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BEMS Delivery Framework

Defining the Standard for Building Energy Management System Delivery

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Introduction

This framework has been developed to improve engineering quality, consistency, and transparency within the Building Energy Management Systems (BEMS) industry.

Its purpose is to provide a structured and measurable delivery framework that allows clients, consultants, contractors, and operators to clearly define, benchmark, and verify the level of BEMS capability being procured and delivered.

By establishing progressive delivery levels and clearer scope expectations, the framework aims to reduce ambiguity within specifications, minimise vague or under-defined tender submissions, and support fairer comparison of contractor proposals.

The wider objective is to help raise engineering standards across the industry, improve long-term maintainability and operational outcomes, and encourage a more professional, accountable, and future-ready approach to BEMS delivery.

Why this framework matters?

Improving engineering quality, consistency and transparency across the Building Energy Management Systems industry.

Competition Law Statement

BCIA and users of this Framework must comply with all applicable competition laws. This Framework is intended solely to describe technical capability levels and procurement outcomes. It does not recommend or prescribe prices, costs, margins, market behaviour, commercial strategies or supplier selection decisions. All suppliers must independently determine their pricing, commercial terms, technical solutions and market strategy. The Framework is voluntary guidance and should not be used to restrict competition or exclude suppliers.



BEMS DELIVERY LEVELS FRAMEWORK (L0-L5)

A structured roadmap from minimal requirement installations through to fully autonomous, smart and data-driven buildings.



1. BEMS Delivery Levels Framework (L0-L5)

This document defines a structured BEMS Delivery Levels Framework, providing a clear roadmap from minimal requirement installations through to fully autonomous, smart and data-driven buildings.

By setting out six progressive levels (L0-L5), it establishes common expectations for clients, contractors, consultants and manufacturers. The framework describes the scope, protocols, data backbone requirements, spare capacity provisions, commissioning requirements and governance standards appropriate to each level.

It is designed to reduce ambiguity in project specifications, support consistent delivery and safeguard against "smartwashing" by clarifying what "smart" truly means at different stages of maturity.

1.1 The Six Delivery Levels

L0 - Minimal / Legacy
Standalone equipment controllers operating independently. No central building management, no integration, minimal documentation. Suitable only where capital cost is the sole driver and operational visibility is not a project requirement.



L1 - Base Build BEMS
Entry Level BEMS. A centralised system providing basic control, monitoring, scheduling and alarming for core HVAC plant. The starting point for professional building management and the foundation for any future upgrade.



L2 - Integration Ready
Multi-system integration platform. Brings third-party plant, packaged equipment and utility metering under unified management, with structured data, naming conventions and a BACnet/IP backbone designed for future expansion.



L3 - Smart Enabled
Semantic data, API readiness and tenant-facing capability. The threshold of "smart" building. Supports analytics, ESG reporting, modern FM tools and tenant interfaces. Good practice today for most owner-occupied and premium commercial buildings.



L4 - Data-Driven Smart
Enterprise-grade building data platform. Cloud/hybrid architecture, unified semantic models across buildings, predictive maintenance and digital twin capability. Typically owned or co-managed by central IT or digital teams rather than site facilities management alone.



L5 - Smart & Autonomous
AI-driven autonomous operation with grid interaction, self-healing systems and portfolio-level intelligence. Reserved for flagship projects, innovation buildings and organisations with the operational maturity to use autonomy effectively.



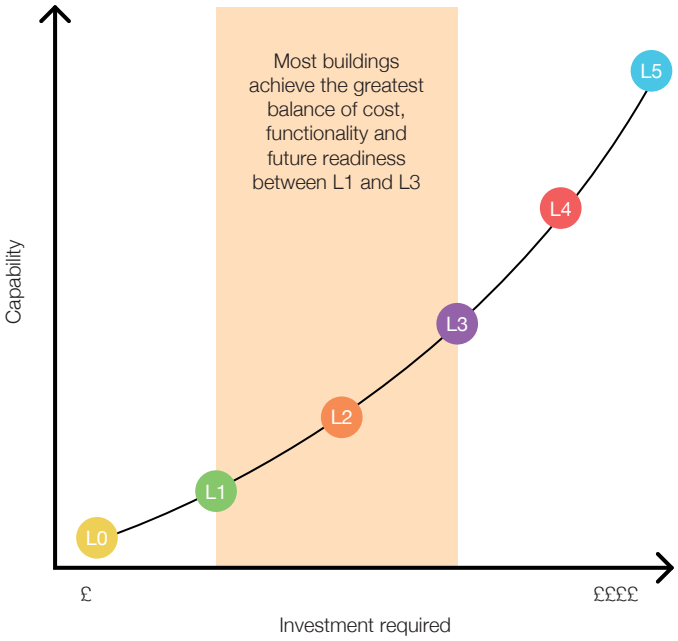
1.2 The Framework At A Glance

Level	Plain Summary	Typical Use	Cost vs L1	Backbone
L0	Standalone controls; no BEMS	Small industrial, warehouse, basic retail	Lower	None / proprietary
L1	Entry Level BEMS	Cost-focused commercial, small offices, base build	Baseline (1.0x)	Simple unmanaged; copper
L2	Integration platform	Office buildings, retail complexes, healthcare	~1.15-1.25x	Star topology, fibre risers, BBMDs
L3	Smart-enabled, API-ready	Premium offices, corporate HQ, ESG-focused	~1.30-1.50x	Redundant ring or dual-star
L4	Enterprise data platform	Corporate campuses, large portfolios, life sciences	~1.60-2.00x	Scalable cloud / hybrid
L5	Autonomous, grid-integrated	Flagship, innovation, net-zero	~2.00-3.00x	Elastic cloud-native / distributed

1.3 Cost Vs Capability

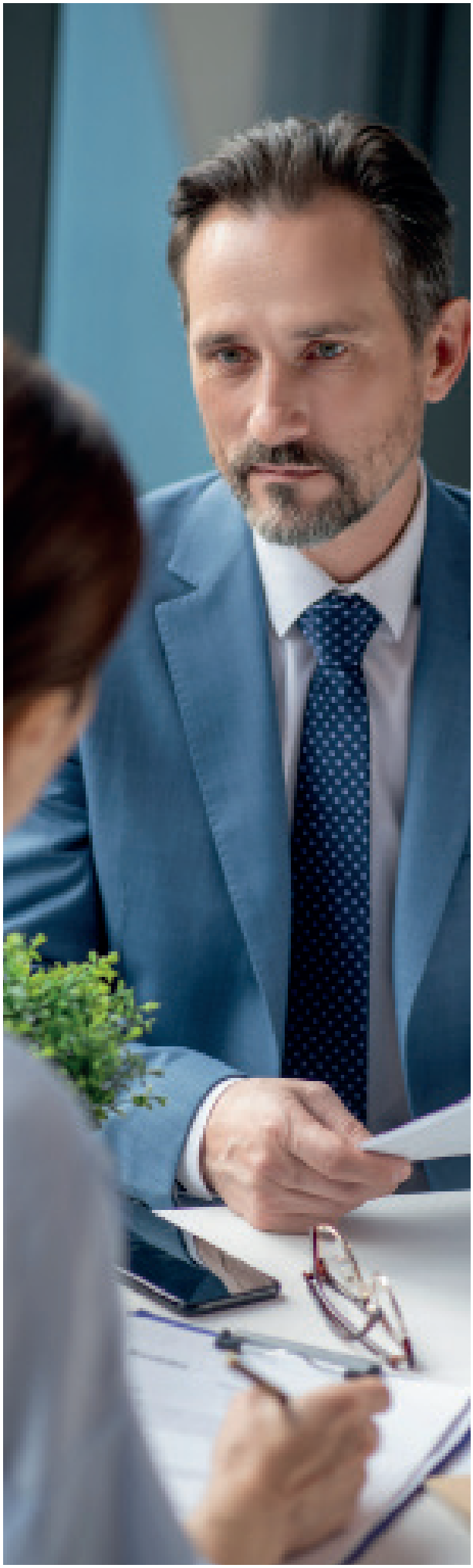
Capital and operational cost rise with Delivery Level, but the cost curve and the benefit curve do not run in parallel.

The most cost-effective increments are typically L1 to L2 and L2 to L3. The steps from L3 to L4 and L4 to L5 involve substantial organisational and operational investment in addition to technology, not technology alone.



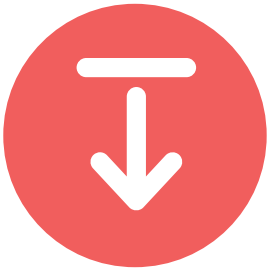
Indicative capital cost ratios are shown in the table above; these depend heavily on the building, the team and the existing infrastructure.

The benefits curve has its own shape: the step from L0 to L1 typically delivers very large value as building management is introduced as a discipline; L1 to L3 captures the majority of operational and reporting value for most buildings; L4 and L5 deliver disproportionate value only where the operational organisation is mature enough to use them effectively.



1.4 Risks Of Choosing The Wrong Level

Misalignment between the chosen Delivery Level and the project's actual needs is the single largest source of disappointment with delivered BEMS. The risks fall into four broad categories:



Choosing too low.

Under-specification at base build typically results in expensive retrofit later. Network backbone, naming conventions and controller choices made at L1 can constrain upgrade options for the life of the building. Where future capability is foreseeable, specifying at the outset typically costs a small fraction of retrofit.



Choosing too high.

Over-specification delivers capability that the operational organisation cannot use effectively. Sophisticated systems require sophisticated operation; without the FM capability and ongoing investment to match, advanced functionality reverts to underuse and disappointment with the technology.



Mismatching scope to level.

Procuring an L3 platform without semantic tagging discipline at handover, or an L4 platform without the data quality regime to maintain it, typically delivers worse outcomes than a well-executed lower level.



Treating the level as a tickbox.

Tender submissions that claim alignment with a Delivery Level without substantive evidence are a recognised risk in the BEMS sector. The Acceptance Framework section of this document sets out how alignment is verified at handover.

PURPOSE & APPLICATION

Providing a common language for defining, procuring, delivering and verifying BEMS capability.



2. Purpose & Application

This framework is intended as guidance to support a consistent definition and delivery of BEMS capability levels.

It does not constitute a specification or contractual requirement unless explicitly adopted within project documentation.

Values, benchmarks, and examples are indicative of typical good practice and may be adapted to suit project-specific requirements.

2.1 Purpose

This framework defines typical expectations and progressive requirements for the delivery, commissioning and handover of Building Energy Management Systems (BEMS) across all project types.

It provides a common language for consultants, contractors and facility teams to ensure consistency, transparency and quality from design through to operation.

Each level (L0-L5) represents a defined standard of scope, integration and performance.

2.2 Intent

The intent of this framework is to align pricing, delivery and final system capability expectations for Building Energy Management Systems (BEMS) across clients, end users, consultants and BEMS contractors.

The framework provides a common, outcome-based reference that enables project teams to clearly define what level of BEMS capability is being procured, without requiring excessive technical detail at tender stage.

By establishing a set of progressive Delivery Levels (L0-L5), the framework allows clients and consultants to select the minimum acceptable level of system functionality, integration and future-readiness appropriate to the project.



Outcome-Based Procurement

A framework that defines capability and outcomes rather than products and vendors.

Each Delivery Level defines the baseline scope, performance expectations, commissioning requirements and governance characteristics that should be achieved at handover, while still allowing detailed system design, configuration and optimisation to be developed post-award. The framework is intentionally vendor-agnostic and solution-neutral, focusing on deliverable outcomes rather than specific products or implementations.

A key objective of the framework is to reduce ambiguity during procurement and enable fair, transparent comparison of tender submissions.

By requiring bidders to explicitly confirm alignment with the selected Delivery Level and to clearly state any assumptions, exclusions, or deviations, the framework makes it more difficult for incomplete or low-cost proposals to succeed through misunderstanding or exploitation of loosely defined BEMS specifications.

Reduce ambiguity during procurement and enable fair, transparent comparison of tender submissions.

The framework recognises that detailed design, integration and commissioning remain essential to successful delivery.

It does not replace good engineering practice; rather, it ensures that design and commissioning effort is directed toward delivering the intended level of capability, rather than resolving scope disputes post-contract.

While no framework can eliminate poor practice entirely, this approach raises the minimum standard of delivery, supports consistent outcomes, and provides clients and operators with a defensible basis for verifying that the delivered BEMS meets the capability level that was procured.

This framework is intended to be read in conjunction with project-specific specifications and does not remove the requirement for detailed system design and commissioning.



2.3 Performance Targets & Baseline Methodology

Quantitative performance indicators referenced throughout this framework (for example, percentage energy improvements, uptime targets, predictive accuracy thresholds, and ROI ranges) are indicative values drawn from typical industry experience and published case studies for BEMS projects of comparable scope and maturity.

They are not guaranteed outcomes and should not be relied upon as performance warranties.

Important

Performance figures are indicative and should not be treated as guaranteed outcomes.

Actual outcomes depend on the building's starting condition, occupancy profile, plant configuration, operational regime, and the quality of design, commissioning and ongoing operation.

Where percentage improvements are quoted, the implied baseline is typical performance of a building operating at the immediately preceding Delivery Level (e.g. L3 improvement figures are quoted relative to typical L1/L2 operation).

Project teams adopting this framework should establish project-specific baselines and performance targets through measurement and verification protocols suited to the building and the level being procured.

2.4 Cost & Effort Estimating Methodology

The engineering and commissioning effort figures expressed throughout this framework are per-point base estimating rates. They represent the effort to deliver each point individually and are intended as the starting point for estimation rather than a final or fixed quantity. The worked examples shown at each Delivery Level apply these base rates directly to the stated point count to illustrate the realistic scale of effort involved; they are not a quotation and do not constitute a recommended or required project duration.

On larger or repetitive installations the estimator should apply professional judgement to reduce these rates where economies of scale apply. Most of the per-point effort sits in activities that are front-loaded or template-driven rather than genuinely repeated point by point: point-to-point commissioning remains broadly linear, as each physical point is verified individually, whereas integration, semantic tagging, graphics, interface, API, metering and messaging configuration are largely established once and replicated across like assets. Economies of scale should therefore be applied to these scalable components in proportion to the repetition present in the design, rather than as a flat discount across the whole figure.

All cost, effort, ROI and resource figures are illustrative only and must not be used as recommended, expected, standard or minimum market pricing. Contractors remain solely responsible for independently determining their commercial terms and pricing.

Where ROI metrics are provided they are indicative only and project dependent.

2.5 Objectives

- Establish clear expectations for the design, installation, commissioning, and documentation of BEMS.
- Support accurate pricing and reduce risk by defining deliverables at each maturity level.
- Enable consistent quality assurance across new build, retrofit and refurbishment projects.
- Provide measurable outcomes for system performance, usability and data quality.

Framework Outcome

A consistent, measurable and transparent approach to defining, procuring and delivering BEMS capability.

