methodology

4.1 Research Design

The study is a structured secondary evidence synthesis. The evidence boundary is 31 December 2021, and sources published from 1 January 2022 onward are excluded. Peer reviewed articles, established academic books, and authoritative institutional reports are prioritized. The study does not claim a new dataset or a new causal estimate; it develops a framework and an empirical design for later testing. Each study was coded by the value stream it informs, by its level of evidence (destination, firm, tourist stated preference, or conceptual and modelling), and by the direction of its reported finding. Table 3 sets out the selection framework.

Table 3. Evidence Selection Framework

Criterion	Included	Excluded
Date	Published before 2022	Published in 2022 or later
Quality	Peer reviewed research, academic books, institutional reports	Unsupported commentary
Topic	Tourism emissions, competitiveness, hospitality economics, green demand	Unrelated sectors
Outcome	Cost, price, demand, yield, risk, emissions, governance	Outcomes without economic relevance
Unit	Property, firm, destination, market	Purely engineering studies

4.2 Measurement Variables

The independent constructs are the intensity of low-carbon practice at the property (the share of energy from low-carbon sources, the share of rooms with energy management, and verified labels) and the destination mix of source markets. The dependent constructs are unit operating cost, rate and occupancy, value added per tonne, and absolute emissions. Outcomes must be reported in both relative and absolute terms. Table 4 lists the constructs.

4.3 Low-Carbon Destination Competitiveness Index

The study proposes the Low-Carbon Destination Competitiveness Index (LCDCI), built from four pillars that correspond to the value streams: operational efficiency (OE, linked to S), visitor value proposition (VP, linked to P and Y), climate resilience and access (CR, linked to R and X), and institutional coordination (IC, the governance condition). Each raw indicator is rescaled to $[0,100]$ by min-max scaling and averaged within its pillar to give $x_p \in [0,100]$. The index is the geometric mean

$$\mathrm{LCDCI}_d = \left(\prod_{p=1}^{4} x_{pd}\right)^{1/4}, \tag{10}$$

which, unlike the arithmetic mean, is not fully compensatory: a very low score on one pillar cannot be offset by high scores on the others. The design reflects the view that a destination with strong operations but no institutional coordination cannot sustain a low-carbon strategy. Table 5 lists indicators. Section 5.7 illustrates the ranking effect. The index describes capability and does not replace the outcome measures DEE, CAVA, and absolute emissions.

4.4 Empirical Models for Future Testing

For an operator panel, unit cost and price outcomes can be modelled as

$$\ln c_{it} = \delta_0 + \delta_1 LCP_{it} + \delta_2 X_{it} + \mu_i + \lambda_t + \varepsilon_{it}, \tag{11}$$

$$\begin{aligned}\ln ADR_{it} = {} & \theta_0 + \theta_1 LABEL_{it} + \theta_2 \left(LABEL_{it} \times VER_{it}\right) \\ & + \theta_3 X_{it} + \mu_i + \lambda_t + \varepsilon_{it},\end{aligned} \tag{12}$$

where μ_i are property effects and λ_t are time effects. Equation (12) is a hedonic price model in the sense of Rosen (1974). Because adoption is not random, identification calls for event study designs around adoption dates that use estimators robust to staggered timing (Callaway and Sant'Anna, 2021; Sun and Abraham, 2021), as two way fixed effects estimates can be biased under heterogeneous timing (Goodman-Bacon, 2021), along with placebo outcomes. The coefficient δ_1 is expected to be negative for negative-MAC practices, and θ_1 is expected to be positive, with a larger θ_2 where verification is independent. Demand side valuation uses a discrete choice experiment (Louviere et al., 2000). The utility of option k is $U_k = \beta_p\, price_k + \beta' \mathbf{z}_k + \varepsilon_k$, where $\mathbf{z}_k$ are green attributes, and willingness to pay for attribute l is $-\beta_l/\beta_p$. Because stated premiums can overstate revealed behavior (Juvan and Dolnicar, 2014), experimental estimates are to be compared with the revealed premium from Equation (12). At destination level,

$$\begin{aligned}\ln \mathrm{DEE}_{dt} = {} & \phi_0 + \phi_1 MIX_{dt} + \phi_2 LCP_{dt} + \phi_3 IC_{dt} \\ & + \phi_4 X_{dt} + \mu_d + \lambda_t + \varepsilon_{dt},\end{aligned} \tag{13}$$

where MIX is the share of arrivals from markets with above-average eco-efficiency. The cost and benefit streams are brought together in a cost-benefit analysis (Boardman et al., 2018), with gross spending netted for displacement so that value added is not overstated (Crompton, 2006; Dwyer et al., 2004).

4.5 Moderation and Decoupling Tests

Institutional coordination is expected to strengthen the translation of practice into value,

$$\begin{aligned}\ln ADR_{it} = {} & \kappa_0 + \kappa_1 LABEL_{it} + \kappa_2 IC_{d(i)t} \\ & + \kappa_3 \left(LABEL_{it} \times IC_{d(i)t}\right) \\ & + \kappa_4 X_{it} + \mu_i + \lambda_t + \varepsilon_{it},\end{aligned} \tag{14}$$

and a positive κ_3 would indicate that practices are rewarded more where coordination is strong. Decoupling is tested by estimating the elasticity in Equation (8) for each destination and by checking whether Equation (9) is satisfied. Figure 4 shows the recommended research design.

Figure 4. Recommended 24 month research design.

4.6 Data for a Bangladesh Application

A study in Bangladesh could focus on coastal and nature-based destinations such as Cox's Bazar and the Sundarbans region, and on Sylhet's tea and hill areas. Candidate sources include hotel and resort accounts and utility records, the registration records of tourism authorities, visitor surveys with origin and spending, airline and road travel distance data to convert origin into travel emissions, and a purpose built survey of practice adoption and verification. Emission factors for the national electricity mix and captive generation should be applied consistently. Access, sampling, confidentiality, and consent conditions must be confirmed before fieldwork.

4.7 Validation Plan

The index and the identities should be validated before inference. For the LCDCI, content validity can be reviewed by experts, dimensionality tested with factor analysis, and rankings compared under arithmetic and geometric aggregation. For the property model, results should be reported under alternative discount rates, service lives, and carbon values. For the destination model, results should be reported under alternative boundaries for travel emissions, because inclusion of return travel and of origin-side emissions changes market eco-efficiency considerably.

5. Analysis and Results

5.1 Evidence Synthesis

Figure 5 classifies the strength of the pre 2022 evidence by value stream and by type of evidence. The classification is the authors' qualitative judgment and is not a pooled estimate. Three patterns emerge. First, the strongest bodies of evidence are conceptual or modelling studies, and they concern externality valuation and climate risk. Second, firm level evidence is moderate for operating costs and governance, and thin for premiums, where the evidence is mixed. Third, destination level evidence linking low-carbon practice to competitiveness outcomes is thin for premiums, resilience at the operator, and externalities. Stated preference evidence supports a premium in principle, and the attitude-behaviour gap shows why stated premiums cannot be assumed to be realized. Direct evidence that connects a package of low-carbon practices to destination level competitiveness is therefore limited, which is the gap the framework addresses.

