SPACES webinar

18 OCTOBER 2022

City of Edinburgh Council's EnerPHit Informed Retrofit

(early steps to Net Zero across CEC Operational Estate)

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October 2022.

EDINBURGH NET-ZERO 2030

CEC’s Operational Estate, New Build Net Zero Approach

New projects delivered across the Operational Estate by The Sustainable Development Service, Capital Projects Team (CPT) are briefed to deliver Certified Passivhaus Classic Standard with Low Zero Carbon (LZC) primary plant (for example heat pumps) as the default.

This addresses key deliverables:

- Contributes to design and construction quality (Cole Report) initiatives
- Addresses building energy performance gap (many new builds perform below expectations)
- Delivers a low energy building which facilitates cost effective deployment of LCZ primary plant
- Passivhaus is primarily a comfort standard ensuring suitable conditions for building occupiers
- Robust approach to address SFT’s energy targets for schools (funding related)
- Contributes directly to delivering Net Zero Carbon aims
- Now addressing NZPSB standard

Certified
Passive House
Passive House Institute

Addressing the existing CEC Operational Estate

The bigger challenge from both a technical and funding perspective will be addressing the existing Operational Estate.

Excluding PPP/DBFM schools and Edinburgh Leisure properties, there are approximately 400 heated buildings across the Operational Estate which require to be addressed.

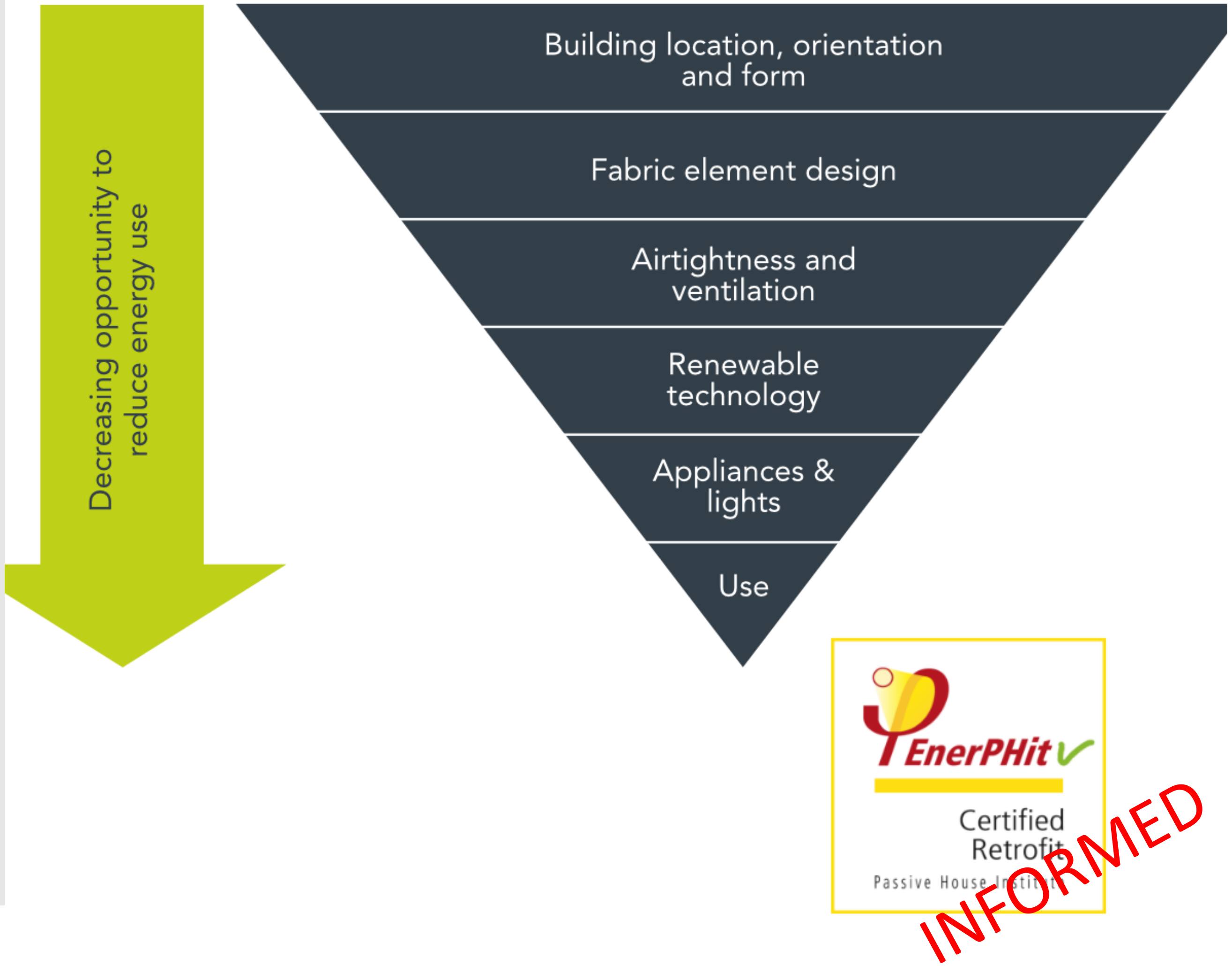
The variety of buildings is extensive:

30% are over 100 years old. 40% built within last 50 years.

There is also an opportunity to show leadership in setting out an approach to delivering this objective.

The challenge in addressing existing buildings

- Existing buildings have greater limitations in delivering low energy solutions. Orientation and form are already fixed.
- However, there is still opportunity to improve the building fabric and airtightness.
- The Passivhaus disciplines provide the most robust approach to addressing building fabric without compromising building user comfort.
- For retrofit of existing buildings the Passivhaus standard is Enerphit.
- A Pilot based on Enerphit <u>Informed</u> methodologies and tools has been undertaken. This approach delivers the required building analysis, setting out potential interventions to reduce energy consumption prior to the deployment of LZC primary plant or connection to any local Heat Network etc
- Suggested delivery vehicle would be the Asset Management Works programme as there is close alignment.



Anticipated scope change to typical annual lifecycle elemental replacement programme

Current typical AMW 'condition' scope	Potential Deep Energy Retrofit (Enerphit Informed) scope (some or all provisions implemented to varying level)
Roof (replacement with insulation to Bldg. Std.)	Roof replacement + enhanced insulation to Higher or PH std
Window (replacement double glazed)	Window replacement + triple glazed to PH std.
Wall Insulation (not addressed)	Wall insulation to Higher or PH std/air leakage reduction
Underfloor Insulation (not addressed)	If possible, underfloor insulation
Improved mech vent and heat recovery (only replace existing)	Improved Mechanical Ventilation and typically Mechanical Ventilation and heat recovery (MVHR)
External door seal/insulation (not addressed)	External doors potentially improved to PH std
Boiler/mechanical services replacement	Resized heat source, address DHWS efficiency and catering loads, if necessary address low temperature flow temps, provision of LZC primary plant.
Electrical rewire	Electrical rewire, address potential requirement for increased connected load (programming implications)
Solar shading (not addressed)	Potential solar shading requirement

Pilot Study
Presentation Overview

This presentation provides a brief overview of the feasibility study, including:

- Initial site investigations
- Liberton Nursery analysis, options/costs
- Brunstane PS analysis, options/costs
- Prioritised weighting methodology (Investment Decision)
- Quality
- Next steps

Pilot Study , On site investigations

Fan set up at Brunstane Primary School

Eastern wall to Store between Office & Resource Area

Construction Conclusions

- 20mm render
- 100mm outer brick leaf
- No Insulation present (90mm cavity)
- 100mm inner brick leaf
- 20mm plaster

Two buildings selected for the Pilot to take to feasibility 'investment decision' stage.

Liberton Nursery and Brunstane PS

- These were selected as they presented very different challenges
- The initial work included significant building investigation and testing:

  Air leakage pressure testing

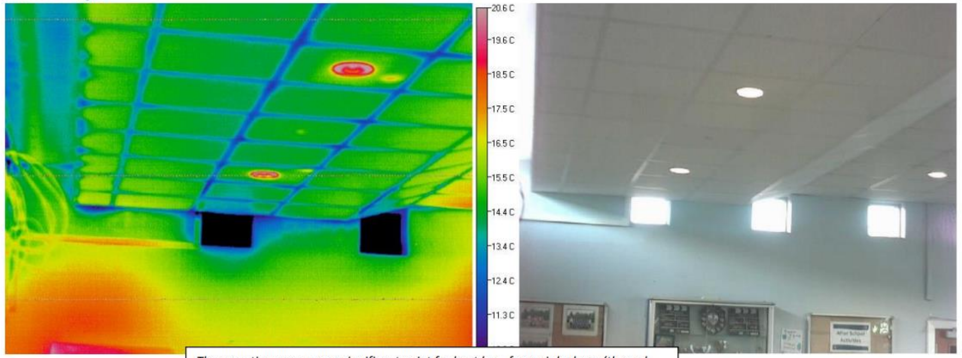
  Opening up to have certainty of main fabric element make up

  Thermal imaging

  Insulation (U value) on site testing

  In addition, where necessary, the buildings were 3D scanned to facilitate the required analysis and minimise on site survey time.

Thermal Images –

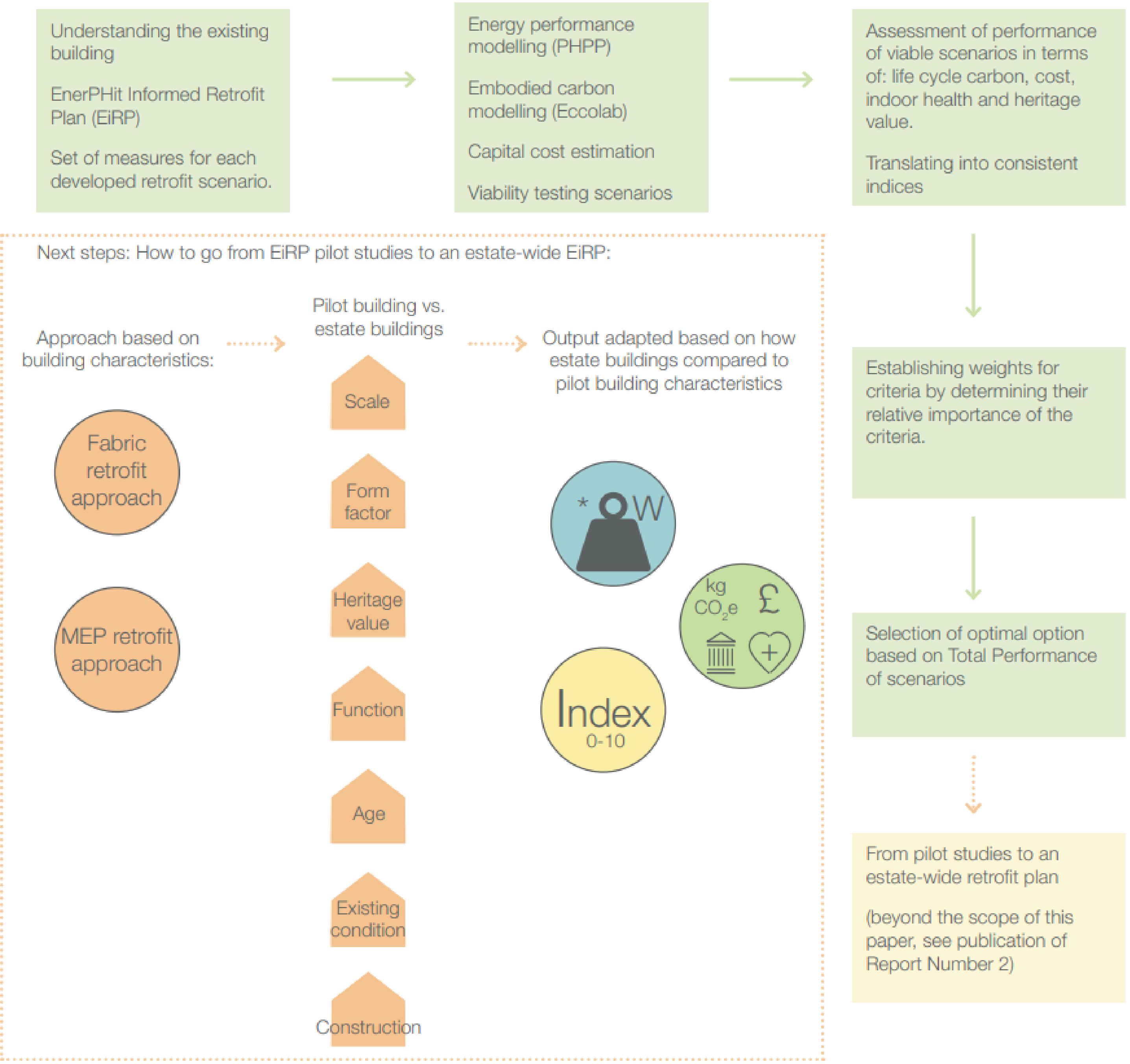


The reception area, was a significant point for heat loss, from air leakage (through suspended ceiling), glazing and uninsulated walls

EnerPHit Informed Pilot Methodology

Following the extensive site investigations the following steps were taken

- Establish reliable thermal/energy performance model PHPP (baselined against existing performance)
- Set out a suite of full interventions for analysis (cost, carbon and thermal performance). Capture in Enerphit Informed Retrofit Plan EiRP.
- Develop a decision making weighting system to balance the competing criteria to provide some consistency of approach to those making the investment decision (Total Performance Index)
- All informing an Investment Decision on which option should be taken forward to design and delivery. This is a CEC decision outside the scope of this feasibility.