2.6 Application

This framework is intended for inclusion within:

- Project specifications and employer's requirements.
- Institutional design and construction guidelines.
- Tender documentation and BEMS scope definitions.

The recommended delivery level (L0-L5) should be identified by the client or consultant at project initiation and verified through commissioning and handover.



2.7 Delivery Level Selection & Risk

Where a Delivery Level is selected that is lower than the building's future operational or performance aspirations, clients and project teams should be aware of the inherent functional limitations of that level, together with the potential cost, disruption and re-commissioning implications that may be associated with any future upgrade.

This consideration is provided as guidance to inform decision-making and does not constitute a contractual acceptance.

Selection of a Delivery Level defines the minimum technical capability, integration depth and future-readiness of the BEMS.

Capabilities not included within the selected level should be treated as variations if required post-award or post-handover.



2.8 Adoption & Precedence

This framework is guidance and does not of itself constitute a contractual specification.

Where a project wishes to adopt the framework on a contractual basis, this is achieved by referencing the framework and the selected Delivery Level within Employer's Requirements or the Project Specification.

Example Adoption Wording

(tailored to suit specific project context and procurement route)

Where referenced in Employer's Requirements, the selected Delivery Level shall define the minimum acceptable scope, integration depth, commissioning and handover requirements for the delivered BEMS. The contractor shall align tender submissions, design, installation and commissioning evidence with the requirements of the selected Delivery Level, in accordance with this Framework.

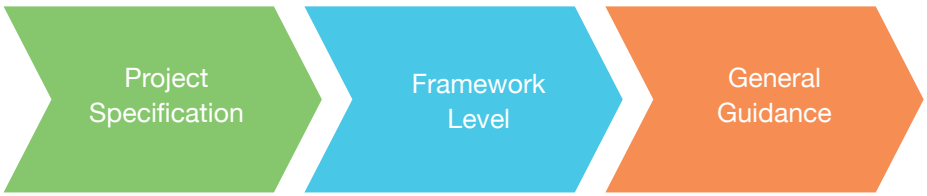
2.9 Order Of Precedence

Where the requirements of the Project Specification differ from the typical expectations of the selected Delivery Level, the Project Specification takes precedence.

Project-specific drawings, schedules and specifications continue to define the technical detail of the delivered system.

The following order of precedence is recommended where the framework is adopted:

In the event of conflict:



This means that:

- Project-specific requirements documented in tender, specification or contract documents take precedence over the typical expectations described for the selected Delivery Level.
- The typical expectations of the selected Delivery Level take precedence over the cross-cutting general guidance contained elsewhere in this Framework.
- Where the framework or the project-specific specification is silent on a particular matter, established good engineering practice applies.

DELIVERY FRAMEWORK

Defining how BEMS capability should be specified, delivered, measured and verified.



3. Delivery Framework

This section explains how the Delivery Levels should be applied in practice.

It sets expectations for scope, protocols, governance, future expansion capacity, network backbone design, commissioning requirements, skills and training and performance metrics, aligned with project scale (small, medium, large).



Each higher Delivery Level builds on the requirements of the levels below.

For example, if graphics are introduced at Level 1, they remain a requirement at Levels 2 - 5, with further enhancements as specified.

This ensures continuity, prevents omissions and provides a clear progression path from basic functionality to fully autonomous operation.

Progressive Capability

Every level builds on the capability delivered by the level below.

Project scale definitions are provided for indicative system sizing and governance only. Project scale does not directly equate to engineering simplicity or required competency. Engineering effort and risk are primarily driven by system complexity, integration requirements, strategy sophistication, commissioning constraints and operational criticality, not solely by controller or device count.

Scale Definitions (Project Size)

- Small-scale: up to ~100 devices/nodes (~1,000 points).
- Medium-scale: 100-500 devices/nodes (~10,000 points).
- Large-scale: 500+ devices/nodes (20,000+ points, multi-building campus).

Projects with high device density, complex control strategies, multi-system interaction, or live operational constraints may require higher delivery controls, governance, or competency than suggested by device count alone.

Nodes = controllers/automation stations/devices.
Points = data/control objects.

3.1 Framework Application Guidelines

Rule of Thumb for the Framework

Level 1 = Base Build (Entry Level BEMS)
Level 3 = Smart Enabled (good practice today)
Level 5 = Smart & Autonomous (future-ready leadership)

BIM LOD Alignment

L1-L2 ≈ LOD 300 (defined systems, basic integration)
L3-L4 ≈ LOD 400 (detailed integration, API-ready)
L5 ≈ LOD 500+ (operational intelligence, digital twin maturity)

3.2 Specification Guidance

When specifying projects:

1. Define minimum level based on project requirements
2. Include cost implications for informed decision-making
3. Specify commissioning requirements for each level
4. Define ongoing support model and skills needed
5. Set measurable performance targets appropriate to the level

3.3 Roles & Responsibilities

Stage	Primary Responsibility	Description / Requirement
Design	Mechanical / BEMS Consultant	Select appropriate BEMS Delivery Level and define system boundaries, control intent, and integration scope.
Procurement	Client / Contractor	Ensure BEMS tender documentation references the selected delivery level and includes the associated commissioning, graphics, and documentation requirements.
Construction	BEMS Contractor	Deliver the system to the defined level, coordinate integration with other systems, and ensure all documentation and testing meet framework standards.
Commissioning	Commissioning Agent / Owner's Representative	Validate that delivered systems comply with the specified framework level through functional testing and performance verification.
Operations	Facilities Management / Building Owner	Maintain delivered functionality, data quality, and connectivity in line with the achieved framework level.



Accountability Matters

A successful BEMS is not achieved through technology alone. Clear ownership and accountability are required throughout design, delivery and operation.

3.4 Manufacturer Agnosticism & Compliance

The framework is intentionally manufacturer-agnostic and does not endorse or favour any specific BEMS hardware, software, or control system vendor.

The Level standards and requirements defined herein can be achieved using products from any reputable manufacturer whose systems support open protocols (BACnet/IP or Modbus TCP).

However, while this framework provides overarching guidance, installations should follow the specific manufacturer's installation guidelines, commissioning procedures and technical specifications for the chosen equipment, in line with applicable warranty and safety requirements.

Where manufacturer recommendations conflict with or exceed the requirements in this guide, the manufacturer's guidance takes precedence for that specific product.

This approach ensures both system openness and vendor independence while maintaining equipment warranty, safety compliance and optimal performance. Contractors and designers remain responsible for selecting appropriate products and following manufacturer-specific requirements throughout design, installation, commissioning, and maintenance phases.

Vendor Neutral by Design

The framework focuses on outcomes and capability rather than specific manufacturers or products.

3.5 Tender Submissions – General Principles

Tender submissions under this Framework are intended to provide **clear, proportionate and decision-ready** information to support informed procurement and delivery. Submissions should be aligned to the specified Delivery Level and should focus on **clarity of intent rather than volume of detail**.

Tenderers are recommended to clearly state **what is included and what is excluded** within their proposal, together with any key assumptions or deviations, to enable clients, operators and engineering teams to make informed, comparable, and risk-aware decisions.

Detailed engineering, configuration, and optimisation should be developed post-award unless explicitly required. Submissions that are ambiguous, rely on implied capability or obscure scope boundaries are discouraged, as the purpose of the tender stage is to establish a shared and transparent understanding of the proposed solution prior to commitment.

Tenderers should determine their pricing independently and in accordance with their own commercial judgment. The selected Delivery Level is intended only to define capability requirements.

Clarity of intent is more important than volume of detail.

ACCEPTANCE FRAMEWORK

Verifying that delivered systems achieve the capability level specified and procured.



4. Acceptance Framework

This section sets out the principles for verification, sign-off and acceptance of a BEMS delivered against this Framework.

It defines who signs off at each stage, what constitutes acceptance, the evidence expected at handover, and the route to be followed where the acceptance thresholds described in the level chapters are not met.

The principles in this section apply across all Delivery Levels. The specific acceptance criteria and pass thresholds for each level are defined within the relevant level chapter, under Commissioning & Handover.

4.1 Sign-Off Authority

The following table summarises typical sign-off responsibilities through the project lifecycle. On any given project these should be confirmed within the project execution plan and adjusted to reflect the procurement route and team structure.

Stage	Sign-Off Authority	Acceptance Basis
Design Acceptance	Mechanical / BEMS Consultant or Lead Designer	Delivery Level selected and documented; project-specific specification developed in alignment with the selected level.
Tender Acceptance	Client / Contractor (with consultant support)	Submissions confirm alignment with the selected Delivery Level; assumptions, exclusions and deviations clearly stated and assessed.
Installation Acceptance	Site Supervisor / Project Manager	Installation completed in accordance with manufacturer guidance and project documentation; installation records maintained.
Commissioning Acceptance	Commissioning Agent / Owner's Representative	All level-specific acceptance criteria met; pass threshold achieved; evidence pack complete and witnessed where required.
Final Acceptance (Handover)	Client / Owner	Beneficial use achieved; documentation pack delivered; training completed; defects rectification period agreed.

4.2 What Constitutes Acceptance

Formal acceptance at each stage requires three elements to be in place:

ONE Criteria met	TWO Evidence supplied	THREE Sign-off recorded
All acceptance criteria defined for the selected Delivery Level in the relevant Commissioning & Handover sub-section have been demonstrated as met, to the documented pass threshold.	A documented evidence pack has been provided demonstrating how each criterion has been verified. Evidence may include witnessed tests, point schedules with test results, network performance reports, screenshots of operating graphics, PIC statements for BACnet devices, certificates of conformance, and training attendance records.	A formal record has been made of the acceptance, identifying the responsible authority, the date, any conditions attached, and any items deferred to the defects rectification period.

Acceptance Requires All Three

Criteria Met + Evidence Supplied + Sign-Off Recorded

Partial acceptance - where the system is accepted into beneficial use subject to outstanding items being completed - is acceptable provided the outstanding items, their owners, and a target completion date are documented and agreed at the time of acceptance.

Undocumented partial acceptances are a recognised source of downstream dispute and should be avoided.



4.3 Evidence Expected At Handover

The following table summarises the minimum evidence types expected at handover for each Delivery Level.

It is indicative; the specific evidence required for any given criterion is defined within the relevant level chapter and project documentation. Higher levels include all evidence types of the lower levels.

Level	Minimum Evidence Pack at Handover
L0	Manufacturer documentation for each piece of equipment; functional test records; safety interlock verification; basic operating instructions.
L1	All L0 evidence plus: complete point schedule (Excel); PIC statements for all BACnet devices; alarm and trend log configuration records; witnessed point responsiveness test; operator training attendance records; as-built drawings.
L2	All L1 evidence plus: integration test results across all third-party systems; gateway and BBMD configuration records; network performance report from 48-hour soak test; documented naming convention and data structure; utility metering verification records.
L3	All L2 evidence plus: semantic tagging validation report (Haystack or Brick); API test results for each exposed API; virtual metering accuracy verification against physical meters; tenant interface acceptance records; access control matrix; data governance approach documented.
L4	All L3 evidence plus: digital twin accuracy validation against the physical building; predictive model performance evidence (test data); cloud / hybrid infrastructure operational records; automated device discovery test results; multi-building data federation evidence where applicable; cyber security baseline evidence.
L5	All L4 evidence plus: AI model validation records from live operation (minimum 4-week proving period); autonomous decision audit trail; demonstrated self-healing event response; penetration test report; grid interaction test records with grid operator; documented human override and fallback arrangements.

The evidence pack should be supplied in a structured format agreed with the Client and indexed against the specific acceptance criteria of the selected Delivery Level.

A standardised evidence index template, where developed by the project team or adopting organisation, supports consistent and efficient acceptance.

4.4 Non-Conformance Routes

Where the acceptance criteria are not met at the scheduled handover date, the following routes are typically available.

The route to be followed in any given case should be agreed between Client, Consultant and Contractor on the merits, and documented at the time of decision.

Route 1

Rectification

The contractor is given a defined period (typically 5 to 20 working days, depending on the nature of the issue) to rectify the non-conformance and present the system for re-test. The cost of re-test is typically borne by the contractor unless the non-conformance is attributable to factors outside the contractor's control.

Route 2

Partial acceptance with deferred completion

The system is accepted into beneficial use with the non-conforming elements documented and a programme agreed for their completion within the defects rectification period. A retention or contra-charge may apply, agreed at the time of partial acceptance.

Route 3

Level downgrade

Where the delivered system materially does not meet the criteria of the selected Delivery Level but does meet the criteria of a lower level, the parties may agree to accept the system at the lower level, with a corresponding commercial adjustment. This route is appropriate only where the lower level represents a coherent, fit-for-purpose outcome for the project.

Route 4

Re-procurement of remediation works

Where remediation by the original contractor is not practical, or where the non-conformance is fundamental, the works may be re-procured from another contractor. This route typically engages contractual remedies and is a last resort.

Documentation is Essential

In all cases, the route agreed and any conditions attached should be documented and signed by the relevant parties at the time of decision. Verbal agreements or undocumented partial acceptances are a recognised source of dispute and should be avoided in all circumstances.

LEVEL 0
MINIMAL / LEGACY

Where building control begins.



5. Level 0 – Minimal / Legacy

Level 0 represents the most basic approach to building control - standalone systems with no central coordination or integration.

This level is characterised by **packaged equipment controllers**, simple time schedules, and **basic local interfaces** operating independently.

Level 0 is typically found in smaller scale installations, small retrofits, or where capital cost is the only consideration.

Level 0 at a glance:

Category	Summary
Delivery Level	L0
Name	Minimal / Legacy
Typical Use	Small industrial, warehouse, basic retail
Integration	None
User Interface	Local controls only
Remote Access	No
Analytics & Reporting	No
Backbone	None / Proprietary

5.1 Scope

- Standalone controls: local thermostats, timeclocks, packaged units.
- No BEMS integration, no remote access.

5.2 Tender Submissions

All Tenderers should provide a formal submission pack aligned with this Framework and the applicable Delivery Level.

Submissions should be sufficiently detailed to allow objective assessment, risk identification, and comparison between proposals.

Tenderers should provide the following as a minimum:

- Confirmation of alignment with Delivery Level 0 of the BEMS Framework
- Detailed Points List identifying all points within scope
- High-level identification of proposed equipment or system type
- Clear statement of scope inclusions (systems and plant covered)
- Summary of assumptions made at tender stage
- Confirmation that manufacturer guidance and statutory requirements will be followed
- Identification of any deviations from Level 0 expectations including brief justification (if applicable).

5.3 Protocols / Interfaces

- Proprietary or none.

5.4 Expectations

- Local comfort only, no monitoring, integration, or analytics.

5.5 Spare Capacity & Backbone

- None expected.
- No structured backbone is provided; any expansion or modification requires additional installation, hardware and reconfiguration, and may require full system replacement.

