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From Fragmented Environmental Labels to Integrated Logics and Operational Structures in Community Development

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Abstract

The proliferation of environmental-community labels has expanded the vocabulary of urban environmental discourse while obscuring a more consequential question: do these labels represent distinct environmental models, or differentiated configurations within a shared operational field? This study examines that question and considers whether such a structure can support environmental decision-making beyond predefined label selection. Using a bounded comparative conceptual synthesis of 177 documents, 33 Qualified Approach Scopes were organized into 14 Analytical Approach Groups, examined through 7 Core Operational Components, and related to 4 Environmental Logic Families defined by environmental success criteria. The results reveal differentiated configurations within a shared operational field: approaches recurrently mobilize common operational domains, but neither label identity nor component presence determines a single environmental purpose or achieved outcome. Cross-linked component–purpose relationships further show that the same operational mechanism can serve different environmental ends depending on the mechanism, boundary, and criterion of success. The resulting Integrated Translation Architecture supports purpose-led environmental decision-making by allowing environmental purpose to define the decision entry point before relevant mechanisms and approach configurations are identified. The framework provides analytical traceability rather than ranking, causal validation, or city-specific optimization.

Keywords: environmental-community labels; community-scale environmental planning; purpose-led environmental decision-making; core operational components; Environmental Logic Families; Integrated Translation Architecture



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1. Introduction

Environmental challenges at the community and district scales rarely occur in isolation. Energy demand, greenhouse-gas emissions, water stress, material consumption, ecological degradation, and exposure to climatic disturbance interact within the same urban settings, while requiring different mechanisms, institutional arrangements, and criteria of success. In response, urban environmental planning and development practice has generated an expanding range of environmental-community approaches, including sustainable, low-carbon, resilient, circular, water-sensitive, positive-energy, regenerative, and nature-positive models. These approaches have helped translate broad environmental ambitions into planning strategies, institutional programmes, technical interventions, and

evaluation systems [1–4]. Their proliferation, however, has also made the relationship between environmental need, named approach, operational mechanism, and expected outcome increasingly difficult to interpret.

The problem is therefore more than terminological. Environmental-community labels can influence how problems are framed, which interventions receive priority, how performance is evaluated, and what is accepted as environmental success. Differently named approaches frequently share operational content, while related approaches can differ substantially in system boundaries, priorities, implementation mechanisms, and evaluation criteria [2,5,6]. Neither the label itself nor the presence of a familiar technology, indicator, or institutional designation is therefore sufficient to establish what environmental purpose is being pursued or whether that purpose has been achieved.

Existing scholarship has examined individual environmental approaches, neighbourhood assessment systems, resilience, circularity, regenerative development, and sustainability transitions in considerable depth [7–11]. Comparative studies have also documented substantial conceptual overlap among sustainable, smart, resilient, low-carbon, and related urban models [2]. More recent work has expanded attention to implementation processes, stakeholder participation, institutional capacity, context-sensitive assessment, biodiversity, and the conditions through which environmental interventions are sustained in practice [12–15]. Nevertheless, named approaches remain the dominant units through which much of this diversity is described and compared. This can conflate four questions that are analytically distinct: what an approach is, how it operates, what environmental purpose its mechanisms serve, and what evidence supports the claimed result.

This conflation also creates a practical decision problem. Where a common analytical structure is absent, environmental-community approaches may be selected, combined, or transferred before there is a transparent basis for determining whether their operational content corresponds to the environmental problem being addressed. Decision-making can therefore begin with whether a community should become sustainable, low-carbon, resilient, circular, or regenerative before more fundamental questions have been resolved: What environmental condition needs to change? What form of environmental success is sought? Which mechanisms are required to pursue it? The practical challenge is consequently to liberate environmental decision-making from dependence on the label, so that environmental purpose can precede nominal model selection rather than being inferred from it.

Addressing this challenge requires separating approach identity, operational configuration, and environmental purpose without erasing the relationships among them. The study therefore constructs an Integrated Translation Architecture linking Qualified Approach Scopes, Analytical Approach Groups, Core Operational Components, and Environmental Logic Families. These levels answer different analytical questions and are treated as related but non-equivalent.

The central research question is

Do proliferating environmental-community approaches represent distinct environmental models, or can they be understood as differentiated configurations within a shared operational field; and, if so, how can this structure support environmental decision-making beyond predefined label selection?

To answer this question, the study traces the comparative field through 33 Qualified Approach Scopes, 14 Analytical Approach Groups, 7 Core Operational Components, and 4 Environmental Logic Families. The forward analysis proceeds from approaches toward environmental purposes, establishing how approach identity, operational configuration, and environmental purpose relate. Once these relationships are established, the architecture

can also be read in reverse for decision interpretation, from an intended environmental purpose toward the relevant components and approach configurations.

The novelty of this study lies not in adding another taxonomy to an already crowded field, but in changing the unit and sequence of comparison. Building on research documenting overlap among urban environmental concepts [2,16], differences in smart and sustainable assessment content [5], and distinctions among indicator domains and assessment stages [6], the study separates approach identity from operational configuration, operational configuration from environmental purpose, and environmental purpose from evidence of performance, before reconnecting these levels through the Integrated Translation Architecture. This allows approaches to be compared without assuming either that each label constitutes an autonomous and internally complete environmental model or that meaningful differences can be collapsed into a single generic environmental category. It also makes explicit that operational components do not carry fixed environmental meanings: the same component may serve different environmental purposes depending on the mechanism, system boundary, and criterion of success.

The study consequently makes four related contributions. First, it provides a reproducible structure for organizing fragmented environmental-community terminology while preserving meaningful differences among approaches. Second, it establishes the Core Operational Components as a translation layer through which differently named approaches can be compared at the level of operational mechanisms and enabling capacities. Third, it distinguishes these mechanisms from four Environmental Logic Families defined by environmental purpose and criteria of success. Fourth, it shows how the resulting structure can support a shift from label-led selection toward purpose-led environmental decision-making. A bounded worked interpretation demonstrates the analytical traceability of this structure while preserving evidential limits. Together, these contributions explain how environmental-community approaches can share recurrent operational structures while retaining meaningful conceptual, institutional, and environmental differentiation, and show how this understanding can inform purpose-led environmental decision-making. Figure 1 summarizes the study's research framework and analytical pathway.

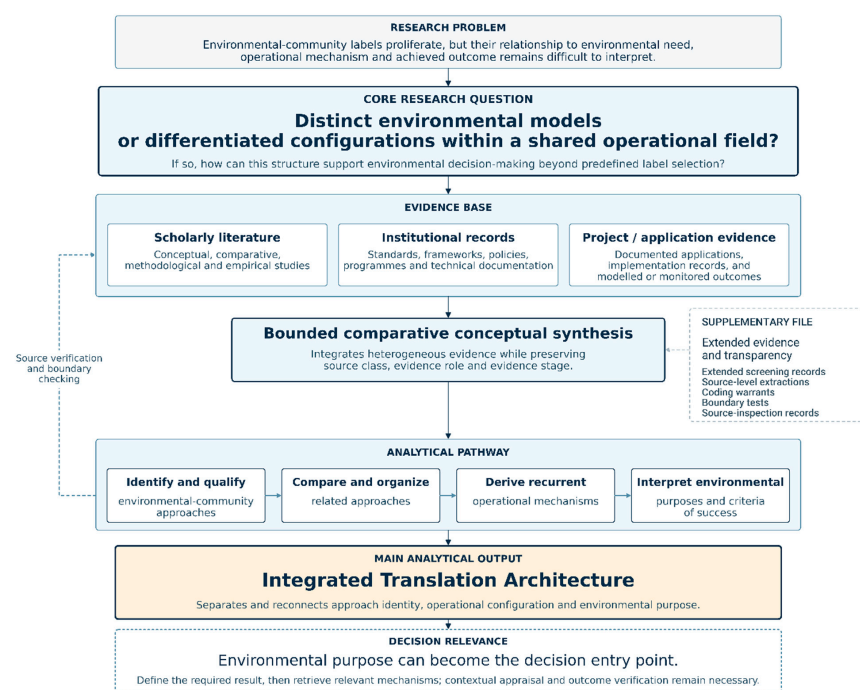


Figure 1. Research framework, evidence base, and analytical pathway of the study. The figure summarizes the progression from the research problem and evidence base through bounded comparative

conceptual synthesis and the analytical pathway to the Integrated Translation Architecture as the main analytical output. The final box indicates its practical decision relevance, while the Supplementary Materials retains the extended evidence and traceability records supporting the analytical process. Source: Authors' analysis.

2. Analytical Framework and Method

2.1. Research Design and Analytical Units

This study employs a comparative conceptual synthesis to examine structural relationships among environmental-community approaches and the operational mechanisms through which they are translated into planning, implementation, and environmental-performance frameworks. Rather than comparing terminology alone, the analysis traces how differently named approaches define environmental problems, organize interventions, establish evaluative criteria, and structure implementation. This orientation follows conceptual research requiring transparent construct selection and an explicit chain of reasoning between evidence and theoretical synthesis [17], while building on earlier work documenting overlap and differentiation across related urban environmental concepts and assessment frameworks [2,5,6,16]. The inquiry is bounded and purposive rather than an exhaustive systematic review or global census; corpus counts characterize the analytical evidence assembled for this study and are not used to estimate prevalence in either the literature or practice.

The analysis distinguishes four related but non-equivalent levels. The terminological level identifies documented environmental-community terms and the source-supported Qualified Approach Scopes to which they refer. The analytical-group level organizes related scopes into Analytical Approach Groups according to their defining environmental commitment, principal object of intervention, and characteristic operating orientation. The operational level identifies the Core Operational Components through which environmental intentions are translated into domains of intervention, coordination, and assessment. The environmental-logic level distinguishes the environmental purposes those mechanisms may serve and the criteria through which success is judged. These levels form an Integrated Translation Architecture rather than a hierarchical taxonomy: approaches may mobilize several components, individual components may serve different environmental purposes, and real-world developments may combine mechanisms associated with several approaches. Non-exclusive relationships are therefore retained where supported by the evidence.