5.2 Where Emissions Arise

Figure 2 uses the six hypothetical markets of Table 6. The baseline destination receives 850 thousand visits, creates US$404.2 million of value added, and generates 816.7 kilotonnes of carbon dioxide equivalent, so DEE is about US$495 per tonne. Travel to the destination accounts for 86.9% of emissions and accommodation for 7.2%, with

Table 4. Constructs, Indicators, and Candidate Data for Destination and Operator Research

Construct	Symbol	Example indicators	Unit	Candidate data source
Low-carbon practice intensity	LCP	Renewable share of energy; rooms under energy management; verified label status	Share or index	Operator survey; certification records
Unit operating cost	c	Energy, water, and waste cost per occupied room-night	USD per room-night	Utility bills; property accounts
Rate and occupancy	ADR, OCC	Average daily rate; occupancy; revenue per available room	USD; share	Booking records; STR-type data
Value added by market	y_m, L_m	Spending and stay length by source market	USD; nights	Visitor survey; national accounts
Emissions by market	e_m^T, e_m^S	Travel and on-site emissions per visit and per night	tCO_2e	Travel distances; utility data; emission factors
Verification credibility	VER	Third-party audit versus self-declared label	Indicator	Certification bodies
Institutional coordination	IC	Existence of destination carbon plan; data sharing; levy fund	Score (0–100)	Agency survey; documents
Controls	X	Property size, star class, location, energy prices, seasonality	Various	Survey; administrative data

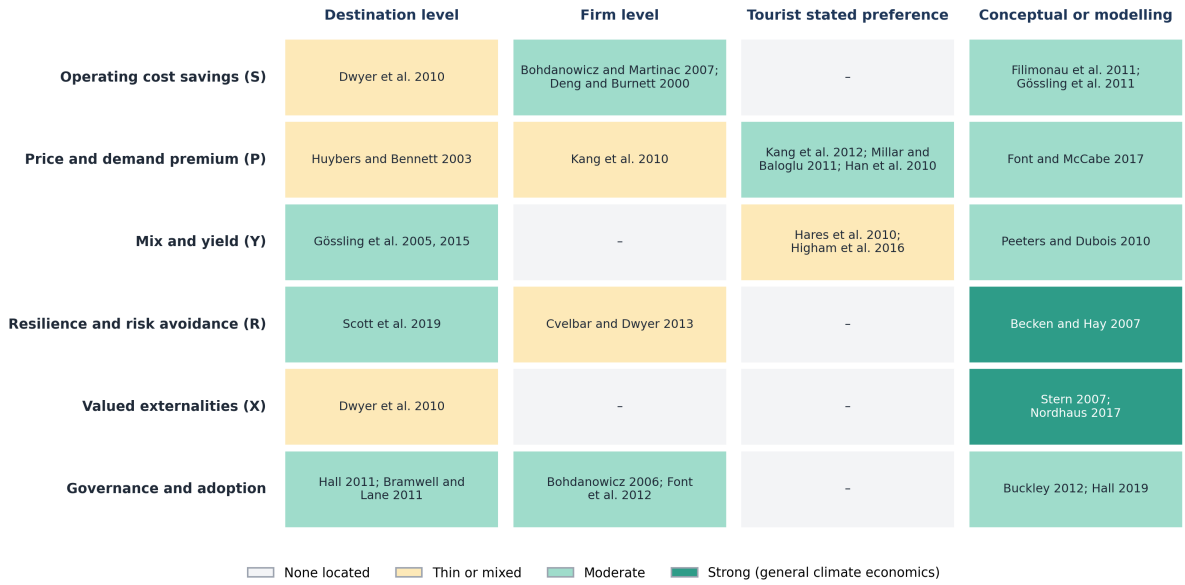

Figure 5. Strength of the evidence by value stream and by type of evidence.

Table 5. LCDCI Pillars and Example Indicators

Pillar	Example indicators	Scoring
OE: operational efficiency	Energy use per room-night; renewable share; waste diversion	Min–max
VP: visitor value proposition	Verified label coverage; value per tonne; low-carbon product range	Min–max
CR: climate resilience and access	Climate vulnerability; low-carbon transfer access; asset exposure	Min–max
IC: institutional coordination	Destination carbon plan; data sharing; levy fund; audit follow-through	Score (0–100)

food, local transport, and activities together about 5.9%. The illustration follows the empirical pattern that transport dominates tourism emissions (Lenzen et al., 2018; UNWTO, 2019; Becken et al., 2003) and carries an implication: if destination actors can influence only a small share of travel emissions, then operator level practices address a minority of the footprint, and the source market mix is the only lever that reaches the largest component.

5.3 Source Market Mix and Eco-Efficiency

Figure 3 and Table 6 show that markets differ greatly in value per tonne. In this illustration the domestic weekend market yields US$1,800 per tonne and the cruise excursion market only US$66 per tonne. Long-haul leisure visitors generate 35.3% of emissions but 29.7% of value added, and cruise excursionists generate 15.6% of emissions but only 2.1% of value added. The long-haul premium segment yields more per tonne (US$529) than the long-haul leisure segment (US$417), because spending per night is far higher while travel emissions are similar. At a carbon value of US$150 per tonne the cruise excursion segment has negative carbon-adjusted value added. These contrasts echo the finding that emission intensities per unit of revenue vary strongly by market (Gössling et al., 2015) and that eco-efficiency differs widely across segments (Gössling et al., 2005).

Consider a mix shift in which cruise excursions fall from 140 to 70 thousand, long-haul leisure from 80 to 60 thousand, long-haul premium rises from 20 to 35 thousand, regional short-haul from 180 to 220 thousand, and medium-haul from 110 to 120 thousand. Arrivals fall by 2.9% to 825 thousand, value added rises by 7.7% to US$435.3 million, emissions fall by 2.7% to 794.4 kilotonnes, and DEE rises from US$495 to US$548 per tonne, a gain of 10.7%. Because the market level values are held constant, all of the change in DEE in Equation (6) is the market mix effect. Emissions per visit rise slightly (by 0.2%), so the improvement comes entirely from higher value per visit (up 11.0%) and fewer visits, and not from lower emissions per visit. Strong decoupling is achieved by a value-over-volume strategy rather than by a technical one.