Upgrade Consideration

Future expansion from Level 0 typically requires significant additional installation work and may necessitate replacement of existing infrastructure.

Network architecture, controllers and field devices are generally not designed for expansion, making upgrades comparatively expensive and disruptive.

5.6 Commissioning & Handover

Functional Testing: All individual equipment operates as designed (on/off, basic sequencing)
Local Interface: HMIs and local controls respond to user input
Safety Systems: All safety interlocks and limit controls functional
Documentation: Manufacturer's standard documentation provided
Pass Threshold: 100% of installed equipment functionally operational

5.7 Skills & Training

- Basic plant operation knowledge
- Local manufacturer training only

5.8 Maintenance & Support

- Reactive maintenance only
- Manufacturer-specific service requirements
- No remote diagnostics

5.9 Performance Metrics

- System operational/non-operational
- Basic comfort achievement

5.10 Tenant / Occupant / Operator Interface

Local HMIs and basic control panels only. Individual equipment interfaces (packaged unit displays, basic thermostats). No centralised interface available.

Operator Access	Tenant/Occupant Access	Expectations
Direct access to individual equipment controls and basic status displays. Operators interact with each system separately using manufacturer-specific interfaces.	Limited to basic local controls (temperature adjustment, fan speed) where provided by individual equipment.	No unified building interface, all interactions are equipment-specific and local.

5.11 Resilience & Business Continuity

- Single point of failure acceptable
- No backup or redundancy

5.12 Compliance & Standards

- Basic building regulations compliance only
- Manufacturer-specific standards and warranties
- No smart building or energy management standards
- Minimal documentation requirements

5.13 Scale Suitability

- Small-scale only

5.14 Use Case

- Small commercial retrofits, industrial units, warehouses
- Budget-constrained commercial projects
- Basic operational buildings with minimal comfort requirements



5.15 Typical Cost Implications

These are per-point base estimating rates. See 2.4 Cost & Effort Estimating Methodology for applying economies of scale.

5.15.1 Delivery

Basic commissioning: 15 min/point (functional testing of local controls)
HMI demonstration: 5 min/point (local interface training)
Documentation: 2 min/point (basic operation guides)
Total effort: ~22 min/point
Example: 50 points = 18 hours engineering/commissioning

5.15.2 Aftercare

Recommended PPM: Minimum of an Annual visit
Total effort: ~15 min/point

Example

~50 points × 15 min = ~12.5 hours per annum (~1.5 days/year)

5.16 Bridge to Level 1 (Base Build BEMS)

The step from Level 0 to Level 1 is the most fundamental in this framework: it represents the transition from a building with no central building management to one with a coherent, professionally managed BEMS.

This is typically a new installation rather than an incremental upgrade, and effectively introduces building management as a discipline to the project.

L0 L1

The transition from Level 0 to Level 1 typically delivers the largest operational improvement, introducing building management as a discipline and providing visibility into system performance.

5.16.1 What Changes

- Standalone equipment controllers give way to a centralised BEMS with a unified front-end.
- Time scheduling, alarm management and basic trending become available as system-wide capabilities.
- A dedicated network backbone is introduced to connect controllers, even if simple and copper-only.
- Documentation expectations increase substantially: point schedules, PIC statements and as-built drawings become standard handover deliverables.
- An operator capability requirement emerges: someone now needs to know how to use the BEMS.

5.16.2 Typical Upgrade Triggers

- Operational visibility of plant status is identified as a gap during occupation.
- Energy reporting or basic consumption monitoring becomes a project requirement.
- Reactive maintenance is becoming costly due to lack of fault visibility.
- Building Regulations or planning conditions require demonstrable central control of HVAC.

5.16.3 Key Considerations

- Specification quality matters disproportionately at this step: poor naming conventions and unstructured tagging at L1 typically need to be retrofitted at significant cost if the building later upgrades to L3.
- Backbone topology and cabling choices made at L1 strongly constrain future upgrade options. Where future expansion is plausible, structured cabling with spare capacity is worth the modest additional capital cost.



Operator training is essential.

A BEMS that operators cannot use confidently delivers little of the value it was specified for

LEVEL 1
BASE BUILD BEMS

Establishing the foundations of building management.



6. Level 1 – Base Build BEMS

Level 1 establishes entry level BEMS - a centralised system that provides basic control and monitoring of core HVAC plant.

This level focuses on operational safety and reliability rather than optimisation, offering building operators essential visibility into major equipment status and basic scheduling capabilities. While data collection begins at this level, the information is primarily used for reactive maintenance and fault identification.

Level 1 represents the entry point for professional building management and sets the foundation for future system development.

Level 1 at a glance:

Category	Summary
Name	Base Build BEMS
Typical Use	Cost-focused commercial, small offices, base build developments
Integration	Core HVAC systems
User Interface	Graphics, alarms and trend logs
Remote Access	Limited / Optional
Analytics & Reporting	Basic monitoring and trending
Backbone	Simple unmanaged copper network
Resilience	Single server acceptable

6.1 Scope

- BEMS for HVAC plant (AHUs, boilers, chillers, pumps).
- Basic functions: time scheduling, alarms, trend logs, simple graphics.

6.2 Tender Submissions

All Tenderers should provide a formal submission pack aligned with this Framework and the applicable Delivery Level. Submissions should be sufficiently detailed to allow objective assessment, risk identification, and comparison between proposals.

Tenderers should provide the following as a minimum:

- Confirmation of alignment with Delivery Level 1 of the BEMS Framework
- Indicative points list identifying all control, monitoring, and alarm points within scope
- High-level description of the proposed system architecture and control strategy
- Identification of proposed controllers, panels, and operator interfaces
- High-level description of any networked connectivity (local or site-wide)
- Clear statement of scope inclusions and system boundaries
- Summary of key assumptions made at tender stage
- Confirmation that manufacturer guidance and all applicable statutory requirements will be followed
- Identification of any deviations from Level 1 expectations, including brief justification (if applicable)

6.3 Protocols / Interfaces

- BACnet/Modbus enabled but unstructured naming/tagging.

6.4 Expectations

- Plant runs safely and reliably.
- Monitoring only (not analytics-ready).
- Basic graphical interfaces with intuitive navigation.

6.5 Spare Capacity & Backbone

- Controllers with ~10-20% spare I/O.
- Backbone: simple unmanaged core; copper cabling only.
- Limited headroom; future expansion usually requires additional controllers/networking components.



Level 1 provides a foundation for future development, but expansion beyond core HVAC functionality often requires additional controllers, network infrastructure and data structuring.

Where future smart building aspirations are anticipated, early consideration of backbone architecture and naming conventions can significantly reduce upgrade costs.

6.6 Commissioning & Handover

Point Responsiveness: ≥95% of all BEMS points responding and communicating
Graphics Functionality: All plant graphics load and display real-time data
Alarm System: Alarm generation, acknowledgment, and logging functional
Trending: Basic trend logs collecting and storing data
Scheduling: Time schedules executing as programmed
Documentation: Complete point schedule in Excel format, PIC statements for all BACnet devices
Training: Operators demonstrate competency in basic BEMS navigation and alarm management
Pass Threshold: ≥95% system functionality, no critical alarms unresolved

6.7 Skills & Training

- BEMS operator training (8-16 hours)
- Basic graphics navigation
- Alarm acknowledgment procedures

6.8 Maintenance & Support

- Annual service visits
- Reactive fault response
- Basic trending for fault diagnosis

6.9 Performance Metrics

- System uptime (>95%)
- Alarm response times
- Energy consumption monitoring (basic)

6.10 Tenant / Occupant / Operator Interface

BEMS graphics access for FM team and operators. Basic plant overview and alarm displays. No tenant-facing interfaces.

Operator Access	Tenant/Occupant Access	Expectations
Full BEMS graphics access with plant overview, alarm management, and basic trending. Operators can monitor equipment status, acknowledge alarms, and view historical data through simple graphics interfaces.	No direct BEMS interface access.	Building operation is managed entirely by facilities team with no tenant visibility or control over building systems.

6.11 Resilience & Business Continuity

- Single server acceptable
- Manual backup procedures
- 24-48 hour fault response acceptable

6.12 Compliance & Standards

- Basic building regulations compliance
- No specific smart building standards

6.13 Scale Suitability

- Small to lower-medium (<100 devices, <500-2,000 points).

6.14 Use Case

- Commercial developer base builds, cost-focused projects
- Industrial facilities requiring basic plant control
- Small office buildings, retail units

6.15 Typical Cost Implications

These are per-point base estimating rates. See 2.4 Cost & Effort Estimating Methodology for applying economies of scale.

6.15.1 Delivery

- +5-10% over L0
- ROI through basic energy savings (3-5 years)
- Point-to-point commissioning: 15 min/point
- Basic graphics development: 5 min/point
- Data logging setup: 3 min/point
- Graphics testing & training: 2 min/point
- BACnet setup: 5 min/point
- Total effort: ~30 min/point
- Example: 3,000 points = 1,500 hours

6.15.2 Aftercare

Recommended PPM: Minimum of 6 Monthly visit
Total effort: ~15 min/point

Example

~100 points × 15 min = 25 hours per annum (~3 days/year)

6.16 Bridge to Level 2 (Integration Ready)

The step from Level 1 to Level 2 transforms the BEMS from a standalone HVAC controller into an integration platform.

The defining shift is that the system stops being purely about plant control and becomes a vehicle for unifying multiple building systems, third-party plant and utility metering under a single front-end.

Structured data begins to emerge as a deliverable in its own right.

L1 L2

The transition from Level 1 to Level 2 transforms the BEMS from a standalone control system into an integration platform, creating the structured foundation required for future smart building capability.

6.16.1 What Changes

- Third-party systems (packaged AHUs, chillers, submeters) are integrated rather than left as islands.
- Core utility metering (energy, water, gas) is brought into the BEMS as a structured data feed.
- Network topology becomes more substantial: star topology, fibre risers for long verticals, BBMDs for multi-VLAN or multi-building installations.
- Naming conventions become formalised and applied consistently across all integrated systems.
- Operator capability expectations rise to include multi-protocol diagnostics and basic network troubleshooting.

6.16.2 Typical Upgrade Triggers

- Multiple separate systems creating operational complexity for the FM team.
- Energy reporting or sub-metering requirements that exceed what L1 utility data can provide.
- Tenant fit-outs needing visibility of base-build performance.
- Site or campus configurations requiring data flow between buildings.

6.16.3 Key Considerations

- This step is straightforward if L1 was specified with structured cabling and BACnet/IP-capable controllers. Where it was not, network re-cabling typically dominates the upgrade cost.
- Naming conventions agreed at this step set the foundation for any future L3 semantic tagging. Investing in a properly considered convention here saves substantial rework later.
- Resist the temptation to integrate every third-party system that has a protocol. Integration scope should be driven by what data the operations team will actually use.

LEVEL 2
INTEGRATION READY

Connecting systems and preparing for growth.



7. Level 2 – Integration Ready

Level 2 transforms the BEMS from a standalone system into an integration platform capable of connecting diverse building systems under unified management.

This level introduces structured data organisation and the network infrastructure needed to support multiple protocols and vendors.

The emphasis shifts from basic monitoring to comprehensive system visibility, with data beginning to be structured for analysis.

Level 2 creates the technical foundation necessary for smart building capabilities while maintaining practical cost-effectiveness for medium-scale projects.

Level 2 at a glance:

Category	Summary
Name	Integration Ready
Typical Use	Office buildings, retail complexes, healthcare, education
Integration	HVAC plus major third-party systems
User Interface	Enhanced graphics and dashboards
Remote Access	Secure remote access
Analytics & Reporting	Reporting-ready data
Backbone	Star topology, fibre risers, BBMDs
Resilience	Basic network redundancy

7.1 Scope

- Integration of major third-party systems (packaged AHUs, chillers, submeters).
- Core utilities (energy, water) included.



7.2 Tender Submissions

All Tenderers **should provide a formal submission pack** aligned with this Framework and the applicable Delivery Level.

Submissions should be sufficiently detailed to allow objective assessment, risk identification, and comparison between proposals.

Tenderers should provide the following as a minimum:

- Confirmation of alignment with Delivery Level 2 of the BEMS Framework
- Indicative points list identifying all control, monitoring, alarm, and integration points within scope
- High-level description of the proposed system architecture, including controller hierarchy
- Outline description of the network topology and segmentation approach
- Identification of proposed controllers, panels, servers, and operator workstations
- Description of system integration scope (e.g. plant systems, metering, third-party interfaces)
- High-level approach to graphics, alarms, trends, and schedules
- Clear statement of scope inclusions and system boundaries
- Summary of key assumptions made at tender stage
- Confirmation that manufacturer guidance and all applicable statutory requirements will be followed
- Identification of any deviations from Level 2 expectations, including brief justification (if applicable)

7.3 Protocols / Interfaces

- BACnet/IP backbone with BBMDs, Modbus TCP/RTU gateways.
- Consistent naming convention, partial semantic tagging.
- BBMDs introduced if the project spans multiple VLANs/subnets or buildings.
- FDT may be used for commissioning laptops or external/cloud gateways requiring broadcast visibility.
- Machine-to-machine communication capabilities.
- Published APIs for external vendor integration.

7.4 Expectations

- Multi-system monitoring from a single front-end.
- Initial data structure supports analytics.

7.5 Spare Capacity & Backbone

- Controllers with ~20-30% spare I/O.
- Backbone: star topology, fibre risers for >90m verticals, copper for edge.
- 30% spare network ports provisioned.

Level 2 is often considered the most cost-effective foundation for future smart building capability.

The structured backbone, open protocols and integration architecture support progression to Level 3 with relatively limited disruption, provided good engineering discipline has been maintained.

7.6 Commissioning & Handover

Integration Success: ≥90% multi-system integration points communicating correctly
Protocol Validation: All BACnet/Modbus gateways and BBMDs functional
Data Quality: Naming conventions validated, data structure documented
Network Performance: Network uptime >98%, no communication dropouts during 48-hour test
Data Archiving: SQL/MongoDB database operational, automated CSV exports functional
Graphics: Multi-system graphics display integrated data from all systems
Pass Threshold: ≥90% integration success, all critical pathways operational

7.7 Skills & Training

- Multi-protocol integration training (16-24 hours)
- Network troubleshooting basics
- Data export/import procedures

7.8 Maintenance & Support

- Bi-annual service visits
- Remote access capabilities
- Basic trending and analytics

7.9 Performance Metrics

- Multi-system integration success rate
- Data quality metrics (completeness, accuracy)
- Network uptime (>98%)

7.10 Tenant / Occupant / Operator Interface

Enhanced BEMS graphics for operations team. Basic dashboard access for key metrics. Limited tenant reporting capabilities.