The analytical architecture comprises 33 distinct Qualified Approach Scopes organized into 14 Analytical Approach Groups, with 6 Named Instruments retained separately as documentary and operational sources rather than additional approaches. Each group was then examined through the common operational-component structure, after which component relationships were interpreted against the Environmental Logic Families. This architecture preserves the distinction between approach identity, operational configuration, and environmental purpose throughout the analysis. The fourteen Analytical Approach Groups are analytical consolidations of all 33 retained Qualified Approach Scopes, not a second-stage selection of fourteen preferred or more prevalent labels. Likewise, the subsequent seven-component and four-family layers answer different analytical questions and do not represent further exclusions from the scope catalogue.

2.2. Evidence Architecture

The evidence architecture was structured around three analytically distinct dimensions: source class, evidence role, and evidence stage. Source class identifies the documentary form through which knowledge enters the analysis; evidence role specifies the analytical

function that a source can legitimately perform; and evidence stage defines the level of inference supported by the material actually examined. Separating these dimensions allows heterogeneous evidence to contribute to a common analytical structure without treating different document types, analytical functions, or evidential stages as equivalent.

At the level of source classification, the consolidated corpus comprises 177 distinct documents, including 70 peer-reviewed journal papers, 98 institutional records, and 9 other research or supporting documents. The scholarly corpus includes conceptual, comparative, methodological, review, and empirical studies informing the interpretation of environmental-community approaches, assessment structures, operational mechanisms, and environmental outcomes. Institutional records include standards, technical manuals, policy and programme documents, official definitions, indicator systems, registries, and governmental or organizational reports. These categories identify the form and provenance of the evidence rather than predetermining the analytical function assigned to it. Selection for analytical use was based on relevance to a defined analytical question, evidential directness, source authority and version, spatial and temporal applicability, and the inspectability of the supporting material; citation counts were not used as an inclusion threshold.

Across these documentary classes, sources were assigned non-exclusive evidence roles according to the analytical function they performed. Conceptual and methodological evidence informed comparative structures and construct derivation; definitional evidence established approach identity and boundaries; institutional evidence documented requirements, procedures, indicators, and governance arrangements; operational and application evidence traced implementation mechanisms; project and case evidence situated those mechanisms within identifiable settings; and performance evidence supported bounded interpretation of modelled, reported, monitored, or measured outcomes. Institutional-uptake evidence was retained separately for certification, programme participation, network membership, and geographical reach. Because evidence role was assigned independently of source class, a single document could support more than one analytical function, while no document type was assumed to establish environmental performance by virtue of its institutional or scholarly status.

The third dimension concerns evidence stage, which determines the inferential reach of an individual record. The analysis distinguishes between a definition or constitutive condition, a mandatory requirement or assessment procedure, a graded criterion or context-selected priority, a design or planning commitment, an implemented feature, and a reported, modelled, monitored, or observed outcome. A requirement establishes what a framework prescribes; a design commitment establishes what is intended; implementation establishes what was undertaken; and outcome evidence establishes what changed according to an identified measure or criterion.

Evidence was therefore retained at the stage directly supported by the inspected material and was not upgraded from prescription to implementation, or from implementation to achieved environmental performance, without additional supporting evidence. Identifying the environmental purpose served by an operational mechanism does not, by itself, demonstrate that the intended outcome was realized. Document provenance, version, spatial scale, evidential stage, claim lineage, and inspection depth were therefore preserved throughout the analysis, while related records from the same framework, project, dataset, institutional programme, or research lineage were not treated as independent corroboration. Extended screening records, source-level extractions, boundary tests, coding warrants, institutional and application evidence, and source-inspection records are retained in the Supplementary Materials to preserve analytical traceability without duplicating the detailed evidential record in the main text.

2.3. Scope Construction

Scope construction distinguished substantive environmental-community approaches from nominal variation, named instruments, and adjacent terminology. Candidate terms were assembled from the existing terminology inventory and targeted retrieval across publisher platforms, search engines, and official institutional repositories; entries requiring clarification were subjected to exact-label follow-up searches and primary-source verification. A term was retained as a Qualified Approach Scope only where the inspected evidence established a traceable environmental approach relevant to the community, neighbourhood, district, or precinct scale, or an explicit mechanism connecting a broader formulation to that scale. Query specifications, access dates, source provenance, eligibility decisions, and final dispositions were retained in the Supplementary Materials.

The initial inventory comprised 193 candidate name records. Eligibility assessment identified 38 qualified name occurrences representing 33 distinct Qualified Approach Scopes. Qualification required four conditions: a traceable scholarly or institutional meaning; relevance to the community-scale analytical domain; an identifiable environmental object, mechanism, or evaluative criterion; and evidence sufficiently direct to support the intended analytical use. Terminological similarity alone was insufficient for inclusion or consolidation. Variant names were combined only where the inspected evidence supported the same substantive approach scope, while distinctions were retained where differences in environmental object, defining commitment, operating arrangement, or success criterion altered the analytical meaning of the approach.

The 33 Qualified Approach Scopes were organized into 14 Analytical Approach Groups according to three comparative features: the environmental object addressed, the intended direction of change, and the characteristic operating arrangement. Approaches were grouped where these features supported a common higher-order comparison while allowing substantive subtype differences to remain visible. A separate group was retained where consolidation would obscure a distinct accounting object, success criterion, agency arrangement, or territorial dependency.

Each Qualified Approach Scope received one primary group position for reproducible cataloguing, while documented cross-links and operational intersections were retained where supported by the evidence. The 14 Analytical Approach Groups are comparison devices rather than replacement labels or exclusive classes; membership therefore does not imply identical operational configurations, environmental purposes, or performance outcomes. Six Named Instruments were retained separately because they function as assessment, certification, guidance, or implementation devices rather than as additional environmental approaches.

2.4. Component Derivation

The operational layer was developed through a structured deductive-comparative procedure. Seven candidate components identified in the initial cross-approach synthesis were reconstructed against passage-level evidence rather than inferred from label names or recurring terminology. A set of 175 meaning units from 34 source documents was examined for the environmental object addressed, the intervention mechanism, and the rule or criterion governing its interpretation. Source location, evidential stage, and documentary scope were retained for each unit to preserve traceability.

A component was retained only where the evidence established both a recurrent analytical object or enabling capacity and a distinction that would be lost if it were merged with its nearest alternative. This process retained seven Core Operational Components: Energy Systems (EN), Carbon and Emissions (CA), Resource Efficiency and Circularity (RE), Water Systems (WS), Ecological Integration (EI), Adaptive Capacity (AC), and Governance

and Data Systems (GOV/DATA). EN encompasses energy supply and generation, storage, distribution, demand, and delivered services. CA encompasses greenhouse-gas sources and sinks, inventories, emission factors, and balancing claims. RE encompasses material stocks and flows, resource throughput, reuse, repair, recovery, and related circular processes. WS covers water supply, demand and use, quality, drainage, and hydrological processes. EI addresses habitat, biodiversity, ecosystem condition, function, and connectivity. AC addresses continuity, adjustment, response, recovery, and transformation under specified disturbance or changing conditions. GOV/DATA encompasses authority, coordination, finance, participation, monitoring, information, and feedback.

The component layer is deliberately heterogeneous: it includes physical service systems, environmental accounts and resource flows, adaptive capacities, and institutional or informational enabling mechanisms. This heterogeneity is analytically intentional because the common function of the seven components is not physical equivalence, but the identification of recurrent operational domains through which environmental approaches can be compared. Their boundaries were informed by both established and recent scholarship and by source-specific institutional frameworks addressing energy, resource flows, water, ecological systems, resilience, and governance [5,10,11,13,18–21].

Component assignment followed the explicit operational mechanism represented in the evidence. Cross-coding was permitted where a record established more than one analytically distinct mechanism, but shared technologies, terminology, assets, or presumed co-benefits were insufficient to create additional component relationships. Multiple assignments therefore required separate documented operational pathways.

Structural robustness was tested through all 21 pairwise boundary comparisons and several alternative representations. Merging Energy Systems with Carbon and Emissions, absorbing Water Systems into general Resource Efficiency and Circularity, or merging Ecological Integration with Adaptive Capacity would erase analytically necessary distinctions. Separating governance and data remains a viable alternative; the present synthesis retains GOV/DATA as one enabling component for compact comparison while preserving distinct GOV and DATA subcodes in the detailed extraction. Mobility and spatial form remain explicit application dimensions rather than additional top-level components. The seven-component structure is therefore retained as a reasoned analytical resolution rather than as a uniquely optimal representation.

The resulting component layer functions as the operational translation interface between approach identity and environmental purpose.

2.5. Analytical Coding

Following component derivation, each of the 14 Analytical Approach Groups was assessed against the seven Core Operational Components, producing 98 group–component positions. The group–component relationship constituted the unit of coding. Each position was evaluated against the group’s defining commitment, evidence from its constituent Qualified Approach Scopes, relevant institutional or application records, and the evidential stage of the supporting material.

Four categorical role codes were applied. D (Defining) identifies a component that forms part of the group’s defining environmental object, constitutive commitment, or characteristic operating arrangement. O (Operational) identifies an explicit operational mechanism or provision documented within the group evidence without constituting its defining commitment. M (Mapped/conditional) identifies a plausible or contextual relationship for which the inspected evidence does not sufficiently specify the mechanism, its attribution to the approach, or a necessary condition. ND (Not demonstrated) records that the inspected evidence does not establish a positive group–component relationship at

the required evidential depth. The codes classify analytical role only; they are not weights, performance scores, rankings, or measures of importance.

