Energy, Simulation and Capital Decisions From One Model: The Machine Readable Building

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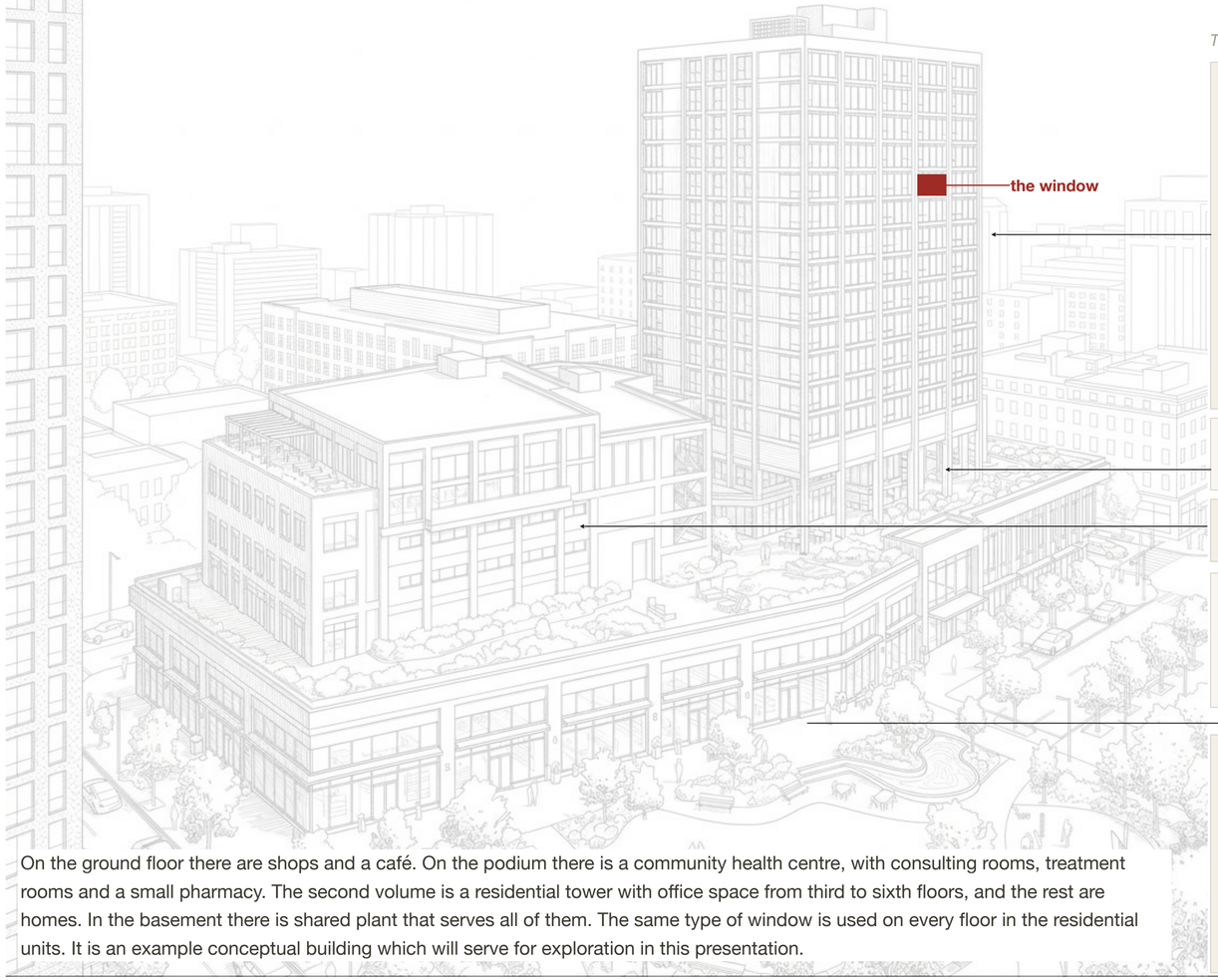
Independent Consultant, Built Environment Data and Regulatory Compliance

ONE WINDOW

A home on the ninth floor



The building it belongs to



Thirteen storeys. The same window type on every floor in the residential units.

Homes for rent, seventh to thirteenth floors

Offices, third to sixth floors

Community health centre, third to sixth floor (separate volume on podium)

Shops and café, ground floor

ground

Shared plant, basement

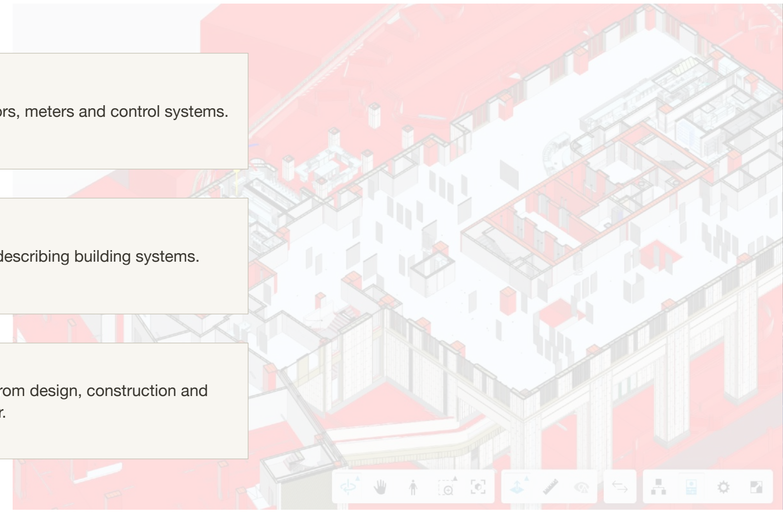
On the ground floor there are shops and a café. On the podium there is a community health centre, with consulting rooms, treatment rooms and a small pharmacy. The second volume is a residential tower with office space from third to sixth floors, and the rest are homes. In the basement there is shared plant that serves all of them. The same type of window is used on every floor in the residential units. It is an example conceptual building which will serve for exploration in this presentation.

Illustrative example.

What we already hold

The window

- Continuous operational data from sensors, meters and control systems.
- Mature, machine readable ways of describing building systems.
- Specification and asset information from design, construction and handover.





We already know a lot about this window, and that is thanks to the work of many people in this field:

- We hold continuous operational data from the sensors, meters and control systems that serve the room.
- We have mature, machine readable ways of describing the building's systems.
- We have the full body of specification and asset information created through design, construction and handover, including the manufacturer's own product data. Our industry has never held as much as it holds today.

Illustrative example.

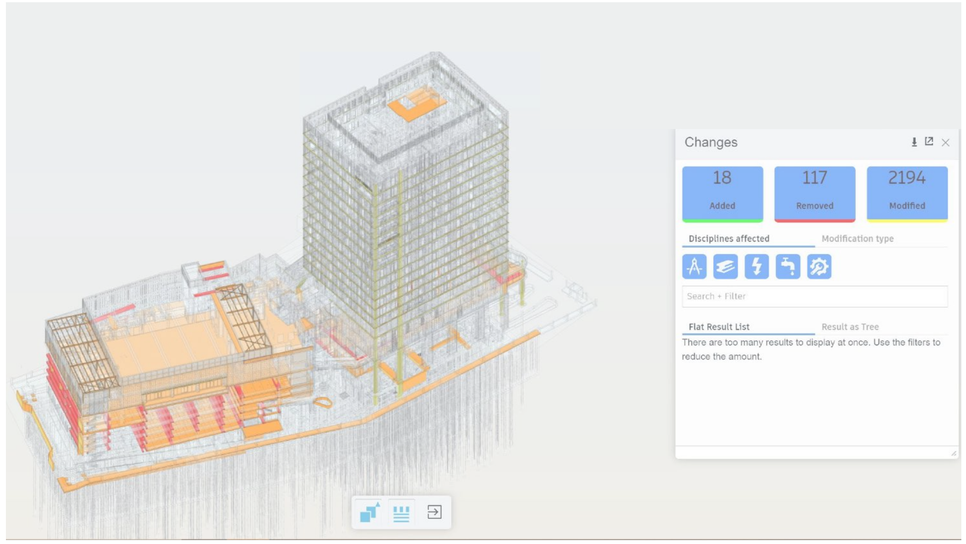
From one window to many decisions

Its performance has an impact on how people live, and what is known about that window informs the work of various disciplines and the evidence for regulatory compliance, including building safety. The figures built from it compound across many buildings and have an impact on the decisions that are made.

- Residents
- Office workers
- Clinicians
- Energy manager
- Energy modeller
- Controls engineer

The window

- Fire engineer
- Facilities team
- Manufacturer
- Investor
- Risk and assurance
- Policy maker



Illustrative example.

ONE WINDOW

Nine records of the same window

> **The figure each discipline works from, whether they produced it or received it.**

Take one property of this window: its thermal transmittance, in watts per square metre per kelvin. It is the heat lost through one square metre for each degree of difference between inside and outside, so a lower number means less heat lost.

Manufacturer
Centre of glazing, Ug
Used for the product declaration a designer specifies from
1.1 W/m²K

Designer
Whole window, Uw, glazing and frame together
Used for the Building Regulations compliance submission
1.6 W/m²K

Energy modeller
Whole window for this opening, with its own frame proportion
Used for predicted demand and the design case
1.8 W/m²K

EPC assessor
A value assigned from a table, not measured
Used for the EPC band, landlord duties and grant eligibility
2.0 W/m²K

Energy manager
The declared whole window value, read against the meters
Used to reconcile predicted against actual
1.6 W/m²K

Retrofit assessor
Condition on site: a failed unit performs as air filled
Used for the retrofit plan and the funding application
2.7 W/m²K

Investor
The figure carried inside the certificate
Used for valuation, the business case and lending
2.0 W/m²K

Risk and assurance
The figure carried in the construction record
Used for the risk view and the terms it supports
1.6 W/m²K

Policy maker
The same assigned values, aggregated across the stock
Used for national targets and where public funding goes
2.0 W/m²K

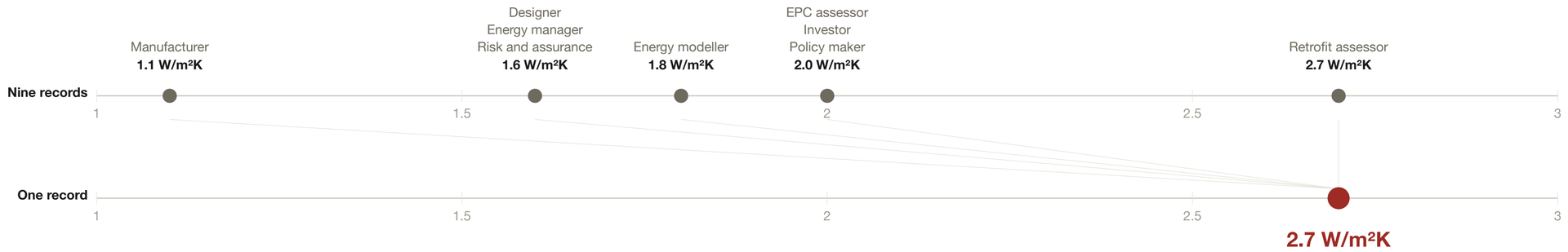
These records may differ but none of them is wrong, because they describe the same window from different angles. One may be the manufacturer's figure for the glazing on its own, and another may be the figure for the whole window with its frame and spacer, which is not the same number. One may come from a laboratory test, another from a calculation, and another from a measurement taken on site, and each of those has its own conventions. The window also sits in a real place. How it was installed, how well the seal and the reveal were finished, which way the elevation faces and how exposed it is all change what the window actually does. And it has been in service for years. If a seal has failed, the unit performs as if it were air filled, so a window measured today will not match the figure it was given on the day it was made. Each record is correct in its own terms.

