SMART BUILDINGS SHOW 2026 · EXCEL LONDON

# Closing the Gap, or Just Describing It?

*The case for a continuous performance audit*

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THURSDAY 15 OCTOBER 2026 · 13:35 · ENERGY MANAGEMENT THEATRE

# A building can be capable of performing and still not sustain it

CONTROLS

**Provide capability**

Execute sequences, hold setpoints, coordinate equipment.

ANALYTICS

**Observe behaviour**

Compare with expectations, detect deviations, raise flags.

AUDIT

**Judge the equipment**

Are we meeting the requirement, what supports that conclusion, and what happens when we are not?

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DRIFT, ONE SMALL CHANGE AT A TIME

| | | | | |
|---|---|---|---|---|
| Sensors drift | Overrides stay in | Schedules outlive the occupancy | Valves pass, strainers block | A new part changes a loop |

**None of it alarms. Together it moves the building.** The opportunity is to shorten the interval between a material deviation and a verified correction.

# Before asking whether the building performs, ask whether the measurements can support the answer

**+18%**

**Site energy, from slowly drifting sensors alone**

Simulated 10-zone office, Guideline 36 control, 3,600 cases. Heating up to about +300%, cooling up to +65%. Li et al., Buildings, 2023.

THREE QUESTIONS OF EVERY READING

| Valid | Reliable | Fit |
|---|---|---|
| Physically plausible | Agrees with the process | Right place, time, accuracy |

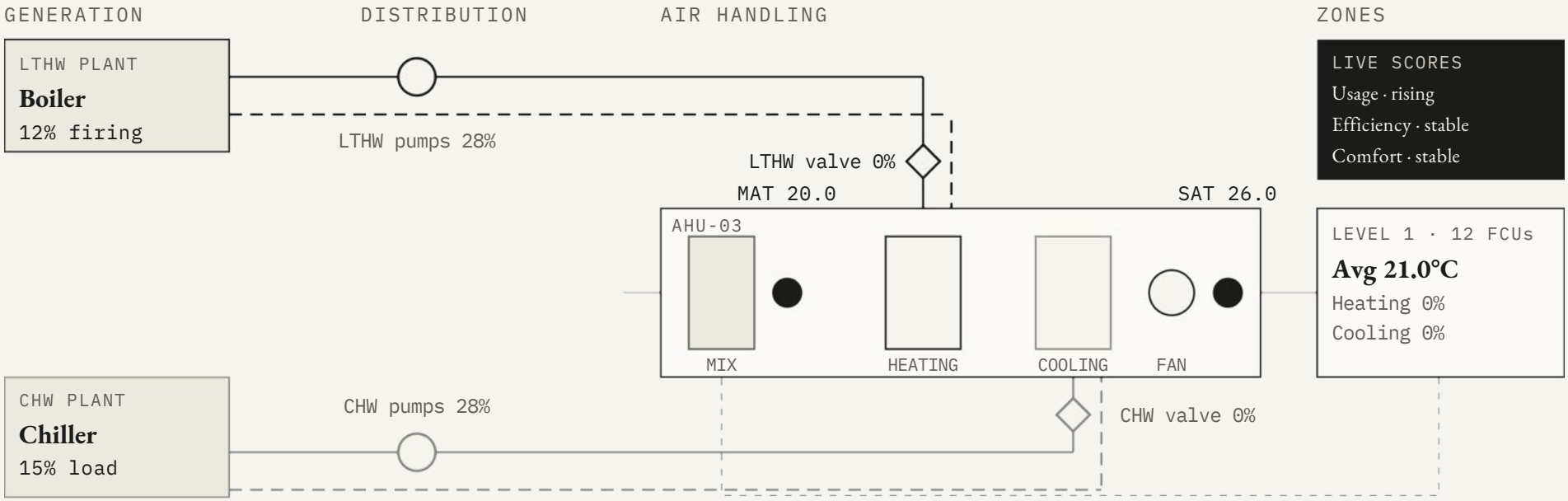
THREE STATES OF EVIDENCE

| Verified | Inferred | Insufficient |
|---|---|---|
| Checked independently | Carries its assumptions | Says what to measure next |

**A BMS executes its logic perfectly on a wrong value.** The audit carries the evidence state through to the diagnosis and the bill.

