SYNCHRONISING RETROFIT AND PLANNED WORKS GUIDANCE REPORT

Produced by XCO2 for London Councils

October 2023

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GLOSSARY

Abbreviation	Description
ASHP	Air Source Heat Pump
CIBSE	Chartered Institution of Building Services Engineers
CWI	Cavity Wall Insulation
DEN / DHN	District Energy/Heat Network
DLO	Direct Labour Organisation
DPC	Damp Proof Course
ECO	Energy Company Obligation
EE	Energy Efficiency
EEMs	Energy Efficiency Measures
EPC	Energy Performance Certificate
EPD	Environmental Product Declaration
EUI	Energy Use Intensity
EWI	External Wall Insulation
GSHP	Ground Source Heat Pump
HIU	Heat Interface Unit
HUG	Home Upgrade Grant
IWI	Internal Wall Insulation
LAs	Local Authorities
LAD	Local Authority Delivery
LBH	London Borough of Hackney
LBL	London Borough of Lewisham
LED	Light-emitting Diode
LETI	London Energy Transformation Initiative
MEP	Mechanical, Electrical, Public Health
MTIP	Medium Term Implementation Plan
MVHR	Mechanical Ventilation with Heat Recovery
NZC	Net Zero Carbon
PAS	Public Available Specification
PV	Photovoltaics
RBKC	Royal Borough of Kensington and Chelsea
SAP	Standard Assessment Procedure (applicable to domestic buildings in the UK)
SHDF	Social Housing Decarbonisation Fund
TM	Technical Memorandum
UFH	Underfloor Heating
WLC	Whole Life Carbon

EXECUTIVE SUMMARY

This guidance report, produced by XCO2 for London Councils, builds upon on previous work for the Retrofit London programme, by providing guidance of a pathway for the integration of Energy Efficiency Measures (EEMs) into Planned Maintenance and Capital Works (hereafter referred to as Planned Works) programmes.

The report covers key areas that can affect the synergy of EEMs and Planned Works. These include PAS 2035, Medium Term Implementation Plans (MTIPs) and the interdependencies between EEMs and Planned Works, including a specific focus on the strategic and technical considerations. In summary, this guidance report recommends that:

- Councils follow the PAS 2035 aligned MTIPs to utilise a whole house retrofit approach that inherently accounts for the challenges associated with the retrofitting of Social Housing, funding streams and timeframes and technical and strategic risks;

- Use the high-level guidance given in this report on the interrelationships between EEMs to attain a better understanding of the interdependencies present between EEMs themselves but also between EEMs and Planned Works to allow asset management teams to better inform the MTIPs and gateway process.

- Councils should adopt a gateway process for all Planned Works items to understand the risks and opportunities these have for the synergy of EEMs with Planned Works and for the Net Zero Carbon (NZC) agenda;

From the information provided by the three participating London Councils, many potential synergies have been found between regular and ongoing Planned Works and EEMs that are either contracted or intended for delivery over the forthcoming three years. If these opportunities for synergised design and delivery are correctly procured and delivered, multiple ‘undo and redo’ risks have the potential to be avoided and project delivery economies can be realised, providing London Boroughs with the opportunity to accelerate the journey through EPC B to NZC by 2050 and deliver better value for money.

Realising these benefits will require new thinking. New procurement and supply chain development pathways will need to be created in accordance with the PAS 2035 standard. Although this is mandatory requirement for current Public Sector domestic retrofit funding streams, it also provides an opportunity for new approaches to Asset Management which can provide significant opportunities for economies of scale with associated resource and capital cost delivery savings.

INTRODUCTION

This Section presents an overview of the project including the background of Retrofit London, previous work carried out by London Councils, and the aims of this report.

BACKGROUND

London's housing stock is currently responsible for approximately a third of all carbon emissions in the capital. This coupled with poll results outlining that 82% of Londoners are concerned about climate change, with 40% being 'very concerned', highlights the need for immediate change in the way we design, manage and maintain out housing stock.

In response to this, the Retrofit London programme was formed. This is a collaborative programme involving, and being led by London boroughs, with the end goal of mass retrofitting London's homes to achieve a universal average energy performance certificate (EPC) rating of B by 2030 and to achieve Net Zero by 2050.

The over-arching aim of the project is to develop a pan-London, borough-owned action plan to determine the most effective suite of retrofitting measures to achieve the key targets outlined above.

PREVIOUS WORKS CARRIED OUT BY LONDON COUNCILS

Four reports have currently been undertaken that relate to the Retrofit London programme. These are listed below:

- London Councils Pathway Report (July 2021) produced by Parity Projects;
- Retrofit London Housing Action Plan (July 2021) produced by London Councils;
- Retrofit London Housing Action Plan - Delivery body workshops report (December 2021) produced by Nesta;
- Retrofit London Housing Implementation Plan (May 2022) produced by London Councils.

The **London Councils Pathway Report** profiles the key characteristics and energy performance of the London Housing stock and analysed requirements to achieve investment scenario targets (Average EPC B and NZC).

The **Retrofit London Housing Action Plan** sets out a path to bring forward a cross tenure home retrofitting programme in London that can achieve an average EPC B rating by 2030 and introduces a series of metrics to guide boroughs' retrofitting activity.

The **Retrofit London Housing Action Plan – Delivery Body Workshops Report** was carried out to understand how local authorities (LAs) are approaching retrofit, find out what LAs think the delivery structure should do, identify the key functions that would need to be resourced and identify points of consensus and disagreement on the best option for delivery.

The **Retrofit London Housing Implementation Plan** takes the recommended actions from the Housing Action Plan and translates them into tasks with timescales for delivery.

AIMS OF THIS REPORT

This guidance report builds upon the earlier pieces of work by providing a suggested pathway for the integration of Energy Efficiency Measures (EEMs) into planned maintenance and capital works programme delivery schedules for three London boroughs; with the intention that this can then be adapted for all other London boroughs. This report aims to do this by covering the following sections:

1. Form both a Risks and Opportunities perspective, provide guidance on the principles of compatibility and interdependency of common Energy Efficiency (EE), Capital and Planned Maintenance measures. These latter shall be referred to as Planned Works for the purposes of this report.
2. Provide a brief overview of the PAS 2035 Risk Assessment methodology and the associated benefits to Asset Management and delivery of Planned Works and EE programmes.
3. Provide Strategic and Technical principles and considerations for the incorporation of Planned Works into multi-stage delivery of whole house net-zero carbon (NZC) pathways.
4. Provide Borough specific suggestions for optimal synergistic delivery of the Planned Works and Energy Efficiency measures communicated to us by each Borough.

LONDON COUNCILS

METHODOLOGY

The section below presents the methodology followed to request and collate information provided and develop general and tailored guidance on synergising retrofit measures with planned work cycles.

QUESTIONNAIRE

An initial questionnaire was developed and sent to each Council following a review and feedback from London Councils. The aim of this was to:

1. Establish a high-level understanding of the social landlords existing housing stock;
2. Establish and map retrofit targets and contracted measures for the next 2 financial years; and,
3. Establish planned maintenance programmes for the next 2 years.

INTERVIEW

Once completed questionnaires were received, each Council was offered a one-hour meeting to provide any missing data, raise queries, respond to any follow up queries and discuss any anticipated challenges, priorities or opportunities for this project.

GUIDANCE REPORT

The purpose of this guidance report was to build on the objectives and principles set out in the four previous reports produced for the Retrofit London project. Following a review of data received, XCO2 has prepared a guidance report which includes recommendations based on; 1) PAS 2035 principles, 2) Energy efficiency measure interdependencies and relationships with each other and maintenance works, and 3) Borough specific opportunities based on the data provided by each respective Council.

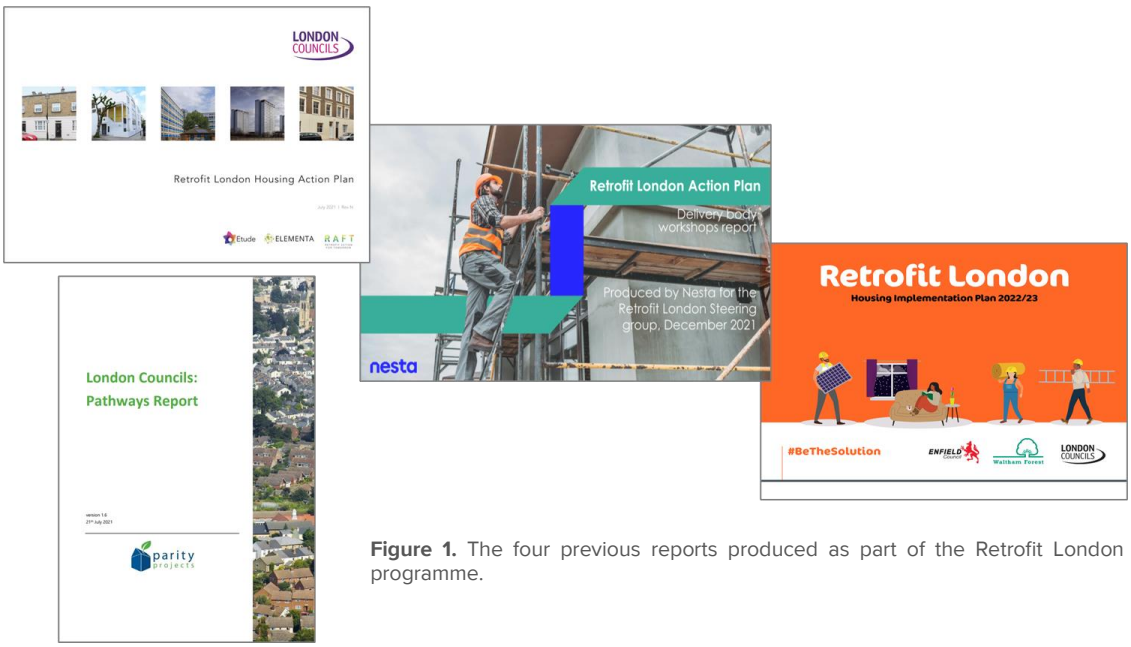


Figure 1. The four previous reports produced as part of the Retrofit London programme.

THE PAS 2035 APPROACH

PAS 2035:2019 is a comprehensive framework and Code of Practice for the design and application of energy retrofit measures to domestic buildings. It provides a risk assessment methodology and assigns professional roles and responsibilities to all those involved in the retrofit process from pre-works building assessment through to post-works monitoring and evaluation.

In parallel to the PAS 2035 process, TrustMark has been appointed as the Quality Mark for the sector with responsibility for delivering an associated Customer Charter, Industry Code of Conduct and a framework of technical standards for installers in accordance with the PAS2030:2019 framework.