Liberton Nursery
Pilot Project No 1
Existing Building Characteristics

This building is of architectural value. While not listed it is located within a conservation area.

Proposed interventions have respected this, targeting the internal envelope for retrofit upgrade measures.

Fig. 55 / View from the south west of the point cloud survey model of Liberton Nursery and surrounding context. This point cloud data was used to build the Revit model, as provided by Multivista.

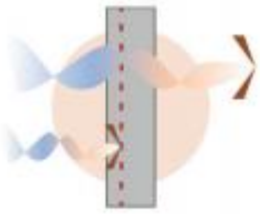
Liberton Nursery

Survey and testing of existing fabric

Key Building Fabric Conclusions

Little to No Insulation

- No wall insulation
- No floor insulation
- Limited roof insulation (none to main roof and assumed none to toilet block, not clear from opening up works)

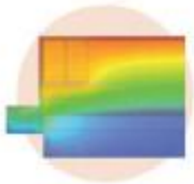


Poor U-Values

- Majority of walls constructed using solid sandstone and rubble infill, poor thermal performance, with lambda value of around 2.3 W/mK.
- Brick walls to rear toilet block of poor thermal performance

Poor Airtightness

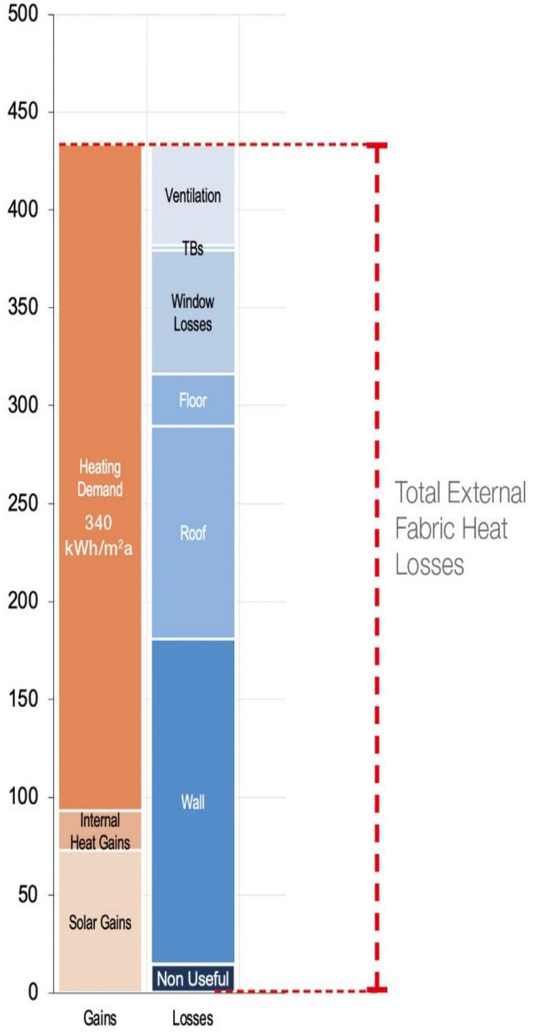
- Air test gave results of air permeability of $13.2m^3/(hm^2)$
- Extensive thermal bridging throughout the building, leaky details around building junctions, window edges etc



Substantial Thermal Bridges

- Significant heat loss through external fabric junctions between windows, walls and roof (although effect negligible in base case given lack of insulation and overall poor U-values)

Liberton Nursery
Heat Losses through External Fabric



Existing Base Case (13.2⁰, Doors closed)

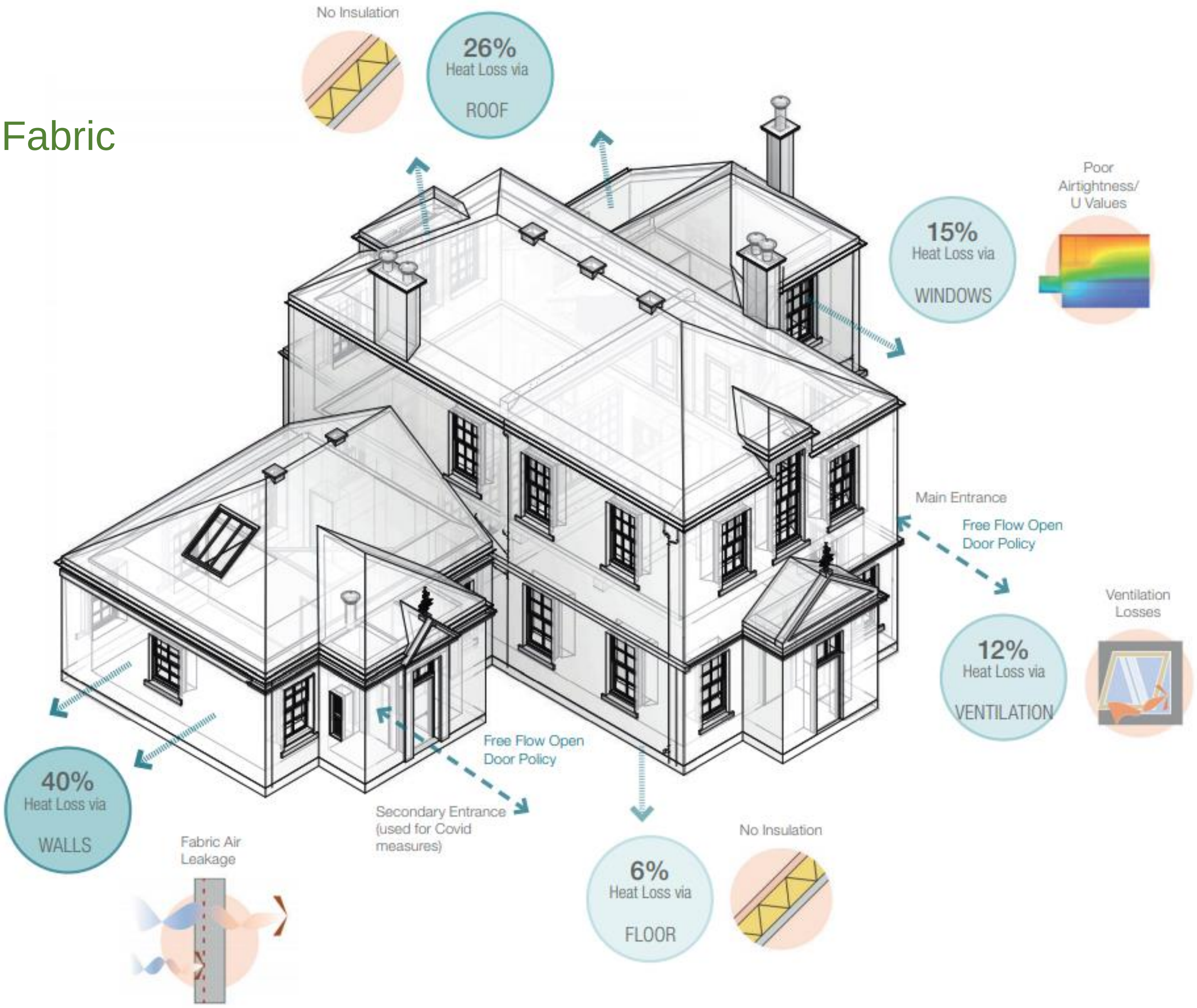
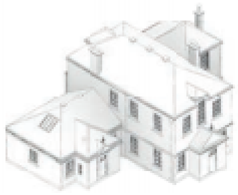


Fig. 109 / Heat loss distribution by building component in Liberton Nursery.

Liberton Nursery

Key PHPP Results – Current compared to full Enerphit

	Liberton Nursery (13.2° av. temp. set point)*		EnerPHit Standard (set at 20°)
	 Liberton Nursery		Typical EnerPHit
Heating Demand	340 kWh/m²a	vs	< 25 kWh/m²a
Heat Load	163 W/m²	vs	<10 W/m²
Airtightness	13.2 m³/hr/m²* or 12.6 ACH	vs	1.06 m³/hr/m²* or < 1 ACH

Liberton Nursery

Comparison of Retrofit Approaches

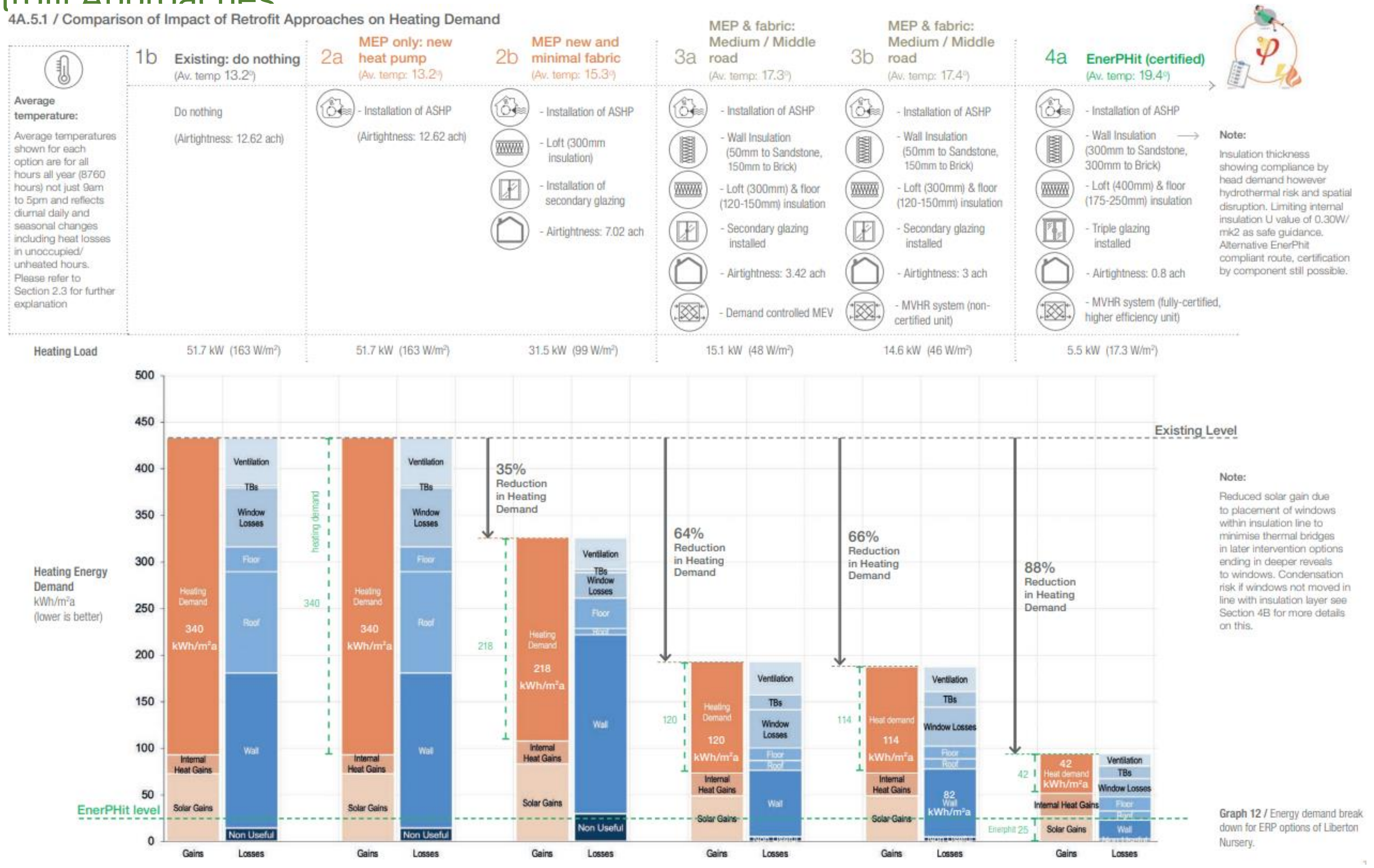
Note:

