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Retrofitting Mid-Century Homes

A Practical Guide to Low-Energy Retrofit

How two London retrofit projects transformed inefficient 1960s homes into healthy, comfortable and low-carbon family houses.

Featuring:

- Connected House
- Modernist EnerPHit

Real projects, measured outcomes, practical lessons.

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Connected House



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1 What is the Purpose of This Guide?

This white paper brings together technical detail and architectural insight. It looks at the limits of mid-century construction, the building physics behind retrofit choices, and the measured performance results. It provides a practical model for professionals working under the combined pressures of conservation and decarbonisation, showing that careful, evidence-based retrofit can improve even the most challenging homes.

The UK's route to net zero depends heavily on improving mid-century housing. Homes built in the 1960s are among the most difficult to upgrade. While their structures are often sound, they usually perform poorly in thermal terms, have been altered over time, and are frequently located within conservation areas where changes to external appearance are restricted.

Our featured project, the Connected House, a deep retrofit project in the Dulwich Estate Scheme of Management in South London, shows how these challenges can be addressed. The project achieved high performance standards despite restrictions on external insulation, visible renewable technologies, and façade changes. By following a carefully planned and sequenced approach, the retrofit reached Passivhaus Low Energy Building performance while preserving the home's original mid-century character.

This guide is for:

+ **Homeowners** upgrading mid-century modernist homes, navigating planning and energy requirements. even in protected estates, such as the Dulwich Estate.

+ **Built environment professionals** including architects, surveyors and energy consultants working on retrofit projects in conservation settings.

+ **Contractors and suppliers** involved in delivering retrofit works and advising on materials and systems.

+ **Planning, conservation and building control** officers responsible for assessing and approving retrofit proposals.



Connected House

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2 Why Mid-Century Homes Need Retrofitting



Connected House, Before: Overheating in Summer & Poor Insulation



Connected House, Before: draughty single glazed windows

Built before modern insulation standards, many mid-century homes lose heat quickly, rely on fossil fuel heating and struggle with overheating, draughts and poor air quality. The 1960s housing boom produced robust but thermally inefficient homes. Speed of construction took precedence over insulation and airtightness, and most properties have since undergone incremental extensions that disrupt thermal continuity. Today, these homes face several challenges when it comes to retrofit, including: thin or uninsulated walls, leaky junctions, inconsistent glazing, fragmented building fabric and outdated heating systems.

Yet these homes often have generous layouts, strong structures and huge long-term potential. Retrofitting existing buildings is one of the most effective ways to reduce operational carbon while avoiding the environmental impact of demolition and rebuild.

Most UK homes that will exist in 2050 have already been built. Improving existing housing stock is therefore essential to achieving climate targets and creating healthier homes.

BEFORE RETROFIT	AFTER RETROFIT
Poor insulation	Lower energy bills
Thermal bridging	Improved comfort
Single glazing	Better air quality
Air leakage and draughts	Reduced carbon emissions
Outdated heating systems	Increased resilience to rising energy costs
Overheating in summer	Preservation of architectural character
Poor indoor air quality	

What is PHPP modelling?

PHPP (Passive House Planning Package) is a detailed energy modelling tool that helps designers make informed decisions by identifying priorities, evaluating trade-offs and verifying building performance. It provides a clear picture of a building's energy performance.

This context shaped every aspect of the Connected House retrofit. PHPP modelling confirmed that the property would remain energy-intensive and thermally unstable without interventions such as a rebuilt roof, improved airtightness, insulated cavities, and a structured ventilation and heating strategy.

3 Case Study: Connected House



Connected House, Before: Poor indoor air quality

Connected House is a deep retrofit of a 1963 modernist home transformed into a zero-bills, low-carbon family house. The project retained the original structure while dramatically improving comfort, efficiency and long-term resilience. Careful interior reconfiguration and minimal structural interventions maximised natural light, strengthened the connection to the surrounding landscape, and created flexible spaces for modern family life and home working.





Connected House, Before: Outdated, expensive heating systems



After: beautiful, modern interiors



- 85% reduction in energy use
- 97% reduction in carbon emissions
- Solar slates and battery storage
- Air source heat pump
- MVHR ventilation system
- Triple glazing and airtight construction

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4 Case Study: Modernist EnerPHit


Before: poor glazing


Before: no solar shading, overheating issues


Before: outdated and tired

An award-winning retrofit of a 1960s home that successfully combines heritage preservation with EnerPHit performance standards. Carefully restoring the original design by Michael Blackstock, the project balances the architectural character of the home with a contemporary approach to sustainable living. Through high-performance insulation, improved airtightness, and upgraded windows and doors, the house now achieves exceptional energy efficiency and comfort while maintaining its distinctive modernist identity.