PRINCIPLES

PAS 2035 is underpinned by a central set of inter-related principles which govern application of the standard.

- **Bespoke Projects** - Every House is unique and every project should be sensitive to that.
- **Professional Accountability** - a professional should take responsibility for success and failure alike.
- **Quality** - reduced defects and improved efficiency underpinning market demand and supply.
- **Whole House Retrofit** - retrofitting a home as a system over time, not as individual elements.
- **Fabric First Retrofit** - prioritising energy demand reduction through fabric improvements before new energy systems.
- **Build Tight, Ventilate Right** - making buildings airtight can have negative impacts if ventilation is inadequate.

PROCESS AND PRACTICE

Delivery of the PAS2035 methodology entails the employment of retrofit professionals including Assessors, Coordinators, Designers and Evaluators to ensure an end-to-end consistent approach and execution of all retrofit projects.

Figure 2. PAS 2035:2019 manual.

WHEN IS PAS2035 APPLICABLE

The UK Government has proposed to make the standard applicable to all publicly funded retrofit projects. At the time of writing, PAS2035 is a mandatory requirement of the following domestic retrofit funding streams:

- The Social Housing Decarbonisation Fund-(SHDF)
- The Energy Company Obligation-(ECO)
- Local Authority Delivery Phase 3 (LAD3)
- Home Upgrade Grant Phase 1 (HUG1)

This means that Social Landlords have no choice but to embrace PAS2035 and develop in-house capabilities to be able to fulfil Retrofit Assessor and Retrofit Coordinator roles; outsourcing these roles can be expensive. Early assessments of supply chain PAS capabilities are also advisable as all contractors delivering publicly funded retrofit will need to be PAS2030 accredited for each individual energy efficiency measure being installed.

THE PAS2035 PROCESS

The Medium-Term Implementation Plan (MTIP), informed Asset Management Approach

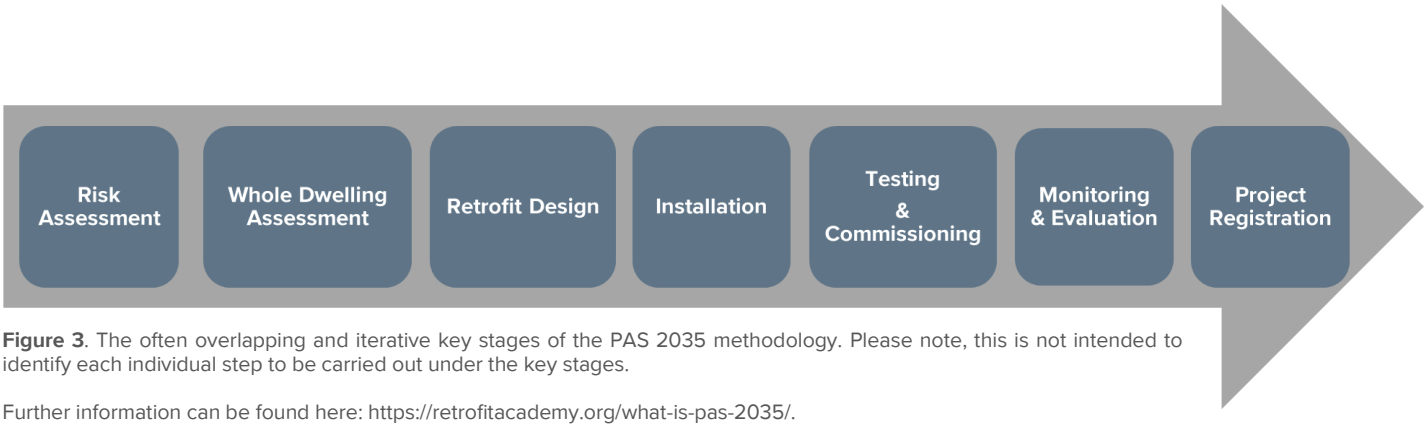


Figure 3. The often overlapping and iterative key stages of the PAS 2035 methodology. Please note, this is not intended to identify each individual step to be carried out under the key stages.

Further information can be found here: https://retrofitacademy.org/what-is-pas-2035/.

RISK ASSESSMENT PATHWAYS

An early-stage output of the PAS2035 process is the risk categorisation of the individual property and the assignment of a Design Pathway to mitigate the associated risks. The risk assessment classifies the project as low, medium or high: low-risk projects follow Path 1 through PAS, medium-risk projects follow Path 2 and high-risk projects follow Path 3. An overview of some of the key qualifying criteria for each risk pathway are provided below.

Low-risk projects

- Limited to the installation of two improvement measures [1]; and,
- Retrofit Designer/ specialist designs must be 'signed off' by a chartered architectural technologist.
- A mandatory retrofit assessment of all dwellings must be undertaken which includes a condition survey and report.

Medium-risk projects

- The Retrofit Coordinator must carry out an improvement options evaluation to form the basis of a medium-term whole dwelling improvement plan (MTIP), and both must be reviewed with the client; which in the case of Social Housing, would be the Social Landlord;
- The Retrofit Designer must have completed a suitable course in Building Physics of Building Science; and,
- Designs must be prepared by a chartered architectural technologist.
- A mandatory retrofit assessment of all dwellings must be undertaken which includes a condition survey and report.

High-risk projects (all those involving historic/ traditionally constructed/ high-rise buildings)

- The Retrofit Coordinator must carry out an improvement options evaluation to form the basis of a medium-term whole dwelling improvement plan (MTIP), and both must be reviewed with the client;
- The Retrofit Designer must have completed a suitable course in Building Physics of Building Science; and,
- Designs are required to be prepared by a registered architect or a registered chartered surveyor.
- A mandatory retrofit assessment of all dwellings must be undertaken which includes a condition survey and report.

[1] For the full list of qualifying criteria for each risk category please refer to the full edition of the latest version of the PAS 2035:2019 standard.

MEDIUM-TERM IMPLEMENTATION PLANS (MTIPs)

One of the outputs of the PAS2035 methodology is an MTIP which describes the range of retrofit measures that are most appropriate for each individual home to achieve predetermined operational energy performance and carbon emission outcomes. Proposed Energy Efficiency Measures (EEMs) are required to be considered alongside any other associated objectives and planned interventions such as, for example, an extension, special needs adaptation or decent homes alignment and referenced to the sequence in which they should be installed over what may be a series of interventions, over an extended period, leading to an eventual whole house retrofit. Whilst this process is inherently asset focused, the challenges arising for Social Landlords, including tenanted properties, would be accounted for within the MTIP approach, typically as part of the options evaluations process and condition report; where tenants will often be specifically asked about any issues and concerns. Additionally, risks typically attributed to a single intervention approach, such as cold bridging and inadequate ventilation, are addressed within this process.

This structured approach to retrofit, as a series of measures (rather than as a single intervention) lends itself particularly well to the medium and longer term planning necessary to deliver Net Zero homes under the obligations of the Climate Change Act 2008; this legally binding legislation requires net zero emissions by 2050 and a 78% reduction in emissions by 2035.

The MTIP approach outlines which EEMs are to be implemented and when over the medium and longer term, therefore allowing the potential to dovetail with the delivery of Planned Works over programmed delivery cycles. When planned and executed coherently, as part of a cohesive Asset Management strategy, there are significant opportunities for economies of scale with associated resource and capital cost delivery savings.

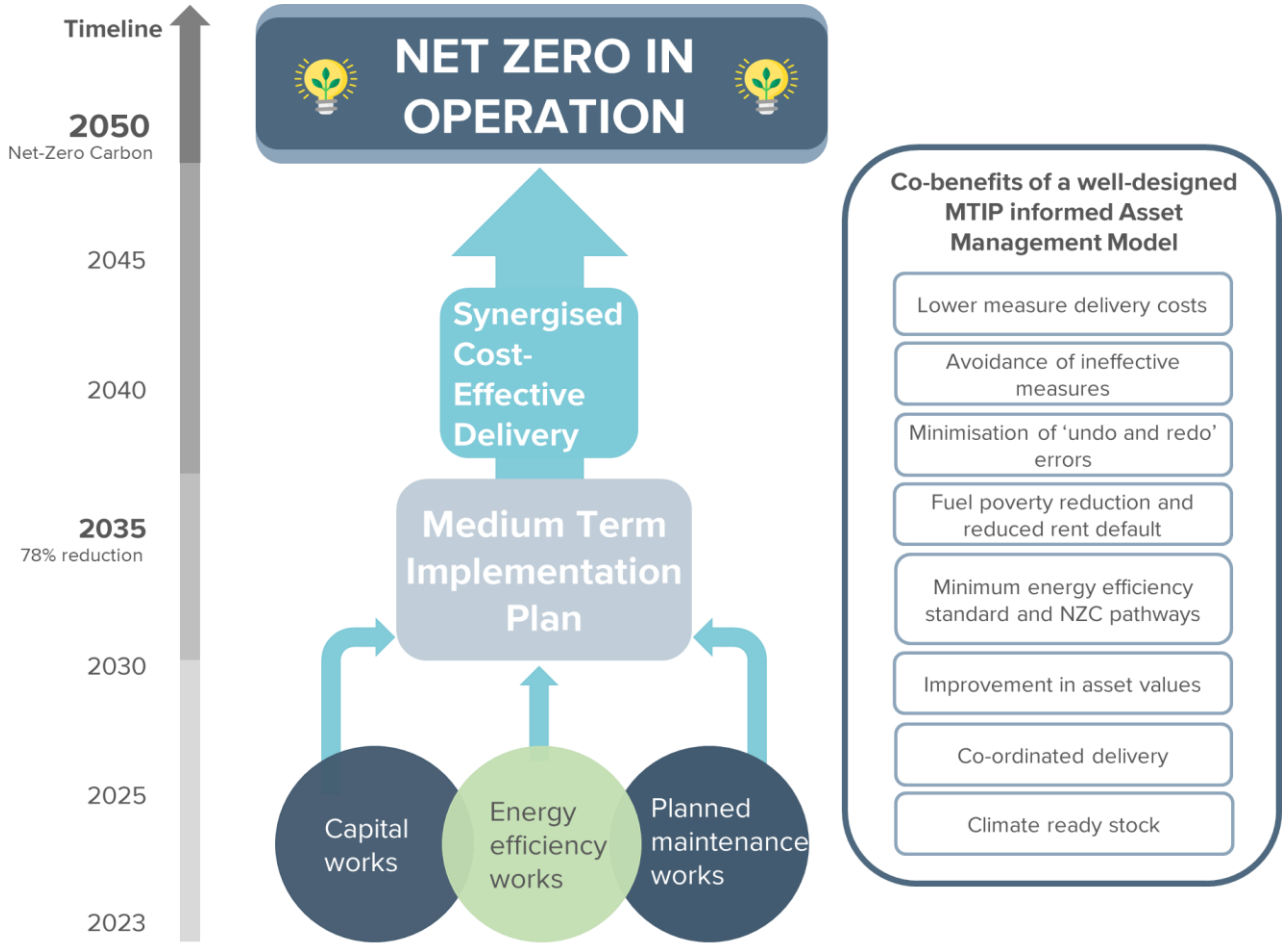


Figure 4. Visual representation of an MTIP with associated benefits.