5.4 Property Level Economics: Abatement, Payback, and Break Even Premium

Table 7 lists eight practices for a hypothetical 100-room property with 62% occupancy and an average daily rate of US$120, so that $R_0 =$ US$2.72 million. The discount rate is 8%. Figure 6 ranks them by marginal abatement cost from Equation (2). Four practices (LED lighting and controls, guest-room HVAC energy management, rooftop solar, and food-waste reduction) have negative costs, between −US$173 and −US$83 per tonne, and abate 265 tonnes per year. The heat pump has a small positive cost of US$50 per tonne, and the electric kitchen conversion (US$223), envelope retrofit (US$300), and electric shuttle (US$738) are costlier. Figure 6 shows which practices are justified by an internal carbon price of US$50 per tonne or by an assumed high carbon value of US$150 per tonne, in the range of values debated in climate economics (Stern, 2007; Nordhaus, 2017).

Bundling changes the economics. The quick wins bundle (practices 1, 2, and 5) needs US$150 thousand of capital, abates 145 tonnes, and has a net annualized cost of −US$20 thousand, so its break even premium is −0.74% of room revenue and it pays without a premium. Adding rooftop solar (practice 4) gives a bundle that abates 265 tonnes with a break even premium of −1.11%. The full programme needs US$1.31 million of capital, abates 480 tonnes, and has a net annualized cost of US$31.6 thousand, so $\pi^* = 1.16\%$ with no carbon value.

Table 6. Hypothetical Source Markets: Value, Emissions, and Eco-Efficiency (CAVA at US$150 per tonne)

Market	Visits (k)	Nights	VA/night (USD)	e^T	e^S	VA/visit (USD)	tCO_2e/visit	USD/t	CAVA (USD/visit)
Domestic weekend	320	2	90	0.05	0.025	180	0.10	1,800	165
Regional short-haul	180	4	110	0.45	0.030	440	0.57	772	355
Medium-haul	110	6	130	1.30	0.035	780	1.51	517	554
Long-haul leisure	80	10	150	3.20	0.040	1,500	3.60	417	960
Long-haul premium	20	7	380	4.40	0.090	2,660	5.03	529	1,906
Cruise excursion	140	1	60	0.90	0.010	60	0.91	66	−77
Destination	850					475	0.96	495	

Table 7. Assumed Parameters of Eight Practices for One 100-Room Property and Resulting Marginal Abatement Cost

No.	Practice	K	M	S	A	T	MAC
1	LED lighting and controls	45,000	500	15,000	45	10	−173
2	Guest-room HVAC management	90,000	2,000	24,000	70	10	−123
3	Heat-pump hot water	120,000	3,000	14,000	60	15	50
4	Rooftop solar PV (200 kWp)	260,000	3,500	40,000	120	20	−83
5	Food waste, local sourcing	15,000	6,000	12,000	30	10	−125
6	Electric shuttle and e-bikes	180,000	8,000	9,000	35	10	738
7	Electric kitchen conversion	80,000	2,000	5,000	40	10	223
8	Envelope retrofit	520,000	1,000	30,000	80	20	300

K capital (USD); M extra operating cost and S operating saving (USD per year); A abatement (tCO_2e per year); T service life (years); MAC in USD per tCO_2e at 8% discount rate.

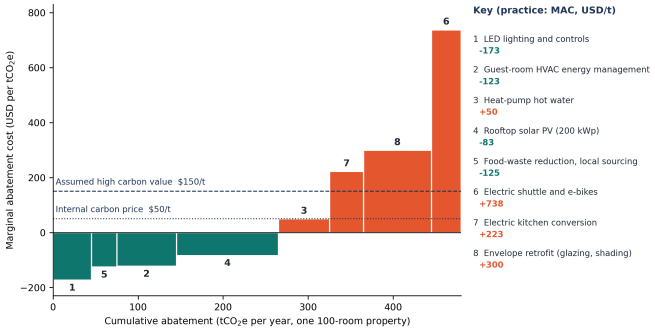

Figure 6. Marginal abatement cost curve for the eight hypothetical practices of Table 7.

Equation (3) shows that the full programme needs no premium once the carbon value reaches US$65.8 per tonne; at US$100 per tonne $\pi^* = -0.61\%$ and at US$150 per tonne $\pi^* = -1.49\%$ (Table 8 and Figure 8). The payback profile in Figure 7 tells the same story over time: the quick wins bundle reaches discounted payback in year 5 and the quick wins plus solar bundle in year 7, while the full programme does not pay back within 20 years on private savings alone (net present value of −US$330 thousand). With a 1.5% premium it reaches a net present value of US$70 thousand with payback in year 19, and with a premium plus a US$100 per tonne carbon value the net present value is US$541 thousand and the cumulative flow first turns positive in year 9.

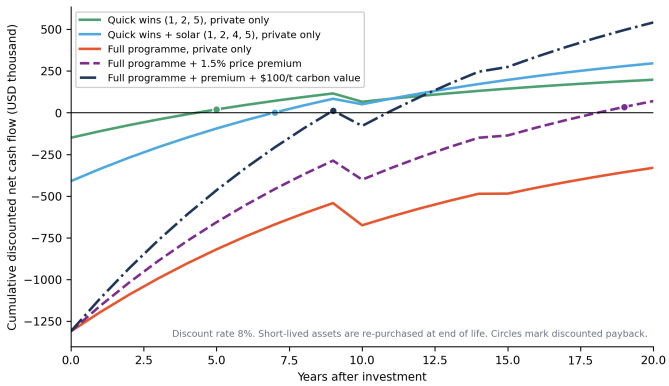

Figure 7. Cumulative discounted net cash flow of three bundles.

5.5 Is the Premium Large Enough? Willingness to Pay

Figure 9 compares the break even premium of the full programme with assumed distributions of willingness to pay in four segments. Climate-concerned leisure guests (assumed mean 9% of the room rate) almost all exceed the required 1.16%; mainstream leisure guests (mean 4%) and business guests under procurement rules (mean 3.5%) mostly do (86% and 85%); and budget guests (mean 1.5%) do so in 46% of cases. With assumed segment weights of 15%, 50%, 20%, and 15%, 82% of

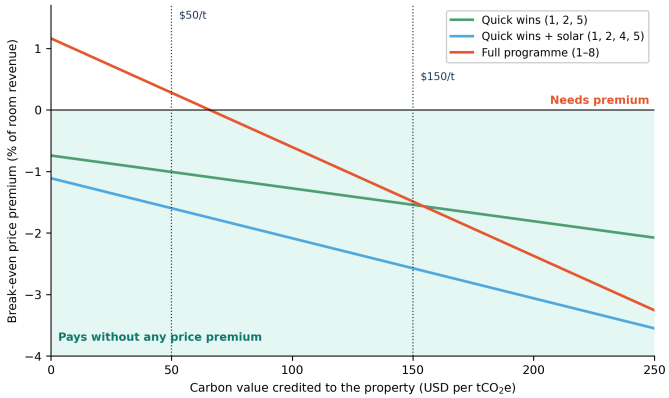

Figure 8. Break even price premium of three hypothetical bundles.

guests state a willingness to pay above the break even premium. This is not the same as capturing the premium: the attitude-behaviour gap (Juvan and Dolnicar, 2014), the disclosure-performance gap (Font et al., 2012), and competition from unlabeled rivals mean that the realized premium may be much lower than the stated one, so the revealed hedonic estimate of Equation (12) is needed.