After: ample solar shading


After: beautifully refreshed interiors



- 88% less energy than standard UK home
- Deep fabric-first retrofit
- Significant heating demand reduction
- Improved airtightness
- Air source heat pump
- PV panels
- Improved air quality

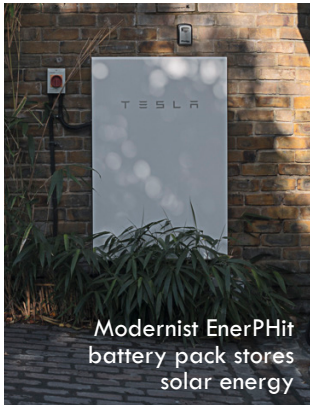
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5 Before and After Performance

There are multiple ways to measure performance post retrofit. The figures below show how efficiently Connected House and Modernist EnerPHit use energy, how comfortable they are to live in, and their environmental impact. The benefits of a high-quality retrofit include lower energy bills, reduced carbon emissions and improved comfort.

Energy Use measures the amount of energy a building requires each year. Lower figures indicate a more energy-efficient home. Renewable Energy technologies such as solar panels, battery storage and heat pumps help reduce reliance on fossil fuels while lowering energy costs. Carbon Emissions measure the amount of carbon dioxide produced through a building's energy use per year. Lower emissions indicate a move away from fossil fuel dependence.

Ventilation Performance measures how effectively fresh air is supplied while removing stale air and moisture. Systems such as Mechanical Ventilation with Heat Recovery (MVHR) recover heat from outgoing air, improving indoor air quality while reducing energy loss. Airtightness describes how much unwanted air leaks through gaps in a building. The average UK home typically achieves between 10–15 m^3/m^2h. High-performance retrofit projects can reduce this to below 1 m^3/m^2h, significantly improving comfort. Glazing Performance relates to the thermal efficiency of windows and glazed doors, commonly measured by a U-value (W/m^2K), which indicates how much heat passes through the glass; lower U-values mean better insulation and improved comfort. Fabric Performance describes how well the building envelope, including the walls, floors, roof and windows, retains heat. High-performance insulation and careful detailing reduce heat loss, helping the building use less energy overall. Because heat naturally rises, decreasing the roof U-value means reduced heat loss, and has a significant impact on a building's overall energy efficiency.



Modernist EnerPHit battery pack stores solar energy

	CONNECTED HOUSE	MODERNIST ENERPHIT
Energy Use	165 kWh/m²/year → 25 kWh/m²/year	Heating demand reduced to 26 kWh/m²/year
Renewable Energy	Solar generation + battery storage	Solar energy integration + low-energy systems
Carbon Emissions	7,700 kg CO_2/year → 260 kg CO_2/year	Significant reduction in operational carbon emissions
Ventilation Performance	MVHR ventilation system	88% heat recovery efficiency through MVHR
Airtightness	0.61m³/m²h @50Pa	1.0 ACH @50Pa
Glazing Performance	Triple glazed windows	Triple glazing with U-values as low as 0.83 W/m²K
Fabric Performance	High performance insulation, solar slate roof	Gas-free low-energy heating strategy
Roof U-value	Roof U-value improved to 0.12 W/m²K	Roof U-value improved to 0.12 W/m²K

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6 What Makes Mid-Century Retrofit Challenging?

Mid-century homes were not designed for today's climate or energy expectations. Retrofitting them requires balancing energy performance, planning constraints, comfort and long-term durability.

Mid-century houses often appear simple in form, but their construction can be highly variable due to original detailing and later alterations. This creates uncertainty around build-ups, junctions and material continuity, making it difficult to predict thermal and moisture behaviour without detailed investigation. Successful retrofit depends on understanding the building as a whole system rather than treating individual elements in isolation.

What is Retrofit?

Retrofit is the process of upgrading an existing building to improve its energy performance, comfort and sustainability while retaining as much of the original structure as possible, without the need for full reconstruction.

Poor Thermal Performance

A defining challenge of mid-century housing is its inherently low thermal performance. Thin walls, limited roof insulation and single glazing allow significant heat loss and create reliance on high-energy heating systems. In projects such as the Modernist EnerPHit retrofit in South London, this has been addressed through a deep fabric-first approach - introducing high-performance insulation, upgraded windows and doors, and carefully controlled airtightness to dramatically reduce energy demand and enable low-carbon operation.