Illustrative example. Not an actual product or real life data.

Ref: Approved Document L, Volume 1: Dwellings, 2021 edition incorporating 2023 amendments, Tables 1.1, 4.1 and 4.2, GOV.UK · RdSAP 2012 version 9.94, Table S14, BRE · BS EN ISO 10077 1:2017, whole window Uw, referencing BS EN 673 for Ug, BSI · Insulating glass units, gas leakage rate and gas concentration tolerances, BS EN 1279 3:2018, BSI · Energy efficiency of housing in England and Wales, 2024, ONS

What becomes possible when all of it is held in one connected model that a machine can read?

The same nine parties, and the same figures, on one scale.



What one agreed figure changes for each of them.

Manufacturer Performance in service, not only at test	**Designer** Specifies from fact	**Energy modeller** Prediction that holds	**EPC assessor** Evidence, not a table value	**Energy manager** The gap explained	**Retrofit assessor** The plan starts from fact	**Investor** Priced on condition	**Risk and assurance** Risk judged on what is there	**Policy maker** Targets on measured stock

What follows looks at what becomes possible when all of it is held in one connected model that a machine can read. We will do that by following this one window, from the room it sits in, all the way out to a whole continent.

Illustrative example.

Asset Intelligence Infrastructure

THREE STEPS, ONE ARCHITECTURE

ASSET INTELLIGENCE INFRASTRUCTURE

STEP 3

Check continuously.

Every change checked against the rules as it happens, and the whole record checked again whenever a rule changes

STEP 2

Write down what is required.

Requirements held as rules a machine can check, each one against the element it governs and signed by the professional responsible

STEP 1

Describe the building once.

Every part, condition, obligation and person, held in defined relationships that a machine can follow

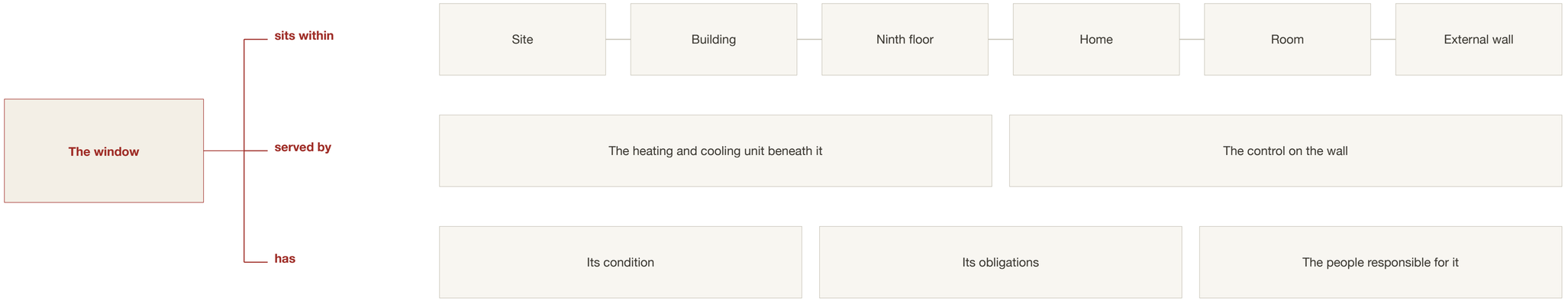
The approach we will follow is called Asset Intelligence Infrastructure, and it rests on three simple steps. We will follow the window through each of these.

Illustrative example.

Describe the building once

> **An ontology is an agreed description of every kind of part, condition, obligation and person in a building, and of how they relate to one another.**

The relationship is named on every line, so a machine can follow it as we would.

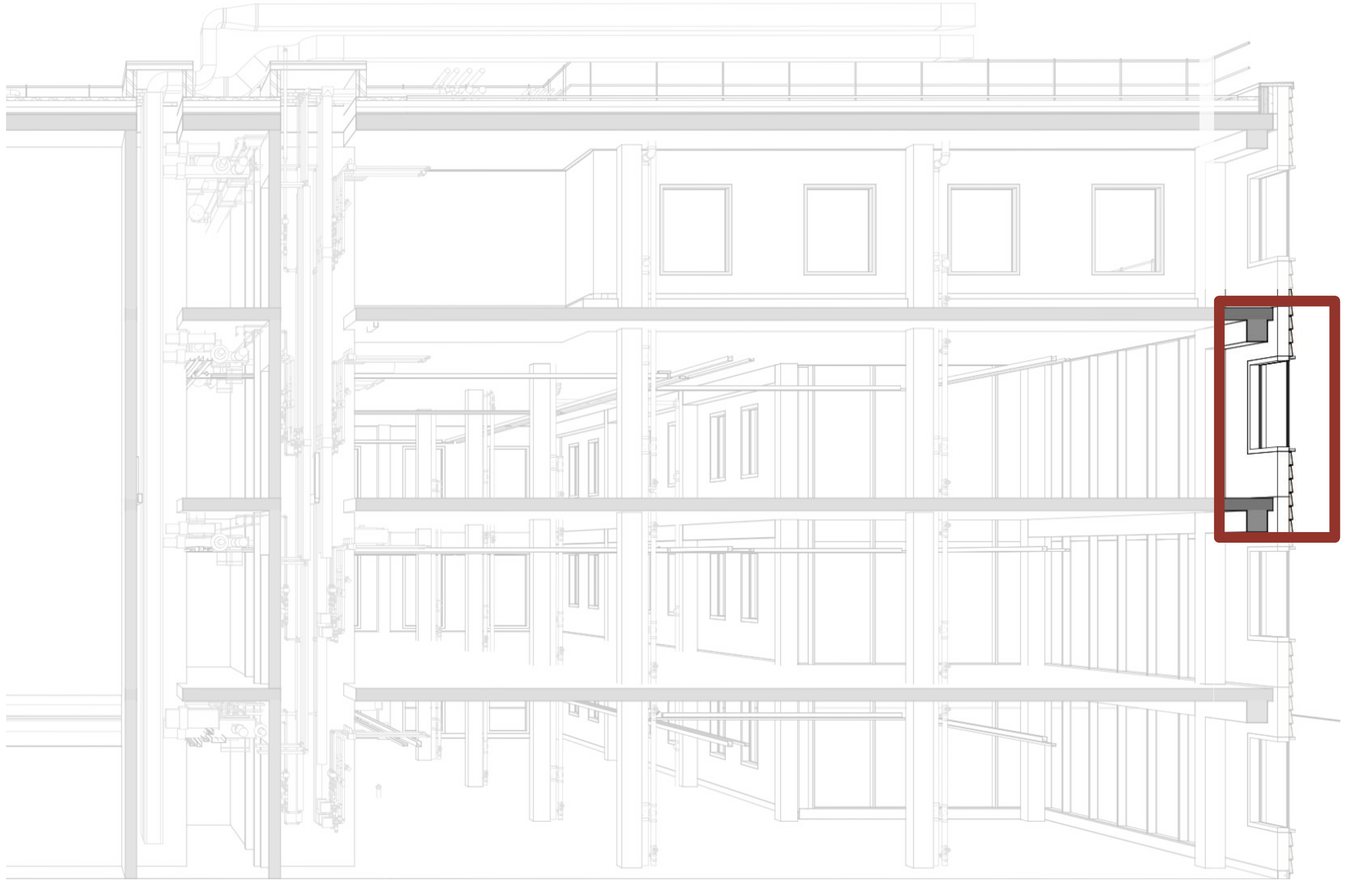


The first step is to describe the building once. To do that, we need an ontology. An ontology is an agreed description of every kind of part, condition, obligation and person in a building, and of how they relate to one another. The building is then described in those terms. Our window sits in the external wall of a room, in a home on the ninth floor. It is served by the heating and cooling unit beneath it and by the control on the wall. It has a condition, it has obligations, and it has people who are responsible for it. All of this is held in defined relationships, so a machine can follow them just as we would.

Illustrative example.

Identifying the window within the hierarchy

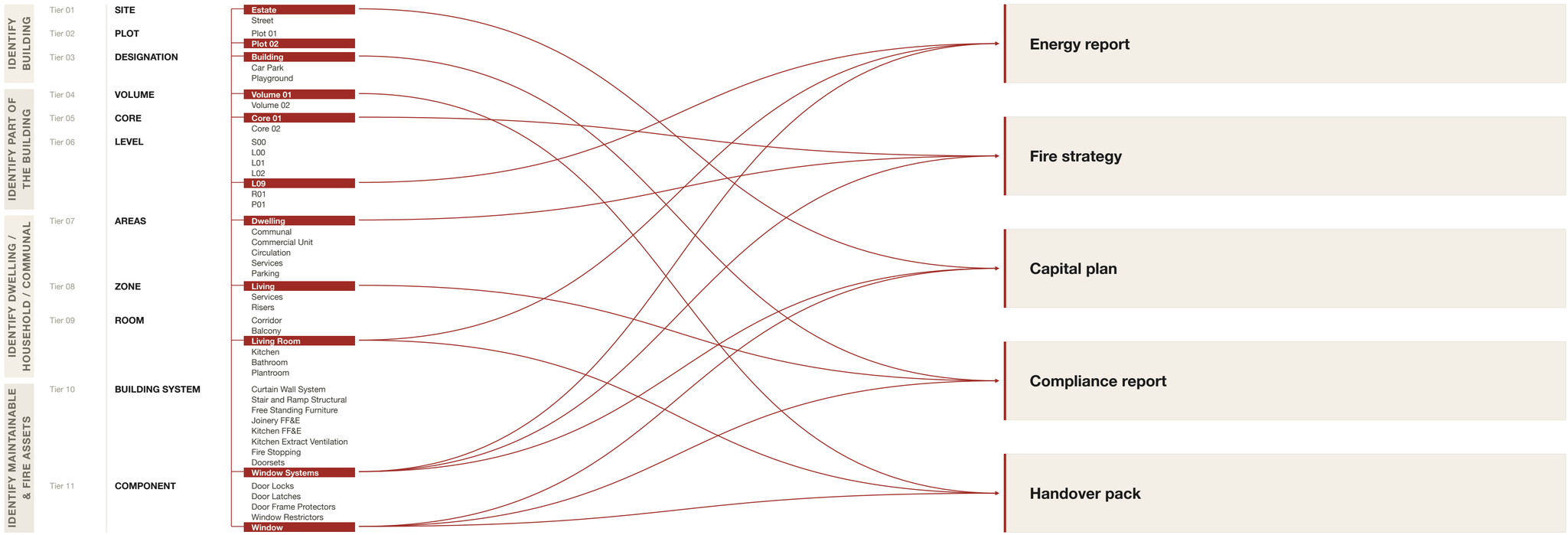
IDENTIFY BUILDING	Tier 01	SITE	**Estate**
			Street
	Tier 02	PLOT	Plot 01
			Plot 02
	Tier 03	DESIGNATION	**Building**
			Car Park
			Playground
IDENTIFY PART OF THE BUILDING	Tier 04	VOLUME	**Volume 01**
			Volume 02
	Tier 05	CORE	**Core 01**
			Core 02
	Tier 06	LEVEL	S00
			L00
			L01
			L02
			L09
			R01
			P01
IDENTIFY DWELLING / HOUSEHOLD / COMMUNAL	Tier 07	AREAS	**Dwelling**
			Communal
			Commercial Unit
			Circulation
			Services
			Parking
	Tier 08	ZONE	**Living**
			Services
			Risers
	Tier 09	ROOM	Corridor
			Balcony
			Living Room
			Kitchen
			Bathroom
			Plantroom
IDENTIFY MAINTAINABLE & FIRE ASSETS	Tier 10	BUILDING SYSTEM	Curtain Wall System
			Stair and Ramp Structural
			Free Standing Furniture
			Joinery FF&E
			Kitchen FF&E
			Kitchen Extract Ventilation
			Fire Stopping
			Doorsets
			Window Systems
	Tier 11	COMPONENT	Door Locks
			Door Latches
			Door Frame Protectors
			Window Restrictors
			Window



Illustrative example.