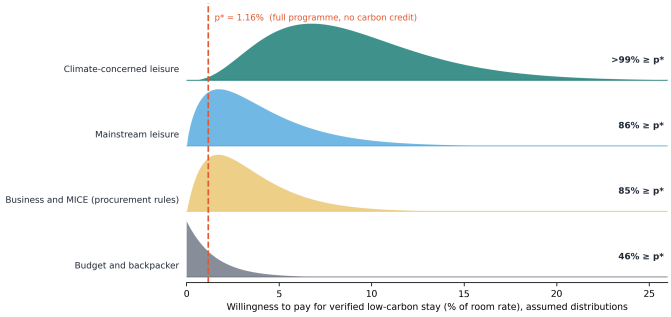

Figure 9. Distributions of willingness to pay for a verified low-carbon stay by guest segment.

5.6 Destination Scenarios: Efficiency Versus Value Over Volume

Figure 10 projects three strategies to 2037 from an index of 100 in 2022, using assumed annual rates. Under business as usual, arrivals grow by 4.5%, value per visit by 0.8%, and emissions per visit fall by 0.5%. Under an efficiency-only strategy, arrivals grow by 3.5%, value per visit by 1.5%, and emissions per visit fall by 3.0%. Under a value-over-volume strategy, arrivals grow by 1.5%, value per visit by 3.0%, and emissions per visit fall by 3.5%. By 2037, value added is 218, 209, and 195 for the three strategies, and emissions are 180 (band 154 to 209), 106 (band 91 to 124), and 73 (band 63 to 86). Eco-efficiency is 121, 197, and 266. The efficiency-only strategy cuts emissions per visit by 3% a year, yet total emissions are slightly higher in 2037 than in 2022, because arrivals growth of 3.5% a year exceeds the break even rate $g^* = 3.1\%$ given by Equation (9) with $\rho = 3\%$. Only the value-over-volume strategy delivers strong decoupling, with value rising by 95% while emissions fall by 27%. The bands show the effect of a one percentage point change in the annual rate of emissions reduction per visit.

5.7 Destination Capability: An LCDCI Illustration

Figure 11 shows three hypothetical destinations. The island resort destination A scores 90, 85, 70, and 20 on the pillars OE, VP, CR, and IC; the mountain destination B scores 62, 60, 64, and 60; and the historic city C scores 70, 55, 60, and 65. By arithmetic mean, A (66.3) ranks above C (62.5) and B (61.5). By geometric mean, C (62.2) ranks

Table 8. Hypothetical Bundle Results: Capital, Abatement, and Break Even Premium π^* (percent of room revenue) at Alternative Carbon Values

Bundle	Capital (USD k)	Abated (t/yr)	Net annual cost (USD)	$\pi^*, \tau = 0$	$\pi^*, \tau = 100$	$\pi^*, \tau = 150$	20-year NPV, private (USD k)
Quick wins (1, 2, 5)	150	145	−20,146	−0.74	−1.28	−1.54	+198
Quick wins + solar (1, 2, 4, 5)	410	265	−30,164	−1.11	−2.09	−2.57	+296
Full programme (1–8)	1,310	480	+31,566	+1.16	−0.61	−1.49	−330

Net present values are computed at 8% over 20 years with re-purchase of short-lived assets at the end of their life, and exclude any premium or carbon value.

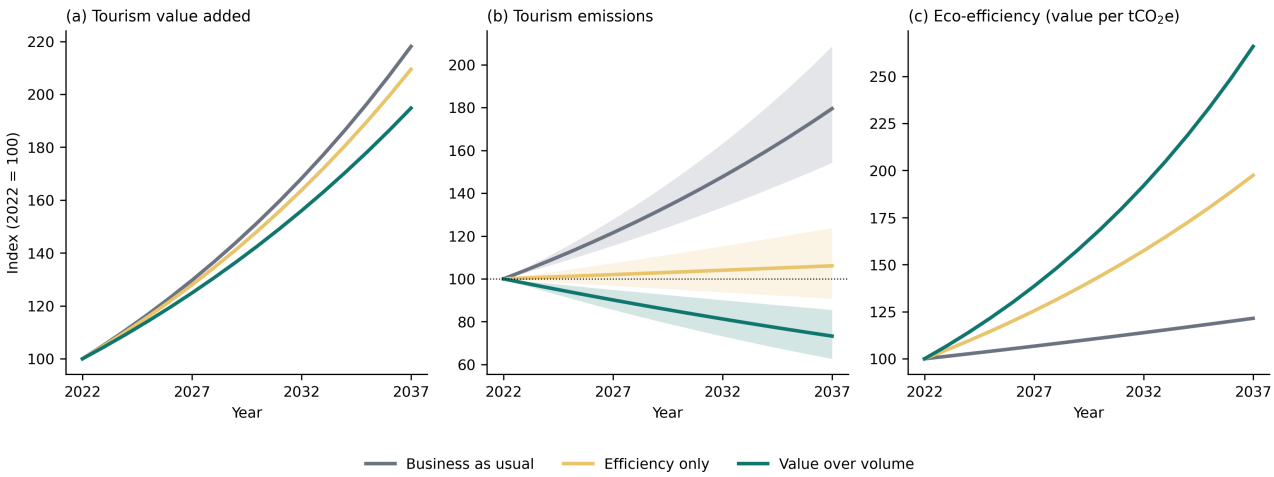

Figure 10. Illustrative paths to 2037 of (a) tourism value added, (b) tourism emissions with a band for plus or minus one percentage point in the annual cut in emissions per visit, and (c) eco-efficiency, under three strategies with assumed growth rates.

first, B (61.5) second, and A (57.2) last, because the weak coordination pillar of A is not compensated by strong operations. The reversal illustrates why the aggregation rule should be reported and why a destination with weak institutional coordination may struggle to turn operator level gains into competitiveness.

5.8 Who Captures the Value?

Figure 12 illustrates how different governance arrangements may distribute the net value created by a low-carbon programme. Under voluntary labels, operators are assumed to capture 46% of the value, and the public and climate shares are small. Under mandatory standards with a levy, the operator share falls to 30% and the public revenue share rises to 14%. Where a levy is reinvested in a destination carbon fund, operators capture 26%, and local suppliers and employees together capture 36%. The numbers are assumptions, but they show a trade-off: arrangements that return more value to communities reduce the operator share, so participation requires that the absolute operator return stays positive.