04 · THE AHU OBSERVATION

# Supply air warmer than mixed air, heating valve commanded shut




TRIGGER · 08:14

**SAT above MAT by 6°C with the heating valve at 0%. No heat should be entering.**

BEFORE CALLING IT A FAULT

Sensor placement and fan heat · heat recovery or another stage · start-up or stored heat · command versus physical state

# The alarm fires, the loop responds, the alarm clears

08:14

### High supply temperature

Reading climbs above setpoint. A high-level alarm appears on the head end.

08:16

### Chilled water valve opens

The cooling loop does its job and pulls the reading back to setpoint.

08:21

### Alarm clears

Return to normal. One line in a log that nobody reads.

All day

### Everything looks fine

Supply on setpoint. Zones on setpoint. Two meters climbing with no ticket attached.

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**The BMS did exactly what it was designed to do. Control is compensation, and compensation hides the cause.**

An alarm disappearing tells you the reading came back. It does not tell you why it left, or what it cost while it was away.

06 · THREE DIAGNOSTIC HYPOTHESES

# Each explains the observation. Each has a different test and a different bill.

### A. Heating valve passing

Water still moves through a shut coil. Test: isolate the coil.



**£2,854 a year**

About 12 kW leaked and removed again. 159p an hour.

### B. Supply sensor reads high

Cooling the air does not need; zones reheat it. Test: an independent supply reading.



**£10,300 a year**

If the reheat response occurred, at 6°C of bias. 574p an hour.

### C. Mixed air sensor reads low

A reading, not a fault. Test: correct it and see if the pattern vanishes.



**About £0 a year**

Unless it drives the economiser. Loss of confidence, not energy.

**Until we know which, we cannot cost it. Until we cost it, we cannot rank it.**

`Q = m · cp · ΔT: 6 m3/s of air is 7.2 kW per °C. Boiler 85%, chiller COP 3.5, 1,800 hours a year, gas 5.28p, electricity 24.51p per kWh. Deliberately competing hypotheses, not an exhaustive list.`

# Separate recognising from investigating, then add two more tasks

SYSTEM 1 · DETECT

**Continuous, cheap, everywhere**

Rules and tolerances. Says: look here.

SYSTEM 2 · INVESTIGATE

**Targeted, deliberate**

Competing hypotheses, more evidence, the wider response.

CONSEQUENCE

**What has it affected?**

Energy, service, risk. kWh and pounds where the evidence allows.

PRIORITY

**What does it warrant?**

Against everything else on the list this week.

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## One alarm collapses all four and hides the assumptions

A temperature difference becomes a valve fault, becomes a saving, becomes a priority, with nobody checking the steps between.

# Widen the boundary, and score every link the same way

1 GENERATION

**Boilers, chillers, heat pumps**

Make heat and cold.

→

2 DISTRIBUTION

**LTHW and CHW, primary and secondary**

Move it to where it is wanted.

→

3 AIR HANDLING

**AHU-03: mixing, heating, cooling, fans**

Condition the air.