Everything from the live record

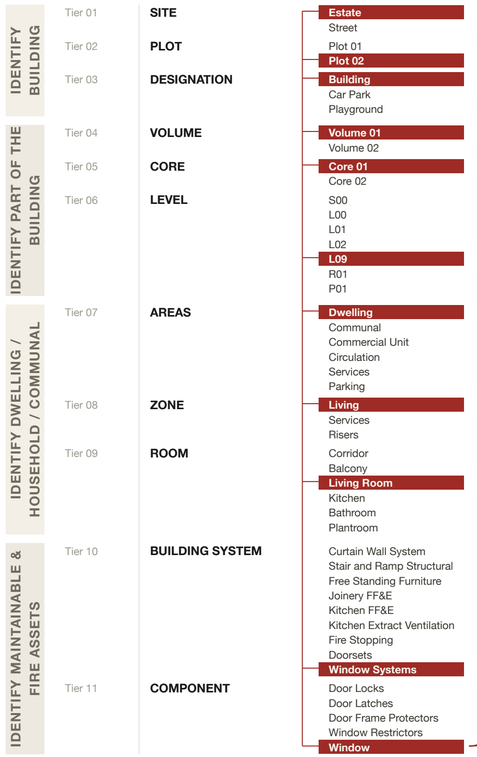
Knowing on demand becomes different capability from querying for it.



Once the building is described, every report and every analysis can be produced from the live record whenever it is needed. The energy report, the fire strategy, the capital plan, the compliance report and the handover pack all come from the same place. Knowing on demand is a different capability from querying for it.

Illustrative example.

What the record has to carry



TYPE

Name
Category
Description
AssetType
Manufacturer
ModelNumber
WarrantyGuarantorParts
WarrantyDurationParts
WarrantyGuarantorLabor
WarrantyDurationLabor
ReplacementCost
ExpectedLife

TYPE, FABRIC AND PERFORMANCE

NominalLength
NominalWidth
NominalHeight
Material
Finish
Color
CodePerformance
SustainabilityPerformance
ResistanceToFireRequiredStructure
ResistanceToFireRequiredIntegrity
ResistanceToFireRequiredInsulation
ReactionToFire

COMPONENT, THIS ONE WINDOW

Name
TypeName
Space
Description
SerialNumber
InstallationDate
WarrantyStartDate
TagNumber
BarCode
AssetIdentifier
Area
Length

DOCUMENT

Name
Category
ApprovalBy
Stage
File
Reference
Description
System
Type

OPERATIONS AND MAINTENANCE

LifeMinimum
LifeMaximum
ReplaceYear
Condition
CostNew
CurrentValue
YearValued
InspectionRequired
InspectionDate

SUSTAINABILITY CARBON ASSESSMENT

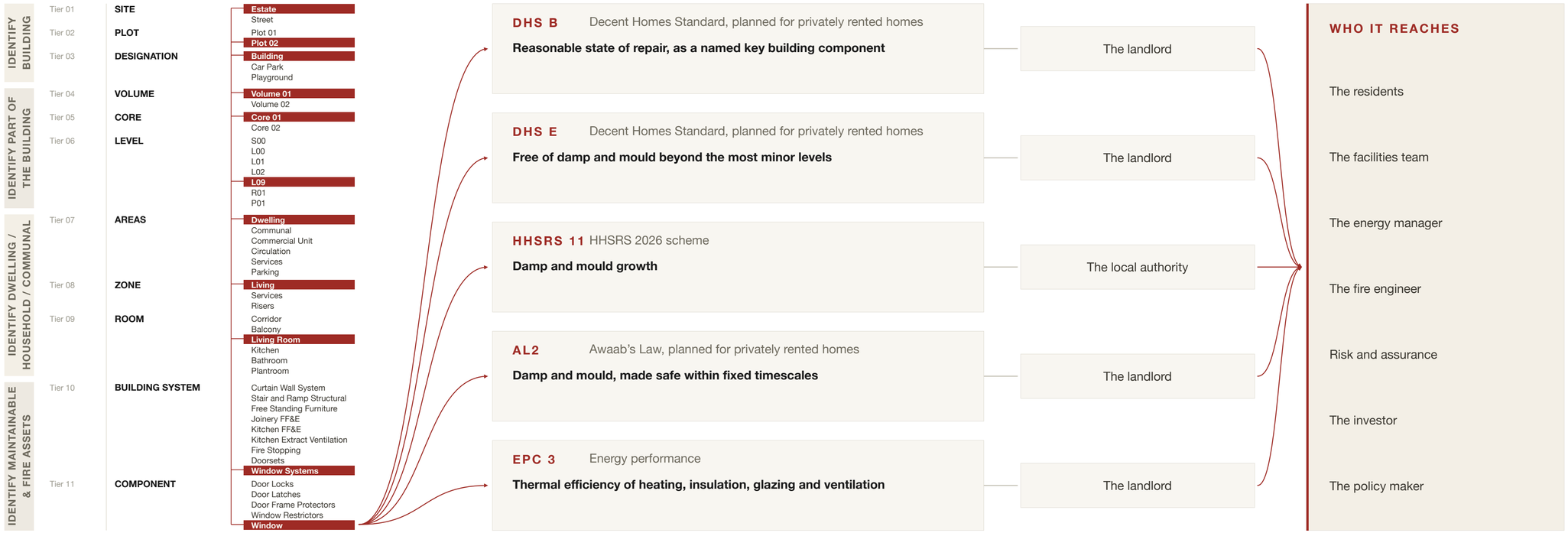
MaterialWeight
EPD
Source
Transport
Manufacturing

The fields the record carries about this one window. The first four are COBie Type, Component and Document fields and their attributes. The last two are added by the asset information requirements.

Illustrative example.

Ref: Information management using building information modelling, Part 4: Information exchange, BS EN ISO 19650 4:2022, BSI (replaces BS 1192 4:2014, withdrawn 16 September 2022) · Uniclass, NBS · Industry Foundation Classes, ISO 16739 1:2024, ISO · Information management using building information modelling, ISO 19650 1:2018, ISO

What the record supports



Part of Lifecycle Responsibility and Information Matrix

Requirements are held as rules that a machine can check, and each one sits against the element it governs. Our window carries several of them. The Housing Health and Safety Rating System looks after the health and safety of the home, including keeping it warm and dry. Energy performance shows how well the home keeps its heat, and the window plays its part in that. Some requirements are on their way. The Decent Homes Standard will apply to privately rented homes, and Awaab's Law is planned to reach them as well. Because the outcome of these rules is based on the record, we can already see what they would mean for this window, well ahead of time. The evidence for each requirement shows what every figure is based on, so everyone can always see where it comes from and use it with confidence.

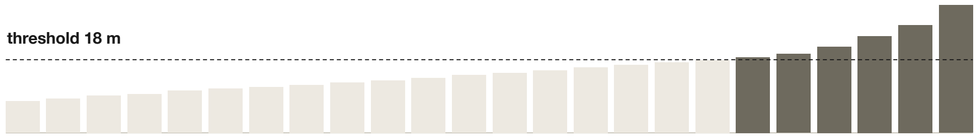
Illustrative example.

Ref: The New Decent Homes Standard, policy statement, January 2026, GOV.UK · Implementing the Renters' Rights Act 2025: Our roadmap for reforming the Private Rented Sector, November 2025, GOV.UK · The Housing Health and Safety Rating System (England) (Amendment) Regulations 2026, SI 2026/571, legislation.gov.uk · The Housing Health and Safety Rating System (HHSRS): Operating Guidance, Part 1: An introductory guide, June 2026, GOV.UK · Energy performance and MEES, as cited in the Decent Homes Standard policy statement, GOV.UK

Check continuously

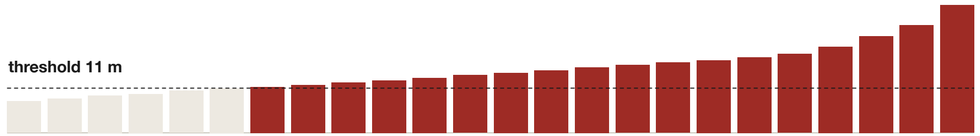
Every height is computed from the model. Move the threshold and the portfolio answers at once. Twelve buildings come into scope.

THE THRESHOLD AT 18 M



6 of 24 buildings

THE THRESHOLD AT 11 M



18 of 24 buildings

SELECTIONS RULE BASED EXAMPLE

FIELD 01 — Wall System Type

B10

Rainscreen cladding, overclad, full elevation

FIELD 02 — Insulation

Y10

PIR, partial fill, behind the cladding

FIELD 03 — Cavity Barriers

Y00

Closed state, horizontal and vertical, mineral wool

FIELD 04 — Reaction to Fire

Y00

A2 s1,d0, declared by the manufacturer, tested to the standard

FIELD 05 — Height, Storeys, Stairs

Y00

Height computed as 14.2 m, so the band is 11 m to 18 m. Five storeys, one stair

FIELD 06 — Fire Resistance

Y10

60 minutes, EI non loadbearing, tested from one side

RULES READING FROM

Tier 10	intervention	extent
A	0	**0**
B	**1**	1
C	2	

Tier 11	fill	position
X	0	**0**
Y	**1**	1
Z		

Tier 11	continuity	material
X	**0**	**0**
Y	1	1
Z	2	

Tier 11	basis	route
X	**0**	**0**
Y	1	1
Z		

Tier 03	Tier 06	Tier 05
X	**0**	**0**
Y	1	1
Z		

Tier 10	criteria	exposure
X	0	**0**
Y	**1**	1
Z		

DEFINITIONS

A	Curtain walling
B	**Rainscreen cladding**
C	Masonry cavity wall

0	Original
1	**Overclad**
2	Replaced

0	**Full elevation**
1	Part elevation

X	Mineral wool
Y	**PIR**
Z	Phenolic

0	Full fill
1	**Partial fill**

0	**Behind the cladding**
1	In the cavity

X	Open state
Y	**Closed state**
Z	Open and closed

0	**Horizontal and vertical**
1	Horizontal only
2	Vertical only

0	**Mineral wool**
1	Intumescent

X	A1
Y	**A2 s1,d0**
Z	B s1,d0

0	**Declared by the manufacturer**
1	Assessed

0	**Tested to the standard**
1	Classified without further testing

X	Under 11 m
Y	**11 m to 18 m**
Z	Over 18 m

0	**Six storeys or fewer**
1	Seven storeys or more

0	**One stair**
1	More than one stair

X	30 minutes
Y	**60 minutes**
Z	120 minutes

0	REI, loadbearing
1	**EI, non loadbearing**

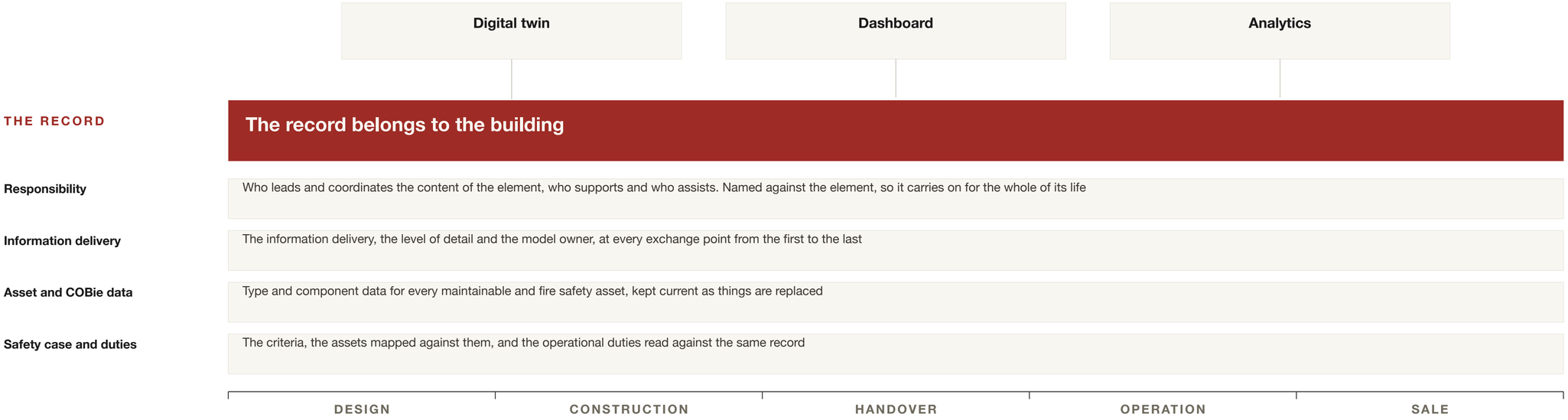
0	**From one side**
1	From both sides

Each one is then checked against what is already recorded about its components. One of the twelve, coded.