5.9 Research Hypotheses

The synthesis supports six hypotheses. Table 9 states each with its test and expected sign.

6. Discussion

The answer to the research question depends on the practice, the bundle, and the market. Some practices are profitable on their own, and those should be adopted first because they reduce cost while building the verified record that supports a premium. Others are not profitable unless supported by a premium or a carbon value, and the break even premium in Equation (3) tells the decision maker how large that support must be. In the illustration the most expensive practices have a marginal abatement cost far above the social cost of carbon, and it is rational to defer them or to subsidize them through a destination fund rather than ask a single operator to carry them.

The main strategic finding concerns scale. Operator practices touch a small part of the footprint, and travel to the destination dominates. The marginal abatement view and the eco-efficiency view therefore point to different levers: the first guides the operator, and the second guides the destination agency. A destination that wants lower emissions and higher income can seek visitors who stay longer and spend more per tonne (Gössling et al., 2015), and it can do so without technological change. At the same time the growth condition of Equation (9) warns against relying on efficiency alone. Growth that is not paired with a market strategy can overwhelm the gain, in the same way that induced demand offsets part of an efficiency saving (Gillingham et al., 2016), a pattern that matches the long-run analysis of Gössling and Peeters (2015) and the doubts about growth oriented management raised by Hall (2019).

The framework also qualifies the view that environmental performance always pays (Porter and van der Linde, 1995; Palmer et al., 1995). Whether it pays depends on which practice, which stream, and whose accounts are used. A positive net economic value from Equation (1) can exist even when the private value is negative, and in that case the case for public support rests on externalities and resilience (Stern, 2007; Scott et al., 2019). Output growth is also not a pure cost: tourism supports income and employment (Balaguer and Cantavella-Jordá, 2002), so decarbonization strategies must be judged by their effect on the economic value that destinations depend on.

6.1 Managerial Implications

Operators should rank practices by marginal abatement cost, start with those that pay for themselves, and bundle costlier practices with verification so that a premium can be claimed. They should report the break even premium for each bundle and compare it with revealed prices rather than with stated willingness to pay. Destination agencies should measure eco-efficiency by source market, include travel emissions in the boundary, and target markets with high value per tonne. Lenders and insurers can use the carbon-adjusted value and the resilience stream to price risk. Table 10 links actions to value streams and indicators.

6.2 Policy Implications

Public agencies can support adoption by funding verification so that labels are credible, by designing levies that are reinvested in local abatement and community benefit, by publishing market level data on spending and emissions, and by treating arrivals growth as a variable to be managed against the growth condition. Programs that subsidize digital or marketing activity to raise arrivals should be evaluated with emissions indicators as well as visitor numbers. In destinations that are highly exposed to climate risk (Scott et al., 2019), resilience investments may be justified on risk grounds even where private returns are low.

6.3 Implications for Bangladesh and Emerging Economies

Emerging destinations often combine growing arrivals, a carbon intensive grid or captive generation, and limited verification infrastructure. These features raise the value of operational measures and make the

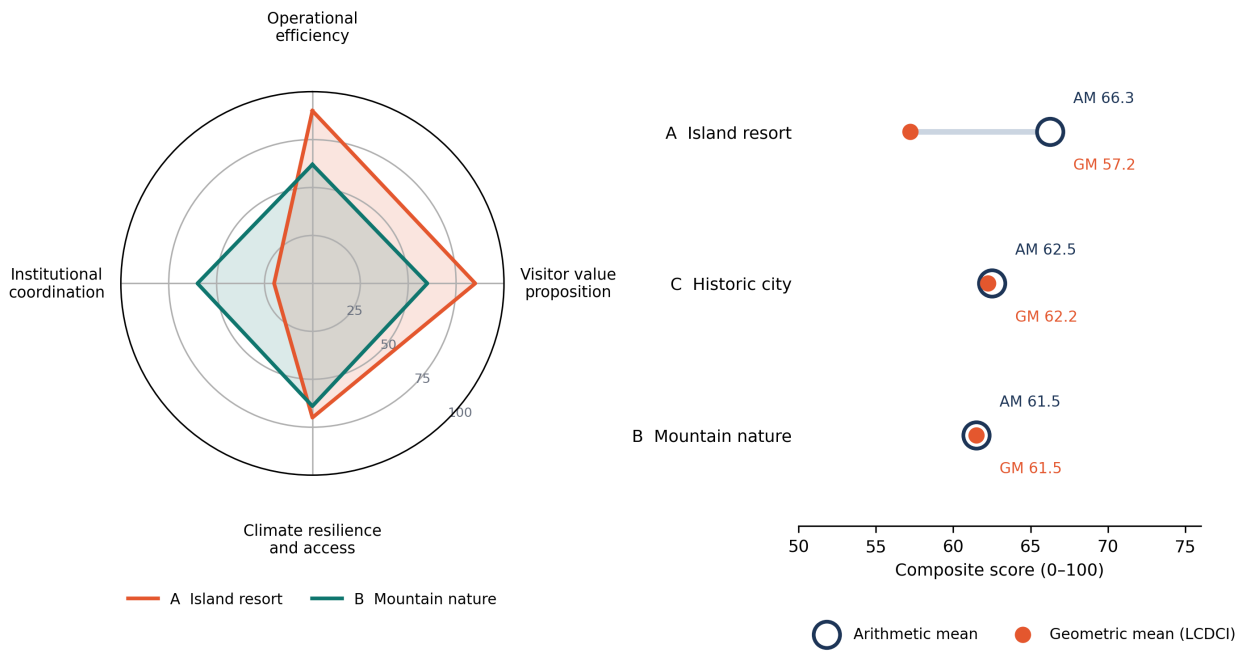

Figure 11. Pillar profiles of two hypothetical destinations (left) and composite scores of three destinations under arithmetic and geometric aggregation (right).