Operator Access	Tenant Access	Expectations
Enhanced graphics showing integrated systems with multi-protocol visibility. Operators can access utility consumption data, perform system integration diagnostics, and manage multiple vendor systems through unified interfaces.	Basic dashboard access showing energy consumption summaries and basic environmental data for their areas.	Operators gain significant system integration benefits while tenants receive basic visibility into their space performance.
	Occupant Access	
	Limited environmental feedback through basic displays.	

7.11 Resilience & Business Continuity

- Redundant network paths recommended
- Automated backup procedures
- 12-24 hour fault response expected

7.12 Compliance & Standards

- Energy reporting requirements
- Basic data protection measures

7.13 Scale Suitability

- Medium-scale (100-500 devices, 3,000-10,000 points)

7.14 Use Case

- Commercial tenant fit-outs, office buildings, retail complexes
- Industrial facilities requiring multi-system visibility
- Healthcare facilities, educational buildings

7.15 Typical Cost Implications

These are per-point base estimating rates. See 2.4 Cost & Effort Estimating Methodology for applying economies of scale.

7.15.1 Delivery

- +15-25% over L1
- ROI through improved operational efficiency (2-4 years)
- Point-to-point commissioning: 15 min/point
- Multi-system integration: 10 min/point
- Enhanced graphics: 5 min/point
- Data structuring & naming: 5 min/point
- BBMD/gateway setup: 5 min/point
- Total effort: ~40 min/point
- Example: 8,000 points = 5,333 hours engineering/commissioning

7.15.2 Aftercare

Recommended PPM: Quarterly visit
Total effort: ~15 min/point

Example

~200 points × 15 min = 50 hours per annum (~6 days/year)

7.16 Bridge to Level 3 (Smart Enabled)

The step from Level 2 to Level 3 is where a BEMS becomes a smart building platform.

The defining shift is the move from structured data to standardised, machine-readable, semantically tagged data exposed via APIs.

At this point the BEMS stops being a closed operational system and becomes a data source for the wider digital estate: analytics platforms, FM tools, sustainability reporting, and tenant applications.



7.16.1 What Changes

- Semantic tagging (Project Haystack, Brick, or BDNS) becomes standard, replacing ad-hoc naming.
- REST/GraphQL APIs expose building data to external consumers.
- Tenant-specific graphics and access control become first-class capabilities, not afterthoughts.
- Virtual metering enables energy apportionment and efficiency tracking beyond what physical meters provide.
- Governance expectations expand to include corporate IT engagement, identity management and basic cyber security posture.
- Documentation expands to include data models, tagging schemas, API specifications and access control matrices.

7.16.2 Typical Upgrade Triggers

- Sustainability reporting or ESG obligations requiring structured, verifiable building data.
- Adoption of analytics, fault detection or energy management platforms that consume building data.
- Tenant expectations for energy data, sub-metering or environmental visibility within their space.
- Strategic move toward a smart building positioning for premium leasing or corporate occupier requirements.

7.16.3 Key Considerations

- This is primarily a software, data and integration exercise rather than a hardware exercise - provided L2 was specified with appropriate backbone and BACnet/IP-capable controllers. Where it was not, this becomes effectively an L1>L3 upgrade in cost terms.
- Engaging corporate IT, cyber security and data governance teams early is essential. Bolting these on after the fact typically results in painful re-architecture or restrictions on what the platform can do.
- Operational capability needs to keep pace. An L3 platform without an FM team capable of using semantic models, APIs and analytics tools tends to revert to L1-style use in practice.
- Procuring L3 capability without budget for the ongoing data quality and tagging maintenance work tends to result in data integrity drift within 12-24 months.

LEVEL 3
SMART ENABLED

Unlocking the value of building data.



8. Level 3 – Smart Enabled

Level 3 represents the threshold of true smart building capability - where building data becomes standardised, machine-readable, and ready for advanced applications.

This level integrates all major building systems under a unified semantic framework, enabling sophisticated analytics, automated reporting, and third-party application development.

The building becomes “API-ready,” supporting modern FM tools, ESG reporting requirements, and tenant engagement applications.

Level 3 delivers measurable operational improvements and positions the building for ongoing technological advancement.

Governance: Level 3 introduces externally consumable data, semantic models and API access that may require engagement with corporate IT, cyber security, or data governance teams. While systems at this level are typically owned and operated by facilities management, early consultation with IT stakeholders is recommended to support secure integration, identity management and future scalability.

Level 3 at a glance:

Category	Summary
Name	Smart Enabled
Typical Use	Premium offices, corporate HQs, ESG-focused developments
Integration	Full building integration
User Interface	Operator and tenant dashboards
Remote Access	Secure enterprise access
Analytics & Reporting	Advanced analytics and virtual metering
Backbone	Redundant ring or dual-star architecture

8.1 Scope

- Full building integration: HVAC, lighting, shading, metering, life safety (monitor only).
- Standardised semantic tagging (Project Haystack / Brick).
- APIs for FM tools, dashboards, and analytics.



8.2 Tender Submissions

All Tenderers **should provide a formal submission pack** aligned with this Framework and the applicable Delivery Level.

Submissions should be sufficiently detailed to allow objective assessment, risk identification, and comparison between proposals.

Tenderers should provide the following as a minimum:

Confirmation of alignment with **Delivery Level 3** of the BEMS Framework

- **Indicative points** list identifying all control, monitoring, alarm, trend, and integration points within scope
- High-level description of the **system architecture**, including supervisory and management layers
- Outline description of the **network topology**, segmentation, and security zoning intent
- Identification of proposed **controllers, servers, operator workstations, and supervisory platforms**
- Description of **system integration scope**, including plant systems, metering, and third-party systems
- High-level approach to **graphics, alarms, trends, scheduling, and reporting**
- Outline of **resilience and availability strategy** (e.g. network, servers, supervisory functions)
- High-level description of **data governance and performance monitoring intent**
- Clear statement of **scope inclusions, exclusions, and system boundaries**
- Summary of **key assumptions** made at tender stage
- Confirmation that manufacturer guidance and all applicable statutory requirements will be followed
- Identification of any **deviations from Level 3** expectations, including brief justification (if applicable)

8.3 Protocols / Interfaces

- BACnet/IP baseline; semantic tagging recommended.
- REST/GraphQL APIs

8.4 Expectations

- Consistent, machine-readable building data.
- Data ready for analytics, dashboards, ESG reporting.

8.5 Spare Capacity & Backbone

- Redundant ring or dual-star backbone for resilience.
- Network designed with 2-3× headroom vs forecast data loads.
- 25-40% spare compute/storage in servers/VMs.
- Tagging namespace expandable for future systems.

Level 3 introduces many of the data structures and integration principles required for advanced smart building operation.

Progression to Level 4 is typically driven less by additional hardware and more by the introduction of governance, semantic data management, analytics platforms and organisational capability.

8.6 Commissioning & Handover

Semantic Validation: ≥90% of points correctly tagged with Haystack OR Brick schema
API Functionality: All specified APIs tested and returning correct data
Virtual Metering: Virtual meter calculations within ±5% of physical meters (where comparable)
Tenant Interfaces: Tenant-specific graphics functional with proper access control
Mobile Access: Mobile applications tested and functional across specified devices
MQTT Configuration: MQTT topics organised and publishing data correctly
VRF Integration: VRF system response time <1 second for setpoint changes
Graphics Quality: Colour-coded environment graphics functional, navigation intuitive (user acceptance test passed)
Data Logging: Variable frequency logging operational, run-hour counters functional
Pass Threshold: ≥90% semantic tags validated, APIs functional, virtual metering accurate

8.7 Skills & Training

- Semantic tagging methodology (24-32 hours)
- API management and troubleshooting
- Advanced analytics platform training
- Energy management system operation
- Graphics development and customisation
- Virtual metering setup and validation
- Tenant access management and control delegation

8.8 Maintenance & Support

- Quarterly system optimisation reviews
- Predictive maintenance capabilities
- Remote monitoring and diagnostics
- Performance benchmarking

8.9 Performance Metrics

- Energy efficiency targets (15-25% improvement)
- Data quality score (>90% tagged and validated)
- API uptime (>99%)
- Carbon reduction targets
- Occupant satisfaction scores
- **Virtual metering accuracy (±5% of physical meters where comparable)**
- **VRF system response time (<1s for setpoint changes)**
- **Graphics navigation efficiency and user satisfaction**

8.10 Tenant / Occupant / Operator Interface

Advanced operator graphics with semantic navigation. Mobile apps for comfort control and building interaction. Real-time dashboards and sustainability reporting access. Tenant-specific interfaces with controlled adjustment capabilities.

Operator Access

Comprehensive graphics with semantic organisation, colour-coded system status, advanced trending, and API integration capabilities. Operators can manage complex building systems through intuitive interfaces that follow installation schematics for easy cross-referencing.

Tenant Access

Dedicated tenant-specific graphics with controlled access to their systems (VRF, lighting controls, energy consumption). Tenants can adjust setpoints and schedules within defined limits, with all changes logged and monitored.

Occupant Access

Mobile applications for comfort control, space booking, and sustainability dashboards. Real-time feedback on environmental conditions and energy performance.

Expectations

All user groups have appropriate interfaces - operators get full system control, tenants get meaningful control over their spaces, and occupants get engagement tools for comfort and sustainability.

8.11 Resilience & Business Continuity

- Graceful degradation modes
- Automated failover systems
- 4-8 hour fault response commitment

8.12 Compliance & Standards

- GDPR/data privacy compliance
- ISO 50001 alignment
- BREEAM/LEED smart building credits

8.13 Scale Suitability

- Medium to large projects (500+ devices, 10,000-20,000+ points)

8.14 Use Case

- Premium commercial offices, corporate headquarters
- Healthcare facilities with advanced requirements
- Educational campuses, mixed-use developments
- ESG-focused commercial developments

8.15 Typical Cost Implications

These are per-point base estimating rates. See 2.4 Cost & Effort Estimating Methodology for applying economies of scale.

8.15.1 Delivery

- +30-50% over L1
- ROI through energy savings, operational efficiency, and ESG value (1-3 years)
- Point-to-point commissioning: 15 min/point
- Full building integration: 15 min/point
- Semantic tagging (Haystack/Brick): 10 min/point
- Advanced graphics & tenant interfaces: 8 min/point
- API development & testing: 8 min/point
- Virtual metering setup: 5 min/point
- MQTT configuration: 5 min/point
- Total effort: ~66 min/point
- Example: 15,000 points = 16,500 hours engineering/commissioning

8.15.2 Aftercare

Recommended PPM: Points-based (see Appendix F for calculation methodology)
Total effort: ~15 min/point

Example

~2,500 points × 15 min = ~625 hours per annum (~78 days/year)

8.16 Bridge to Level 4 (Data-Driven Smart)

The step from Level 3 to Level 4 elevates the BEMS from a single-building smart platform to an enterprise-grade building data platform.

The defining shift is from per-building data to portfolio-grade data architecture, with cloud or hybrid infrastructure, unified semantic models across buildings, and the predictive and digital-twin capabilities that emerge once data is consistent at scale.

L3 L4

The transition from Level 3 to Level 4 shifts the focus from integration to intelligence, enabling buildings to operate as governed data platforms capable of supporting predictive insights and portfolio-wide optimisation.

8.16.1 What Changes

- A unified semantic data model (Brick, RealEstateCore, UDMI or a hybrid) replaces per-building tagging schemas.
- Cloud or hybrid data architecture becomes the norm, supporting longer retention, larger datasets and cross-building analytics.
- Digital twin visualisation, predictive maintenance and ML-driven analytics move from optional to expected.
- Automated device discovery and onboarding reduce the per-device commissioning effort and support estates that grow over time.
- System ownership typically shifts from facilities to digital, IT or estates teams, with corresponding governance changes.
- Cyber security moves from posture to formal compliance against frameworks such as ISO 27001.

8.16.2 Typical Upgrade Triggers

- Estate-wide portfolio reporting requirements that cannot be served from per-building data extracts.
- Adoption of digital twin, predictive maintenance or advanced analytics as strategic estate initiatives.
- Corporate IT taking ownership of the building data platform as part of broader digital estate strategy.
- Net-zero or science-based-target commitments requiring auditable, granular data across the estate.

8.16.3 Key Considerations

- This step is as much organisational as it is technical. Without corporate IT, digital and FM teams aligned on ownership and operating model, the platform underdelivers regardless of technical maturity.
- Data quality discipline established at L3 is the foundation. Federating poor data across a portfolio multiplies problems rather than solving them.
- Cloud architecture decisions have long tails. Vendor selection, data residency, cost modelling and exit/portability arrangements all warrant proper consideration before commitment.
- Predictive maintenance and ML models require sustained investment to remain accurate. A one-off model build that is not maintained typically becomes worse than no model within 18 months.

LEVEL 4
DATA-DRIVEN SMART

Turning intelligence into operational advantage.



9. Level 4 – Data-Driven Smart

Level 4 elevates building intelligence to enterprise level, where unified data models enable sophisticated analytics, predictive insights, and seamless integration with corporate systems.

This level implements cloud-hybrid architectures that support digital twins, automated device discovery, and advanced performance optimisation.

The building becomes a proactive partner in facility management, predicting maintenance needs, optimising energy performance, and integrating with broader organisational workflows.

Level 4 is designed for large-scale operations where building intelligence directly contributes to business objectives.

Enterprise Threshold: Level 4 represents the transition from a single-building smart system to an enterprise-grade building data platform. At this level, portfolio-wide data consistency, corporate IT involvement and formal OT/IT governance become unavoidable. Level 4 solutions are typically owned, governed, or co-managed by central IT, digital, or estates teams rather than solely by site-based facilities management.

Level 4 at a glance:

Category	Summary
Name	Data-Driven Smart
Typical Use	Corporate campuses, life sciences, large estates and portfolios
Integration	Enterprise-wide integration
User Interface	Advanced operational dashboards
Remote Access	Cloud / hybrid access
Analytics & Reporting	Predictive analytics and optimisation
Backbone	Scalable cloud or hybrid architecture
Resilience	Multi-path redundancy

9.1 Scope

- Unified semantic data model (Brick/RealEstateCore/UDMI or Combination).
- Advanced integration: HVAC, lighting, IoT, lifts, FM/work order systems.
- Cloud/hybrid data layer for storage, analytics, and digital twins.
- Automated device discovery and onboarding.

9.2 Tender Submissions

All Tenderers should provide a formal submission pack aligned with this Framework and the applicable Delivery Level. Submissions should be sufficiently detailed to allow objective assessment, risk identification, and comparison between proposals.