Coding was anchored to the explicit object, mechanism, rule, and evidential stage represented in the supporting evidence. A positive assignment required an analytical warrant linking the defining characteristics of the Analytical Approach Group, the boundary of the Core Operational Component, and the source evidence supporting the relationship. Where constituent scopes operationalized a component differently, the variation was retained at the scope or subtype level rather than generalized to the group. Likewise, provisions specific to an assessment or certification instrument remained bounded to that instrument unless broader evidence justified extension. Multiple component assignments were permitted only where distinct operational mechanisms were documented; shared terminology, technologies, institutional association, or assumed co-benefits were insufficient to generate additional relationships.

The resulting 14×7 matrix represents operational configuration, not environmental purpose or performance. A component's coded role within an Analytical Approach Group therefore cannot, by itself, determine the Environmental Logic Family it may serve.

2.6. Logic Derivation

The environmental-logic layer was derived from the criterion by which environmental success is defined, rather than from the name of an approach, operational component, or technology. Across the inspected evidence, four recurrent evaluative questions were identified: How much resource input is required for a stated service? What harmful environmental pressure or burden is reduced? What continues, recovers, adjusts, or transforms under disturbance? How does ecological condition or function improve relative to a defined reference? These questions define four Environmental Logic Families: Resource Optimization and Efficiency (F1), Impact Mitigation and Emissions Management (F2), System Robustness and Adaptive Capacity (F3), and Ecological Regeneration and Co-Evolution (F4).

Distinctiveness was tested through all six pairwise contrasts among the four candidate families. Each contrast asked whether two purposes could be merged without losing a distinct criterion of environmental success. F1 was separated from F2 because lower resource use does not necessarily establish lower environmental burden; F1 from F3 because routine efficiency does not establish continuity or adjustment under disturbance; F2 from F4 because reducing harm does not establish positive ecological improvement; and F3 from F4 because maintaining or recovering function does not necessarily imply an improving ecological trajectory. The remaining contrasts were assessed using the same criterion: a separate family was retained only where merging would erase a distinct environmental endpoint or success condition.

The seven Core Operational Components were then assessed against the four Environmental Logic Families, producing 28 non-exclusive component–purpose positions. Each position was evaluated against the mechanism linking the component to the intended environmental end, the criterion through which success would be judged, and the evidential stage of the supporting material. Relationships were coded as S (Substantive) where an explicit mechanism directly served the stated environmental purpose; E (Enabling) where the component provided institutional, informational, adaptive, or other conditions supporting the pursuit or verification of that purpose; and C (Conditional) where the relationship depended on a specified mechanism, boundary, context, or additional condition. These codes characterize the form of the relationship, not its strength, performance, probability, or importance, and do not by themselves establish application-level relevance; this requires

the particular mechanism, target indicator, system boundary, and evidence stage to be matched to the intended environmental result.

The four-family structure was also challenged against plausible alternatives, including merging F1 with F2, merging F3 with F4, organizing higher-order families around service domains or technologies, and adding further categories for social, health, access, affordability, distributional, or legitimacy concerns. The four-family solution was retained because the proposed mergers removed distinct environmental success criteria, while the additional concerns did not establish equivalent environmental-purpose criteria within the bounded scope of this study. Those concerns therefore remain visible as outcomes, constraints, enabling conditions, or contextual dimensions rather than additional Environmental Logic Families.

2.7. Analytical Robustness and Inferential Control

Analytical robustness began with evidence provenance and dependency control. Each evidential unit retained its source identity, document version, spatial scale, evidence stage, and analytical role. Documents belonging to the same framework, project, dataset, institutional programme, or research lineage were treated as related evidence rather than independent corroboration. Documentary breadth was therefore kept analytically distinct from evidential independence.

Inferential control required every claim to remain within the evidence stage directly supported by the inspected record. Institutional recognition, certification, programme participation, implementation, and observed performance were therefore not treated as interchangeable. Relationships were extended only where the relevant object, mechanism, criterion, and evidence stage were explicitly supported; terminology, shared technology, institutional association, or assumed co-benefits were insufficient grounds for inference.

Structural robustness was assessed through boundary comparisons, alternative representations, and consistency checks between the retained analytical structure and its source warrants. These tests examined which distinctions would be lost through merger and which could be preserved under another representation; some alternatives obscured necessary differences in environmental object, mechanism, account, or success criterion, while others remained viable but less suitable for the compact comparative structure adopted here. The retained structure is therefore a reasoned analytical resolution of the bounded corpus rather than a uniquely validated typology.

Published quantitative contrasts and documentary applications were used as bounded analytical tests of whether separating approach identity, operational mechanism, system boundary, environmental purpose, and evidence stage changes interpretation. Their role is interpretive rather than causal: they show how the analytical distinctions discriminate among claims and outcomes within the evidence examined.

The framework is bounded to the environmental dimension of community development. Social, economic, cultural, spatial, behavioural, and distributional conditions remain relevant to implementation and contextual appraisal but are not additional environmental-purpose families in this synthesis. The architecture identifies and relates documented mechanisms; recommending a configuration for a particular place requires further evidence on feasibility, institutional capability, finance, infrastructure, and local conditions.

3. Analytical Approach Groups and Operational Configurations

3.1. From Label Proliferation to Analytical Approach Groups

The scope-construction analysis retained 38 qualified name occurrences representing 33 distinct Qualified Approach Scopes and organized them into 14 Analytical Approach Groups. No Qualified Approach Scope was discarded to obtain the fourteen-group

structure, and the 6 Named Instruments remained analytically separate. The resulting groups preserve substantive approach identities while providing a common basis for comparing forms of environmental commitment that would remain obscured in direct label-to-label comparison.

The fourteen groups also differ in historical and institutional formation. Some consolidate broad traditions developed through multiple programmes and assessment systems, whereas others originate in more specialized policy, research, professional, technological, or community-based lineages. Because several groups contain approaches with distinct trajectories, assigning a single founding date would create false precision. Table 1 therefore reports representative institutional lineages and emergence anchors together with the complete scope membership and organising commitment of each group.

Table 1. Analytical Approach Groups: Scope Membership, Institutional Lineages, and Organising Commitments.

Analytical Approach Group	Qualified Approach Scopes	Representative Institutional Lineage/Anchors	Organising Commitment
G01 Integrated environmental communities	Sustainable community; Green community; Eco-community; Garden community	Broad integrative traditions spanning ecocity and sustainable-development initiatives, formal community-scale assessment, green-neighbourhood programmes, and contemporary garden-community principles [22–25].	Whole-place environmental improvement through coordinated planning across multiple service and ecological domains.
G02 Carbon-oriented communities	Low-carbon community; Carbon-neutral or net-zero-GHG community; Climate-positive development	Carbon-reduction, neutrality, and beyond-neutral accounting expressed through climate-policy, planning, and reporting frameworks [26–29].	A declared greenhouse-gas trajectory or balance constitutes the distinguishing environmental account.
G03 District energy performance	Net-zero-energy community; Positive Energy District; Smart-energy neighbourhood	Community and district energy-balance definitions, PED reference frameworks, and coordinated smart-energy precinct applications [20,30,31].	Coordinated local energy supply, demand, storage, and exchange assessed through an energy account or service-performance criterion.
G04 Collectively governed energy communities	Territorial energy community	Collective-energy arrangements expressed through energy-community policy and associated participation, ownership, and control models [32,33].	Collective participation, ownership, or control of energy activity defines the approach rather than a prescribed energy balance.
G05 Circular resource communities	Circular community; Zero-waste community; Productive Fab neighbourhood	Circular-economy, zero-waste, and distributed-production traditions linked through urban material-flow and resource-retention frameworks [34–37].	Reduction in material throughput and retention of useful products or materials through prevention, reuse, recovery, and local productive flows.

Table 1. *Cont.*

Analytical Approach Group	Qualified Approach Scopes	Representative Institutional Lineage/Anchors	Organising Commitment
G06 Water-sensitive and blue-green communities	Water-sensitive community; Sponge neighbourhood; Blue-green neighbourhood	Distinct but hydrologically connected traditions in water-sensitive urbanism, sponge-city programmes, and blue-green infrastructure research and implementation [19,38–41].	Urban water flows and their landscape or infrastructure interfaces constitute the organising service domain.
G07 Biophilic communities	Biophilic neighbourhood	Biophilic-city scholarship and the Biophilic Cities Network, emphasizing everyday contact and relationships between people and nature [42–44].	Human experience of and relationship with nature is the distinguishing commitment rather than biodiversity gain alone.
G08 Biodiversity-oriented communities	Nature-positive community; Biodiversity-conscious neighbourhood	Biodiversity-conscious planning and nature-positive agendas emphasizing habitat condition, connectivity, and demonstrable ecological improvement [13,45,46].	Habitat condition, biodiversity, and ecological connectivity form the principal environmental object.
G09 Regenerative communities	Regenerative community	Regenerative-development scholarship and institutional roadmaps centred on reciprocal settlement–ecosystem relationships, ecological improvement, and continuing stewardship [9,47,48].	Improvement of relationships between settlements and the living systems that support them.
G10 Resilient and climate-adapted communities	Resilient community; Winter neighbourhood	Resilience frameworks and networks addressing disturbance response and adaptive capacity, with climate- and season-specific studies providing more bounded continuity and adaptation applications [11,49,50].	Maintenance, recovery, or adjustment of relevant functions under specified disturbance or demanding environmental conditions.
G11 Smart sustainable communities	Smart sustainable community	International smart-sustainable-city frameworks, particularly U4SSC and related ITU initiatives, positioning information, monitoring, and feedback as cross-service environmental enablers [51–53].	Information, monitoring, feedback, and coordinated governance explicitly support environmental services across domains.
G12 Community-led environmental transition	Urban ecovillage; Transition community	Movement- and network-based traditions represented by the Global Ecovillage Network and Transition Network, emphasizing collective local action and changes in everyday practice [54–56].	Residents collectively organize changes in practices, resources, and local environmental action.