Table 9. Research Hypotheses and Their Empirical Tests

No.	Hypothesis	Test	Expected sign	Key data
H1	Practices with negative marginal abatement cost lower unit operating cost per occupied room-night	Eq. (11): δ_1	$-$	Utility bills; room-nights
H2	Verified low-carbon practice earns a rate premium that is larger when verification is independent	Eq. (12): θ_1, θ_2	$+$	Rate and occupancy panel
H3	Destination eco-efficiency rises when arrivals shift toward markets with higher value per tonne	Eq. (13): ϕ_1; Eq. (6)	$+$	Market arrivals, spending, emissions
H4	Absolute emissions fall only when arrivals growth is below g^*; efficiency alone does not secure decoupling	Eq. (9); elasticity η	Sign of η varies	Arrivals, emissions per visit
H5	Institutional coordination strengthens the translation of practice into price and cost outcomes	Eq. (14): κ_3	$+$	Agency survey; rate panel
H6	Governance arrangements that reinvest levies broaden local value capture without making the operator return negative	Value incidence accounts	Local share $+$	Accounts; surveys

Table 10. Implications for Actors: Actions, Value Streams Targeted, and Monitoring Indicators

Actor	Recommended action	Stream targeted	Indicator to monitor
Hotels and operators	Rank practices by MAC; adopt negative-MAC measures; bundle costly ones with verification	S, P	MAC; break even premium; realized rate premium
Destination management agencies	Measure eco-efficiency by market; target high value-per-tonne markets	Y	DEE by market; CAVA
Certification bodies	Use independent audits and publish performance, not only commitments	P	Share of independently verified properties
Lenders and insurers	Price resilience and carbon value into loan and insurance terms	R, X	Expected loss avoided; carbon value used
Governments and regulators	Fund verification; design levies reinvested locally; publish market data	P, X	Levy reinvestment share; data availability
Researchers	Report revealed and stated premiums, MAC, DEE, and decoupling elasticity together	All	π^*; η; LCDCI sensitivity

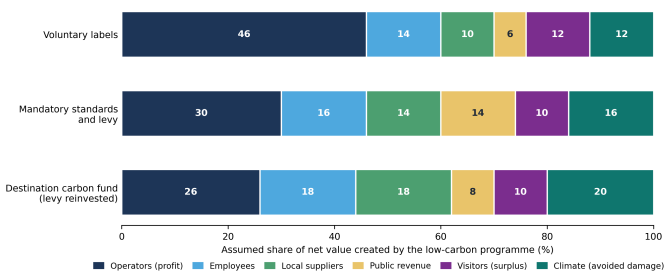

Figure 12. Distribution of the net value of a low-carbon programme.

growth condition especially relevant. A Bangladesh study could examine whether coastal and nature-based destinations can raise value per visit through longer stays and local sourcing before expanding volume, and whether domestic and regional markets, which in the illustration have the highest value per tonne, offer a strategy that fits the existing market. The conclusions should be tested with plant and visitor data rather than assumed from international studies.

7. Limitations and Future Research

The study has several limitations. First, it is a structured evidence synthesis and not a systematic review with a registered protocol. Second, direct evidence that links a package of low-carbon practices to destination competitiveness is thin, so the framework draws on adjacent literatures on hospitality economics, green demand, eco-efficiency, and climate economics. Third, the evidence is mainly from developed economies and from the accommodation sector, and may not apply to other settings or to transport and attractions. Fourth, the numerical illustrations use assumed parameters, and they show the logic of the framework and not estimates. Fifth, stated willingness to pay is not realized premium. Sixth, the strength classification in Figure 5 is a qualitative judgment that does not weight studies by quality or sample size. Table 11 pairs each limitation with a response.

The proposed LCDCI is a measurement framework and not a validated scale. Future work should validate it with factor analysis and observed data, test alternative aggregation rules, and examine how the MAC ranking changes with energy prices and grid carbon intensity. Priority questions include how large the realized premium is relative to

Table 11. Limitations and Proposed Responses

Limitation	Proposed response
No new causal estimate	Test H1–H6 with operator panels, event studies, and choice experiments
Thin destination level evidence	Build destination emissions and value accounts by source market
Mainly accommodation evidence	Extend to transport, food, and attractions
Assumed numbers	Replace with estimated costs, savings, shares, and elasticities
Stated versus revealed premium	Compare hedonic and choice experiment estimates
Qualitative evidence grading	Add a registered systematic review with quality weights

the break even premium in different markets, how long it persists as labels spread, whether market mix shifts can be achieved without loss of value, how much of tourism's footprint can be influenced by destination actors, and how value capture affects the support of local communities.

8. Conclusion

This study examines the economic value of low-carbon tourism practices and the conditions under which they strengthen destination competitiveness. The evidence available before 2022 indicates that low-carbon practice is neither a free lunch nor a pure cost. Some operating practices reduce costs, guests often state a willingness to pay for green attributes, source market mix strongly affects value per tonne of emissions, and climate risk and externalities provide further value that private accounts do not record. At the same time, travel to the destination dominates emissions, stated premiums are not realized premiums, and direct evidence on destination level competitiveness is limited. The conclusion is therefore conditional.

The framework gives a simple set of decision rules. At the operator, rank practices by marginal abatement cost, adopt those that pay for themselves, and compare the break even premium of costlier bundles with the premium that guests actually pay. At the destination, measure eco-efficiency by source market and count travel emissions. For decoupling, check that arrivals growth stays below

$$g^* = \frac{\rho}{1-\rho}, \tag{15}$$

where ρ is the proportional cut in emissions per visit. In the illustrations, an efficiency-only strategy that cut emissions per visit by 3% a year could not offset arrivals growth of 3.5% a year, whereas a value-over-volume strategy raised value by 95% while emissions fell by 27%.

The consequences may differ across destinations. Destinations with credible verification, institutional coordination, and low-carbon energy supply may convert practice into competitive advantage more readily, and destinations with a weak pillar may find that strong operations are not enough. The findings also have implications for operators, destination agencies, certifiers, lenders, and policy makers: they can fund verification, align levies with local benefit, and judge programs by absolute emissions and value per tonne as well as visitor numbers.

Future research should test the hypotheses with operator panels, choice experiments, and destination accounts, and should replace the assumed numbers in this paper with estimates. Overall, the central question is not whether low-carbon tourism is inherently profitable, but under what bundles, verification, market, and governance conditions its value outweighs its cost, and when growth in arrivals erodes it. The framework provides a basis for answering that question.

Data Availability

No new primary dataset was collected for this evidence synthesis. All numerical illustrations use assumed parameters. The code used to produce the figures and numerical examples (`make_figures.py`) is provided with the manuscript files.

References

Ang, B. W. (2005). The LMDI approach to decomposition analysis: a practical guide. *Energy Policy*, 33(7), 867–871. https://doi.org/10.1016/j.enpol.2003.10.010

Ang, B. W., and Liu, F. L. (2001). A new energy decomposition method: perfect in decomposition and consistent in aggregation. *Energy*, 26(6), 537–548. https://doi.org/10.1016/S0360-5442(01)00022-6

Balaguer, J., and Cantavella-Jordá, M. (2002). Tourism as a long-run economic growth factor: the Spanish case. *Applied Economics*, 34(7), 877–884. https://doi.org/10.1080/00036840110058923

Becken, S., Simmons, D. G., and Frampton, C. (2003). Energy use associated with different travel choices. *Tourism Management*, 24(3), 267–277. https://doi.org/10.1016/S0261-5177(02)00066-3

Becken, S., and Hay, J. E. (2007). *Tourism and Climate Change: Risks and Opportunities*. Channel View Publications, Clevedon.