Illustrative example.

Ref: BS EN 13501 1:2018, reaction to fire classification, BSI · BS EN 13501 2:2023, fire resistance classification, BSI · Approved Document B, Volume 1: Dwellings, paragraphs 3.30 and 3.32 and Section 10, GOV.UK · Building Safety Act 2022, section 65, higher risk building, legislation.gov.uk

The record belongs to the building



Part of Lifecycle Responsibility and Information Matrix

The record belongs to the building. It begins in design and it travels with the building through construction, handover, operation and sale. Because it is open, every platform can draw on it. Digital twins, dashboards and analytics all become stronger when there is verified data beneath them, and that is good news for everyone who makes them.

Illustrative example.

Foundation to future proof



The foundation comes first and the intelligence follows, because simulation, prediction and analysis show what they are truly capable of when the record and the rules they stand on are right. From here we will follow our window through four opportunities.

- Simulation grounded in real components.
- Capital plans that we can interrogate and evidence.
- Requirements that the building checks itself against.
- Performance in use that reaches the people who make the products.

We have already met the beginning of the third one, because it starts with the rules. The four opportunities lead to two simple questions, what if and what next: simulation answers the first, prediction answers the second, and both depend on a true record of what is there, beginning with the smallest parts of the building.

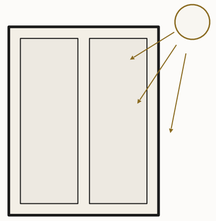
Illustrative example.

What is really installed

The model uses what is really installed.

The window

FOR ILLUSTRATION



Thermal performance

Less heat lost through the glass and frame

2.7 W/m²K

default 1.6

lower is better

0 — 3.0

Solar gain

Share of the sun's heat that gets in

0.50

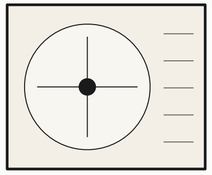
default 0.60

lower lets in less heat

0 — 1.0

The heat pump

FOR ILLUSTRATION



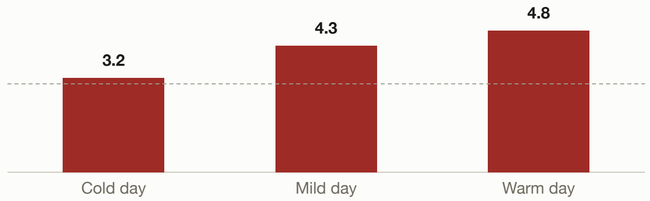
Efficiency across the conditions

Heat delivered for each unit of electricity used

3.8 seasonal figure (SCOP)

default 3.0 (dashed line)

Efficiency (COP): heat out for each unit of electricity in. Lower when it is colder.



THE SIMULATION MODEL

Runs on the values the record holds for what is installed

The window: its thermal performance and its solar gain

The heat pump: its efficiency through the seasons

Real value, from the record

Default, used when the record doesn't hold a value

In simulation it is very common to begin with default values, because the real ones are not always to hand. When the record holds the actual data for this window, and for the heat pump that serves the room, the simulation can use what is really installed. The window brings its real thermal performance and its real solar gain. The heat pump brings how efficiently it really works through the seasons.

Illustrative example, not a real product or manufacturer.

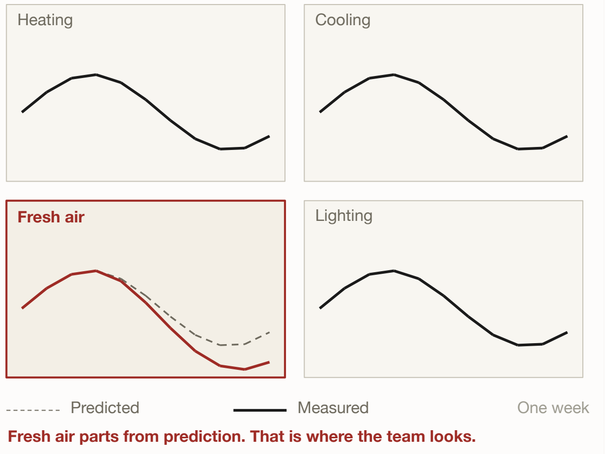
Illustrates **simulation**

Ref: Approved Document L, Volume 1: Dwellings, 2021 edition incorporating 2023 amendments, Tables 4.1 and 4.2, GOV.UK · Calculation of thermal transmittance, BS EN ISO 10077 1:2017, BSI · Seasonal performance of heat pumps, BS EN 14825:2022, BSI

From readings to remaining life

1 PREDICTED AND MEASURED

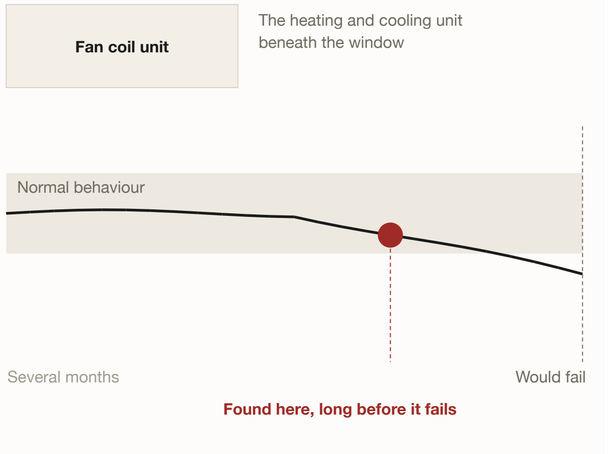
Predicted and measured performance sit side by side for every system.



Fresh air parts from prediction. That is where the team looks.

2 FOUND BEFORE IT FAILS

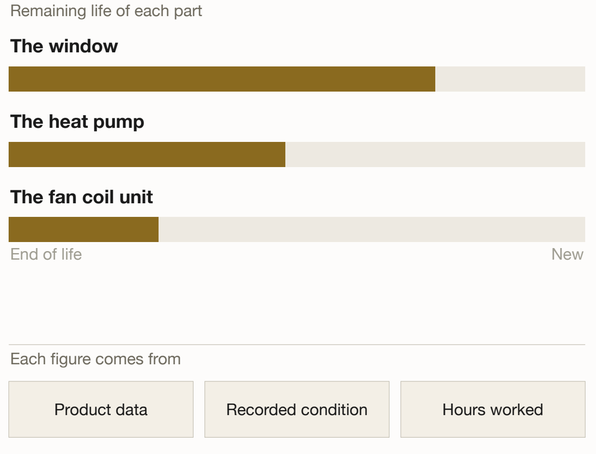
The drift is found before the unit fails, and before it wastes energy.



Found here, long before it fails

3 REMAINING LIFE

Every part has a remaining life based on real data.



The simulation is then compared with what the meters, sensors and controls actually record. Because every reading is connected to the part of the building it comes from, any difference between predicted and measured performance shows for each system, and not only for the building as a whole. That tells the team exactly where to look.

Prediction looks at the same readings over time. Suppose the fan coil unit beneath our window begins to drift slowly away from its normal behaviour. Prediction notices this long before the unit fails, and before it starts to waste energy. The facilities team can plan a visit at a convenient time, and the family on the ninth floor stays comfortable throughout. This is also the first glimpse of something the manufacturer would very much like to know, and we will come back to it.

The same record gives each part a remaining life, based on its real product data, its recorded condition and how hard it has actually worked. This is where capital planning begins, with a model based on real data of one component at a time.

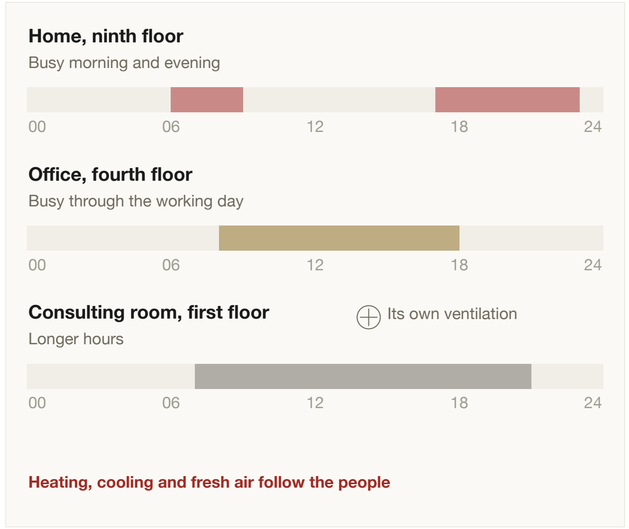
Illustrative example, not a real product. Bar lengths and drift shape are schematic, not real world data.

Illustrates **simulation**, **in use performance** and **capital planning**

From one room to the whole building

1 EVERY ROOM AS IT IS REALLY USED — What the model is given

Every room is modelled as it is really used.



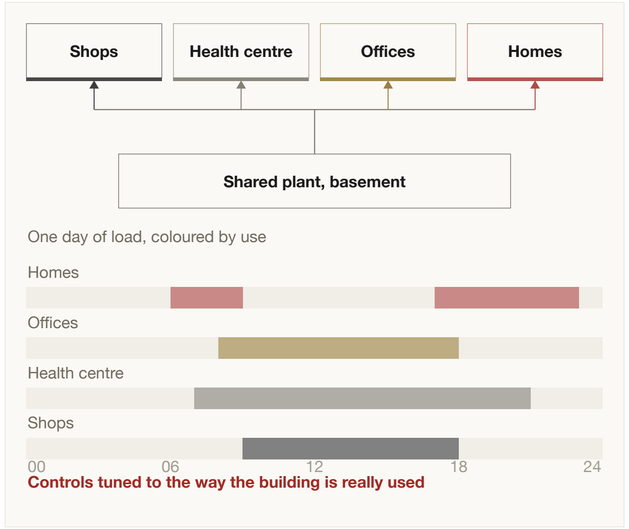
2 A HOTTER SUMMER — What the simulation shows

A hotter summer is tested before it arrives.



3 ONE PLANT, FOUR USES — What it helps with

One shared plant serves four uses through the day.



Simulation is most useful when it reflects how each room is really used. The home on the ninth floor is busy in the morning and in the evening. The offices are busy during the working day. The consulting room in the health centre is open for longer hours, and it has its own ventilation needs. When the model knows this, heating, cooling and fresh air can follow the people who use each room.