Table 1. *Cont.*

Analytical Approach Group	Qualified Approach Scopes	Representative Institutional Lineage/Anchors	Organising Commitment
G13 Proximity and compact urban form	Compact neighbourhood; Walkable neighbourhood; Transit-oriented development; Fifteen-minute neighbourhood; Smart-growth community; New Urbanist neighbourhood	Planning traditions including New Urbanism, compact development, transit-oriented development, smart growth, and the fifteen-minute-city formulation, connected through proximity, accessibility, and reduced travel or land demand [57–60].	Spatial organization seeks to improve access and reduce travel or land demand through proximity, connectivity, and transport choice.
G14 Local resource autonomy	Self-sufficient neighbourhood	Retained as a source-limited neighbourhood-scale proposition, supported by research on local resource self-provision and neighbourhood self-sufficiency across energy, water, and nutrient systems [61–64]. Widespread institutionalization and achieved autonomy are not established.	The share of local needs met within a declared territorial resource boundary defines the ambition.

Source: Authors' synthesis. Note: Each Qualified Approach Scope has one primary group position for comparative cataloguing. Group membership preserves substantive subtype differences and does not imply identical operational configurations, equivalent performance, or comparable prevalence. Institutional anchors identify representative lineages rather than a single founding date.

The fourteen groups reveal three principal bases of differentiation. Some are organized around environmental accounts or managed domains, including greenhouse gases, energy performance, material flows, water systems, and biodiversity (G02, G03, G05, G06, and G08). Others are distinguished primarily by their mode of action or organization, including collective energy control, information-mediated coordination, community-led transition, and spatial proximity (G04, G11, G12, and G13). A third set retains distinct conceptual commitments centred on human–nature relationships, regenerative settlement–ecosystem relations, and disturbance-oriented adaptive capacity (G07, G09, and G10). G01 remains deliberately integrative, while G14 represents territorially bounded resource autonomy. The grouping therefore exposes distinct bases of organization that would remain obscured in direct nominal comparison.

Group size and primary assignment are analytical properties, not measures of prevalence, maturity, evidential strength, implementation success, or exclusivity. G13, for example, consolidates six spatial-planning approaches because they share proximity and accessibility mechanisms, whereas G14 remains a single-scope, source-limited comparator because further aggregation would obscure its territorial self-sufficiency claim. Cross-links remain visible operationally: garden-community principles intersect with biodiversity and proximity, smart-energy approaches with information systems, collective-energy arrangements with community-led transition, and ecovillage approaches with regenerative principles. The primary group position therefore stabilizes comparison without suppressing documented overlap.

Taken together, the results indicate layered differentiation rather than linear succession or nominal equivalence. Earlier integrative approaches coexist with increasingly specialized approaches organized around environmental accounts, service domains, ecological conditions, governance arrangements, and territorial mechanisms. Historical lineage helps explain how these approaches emerged, but it does not determine their subsequent operational configuration or environmental purpose.

3.2. Institutional Expression and Evaluation

The fourteen Analytical Approach Groups are expressed through markedly different institutional and evaluative arrangements, including certification systems, policy programmes, diagnostic frameworks, technical guidance, professional or civic networks, collective organizational structures, and documented project applications. This heterogeneity is consistent with research showing substantial variation in territorial scale, indicator structure, institutional authority, and the relationship between assessment and implementation [6,7,12,65]. An environmental approach and the instrument through which it is assessed, guided, or implemented are therefore distinct analytical objects: one instrument may operationalize several environmental concerns, while one Analytical Approach Group may be expressed through several institutional pathways. Institutional form consequently cannot be interpreted as a scale of conceptual maturity, environmental superiority, or demonstrated performance.

Table 2 identifies six recurrent institutional and evaluation pathways across the evidence base. Each pathway describes how an approach becomes institutionally expressed, operationally supported, or evaluatively structured, and each supports a different evidential claim and interpretive boundary.

Table 2. Institutional and evaluation pathways across the analytical approach groups.

Institutional/ Evaluation Pathway	Representative Examples	Principal Function	What the Evidence Can Establish	Interpretive Boundary
Certification or formal assessment	BREEAM Communities; EcoDistricts Protocol; Climate Active precinct accounting	Formalizes specified requirements, credits, accounting rules, review procedures, and assessment or certification stages [22,28,66].	Establishes the documented assessment or certification status of an identified unit against the specified requirements and at the stage reported by the source.	Certification, compliance, or completion of an assessment stage does not by itself establish achieved environmental performance, persistence of performance over time, or superiority over uncertified approaches.
Framework or diagnostic tool	City Resilience Framework; Water-Sensitive Cities Index; PED Reference Framework; ZEN framework; ELITE Cities; SLIM CITY	Structures diagnosis, indicator selection, scenario assessment, performance definition, or decision support [20,39,49,67–69].	Establishes that a documented analytical or diagnostic structure exists, including specified criteria, indicators, boundaries, or decision rules available for interpretation or application.	Framework authority or methodological specification does not establish certification, actual implementation, uptake, or measured environmental improvement.

Table 2. *Cont.*

Institutional/ Evaluation Pathway	Representative Examples	Principal Function	What the Evidence Can Establish	Interpretive Boundary
Programme or technical- assistance pathway	C40 neighbourhood programmes; EBRD Green Cities; Garden Communities; ÉcoQuartier	Connects policy objectives with participating places through staged commitments, technical guidance, institutional support, or implementation assistance [23,70–72].	Establishes documented participation of an identified place or project in a programme and the objectives, commitments, support mechanisms, or delivery stage attached to that participation.	Programme participation, selection, recognition, or technical assistance does not establish completed implementation or verified environmental outcomes.
Network or movement pathway	Resilient Cities Network; Biophilic Cities; Transition Network; Global Ecovillage Network	Organizes membership, knowledge exchange, collective learning, commitments, and diffusion of principles or practices [43,54,56,73].	Establishes organized institutional or social participation and the documented commitments, membership conditions, or knowledge-sharing structures associated with that network or movement.	Membership or participation does not establish compliance with every analytical criterion, neighbourhood-scale implementation, or measured environmental performance.
Collective organizational arrangement	Territorial energy communities and related collective-energy structures	Formalizes participation, ownership, decision rights, or collective control over locally relevant environmental services [32,33].	Establishes that governance, ownership, participation, or decision rights constitute part of the documented operating arrangement of the approach.	Legal or organizational existence may span dispersed sites and does not establish a contiguous community-scale application, a particular environmental purpose, or achieved performance.
Documented project or research application	Monash smart-energy precinct; Augustenborg blue–green retrofit; other source-bounded neighbourhood or district applications	Provides place-specific evidence of proposed, implemented, modelled, monitored, or evaluated interventions and mechanisms [30,38].	Establishes that a specified intervention or mechanism has reached the documented evidence stage (proposed, implemented, modelled, monitored, or evaluated) within an identified setting.	A single application establishes practical expression only within its documented boundary; it does not establish diffusion, general effectiveness, or the performance of the entire Analytical Approach Group.

Source: Authors' synthesis. Note: Institutional and evaluation pathways are non-exclusive. Counts of certificates, programme participants, network members, jurisdictions, and research applications retain their original units and are not additive measures of diffusion or environmental success.

Within this institutional landscape, six Named Instruments remained analytically separate from the Qualified Approach Scopes: EcoDistricts Protocol, ÉcoQuartier, One Planet Living, the Zero Emission Neighbourhood (ZEN) definition framework, ELITE Cities, and SLIM CITY. Their functions range across assessment, certification, definition, planning,

and decision support, reinforcing the distinction between an environmental approach and the institutional instrument through which particular provisions are formalized or applied [66–69,71,74].

Read together, Tables 1 and 2 connect approach identity with institutional expression. The fourteen Analytical Approach Groups are expressed through different institutional routes: integrated environmental communities through assessment systems, programmes, and planning frameworks; district energy through reference frameworks and documented project applications; resilient and biophilic approaches through diagnostic frameworks and networks; and community-led transition through organized movements and local collective action. These differences describe modes of institutional expression rather than a progression from less to more mature approaches. Institutional reach is likewise non-additive, because certification records, programme participants, network members, and research applications retain different units and evidential meanings.

The principal result is therefore that institutional heterogeneity coexists with operational comparability without implying environmental equivalence. Different approaches may be embedded in different organizational, evaluative, and governance arrangements while addressing recurrent environmental objects and mechanisms; conversely, a common instrument or programme does not make the approaches it supports analytically identical. Institutional expression is therefore an important contextual and evidential layer, but it neither determines operational configuration nor establishes environmental purpose or performance.

3.3. Operational Configuration Across Analytical Approach Groups

Application of the coding procedure to the complete 14×7 matrix produced 98 group–component positions: 13 Defining (D), 62 Operational (O), 12 Mapped/conditional (M), and 11 Not demonstrated (ND). Seventy-five positions are therefore supported as defining or operational relationships, with a further twelve retaining documented but bounded connections. This distribution establishes a shared operational field across the fourteen Analytical Approach Groups while demonstrating that they occupy that field through differentiated configurations. Table 3 presents the group–component matrix.