INTERDEPENDENCY OF MEASURES

The following section will take a more detailed look at the interdependency of EEMs themselves, and the interdependency of EEMs with Planned Works, with a specific focus on the strategic and technical considerations, to guide Asset Management teams on how to successfully implement EEMs and synergise them more efficiently with Planned Works.

Planned Works have traditionally been considered either to be essential or high priority core elements of asset management and budgetary planning. EEMs have not benefited from the same prioritisation and accumulated delivery experience unless they have been an integral part of Decent Homes, Energy Company Obligation schemes or similar. As a result, Asset Management teams will often not have in-depth knowledge of energy efficiency standards or principles and therefore will not be able the opportunities and risks in existing Planned Works programmes.

This is beginning to change with Central Government rolling out more targeted energy efficiency programmes, These, however, remain characterised by short term design and delivery, and energy performance outcomes based on EPC improvements.

Structured energy efficiency programmes with climate mitigation, adaptation and NZC goals remain in their infancy, leading to sub-optimal consideration of long-term outcomes. Local Authorities are therefore left with the responsibility for consideration of longer-term impacts, often through the delivery mechanisms of capital and/or planned maintenance programmes.

To successfully deliver EEMs, Asset Management teams must understand the key criteria that their successful implementation is judged against.

- **Asset Integrity and Risk Avoidance**
  Ensure that the fabric integrity of the treated property is maintained.
- **Energy and Environmental Impact**
  Ensure that the impact of the EEMs has been assessed and determine that they have achieved their intended impact.
- **Occupier benefits**
  Ensure that the EEMs carried out have reduced the tenant's energy bills and improved their standard of living through a healthier internal environment.
- **Value for money**
  Ensure that optimal value for tax-payers' money has been achieved.

For Asset Management teams to ensure these primary criteria of successfully delivered EEMs are achieved, the following points will need to be addressed:

1. Develop an understanding of the inter-connectedness and interdependency of the full range of measures likely to be carried out in each housing archetype across its lifecycle.
2. Develop an understanding of the proposed retrofit to NZC pathway for the chosen property and the interdependencies between the proposed EEMs and consequently of their sequencing.
3. Develop an understanding of the degree of overlap between the measures entailed within objectives 1 and 2 above, and the associated consequences.

Once there is a greater understanding of each of these points, and of the key criteria required to successfully implement EEMs, Asset Management teams will be better equipped to start implementing this knowledge into Planned Works programmes. To guide this understanding, the following subsections will cover the technical and strategic considerations of the interdependencies of EEMs and Planned Works.

TECHNICAL CONSIDERATIONS

The first step for Asset Management teams in understanding the interdependency of EEMs is to get a better understanding of the technical considerations and interrelationships between EEMs alone; separate from any synergy with Planned Works. This is key due to the often lack of in-depth knowledge on the technicalities of EEMs from Asset Management teams, and this knowledge being key to meeting the four key criteria required for successful EEM delivery.

When a greater understanding of the interrelationships of the technical considerations of EEMs is sought, two main areas should be understood. The opportunities that each EEM presents; meaning does the installation of one EEM allow for the easy installation of another EEM, and the risks of each EEM if they are installed independently; for example, if only internal wall insulation is installed this could potentially exacerbate or create cold bridging and damp issues at junctions meeting the floor and/ or roof.

The figures on the following pages are intended to guide Councils and assist in getting a better understanding of the opportunities and risks, from a strictly technical perspective, for relevant EEMs. The relevance of EEMs was determined based on the contracted and intentioned retrofit measures data provided to XCO2 by the participating London Boroughs.

The following graphic is a development of the PAS2035 Measure Interactions Matrix, which is provided in full in Appendix B. The version provided below is simplified to represent the relevant range of measures being considered by the three participating London Boroughs. This matrix highlights, through an easy-to-use colour coding scheme, which EEMs have relationships with each other and can therefore be installed together or allow the easier installation, and which EEMs should not be installed together. This graphic, and the full version in Appendix B should be used as guidance by Councils to assist with the streamlining of EEM integration and prevent the costs and time associated with abortive work being undertaken that then may need to be undone and redone in the future. This matrix also forms a key part of the options evaluation stage of the PAS 2035 aligned MTIP process for medium and high-risk projects.

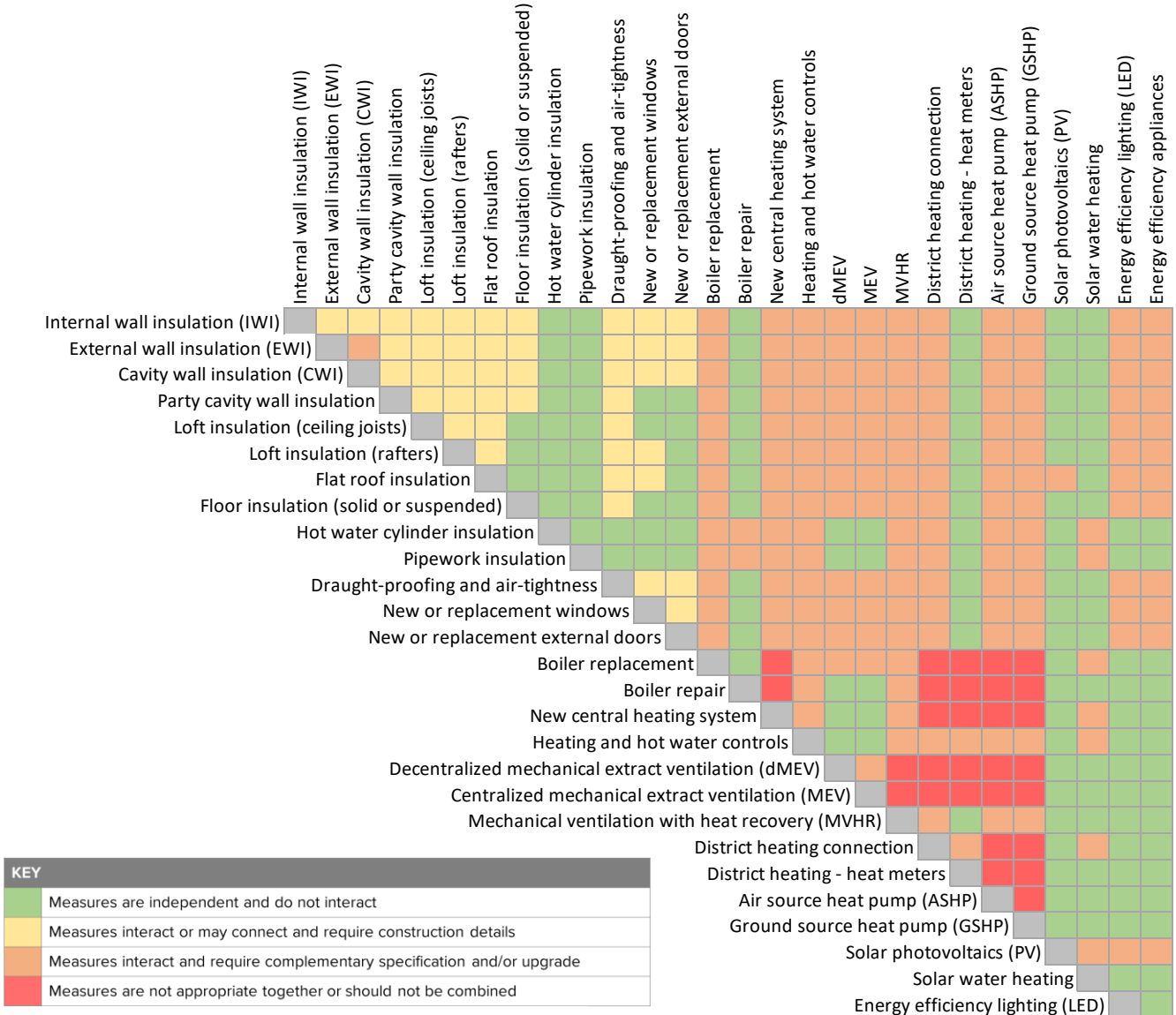


Figure 5. Condensed PAS 2035:2019 Measures Interactions Matrix.

Figure 6 on the following page further illustrates the interrelationships between EEMs, but in the context of a residential dwelling and with a specific focus on the opportunities and risks associated with each measure. This figure is intended as visual guidance to further the understanding of which EEMs can viably be combined or used to aide the other for efficient future installation and what risks could arise if these are not installed effectively and/or in alignment with other EEMs. The opportunities and risks outlined are not intended to be exhaustive but provide an indication of the thought processes that should be engaged in, to meet the four key criteria that successful EEM delivery are judged against, when carrying out any EEMs.