Boardman, A. E., Greenberg, D. H., Vining, A. R., and Weimer, D. L. (2018). *Cost-Benefit Analysis: Concepts and Practice* (5th ed.). Cambridge University Press.

Jahan, I., Nahid, M. A. H., and Samrat, R. I. (2021). Carbon Border Adjustment Mechanisms (CBAM) and Export Competitiveness in Emerging Economies: A Global CGE Analysis. *Eco-Business and Environmental Progress Journal*, 1(1).

Ahmed, A., Khan, H. H., and Mazumder, M. (2021). ICT for Sustainable Development: Assessing the Carbon Footprint of National Communication Networks. *Digital Transformation and Technology Dynamics*, 1(2).

Bohdanowicz, P. (2006). Environmental awareness and initiatives in the Swedish and Polish hotel industries—survey results. *International Journal of Hospitality Management*, 25(4), 662–682. https://doi.org/10.1016/j.ijhm.2005.06.006

Bohdanowicz, P., and Martinac, I. (2007). Determinants and benchmarking of resource consumption in hotels—Case study of Hilton International and Scandic in Europe. *Energy and Buildings*, 39(1), 82–95. https://doi.org/10.1016/j.enbuild.2006.05.005

Bramwell, B., and Lane, B. (2011). Critical research on the governance of tourism and sustainability. *Journal of Sustainable Tourism*, 19(4–5), 411–421. https://doi.org/10.1080/09669582.2011.580586

Buckley, R. (2012). Sustainable tourism: Research and reality. *Annals of Tourism Research*, 39(2), 528–546. https://doi.org/10.1016/j.annals.2012.02.003

Butler, R. W. (1980). The concept of a tourist area cycle of evolution: implications for management of resources. *Canadian Geographer*, 24(1), 5–12.

Callaway, B., and Sant'Anna, P. H. C. (2021). Difference-in-differences with multiple time periods. *Journal of Econometrics*, 225(2), 200–230. https://doi.org/10.1016/j.jeconom.2020.12.001

Croes, R. (2011). Measuring and explaining competitiveness in the context of small island destinations. *Journal of Travel Research*, 50(4), 431–442. https://doi.org/10.1177/0047287510368139

Crompton, J. L. (2006). Economic impact studies: instruments for political shenanigans? *Journal of Travel Research*, 45(1), 67–82.

Crouch, G. I. (2011). Destination competitiveness: an analysis of determinant attributes. *Journal of Travel Research*, 50(1), 27–45. https://doi.org/10.1177/0047287510362776

Cvelbar, L. K., and Dwyer, L. (2013). An importance–performance analysis of sustainability factors for long-term strategy planning in Slovenian hotels. *Journal of Sustainable Tourism*, 21(3), 487–504. https://doi.org/10.1080/09669582.2012.713965

Deng, S.-M., and Burnett, J. (2000). A study of energy performance of hotel buildings in Hong Kong. *Energy and Buildings*, 31(1), 7–12. https://doi.org/10.1016/S0378-7788(99)00045-0

Dwyer, L., and Kim, C. (2003). Destination competitiveness: determinants and indicators. *Current Issues in Tourism*, 6(5), 369–414.

Dwyer, L., Forsyth, P., and Spurr, R. (2004). Evaluating tourism's economic effects: new and old approaches. *Tourism Management*, 25(3), 307–317. https://doi.org/10.1016/S0261-5177(03)00131-6

Dwyer, L., Forsyth, P., Spurr, R., and Hoque, S. (2010). Estimating the carbon footprint of Australian tourism. *Journal of Sustainable Tourism*, 18(3), 355–376. https://doi.org/10.1080/09669580903513061

Enright, M. J., and Newton, J. (2004). Tourism destination competitiveness: a quantitative approach. *Tourism Management*, 25(6), 777–788. https://doi.org/10.1016/j.tourman.2003.06.008

Filimonau, V., Dickinson, J., Robbins, D., and Huijbregts, M. A. J. (2011). Reviewing the carbon footprint analysis of hotels: Life Cycle Energy Analysis (LCEA) as a holistic method for carbon impact appraisal of tourist accommodation. *Journal of Cleaner Production*, 19(17–18), 1917–1930. https://doi.org/10.1016/j.jclepro.2011.07.002

Font, X., Walmsley, A., Cogotti, S., McCombes, L., and Häusler, N. (2012). Corporate social responsibility: The disclosure–performance gap. *Tourism Management*, 33(6), 1544–1553. https://doi.org/10.1016/j.tourman.2012.02.012

Font, X., and McCabe, S. (2017). Sustainability and marketing in tourism: its contexts, paradoxes, approaches, challenges and potential. *Journal of Sustainable Tourism*, 25(7), 869–883. https://doi.org/10.1080/09669582.2017.1301721

Gillingham, K., Rapson, D., and Wagner, G. (2016). The rebound effect and energy efficiency policy. *Review of Environmental Economics and Policy*, 10(1),

68–88. https://doi.org/10.1093/reep/rev017

Goodman-Bacon, A. (2021). Difference-in-differences with variation in treatment timing. *Journal of Econometrics*, 225(2), 254–277. https://doi.org/10.1016/j.jeconom.2021.03.014

Gössling, S. (2002). Global environmental consequences of tourism. *Global Environmental Change*, 12(4), 283–302. https://doi.org/10.1016/S0959-3780(02)00044-4

Gössling, S., Peeters, P., Ceron, J.-P., Dubois, G., Patterson, T., and Richardson, R. B. (2005). The eco-efficiency of tourism. *Ecological Economics*, 54(4), 417–434. https://doi.org/10.1016/j.ecolecon.2004.10.006

Gössling, S., Garrod, B., Aall, C., Hille, J., and Peeters, P. (2011). Food management in tourism: Reducing tourism's carbon 'foodprint'. *Tourism Management*, 32(3), 534–543. https://doi.org/10.1016/j.tourman.2010.04.006

Gössling, S., Hall, C. M., Ekström, F., Brudvik Engeset, A., and Aall, C. (2012). Transition management: a tool for implementing sustainable tourism scenarios? *Journal of Sustainable Tourism*, 20(6), 899–916. https://doi.org/10.1080/09669582.2012.699061

Gössling, S., Scott, D., and Hall, C. M. (2015). Inter-market variability in CO_2 emission-intensities in tourism: Implications for destination marketing and carbon management. *Tourism Management*, 46, 203–212. https://doi.org/10.1016/j.tourman.2014.06.021

Gössling, S., and Peeters, P. (2015). Assessing tourism's global environmental impact 1900–2050. *Journal of Sustainable Tourism*, 23(5), 639–659. https://doi.org/10.1080/09669582.2015.1008500

Gössling, S., and Scott, D. (2018). The decarbonisation impasse: global tourism leaders' views on climate change mitigation. *Journal of Sustainable Tourism*, 26(12), 2071–2086. https://doi.org/10.1080/09669582.2018.1529770

Hall, C. M. (2011). Policy learning and policy failure in sustainable tourism governance: from first- and second-order to third-order change? *Journal of Sustainable Tourism*, 19(4–5), 649–671. https://doi.org/10.1080/09669582.2011.555555

Hall, C. M. (2019). Constructing sustainable tourism development: The 2030 agenda and the managerial ecology of sustainable tourism. *Journal of Sustainable Tourism*, 27(7), 1044–1060. https://doi.org/10.1080/09669582.2018.1560456

Hall, C. M., and Williams, A. M. (2008). *Tourism and Innovation*. Routledge, London.