→

4 ZONES

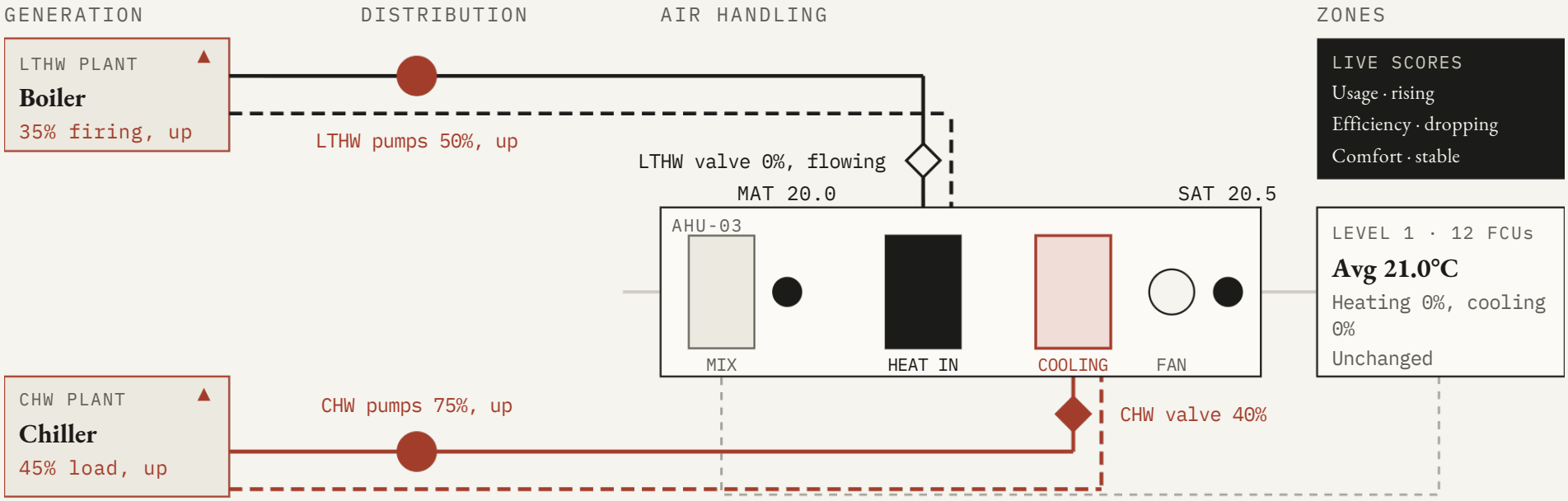
**Spaces, terminal reheat, units**

Deliver the service.

| Usage | Efficiency | Mechanical effort | Comfort |
|---|---|---|---|
| Against its own weather-adjusted expectation | Useful work per kilowatt-hour | The aggregate of Usage & Efficency | Is the service delivered where it matters? |

**Topology says where to look. Scores say what moved.** Energy flows left to right; demand flows right to left.

# The valve is passing: the symptom spreads to the plant, the source stays at the coil



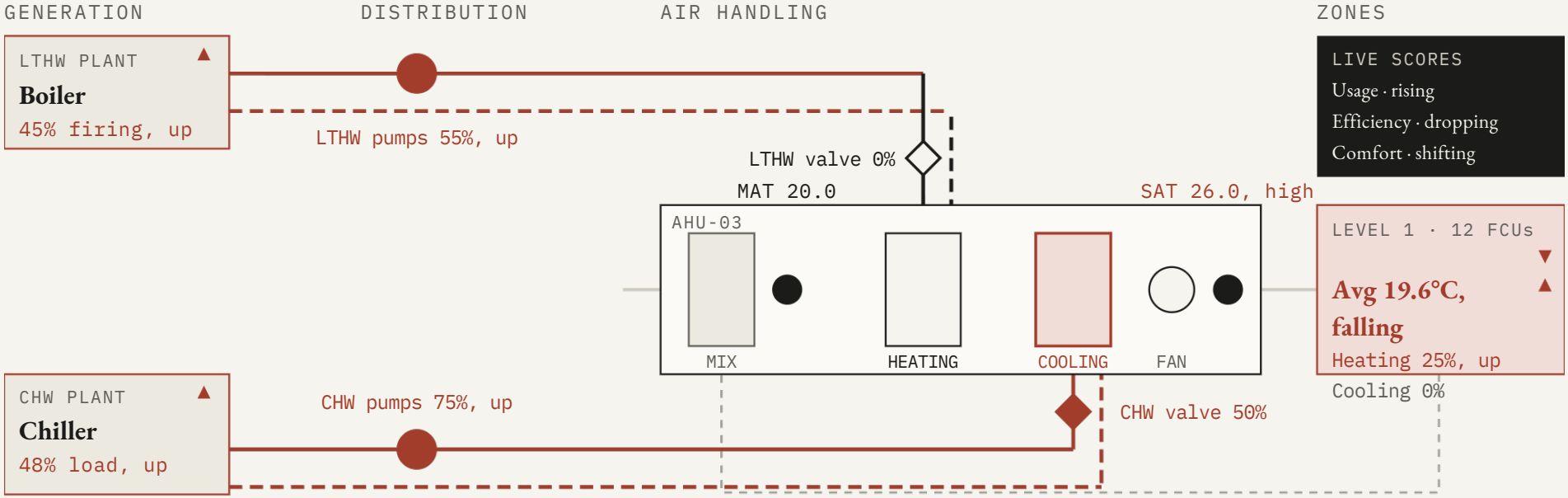

**CAUSE**
Heating valve not seating. Hot water passes a coil commanded shut.

**RESPONSE**
Cooling opens, SAT recovers, alarm clears. LTHW keeps flowing; boiler and chiller both load. Zones unchanged.

**WHAT IT MEANS**
Heat nobody asked for, made and removed again. Usage up, efficiency down, comfort untouched. Nobody feels it.