Overheating

Although often associated with coldness, many mid-century homes are also prone to overheating due to generous glazing, lightweight construction and limited shading strategies. When insulation and airtightness are improved without considering solar gain, summer comfort can quickly deteriorate. The Connected House demonstrates how this challenge can be resolved through a combination of strategies including enhanced glazing performance and carefully controlled ventilation, resulting in stable indoor temperatures and improved comfort.

Air Leakage

Air leakage is one of the most persistent issues in mid-century homes, often occurring at junctions between original construction and later extensions, as well as around windows, floors and roof connections. These uncontrolled gaps contribute to draughts, heat loss and inconsistent internal temperatures. EnerPHit-level retrofits demonstrate that achieving exceptional airtightness is possible, but only through meticulous detailing, coordinated sequencing of works, and rigorous on-site testing to verify performance.



ModernistEnerPHit,Before


ConnectedHouse,Before


ModernistEnerPHit,Before

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Existing Extensions

Many mid-century homes have been incrementally extended, often in ways that compromise light, layout and thermal performance. The Connected House illustrates this clearly, where a poorly integrated extension reduced daylight and created a cold, damp internal environment. Rather than demolishing and rebuilding, the project retained and reworked the existing structure, using excavation, reconfiguration and full-height glazing to restore daylight, improve spatial flow and significantly reduce embodied carbon.



ConnectedHouse,Before

Conservation Constraints

The architectural significance of many mid-century homes means that external alterations are often tightly controlled. This can limit options for visible upgrades such as façade changes or standard photovoltaic installations. For the Connected House, the constraints imposed by the Dulwich Estate prohibited the most common deep-retrofit strategies such as EWI (external wall insulation), external insulated roof build-ups, and visible solar panels.

The Lessons

The most successful mid-century retrofits begin with the building fabric and its spatial logic, rather than with technology. Both the Modernist EnerPHit and Connected House projects demonstrate that deep improvements to insulation, airtightness and layout can transform comfort and performance while reducing energy demand by over 80%. Once the fabric is properly addressed, systems such as heat pumps, MVHR and solar technologies can operate efficiently, enabling homes to move towards net-zero performance without compromising their original architectural character.

Assess Your Home:

Factors to consider when assessing a mid-century home for retrofit.

Building Fabric and Heat Loss
- Thin or poorly insulated walls
- Roof and floor insulation levels
- Thermal bridging on concrete slabs and balconies
- A fragmented building fabric by past alterations

Airtightness and Detailing
- Air leakage at junctions and service routes
- Poor connections between walls, floors and roofs
- Inconsistent construction quality from previous works

Windows and Doors
- Inconsistent or outdated glazing
- Draughts, poor seals, poor frame performance
- Solar gain and shading

Moisture and Ventilation
- Risk of condensation and mould
- Ventilation strategy
- Indoor air quality

Heating and Building Services
- Outdated, inefficient or oversized boiler/heater systems

Comfort and Wellbeing
- Cold internal surfaces
- Uneven temperatures
- Overheating risk
- Acoustic performance and internal comfort

Planning,Conservation,Compliance
- Planning and conservation constraints in your local area
- Building regulations
- Compliance triggers
- Limitations on insulation, glazing changes and renewables

Construction and delivery
- Buildability of retrofit solutions
- Sequencing of works to avoid performance gaps

Occupation and Long-term Use
- How occupants use and maintain the building
- Clarity of controls and systems
- Monitoring and performance feedback

Costing and Phasing
- Budget constraints
- Value for money
- Disruption to occupants during works
- Ability to phase upgrades over time without compromising performance

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7 The Five-Step Retrofit Strategy

Fabric First Approach: a successful retrofit reduces energy demand by first improving building fabric before introducing renewable technologies.

FABRIC FIRST APPROACH

Step 1
INSULATION
Insulating walls, roof and floor to reduce heat loss.

Step 2
AIRTIGHTNESS
Minimise uncontrolled air leakage and improve energy efficiency.

Step 3
HIGH PERFORMANCE WINDOWS
Triple glazing enhances thermal comfort while reducing heat loss.

Step 4
VENTILATION + HEATING
(MVHR + Heat Pump)
Integrate efficient building services designed for low-energy operation.

Step 5
RENEWABLES
Incorporate renewable energy solutions compatible with conservation requirements.