Internal wall insulation

Insulation approach to be balanced with wall requirement to breathe (interstitial condensation can be a risk)

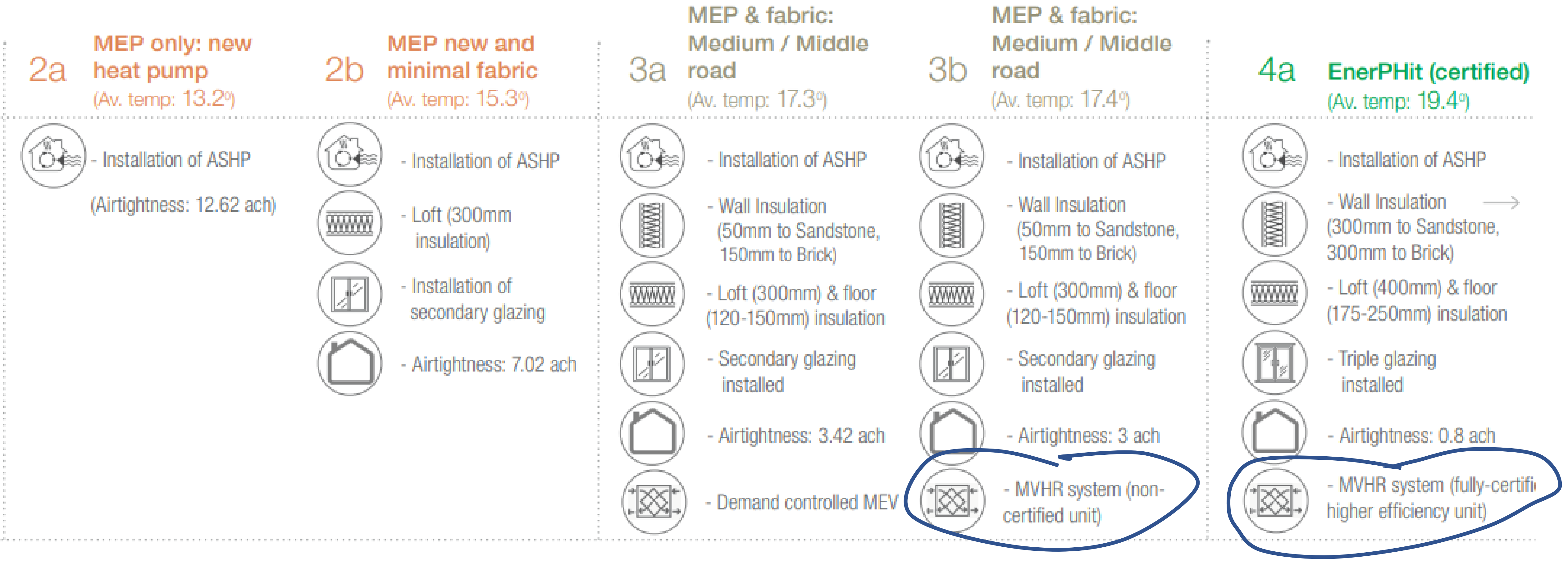
For lesser specifications, secondary glazing has been considered to preserve appearance

Some Enerphit 4a proposals could be impractical (subject to design development)



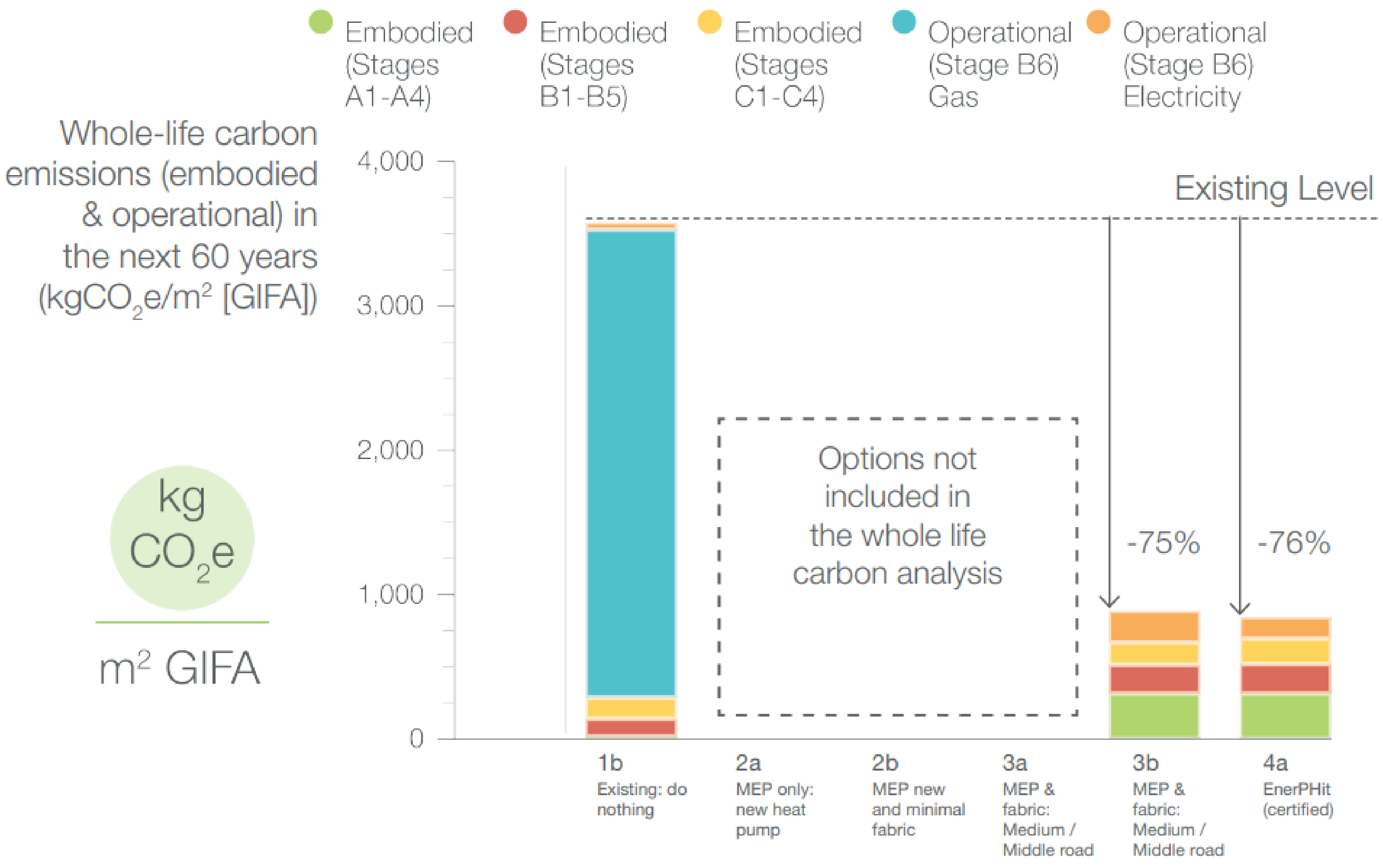
Liberton Nursery

Comparison of Retrofit Approaches (zoom in)



Liberton Nursery

Whole Carbon Analysis (operational+ embodied)



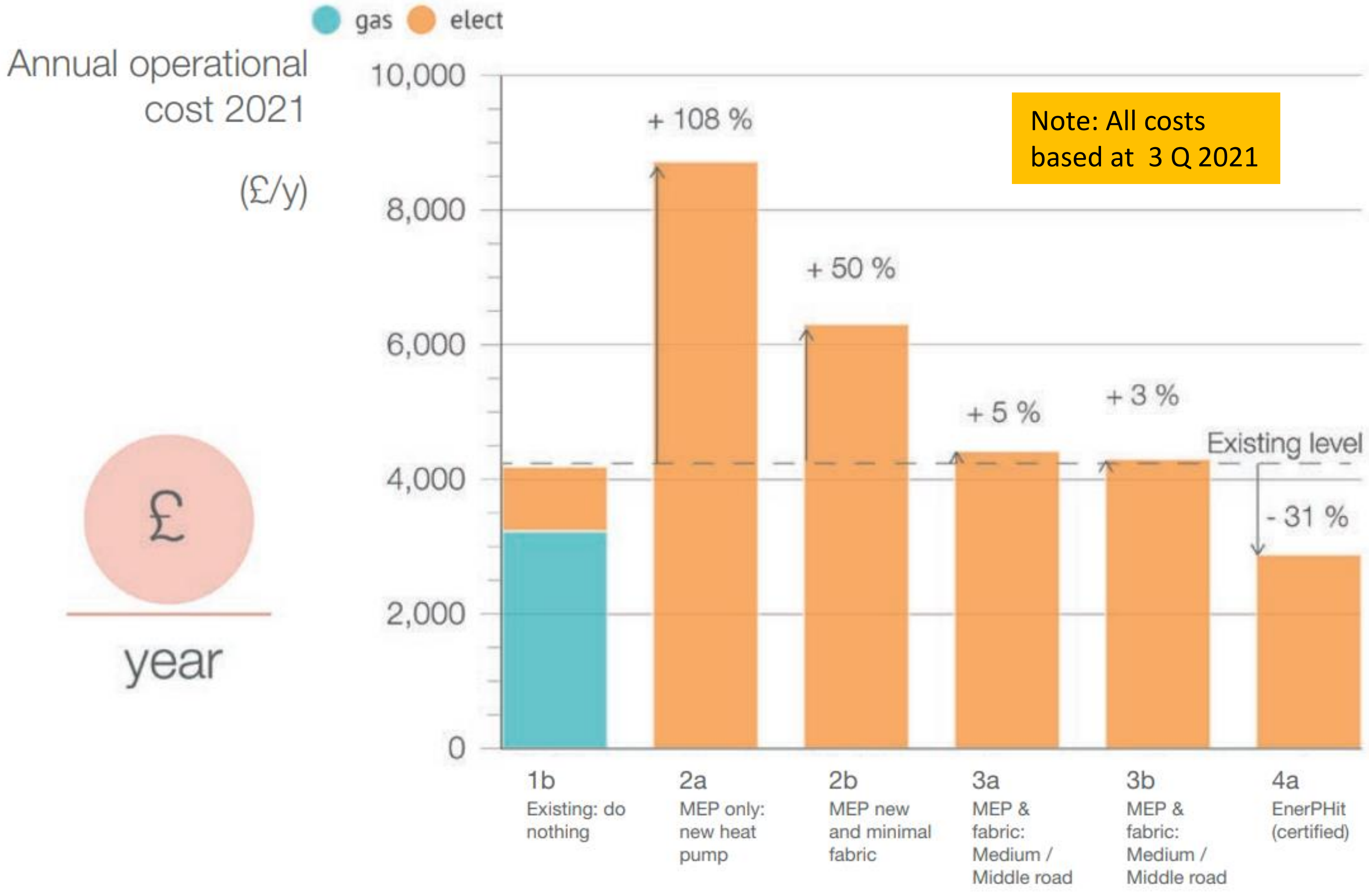
Graph 16 / Whole life carbon emissions over the next 60 years ($kgCO_2e/m^2$/60 years) - Liberton.

Key Results

- Whole life carbon emissions for refurbishment scenarios are almost 75% and 76% lower than scenario 1b, as a result of reduced energy use and the move from gas to electricity.
- The impact of the additional embodied carbon for refurbishment is minimal over the life-cycle emissions of the building.

Liberton Nursery

Operational/Running Costs



Annual running cost snapshot (£/year) for Liberton

Key Results

- Operational costs increase from 1b to 2a.
- Only option 4a 'EnerPHit' shows a considerable improvement in annual energy costs (2021 rates).
- The middle road options (3a / 3b) match the cost of the existing building (1b).