**VERDICT**
AHU failing, plant compensating. £2,854 a year. Probable: isolate the coil, then replace the actuator.

# The supply sensor reads high: the AHU overcools, every zone reheats, both plants strain



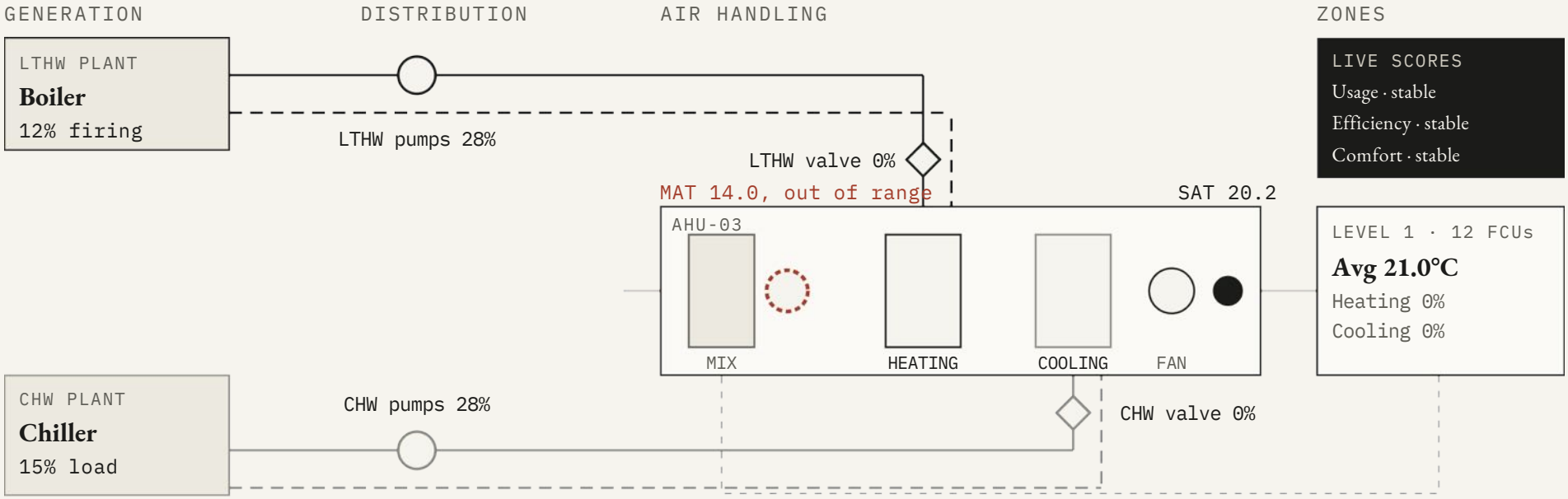

**CAUSE**
Supply sensor reads 6°C high. The loop chases a number that cannot come down.

**RESPONSE**
Cooling opens hard; the reading holds. Zones overcool to 19.6, fan coil heating opens, boiler and chiller both load.

**WHAT IT MEANS**
The AHU cools air the fan coils then reheat. Usage up, efficiency down, comfort shifting. Only a wrong reading explains all of it.

**VERDICT**
AHU failing on a false reading; zones and plant compensating. £10,300 a year. Probable: independent SAT check, then recalibrate.

# The mixed air sensor reads low: the whole building is quiet, and the trigger stays on




**CAUSE**
Mixed air sensor reads low. Nothing in the control path uses it.

**RESPONSE**
None. Plant, pumps, coils and zones all sit at baseline. The trigger stays on.

**WHAT IT MEANS**
A real heating fault would propagate. SAT tracks the zones; MAT sits below the outside air that made it. The reading is the fault.

**VERDICT**
Nothing failing. About £0 in energy; an observability exposure. Confirmed: recalibrate MAT, check placement.

# What are we exposed to while this condition remains?

ENERGY

**Avoidable consumption**

kWh, cost, carbon, against a defensible baseline. The easy column.

SERVICE

**Required conditions not met**

Ventilation, temperature, pressure: magnitude, duration and the spaces affected.

RELIABILITY

**Degraded operation, lost redundancy**

A standby changeover that fails costs nothing today and resilience tomorrow.

COMPLIANCE

**Departure from a requirement**

Identified for that site. A general analytics rule cannot establish legal compliance by itself.