Because the model holds the real window and the real plant, we can test a hotter summer before it arrives. We can see which rooms would become too warm, including the family's home on the ninth floor and the pharmacy's medicine store, and we can plan the cooling before it is needed.

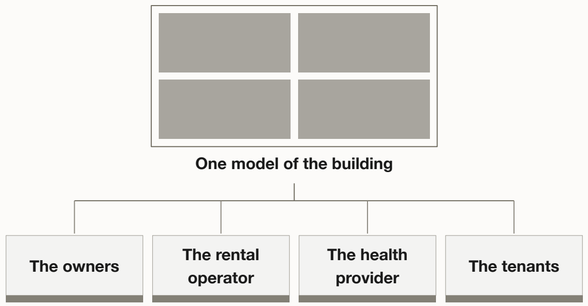
In the whole building, the shared plant in the basement serves all four uses, and the load moves across the day as people move between home, work and care. When the model can see this, the controls can be tuned to the way the building is really used.

Illustrative example. Hours, room colours and load are schematic.

One model, shared decisions

1 THE POINT OF COORDINATION

Simulation becomes the point of coordination.

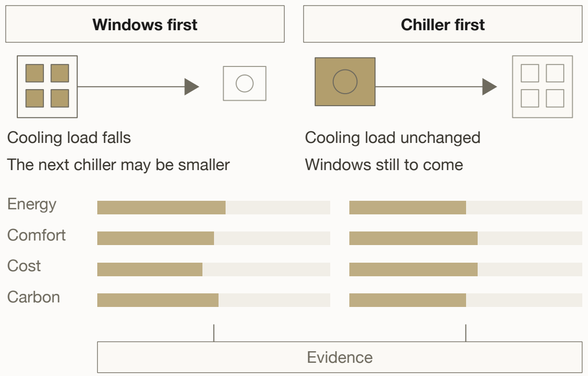


Each sees their own part, and how it connects to the whole

The next investment can be agreed together

2 WINDOWS FIRST, OR THE CHILLER FIRST?

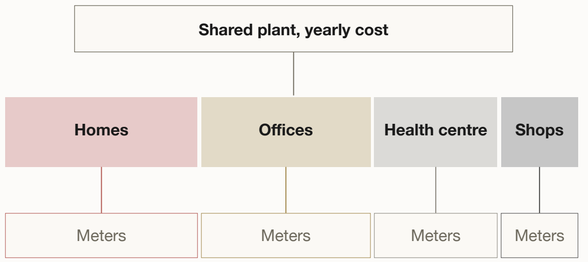
Windows first, or the chiller first?



Every number traced to its evidence

3 SHARED COSTS FOLLOW REAL USE

Shared costs follow real use.



Each share is sized by what that use actually draws from the plant

Each share traced back to its own meters

When the owners, the rental operator, the health provider and the tenants all look at the same model, each seeing their own part and how it connects, simulation becomes the point of coordination: a decision many owners will recognise, whether to replace the windows or the chiller first, can be tested for energy, comfort, cost and carbon, including how better windows can lower the cooling load and allow a smaller chiller, and with every number traced to its evidence, the next investment can be agreed together through capital planning that can be interrogated and evidenced.

Illustrative example. Proportions and bar lengths are schematic.

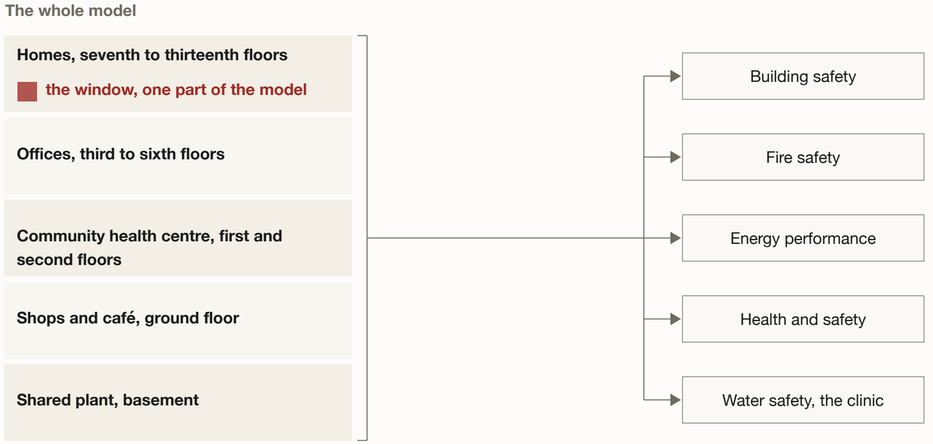
Illustrates **simulation** and **capital planning**

From question to signed answer

1 DOES THIS BUILDING MEET WHAT IS REQUIRED OF IT TODAY?

The building answers for itself.

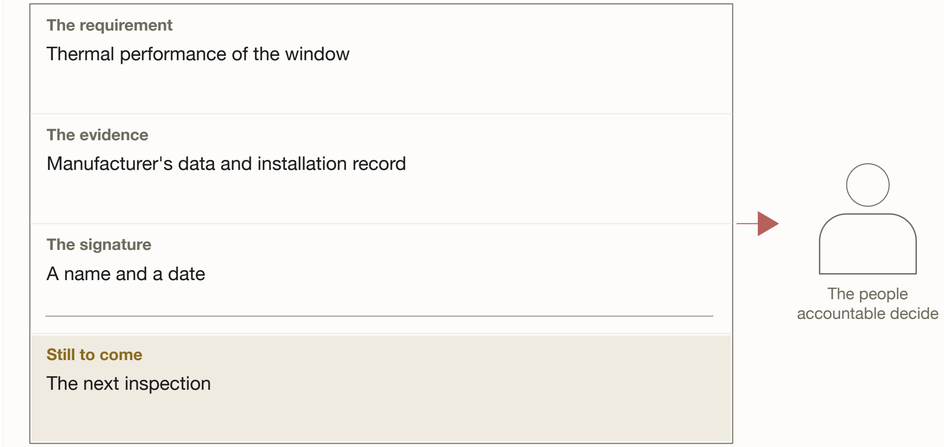
Does this building meet what is required of it today?



2 THE EVIDENCE, THE SIGNATURE AND THE NEXT STEP

For every requirement, the record shows the evidence held, who signed it and what is still to come.

The people accountable for the building make every decision.



Because the requirements sit in the record, the building can show whether it meets what is required of it today across every regime at once, with the evidence, the signature and what is still to come for each requirement, while the people accountable make every decision with confidence.

Illustrative example.

Illustrates **requirements a model can verify**

Ref: Building Safety Act 2022, legislation.gov.uk · The Regulatory Reform (Fire Safety) Order 2005, SI 2005/1541, legislation.gov.uk · The Energy Performance of Buildings (England and Wales) Regulations 2012, SI 2012/3118, legislation.gov.uk · Health and Safety at Work etc. Act 1974, legislation.gov.uk · Health Technical Memorandum 04 01: Safe water in healthcare premises, NHS England, 20 May 2016

The building answers every day

1 THE HEALTH CENTRE

The water stays safe, and the system uses no more energy than it needs.

THE ROOM AND THE SYSTEM BEHIND THE WALL



THE WATER SAFETY CHECKS, AS THEY ARE KEPT

CHECK	DATE	RESULT	SIGNED
Temperature at the outlet	12 Jan	Within limits	■
Temperature at the outlet	9 Apr	Within limits	■
Sample at the outlet	9 Apr	Within limits	■
Temperature at the outlet	11 Jul	Within limits	■
Little used outlet flushed	11 Jul	Completed	■

AND THE ENERGY IT TAKES

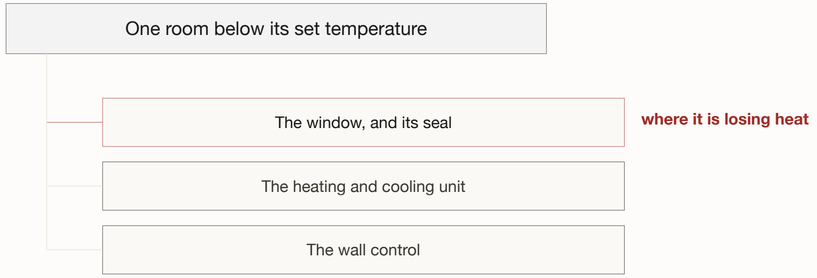
Energy used to keep the hot water hot enough



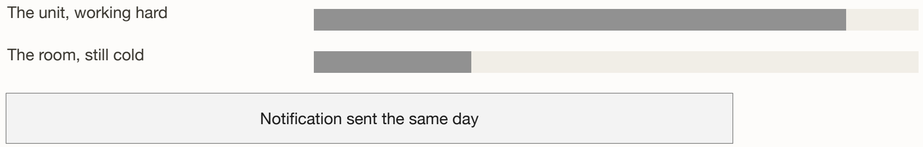
2 THE HOME ON THE NINTH FLOOR

Every day, not only on inspection day.

WHAT THE CHECKS FIND



WHAT THE READINGS SHOWED



The building answers every day and not only on inspection day: in the health centre, the record holds the dates, the results and who signed the water safety checks alongside the energy used to keep the hot water hot enough, so the team can keep the water safe and use no more energy than it needs, and in the home on the ninth floor, the readings show one room staying cold even though its heat supply is already optimised, which points to the window seal, so the right team is called the same day and the family stays warm.

Illustrative example. Check dates, results and bar lengths are schematic.

Illustrates **requirements a model can verify** and **in use performance**

Ref: Health Technical Memorandum 04 01: Safe water in healthcare premises, Parts A, B and C, NHS England, 20 May 2016 · Legionnaires' disease: the control of legionella bacteria in water systems, Approved Code of Practice and guidance L8, fourth edition, 2013, HSE

A higher risk building, and what it answers for

1 A HIGHER RISK BUILDING

With a thirteen storey residential tower, this is a higher risk building.

THIRTEEN STOREYS ABOVE GROUND, COUNTED

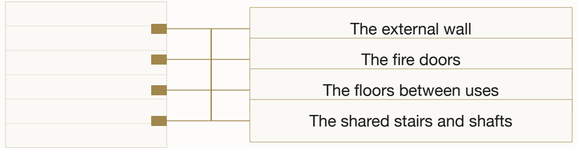


A building is a higher risk building when it is at least 18 metres high or has at least seven storeys, and contains at least two residential units.

2 WHAT MUST BE KEPT ABOUT IT

The golden thread is the information the law requires us to keep about the building.

THE INFORMATION THE LAW REQUIRES US TO KEEP



the building, described once

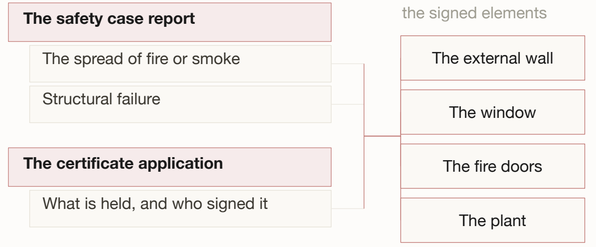
Kept digitally | Accurate | As up to date as possible

a building's single source of truth

3 WHAT IT IS ASSEMBLED INTO

The safety case report and the certificate application come from the same record.

ASSEMBLED FROM THE SAME SIGNED RECORD



Because our building is classified as a higher risk building, the law asks us to keep its golden thread digitally, accurately and as up to date as possible, and when that comes from the record the professionals have already signed, the same record also supports the safety case report and the application for the building assessment certificate, which the regulator gives when it is satisfied that all the relevant duties are being met.

Illustrative example, not a real building or record. The storey count, the highlighted homes and the document contents are schematic.