Liberton Nursery
Return on Capital

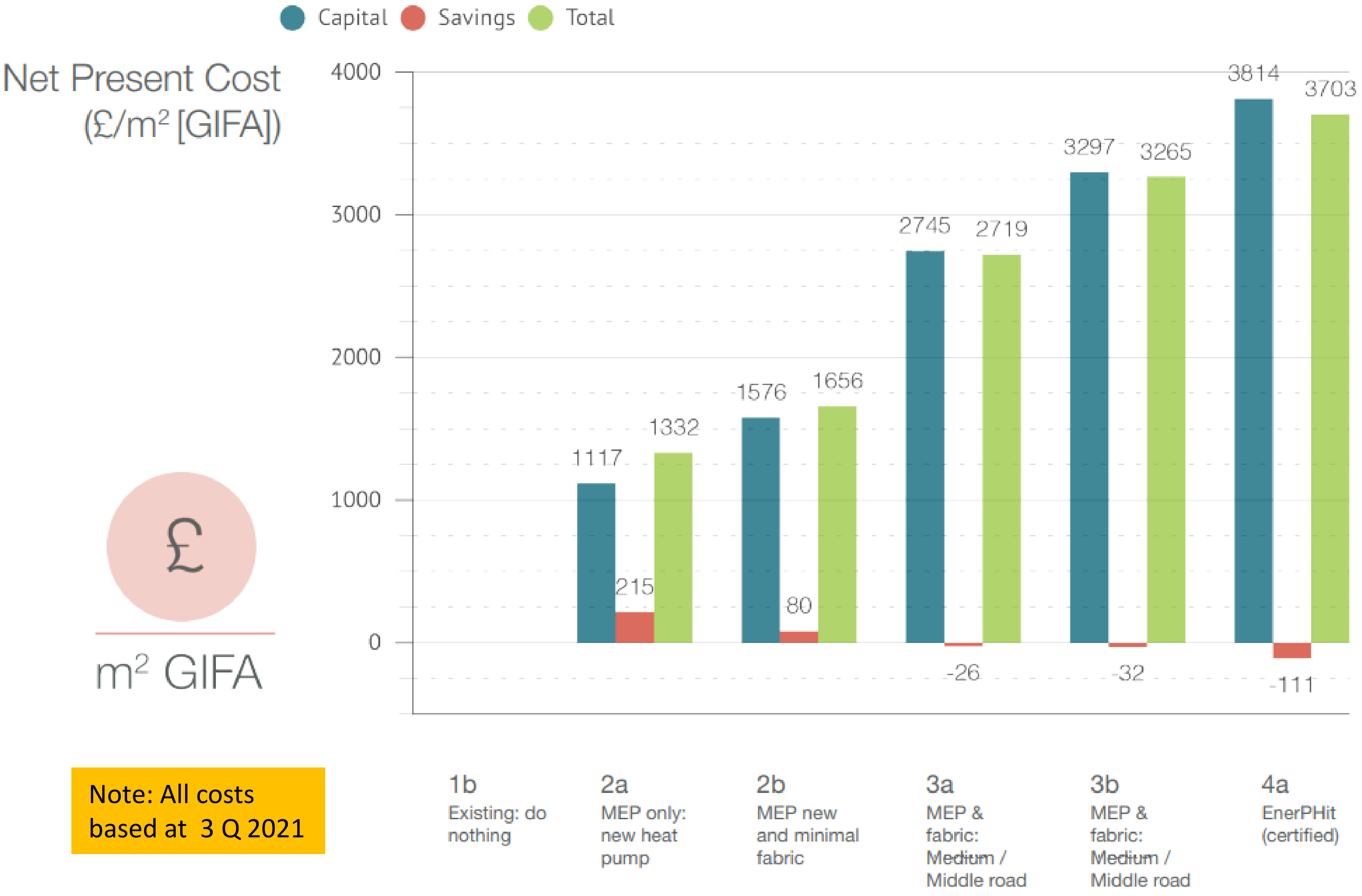
Net Present 30 year costs assessed.

Analysis based on number of assumptions over the period;
3% inflation rates
6% discount rate

There is no allowance for:
Energy tax changes, incentives or tariff changes

A minimal return on capital cost associated with energy costs savings (at current tariffs) can be seen for Options 3a, 3b and 4a. However, based on current energy costs, this is not a building specific return on investment decision, more a carbon decision.

The return on investment is possibly more a global proposition



Note: All costs based at 3 Q 2021

Graph 20 / Net Present Cost of retrofit showing offset of capital investment over the next 30 years (£/ year).

Liberton Nursery (summary)

Note: All costs based at 3 Q 2021

0	1	2	3	4	5	6	7
	Heating Demand *kWh/m²/yr [GIFA]*	Heating Demand Reduction against Baseline *%*	Annual Operational Cost 2021 [2] *£*	Capital Construction Cost [3] *£ and £/m² [GIFA]*	Savings on Annual Operational Cost over 30 years [4] *£/m² [GIFA]*	Reduction in Operational CO_2 Emissions against Baseline [5]	Risk to Indoor health and to Building Fabric [6]
Option 1: Existing, Do Nothing	**340**	**N/A**	**£4,192**	**N/A**	**N/A**	**N/A**	**Unknown**
Option 2A: MEP only (New Heat Pump)	**340**	**0%**	**£8,721 (+108%)**	**£423,000** (£1,117/m²)	**+ £215**	**87%**	**Unknown**
Option 2B: MEP & Minimal Fabric	**218**	**35%**	**£6,304 (+50%)**	**£597,100** (£1,576/m²)	**+ £80**	**90%**	**Unknown**
Option 3A: MEP & Fabric (Middle Road, MEV)	**120**	**64%**	**£4,413 (+5%)**	**£1,040,100** (£2,745/m²)	**£26**	**93%**	**Medium**
Option 3B: MEP & Fabric, (Middle Road, MVHR)	**114**	**66%**	**£4,308 (+3%)**	**£1,249,200** (£3,297/m²)	**£32**	**93%**	**Medium**
Option 4A: EnerPHit (Certified) [7]	**42**	**88%**	**£2,890 (-31%)**	**£1,445,500** (£3,814/m²)	**£111**	**96%**	**Low**

Implications of (2a) MEP only

‘Just deliver option 2a, swap out the boiler for a heat pump’

Option 2a delivers significant decrease in carbon emission as a result in the move for gas to electricity coupled with heat pump CoP

However practical implications should steer the solution away from option 2a:

- Number of heat emitters (x3 same size increase) impacting on useable space.
- Large Heat Pump and thermal store etc with associated space requirements
- Significantly increased energy costs based on current tariffs
- Risk of need for new/increased power supply to building
- Potential impact on grid (city wide impact)
- Occupier Comfort concerns, system response to fluctuating load

While Option 2b has provision for improved building fabric, but this option carries many of the above issues and risks which will vary for any given building.

While potentially more viable Option 2b should still be considered with care.

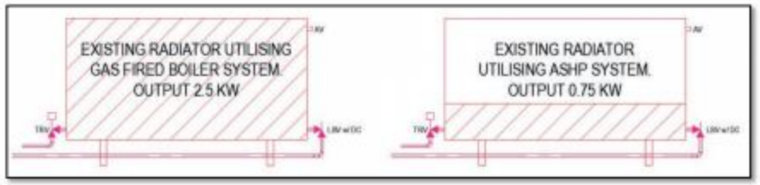
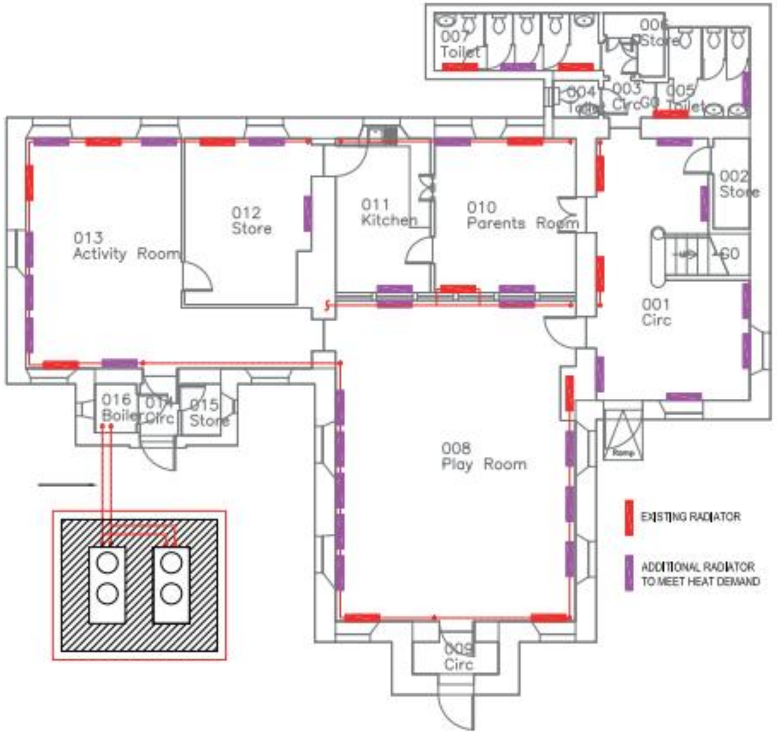


Fig. 40 / Extract from Harley Haddow Information / Example of reduced radiator output with ASHP retrofit.

	Retrofit Options					
	Option 1B	Option 2A	Option 2B	Option 3A	Option 3B	Option 4A
Air Source Heat Pump Required Capacity	N/A	54kW	31.4 kW	8.5kW	8.5kW	6kW
Number of Radiators Required	19 Existing Cast Iron Style	19 Existing and 58 Additional Cast Iron Style	19 Existing and 22 Additional Cast Iron Style	24 New Modern Radiators	24 New Modern Radiators	12 New Modern Radiators

Fig. 41 / Table Extract from Harley Haddow Information / Liberton Nursery Heating D



Brunstane Primary
Existing Building Characteristics

The external fabric at Brunstane Primary is not considered to be of any historic quality and can therefore be considered for upgrade as part of any retrofit works.

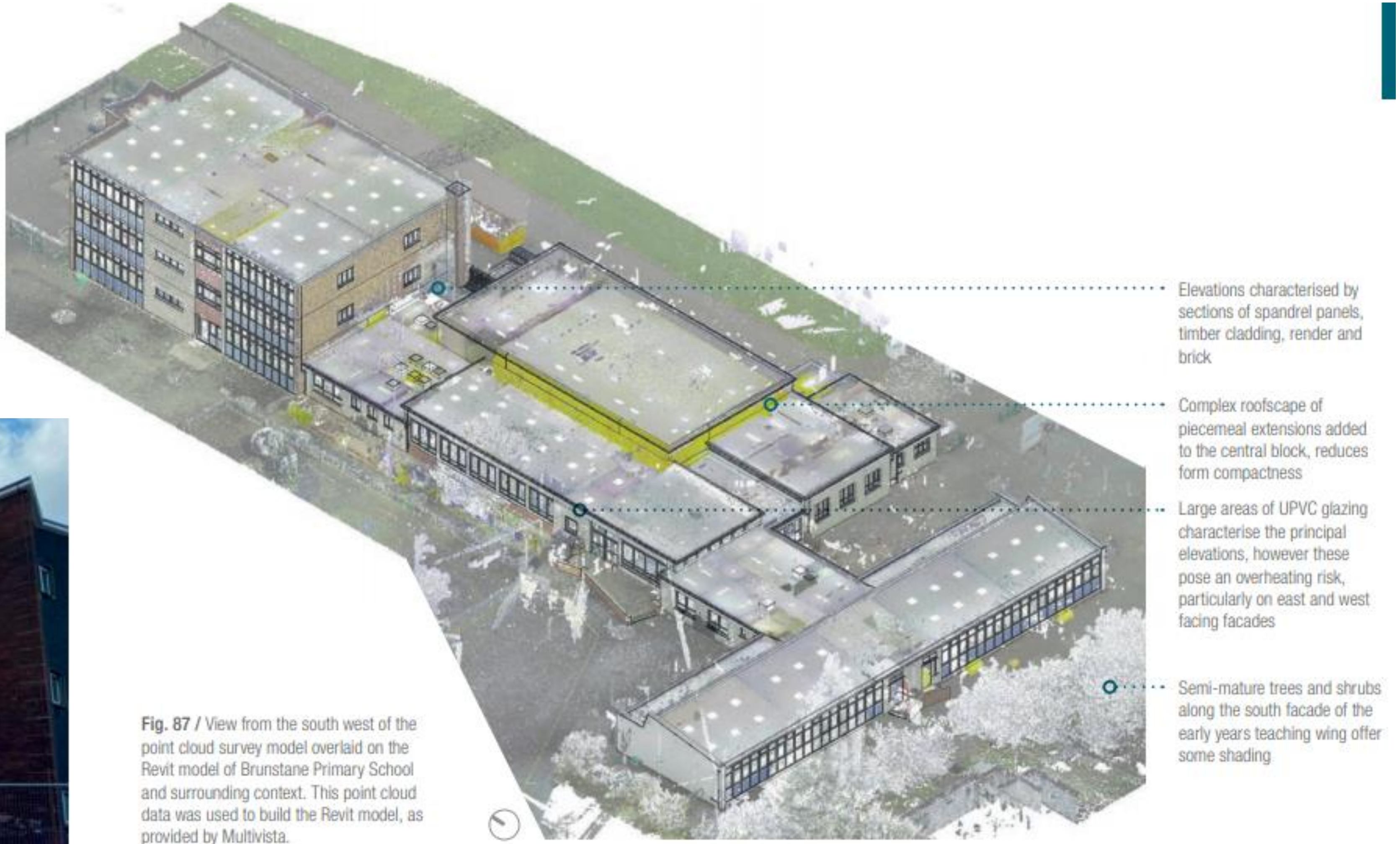


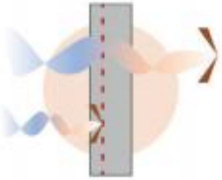
Fig. 87 / View from the south west of the point cloud survey model overlaid on the Revit model of Brunstane Primary School and surrounding context. This point cloud data was used to build the Revit model, as provided by Multivista.