OBSERVABILITY

**Reduced ability to know**

A lost flow meter wastes little energy and undermines several decisions at once.

CAUSE B · SUPPLY SENSOR

Energy, service and reliability at once

CAUSE C · MIXED SENSOR

Near zero on energy, real on observability

Methods, not a universal score: ASHRAE Guideline 36 (sequences, FDD context) · Standard 211 (energy audits) · Standard 230 (commissioning existing buildings) · Standard 180 (HVAC inspection and maintenance) · IPMVP (savings M&V). Different scopes; none prescribes this framework.

# Findings cannot be ranked from their names. Rank them from their exposure.

| Rank | Finding | Energy a year | Other exposure | Status | Next step |
|---|---|---|---|---|---|
| 1 | AHU-03 supply sensor reading high | £10,300 | Service, reliability | Probable | Independent reading, then replace |
| 2 | Duty and standby pump changeover failed | about £0 | Reliability: only redundancy on a critical circuit | Confirmed | Repair, functional test |
| 3 | Chiller 2 efficiency down 25% at same load | £6,100 | Reliability: summer capacity | Probable | Service visit |
| 4 | CHW flow meter reading doubtful | about £0 | Observability: capacity decision depends on it | Unresolved | Independent check |
| 5 | AHU-07 heating valve passing | £2,850 | Low | Probable | Isolation test |
| 6 | AHU-03 mixed air sensor reading low | about £0 | Observability | Confirmed | Replace at next visit |

**Two rows from one trigger sit first and sixth.** When confidence is low, the next step is a measurement, not a part.

Illustrative site. Costs modelled, not metered.

# Closing a work order records an intervention. Verification establishes recovery.

FOR OUR AHU, AFTER THE SENSOR IS REPLACED

**Check the new reading against independent evidence**

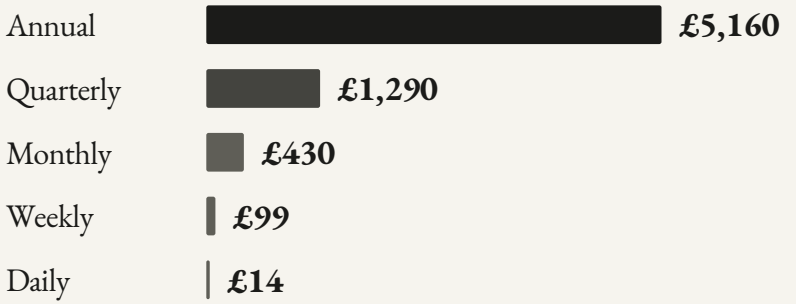
**Confirm the sequence responds as intended**

**Re-examine the connected consequences**

**Protect the service requirement**

**Check persistence under other modes and loads**

WHY THE CADENCE MATTERS: CAUSE B, FOUND AT THE NEXT REVIEW




*Average waste before anyone looks. One fault, random start, found at the next review.*

A lower meter reading is not a saving. Boundary, baseline, weather adjustment (IPMVP). Then keep watching: sensors drift back.

**The success criterion is restored required performance with adequate evidence.** Alarm clearance supports it. It cannot carry it alone.

# Every tool runs this loop. The difference is how much is handed to a person.

| STEP | BMS | ANALYTICS | FDD | CONTINUOUS AUDIT |
|---|---|---|---|---|
| Define | Setpoints and alarm limits | A baseline or benchmark | A rule library | A requirement and a boundary |
| Trust | None. A reading is a reading | Meters checked, points not | Partial, rule by rule | Every reading; doubtful ones quarantined |
| Detect | Alarm, now | Variance, a month later | Flag, now | Flag, now |
| Investigate | None. The loop compensates | A person, from the trends | A person, from a list of causes | Traced on the chain, both directions |
| Judge | Return to normal | A variance, a league table | Severity per rule, not per cause | Cause, cost, exposure, confidence |
| Act | Acknowledge | A report in an inbox | A work order from the flag | Owner, date, success test |
| Verify | Alarm clear | Next month's number | Rule silent | Recovery against baseline, then persistence |

**In cause A the alarm clears and the rule goes quiet because the fault is being compensated, not fixed.** Two of the four call that verified.

# One process, people as well as software, and a record that stays connected

1
**Define**
The requirement and the boundary.

2
**Trust**
Can the measurements support the checks?

3
**Detect**
Deviations in their operating context.

4
**Investigate**
Competing explanations, on the chain.