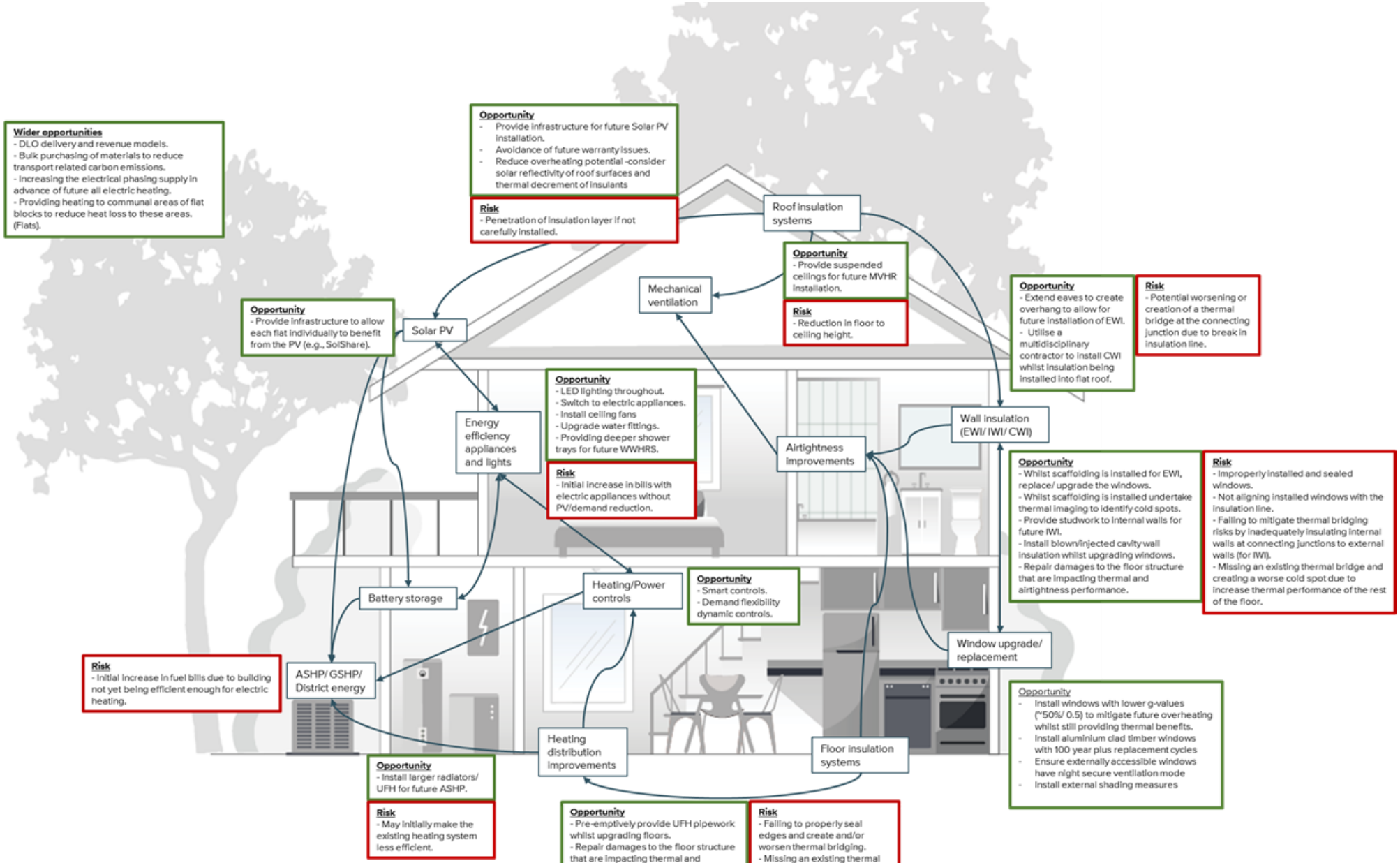


Figure 6. Image reflecting the interrelationships between EEMs and the associated risks and opportunities these works can present, in the context of a residential dwelling.

STRATEGIC CONSIDERATIONS

With a greater understanding of the technical interrelationships between EEMs, there is a greater ability of how to efficiently streamline the NZC pathway through the integration of multiple measures. However, to synergise these EEMs with Planned Works, there are strategic considerations that must be understood, and processes adopted.

As mentioned earlier, Asset Management teams often do not currently have in-depth knowledge of energy efficiency standards and principles, therefore the energy efficiency opportunities and risks of Planned Works will rarely have been investigated and addressed.

Therefore, a gateway process should be implemented into all Planned Works programmes that specifically focuses on the potential risks and opportunities. This gateway process would involve a mandatory review of each Planned Works item before it is procured or contracted, in which six important questions will be answered.

These questions will guide Asset Management teams into viewing Planned Works items from an energy efficiency perspective, from which any opportunities can be actioned, and the risks mitigated. These six Planned Works gateway questions for every work item are outlined in Figure 6 on the following page and should be answered in the stated order. Please note, the examples provided in the final column of each gateway question are not exhaustive and intended only as guidance in understanding the thinking that should be adopted for each question.

GATEWAY QUESTION	PERSPECTIVE(S)	EXAMPLES FOR GUIDANCE
Stage 1		
What are the environmental improvements inherent in the current Capital/ Planned maintenance works?	Opportunity & Risk	- Typical window upgrades will likely include the installation of modern double-glazed units. These will provide an inherent improvement in EE over the replaced units. However they will likely need upgrading again to meet NZC requirements.
Stage 2		
Can this capital/planned works item be additional purposed to deliver EE benefits?	Opportunity	- Can a new pitched roof re-covering have the eaves extended to allow for future EWI installation? - Can a new pitched or flat roof re-covering have roof mounting hooks installed for future solar PV installation, thus avoiding roof warranty issue?
Stage 3		
Is there any element of these works which will make future NZC retrofit mesures more difficult or require prior measures to be undone and redone to achieve EE outcomes?	Risk	- Can replacement windows and doors be specified to U-values of < 1.0W/m^{2}K rather than Building Regulations Part L defaults (standard modern double-glazing)? - Can window sizing and installation be sized to be EWI or IWI ready?
Stage 4		
Is there any element of this capital/planned works item which can make future EE work easier and less expensive?	Opportunity	- Can any standard single coil replacement hot water cylinders be upgraded to twin coil + immersion capacity? This will enable future installation of renewable hot water generation to connect to the earlier cylinder replacement and avoid the need for an additional replacement cylinder. - Can any replacement radiators and distribution pipework be sized to allow future compatibility with eventual ASHP or GSHP provision?
Stage 5		
Can this work be co-delivered with an EE measure to reduce site set-up, supervision, prelims etc., and deliver better economic value?	Opportunity	- Could any ventilation system upgrades be improved to also include heat recovery? - Could ceilings be pre-suspended to allow for future ventilation ductwork?
Stage 6		
What are the decent homes improvements inherent in retrofit / EE led works?	Opportunity	- New entrance doors. - New windows. - Reparation of building fabric through thermal improvements.

Figure 7. Capital/ Planned works gateway questions.

The following graphic illustrates a combined list of Planned Works and EEMs to be delivered over the forthcoming 3 years across the three participating London Boroughs. Each of the items highlighted in the left box are measures which can have direct or indirect energy efficiency impacts, with the arrows indicating the direct relationships between each Planned Works and EEMs.

This figure can be used to assist with the gateway process proposed in Figure 6 but it is also intended to highlight possible synergies between Planned Works and EEMs that could then be dovetailed into the MTIPs to promote a joined up approach of both EEMs and Planned Works.

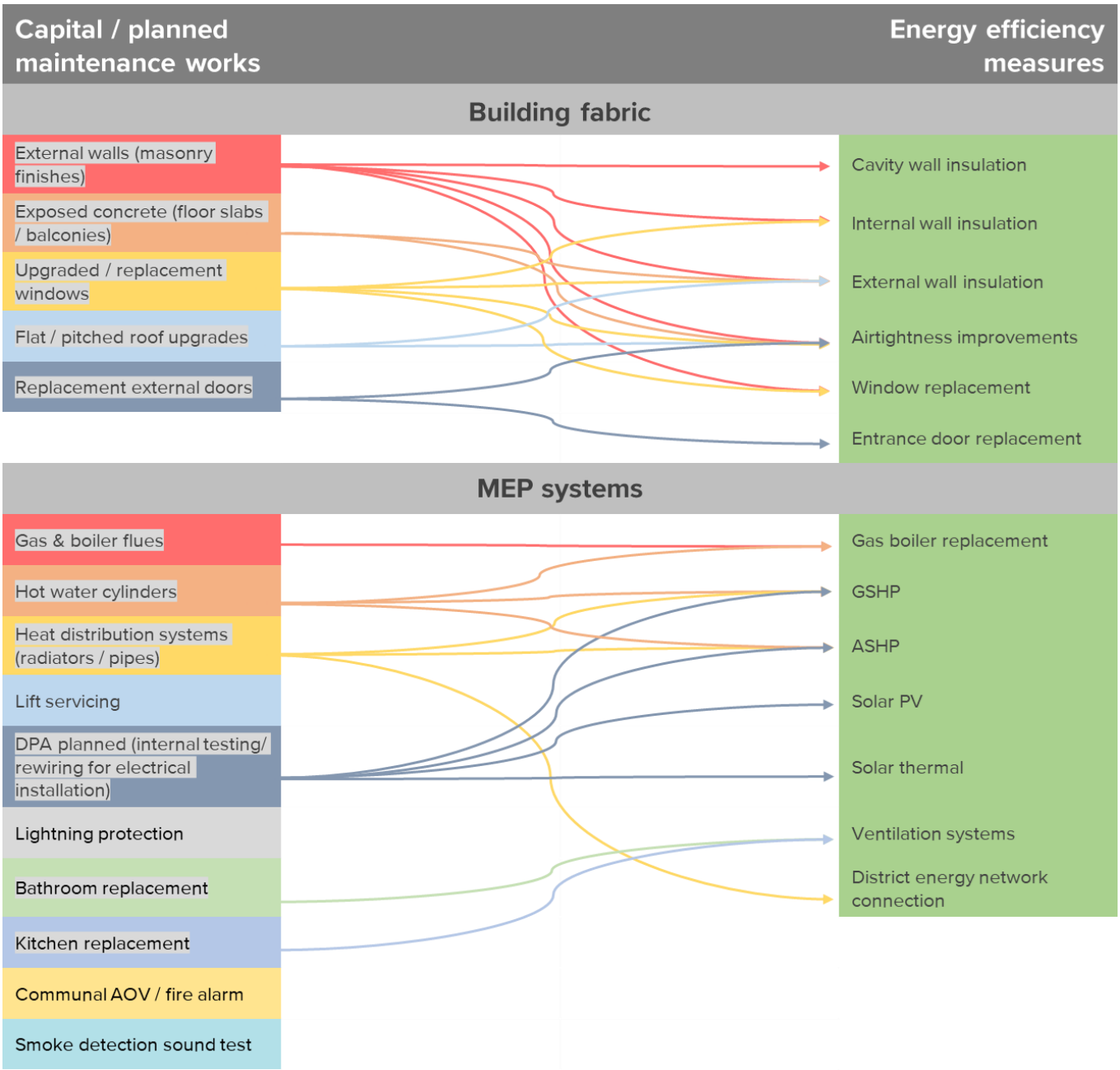


Figure 8. Possibly synchronising relationships between Capital/ Planned Maintenance Works and EEMs.

BOROUGH SPECIFIC SYNERGY STRATEGIES

The following diagram illustrates the numerous potential Planned and EE Works delivery interaction points for a notional property with a D rating (SAP 60) starting a new maintenance cycle, on its journey through EPC B by 2030 (London Council targets), 78% reductions by 2035, (Climate Change Act legally binding targets) and Net Zero carbon by 2050 (Climate Change Act legally binding targets).