Brunstane Primary
Survey and testing of existing fabric

Key Building Fabric Conclusions

Little to No Insulation

- No wall insulation
- No floor insulation
- Limited roof insulation - some recently installed to tower block roof, minimal insulation between joists elsewhere

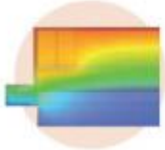


Poor U-Values

- Uninsulated brick cavity walls give poor U-Value of 1.4 W/m²K.
- Uninsulated floors offers poor thermal performance, giving U-Value of around 1.9 W/m²K in suspended timber floor areas and around 3.9 W/m²K for the solid concrete floor in the stair core areas
- Minimal insulation to single storey roof areas gives poor U-Value of around 1.3 W/m²K.

Poor Airtightness

- Air test gave results of air permeability of $13.2m^3/(hm^2)$
- High air infiltration through roof and suspended ceiling zones
- Poor seals, high air leakage around window frames and services penetrations

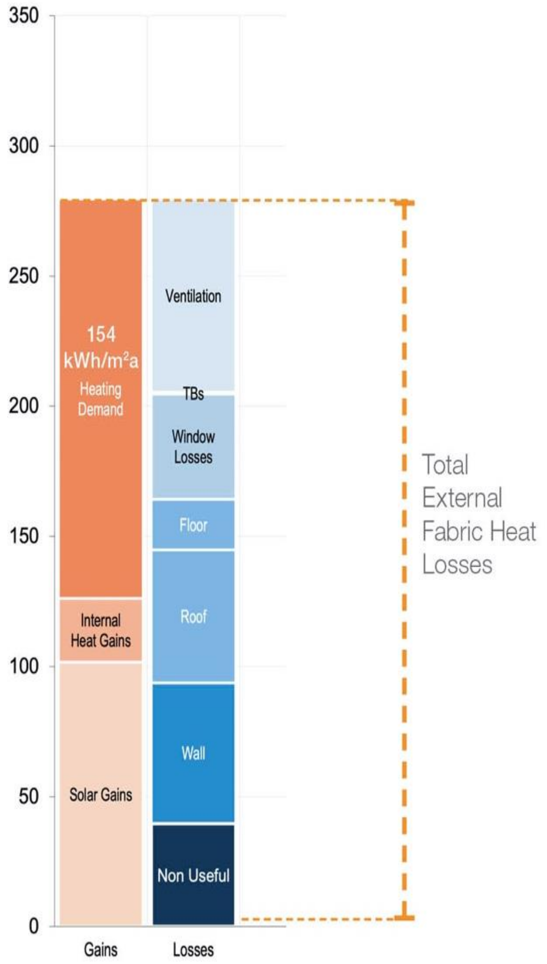


Substantial Thermal Bridges

- Significant heat loss through external fabric and particularly at junctions between windows, walls and roof (although effect negligible in base case given lack of insulation and overall poor U-values)

Brunstane Primary

Heat Losses Through External Fabric



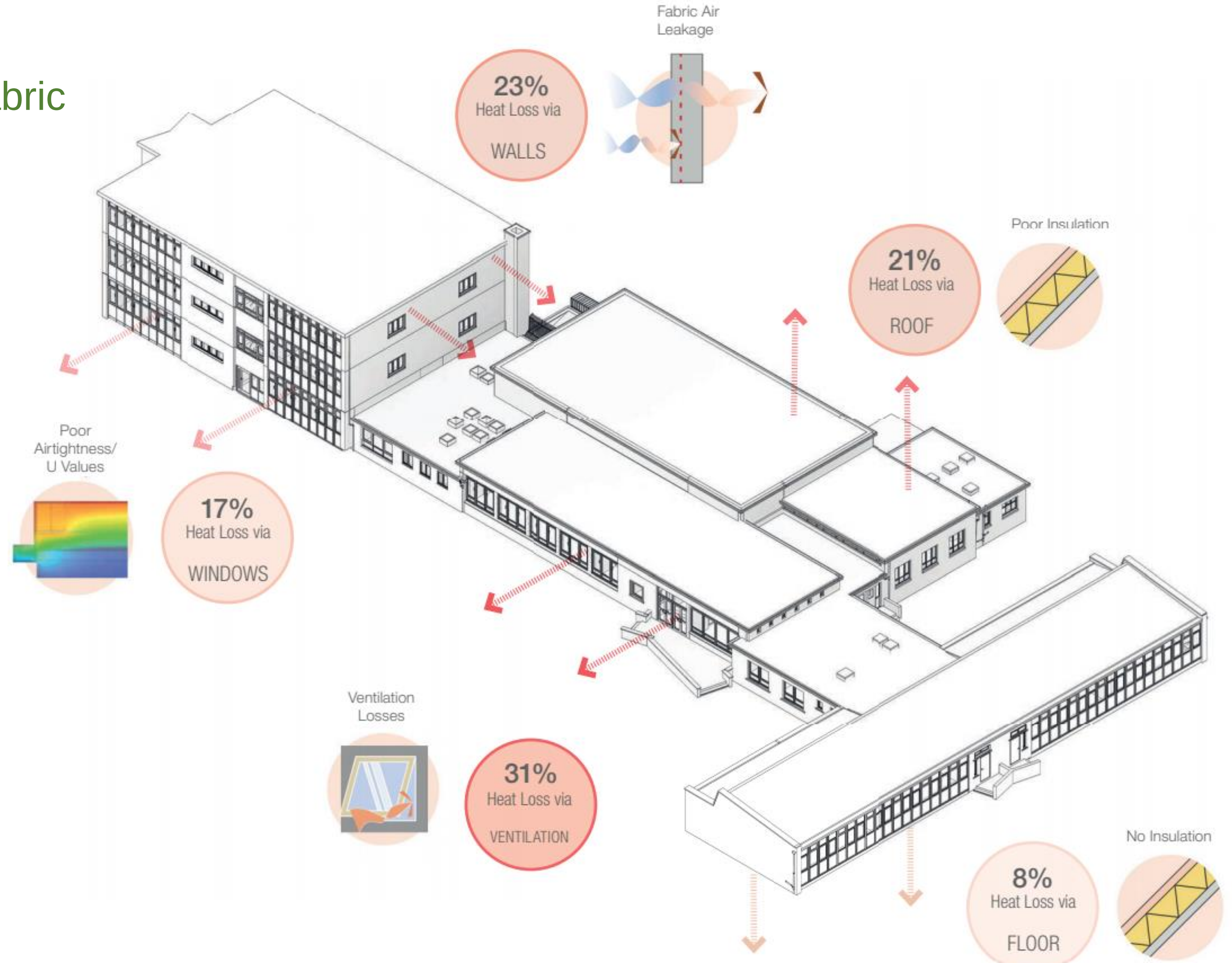


Fig. 133 / Heat loss break down for Brunstane Primary school.

Brunstane Primary

Key PHPP Results – Current compared to full Enerphit

	Brunstane Primary (15^0 av. temp. set point)*		EnerPHit Standar (set at 20^0)
	Brunstane Primary	vs	Typical EnerPHit
Heating Demand	154 kWh/m^2a	vs	< 25 kWh/m^2a
Heat Load	88 W/m^2	vs	<10 W/m^2
Airtightness	12 m^3/hr/m^2* or 9.6 ACH	vs	1.06 m^3/hr/m^2* or < 1 ACH

Brunstane Primary

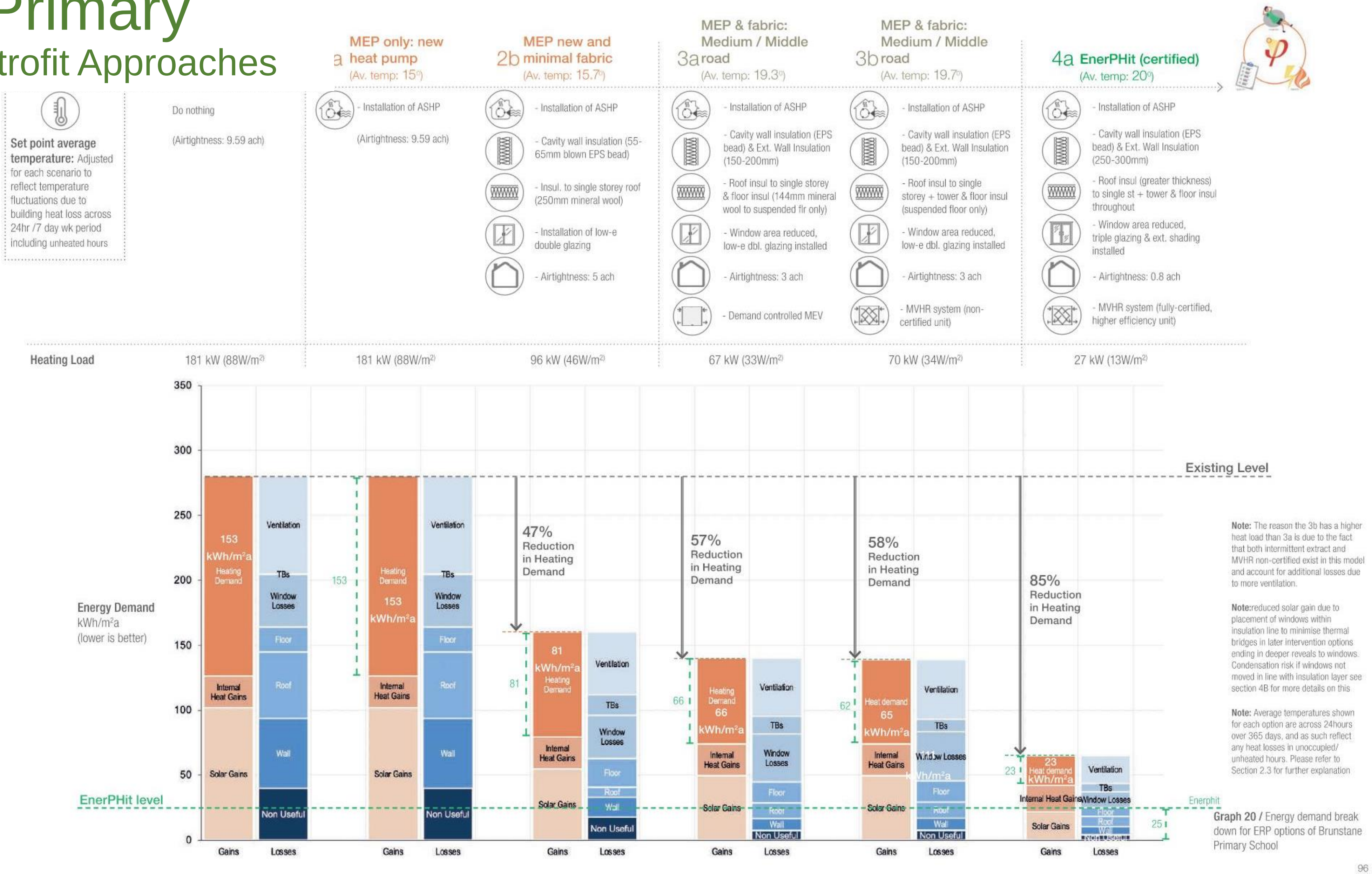
Comparison of Retrofit Approaches

Note:

External wall insulation

Potential to reduce overall window area and provision of low-e glazing to address reported overheating issues

For airtightness of 3 and below MVHR required. Also addresses classroom ventilation concerns.