The defining relationships reveal that group identity is anchored in different kinds of operational commitments. Some groups are organized around a primary environmental account or service domain: CA defines G02, EN defines G03, RE defines G05, and WS defines G06 [19,20,26,28,37,39]. Others are distinguished through ecological, adaptive, or governance capacities: EI defines G07–G09, AC defines G10, and GOV/DATA forms part of the defining structure of G04, G11, and G12 [11,13,32,42,48,53,55]. EN also contributes to the defining structure of G04 and G14, where collective energy organization and territorially bounded self-provision are constitutive rather than merely operational [32,64]. The same component can therefore define several groups without making those groups equivalent because its role is embedded in different commitments, boundaries, and operating arrangements.

G01 and G13 show why operational configuration cannot always be reduced to a single defining component. G01 records operational relationships across all seven components because whole-place integration is itself its distinguishing commitment. G13 likewise spans all seven because spatial configuration acts across environmental systems rather than constituting an additional environmental service domain. Proximity, compactness, walkability, transit orientation, and related spatial strategies can alter energy demand, emissions, resource use, water relationships, ecological conditions, adaptive capacity, and governance arrangements [5,59,60]. These cases demonstrate that the absence of a single

defining component does not imply analytical weakness; group identity may instead arise from the way multiple operational domains are coordinated.

Table 3. Operational configuration of the 14 Analytical Approach Groups.

Analytical Approach Group	EN	CA	RE	WS	EI	AC	GOV/DATA
G01. Integrated environmental communities	O	O	O	O	O	O	O
G02. Carbon-oriented communities	O	D	O	O	O	O	O
G03. District energy performance	D	O	O	ND	ND	O	O
G04. Collectively governed energy communities	D	M	ND	ND	ND	M	D
G05. Circular resource communities	O	M	D	O	M	ND	O
G06. Water-sensitive and blue–green communities	O	O	O	D	O	O	O
G07. Biophilic communities	ND	ND	M	O	D	M	O
G08. Biodiversity-oriented communities	M	O	M	O	D	O	O
G09. Regenerative communities	O	O	O	O	D	M	O
G10. Resilient and climate-adapted communities	O	O	O	O	O	D	O
G11. Smart sustainable communities	O	O	O	O	O	O	D
G12. Community-led environmental transition	O	O	O	M	O	M	D
G13. Proximity and compact urban form	O	O	O	O	O	O	O
G14. Local resource autonomy	D	ND	O	ND	M	ND	O

Legend: D = Defining; O = Operational; M = Mapped/conditional; ND = Not demonstrated. Source: Authors' analysis. Note: Codes denote group-level analytical roles, not performance or prevalence; group-level assignments do not imply uniformity across constituent scopes, and ND denotes non-demonstration at the inspected evidential depth.

Cross-group operational recurrence is extensive. GOV/DATA holds a defining or operational role in all fourteen groups, while RE and EN have documented D, O, or M relationships in thirteen groups and CA in twelve. These frequencies are not importance scores; they show that differently named approaches repeatedly mobilize a limited set of operational domains even when those domains occupy different roles within each configuration. WS, EI, and AC are more selectively distributed because their relevance depends more directly on specific service, ecological, or disturbance-related mechanisms.

The M and ND positions delimit the shared operational field. M retains a plausible or contextual connection for which the inspected evidence does not sufficiently specify the mechanism, its attribution to the approach, or a necessary condition to warrant D or O. ND records that the inspected evidence does not establish a positive relationship at the required analytical depth. These positions distinguish warranted operational roles from conditional interpretations and evidential gaps; neither establishes that a relationship is impossible in another application.

Taken together, the matrix demonstrates convergence and differentiation simultaneously. Convergence lies in the recurrent operational vocabulary shared across the fourteen groups, while differentiation rests on their organising commitments, constituent scopes, mechanisms, and boundaries rather than on code patterns alone. Thus, groups may share the same aggregate component profile without becoming analytically equivalent, and the shared operational field does not predetermine environmental purpose.

4. Environmental Logic Families and Integrated Translation Architecture

4.1. Environmental Logic Families and Success Criteria

The analysis identified four recurrent forms of environmental success, distinguished by the environmental end pursued and the criterion through which achievement is judged.

These are Resource Optimization and Efficiency (F1), Impact Mitigation and Emissions Management (F2), System Robustness and Adaptive Capacity (F3), and Ecological Regeneration and Co-Evolution (F4).

The four families correspond to four distinct environmental success criteria: reducing resource input for a stated service or function; reducing, avoiding, or managing harmful environmental pressures or burdens; maintaining, recovering, adjusting, or transforming function under disturbance; and producing positive improvement in ecological condition, function, connectivity, or settlement–ecosystem relationships. Table 4 summarizes these families and their distinguishing success criteria.

Table 4. Environmental logic families and distinguishing success criteria.

Environmental Logic Family	Central Environmental Question	Principal Success Criterion	Key Analytical Boundary
F1 Resource Optimization and Efficiency	How much resource input is required to provide a stated service or function?	Reduced demand or throughput; increased reuse, recovery, productivity, or service-adjusted efficiency [19,37,75].	Resource-saving must not be interpreted automatically as lower environmental burden, greater disturbance resilience, or ecological improvement; these require separate criteria and evidence.
F2 Impact Mitigation and Emissions Management	What harmful environmental pressure or burden is reduced within a declared boundary?	Reduction, avoidance, balancing, or management of GHG emissions, pollutants, or other specified environmental burdens [28,29,76].	Mitigation requires a declared burden or accounting boundary and does not by itself establish efficient resource use, performance under disturbance, or ecological regeneration.
F3 System Robustness and Adaptive Capacity	What continues, recovers, adjusts, or transforms under a specified disturbance or changing condition?	Service continuity, response, recovery, flexibility, reduced exposure, adaptation, or transformation under defined stress [11,38,49,52].	Routine efficiency, mitigation, or preparedness does not establish performance under disturbance; the disturbance, affected function, and response criterion must be explicit, and persistence alone does not establish ecological improvement.
F4 Ecological Regeneration and Co-Evolution	How does ecological condition or function improve relative to a stated reference?	Positive change in habitat condition, biodiversity, connectivity, ecological function, or settlement–ecosystem relationships [9,13,47,48].	Protection, greening, or reduced damage is insufficient by itself; regeneration requires directional ecological improvement against a declared reference condition.

Source: Authors' synthesis. Note: Environmental Logic Families classify environmental purposes and success criteria, not technologies, service domains, or complete environmental-community approaches. A single operational component may support more than one family where distinct mechanisms and evidential criteria are documented.

Water Systems (WS) illustrate the distinction directly. Reduced potable-water demand corresponds to F1 because success is defined through lower resource input; reduced pollutant loads or harmful water-related pressures correspond to F2; service continuity or reduced flood disruption under disturbance corresponds to F3; and restoration of hydrological processes, aquatic habitat, or ecological function corresponds to F4. The operational component remains Water Systems in every case; what changes is the environmental purpose, mechanism, and criterion of success.

The Environmental Logic Families provide the interpretive layer of the structure. They explain why similar operational interventions can be understood and evaluated differently: efficiency concerns the resource requirements of a service, mitigation concerns an environmental burden, robustness concerns function under disturbance, and regeneration concerns an improving ecological trajectory. Their success criteria make these rationales distinguishable without assigning each approach or component to a single environmental purpose. Operational components therefore explain how environmental action is organized, while the logic families clarify the environmental ends through which that action acquires meaning.

4.2. Component–Purpose Relationships

Application of the component–purpose coding across all 28 positions produced 14 substantive, 5 enabling, and 9 conditional relationships. The distribution confirms that operational components are not tied to single environmental purposes and that the four Environmental Logic Families are supported through different combinations of operational mechanisms.

Table 5 reveals three recurring relationship patterns. First, some components have broad substantive reach: Water Systems (WS) is substantive across all four Environmental Logic Families, while Energy Systems (EN) and Ecological Integration (EI) are substantive across three, although their environmental meaning changes with the mechanism and criterion involved [13,19,20,49,66]. Second, other components show more purpose-specific relationships: Carbon and Emissions (CA) is substantive primarily for F2, Resource Efficiency and Circularity (RE) for F1 and F2, and Adaptive Capacity (AC) for F3 while enabling F4; their remaining relationships are conditional on additional mechanisms or criteria [11,28,29,37]. Third, Governance and Data Systems (GOV/DATA) are enabling across all four families, reflecting the cross-cutting role of authority, coordination, finance, participation, monitoring, information, and feedback without treating these capacities as environmental outcomes [18,52,77]. Together, these patterns show that broad operational relevance does not imply a fixed environmental purpose.

Taken together, the 7×4 matrix establishes cross-linked, non-exclusive relationships between operational structure and environmental purpose. No Core Operational Component maps to a single Environmental Logic Family, nor can any family be reduced to one component. Environmental meaning therefore arises from the relationship among component, mechanism, environmental purpose, and success criterion rather than from the component or technology alone. The matrix thus preserves both operational differentiation among approaches and purpose differentiation among environmental outcomes.

Table 5. Relationships between core operational components and environmental logic families.

Core Operational Component	F1	F2	F3	F4	Mechanism–Purpose Interpretation
(EN) Energy Systems	S	S	S	C	Demand, supply, and storage can serve F1–F3 through distinct mechanisms; F4 requires an evidenced ecological-improvement pathway.
(CA) Carbon and Emissions	C	S	C	C	Emissions accounts directly address F2; other purposes require mechanisms beyond the account or balance itself.
(RE) Resource Efficiency and Circularity	S	S	C	C	Resource retention and throughput reduction serve F1; avoided environmental burdens serve F2. F3 and F4 require additional pathways.