Tenderers should provide the following as a minimum:

- Confirmation of alignment with **Delivery Level 4** of the BEMS Framework
- **Indicative points list** identifying all control, monitoring, alarm, trend, analytics, and integration points within scope
- High-level description of the **system and enterprise architecture**, including supervisory, management, and analytics layers
- Outline description of the **network architecture, segregation, and cyber security intent**
- Identification of proposed c**ontrollers, servers, platforms, analytics tools, and operator interfaces**
- Description of **enterprise and third-party system integration scope** (e.g. energy platforms, FM systems, cloud services)
- High-level approach to **analytics, fault detection, optimisation, and performance reporting**
- Outline of **resilience, availability, and backup strategies** across system layers
- High-level description of **data governance**, data quality, and performance KPI intent
- Clear statement of **scope inclusions, exclusions, and system boundaries**
- Summary of **key assumptions** made at tender stage
- Confirmation that manufacturer guidance and all applicable statutory requirements will be followed
- Identification of any **deviations from Level 4 expectations**, including brief justification (if applicable)

9.2.1 Tender Stage Clarifications

- Detailed analytics models, algorithms, dashboards, or tuning parameters are **not typically required**
- Cyber security implementation detail and compliance evidence will be developed post-award
- Autonomous or self-learning control strategies are **not typically required at this level**
- Submissions are assessed on **performance intent, data strategy, and integration maturity**, not configuration detail

9.3 Protocols / Interfaces

- Event-driven APIs (REST/GraphQL, MQTT).
- Schema validation recommended

9.4 Expectations

- Real-time analytics, predictive maintenance, FM integration.

9.5 Spare Capacity & Backbone

- Scalable cloud/hybrid backbone for **5+ years of high-resolution trend data**.
- 30% spare network port capacity (modular racks/switches).
- Backbone core at 1-10 Gbps, expandable as demand grows.
- Automated onboarding should handle incremental devices.

The transition from Level 4 to Level 5 is primarily an operational and organisational challenge rather than a technology challenge.

While much of the technical foundation already exists, successful adoption of autonomous operation requires mature governance, cyber security, AI assurance processes and clearly defined human override procedures.

9.6 Commissioning & Handover

Digital Twin Accuracy: Digital twin model reflects physical building with >90% accuracy
ML Model Performance: Predictive models demonstrate >85% accuracy on test data
Cloud Integration: Cloud/hybrid infrastructure operational, data synchronisation functional
Automated Discovery: Automated device discovery tested and onboarding new devices successfully
API Orchestration: Multiple API integrations tested, data flowing between systems
Advanced Analytics: Predictive maintenance indicators operational, dashboards displaying insights
High-Resolution Logging: Sub-minute logging operational for critical points
Portfolio Integration: Multi-building data federation functional (where applicable)
Pass Threshold: Digital twin >90% accurate, ML models >85% predictive accuracy, all integrations functional

9.7 Skills & Training

- Digital twin management (40+ hours)
- Advanced analytics and ML basics
- Cloud platform management
- Cyber security awareness
- Vendor-agnostic system management
- **BEMS platform operation and customisation**
- **EV charging system management and load balancing**
- **Advanced electrical system monitoring and maintenance scheduling**

9.8 Maintenance & Support

- Continuous monitoring and optimisation
- Predictive maintenance with ML
- Quarterly performance reviews
- Vendor-agnostic support model

9.9 Performance Metrics

- Predictive accuracy (>85% for equipment failures)
- Energy optimisation (25-40% improvement)
- Digital twin accuracy validation
- Mean time to resolution (MTTR) improvement
- Carbon neutrality progress

9.10 Tenant / Occupant / Operator Interface

Digital twin visualisation for operations. Personalised applications for space optimisation. Predictive analytics dashboards. Advanced integration portals for portfolio management.

Operator Access

Digital twin interfaces with 3D visualisation, predictive analytics dashboards, and ML-driven insights. Operators can manage portfolio-level systems with automated device discovery and advanced integration capabilities across multiple buildings.

Tenant Access

Personalised applications with predictive space booking, energy optimisation recommendations and detailed consumption analytics. Tenants receive AI-driven suggestions for improving space utilisation and energy efficiency.

Occupant Access

Personalised comfort applications that learn preferences, predictive wellness dashboards and productivity optimisation tools. Advanced mobile interfaces with location-aware services.

Expectations

All interfaces leverage data analytics - operators get predictive maintenance insights, tenants get business intelligence for their operations and occupants get personalised building experiences that adapt to their needs.

9.11 Resilience & Business Continuity

- Autonomous fault detection and response
- Multi-path redundancy
- 1-4 hour fault response with predictive intervention

9.12 Compliance & Standards

- Advanced cyber security frameworks
- ISO 27001 alignment
- Real-time compliance monitoring

9.13 Scale Suitability

- Large-scale, multi-building/campus (20,000+ points).

9.14 Use Case

- Corporate campuses, multi-building commercial complexes
- Large healthcare systems, major educational institutions
- Industrial facilities with advanced operational requirements
- Commercial real estate portfolios

9.15 Typical Cost Implications

These are per-point base estimating rates. See 2.4 Cost & Effort Estimating Methodology for applying economies of scale.

9.15.1 Delivery

- +60-100% over L1
- ROI through operational excellence, predictive maintenance savings (1-2 years)
- Point-to-point commissioning: 15 min/point
- Advanced system integration: 15 min/point
- Unified data model implementation: 12 min/point
- Cloud/hybrid infrastructure setup: 10 min/point
- Digital twin validation: 10 min/point
- Interactive dashboards & interfaces: 8 min/point
- Multiple API integrations: 10 min/point
- ML algorithm validation: 8 min/point
- Automated device discovery setup: 5 min/point
- Total effort: ~93 min/point
- Example: 25,000 points = 38,750 hours engineering/commissioning

9.15.2 Aftercare

Recommended PPM:
Points-based (see Appendix F for calculation methodology)

Total effort:
~15 min/point for Hardware / ~5min/point for Integration

Example

~1,000 points × 15 min = ~250 hours per annum (~31 days/year)

~1,000 points × 5 min = ~83 hours per annum (~10 days/year)

9.16 Bridge to Level 5 (Smart & Autonomous)

The step from Level 4 to Level 5 introduces autonomy.

The defining shift is that the building, supported by AI and ML, begins to make and act on operational decisions itself, within defined boundaries and with human oversight.

The technical foundations established at L4 (data quality, integration maturity, governance) are the prerequisite; what changes at L5 is the operating model, the assurance regime, and the relationship between the building and its operators.



9.16.1 What Changes

- AI-driven optimisation of HVAC, lighting and comfort, with operators moving from real-time control to strategic oversight.
- Dynamic demand response, grid interaction and (where applicable) energy trading become live operational capabilities.
- Self-healing systems handle a meaningful proportion of faults autonomously, with audit trails available for human review.
- Governance, assurance and accountability mechanisms for autonomous decision-making become formal deliverables in their own right.
- Manual override, fallback and operator authority remain available and explicitly designed-for, never engineered out.
- Cyber security moves to zero-trust architectures and real-time compliance monitoring.

9.16.2 Typical Upgrade Triggers

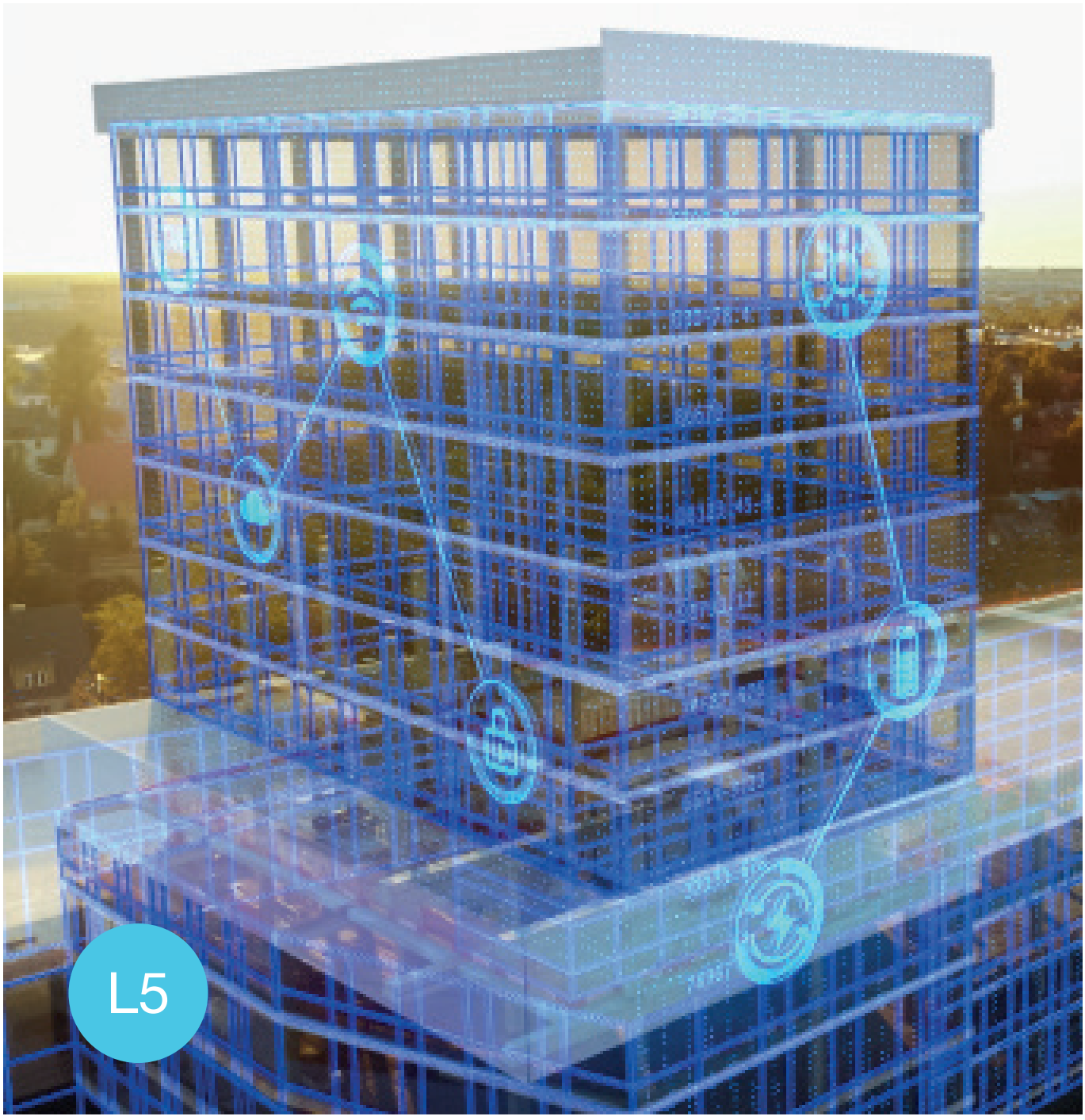
- Flagship or innovation projects where demonstrable leadership in autonomous building operation is a strategic objective.
- Net-zero pathways requiring active demand response and grid interaction at the building level.
- Estates with sufficient scale and data maturity to make portfolio-level autonomous optimisation worthwhile.
- Operational models where human FM resource is genuinely constrained and AI augmentation delivers measurable capacity.

9.16.3 Key Considerations

- Autonomy is an operating-model question more than a technology question. Without governance frameworks, accountability arrangements and operator training to match, autonomous systems tend to be switched back to manual operation in practice.
- Maintaining human override capability and meaningful operator authority is essential. Systems that cannot be safely overridden are not appropriate at any Delivery Level.
- AI and ML models require ongoing validation, retraining and drift management. The model lifecycle is a permanent operational discipline, not a project deliverable.
- The benefit case at L5 should be tested rigorously against L4 alternatives. For many estates, a well-operated L4 platform delivers most of the available value at a fraction of the L5 cost and complexity.

LEVEL 5
SMART & AUTONOMOUS (FUTURE)

Enabling the next generation of building performance.



10. Level 5 – Smart & Autonomous (Future)

Level 5 represents the pinnacle of building intelligence - a fully autonomous ecosystem that continuously optimises itself while contributing to broader sustainability and grid objectives.

This level deploys artificial intelligence to manage complex interactions between building systems, occupant needs, and external factors such as weather and energy markets.

The building becomes self-healing, predictive, and adaptive, requiring minimal human intervention while delivering optimal performance across all metrics.

Level 5 is reserved for flagship projects, innovation hubs, and organisations committed to demonstrating leadership in sustainable building operation.

Level 5 at a glance:

Category	Summary
Name	Smart & Autonomous
Typical Use	Flagship developments, innovation projects, net-zero estates
Integration	Autonomous ecosystem integration
User Interface	AI-assisted operator experience
Remote Access	Cloud-native distributed architecture
Analytics & Reporting	Autonomous optimisation and machine learning
Backbone	Elastic cloud-native / distributed architecture
Resilience	Self-healing systems



10.1 Scope

- Fully self-optimising building ecosystem.
- AI-driven optimisation of HVAC, lighting, comfort.
- Dynamic demand response, grid interaction, energy trading.
- Autonomous fault detection and subsystem self-healing.

10.2 Tender Submissions

All Tenderers **should provide a formal submission pack** aligned with this Framework and the applicable Delivery Level.

Submissions should be sufficiently detailed to allow objective assessment, risk identification, and comparison between proposals.

Tenderers should provide the following as a minimum:

- Confirmation of alignment with **Delivery Level 5** of the BEMS Framework
- **Indicative points list** identifying all control, monitoring, alarm, trend, analytics, optimisation, and integration points within scope
- High-level description of the **end-to-end system architecture**, including supervisory, analytics, autonomy, and assurance layers
- Outline description of the **enterprise, cloud, and data architecture**, including segregation and cyber security intent
- Identification of proposed **controllers, platforms, analytics engines, optimisation tools, and operator interfaces**
- Description of **enterprise, digital twin, and third-party system integration scope**
- High-level approach to **autonomous control, optimisation loops, and human override mechanisms**
- Outline of **governance, assurance, and accountability mechanisms** for autonomous operation
- High-level description of **data governance, model management, and continuous improvement strategy**
- Outline of **resilience, availability, fail-safe, and fallback strategies**
- Clear statement of **scope inclusions, exclusions, and system boundaries**
- Summary of key **assumptions** made at tender stage
- Confirmation that manufacturer guidance and all applicable statutory requirements will be followed
- Identification of any **deviations from Level 5 expectations**, including brief justification (if applicable)

10.2.1 Tender Stage Clarifications

- Detailed AI models, algorithms, training datasets, or control logic are not typically required
- Proof-of-performance, live optimisation metrics, and validation evidence will be developed post-award
- Manual override, fallback, and operator authority should be retained
- Submissions are assessed on maturity, governance, and lifecycle credibility, not marketing claims

10.3 Protocols / Interfaces

- Unified semantic twin.
- API-first, vendor-neutral architecture.

10.4 Expectations

- Net zero aligned.
- Predictive and autonomous operation.

10.5 Spare Capacity & Backbone

- Fully elastic, cloud-native/distributed backbone.
- Core backbone: redundant rings, dual-location servers.
- Edge devices sized for AI/ML workloads.
- Core backbone at 10 Gbps+, expandable to 40 Gbps.

Level 5 represents the highest maturity level within this framework.