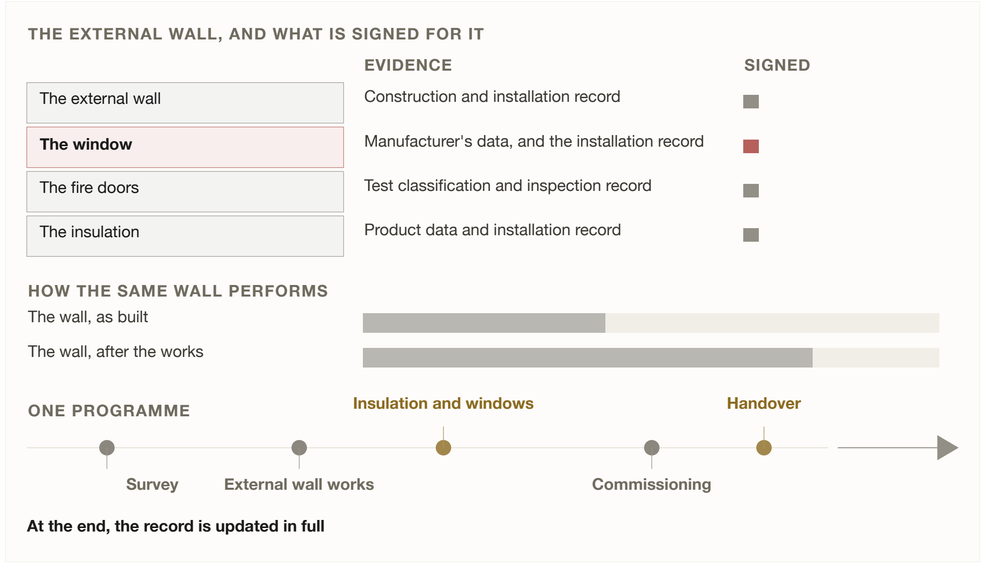
Illustrates **requirements a model can verify**

Ref: Building Safety Act 2022, section 65, legislation.gov.uk · The Higher Risk Buildings (Descriptions and Supplementary Provisions) Regulations 2023, SI 2023/275, regulation 6, counting storeys, legislation.gov.uk · Building Safety Act 2022, section 88, keeping information about higher risk buildings, legislation.gov.uk · The Higher Risk Buildings (Management of Safety Risks etc) (England) Regulations 2023, SI 2023/907, regulation 7, legislation.gov.uk · The Higher Risk Buildings (Keeping and Provision of Information etc.) (England) Regulations 2024, SI 2024/41, legislation.gov.uk · Keeping information about a higher risk building: the golden thread, Building Safety Regulator, GOV.UK, last updated 18 September 2024 · Building Safety Act 2022, sections 62, 79, 81 and 85, legislation.gov.uk · Preparing a safety case report, Building Safety Regulator, GOV.UK, last updated 6 December 2024

Safety works, energy improvements, one evidence base

1 THE WORKS, PLANNED FROM THE RECORD

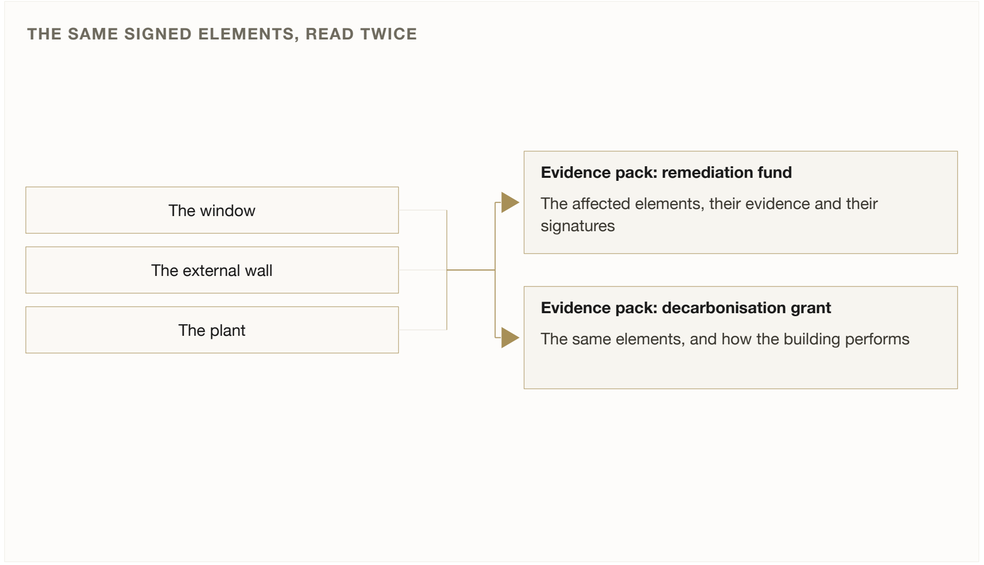
Safety works and energy improvements are planned together.



At the end, the record is updated in full

2 THE EVIDENCE, DRAWN FROM THE RECORD

One record provides the evidence for every application.



Our window is part of the external wall. When works to the external wall are planned, the record shows which elements are affected, what evidence exists and who signed it. The same record also holds the wall's thermal performance, so safety works and energy improvements can be planned together, in one programme. When the works are complete, the record is updated in full, so the next owner, and whoever next assesses the building's risk, can see it straight away.

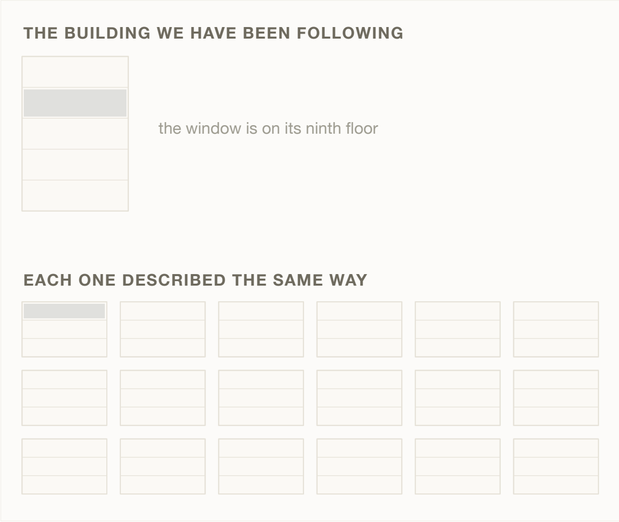
When it is time to apply for funding, the same record produces the evidence pack. One application may go to a remediation fund and another to a decarbonisation grant, and the same evidence supports both. This is the third opportunity in practice: requirements that the building can verify itself against, every day.

Illustrative example. Evidence, signatures, bar lengths and programme are schematic.

From one building to many, thirty years ahead

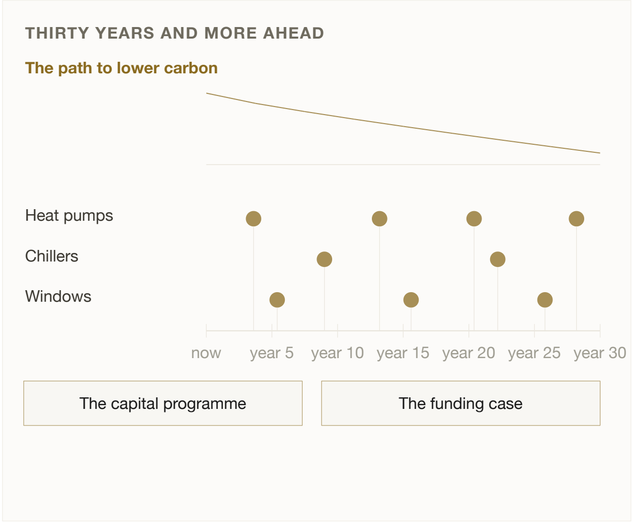
1 ONE BUILDING BECOMES MANY

From one building to many.



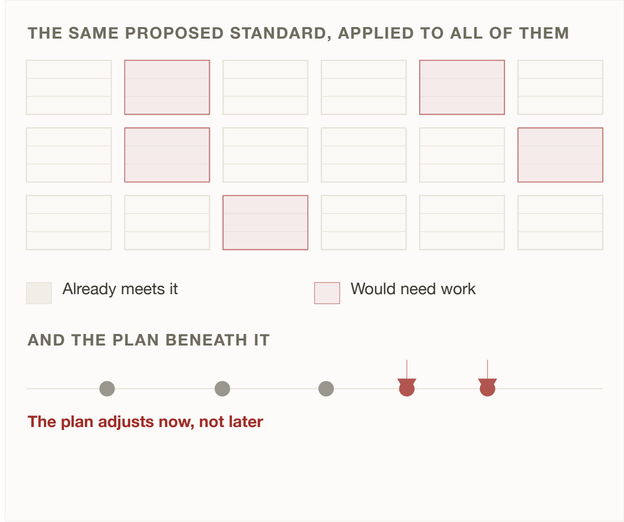
2 THE PLAN THAT FOLLOWS FROM IT

The life of every asset is planned thirty years and more ahead.



3 AND A REQUIREMENT NOT YET IN FORCE

A proposed standard is tested before it takes effect.



Our building is one of the many an operator may hold, and when each is described in the same way, the life of every asset can be planned thirty years and more ahead in one plan for capital, funding and the path to lower carbon, with every figure traceable to the record of a real component, like our window. When a higher energy performance standard is proposed, the operator can test what it would mean for the whole portfolio before the standard takes effect, so the work can be planned calmly and in good time.

Illustrative example. Building counts, renewal dates and the carbon path are schematic.

Illustrates **capital planning** and **requirements a model can verify**

A healthcare estate

Ready for power loss, heat and flood.



THREE SCENARIOS, ONE ESTATE

	POWER LOSS	HEAT	FLOOD
Operating theatres	Supported	Supported	Supported
Intensive care	Supported	Supported	Supported
Imaging	Supported	Needs support	Supported
Inpatient wards	Supported	Supported	Needs support
Pharmacy and its store	Supported	Supported	Supported
Outpatient clinics	Needs support	Needs support	Needs support
Services continue	Without interruption	Without interruption	Reduced, then restored

Read from the same record: the plant, its fuel, its cooling and the levels each department sits on

The same approach serves a hospital estate. The estate can be tested against power loss, heat and flood, to see which departments are supported and how quickly services continue. Its decarbonisation bid is produced from its record in the same way as our building's.

Illustrative example. Departments and continuity are schematic.

What the manufacturer learns

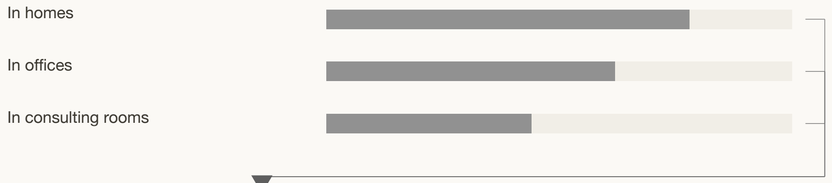
In use performance reaches the people who make the products.