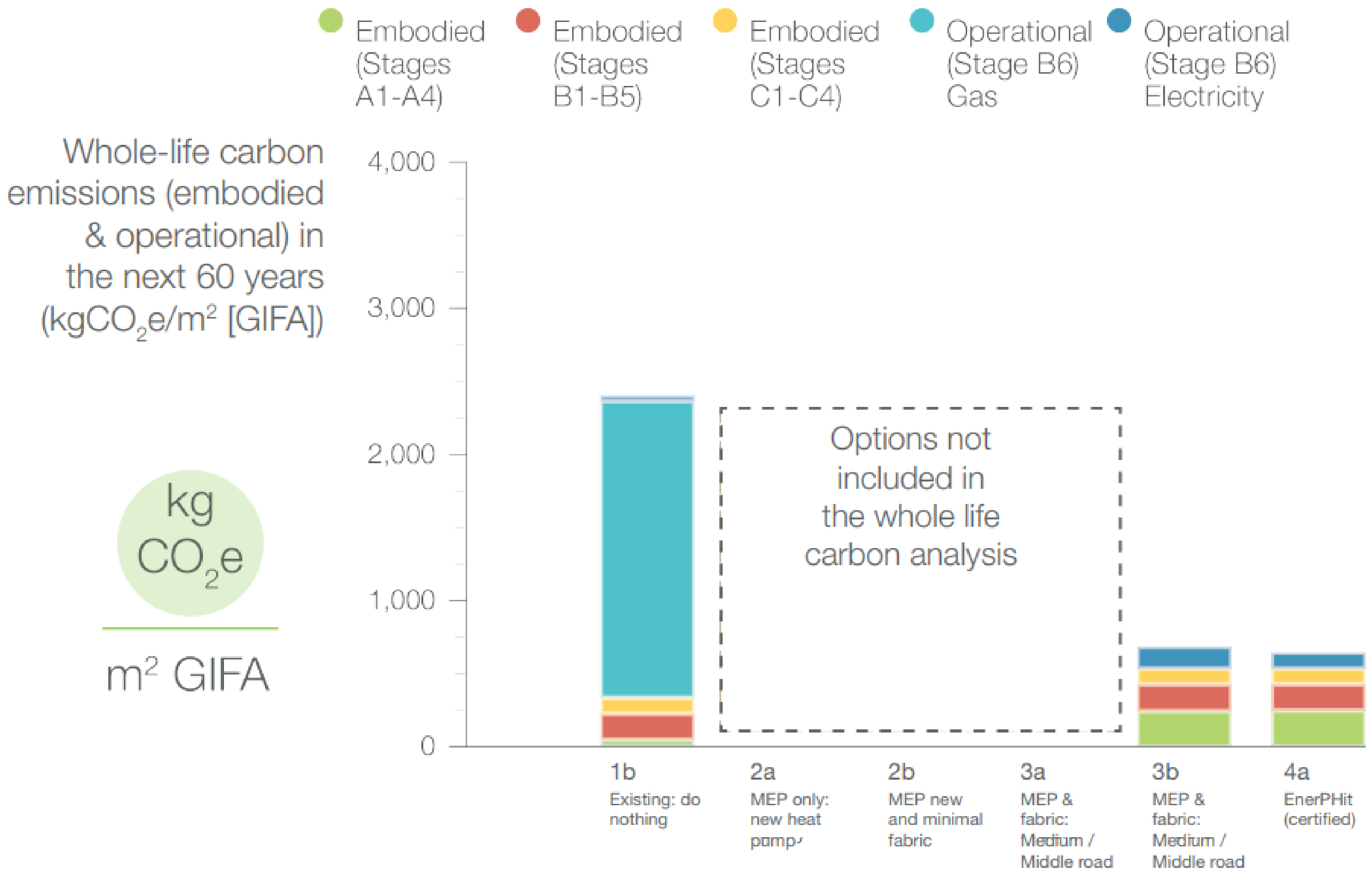
Brunstane Primary

Comparison of Retrofit Approaches (zoom in)

2a MEP only: new heat pump (Av. temp: 15⁰)	2b MEP new and minimal fabric (Av. temp: 15.7⁰)	3a MEP & fabric: Medium / Middle road (Av. temp: 19.3⁰)	3b MEP & fabric: Medium / Middle road (Av. temp: 19.7⁰)	4a EnerPHit (certified) (Av. temp: 20⁰)
- Installation of ASHP	- Installation of ASHP	- Installation of ASHP	- Installation of ASHP	- Installation of ASHP
(Airtightness: 9.59 ach)	- Cavity wall insulation (55-65mm blown EPS bead)	- Cavity wall insulation (EPS bead) & Ext. Wall Insulation (150-200mm)	- Cavity wall insulation (EPS bead) & Ext. Wall Insulation (150-200mm)	- Cavity wall insulation (EPS bead) & Ext. Wall Insulation (250-300mm)
	- Insul. to single storey roof (250mm mineral wool)	- Roof insul to single storey & floor insul (144mm mineral wool to suspended flr only)	- Roof insul to single storey + tower & floor insul (suspended floor only)	- Roof insul (greater thickness) to single st + tower & floor insul throughout
	- Installation of low-e double glazing	- Window area reduced, low-e dbl. glazing installed	- Window area reduced, low-e dbl. glazing installed	- Window area reduced, triple glazing & ext. shading installed
	- Airtightness: 5 ach	- Airtightness: 3 ach	- Airtightness: 3 ach	- Airtightness: 0.8 ach
		- Demand controlled MEV	- MVHR system (non-certified unit)	- MVHR system (fully-certified, higher efficiency unit)

Brunstane Primary

Whole Carbon Analysis (operational+ embodied)

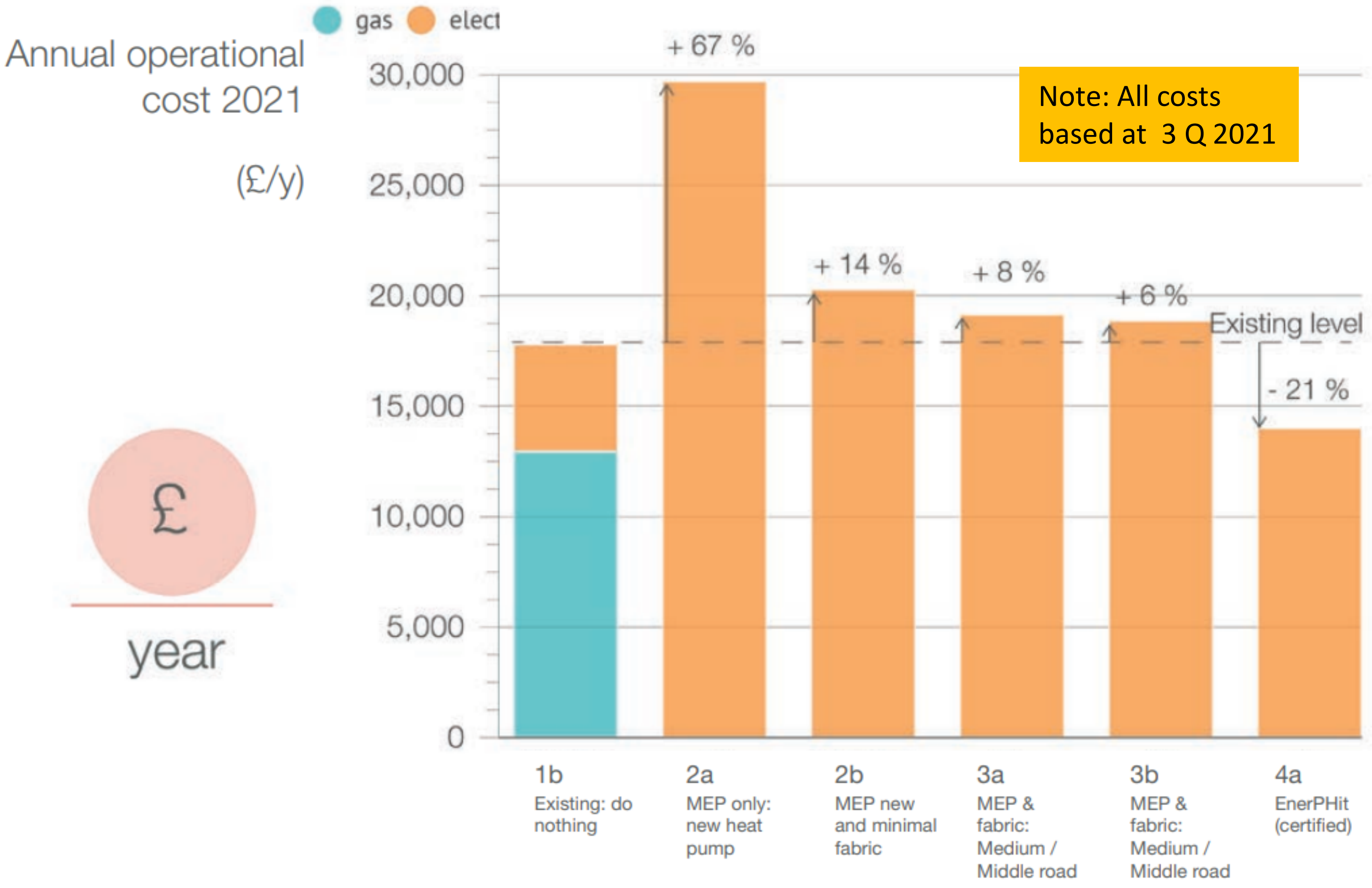


Graph 27 / Whole life carbon emissions over the next 60 years ($kgCO_2e/m^2$/60 years) - Brunstane Primary

Key Results

- Whole life carbon emissions for refurbishment scenarios are almost 72% and 73% lower than scenario 1b, as a result of reduced energy use and the move from gas to electricity.
- The impact of the additional embodied carbon for refurbishment is relatively small over the life-cycle emissions of the building, when compared to the operational carbon emissions.

Brunstane Primary
Operational/running Costs



Graph 26 / Annual running cost 2021 snapshot (£/ year) for Brunstane Primary.

Key Results

- Running costs increase from Option 1b to 2a by 67%
- Costs reduce significantly between options 2a and 2b, and continue to decrease for the middle road options (3a / 3b).
- The annual operational cost for option 4a 'EnerPHit' is 21% cheaper that the existing building.