Future development is likely to focus on emerging technologies, evolving AI capabilities, grid interaction services and organisational optimisation rather than fundamental changes to building control architecture.

10.6 Commissioning & Handover

AI Model Validation: AI models proven in live operation with >95% autonomous decisions made correctly
Autonomous Operation: Self-optimisation demonstrated over minimum 4-week proving period
Grid Integration: Demand response and energy trading systems tested with grid operator
Self-Healing: Autonomous fault detection and recovery demonstrated through simulated failures
Security Validation: Comprehensive penetration testing completed, zero-trust architecture validated
Portfolio Intelligence: Multi-site optimisation operational, benchmarking functional
AI Transparency: Autonomous decision audit trails complete and accessible
Voice/Gesture Control: Natural language and gesture interfaces tested and functional
Pass Threshold: AI autonomous decisions >95% successful, self-healing demonstrated, grid integration tested

10.7 Skills & Training

- AI/ML systems management (60+ hours)
- Autonomous systems oversight
- Advanced cyber security management
- Grid interaction and energy trading
- Portfolio-level optimisation

10.8 Maintenance & Support

- Self-healing systems with human oversight
- Continuous autonomous optimisation
- Portfolio-level performance management
- Vendor-agnostic, outcome-based support

10.9 Performance Metrics

- Pathway toward carbon-negative operation
- Autonomous optimisation effectiveness (>95% decisions without human input)
- Grid interaction revenue generation
- Occupant productivity improvements
- Portfolio-level KPI achievement

10.10 Tenant / Occupant / Operator Interface

AI personal assistants for building interaction. Autonomous optimisation with transparent decision-making. Voice and gesture control interfaces. Portfolio-level intelligence and benchmarking.

Operator Access

AI-assisted building management with autonomous operation dashboards showing transparent AI decision-making. Operators oversee self-optimising systems with portfolio-level intelligence, predictive intervention capabilities, and voice/gesture control for complex operations.

Tenant Access

AI personal assistants that understand business operations and automatically optimise space utilisation, energy consumption and comfort based on usage patterns. Tenants receive autonomous energy trading benefits and predictive space planning recommendations.

Occupant Access

Natural language interaction with building systems, predictive comfort optimisation that anticipates needs and wellness interfaces that adapt to individual preferences and productivity patterns.

Expectations

Building intelligence becomes proactive partner - operators focus on strategic oversight while AI handles routine optimisation, tenants benefit from autonomous business space optimisation and occupants enjoy seamless, anticipatory building responses to their needs.

10.11 Resilience & Business Continuity

- Autonomous disaster recovery
- Self-healing distributed architecture
- Immediate fault response with predictive prevention

10.12 Compliance & Standards

- Zero-trust security architecture
- Real-time regulatory compliance
- Advanced privacy protection (privacy by design)

10.13 Scale Suitability

- Very large, portfolio-scale projects.

10.14 Use Case

- Flagship commercial buildings, corporate innovation centres
- Major industrial facilities, manufacturing complexes
- Large-scale real estate portfolios
- ESG leadership projects, net-zero commercial developments.

10.15 Typical Cost Implications

These are per-point base estimating rates. See 2.4 Cost & Effort Estimating Methodology for applying economies of scale.

10.15.1 Delivery

- +100-200% over L1
- ROI through autonomous operation, energy trading, productivity gains (<1 year)
- Point-to-point commissioning: 15 min/point
- Fully autonomous integration: 15 min/point
- AI model training & validation: 15 min/point
- Autonomous operation proving: 12 min/point
- Grid interaction & energy trading setup: 10 min/point
- Self-healing system validation: 10 min/point
- Advanced AI interfaces: 10 min/point
- Portfolio-level API integration: 10 min/point
- Zero-trust security implementation: 8 min/point
- Elastic backbone validation: 5 min/point
- Total effort: ~120 min/point
- Example: 30,000+ points = 60,000+ hours engineering/commissioning

10.15.2 Aftercare

Recommended PPM: Points-based (see Appendix F for calculation methodology)
Total effort: ~15 min/point

Example

~2,500 points × 15 min = ~625 hours per annum (~78 days/year)

APPENDICES

Supporting guidance, reference tools and practical resources.



APPENDIX A – CROSS-CUTTING DIMENSIONS (ALL LEVELS)

11. CROSS-CUTTING DIMENSIONS (ALL LEVELS)

Cyber Security	L0 = None > L5 = Zero-trust, monitored
Openness	L0 = Proprietary > L5 = API-first, vendor-neutral
Governance	L0 = Minimal docs > L5 = Automated semantic compliance
Data Quality	L1 = Raw > L5 = Validated, contextualised datasets
Future-Proofing	L0-1 = No expansion path > L5 = Elastic, portfolio-ready
Backbone	L1 = Copper-only unmanaged > L5 = Redundant fibre rings, modular core, elastic cloud/ hybrid

APPENDIX B – LEVEL SHORTHAND REFERENCE

12. LEVEL SHORTHAND REFERENCE

Level	Minimum Evidence Pack at Handover
L0 = Level 0 (Minimal / Legacy)	Standalone controls only; no BEMS integration, no backbone, no future-proofing.
L1 = Level 1 (Base Build BEMS)	Entry level BEMS; HVAC plant only; basic monitoring, copper-only backbone.
L2 = Level 2 (Integration Ready)	Core utilities integrated, partial semantic tagging, BBMDs introduced for multi-subnet projects.
L3 = Level 3 (Smart Enabled)	Full building integration; semantic tagging standardised; BBMDs/FDTs standard; APIs exposed.
L4 = Level 4 (Data-Driven Smart)	Unified semantic model, cloud/hybrid backbone, digital twin support.
L5 = Level 5 (Smart & Autonomous)	AI-driven optimisation, self-healing, net-zero aligned; elastic backbone and portfolio-ready.

APPENDIX C – GRAPHICS & DATA LOGGING REQUIREMENTS

13. GRAPHICAL USER INTERFACE STANDARDS BY LEVEL

13.1 LEVEL 0: NO CENTRAL GRAPHICS

- Local HMIs and display panels only
- Individual equipment interfaces (thermostat displays, timer interfaces)
- No centralised graphical system

13.2 LEVEL 1: BASIC BEMS GRAPHICS

- **Plant Overview Graphics:** Single-line diagrams showing major plant status
- **Equipment Graphics:** Individual AHU, boiler, chiller graphics with basic parameters
- **Alarm Summary:** Simple alarm list with acknowledge capability
- **Trend Displays:** Basic trending of key parameters (temperature, pressure)
- **Navigation:** Simple menu structure, minimal drilling down
- **Colour Coding:** Green (running), Red (fault), Grey (off)
- **Setpoint Access**: Read-only setpoints displayed, limited adjustment capability

13.3 LEVEL 2: ENHANCED INTEGRATION GRAPHICS

- **Multi-System Overview:** Combined HVAC, utilities, and third-party systems
- **System Integration Graphics:** Show relationships between integrated systems
- **Enhanced Plant Graphics:** More detailed equipment representations
- **Utility Graphics:** Energy, water, gas consumption displays
- **Historical Data:** Basic trending with time period selection
- **User Management:** Basic user access levels and permissions
- **Setpoint Control:** Editable setpoints with user access control

13.4 LEVEL 3: SMART BUILDING GRAPHICS

- **Environment Graphics by Level:**
  - **Colour-coded by heating/cooling status:**
    - Transparent fill: No heating or cooling plant operating
    - Orange: Heating plant or room emitters operating
    - Light blue: Cooling plant or room FCUs operating
    - Red: Fault condition on any equipment
- Live text for plant status, sensors, and setpoints
- Equipment-specific graphics following installation schematics
- Tenant-specific graphics with controlled access
- Direct setpoint editing from graphics
- **Semantic Navigation:** Graphics organised by semantic relationships
- **Tenant-Specific Graphics:** Dedicated interfaces per tenancy with controlled access
- **Virtual Metering Displays:** Energy performance dashboards and KPIs
- **Mobile Responsive:** Graphics accessible on tablets and mobile devices
- **API-Driven Content:** Graphics populated via APIs for third-party integration
- **Advanced Setpoints:** All setpoints and overrides editable from graphics per access rights

13. 5 LEVEL 4: DATA-DRIVEN INTERACTIVE GRAPHICS

- **Digital Twin Visualisation:** 3D building models with real-time data overlay
- **Predictive Analytics Dashboards:** ML-driven insights and recommendations
- **Interactive Floor Plans:** Click-through navigation with equipment drill-down
- **Multi-Building Campus Views:** Portfolio-level visualisation capabilities
- **Custom Dashboard Creation:** User-configurable interfaces
- **Real-Time Performance:** Live updating with minimal latency
- **Integration Portals:** Embedded third-party applications and services

13.6 LEVEL 5: AI-DRIVEN AUTONOMOUS GRAPHICS

- **Autonomous Operation Dashboards:** AI decision-making transparency
- **Predictive Modeling Interfaces:** Energy trading, demand response visualisation
- **Voice and Gesture Control:** Natural language interaction capabilities
- **Augmented Reality Integration:** Overlay digital information on physical space
- **Portfolio Intelligence:** Multi-site optimisation and comparison tools
- **Self-Optimising Displays:** Interfaces that adapt to user behaviour and preferences

14. DATA LOGGING REQUIREMENTS BY LEVEL

14.1 LEVEL 1: BASIC LOGGING

- **Frequency:** Hourly logging minimum
- **Parameters:**
  - Equipment status (on/off/fault)
  - Key temperatures (supply, return, outside air)
  - Basic setpoints
  - Major alarms and events
- **Retention:** 12 months minimum
- **Storage:** Local database (simple file-based or basic SQL)
- **Export:** Manual CSV export capability

14.2 LEVEL 2: INTEGRATION LOGGING

- **Frequency:** 15-minute intervals for key points, hourly for others
- **Parameters:**
  - All Level 1 requirements plus:
  - Utility consumption (energy, water, gas)
  - Multi-system integration points
  - User actions and setpoint changes
  - Network and communication status
- **Retention:** 24 months minimum
- **Storage:** Structured SQL database
- **Export:** Automated monthly CSV exports organised by system

14.3 LEVEL 3: SMART BUILDING LOGGING

- **Frequency: Variable (1-15 minutes based on point criticality)**
- **Parameters:** All Level 2 requirements plus:
  - Virtual metering calculations
  - Tenant-specific consumption data
  - VRF system detailed parameters (FCU temperatures, loads)
  - Equipment run hours and maintenance counters
  - Air quality sensors (CO2, temperature, humidity)
  - Lighting and occupancy sensors
- **Retention:** 36 months minimum (60 months for compliance data)
- **Storage:** Enterprise-grade SQL with partitioning
- **Export:** API-accessible data, automated reporting, real-time dashboards

14. 4 LEVEL 4: HIGH-RESOLUTION DATA-DRIVEN LOGGING

- **Frequency:** Sub-minute for critical points, variable for others based on change-of-value
- **Parameters:** All Level 3 requirements plus:
  - Predictive maintenance indicators
  - Digital twin validation data
  - Cloud integration metrics
  - Advanced analytics inputs
  - IoT device data streams
  - Performance benchmarking data
- **Retention:** 60+ months with cloud archiving
- **Storage:** Hybrid cloud/local with real-time streaming capabilities
- **Export:** Multiple API formats, real-time data streams, custom analytics exports

14.5 LEVEL 5: AUTONOMOUS SYSTEM LOGGING

- **Frequency:** Real-time streaming with edge processing and intelligent buffering
- **Parameters:** All Level 4 requirements plus:
  - AI decision audit trails
  - Grid interaction data (demand response, energy trading)
  - Autonomous optimisation actions
  - Self-healing system events
  - Portfolio-level comparative data
  - Regulatory compliance automated reporting
- **Retention:** Indefinite with intelligent archiving and compression
- **Storage:** Fully distributed cloud-native with edge computing
- **Export:** Real-time APIs, automated regulatory reporting, portfolio analytics

15. DATA LOGGING SCALING RULES
15.1 POINT CATEGORIES & FREQUENCIES

- **Critical Control Points:** Real-time to 1-minute intervals / Event Driven
- **Equipment Status:** 5-15 minute intervals
- **Temperature/Pressure:** 15-minute to hourly intervals
- **Energy Consumption:** 15-minute intervals (OR Utility standard)
- **Environmental Sensors:** 15-minute to hourly intervals
- **Setpoint Changes:** Event-driven (immediate logging)
- **Alarms & Faults:** Event-driven (immediate logging)
- **User Actions:** Event-driven (immediate logging with timestamp and user ID)

15.2 RETENTION SCALING

- **Operational Data:** 12-60 months based on level
- **Compliance Data:** 60+ months (energy reporting, safety records)
- **Maintenance Data:** Equipment lifetime plus 5 years
- **Audit Trails:** 7+ years for security and compliance

15.3 STORAGE SCALING

- **L1:** Local file/database (~100MB per 1,000 points/year)
- **L2-L3:** Structured SQL (~500MB-1GB per 1,000 points/year)
- **L4-L5:** Cloud/hybrid with compression (~2-5GB per 1,000 points/year)

16. DATA MANAGEMENT & ARCHIVE REQUIREMENTS
16.1 LEVEL 2+: BASIC DATA STORAGE

- SQL/MongoDB database for 5+ years of data
- Automated CSV exports monthly by system
- Hourly and half-hourly trend logging
- Equipment run-hour tracking with maintenance reset capability

16.2 LEVEL 3+: ENHANCED DATA MANAGEMENT

- MQTT/JSON topic organisation
- API-accessible trend data
- Virtual metering calculations
- Tenant energy apportionment

APPENDIX D – INTEGRATION SPECIFICATIONS

17. INTEGRATION SPECIFICATIONS
17.1 VRF SYSTEM INTEGRATION (LEVEL 3+)

- Full FCU monitoring and control
- <1s response time for setpoint changes
- Dynamic FCU regrouping capability
- Virtual metering by FCU zones

17.2 ELECTRICAL INTEGRATION (LEVEL 3+)

- MCCB status monitoring (on/off/tripped)
- Contact wear percentage tracking
- Operating cycle counting
- Trip and alarm history logging

17.3 EV CHARGING INSTALLATION (LEVEL 4 +)

- OCPP 1.6 and OSCP 1.0 protocol compliance
- Dynamic load management across charging points
- RFID and mobile digital key support
- API integration for 3rd party platforms
- Multiple payment method support

APPENDIX E – VIRTUAL METERING CAPABILITIES (LEVEL 3+)

18. VIRTUAL METERING CAPABILITIES (LEVEL 3+)
18.1 STANDARD CALCULATIONS

- Remaining electrical loads (by subtraction from main meters)
- Heat delivery summation (space heating + DHW circuits)
- Fan energy efficiency (kWh vs. flow rate = SFP)
- Hot water generation efficiency (kWh/m^3)
- AHU energy consumption (electrical + thermal)
- Tenant area energy apportionment

18.2 PERFORMANCE MONITORING

- System-specific efficiency trending
- Consumption benchmarking against targets
- Out-of-range consumption alarms

19. AFTERCARE & PLANNED PREVENTATIVE MAINTENANCE

19.1 OVERVIEW

Planned preventative maintenance (PPM) is a critical component of long-term system performance and should be considered during initial project budgeting.