1 Improve Insulation

Walls, roofs and floors upgraded using high-performance insulation to reduce heat loss and stabilise internal temperatures. This provides the basis for further improvements, instantly lowering heating demand and improving year-round comfort.

The Connected House roof required full replacement; this enabled a high-performance envelope.

Roof Build-Up Before:	Roof Build-Up After:
100 mm Kooltherm K7	150 mm Kooltherm K7 PIR
42.5 mm K118 insulated board	37.5 mm K118 insulated board
Final U-value: 0.18 W/m²K	Final U-value: 0.16 W/m²K
Condensation risk: 0.00 kg/m²/year	Condensation risk: 0.00 kg/m²/year

The new roof provided better thermal performance, achieving a lower U-value (0.16 W/m²K). The cavity walls were insulated with cellulose wood fibre, a breathable and conservation-friendly solution that avoided changes to the external façade. Typical post-retrofit wall U-value is approximately 0.55 W/m²K.



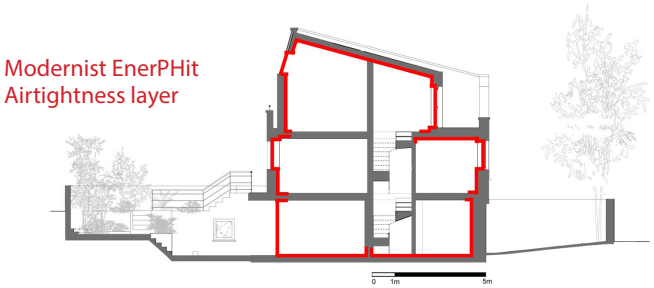
The Connected House's
New pitched roof

2 Increase Airtightness, Reduce Air Leakage

Careful airtightness detailing reduces uncontrolled draughts, improves energy efficiency, reduces energy waste and creates more stable temperatures.

Airtightness can be delivered entirely internally to preserve the building's façade:
- SIGA Sicrall airtight tape (sd-value = 8 m)
- Integrated membrane system
- Sequenced airtightness tests

Final airtightness: 0.6 ACH@50Pa (Passivhaus standard)
Compared to an average mid-century home:
8 to 15 ACH@50Pa.





Connected House
Wood fibre insulation

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Modernist EnerPHit
Airtightness testing

3 Upgrade Windows and Glazing

Triple glazing improves thermal performance while reducing noise and cold downdraughts. The immediate benefits are warmer interiors and improved comfort near windows.

4 Install Low-Energy Systems

Air source heat pumps and MVHR systems replaced conventional fossil fuel heating systems. Benefits: lower operational carbon and healthier indoor air quality.

Mechanical Ventilation with Heat Recovery (MVHR)
Continuously supplies fresh filtered air while recovering heat from extracted air, reducing ventilation heat losses and improving indoor air quality.

Air Source Heat Pump
- Mitsubishi Ecodan PUZ-WM112VAA
- 11.2 kW output at A-7/W35
- SCOP: 4.78
- Compatible with low-temperature underfloor heating
- 30–35°C flow temperature
- Dense coverage at lower levels, wider spacing on upper floors

Mixergy Smart Tank
Supports variable renewable inputs and improves domestic hot water efficiency.

5 Integrate Renewable Energy

Solar slates and battery storage reduced reliance on the grid and lowered running costs. Benefits: reduced energy bills and long-term resilience.

For the Connected House, because visible PV (photovoltaic) panels were prohibited by the Dulwich Estate, the project used 9.5–10 kW solar slates.

- Estimated generation: ~ 9,200 kWh/year
- Seamlessly integrated into the roofline
- First such installation approved on a Dulwich Estate front elevation

Battery storage increased self-consumption: the house used more of its own solar energy instead of electricity from the grid. It also stabilised evening loads, meaning that the battery system stored excess electricity generated by the solar slates during the day so it could be used in the evenings.



Storing solar energy



Air Source Heat Pump



Connected House
Seamless solar slates

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8 Retrofitting Without Losing Character

One of the biggest concerns for homeowners undertaking retrofit is preserving the architectural identity of their home. Both projects demonstrate how significant energy improvements can be achieved while respecting the original character of mid-century architecture and responding sensitively to the planning constraints of The Dulwich Village and The Dulwich Estate.