Brunstane Primary

Return on Capital

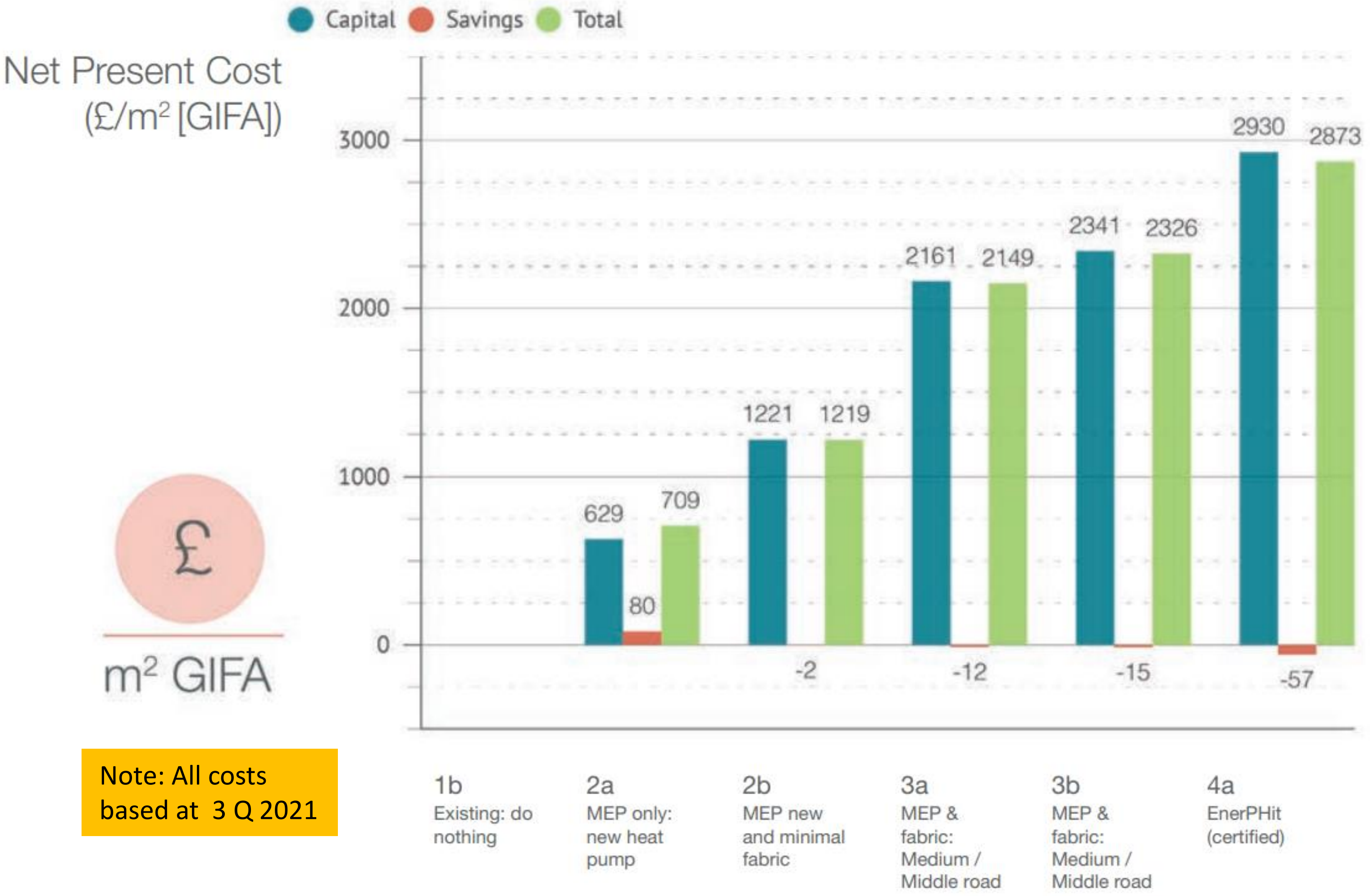
Net Present 30 year costs assessed.

Analysis based on number of assumptions over the period;
3% inflation rates
6% discount rate

There is no allowance for energy tax changes, incentives or tariff changes

A small return on capital cost associated with energy costs savings (at current tariffs) can be seen for Options 2b, 3a, 3b and 4a. However based on current energy costs, this is not a building specific return on investment decision, more a carbon decision.

The return on investment is possibly more a global proposition.



Note: All costs based at 3 Q 2021

Graph 28 / Net Present Cost of retrofit showing offset of capital investment for Brunstane over the next 30 years (£/ 30 years).

Brunstane Primary (summary)

Note: All costs based at 3 Q 2021

0	1	2	3	4	5	6	7
	Heating Demand	Heating Demand Reduction against Baseline	Annual Operational Cost 2021	Capital construction Cost	Savings on Annual Operational Cost over 30 years	Reduction in Operational CO_2 Emissions against Baseline	Risk to Indoor health and to Building Fabric
	kWh/m²/yr [GIFA]	*%*	*£*	*£ and £/m² [GIFA]*	*£/m² [GIFA]*		
Option 1: Existing, Do Nothing	**154**	**N/A**	**£17,789**	**N/A**	**N/A**	**N/A**	**Unknown**
Option 2A: MEP only (New Heat Pump)	**154**	**0%**	**£29,702 (+67%)**	**£1,518,100 (£629/m²)**	**+ £80**	**89%**	**Unknown**
Option 2B: MEP & Minimal Fabric	**81**	**47%**	**£20,277 (+14%)**	**£2,947,500 (£1,220/m²)**	**£2**	**92%**	**Unknown**
Option 3A: MEP & Fabric (Middle Road, MEV)	**66**	**57%**	**£19,135 (+8%)**	**£5,221,500 (£2,161/m²)**	**£12**	**93%**	**Medium**
Option 3B: MEP & Fabric, (Middle Road, MVHR)	**65**	**58%**	**£18,849 (+3%)**	**£5,657,500 (£2,341/m²)**	**£15**	**93%**	**Medium**
Option 4A: EnerPHit (Certified)	**23**	**85%**	**£13,994 (-21%)**	**£7,080,900 (£2,930/m²)**	**£57**	**95%**	**Low**

Brunstane Primary (MEP comparisons)

MEP Intervention Comparison

	1b Existing: do nothing	2a MEP Only: new heat pump	2b MEP new and minimal fabric	3a MEP & fabric: Medium / Middle Road	3b MEP & fabric: Medium / Middle Road	4a EnerPHit (certified)
MEP Strategy	Natural Ventilation + Extract	MEV	MEV	MEV	MVHR (Std spec)	MVHR (PH Certified)
Litre/Second/Person	Unknown	101 l/s/p	101 l/s/p	8 l/s/p (consideration will be given during design for boost capacity)	8 l/s/p (consideration will be given during design for boost capacity)	6 l/s/p (consideration will be given during design for boost capacity)
Distribution Method	Natural ventilation, passive vents & extract	Natural ventilation, passive vents & extract	Natural ventilation, passive vents & extract	Demand Controlled MEV	De-centralised (localised extract)	Centralised
BB101 Compliant	✗	✗	✗	✓	✓	✓
Unit Size	NA					
Heating Load	181 kW (88 W/m²)	181 kW (88 W/m²)	96 kW (46 W/m²)	67 kW (33 W/m²)	70 kW (34 W/m²)	27 kW (13 W/m²)
Radiators	84 Existing (Cast Iron)	256 Existing + New (Cast Iron)	146 Existing + New (Cast Iron)	102 New (Modern)	102 New (Modern)	61 New (Modern)
Airtightness @50 Pa	9.6 ach	9.6 ach	5 ach	3 ach	3 ach	0.8 ach
Heating Demand	154 kWh/m²a	154 kWh/m²a	81 kWh/m²a	66 kWh/m²a	65 kWh/m²a	23 kWh/m²a
Average Temperature *	15 °C	15 °C	15.7 °C	19.3 °C	19.6 °C	19.4 °C

Key Conclusions

- Option 2a, the 'MEP Only' option indicates the huge size of ASHP which would need to be installed to meet the building's current demand, illustrating how impractical this option would be
- Options 3a & 3b start to show better investment value, offering BB101 level ventilation rates with much smaller ASHPs required

Decision Making Tool

Total Performance Index

The EiRP sets out numerous options with associated key criteria to be considered (user comfort, cost, carbon etc)

The feasibility report does not make a direct Investment Decision recommendation. Only illustrates process.

A methodology has been developed to assist in making consistent investment decisions (Total Performance Index)

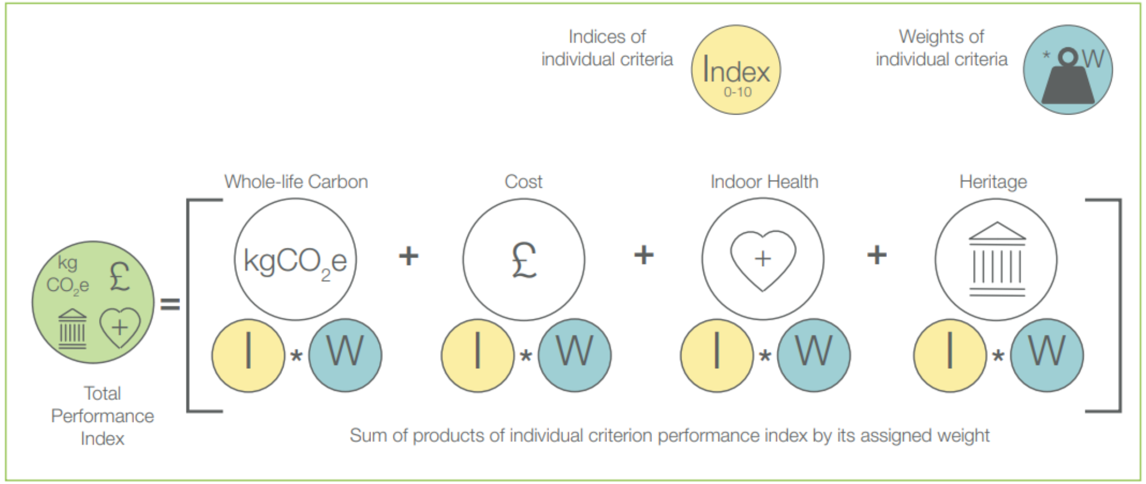


Fig. 181 / Selecting the optimal EiRP scenario.
Refer to Sections 2.7 & 2.11 for further details regarding the calculation method used to arrive at the TPI.

CEC have to determine priorities (weightings)

Example of Liberton calculation
Based on following weightings

Comfort	20
Lifecycle carbon	20
Running costs	20
Capital cost	15
Heritage impact	10
Fabric risk	10
User Disruption	5
Total	100

		Overheating and thermal comfort	CO2 and Ventilation rates	Indoor air quality	Daylighting	* Lifecycle * Lifecycle carbon (Operational and embodied)	Running cost	Capital cost	Conservation of heritage value	Minimised risk to fabric integrity	Minimised user disruption	Total
Index	Index (1 -10)											
	1b "Do nothing"	1.0	1.0	1.0	5.0	1.00	7.99	10.00	3.0	2.0	8.0	
	2a "MEP only"	2.0	2.0	2.0	5.0	6.02	1.00	7.22	1.0	1.0	3.0	
	2b "Do minimum"	4.0	4.0	2.0	5.0	6.02	4.73	6.08	6.0	3.0	6.0	
	3a "Middle road"	6.0	8.0	6.0	5.0	9.58	7.65	3.48	10.0	8.0	5.0	
	3b "Middle road"	9.0	10.0	9.0	5.0	9.78	7.81	2.11	9.0	10.0	5.0	
	4a "EnerPHit"	10.0	10.0	10.0	5.0	10.00	10.00	1.00	6.0	9.0	4.0	
Weights (determined by CEC)	100-point allocation	5	5	5	5	20	20	15	10	10	5	100
	(calculated from '100-point	0.05	0.05	0.05	0.05	0.2	0.2	0.15	0.1	0.1	0.05	1
Performance Index	Weighted Index (Weight * Performance Index)											TPI
	1b "Do nothing"	0.05	0.05	0.05	0.25	0.20	1.60	1.50	0.30	0.20	0.40	4.60
	2a "MEP only"	0.10	0.10	0.10	0.25	1.20	0.20	1.08	0.10	0.10	0.15	3.39
	2b "Do minimum"	0.20	0.20	0.10	0.25	1.20	0.95	0.91	0.60	0.30	0.30	5.01
	3a "Middle road"	0.30	0.40	0.30	0.25	1.92	1.53	0.52	1.00	0.80	0.25	7.27
	3b "Middle road"	0.45	0.50	0.45	0.25	1.96	1.56	0.32	0.90	1.00	0.25	7.63
	4a "EnerPHit"	0.50	0.50	0.50	0.25	2.00	2.00	0.15	0.60	0.90	0.20	7.60

Fig. 51 / Calculating the Total Performance Index - Applying the formula (based on Liberton Nursery calculation spreadsheet)

Total Performance Index

Liberton Nursery (illustrative outcome based on weightings)

Based on following weightings

Comfort	20
Lifecycle carbon	20
Running costs	20
Capital cost	15
Heritage impact	10
User Disruption	5
Total	100

The Total Performance Index in this case points to 3b.

However the close ratings of 3a and 4a indicate the sensitivity of the result to small changes in subjective criteria performance assessments or the above weightings

Note: All costs based at 3 Q 2021

Graph 19 / 'Total performance index'* for all retrofit options of Liberton Nursery.