The 'contracted' and 'intentioned' EE measures outlined between the years 2024 and 2026 are based on data provided by all three participating London Boroughs. The 'possible future' EE measures highlighted in blue are an extrapolation of this information, then aligned with averaged maintenance cycles (above the line) to indicate possible synergies and highlighting subsequent opportunities to carry out EE measures compatible with operational NZC pathways.

It goes without saying that all the measures outlined at each synergy point would likely not be installed at once, however the purpose of the graph is to point to EE measures that could be linked to a particular Planned Works measure whether from a future readiness or immediate installation perspective. It would then be for each Borough to procure the combined/altered scope of works based on supply chain capabilities and budgets.

POTENTIAL PLANNED AND ENERGY EFFICIENCY DELIVERY PATHWAYS - NOTIONAL DWELLING

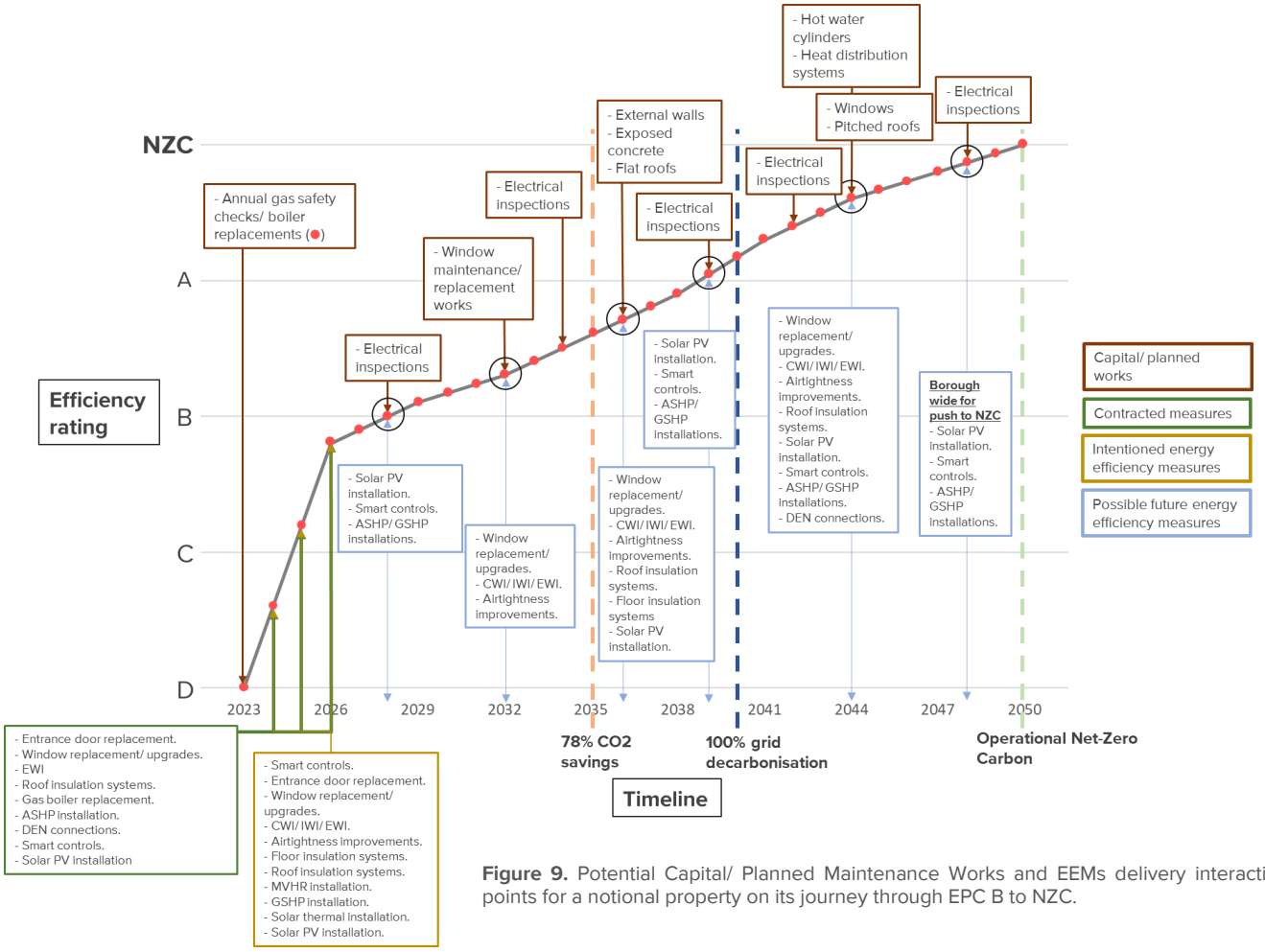


Figure 9. Potential Capital/ Planned Maintenance Works and EEMs delivery interaction points for a notional property on its journey through EPC B to NZC.

The previous figure is based on a notional property and pathway. It should therefore be read with the following caveats in mind:

- 2023 has been taken as a baseline date from which all maintenance cycles start;
- At individual property levels, the measures, scopes and specifications will be property specific and determined by the Retrofit Designer, Assessor and Co-ordinator in response to risk pathways under the PAS2035 process;
- The dates of Planned Works have been included using averaged data from each of the participating Boroughs, based on their quote cycle time frames;
- The participating Boroughs have not provided specific dates of Planned works, only timeframes for types of work;
- Conservative assumption for estimated date of 2040 for 100% decarbonisation of the electrical grid in case the more ambitious estimates made by the National Grid (100% by 2035) are not realised. See 'Additional Considerations' section for more information on this.

BOROUGH SPECIFIC POTENTIAL PLANNED AND ENERGY EFFICIENCY SYNERGY PATHWAYS

The following sub-sections take a more detailed look at the contracted and intentioned EE measures provided by each council for the next three years with the assumption that all Planned Works items will be carried out. This provides each participating Borough with a better understanding of how they can synergise their contracted and intentioned EE measures within Planned Works cycles.

HOUSING TYPOLOGIES AND ASSOCIATED RETROFIT APPROACHES

Consideration of optimal synergised retrofit delivery needs to be informed by a sufficiently detailed planned and energy efficiency works programme. The level of detail necessary to develop this was not forthcoming and needs to be the subject of an additional piece of work informed by an eventual NZC retrofit and planned works strategy. This will also depend upon an agreed alignment of housing typologies which reflects wider planned works priorities and risk assessment pathways defined by PAS 2035.

HOW TO READ THE FOLLOWING THREE FIGURES

Figures 10, 11 and 12 on the following pages have been vertically split into the relevant years; 2024, 2025 and 2026 and horizontally split to separate Planned Works; the information above the grey line, and EE measures; the information below the grey line.

Based on the assumption that all the Planned Works items are expected to be being carried out to a determined number of buildings across each Borough, all have been included as active within each year. A sample fabric-based and MEP based Planned Works measure has then been selected in each year to provide an example of instances where specifics works can be synergised with confirmed contracted or intentioned EE measures based on the data provided by each Borough.

With this knowledge and using the interrelationships diagram in figure 8, it is then intended that the Boroughs individually can carry out the same exercise for each of the Planned Works to identify all the possible synergy points, for all buildings having the various maintenance works carried out.

Please note, where insufficient data has been provided, the relevant areas of any figures have been left blank.

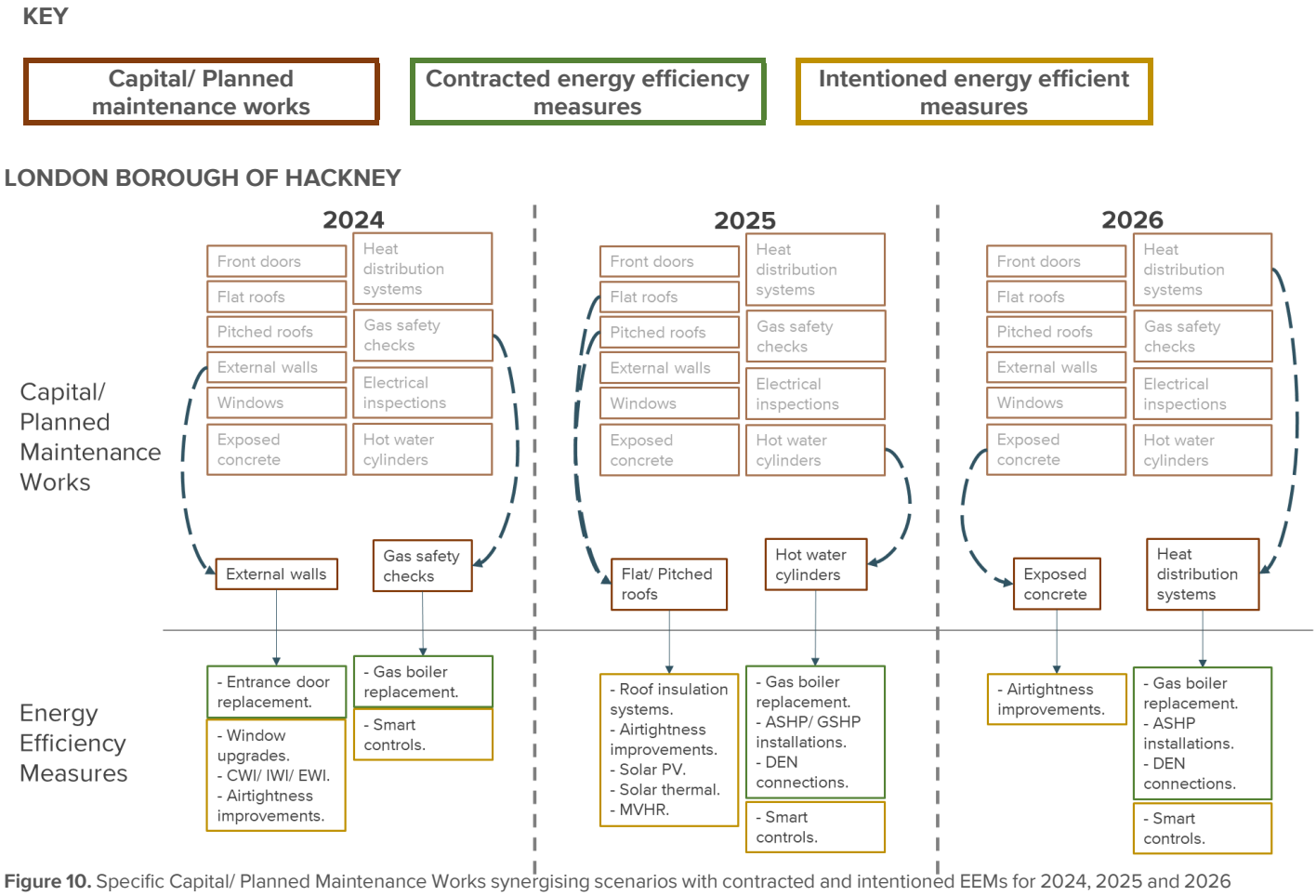


Figure 10. Specific Capital/ Planned Maintenance Works synergising scenarios with contracted and intentioned EEMs for 2024, 2025 and 2026 for the London Borough of Hackney.