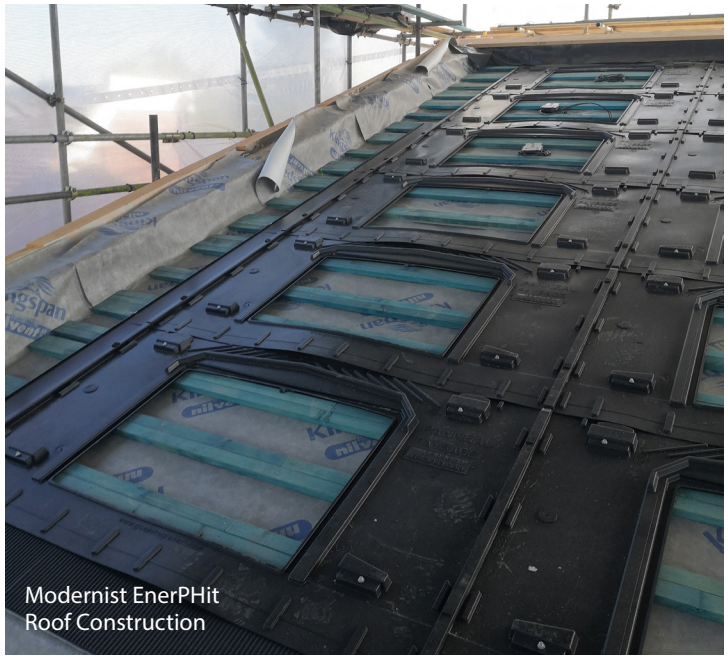
At Connected House, integrated solar slates were used instead of visible photovoltaic panels to comply with local planning and conservation requirements while maintaining the clean roof profile of the original house. The retrofit retained and upgraded the existing structure rather than demolishing and rebuilding, preserving embodied carbon and minimising construction waste.

Similarly, Modernist EnerPHit carefully restored a 1960s modernist home originally designed by Michael Blackstock, combining high performance insulation, airtightness upgrades and renewable technologies with a sensitive architectural approach. New windows, roof upgrades and solar integration were designed to enhance comfort and energy performance while remaining sympathetic to the home's original modernist language. Carefully integrated insulation, glazing and ventilation upgrades allowed both homes to perform to modern standards without compromising their design identity. Planning and conservation constraints can encourage more thoughtful, innovative and architecturally sensitive retrofit solutions.


Modernist EnerPHit
New triple-glazed windows


Connected House
OriginalEstateBrochure


Connected House
Integrated solar slates


Modernist EnerPHit
Roof Construction


Modernist EnerPHit
Solar Integration

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9 What Should Homeowners Prioritise?

Retrofitting a mid-century home can feel overwhelming at first. The most successful projects start with a clear strategy, focusing on the improvements that will have the biggest impact on comfort, energy use and long-term running costs.


Modernist EnerPHit
Old bedroom


Modernist EnerPHit
New bedroom

1. Start With the Building Fabric

Before adding new technologies, improve how the house retains heat. Remember, FABRIC FIRST.

Highest Impact Improvements:

- Roof insulation
- Airtightness and draught reduction
- Wall and floor insulation
- Ventilation and air quality strategy
- High-performance windows and glazing

Why This Matters:

A well-insulated and airtight home stays warmer in winter, cooler in summer and requires far less energy to run.

2. Plan Technical Systems Early

Renewable systems and ventilation equipment need careful coordination from the start of the project.

Plan Early For:

- Plant room and storage space
- Ventilation duct routes
- Battery storage location
- Access for maintenance
- Roof orientation for solar panels or slates

Why This Matters:

Many retrofit challenges happen because systems are introduced too late in the design process.

Common Mistakes to Avoid

- Installing a heat pump before improving insulation
- Focusing on technology before reducing heat loss
- Poor airtightness detailing around windows and junctions
- Ignoring ventilation requirements
- Underestimating how different systems need to work together

Important Reminder

Successful retrofit projects rely on early planning, realistic budgeting and experienced architects, consultants and installers who understand both retrofit and low-energy design.

✓ Fabric First
✓ Ventilation
✓ Heating
✓ Renewables
✓ Comfort


Connected House
Section

10 Lessons Learned

Retrofitting a mid-century home is not simply about adding new technology. The most successful projects carefully coordinate architecture, insulation, ventilation and renewable energy systems from the earliest design stages.

At Connected House, integrating MVHR, heat pumps and solar technologies within the existing structure required detailed planning and close collaboration between consultants, contractors and installers. Achieving high airtightness standards also depended on careful detailing around windows, junctions and structural connections. Planning and conservation constraints shaped many of the design decisions on both projects. Restrictions on visible solar panels led to the use of integrated solar slates, showing how limitations can encourage more thoughtful and innovative solutions. Perhaps the biggest lesson from both projects is that retaining and upgrading existing buildings can deliver exceptional environmental performance while preserving architectural character and reducing embodied carbon.