THE SAME MODEL OF FAN COIL UNIT, AND THE SAME MODEL OF HEAT PUMP



each dot is one building

HOW IT PERFORMS, BY USE

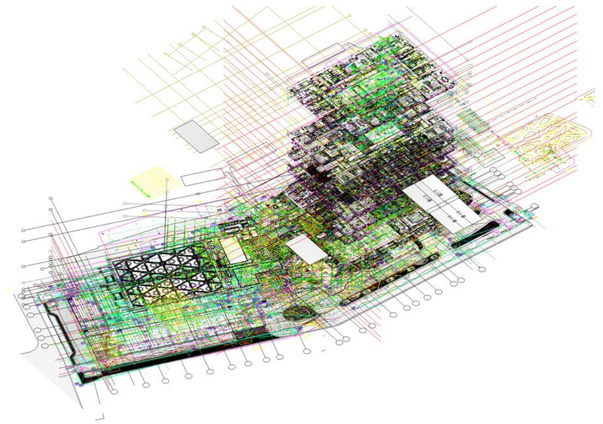


The manufacturer's design team

Where the next improvement saves the most energy

Shared with the owners' agreement, and about the product, not the people





Now we come back to the manufacturer and to the fourth opportunity, in use performance reaching the manufacturers who can act on it: with the owners' agreement, the manufacturer can see across thousands of buildings how its heat pumps and fan coil units actually perform in homes, in offices and in consulting rooms, and where the next improvement will save the most energy.

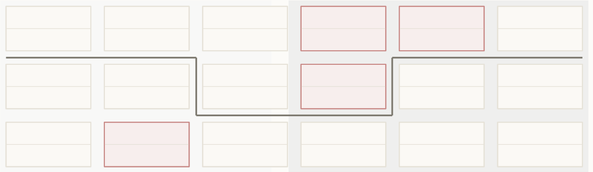
Illustrative example. Counts and performance summaries are schematic.

City, country, continent

1 THE CITY

A city can see where heat networks, grid capacity and retrofit will help people most.

A CITY DISTRICT, EVERY BUILDING DESCRIBED THE SAME WAY



Possible heat network route

Grid capacity by area

Where retrofit helps most

2 THE COUNTRY

A country can see what needs support before it is needed.

THE NATIONAL STOCK, TESTED REGION BY REGION

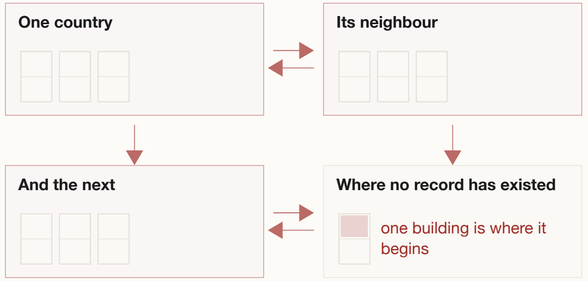
Flood | Heat | Fire

And a proposed standard, tested across the whole stock before it is made.

3 THE CONTINENT

Open and shared ways of describing buildings let models connect across countries.

NATIONAL MODELS, JOINED BY OPEN DESCRIBES



Energy and weather cross the borders, and the same description is read on both sides of them.

Many buildings modelled together show a city where heat networks, grid capacity and retrofit will help people most. London already brings its data together, through the State of London report from the Greater London Authority's City Intelligence Unit, and through the London Datastore, which opens the city's data to everyone. Machine readable buildings add the buildings themselves to that picture, so public funding can be directed by evidence to where it helps most.

At the scale of a nation, whole building stocks can be simulated against flood, heat and fire, so a country can see what needs support before it is needed. Policy makers can test a proposed standard across the national stock before it is made, and that makes efficient policy easier to achieve.

Open and shared ways of describing buildings let models connect across countries. Industry Foundation Classes, for example, are an open international standard for sharing building information between software applications. Energy and weather move across borders, so neighbouring countries can plan their energy transition together. And places where no record has ever existed can begin with one building.

Illustrative example. Layers, regions and flows are schematic.

Illustrates **simulation** and **capital planning**

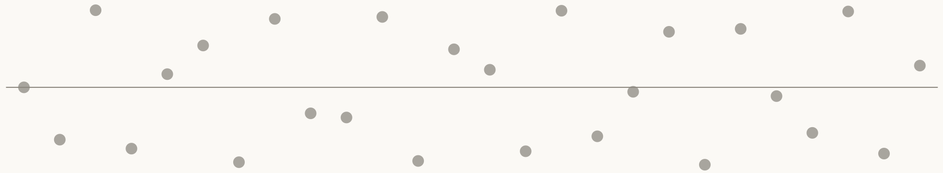
Ref: State of London report, Greater London Authority City Intelligence Unit · London Datastore, Greater London Authority · Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries, Part 1: Data schema, ISO 16739 1:2024, edition 2, March 2024, ISO

A true record of each window

1 ERRORS THAT CANCEL

Small random deviations can balance out.

MANY SMALL DEVIATIONS, IN BOTH DIRECTIONS



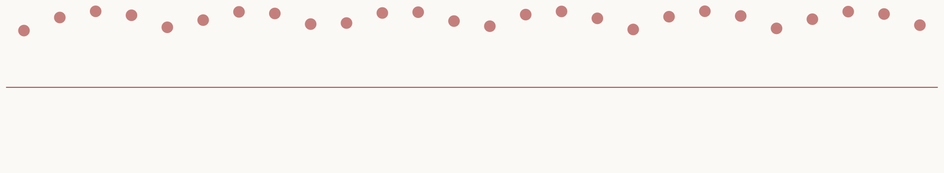
the average stays on the line

Measure each window and the mistakes sit on both sides of the truth. Add them up and they cancel.

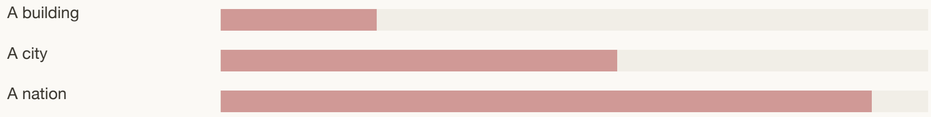
2 A SHIFT THAT DOES NOT

One default, repeated, grows at every scale.

ONE DEFAULT, REPEATED THE SAME WAY



every reading is shifted the same way



Assume the same default for every window and every answer leans the same way, by more at every scale above it.

A true record of each window gives confidence at every scale above it.

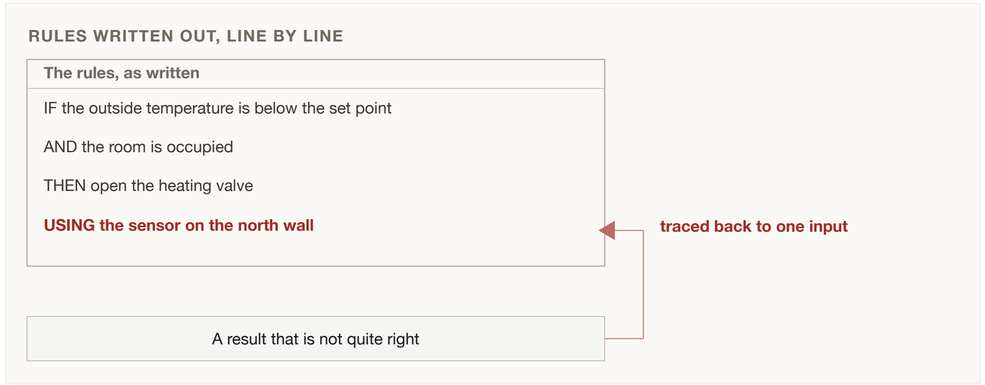
Working at this scale shows us one more thing. Small random errors tend to balance each other out when many records are combined. A default value used in place of a real one tends to compound the effects of deviation and does not balance out. If every model assumes a default efficiency for a heat pump instead of the real one, the same error is repeated in every building, and it grows until it is part of a national energy plan. When small misreadings are corrected at the source, they do not repeat across thousands of buildings. That is why a true record of each window gives confidence at every scale above it.

Illustrative example, not real world data. The scatter, the shift and the scale factors are schematic.

Clear rules, and a trace we can audit

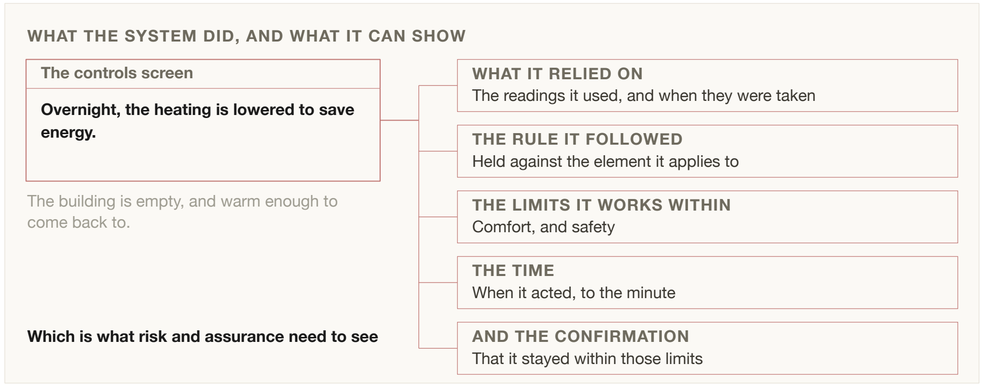
1 EARLIER SOFTWARE

Simple clarity has always been valuable.



2 THE SAME CLARITY, NOW

The system shows what information it relied on, and whether it stayed within the process it was approved for.



People stay involved.

Every result can be traced to the clause, the data and the time.

Everyone knows what is actually happening.

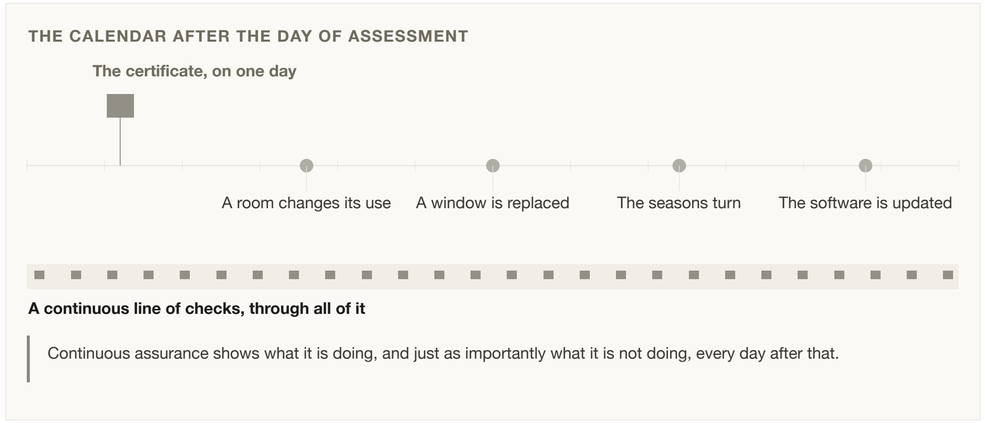
The software that adjusts the heating and cooling to save energy should be able to show what information it relied on, and whether it stayed within the process it was approved for. Here, that process includes the comfort and safety limits it was approved to work within. When it can show this, everyone can see how it reached its result, and that includes everyone responsible for risk and assurance.

Illustrative example, not a real product or system, and not real world data. Screen contents, readings and limits are schematic.

A point in time, and every day after it

1 THE DAY IT WAS ASSESSED

A standard or a certificate tells us that a system was sound on the day it was assessed.

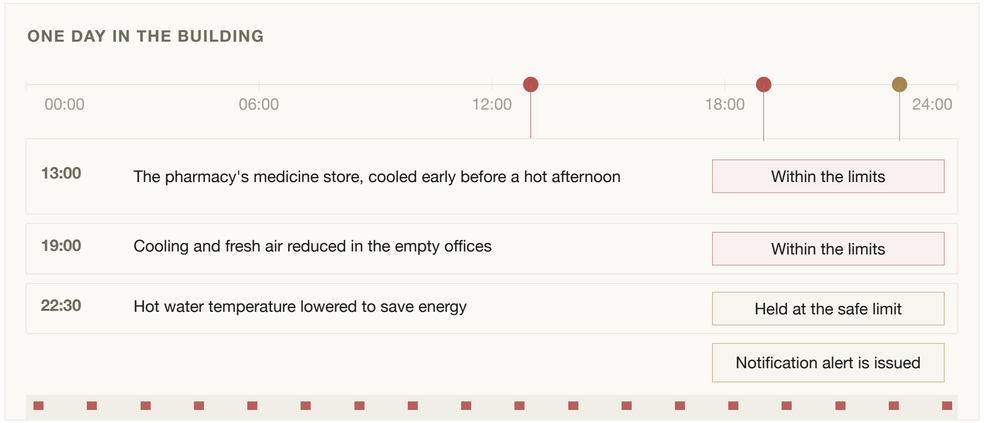


A continuous line of checks, through all of it

> Continuous assurance shows what it is doing, and just as importantly what it is not doing, every day after that.