London Borough of Hackney (LBH) confirmed that in 2024 they have contracted 2,000 entrance door replacements, therefore there is a probability that buildings expected to have external walls maintenance works carried out on them will also have their doors replaced. This provides an opportunity to synergise the two works.

Further synergies can be achieved through the intention in 2024 to upgrade windows, install cavity, internal or external wall insulation and carry out airtightness improvements. With careful planning and procurement, a selection of, or all these measures can also be carried out more cost effectively than if procured and delivered separately. Utilisation of any scaffolding present to replace windows, install external wall insulation or carry out thermal imaging to identify cold spots that can then be dealt with. Depending on design pathways, injecting cavity wall insulation, installing internal wall insulation or studwork for future installation or carrying out airtightness improvements would also be possible.

2,000 gas boiler replacements, ASHP installations and DEN connections across 2024, 2025 and 2026 have also been contracted. Gas safety checks and replacement boilers provide and opportunity to install weather compensation or optimum start thermostat smart controls which comprise intended EE works. Further, it is expected that hot water cylinder and heat distribution system replacements or maintenance will be carried out across the three years. This can provide numerous opportunities for synergy with both the contracted and intentioned measures mentioned in the figure above. Possible key opportunities could include:

- Using the same engineers to replace the gas boilers;
- Install smart controls on heating emitters or water cylinders;
- Upgrade distribution system to ASHP or DEN ready, e.g. install larger radiators for lower flow temperatures;
- Replace hot water cylinders and gas boilers with HIUs;
- Remove hot water cylinders and install communal buffer vessels during same set of planned works;

ROYAL BOROUGH OF KENSINGTON AND CHELSEA

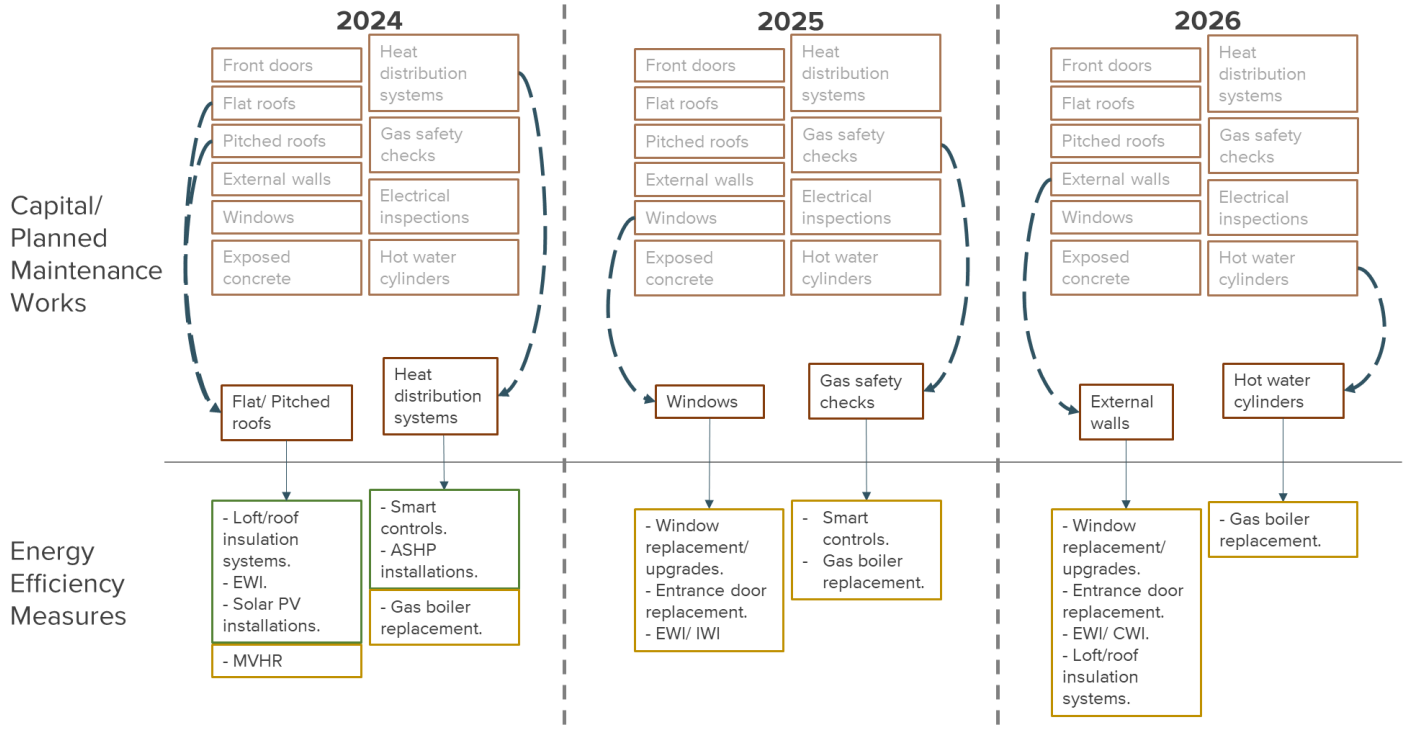


Figure 11. Specific Planned Works synergising scenarios with contracted and intentioned EEMs for 2024, 2025 and 2026 for the Royal Borough of Kensington and Chelsea.

Royal Borough of Kensington and Chelsea (RBKC) confirmed that they have only contracted EE measures in 2024 and these included loft/roof insulation systems, EWI, solar PV and ASHP installations and smart controls.

The first three of these measures can all be aligned to Planned Works on flat or pitched roofs. This synergising could include insulating the roof systems, extending the eaves to allow for future EWI, installing solar PV or laying the infrastructure for future PV installation, once any external maintenance is completed. As the largest portion of the housing stock within RBKC is comprised of flats, this provides the potential to significantly reduce the carbon emissions of a large proportion of their housing stock and help progress the Borough towards the 2050 NZC target.

Similarly, to LBH, RBKC are intending to carry out window upgrades, install EWI, IWI and CWI and replace entrance doors. Therefore, with aligned planning, these can all be synchronised with both, the relevant maintenance works cycles, and each other.

RBKC have also contracted and outlined the intention to undertake gas boiler replacements and ASHP installations across 2024, 2025 and 2026. Gas safety checks and replacement boilers provide an opportunity to install weather compensation or optimum start thermostat smart controls which comprise both contracted and intended EE works with the Borough through 2024 and 2025. Further, it is expected that hot water cylinder and heat distribution system replacements or maintenance will be carried out across the three years. This can provide numerous opportunities for synergy with both the contracted and intentioned measures mentioned in the figure above. Possible key opportunities could include:

- Using the same engineers to replace the gas boilers;
- Install smart controls on heating emitters or water cylinders;
- Upgrade distribution system to ASHP or DEN ready, e.g. install larger radiators for lower flow temperatures;
- Replace hot water cylinders and gas boilers with HIUs;
- Remove hot water cylinders and install communal buffer vessels during same set of planned works;

LONDON BOROUGH OF LEWISHAM

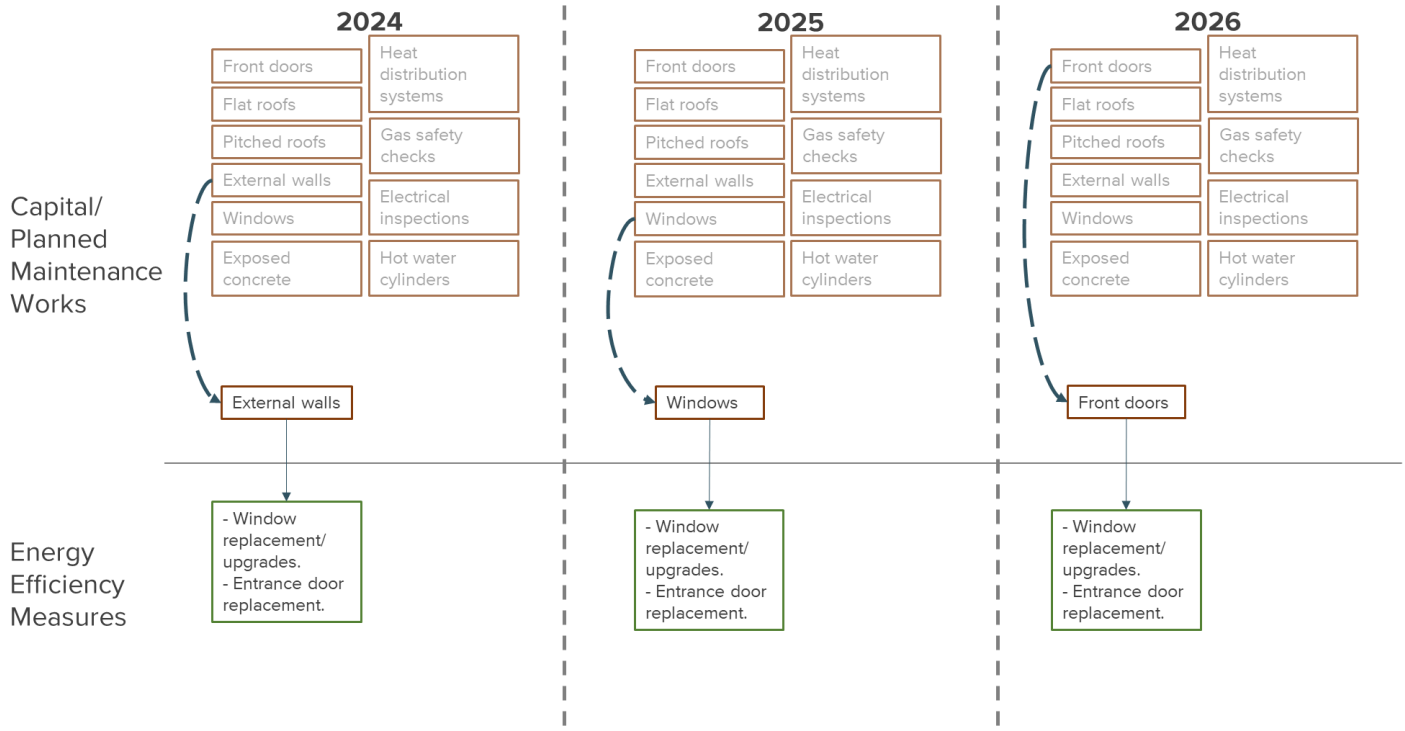


Figure 12. Specific Capital/ Planned Maintenance Works synergising scenarios with contracted EEMs for 2024, 2025 and 2026 for the London Borough of Lewisham.