Han, H., Hsu, L.-T., and Sheu, C. (2010). Application of the theory of planned behavior to green hotel choice: Testing the effect of environmental friendly activities. *Tourism Management*, 31(3), 325–334. https://doi.org/10.1016/j.tourman.2009.03.013

Hares, A., Dickinson, J., and Wilkes, K. (2010). Climate change and the air travel decisions of UK tourists. *Journal of Transport Geography*, 18(3), 466–473. https://doi.org/10.1016/j.jtrangeo.2009.06.018

Hassan, S. S. (2000). Determinants of market competitiveness in an environmentally sustainable tourism industry. *Journal of Travel Research*, 38(3), 239–245. https://doi.org/10.1177/004728750003800305

Higham, J., Cohen, S. A., Cavaliere, C. T., Reis, A., and Finkler, W. (2016). Climate change, tourist air travel and radical emissions reduction. *Journal of Cleaner Production*, 111, 336–347. https://doi.org/10.1016/j.jclepro.2014.10.100

Hjalager, A.-M. (2010). A review of innovation research in tourism. *Tourism Management*, 31(1), 1–12. https://doi.org/10.1016/j.tourman.2009.08.012

Huybers, T., and Bennett, J. (2003). Environmental management and the competitiveness of nature-based tourism destinations. *Environmental and Resource Economics*, 24(3), 213–233. https://doi.org/10.1023/A:1022593019332

Juvan, E., and Dolnicar, S. (2014). The attitude–behaviour gap in sustainable tourism. *Annals of Tourism Research*, 48, 76–95. https://doi.org/10.1016/j.annals.2014.05.012

Kang, K. H., Lee, S., and Huh, C. (2010). Impacts of positive and negative corporate social responsibility activities on company performance in the hospitality industry. *International Journal of Hospitality Management*, 29(1), 72–82. https://doi.org/10.1016/j.ijhm.2009.05.006

Kang, K. H., Stein, L., Heo, C. Y., and Lee, S. (2012). Consumers' willingness to pay for green initiatives of the hotel industry. *International Journal of Hospitality Management*, 31(2), 564–572. https://doi.org/10.1016/j.ijhm.2011.08.001

Kesicki, F., and Strachan, N. (2011). Marginal abatement cost (MAC) curves: confronting theory and practice. *Environmental Science & Policy*, 14(8), 1195–1204. https://doi.org/10.1016/j.envsci.2011.08.004

Lenzen, M., Sun, Y.-Y., Faturay, F., Ting, Y.-P., Geschke, A., and Malik, A. (2018). The carbon footprint of global tourism. *Nature Climate Change*, 8, 522–528. https://doi.org/10.1038/s41558-018-0141-x

Louviere, J. J., Hensher, D. A., and Swait, J. D. (2000). *Stated Choice Methods: Analysis and Applications*. Cambridge University Press.

Manaktola, K., and Jauhari, V. (2007). Exploring consumer attitude and behaviour towards green practices in the lodging industry in India. *International Journal of Contemporary Hospitality Management*, 19(5), 364–377. https://doi.org/10.1108/09596110710757582

Mihalič, T. (2000). Environmental management of a tourist destination: A factor of tourism competitiveness. *Tourism Management*, 21(1), 65–78. https://doi.org/10.1016/S0261-5177(99)00096-5

Mihalič, T. (2016). Sustainable-responsible tourism discourse—Towards 'responsustable' tourism. *Journal of Cleaner Production*, 111, 461–470. https://doi.org/10.1016/j.jclepro.2014.12.062

Millar, M., and Baloglu, S. (2011). Hotel guests' preferences for green guest room attributes. *Cornell Hospitality Quarterly*, 52(3), 302–311. https://doi.org/10.1177/1938965511409031

Nordhaus, W. D. (2017). Revisiting the social cost of carbon. *Proceedings of the National Academy of Sciences*, 114(7), 1518–1523. https://doi.org/10.1073/pnas.1609244114

Palmer, K., Oates, W. E., and Portney, P. R. (1995). Tightening environmental standards: The benefit-cost or the no-cost paradigm? *Journal of Economic Perspectives*, 9(4), 119–132. https://doi.org/10.1257/jep.9.4.119

Peeters, P., and Dubois, G. (2010). Tourism travel under climate change mitigation constraints. *Journal of Transport Geography*, 18(3), 447–457. https://doi.org/10.1016/j.jtrangeo.2009.09.003

Porter, M. E., and van der Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. *Journal of Economic Perspectives*, 9(4), 97–118. https://doi.org/10.1257/jep.9.4.97

Priyadarsini, R., Xuchao, W., and Eang, L. S. (2009). A study on energy performance of hotel buildings in Singapore. *Energy and Buildings*, 41(12), 1319–1324. https://doi.org/10.1016/j.enbuild.2009.07.028

Ritchie, J. R. B., and Crouch, G. I. (2003). *The Competitive Destination: A Sustainable Tourism Perspective*. CABI Publishing, Wallingford.

Rosen, S. (1974). Hedonic prices and implicit markets: product differentiation in pure competition. *Journal of Political Economy*, 82(1), 34–55. https://doi.org/10.1086/260169

Scott, D., Hall, C. M., and Gössling, S. (2019). Global tourism vulnerability to climate change. *Annals of Tourism Research*, 77, 49–61. https://doi.org/10.1016/j.annals.2019.05.007

Stern, N. (2007). *The Economics of Climate Change: The Stern Review*. Cambridge University Press.

Sun, L., and Abraham, S. (2021). Estimating dynamic treatment effects in event studies with heterogeneous treatment effects. *Journal of Econometrics*, 225(2), 175–199. https://doi.org/10.1016/j.jeconom.2020.09.006

Tapio, P. (2005). Towards a theory of decoupling: degrees of decoupling in the EU and the case of road traffic in Finland between 1970 and 2001. *Transport Policy*, 12(2), 137–151. https://doi.org/10.1016/j.tranpol.2005.01.001

United Nations World Tourism Organization (2019). *Transport-related CO_2 Emissions of the Tourism Sector—Modelling Results*. UNWTO, Madrid.