2 AND EVERY DAY AFTER THAT

Every action is checked against the rules as it happens.



The evidence of every check is kept

Standards and certificates are extremely valuable. They give us the shape of the answer, and they tell us that a system was sound on the day it was assessed. The Building Safety Regulator describes its own building assessment certificate in the same way, as a snapshot of compliance at the time of assessment rather than a guarantee of ongoing compliance. After that day, buildings and software keep changing. A room changes its use, a window is replaced, the seasons turn, and the software itself is updated. Continuous assurance shows what a system is doing, and just as importantly what it is not doing, at every moment in between.

Here is what continuous risk assessment means in our building. Through the day, the software makes many small changes to save energy. It cools the pharmacy store early, before a hot afternoon, and it reduces the cooling in the offices once they are empty. Each change is checked against the rules in the record as it happens. Then, later that evening, it tries to save energy by lowering the temperature of the hot water in the health centre. The water safety rule in the record holds it at the safe limit, and the facilities manager is notified straight away. The risk is assessed at the moment it could arise, and the evidence is kept for everyone who needs to see it. This is what allows an organisation to adopt technology at enterprise level with a safety net and a clear path, so it can move quickly and keep control at the same time.

Illustrative example. Dates, actions and limits are schematic.

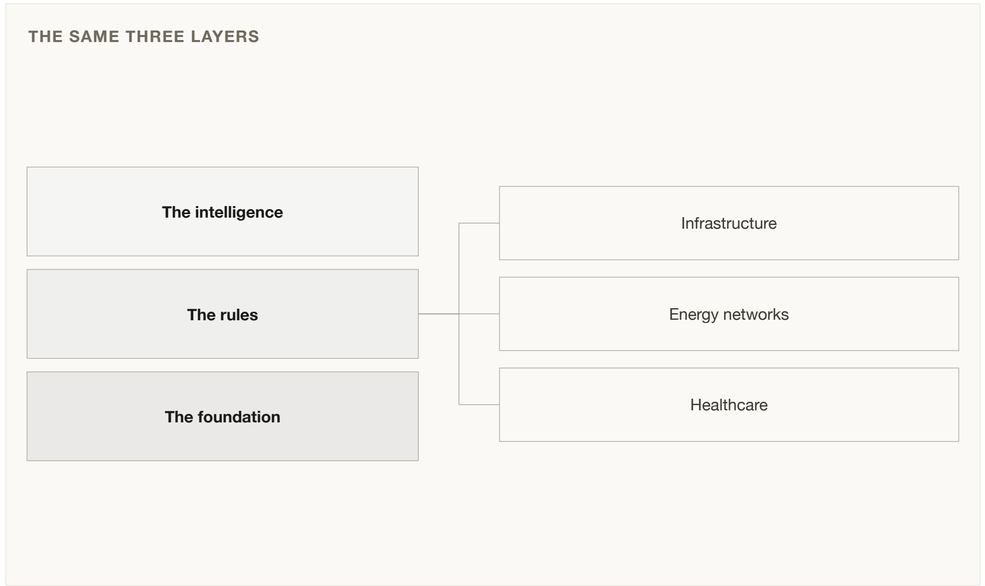
Illustrates **requirements a model can verify**

Ref: Building assessment certificates for higher risk buildings, Building Safety Regulator, last updated 25 August 2026 · Apply for a building assessment certificate, GOV.UK, last updated 10 April 2026 · Health Technical Memorandum 04 01: Safe water in healthcare premises, NHS England, 20 May 2016 · Legionnaires' disease: the control of legionella bacteria in water systems, Approved Code of Practice and guidance L8, fourth edition, 2013, HSE

Principles that hold on any application

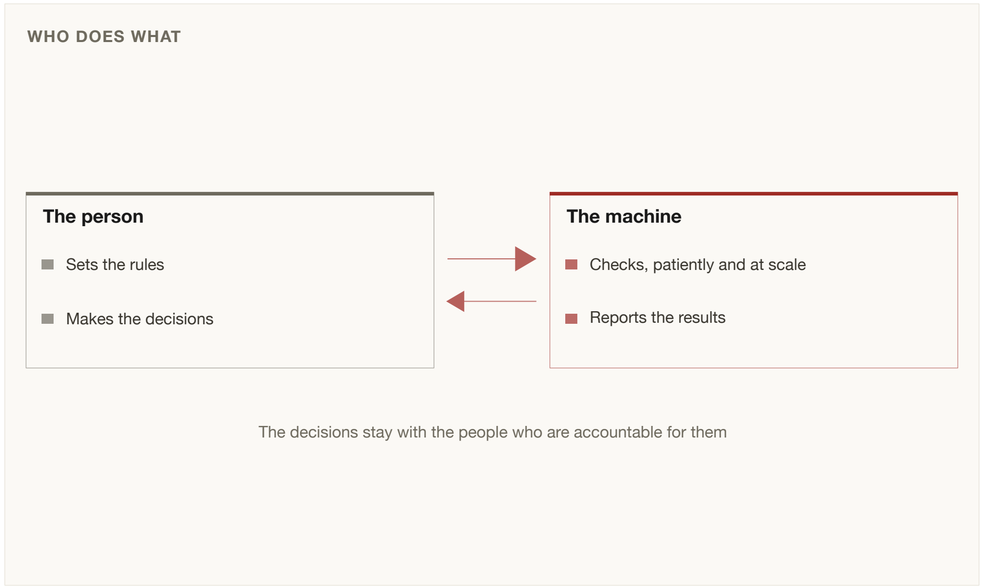
1 WHEREVER RECORDS AND RULES MEET

Wherever there is a structured record and rules that can be read against it continuously, the same approach holds.



2 AND THE PART THAT STAYS HUMAN

Following rules at scale is something machines do exceptionally well.



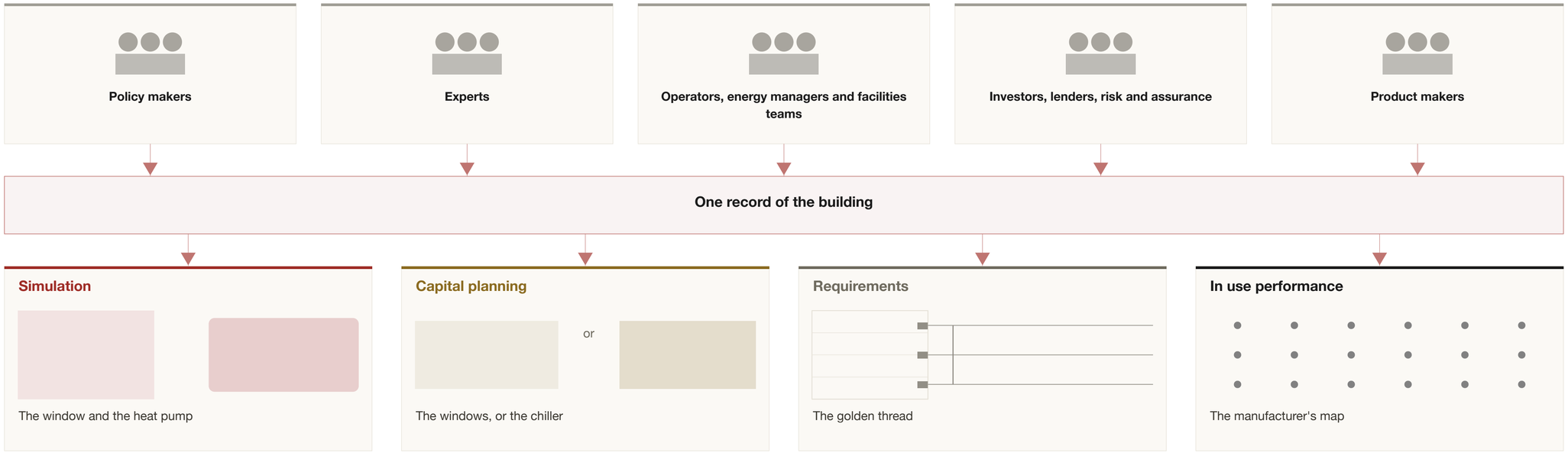
None of this is specific to buildings. Wherever there is a structured record, and rules that can be read against it continuously, the same approach holds. Technology has always helped us advance in quality assurance and not only in volume, and following rules at scale is something machines do exceptionally well.

Illustrative example.

EVERYONE BENEFITS

Four opportunities, one record

EVERYONE HAS A PART IN THIS



All four come from the same record

Policy makers set the direction that gives the market certainty. Experts give the signed knowledge that makes the record trusted. Operators, energy managers and facilities teams look after buildings every day and keep the record current. Investors, lenders, and the people who assess and carry risk are ready to reward quality they can see. And product makers create the technology and the data that make all of this possible.

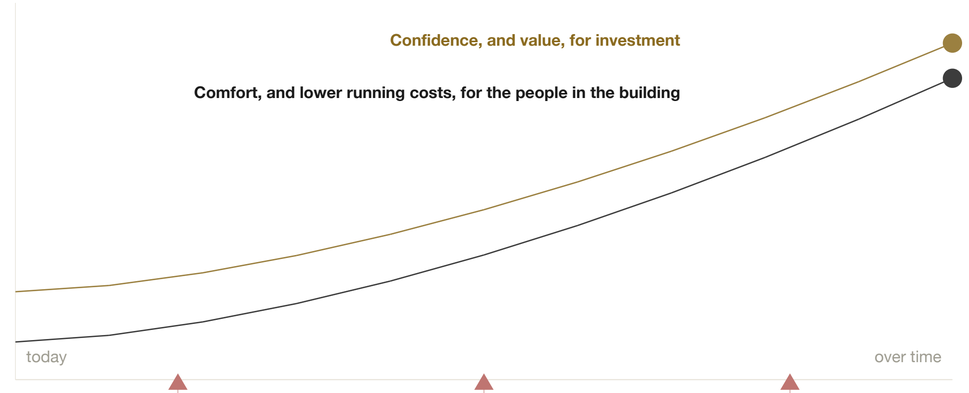
We have followed one window through four opportunities: simulation grounded in real components, capital plans that can be interrogated and evidenced, requirements that the building can verify itself against, and in use performance that reaches the people who make the products. All four come from the same record.

Illustrative example.

EVERYONE BENEFITS

Social benefit and investment are aligned

TWO THINGS THAT RISE TOGETHER, FROM THE SAME RECORD BENEATH THEM





One record of the building

Those who assess and manage risk

The evidence behind the risk, and how the systems decide

Lender

The condition of the building, and the plan behind its value

Investor

What they are buying, before they buy

Portfolio manager

The exposures that are still to be quantified

Owner

Where the real cost is

We traced our window's performance and its impact across the whole building, and the same record that shows what the family's home, the offices and the clinic need to be comfortable, compliant and cheaper to run also shows an investor the cost and the value of that work, so investment can move with confidence to where it is needed most, and lives improve because of it.

Illustrative example.

Illustrates **capital planning**

Thank you

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