London Borough of Lewisham (LBL) were not able to provide significant information on contracted or intentioned EE measures for the next 3 years. LBL were able to confirm that window upgrades and entrance door replacements have been contracted in some capacity across each of the next three years. Based on the guidance provided within this report, these EE measures can be synchronised with external wall, windows, and front door maintenance cycles.

By reviewing figure 8 earlier in the report, further opportunities can be identified once these work streams are aligned to enable LBL to further align their housing stock with the NZC delivery pathway.

If LBL make the decision to contract or investigate heating system improvements (gas boiler replacements, ASHP/GSHP installations or DEN connections), hot water cylinder, heat distribution system and gas boiler replacements or maintenance all provide numerous opportunities for synergy; key opportunities could include:

- Using the same engineers to replace the gas boilers;
- Install smart controls on heating emitters or water cylinders;
- Upgrade distribution system to ASHP or DEN ready, e.g. install larger radiators for lower flow temperatures;
- Replace hot water cylinders and gas boilers with HIUs;
- Remove hot water cylinders and install communal buffer vessels during same set of planned works;

ADDITIONAL CONSIDERATIONS

ENERGY EFFICIENCY MEASURES 'QUICK WINS'

The below list outlines a few examples of best practice energy efficiency principles and 'quick wins' that are either cost effective/ inexpensive/ simple to install but that can have a positive impact on energy efficiency and EPC ratings.

- Smart controls onto heating emitters (radiators, underfloor heating);
- Smart controls for heating systems (including optimum start thermostats, weather compensators);
- Smart meters;
- Switching to energy tariffs that provide cheaper energy at 'off-peak hours', which can help EPC ratings due to EPCs being based on the cost of energy used (and would help occupants to save money);
- Having dwellings air-tested now, as typically the value is lower than what is assumed in the energy modelling used to create the EPC - and if values are higher, it is a good indicator of general issues to be investigated further;
- Provide background heating to communal corridors and stair cores, where it is not present. Any walls adjacent to these areas can then be attributed as 'party walls' in the energy modelling used to produce EPCs;
- Installing loft insulation, often uses cheaper wool insulation therefore can be installed in greater thicknesses and is often easily accessible even if a property is tenanted.
- Installing photovoltaic arrays on available roof spaces. These have the potential to significantly improve the EPC ratings of houses but also flats. However, with respect to flats, this is subject to the following;
- Installing of SolShare technology into apartment blocks. This technology allows each flat individually to benefit from a single rooftop solar system through dedicated hardware connecting each flat to this rooftop system. This particular 'quick win' relates primarily to being immediately compatible with social housing and improving EPC ratings, not from a cost perspective.

ENERGY EFFICIENCY MEASURES REQUIRING GREATER INVESTMENT AND PLANNING

The below list outlines a few examples of EEMs that will likely require a greater investment, longer term planning and complex installation. Whilst these examples do account for the more complex EEMs from a Council perspective, these will often have the greatest impact on energy efficiency, EPC ratings and achieving NZC.

- Upgrading heating systems to heat pumps, either ASHPs and GSHPs, individually or as part of energy networks. These technologies are pivotal in meeting NZC by 2050 due to being able to accommodate the eventual decarbonised electricity grid, however they require much greater investment than most EEMs due to their capital costs, and in the short term, without prior improvement to the heating demand of social houses, could increase the cost of energy bills for tenants;
- Upgrading heating systems to decarbonised heat networks. These are also pivotal in meeting NZC by 2050 however these will often require much greater investment due to the infrastructure for these district energy networks needing to be installed. In addition, there is the added complexity that these networks require both approval and enough load to be viable, and the lead time before they're operational can be many years.
- Installing MVHR systems. This technology is fundamental if the air tightness of social houses drops below 5 m^3/hm^2, which is possible if multiple EEMs are installed to improve the building fabric. The complexity with this technology is that the unit has to be located in an adequate space inside the dwelling or in a loft, suspended ceilings or casings will need to be installed for ductwork, the intake and exhaust will need to penetrate the external wall, and all ductwork will need to be insulated adequately to maintain efficiency. Further, to run properly the MVHR must be left on permanently, therefore meaning tenants will need to be informed of how to use it properly, but ultimately great energy and carbon savings can be achieved using MVHR to make the most of the warmth from internal air to pre-heat incoming fresh air in cold winter months.

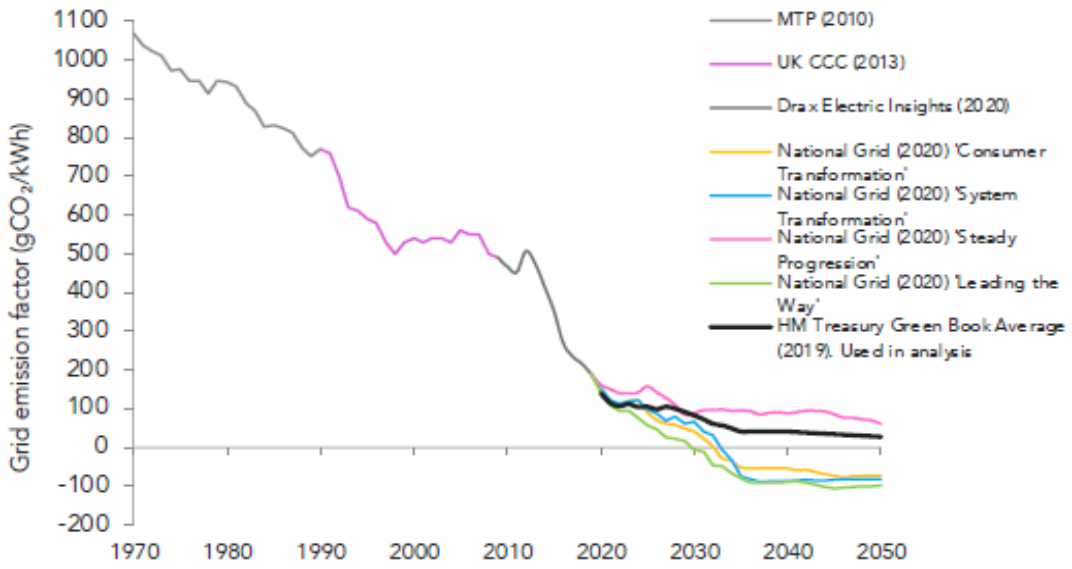
NET-ZERO CARBON

For the purposes of this report, any mention of net-zero carbon (NZC) has been in reference to operational NZC. This is achieved "*when the amount of carbon emissions associated with a building's operational energy on an annual basis is zero or negative. A net zero carbon building is highly energy efficient and powered from on-site and/or off-site renewable energy source*" [1].

To be able achieve operational NZC, a building's total energy use needs to be supplied entirely from electricity, ultimately from a fully decarbonised heat networks. Therefore, the electricity grid needs to be completely decarbonised (emissions factor equivalent to 0 or a negative number) to ensure that this energy being used within the building has been generated from a renewable source.

The figure below outlines the historical and projected decarbonisation of the UK electricity grid using the grid emissions factor as the tested variable. Based on the National Grid 'Consumer and 'System Transformations' and 'Leading the Way' projections, the UK electric grid is on track to be completely decarbonised by 2035.

Should the National Grid 'Steady Progression' or HM Treasury Green Book Average projected trend lines be realised this would significantly impact the ability of social housing within the London Borough's to meet operational NZC by 2050.



Long-term variations in emission factor of grid electricity show the rapid historical reduction in emission factors. © Etude based on data from Market Transformation Programme, UK Committee on Climate Change, Drax, National Grid and HM Treasury.

Figure 12. Historical and projected timeline for the decarbonisation of the UK electrical grid.

Reference; London Councils Housing Action Plan 2021 (p.17)

[1] Government Property Agency: Sustainability and Net Zero Design Guide – Sustainability Annex, March 2022

UNREGULATED OPERATIONAL ENERGY

In order to meet the operational NZC classification both the regulated and unregulated carbon emissions need to be reduced to zero. Regulated emissions are based on building energy consumption from the specification of controlled, fixed building services and fittings; these include space heating and cooling, hot water, ventilation, fans, pumps, and lighting. The carbon emissions attributed to these energy uses are easy to assess due to being an inherent part of the design of a building and form the basis of all Building Regulations modelling.

Emissions deriving from unregulated energy are more complex to accurately assess as they do not form part of the Building Regulations modelling but can account for up to 50% of all energy use. Unregulated energy is building energy consumption resulting from a system or process that is not controlled and are heavily dependent on occupier behaviour. This could include energy consumption from systems essential to the building and its operation, e.g. external lighting, cooking equipment, white goods and other appliances.

As London Council's look to move through the delivery pathway to NZC, unregulated emissions must receive equal focus as the more manageable regulated emissions in order to meet true operational NZC by 2050, however such a study falls outside of the remit of this current report.

VOID PERIODS

All three participating Boroughs have reported significant instances where properties remain unoccupied between tenancies. These vary between 100 to 500 voids per annum with average unoccupied periods of between 50 and 130 days for each property.

These void periods have the potential to be one of the best opportunities to deliver a scope of retrofit which would otherwise be much more difficult and costly to effect whilst the dwellings are occupied. Grasping the opportunity to deliver a wider and deeper EEM informed retrofit is also an opportunity to make direct meaningful impact on new tenant energy consumption and provides the opportunity to install with tenant consent, via new leases, the means to monitor energy consumption and atmospheric quality through the use of temperature, CO_2 and relative humidity sensors.

The scope and specification of such Void retrofit works will be dependent upon a number of factors and constraints. The dependent factors include; length of inoccupation, budgets, supply chain capacities and materials availability. A major constraint would of course be that the time a void is spent unoccupied is lost income and lost housing. XCO2 therefore recommend that an advanced deployment strategy be developed to ensure that these opportunities are seized.

HERITAGE

Heritage buildings are those which have special considerations under the planning system, due to the character and historic interest attached to the building. As a result, this category of building often has far more limitations and restrictions on what EE measures can be carried and to the extent they can be carried out, in addition, maintenance work will likely be specialised making any synergising with EE measures less viable. Therefore, heritage buildings require a much more balanced, holistic, and bespoke approach to retrofit.