Table 5. *Cont.*

Core Operational Component	F1	F2	F3	F4	Mechanism–Purpose Interpretation
(WS) Water Systems	S	S	S	S	Demand reduction, pollution control, disturbance response, and hydrological restoration connect water mechanisms to F1, F2, F3, and F4, respectively.
(EI) Ecological Integration	C	S	S	S	Ecosystem mechanisms may reduce burdens, support adaptation, or improve ecological condition; F1 requires a specified resource-saving mechanism.
(AC) Adaptive Capacity	C	C	S	E	Response and adjustment directly address F3 and can enable F4; F1 and F2 require a documented connection to the relevant resource or burden.
(GOV/DATA) Governance and Data Systems	E	E	E	E	Authority, coordination, finance, participation, monitoring, and feedback enable action and verification across all four purposes; they do not constitute environmental outcomes.

Legend: S = Substantive mechanism–purpose relationship; E = Enabling relationship; C = Conditional relationship. Source: Authors’ analysis. Note: Codes characterize the form of the component–purpose relationship supported within the inspected evidence; they are not measures of strength, performance, probability, importance, or causal effect. A documented target or enabling arrangement does not establish an achieved environmental outcome.

4.3. Integrated Translation Architecture

The preceding analyses establish an Integrated Translation Architecture linking 33 Qualified Approach Scopes, 14 Analytical Approach Groups, 7 Core Operational Components, and 4 Environmental Logic Families. The first mapping connects approach groups to operational components, while the second connects those components to the environmental purposes they may serve. These levels are connected but non-equivalent: the D/O/M/ND relationships translate approach identity into operational configuration, while the S/E/C relationships translate operational configuration into environmental purpose. The sequence therefore represents distinct analytical transitions rather than progressive compression into a single hierarchy.

Environmental labels remain important because they carry historical, institutional, regulatory, professional, and communicative meaning and provide access to established mechanisms, standards, instruments, and implementation experience. Once operational configuration and environmental purpose are made explicit, however, their role shifts from self-contained decision units to sources of knowledge and institutional practice.

Once these relationships have been established, the architecture can also be read in reverse for decision interpretation:

Intended environmental purpose → relevant Environmental Logic Family/Families → relevant Core Operational Components → relevant approach mechanisms and configurations

This reverse reading uses the relationships established through the forward analysis to identify mechanisms and approach configurations relevant to a stated environmental purpose. The Environmental Logic Families clarify the form of environmental success sought, the Core Operational Components identify the operational domains through which it may be pursued, and the Analytical Approach Groups and Qualified Approach Scopes indicate where relevant mechanisms, institutional provisions, and implementation pathways can be examined. In this way, the architecture allows environmental purpose to become the decision entry point without reducing the diversity of environmental approaches. Figure 2 presents the Integrated Translation Architecture.

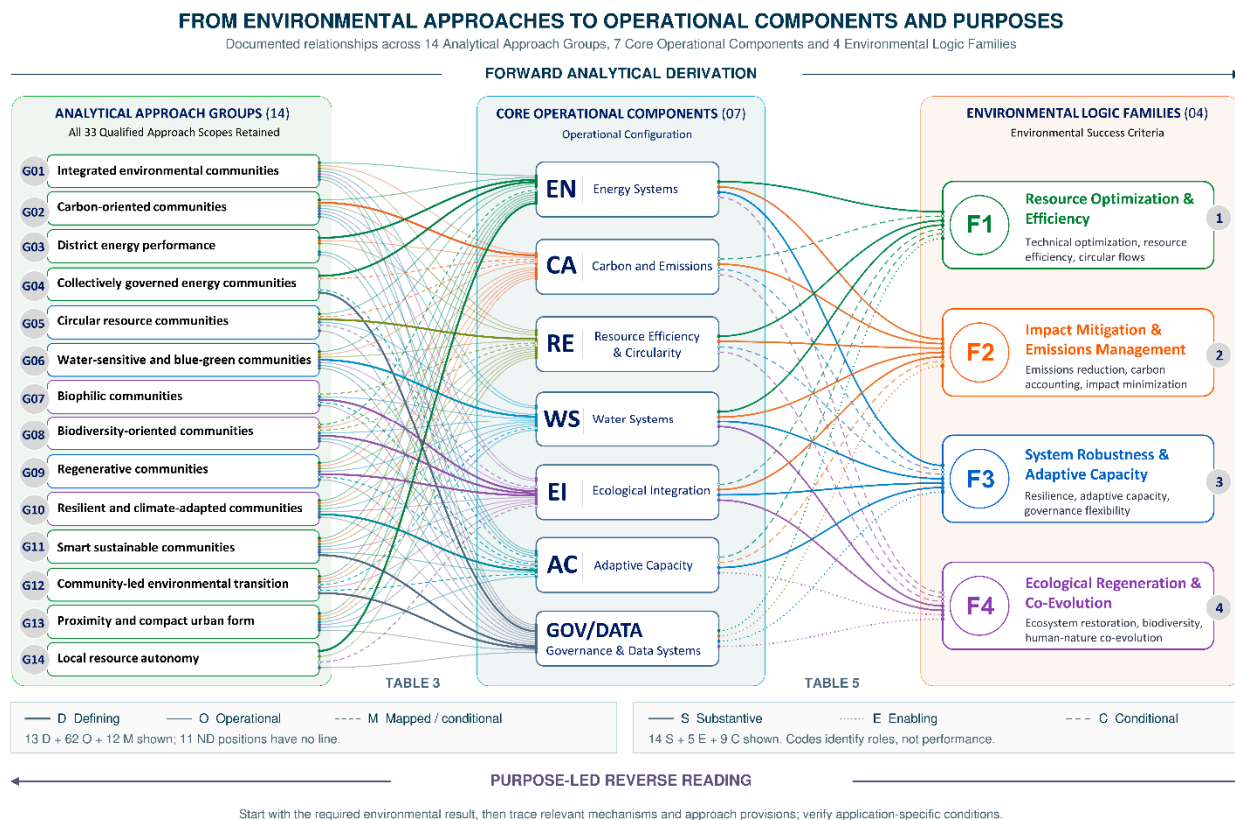


Figure 2. Integrated Translation Architecture Linking Environmental Approaches, Operational Components, and Environmental Logic Families. The figure links the 14 Analytical Approach Groups, 7 Core Operational Components, and 4 Environmental Logic Families, while retaining all 33 Qualified Approach Scopes within the group structure. The forward direction represents the analytical derivation through which these relationships were established, while the reverse direction shows how the same structure can be read from an intended environmental purpose toward relevant mechanisms and approach configurations. Source: Authors' analysis.

The integrated architecture therefore clarifies how fragmentation and convergence co-exist. Environmental-community approaches remain nominally and institutionally diverse, but their operational structures are not disconnected: the fourteen Analytical Approach Groups occupy a shared operational field of seven recurrent Core Operational Components, while the four Environmental Logic Families distinguish the forms of environmental success those components may serve. Convergence therefore concerns a shared operational vocabulary, whereas differentiation lies in the commitments, mechanisms, boundaries, and purposes through which that vocabulary is configured. These levels remain analytically distinct: approach identity does not fully specify operational configuration, component presence does not determine a single environmental purpose, and intended environmental purpose does not establish achieved performance without corresponding evidence. The contribution is therefore not a new hierarchy of labels, but a translation architecture that makes these relationships explicit while preserving the distinctions obscured by direct label-to-label comparison.

4.4. Worked Interpretation Using the Integrated Translation Architecture

To demonstrate how the Integrated Translation Architecture operates against published evidence, this section uses Positive Energy District (PED) as a bounded worked interpretation. PED is not treated as representative of all environmental-community approaches or as a preferred model; it is selected because it combines an explicit district-scale definition, a clearly identifiable operational configuration, and published quantitative

evidence that distinguishes energy, carbon, and resource consequences within the same intervention. As one of the 33 Qualified Approach Scopes, PED is supported by both framework-level and quantitative evidence [20,21,75].

Within the scope structure, PED, catalogued as CS18 in the Supplementary Materials, is assigned to G03 District Energy Performance, together with net-zero-energy communities and smart-energy neighbourhoods. Their common basis lies in coordinated local energy supply, demand, storage, exchange, and service performance, while differences in energy-balance definitions, emissions boundaries, flexibility requirements, and control arrangements remain visible. PED is therefore treated as a defined environmental approach whose operational configuration and environmental purposes must be established analytically rather than inferred from its name.

For PED specifically, the JPI Urban Europe and SET Plan Action 3.2 framework identifies coordinated demand, supply, and exchange as Energy Systems (EN) mechanisms; explicit emissions conditions as a Carbon and Emissions (CA) route; energy-efficiency provisions as a bounded Resource Efficiency and Circularity (RE) route; and energy flexibility, including demand management, sector coupling, and storage, as an Adaptive Capacity (AC) route linked to energy-system resilience. ICT, monitoring, user engagement, and implementation arrangements provide Governance and Data Systems (GOV/DATA) support [20]. These are PED-specific framework provisions rather than properties inherited automatically from G03. The inspected PED provisions do not establish separate Water Systems (WS) or Ecological Integration (EI) routes at this analytical depth, and framework-level roles do not demonstrate achieved project performance.

PED → G03 District Energy Performance → EN + CA + RE + AC + GOV/DATA

This establishes how the approach is operationally configured, but it does not establish a single environmental purpose. Through the component–purpose relationships in Table 5, EN can substantively serve F1 Resource Optimization and Efficiency, F2 Impact Mitigation and Emissions Management, and F3 System Robustness and Adaptive Capacity; CA most directly serves F2; RE can substantively serve F1 and F2; AC directly serves F3; and GOV/DATA enables all four Environmental Logic Families. The analytical chain therefore continues as

PED → G03 → EN/CA/RE/AC/GOV-DATA → multiple Environmental Logic Families rather than

PED → one predetermined Environmental Logic Family

The consequence becomes visible when the architecture is applied to published quantitative evidence. In the examined PED study [75], storage alternatives are compared within the same 1413 kWp photovoltaic configuration. Increasing storage from 0.4 MWh to 1.2 MWh reduces reported primary energy by 3.16% and increases load cover by 9.85 percentage points, while reported embodied carbon increases by 58.90% and the abiotic-depletion indicator by 57.75%. The same technological intervention therefore improves some environmental criteria while increasing burdens under others.