5
**Judge**
Exposure, cost, status, priority.

6
**Act**
An owner, a date, a success test.

7
**Verify**
Recovery, then keep checking.

### People
Owners set the outcome. FMs act. Engineers test. Analysis keeps the evidence.

### Continuous
The process stays active, at a cadence suited to the equipment, service and risk.

### Start small
One system, one requirement, a few checks. Half-hourly energy, existing points, outside temperature.

# Automation controls the building. Analytics observes it. Auditing holds its performance accountable.

| | | |
|---|---|---|
| 1 | **Trust the measurement** | Is the evidence fit for the decision? Make inferred values visible. |
| 2 | **Investigate competing causes** | A symptom is the start of an enquiry. The diagnosis decides the action. |
| 3 | **Trace consequences across systems** | The effect appears in a zone, a circuit or the plant room. Follow the real relationships. |
| 4 | **Prioritise the exposure** | Energy, service, reliability, compliance, observability. What matters here, and how urgently. |
| 5 | **Verify recovery and keep checking** | Closure is earned by evidence of restored performance, not by a cleared alarm. |

*Do not describe the fault. Judge the equipment. A process an owner can understand, an FM can operate and an engineer can defend.*

THANK YOU

# Questions

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A thirty-minute walkthrough on a real building: griotech.co.uk/demo

BACKUP · TECHNICAL REFERENCES

# For preparation and follow-up

| | |
|---|---|
| **+18% site energy** | Li, Im, Lee, Bae, Yoon and Lee (2023). Sensor Incipient Fault Impacts on Building Energy Performance. Buildings 13(2), 520. Simulation, 3,600 cases. |
| **The observation rule** | Schein, Bushby, Castro and House (2003). NISTIR 6994, field testing of AHU and VAV fault detection tools. Rules from mass and energy balances; inter-coil sensor note. |
| **Guideline 36-2021** | ASHRAE, High-Performance Sequences of Operation for HVAC Systems; Addendum p (2024) for AHU fault detection context and sensor placement. |
| **Standards 180, 211, 230** | ASHRAE: HVAC inspection and maintenance; commercial building energy audits; commissioning existing buildings and systems. |
| **IPMVP** | Efficiency Valuation Organization. Measurement boundary, comparison and adjustment for changed conditions. |
| **US DOE FEMP** | Commissioning Process for Federal Facilities: investigation, implementation, retesting, remonitoring. |
| **24.51p, 5.28p** | DESNZ Quarterly Energy Prices, September 2026. Non-domestic averages per kWh including Climate Change Levy. |
| **Persistence** | Bourassa, Piette and Motegi (2004): 10.5% peak, about 8% by year four. Claridge and Toole (2007), Texas A&M. |

*The five exposure categories and the System 1 / System 2 architecture are this talk's framework. The references support particular methods, not a universal scoring system or a claim of certification. Check editions and site applicability before formal use.*

# The illustrative model, in full

| | |
|---|---|
| **Airflow** | 6 m3/s, 7.2 kg/s (1.2 kg/m3, cp 1.005), so 7.236 kW per °C |
| **Day** | Mild, about 16°C outside, return 22°C, mixed 17°C, free cooling, zones on setpoint |
| **Cause A** | 12 kW through a shut heating valve, 1.66°C rise, removed by the cooling coil. Gas 14.1 kWh/h, electricity 3.4 kWh/h |
| **Cause B** | Supply sensor +6°C bias; true supply 6°C cold; 43.4 kW cooling; terminal reheat fully offsets it. Electricity 12.4, gas 51.1 kWh/h |
| **Cause C** | Mixed sensor reads below outside air; drives no valve or damper; energy about 0 |
| **Conversion** | Boiler 85%, chiller COP 3.5, both assumed constant |
| **Hours and tariffs** | 12 h a day, 1,800 h a year, 150 operating days; gas 5.28p, electricity 24.51p |
| **Interval model** | Random start, found at next review, average wait half the interval, £68.85 per operating day |

*None of these is a measurement. All are chosen to be defensible and easy to change live.*

IF ASKED FOR THE SCORE NAMES

Usage · **NUF**, normalised usage

Efficiency · **AER**, adjusted efficiency

Mechanical effort · **MEI**, from NUF and AER

Comfort · **CEI**, from comfort sensors

Headline · **OEI**, with a confidence

Mechanical effort is being reworked to weight components by control duty and run time. Say "being refined" if pressed.