It is for these reasons that heritage buildings have not been accounted for within this report, however this building type forms part of the housing stock in all of the three participating Boroughs and therefore consideration as to how these, often highly inefficient, buildings can be improved needs to be given if NZC is to be delivered across the city.

WHOLE LIFE CARBON AND EMBODIED CARBON

This report has focused on delivery pathways for London Council's to achieve operational NZC by 2050, however operational carbon only accounts for a portion of the total carbon 'emitted' by a building. To be classed a true NZC building, the whole life cycle carbon must be accounted for, this includes carbon attributed to the extraction and manufacturing of materials, the transportation to site and subsequent installation on site, the capital and planned maintenance throughout the building's life and finally the deconstruction, demolition, and disposal at the end of its life. The figure below represents all life-cycle stages of a building from which carbon emissions are produced; the operational emissions are only represented by stages B6 and B7.

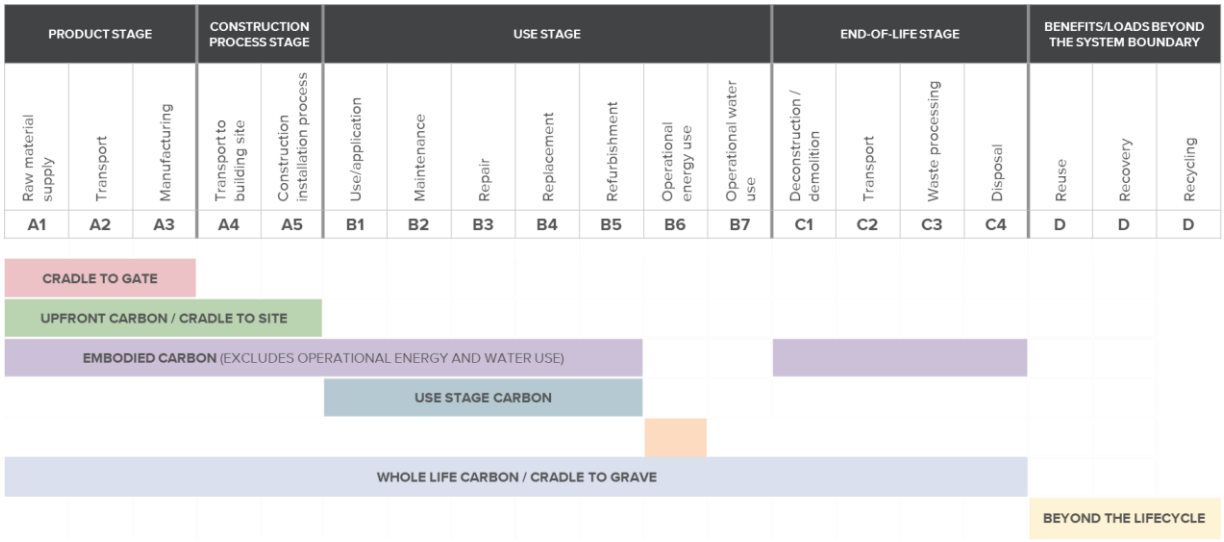


Figure 13. Whole life carbon life-cycle stages of a building.

Reducing the embodied carbon of materials can help significantly reduce the carbon emissions attributed to the product, construction process, use and end-of-life stages. Therefore, when procuring work for future EE measures, London Council's should ensure they are prioritising low embodied carbon strategies, these can include but not be limited to:

- Sourcing products and materials from local suppliers and sustainable sources;
- Using materials that have been extracted and sourced locally;
- Reusing existing materials when demolishing or replacement occurs;
- Utilising low carbon materials, such as timber and materials with high recycled content, where possible;
- Specifying products with Environmental Product Declarations (EPDs);
- Bulk buying materials to use on a Borough wide basis;
- Use manufacturers and suppliers that operate take-back schemes; and,
- Use durable materials with longer life spans.

NEXT STEPS

FOR COUNCILS

1. Develop a bespoke Planned Works Gateway Procedure including check and sign-off process and implement this so that no risks or opportunities are left unconsidered for all Planned Works design and delivery.
2. Develop a Risk Assessment procedure for all ongoing Planned and Maintenance works on retrofitted properties.
3. Conduct a PAS2030 skills and capacities audit of existing supply chain. Actively support, encourage, and mandate qualification for all existing and proposed contractors.
4. Ensure qualified in-house PAS2035 Retrofit Coordinator capacity.
5. Assess Direct Labour Organisation (DLO) skills and develop training, qualification and capacity of the organisation for delivery of PAS2030 certified retrofit measures. Evaluate cost-savings for DLO versus externally delivered measures and consider the business case for offering these services externally.
6. Design and implement processes to monitor, measure and evaluate impact beyond SAP points and EPC's so that performance is captured across each of the following three criteria:
    a) Total energy consumption (Energy Intensity-EUI): in kWh/m^2/per year;
    b) Heating energy consumption: in kWh/m^2/per year; and,
    c) Carbon emissions: in $kgCO_2/m^2$/per year.
7. Develop specification clauses that would incorporated into Employer's Requirements and/or tender documents to help align Planned Works with the NZC pathway.

ADDITIONAL WORK RECOMMENDATIONS

XCO2 recommends the commissioning of the following additional pieces of work to facilitate the accelerated delivery of effective NZC retrofit:

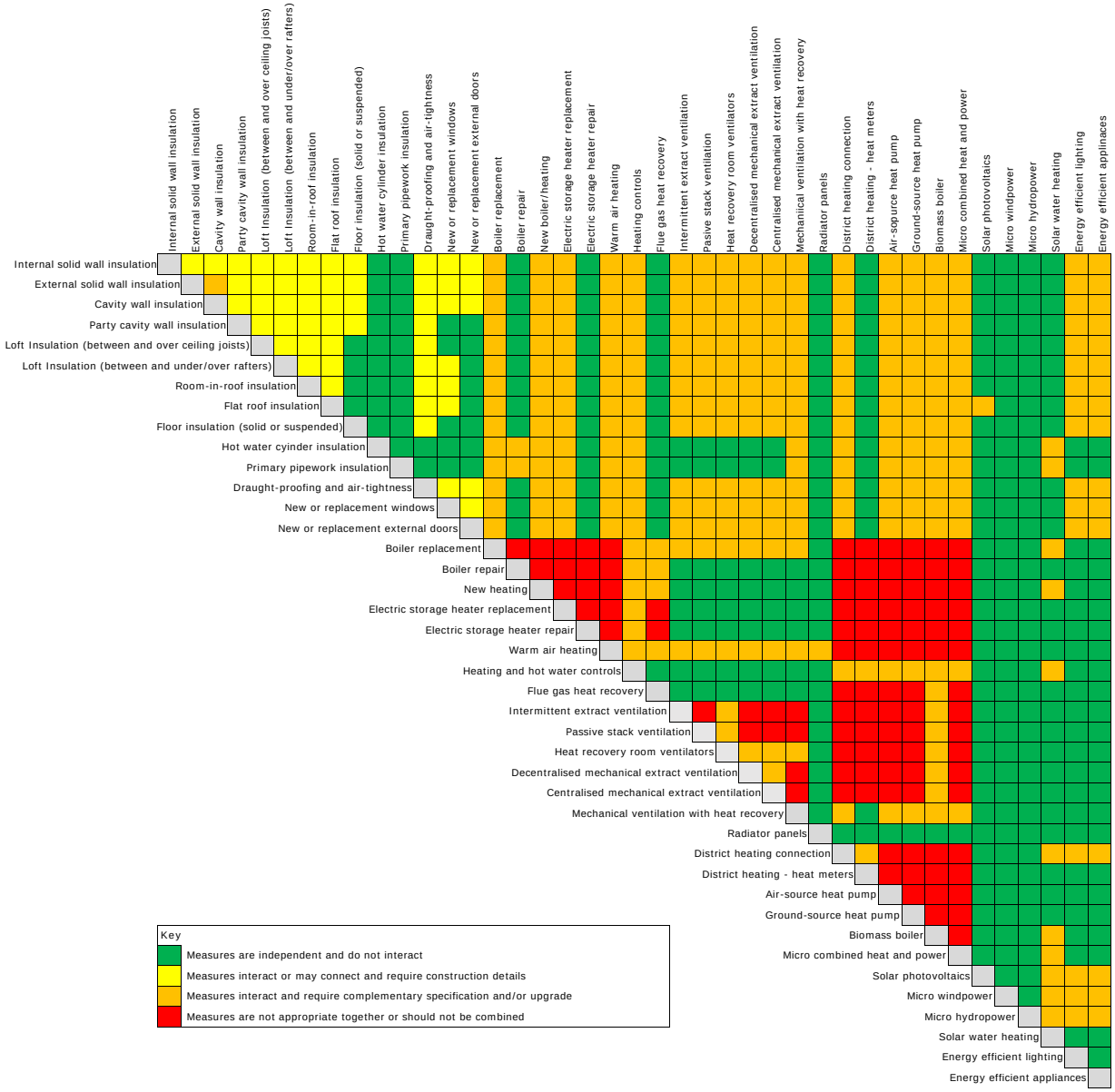
1. Provision of a detailed cost study of present Planned Works and EEM delivery projects to quantify costs and compare with optimised synchronised delivery.
2. Development of a Voids Strategy and associated retrofit packages for major architypes. This would be aimed at providing the means Policy to fast-track the assessment, design, and delivery of the widest and deepest set of energy efficiency upgrades to:
    a) improve immediate energy performance;
    b) ensure that the application of future measures are not impeded and are made easier by current void retrofit measures; and,
    c) Development of a Retrofit Guidance Scope of measures to mitigate against overheating in retrofitted buildings.
3. Development of an architype-led retrofit playbook which can be used for the progressive synchronised delivery of NZC retrofit by property architype.
4. Development of a "how to" guide for the practical implementation of EEMs into Planned Works programmes. This could be included within point 4, or be a separate piece of work.
5. Embodied carbon studies of retrofit works to give a better understanding of true net zero.
6. Unregulated energy decarbonisation study looking at operational energy consumption not captured by Part L of Building Regulations such as white goods, kitchen equipment, lifts and external lighting.

APPENDIX A – PAS 2030 RETROFIT MEASURES INTERACTION MATRIX

BSI PAS 2030 Steering Group
BSI Retrofit Standards Task Group

RETROFIT MEASURES INTERACTION MATRIX

Version D, 20 November 2016



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