The translation architecture makes these differences analytically explicit. Lower reported primary-energy input supports an EN–F1 interpretation within the modelled service and system boundary. Higher load cover describes local energy-service coverage; without a disturbance-specific test, it does not establish F3 robustness. Increased embodied carbon represents an adverse CA–F2 result. The reported abiotic-depletion indicator is likewise an impact-assessment quantity rather than a direct measure of physical material throughput; its increase therefore represents an adverse resource-related environmental burden under F2 in this application, not direct evidence of greater material consumption or reduced RE–F1 efficiency. The environmental interpretation consequently changes with the measured criterion and accounting boundary, even within the same technological intervention.

This distinction prevents improvement in one environmental criterion from being generalized into overall environmental improvement. A PED may demonstrate a favourable energy result while simultaneously producing less favourable carbon or material consequences within another accounting boundary. The label alone cannot resolve these competing outcomes, nor can the presence of storage, photovoltaic generation, or another familiar technology. Environmental performance must be interpreted against the specific purpose and criterion to which each claim belongs.

The application also demonstrates why evidence stage remains essential. At group level, G03 establishes documented operational relationships with adaptive capacity and governance, but those relationships do not demonstrate that every PED application achieves resilience or effective governance. In the quantitative example, the inspected evidence supports modelled comparisons of primary energy, load cover, embodied carbon, and characterised abiotic-depletion impacts. It does not establish observed outage resilience, ecological regeneration, social acceptance, institutional effectiveness, or long-term operational continuity. Group-level analytical possibilities therefore cannot be promoted to project-level outcomes without corresponding evidence.

The worked application demonstrates three analytical consequences. First, one Qualified Approach Scope can operate through several Core Operational Components. Second, those components can serve different Environmental Logic Families rather than one pre-determined environmental purpose. Third, improvement under one criterion can coexist with deterioration under another. The resulting separation can be stated directly:

Approach identity $\neq$ operational configuration $\neq$ environmental purpose $\neq$ demonstrated performance

The architecture connects these levels without collapsing them, making convergence, trade-offs, and evidential boundaries visible within the same analytical sequence.

The application remains intentionally bounded. It demonstrates forward analytical traceability and the discriminating value of the proposed architecture when applied to published quantitative and documentary evidence. It does not constitute independent causal validation, rank PED against other environmental approaches, establish the environmental superiority of a particular configuration, or demonstrate that use of the architecture improves project performance.

Having established the analytical relationships and their traceability, the following section considers their practical implication: whether a specified environmental purpose can guide the examination of relevant mechanisms and approach provisions across the same architecture.

4.5. Practical Implication: Purpose-Led Interpretation

The established relationships can also be read from a specified environmental purpose towards relevant mechanisms and approach provisions. The Environmental Logic Families clarify the criterion of success, the Core Operational Components identify the operational domains through which that purpose may be pursued, and the Analytical Approach Groups and Qualified Approach Scopes indicate where relevant mechanisms and institutional provisions can be examined. This reading preserves the conceptual and institutional value of environmental approaches while making the basis for considering their mechanisms explicit. It relies on relationships established through the comparative analysis, with each connection interpreted against the relevant mechanism, system boundary, and evidence stage.

The PED example in Section 4.4 illustrates this practical implication using the same analytical structure in reverse. If the intended result is to reduce the embodied-carbon burden of the energy configuration, F2, Impact Mitigation and Emissions Management,

provides the relevant environmental-purpose frame. The component–purpose relationships then identify Carbon and Emissions (CA) and Energy Systems (EN) as directly relevant operational domains: CA provides the emissions-accounting basis, while EN identifies the photovoltaic and storage configuration through which the burden is generated or altered. The analysis can then return to G03, District Energy Performance, and to the PED-specific provisions and published evidence examined in Section 4.4. In that evidence, greater storage improves selected energy-performance measures while increasing embodied carbon [75]. Reading the same evidence from a carbon-reduction objective therefore changes which criterion governs the environmental claim, without making the accompanying energy-service consequences irrelevant. The value of the reverse reading lies in making this relationship explicit: the purpose identifies the relevant criterion, the components locate the mechanisms to examine, and the approach evidence establishes what those mechanisms actually support. Table 6 summarizes this reverse interpretation. Contextual feasibility and achieved project performance remain subsequent matters of appraisal and verification.

Table 6. Purpose-led reinterpretation of the positive energy district example.

Analytical Step	Guiding Question	Interpretation within the PED Example
Specify the intended result	What environmental condition should change?	Reduce the embodied-carbon burden of the energy configuration within a declared system boundary, while keeping the required energy service explicit.
Identify the environmental purpose	What defines environmental success?	F2, Impact Mitigation and Emissions Management, frames the claim because success is defined by reduction in a specified environmental burden. Energy-performance measures remain distinct criteria and cannot substitute for the carbon result.
Identify relevant operational mechanisms	Which operational relationships are relevant to that result?	CA provides the emissions-accounting basis, while EN identifies the photovoltaic and storage configuration whose energy and carbon consequences are examined.
Return to approach-specific evidence	Where are the relevant mechanisms and outcomes evidenced?	G03 identifies the relevant approach group, while PED-specific provisions and the published storage comparison establish the applicable mechanisms, boundaries, and evidenced outcomes. Greater storage improves selected energy measures while increasing embodied carbon, showing why the governing environmental criterion must remain explicit.

Source: Authors' analytical reinterpretation of the PED evidence examined in Section 4.4. Note: PED = Positive Energy District; CA = Carbon and Emissions; EN = Energy Systems. Contextual feasibility and achieved project performance require subsequent appraisal and verification.

5. Discussion

The findings reposition the problem of environmental-community fragmentation. The 33 Qualified Approach Scopes are neither autonomous environmental systems nor interchangeable expressions of a single model; they constitute differentiated configurations within a shared operational field. The 14 Analytical Approach Groups retain distinct conceptual and institutional commitments, while the seven Core Operational Components reveal recurrent ways through which environmental action is organized. The four Environmental Logic Families add a further distinction by separating operational mechanisms from the forms of environmental success they may serve. The central theoretical contribution is therefore not a more orderly taxonomy, but a change in the unit of analysis: approach identity, operational configuration, environmental purpose, and evidence of performance are treated as connected but non-equivalent levels. This explains how operational convergence can coexist with meaningful conceptual and institutional differentiation.

This interpretation extends earlier work on overlap among sustainable, smart, resilient, low-carbon, ecological, and related urban concepts [2,16]. That literature established that

such concepts intersect and borrow from one another; the present findings clarify what that overlap means analytically. Shared mechanisms do not make approaches synonymous, while different labels do not imply operational independence. Approaches may share energy, water, resource, ecological, adaptive, or governance mechanisms while differing in defining commitments, accounting boundaries, institutional arrangements, and success criteria. The field is therefore better understood as a structured system of recurrent mechanisms configured around different commitments and purposes, rather than as either isolated models or superficial synonyms.

The distinction between mechanism and purpose is critical because environmental meaning cannot be assigned to a component or technology in isolation. Energy systems may support efficiency, emissions mitigation, or robustness depending on the mechanism and criterion applied; water systems may support conservation, pollution reduction, continuity, flood response, or ecological restoration. The Positive Energy District worked interpretation in Section 4.4 makes the consequence explicit: within the same photovoltaic configuration, greater storage improves selected energy-performance measures while increasing embodied-carbon and resource-depletion burdens [75]. Improvement under one environmental criterion cannot therefore be generalized into overall environmental improvement. The Integrated Translation Architecture makes such trade-offs visible by requiring environmental claims to be interpreted through explicit component-mechanism-purpose relationships and evidence appropriate to the criterion being asserted.

The four Environmental Logic Families also expose different questions about the translation of environmental ambition into practice. F1 requires resource savings to be assessed against the delivered service and operating conditions; F2 requires distinctions among gross reductions, net balances, and burdens shifted across accounting boundaries. F3 requires preparedness or installed capacity to be distinguished from function under a specified disturbance, while F4 requires ecological improvement to be assessed against a reference condition and a timescale appropriate to the process. These distinctions connect the evaluative meaning of each logic to the operational conditions under which its purpose can be pursued, without treating implementation difficulties as universal deficiencies in particular approaches.

The same separation helps explain why design-stage ambition may diverge from operational performance. A requirement, certification, installed system, or institutional commitment is not evidentially equivalent to a monitored outcome. Continuing performance depends on how systems are operated, maintained, adjusted, and supported by users and institutions. Research on Positive Energy District transitions similarly treats implementation as a staged process involving technical arrangements, users, institutions, and participation [15]. Occupant-behaviour and community-energy studies likewise show why intended or simulated performance cannot be assumed to reproduce operating conditions automatically [78,79]. Perception, trust, participation, social acceptance, and other psychosocial conditions can therefore influence operational continuity. The available evidence does not justify treating community education as an independently demonstrated causal driver of environmental performance; it is better understood as an enabling condition whose influence depends on whether knowledge is translated into participation, operating practices, maintenance, and feedback.