PPM is costed at 15 minutes per point as a baseline, with the first service visit taking 20-25% longer.

This extended initial period allows engineers to familiarise themselves with the as-built system, validate handover documentation against real-world operation, identify any teething issues and establish baseline performance data.

Subsequent visits become more efficient as system knowledge builds and any initial adjustments are completed.

19.1.1 PPM SCOPE PER VISIT

The 15-minute per point allowance covers:

- Visual inspection and physical condition checks
- Functional testing (command/response verification)
- Setpoint and schedule verification
- Alarm testing and threshold validation
- Trend data review and analysis
- Documentation updates and anomaly logging

Point Type Variations

While 15 min/point is the standard baseline:
Integration/virtual points: ~5 min/point (software-based checks)
Standard hardwired I/O points: ~15 min/point (physical + functional testing)
Complex controller points: ~20-25 min/point (multi-parameter validation)

19.1.2 ADDITIONAL CONSIDERATIONS

- Geographic spread and site accessibility affect actual visit duration
- Quality of handover documentation directly impacts first-visit efficiency
- Remote access capability enables pre-visit preparation and faster on-site work
- System complexity and integration depth may require specialist attendance
- First-year PPM should include quarterly reviews regardless of level to capture seasonal variations
- Higher framework levels may require additional time allowances for analytics validation, data quality reviews, and AI/ML optimisation checks beyond the standard per-point time

19.2 COST PLANNING

- For budgeting purposes: (Total System Points × 15 minutes × Engineer Hourly Rate × Frequency) + 25% first-year premium
- This provides a realistic aftercare cost that should be included in whole-life project planning and Level-of-Service discussions with clients.

APPENDIX G – BEMS CONTRACTOR SKILLS REQUIREMENTS

20. BEMS CONTRACTOR SKILLS REQUIREMENTS

20.1 CUMULATIVE SKILLS FRAMEWORK

These factors are illustrative indicators only and should not be treated as mandatory market-entry requirements or prerequisites for tender participation.

The framework does not certify, accredit or rank contractors and should not be used as a mechanism to exclude suppliers from procurement processes.

Each level builds upon all previous levels. A Level 5 contractor would typically demonstrate competency across all levels L0-L5.

20.1.1 LEVEL 0 – FOUNDATION SKILLS (TYPICALLY REQUIRED FOR ALL LEVELS)

20.1.1.1 CORE COMPETENCIES

- Electrical Systems: Basic electrical installation, wiring, and safety protocols
- HVAC Fundamentals: Understanding of heating, cooling, and ventilation principles
- Control Theory: Basic on/off control, timing, and sequencing logic
- Safety Standards: Health and safety regulations, confined space, electrical safety
- Documentation: Basic technical documentation and as-built drawings
- Commissioning: Functional testing of individual components and systems
- Communication: Client liaison and basic training delivery

20.1.1.2 TECHNICAL SKILLS

- Installation of standalone controllers and sensors
- Basic electrical troubleshooting and fault finding
- Understanding of mechanical systems (pumps, fans, valves)
- Use of basic test equipment (multimeters, pressure gauges)
- Manufacturer-specific programming (packaged unit controllers)

20.1.1.3 CERTIFICATIONS TYPICALLY REQUIRED

- Relevant electrical/mechanical trade qualifications
- Health and safety certifications
- Basic refrigerant handling certificates (where applicable)

20.1.2 LEVEL 1 – BASIC BEMS SKILLS (L0 + L1)

20.1.2.1 ADDITIONAL COMPETENCIES

- BEMS Fundamentals: Understanding of centralised building management principles
- Protocol Basics: Introduction to BACnet and Modbus protocols
- Network Installation: Basic copper network cabling and topology
- Graphics Development: Simple BEMS graphics creation and configuration
- Data Management: Basic trending, alarming, and data export
- System Integration: Single-vendor system integration and configuration

20.1.2.2 TECHNICAL SKILLS

- BACnet device configuration and addressing
- Basic network troubleshooting (ping, device discovery)
- Simple graphics programming and interface design
- Trend log setup and basic data analysis
- Alarm configuration and management
- Basic scheduling and time-based control

20.1.2.3 SOFTWARE PROFICIENCY

- Primary BEMS software platform expertise
- Basic database management (SQL basics)
- Microsoft Excel for data analysis and reporting
- Basic network diagnostic tools

20.1.3 LEVEL 2 – INTEGRATION SKILLS (L0 + L1 + L2)

20.1.3.1 ADDITIONAL COMPETENCIES

- Multi-Protocol Integration: Advanced BACnet/IP, Modbus TCP/RTU, M-Bus
- Network Design: Star topology design, fibre optic installation
- Gateway Configuration: Protocol conversion and data mapping
- Advanced Graphics: Multi-system graphic development
- Data Structuring: Naming conventions and basic data organisation
- Vendor Coordination: Managing multiple equipment suppliers

20.1.3.2 TECHNICAL SKILLS

- BBMD configuration for multi-subnet networks
- Gateway setup and protocol translation
- Fibre optic termination and testing
- Advanced trending and data correlation
- Multi-vendor system troubleshooting
- Network performance monitoring

20.1.3.3 SOFTWARE PROFICIENCY

- Multiple BEMS platform familiarity
- Advanced Excel functions and pivot tables
- Basic SQL database queries
- Network monitoring tools (Wireshark basics)

20.1.4 LEVEL 3 – SMART BUILDING SKILLS (L0 + L1 + L2 + L3)

20.1.4.1 ADDITIONAL COMPETENCIES

- Semantic Tagging: Haystack, Brick, and BDNS implementation
- API Development: REST/GraphQL API creation and management
- Advanced Graphics: Colour-coded, interactive interface design
- Data Analytics: Understanding of building performance analytics
- Cyber Security Basics: Network security and access control
- Tenant Management: Multi-tenant system design and access control

20.1.4.2.VIRTUAL METERING: ENERGY CALCULATION AND VALIDATION METHODOLOGIES

20.1.4.3 TECHNICAL SKILLS

- Semantic data model implementation
- API testing and validation
- MQTT broker setup and configuration
- Advanced database management and partitioning
- Mobile application integration
- Energy modeling and virtual metering calculations
- Advanced network security configuration

20.1.4.4 SOFTWARE PROFICIENCY

- API development tools (Postman, Swagger)
- Advanced SQL and database design
- JSON and XML data handling
- Mobile application platforms
- Analytics platforms (Power BI, Tableau basics)
- Version control systems (Git)

20.1.5 LEVEL4 – DATA-DRIVEN SMART SKILLS (L0 + L1 + L2 + L3 + L4)

20.1.5.1 ADDITIONAL COMPETENCIES

- Digital Twin Technology: 3D visualisation and data model integration
- Cloud/Hybrid Architecture: Cloud platform deployment and management
- Machine Learning Basics: Understanding of predictive analytics and ML models
- Advanced Integration: IoT devices, enterprise systems, CAFM integration
- Data Architecture: Big data handling, streaming data, and data lakes
- Advanced Cyber Security: Zero-trust principles, advanced threat management
- Portfolio Management: Multi-building and campus-level systems

20.1.5.2 TECHNICAL SKILLS

- Cloud platform configuration (AWS, Azure, Google Cloud)
- Digital twin software implementation
- Machine learning model deployment and validation
- Advanced API orchestration and microservices
- IoT device integration and management
- Big data processing and analytics
- Advanced cyber security implementation

20.1.5.3 SOFTWARE PROFICIENCY

- Cloud platforms and services
- Digital twin software (Unity, Bentley, etc.)
- Advanced analytics platforms
- Container technologies (Docker, Kubernetes)
- Advanced programming languages (Python, C#, JavaScript)
- Machine learning frameworks (TensorFlow basics)

20.1.6 LEVEL 5 – AUTONOMOUS SYSTEM SKILLS (L0 + L1 + L2 + L3 + L4 + L5)

20.1.6.1 ADDITIONAL COMPETENCIES

- Artificial Intelligence: AI/ML model development and autonomous system design
- Grid Integration: Demand response, energy trading, and grid interaction
- Advanced Automation: Self-healing systems and autonomous optimisation
- Portfolio Intelligence: Multi-site optimisation and benchmarking
- Regulatory Compliance: Advanced environmental and energy regulations
- Innovation Leadership: Emerging technology evaluation and implementation

20.1.6.2 TECHNICAL SKILLS

- AI/ML model training and validation
- Grid interaction protocols and energy trading systems
- Autonomous system logic development
- Advanced self-healing and fault tolerance design
- Multi-site data federation and analytics
- Advanced voice and gesture control integration
- Blockchain and smart contract implementation (where applicable)

20.1.6.3 SOFTWARE PROFICIENCY

- Advanced AI/ML frameworks (TensorFlow, PyTorch)
- Advanced programming languages (Python, R, JavaScript, Go)
- Grid integration software platforms
- Advanced automation platforms
- Voice recognition and NLP platforms
- Advanced cyber security tools and frameworks

20.2 CONTRACTOR QUALIFICATION MATRIX

Capability	L0	L1	L2	L3	L4	L5
Team Size (Typical)	2-4	3-6	5-10	8-15	12-25	20+
Project experience	1+ years	2+ years	3+ years	5+ years	7+ years	10+ years
Certifications typically required	Basic trade	+ BEMS vendor	+ Network / Integration	+ Smart Building	+Cloud / Analytics	+ AI / Advanced Systems
Continuing Education	Basic	40 hrs/year	60 hrs/year	80 hrs/year	100 hrs/year	120 hrs/year

20.3 SKILLS VALIDATION REQUIREMENTS

20.3.1 FOR EACH LEVEL, CONTRACTORS WOULD TYPICALLY DEMONSTRATE:

- **Portfolio Evidence:** Completed projects at the claimed level
- **Technical Competency:** Skills assessment or certification
- **Team Qualifications:** Staff credentials and experience
- **Training Records:** Evidence of ongoing professional development
- **Vendor Relationships:** Partnerships and training with key suppliers
- **Reference Projects:** Client references for similar complexity projects

20.3.2 ONGOING REQUIREMENTS

- Annual Skills Review: Regular assessment of team capabilities
- Technology Updates: Training on new protocols, standards, and technologies
- Industry Participation: Involvement in professional bodies and standards development
- Innovation Investment: Demonstration of R&D and emerging technology adoption

20.4 CONTRACTOR SELECTION GUIDELINES

20.4.1 WHEN EVALUATING CONTRACTORS:

- ✓ **Verify Cumulative Skills:** Ensure competency across all relevant levels
- ✓ **Check Recent Experience:** Projects completed within last 3 years at claimed level
- ✓ **Assess Team Depth:** Multiple staff qualified at each level (not single-person dependency)
- ✓ **Review Training Programs:** Evidence of structured skills development
- ✓ **Evaluate Innovation:** Approach to emerging technologies and standards
- ✓ **Confirm Support Capabilities:** Long-term support and maintenance skills

APPENDIX H – SELECTING THE APPROPRIATE DELIVERY LEVEL

21. SELECTING THE APPROPRIATE DELIVERY LEVEL

This appendix provides guidance to help clients, consultants and project teams identify the Delivery Level most appropriate to their project.

Selection should be informed by the intended use of the building, the ownership and operational horizon, sustainability and reporting ambitions, available operational budget, and the in-house capability of the facilities team.

The framework is not prescriptive about which level should be chosen for a given building type; rather, it provides a structured way to reason about the trade-offs involved.

21.1 SELECTION CONSIDERATIONS

The following considerations typically influence Delivery Level selection. They are presented as prompts for project teams rather than as a scoring system.

- Building purpose and operational criticality: buildings with critical operational requirements (healthcare, data centres, research facilities) typically warrant higher Delivery Levels to support resilience, predictive maintenance and rapid fault response.
- Ownership horizon: owner-occupiers and long-hold investors generally benefit from higher Delivery Levels as the lifecycle value of operational data accrues over time. Short-hold or speculative developments may take a more capex-focused view.
- Sustainability and reporting ambitions: buildings subject to formal sustainability frameworks (BREEAM In-Use, NABERS, ESG reporting, net-zero pathways) typically require Level 3 or higher to deliver the structured, machine-readable data needed for verifiable reporting.
- Operational budget and FM capability: higher Delivery Levels require commensurate investment in operational support, skilled FM teams and ongoing data management. A high-level system without the operational capability to use it tends to underperform.
- Future-readiness and upgrade paths: where the building may be upgraded in future, selecting a Delivery Level with appropriate backbone, spare capacity and network design at outset is typically far less disruptive than retrofitting.
- Tenant and occupant expectations: buildings serving sophisticated tenants (premium commercial, life sciences, large corporates) increasingly expect Level 3+ capability for tenant interfaces, sub-metering and environmental data.

21.2 TYPICAL DELIVERY LEVEL SUITABILITY BY BUILDING TYPE

The table below indicates Delivery Levels typically observed as appropriate for common building types.

These are observations of industry practice, not recommendations or requirements.

Project teams should select the level that best fits the specific project context.

Building Type / Use	Typical Level	Key Drivers
Small industrial / warehouse / standalone retail	L0-L1	Capital cost, basic plant control, limited operational requirements
Speculative commercial base build	L1-L2	Cost focus at base build; tenant fit-out provides further capability
Owner-occupied office, mid-scale commercial	L2-L3	Operational efficiency, sustainability reporting, tenant expectations
Premium commercial, corporate HQ	L3-L4	ESG reporting, occupant experience, portfolio integration
Education (campus, university estate)	L2-L4	Portfolio efficiency, sustainability targets, varied building stock
Healthcare (acute, research)	L3-L4	Operational resilience, environmental control, integration with clinical systems
Life sciences / GMP facilities	L3-L4	Environmental control, validation, data integrity
Data centres	L3-L5	Operational criticality, cooling efficiency, grid interaction
Flagship / net-zero / innovation buildings	L4-L5	ESG leadership, autonomous operation, demonstrable performance

21.3 MIXED-LEVEL PROJECTS

It is common for a single building to be delivered against more than one Delivery Level.

For example, a commercial development may specify Level 2 for back-of-house plant and Level 3 for the tenant-facing systems and metering infrastructure.

Where this is the case, the project documentation should clearly identify which systems are delivered to which level, and the commissioning and handover documentation should reflect this split.

APPENDIX I – LEVEL-JUMP CONSIDERATIONS

22. LEVEL-JUMP CONSIDERATIONS

22.1 GENERAL PRINCIPLES

- **Backbone is the long pole:** network backbone, cabling topology and spare capacity provisioned at the original installation typically determine whether a level jump is straightforward or whether it requires substantial physical works. A copper-only unmanaged backbone (typical of L1) rarely supports a jump to L3 or above without re-cabling.