The Connected House achieved all of its project objectives:

- High comfort and low energy use
- Integrate renewable systems discreetly
- Enable low-temperature heating
- Maintain conservation compliance
- Improve airtightness while preserving façade
- Resolve thermal discontinuities from past extensions

Full roof reconstruction, solar slates and a battery, an internal airtightness strategy, an air source heat pump, MVHR throughout, underfloor heating and smart hot water made this possible. These could be possible in your mid-century home too.

"The fact that we no longer pay energy bills and the house now meets modern efficiency standards suggests that the investment will pay off in the long run. Plus, the improvements have made the house so much more comfortable and enjoyable to live in." - Connected House owners







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11 Retrofit, Health and Wellbeing

A successful retrofit is not only about reducing energy use. It is also about creating healthier, more comfortable homes that support everyday wellbeing.

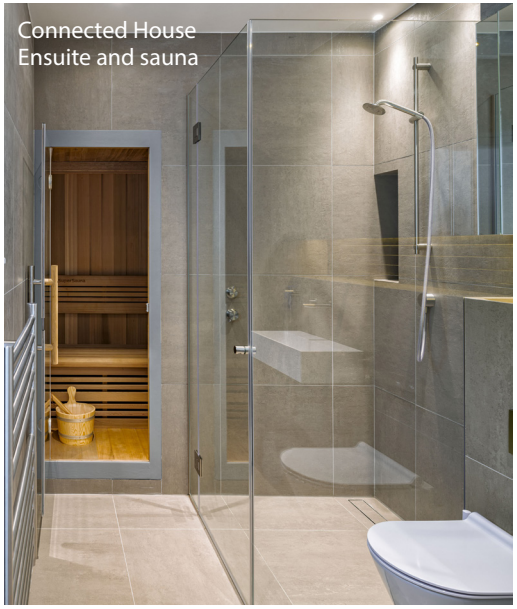
Both Connected House and Modernist EnerPHit were designed to improve:

- indoor air quality
- thermal comfort
- daylight access
- acoustic performance
- connection to outdoor spaces

MVHR systems continuously supply filtered fresh air while reducing heat loss, helping create healthier indoor environments with fewer pollutants and allergens. Improved insulation and airtightness eliminate draughts, cold surfaces and temperature fluctuations, making homes feel consistently comfortable throughout the year. Triple glazing also helps reduce external noise, creating calmer interior spaces. Natural materials and low-VOC finishes were carefully selected to support healthier living environments and improve air quality.

The result: homes that are warmer in winter, cooler in summer, quieter, healthier and more resilient to future climate conditions.


Connected House
Living room


Connected House
Ensuite and sauna


Connected House
Large windows, ample light

"Now, our home feels larger, more functional thanks to additions like a wider staircase and open plan kitchen, quieter and warmer. We are very satisfied with the project, our space is now so beautiful - and we don't pay for gas, use primarily solar energy and have extremely low running costs." - Modernist EnerPHit owners




Modernist EnerPHit
Kitchen


Modernist EnerPHit
Bathroom

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12 Why Retrofit Matters for the Future

Retrofitting existing homes will play a critical role in reducing carbon emissions and preparing UK housing stock for future climate conditions.

Projects such as Connected House and Modernist EnerPHit demonstrate that:

- demolition is not always necessary
- existing homes can achieve exceptional performance
- retrofit can preserve architectural heritage
- renewable systems can integrate successfully within existing buildings.









As energy costs rise and climate targets tighten, fabric-first retrofit approaches will become increasingly important.

Mid-century housing stock represents a major opportunity for low-carbon transformation across the UK.

Remember: the greenest building is often the one that already exists.



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13 Further Guidance

Every building is different, so taking the time to research its condition, constraints and opportunities is essential to delivering a successful retrofit project.

TOP TIPS

- Retrofit before extending where possible
- Improve insulation before installing renewable systems
- Prioritise airtightness and ventilation together
- Retain and adapt existing structures
- Plan plant room space early
- Use experienced retrofit professionals
- Consider long-term maintenance and access
- Balance energy performance with heritage considerations

FURTHER GUIDANCE

- Passivhaus Trust
- LETI Retrofit Guide
- RIBA Sustainable Outcomes Guide
- Local planning and conservation guidance









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Get in touch:

We invite you to get in touch. We would be delighted to discuss your project and how we can work together to design your new home.

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