Governance, information, and finance extend this argument from operation to feasibility. The finding that GOV/DATA enables all four Environmental Logic Families reflects the recurrent importance of authority, coordination, responsibility allocation, monitoring, participation, financing, and feedback. These functions support environmental action but are not themselves evidence of environmental success. Research on urban nature-based solutions and comparative implementation similarly emphasizes institutional capacity, part-

nerships, finance, reporting, and responsibility allocation [14,77]. These conditions become particularly consequential in low- and middle-income and other resource-constrained settings, where data availability, maintenance capability, institutional capacity, and investment priorities may differ substantially from assumptions embedded in standardized assessment systems [12]. Formal certification and adaptive or regenerative approaches therefore impose different forms of implementation burden rather than a simple hierarchy of cost: the former may concentrate resources on documentation, verification, data, and compliance, while the latter may require continuing stewardship, coordination, maintenance, local capability, and long-term financing.

The practical relevance of these findings follows from the explanatory structure established above. Section 4.5 shows how the same analytical relationships can be read from a specified environmental purpose towards relevant mechanisms and approach-specific evidence. This purpose-led interpretation provides a traceable basis for examining why particular mechanisms are relevant to a stated environmental result while retaining their technical, institutional, and evidential conditions. Its value lies in making that relevance explicit across differently named approaches; whether analytically relevant mechanisms are feasible, preferable, or sufficient in a particular context requires subsequent appraisal, and whether this use improves professional judgement or environmental outcomes remains an empirical question. Figure 3 illustrates the forward analytical derivation and the purpose-led interpretive reading.



Figure 3. Forward analytical derivation and purpose-led interpretive reading. The shared analytical levels connect Qualified Approach Scopes, Analytical Approach Groups, Core Operational Components, and Environmental Logic Families. The forward direction represents the analytical derivation through which these relationships are established, while the reverse direction illustrates their purpose-led interpretive use. Contextual feasibility and outcome verification remain subsequent requirements. Source: Authors' analysis.

The claims of the study remain bounded by its documentary and conceptual design. Sections 4.4 and 4.5 illustrate two complementary uses of the same Integrated Translation Architecture: a forward interpretation from approach identity through operational configuration to environmental purpose, and a purpose-led interpretation from a specified environmental result towards relevant mechanisms and approach-specific evidence.

Neither constitutes independent causal validation or demonstrates improved environmental outcomes. The evidence base also remains heterogeneous in geography, scale, institutional form, inspection depth, and implementation stage, while the categorical matrices describe documented analytical relationships rather than their prevalence, universal necessity, or implementation strength. Further research should therefore test coding stability and the Integrated Translation Architecture through independent and longitudinal cases, examine the stability of component–purpose relationships across institutional and socioeconomic contexts, and compare intended configurations with measured outcomes over time. Applied research can subsequently examine how contextual feasibility and purpose-led interpretation influence professional judgement and environmental outcomes. The present study therefore establishes the analytical basis for comparing and interpreting environmental-community approaches without allowing label identity to stand in for operational configuration, environmental purpose, or demonstrated performance.

6. Conclusions

This study clarifies a central analytical problem in environmental-community research that extends beyond the proliferation of terminology itself. The difficulty is not simply that numerous environmental labels coexist, overlap, and evolve but that the label can substitute for questions that should remain analytically distinct: what an approach represents, how it operates, what environmental purpose its mechanisms serve, and what evidence demonstrates that the intended result has been achieved. The findings move the debate beyond whether environmental-community approaches are wholly distinct environmental models or merely interchangeable expressions of a common environmental agenda. They instead reveal differentiated configurations within a shared operational field, in which approaches retain meaningful conceptual and institutional identities while drawing on recurrent operational domains. This interpretation also provides the analytical basis for a purpose-led reading in which environmental purpose can guide the examination of relevant mechanisms and approach provisions.

The analysis establishes this structure through four connected but non-equivalent levels. Thirty-three Qualified Approach Scopes are organized into 14 Analytical Approach Groups, which are examined through 7 Core Operational Components and related to 4 Environmental Logic Families representing distinct environmental purposes and criteria of success: resource optimization and efficiency, impact mitigation and emissions management, system robustness and adaptive capacity, and ecological regeneration and co-evolution. These levels are not successive reductions in a single taxonomy. They answer different analytical questions. Shared operational components therefore do not make approaches equivalent, component presence does not determine a single environmental purpose, and intended environmental purpose does not establish achieved performance without corresponding evidence.

The principal conceptual novelty lies not in proposing another classification of environmental-community models, but in changing the analytical unit through which the field is interpreted. Approach identity is separated from operational configuration, operational configuration from environmental purpose, and environmental purpose from demonstrated performance, before these dimensions are reconnected through the Integrated Translation Architecture. The four Environmental Logic Families are therefore not higher-order labels, but purpose categories distinguished by different criteria of environmental success. The architecture supports two complementary readings of the same analytical relationships. In the forward direction, relationships are derived from approaches toward operational components and environmental purposes. Once established, those relationships can also be read in reverse from a specified environmental purpose toward

the components, mechanisms, and approach configurations capable of serving it. The reverse reading therefore extends the interpretive use of the architecture while remaining grounded in the relationships established through the forward analysis.

This distinction has implications for both scholarly interpretation and practice. For research, environmental approaches should not be compared solely through nominal categories, nor should environmental purpose be inferred automatically from a technology, component, certification, or institutional designation. Interpretation instead requires explicit attention to mechanism, purpose, criterion of success, system boundary, and evidential stage. For practice, the Integrated Translation Architecture allows environmental purpose to become an entry point for examining relevant mechanisms and approach provisions rather than treating any label as a complete response. The Environmental Logic Families clarify the environmental end, the Core Operational Components identify the relevant operational domains, and the Analytical Approach Groups and Qualified Approach Scopes indicate where documented mechanisms and institutional routes can be examined. This purpose-led reading strengthens the comparability and traceability of environmental choices while leaving contextual feasibility and achieved performance to subsequent appraisal and verification.

The study does not claim that one environmental-community approach is superior to another, that the four Environmental Logic Families constitute a universal environmental model, or that a fixed configuration can be prescribed independently of context. The Integrated Translation Architecture establishes analytical relationships among approach identity, operational configuration, environmental purpose, and evidence of performance, while contextual application remains dependent on financial capacity, governance capability, institutional readiness, infrastructure, social and behavioural conditions, and implementation continuity. Future research should therefore test coding stability and the Integrated Translation Architecture through independent and longitudinal cases, examine the stability of component–purpose relationships across contrasting institutional and socioeconomic contexts, and compare intended configurations with measured outcomes over time. The contribution of the present study is therefore not to replace existing environmental approaches with a new model, but to provide a shared analytical language for understanding how they converge, where they differ, and how their mechanisms relate to different environmental purposes. Operational components explain how approaches work; Environmental Logic Families clarify the ends they pursue. Connecting these levels provides a coherent foundation for understanding environmental-community approaches beyond the label.

Supplementary Materials: The following supporting information can be downloaded at <https://www.mdpi.com/article/10.3390/urbansci10100587/s1>, Table S1: Analytical operations and units; Table S2: Eligibility and characterization rules; Table S3: Reconciliation of candidate records; Table S4: Grouping and evidence rules; Table S5: Fourteen Analytical Approach Groups and complete scope membership; Table S6: Grouping boundary tests and retained decisions; Table S7: Coding rules for the 33×14 scope–group relationship audit; Table S8: Scope–group relationship matrix for the 33 Qualified Approach Scopes; Table S9: Scope-level audit of primary assignment, explicit links, operational intersections, and evidential boundaries; Table S10: Cell-level audit of every accepted non-primary scope–group relationship; Table S11: Boundary tests for secondary scope–group relationships; Table S12: Named Instruments retained as a separate analytical layer; Table S13: Prior studies and the specific contribution of the present synthesis; Table S14: Contribution established by the comparative evidence; Table S15: Derivation and operational boundaries of the seven Core Operational Components; Table S16: All 21 pairwise component boundary comparisons; Table S17: Alternative component structures and residual concerns; Table S18: Operational configuration of the 14 Analytical Approach Groups; Tables S19–S32: Group–component decisions and source

warrants for Analytical Approach Groups G01–G14; Table S33: Environmental Logic Families and distinguishing success criteria; Table S34: Six contrasts separating the four Environmental Logic Families; Table S35: The same Water Systems component under four different assessment criteria; Table S36: Purpose dependence of governance and information mechanisms; Table S37: Qualitative tests of alternative Environmental Logic Family structures; Table S38: Relationships between Core Operational Components and Environmental Logic Families; Table S39: Passage warrants and inference boundaries for all 28 component-purpose relationships; Table S40: Joint interpretation of connected components and purposes; Table S40a: Mechanism tests for an illustrative district GHG objective; Table S41: Published Positive Energy District storage scenarios; Table S42: Recalculated large-versus-small storage contrast; Table S43: BREEAM Communities issues with distinct requirements, credits, and weights; Table S44: Elmsbrook carbon balances under alternative emissions-factor sets; Table S45: Documentary Evidence Contrasts and Discriminating Tests; Table S46: Institutional and evaluation pathways beyond certification; Table S47: Documented Institutional, Project, and Geographical Evidence Across the Fourteen Analytical Approach Groups; Table S47a: Countries represented in the C40 pilot announcement; Table S47b: Country frequencies in the retained BREEAM Communities register; Table S47c: Geographical enumeration of the retained Biophilic Cities directory; Table S47d: U4SSC report entries and distinct jurisdictions by country; Table S48: Evidence stages and permissible claims; Table S49: Source composition and non-additive analytical roles; Table S50: Complete classified source and inspection ledger; Table S51: Complete candidate census with provenance and final treatment; Table S52: Exact-label follow-up search log; Tables S53.1–S53.8: Source readings on labels, circularity, resilience and ecology, water, assessment, energy, governance, and project and case evidence; Tables S54.1–S54.34: Passage records for cited references; Table S55: Complete retained BREEAM Communities certificate-stage records. References [80–181] are cited in the Supplementary Materials.

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