- **Data structure is the second long pole:** unstructured point naming and tagging at L1 can be retrofitted to a semantic schema, but the effort is significant and is typically charged per-point. Where future upgrade to L3+ is anticipated, consistent naming conventions should be applied from the outset even at L1.
- **Reversibility:** some decisions are easily reversed (graphics, schedules, alarm thresholds); others are effectively one-way doors (vendor lock-in via proprietary protocols, headend platform selection, cabling topology). One-way decisions warrant proportionately greater consideration at design stage.
- **Operational disruption:** level jumps in live operational buildings typically require careful phasing to avoid loss of control during transition. Allow contingency for parallel running, fall-back arrangements and out-of-hours work.

22.2 TYPICAL EFFORT BY LEVEL JUMP

The following observations describe typical industry experience for level jumps in existing buildings.

Actual effort depends heavily on the quality and specification of the existing installation.



L0 > L1: typically requires installation of a centralised BEMS, controllers, basic network and headend platform. Largely a new installation rather than an upgrade. Cost-effective only where existing plant is suitable for retrofit control.



L1 > L2: achievable where the original L1 was specified with structured cabling and BACnet/IP-capable controllers. Where the original used proprietary protocols or unmanaged copper-only networks, this jump typically requires substantial network upgrade.



L2 > L3: primarily a software, data and integration exercise where the L2 backbone and controllers are suitable. Semantic tagging, API exposure and tenant interface development are the major work packages. Cabling rarely needs to change.



L3 > L4: requires enterprise-grade data infrastructure, cloud or hybrid integration, and typically engagement with corporate IT. Often coincides with a transition of system ownership from facilities to digital/IT teams.



L4 > L5: primarily an AI, autonomy and governance exercise rather than a hardware exercise. The pre-requisites are robust data quality, integration maturity and operational confidence in autonomous decision-making.

22.3 COMMON PITFALLS

- Specifying L1 with no consideration for future expansion, then discovering at L3 procurement that the entire backbone needs replacement.
- Assuming that a higher Delivery Level can be retrofitted later at marginal cost. In practice, retrofit is typically several times the cost of specifying the higher level at outset where future use is anticipated.
- Procuring L3+ capability without the matching FM capability or operational budget to use it. Sophisticated systems require sophisticated operation to deliver value.
- Treating semantic tagging or API readiness as a tender-stage tickbox rather than a substantive deliverable validated at commissioning.
- Selecting a vendor at L1 whose platform does not scale to L3+ functionality, creating future lock-in or forced platform migration.

23. WORKED EXAMPLES

The following examples illustrate how the Delivery Level framework can be applied to typical project scenarios. They are composite illustrations drawn from common industry situations and do not represent specific projects.

23.1 WORKED EXAMPLE 1: SPECULATIVE COMMERCIAL OFFICE BASE BUILD



Project profile

8,000 m² speculative office development across six floors. Developer intends to sell or let on completion. Tenant fit-outs to be procured separately by future occupiers.

Selected Delivery Level

Level 2 at base build.

Rationale

Level 1 would have been adequate for the developer's immediate cost focus but would have constrained tenant fit-out options and reduced lettability to corporate occupiers expecting energy data and sub-metering. Level 3 was considered but rejected at base build on cost grounds, with the expectation that tenant fit-outs would extend to Level 3 capability where required. Level 2 provided a defensible base position: BACnet/IP backbone, structured cabling with spare capacity, consistent naming conventions and core utility metering - all of which protect future upgrade options.

Key Specification Points

30% spare network port capacity, fibre risers, BACnet/IP throughout, naming convention documented and applied consistently, BBMDs provided to support future multi-VLAN expansion.

Outcome

Base build delivered within developer's capex envelope; subsequent tenant fit-outs extended to Level 3 with comparatively low incremental cost on the metering and tenant interface side.

23.2 WORKED EXAMPLE 2: UNIVERSITY ESTATE PHASED UPGRADE



Project profile

University estate of 40 buildings across two campuses. Existing BEMS estate is mixed: approximately 60% at Level 1, 30% at Level 2, 10% with no central BEMS. Estate strategy requires consistent reporting against carbon and energy targets across the portfolio by year five.

Selected Approach

Phased upgrade to a portfolio-wide Level 3 target, with a Level 4 data platform overlay at estate level.

Rationale

A single-step upgrade was not affordable within the available capital programme. Phasing allowed the highest-priority buildings (those with the largest energy footprint and the most engaged FM teams) to be upgraded first, building operational capability progressively. A common semantic tagging schema and naming convention were defined at outset and applied to all upgrades, ensuring that the Level 4 estate platform could federate data from all buildings as they came online.

Key Learnings

The discipline of agreeing tagging and naming conventions before the first building upgrade saved significant rework. Two buildings were upgraded to L3 without the agreed conventions in place; both required subsequent re-tagging at a cost approaching 20% of the original upgrade.

23.3 WORKED EXAMPLE 3:
LIFE SCIENCES BUILDING WITH MIXED LEVELS



Project profile

12,000 m² life sciences building combining laboratory space, write-up areas and back-of-house plant. Laboratory environmental control is critical to ongoing research; back-of-house is non-critical.

Selected Approach

Level 4 for laboratory AHUs, environmental control and validation-relevant systems; Level 2 for back-of-house plant, lighting and metering.

Rationale

The operational and validation requirements for the laboratory space justified the predictive maintenance, high-resolution logging and digital twin support of Level 4. Applying Level 4 to back-of-house systems would have added cost without proportionate benefit. The mixed-level approach was clearly identified in tender documentation, with the system boundary defined at the AHU plant level.

Key Specification Points

Unified semantic tagging schema across both levels to support estate-wide reporting; common headend platform with appropriate access controls separating critical and non-critical systems; resilience and backup strategy aligned with the higher level for laboratory systems.

23.4 WORKED EXAMPLE 4:
HEALTHCARE FACILITY AVOIDING OVER SPECIFICATION



Project profile

Medium-sized acute hospital. Initial brief from estates team requested Level 5 (AI-driven autonomous) on the basis that “the technology is the future.”

Selected Approach

Level 3 with explicit upgrade path to Level 4.

Rationale

Review of the estate’s operational capability, IT engagement and FM team skills identified that autonomous operation was not realistically achievable within the project timeline. Level 5 would have delivered capability that the operational organisation could not use effectively, while substantially increasing capital cost. Level 3 delivered the structured data, API readiness and tenant/department interfaces that the estate genuinely needed, with a documented backbone, spare capacity and data architecture sufficient to support a future Level 4 upgrade once the digital and FM capability had matured.

Key Learnings

Sophistication of the system should be matched to the sophistication of the organisation operating it. Procuring above the operational capability of the FM team typically results in underperformance and disappointment with the technology, even where the technology itself is sound.

APPENDIX K – GLOSSARY AND ACRONYMS
24. GLOSSARY AND ACRONYMS

The following glossary covers terms and acronyms used in this framework. Where industry usage varies, the definitions below describe how the term is used within this document.

- **AHU:** Air Handling Unit. Mechanical equipment that conditions and circulates air.
- **AI / ML:** Artificial Intelligence / Machine Learning. Computational techniques used at higher Delivery Levels for predictive analytics, autonomous control and optimisation.
- **API:** Application Programming Interface. A defined method by which software systems exchange data or functionality.
- **BACnet:** Building Automation and Control Networks. An open communication protocol widely used in BEMS.
- **BACnet/IP:** BACnet over Internet Protocol. The network-layer variant of BACnet used in modern installations.
- **BBMD:** BACnet Broadcast Management Device. Used to forward BACnet broadcast messages between IP subnets in multi-VLAN installations.
- **BDNS:** Building Data Naming Standard. A naming convention framework used to structure point names consistently.
- **BEMS / BMS:** Building Energy Management System / Building Management System. Used interchangeably in this document; BEMS is preferred where energy management is the primary purpose.
- **BIM:** Building Information Modelling.
- **Brick:** An open-source ontology and schema for describing building systems and their relationships.
- **CAFM:** Computer-Aided Facilities Management. Software used by FM teams to manage assets, work orders and maintenance.
- **Digital Twin:** A digital representation of a physical building, including its systems, geometry and live data, used for visualisation, simulation and analysis.
- **ESG:** Environmental, Social and Governance. A framework for reporting non-financial performance.
- **FCU:** Fan Coil Unit. A small terminal unit providing local heating or cooling.
- **FDT:** Foreign Device Table. A BACnet mechanism allowing devices outside the local network to participate.
- **FM:** Facilities Management.
- **Haystack:** Project Haystack. An open-source semantic tagging methodology for building data.
- **HMI:** Human-Machine Interface. The display or panel through which a user interacts with a system.
- **HVAC:** Heating, Ventilation and Air Conditioning.
- **I/O:** Input/Output. The hardware connections between a controller and the field devices it monitors or controls.
- **IoT:** Internet of Things. Connected devices that exchange data over networks.
- **LOD:** Level of Development (in BIM contexts). Describes the maturity and completeness of model information.
- **MCCB:** Moulded Case Circuit Breaker.
- **MQTT:** Message Queuing Telemetry Transport. A lightweight publish-subscribe protocol commonly used for IoT and data streaming.

- **MTTR:** Mean Time To Resolution. A maintenance metric describing the average time taken to resolve faults.
- **Modbus:** An open communication protocol widely used for connecting industrial and HVAC equipment. Variants include Modbus RTU (serial) and Modbus TCP (Ethernet).
- **OCPP:** Open Charge Point Protocol. The standard protocol for communication between EV charging stations and management systems.
- **OSCP:** Open Smart Charging Protocol. A protocol for communication between EV charging management systems and grid operators.
- **PIC:** Protocol Implementation Conformance statement. A document describing which features of a protocol a device supports.
- **PPM:** Planned Preventative Maintenance.
- **REST / GraphQL:** Two common API architectural styles used for data exchange over HTTP.
- **SFP:** Specific Fan Power. A measure of fan energy efficiency.
- **SQL:** Structured Query Language. The standard language for relational database queries.
- **UDMI:** Universal Device Management Interface. An open standard for device management in smart
- building deployments.
- **Virtual Metering:** Calculation of energy or utility consumption by inference from other measured points, rather than by direct physical metering.
- **VLAN:** Virtual Local Area Network. A logical network segmentation technique.
- **VRF:** Variable Refrigerant Flow. A type of HVAC system using refrigerant as the heat transfer medium between a common outdoor unit and multiple indoor units.
- **Zero-Trust**: A security model in which no user or device is implicitly trusted; verification is required for every access request.

APPENDIX L – CYBER SECURITY BASELINE BY LEVEL
25. CYBER SECURITY BASELINE BY LEVEL

This appendix defines a minimum cyber security baseline for BEMS installations at each Delivery Level. It is provided as guidance and represents a starting point; project-specific cyber security requirements imposed by Client IT policy, sector regulation, insurance terms or applicable legislation may exceed these expectations and take precedence where stricter.

Building energy management and operational technology systems have increasingly been targets for cyber incidents, including ransomware events affecting operational technology networks across multiple sectors. Saying “none” at L1 is no longer a defensible position in 2026 and beyond. The baseline below is intended as a sensible minimum for project teams; it is not a substitute for formal risk assessment, nor for engagement with Client IT and cyber security teams where required by the project context.

25.1 PER-LEVEL MINIMUM BASELINE

The following table sets out a minimum baseline of controls for each Delivery Level. Each higher level inherits the controls of all lower levels and adds the additional controls listed.

Level	Minimum Baseline Controls
L0	Manufacturer default credentials changed before operational handover. Equipment maintained on supported firmware where security updates are issued. Physical access to controllers controlled in accordance with general estate security.
L1	All L0 controls plus: dedicated BEMS network segregated from corporate IT and tenant networks; no controllers, headend or operator workstations directly exposed to the public internet; user accounts on the headend with named credentials (no shared logins); basic audit logging of operator actions enabled and retained for 12 months minimum; documented backup of headend configuration.
L2	All L1 controls plus: documented network topology including VLANs and segmentation; protocol gateways and BBMDs deployed with controlled administrative access; remote access (where required) via VPN or secure remote access gateway; role-based access control on headend; firmware update regime documented and applied; backups verified by restore test at least annually.
L3	All L2 controls plus: formal engagement with Client IT and where applicable cyber security team documented at design stage; identity management aligned to Client IT standards where the BEMS is connected to corporate identity systems; security zoning of the network documented; API access controlled by token or equivalent with audit logging; data governance approach documented including retention, access and lawful basis for processing personal data.
L4	All L3 controls plus: alignment with a recognised cyber security framework (such as ISO 27001 or equivalent) documented and evidenced; security monitoring (logging and alerting) integrated with Client SIEM or equivalent where present; cloud and hybrid services subject to documented assurance (cloud provider attestations, data residency, exit and portability arrangements); patching and vulnerability management regime documented and operating.
L5	All L4 controls plus: zero-trust principles applied to network and application access; comprehensive penetration testing completed and findings remediated prior to acceptance; real-time security monitoring with documented incident response process; AI and autonomous decision-making subject to documented assurance including audit trails; supply chain assurance documented for connected third-party services.

25.2 CROSS-CUTTING PRINCIPLES (ALL LEVELS)

The following principles apply across all Delivery Levels and should be considered regardless of the level selected.

- **No internet-exposed controllers.** Field controllers, headend platforms and integration gateways should not be directly exposed to the public internet. Where remote access is required, it should be provided through a secure means (VPN, ZTNA, secure remote access gateway) administered by appropriately qualified personnel.
- **No default credentials at operational handover.** Manufacturer default usernames and passwords should be changed before the system enters operational service. Default credentials remain a leading cause of operational technology compromise.
- **Manufacturer support and patching.** Equipment that is no longer receiving security patches from its manufacturer is approaching end of supported life. Such equipment should be identified at handover with a planned replacement horizon, and additional compensating controls considered in the interim.
- **Network segregation.** The BEMS network should be logically separated from corporate IT and tenant networks. The degree of separation appropriate to the project should be agreed with Client IT at design stage.
- **Engagement with Client IT.** Cyber security is a shared responsibility. Project teams should engage with Client IT, and where applicable the Client cyber security team, at the earliest opportunity, especially where the BEMS is to be connected to corporate networks or cloud services.
- **Documentation of residual risk.** Where the baseline cannot be met for legitimate project reasons (legacy plant, programme constraints, commercial constraints), the residual risk should be documented and acknowledged by the Client at handover, with a remediation horizon where appropriate.

Project teams should treat this baseline as a minimum, not a target. Cyber Security expectations across the construction and operational technology sectors continue to evolve. This baseline reflects industry practice at the time of issue; project-specific requirements and applicable legislation should be re-confirmed at the outset of each project.

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