Total Performance Index

Brunstane (illustrative outcome based on weightings)

Based on following weightings

Comfort	20
Lifecycle carbon	20
Running costs	20
Capital cost	15
Heritage impact	10
User Disruption	5
Total	100

The Total Performance Index points to full Enerphit 4a.

Again, the close ratings of 3a and 3b indicate the sensitivity of the result to small changes in subjective criteria performance assessments or the above weightings

Note: All costs based at 3 Q 2021

Graph 30 / 'Total performance index'* for all retrofit options of Brunstane Primary.

Compliance

Certified Enerphit benefits from a rigorous quality compliance process

Consideration has been given to adopting a suitable approach across lesser options. Aim will be to adopt compliance check workflow.

Aim to show the integration of consultants, quality assurance roles and ‘clients’ within the development process in a circular collaborative manner.

Clear lines of responsibility are required between each party’s workflow.

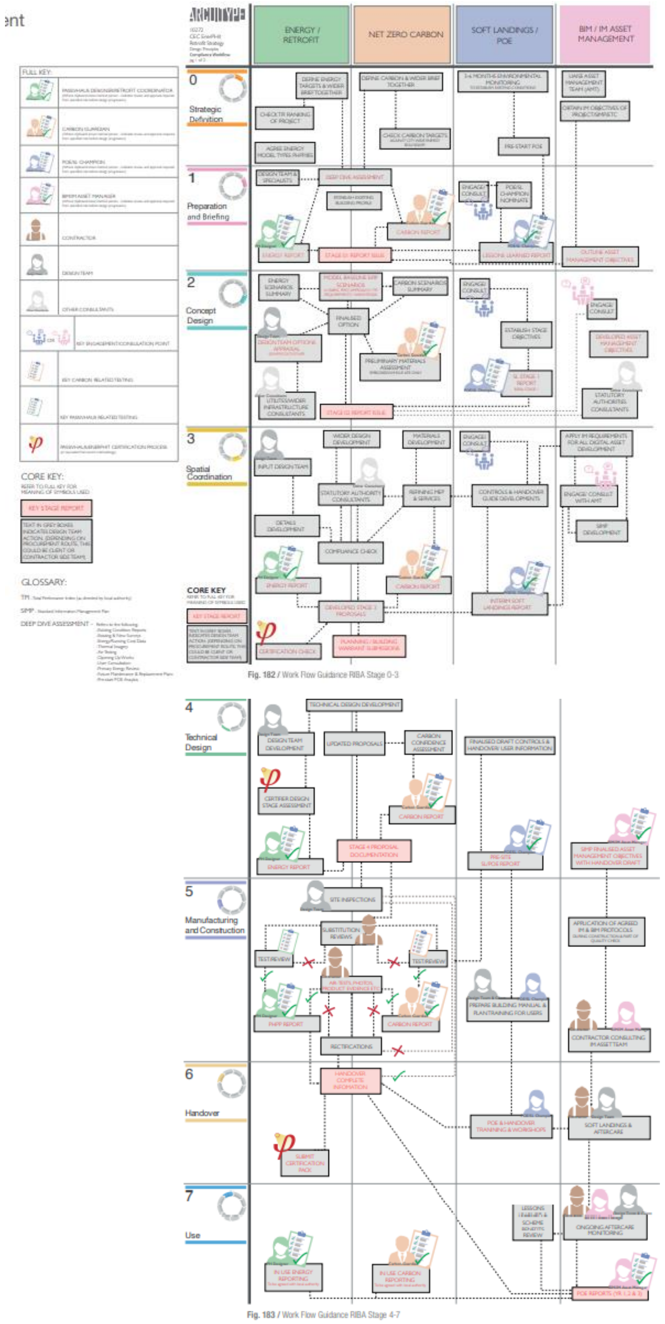
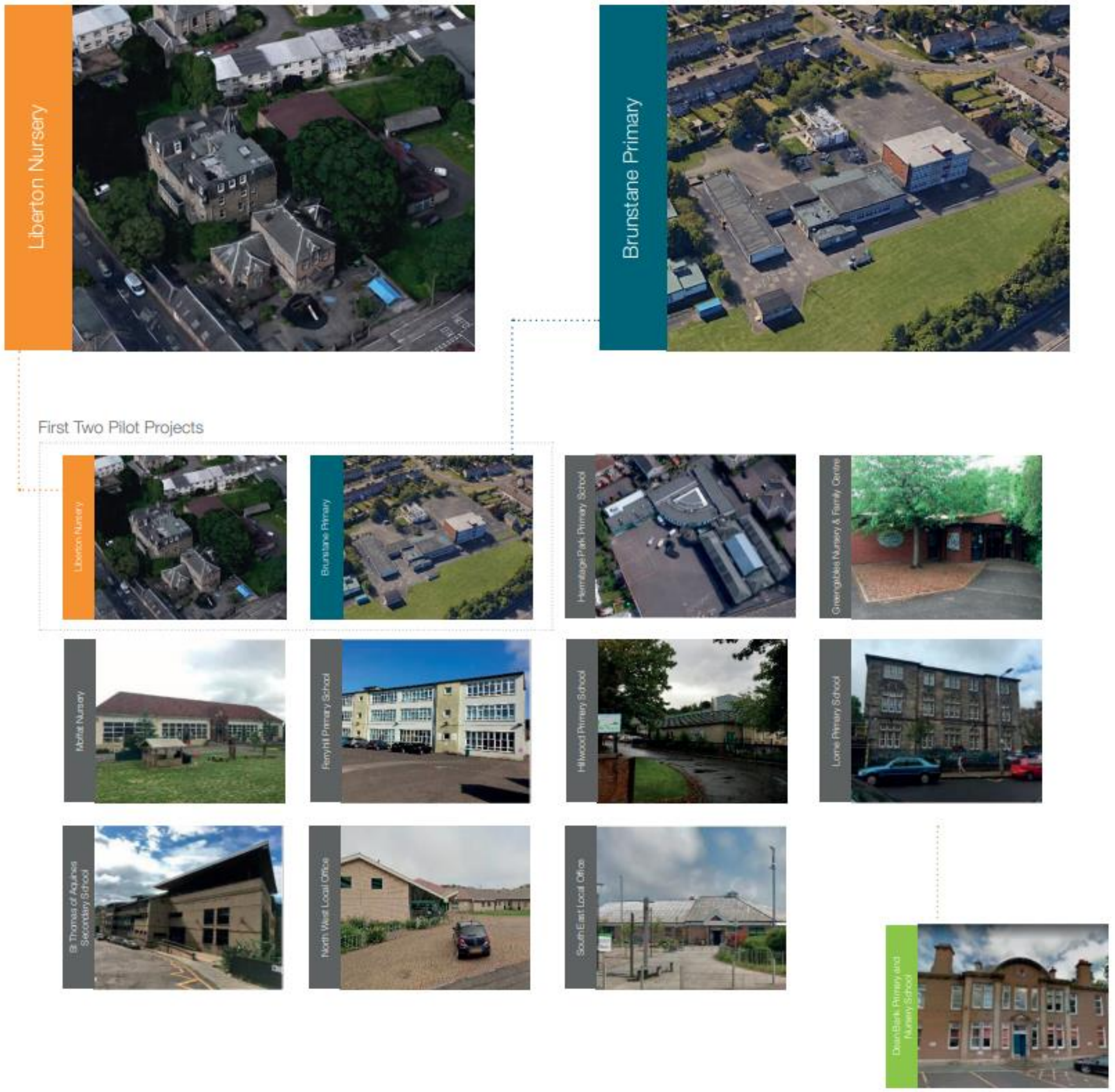


Fig. 182 / Work Flow Guidance RIBA Stage 0-3

Fig. 183 / Work Flow Guidance RIBA Stage 4-7

Next Steps

- A further 10 properties were taken to Enerphit informed Retrofit feasibility stage to allow CEC investment decision
- CEC made an informed investment decision, on the back of Green Growth Accelerator funding case to take two buildings to full delivery.
- Scottish Futures Trust are expected to issue their Net Zero Public Sector Building Standard for Existing Buildings in coming months. This is expected to capture an Operational Energy Target for retrofits. This will also inform the investment decision process.
- Experience to date indicates that full Enerphit is difficult to justify particularly in view of current price inflation and in the case of schools where decant is a serious consideration.
- The Net Zero initiative is also now an estate optimisation driver



NZC building heat options

Heat pumps (air or ground sourced) are the currently recognised viable LZC primary plant technology.

Costs for properly considered installations demonstrate a level of incompatibility of heat pumps with existing buildings without significant fabric and MEP interventions.

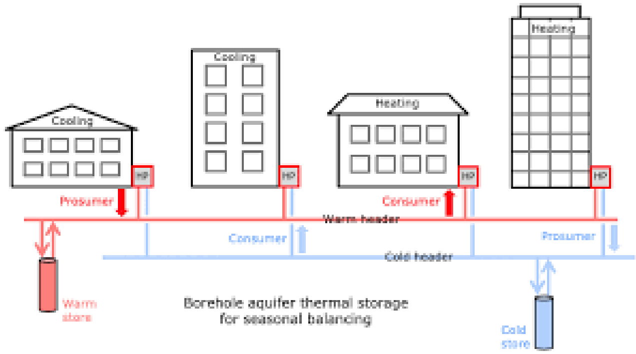
Heat Networks will offer a viable solution where they can be economically and efficiently delivered, but their deployment is still at early initiation stage

Hydrogen, a 100% Hydrogen network is said to be at least 15 years away. But Blue Hydrogen is receiving big push for earlier delivery over the network. Blue Hydrogen is a contentious solution for building heating.

IF (arguably a big IF) Low or Zero Carbon Hydrogen can be economically delivered it could offer a cost effective decarbonising route for building heat. H2 boilers can directly replace existing natural gas boilers from a performance perspective. Possibly biggest potential would be on buildings were significant fabric interventions would be deemed inappropriate.

Any approach to the estate will evolve with emerging technologies.

It is expected that a **'no regret approach'** would be to embrace energy reduction/fabric improvement regardless of heating technology deployed.

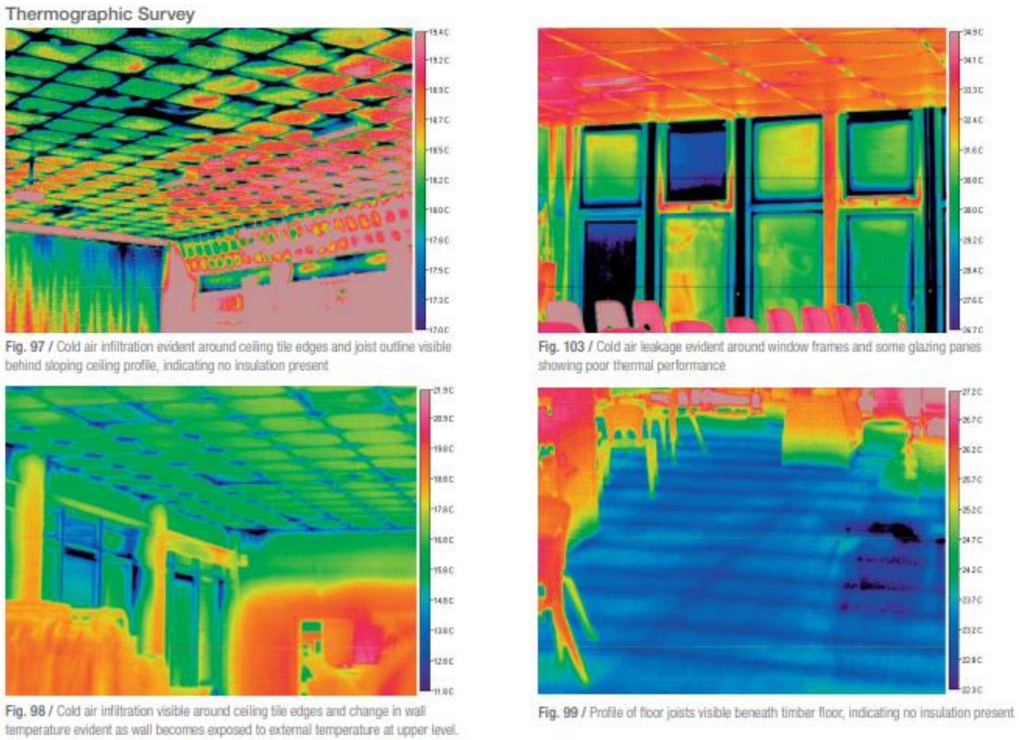


Collaborative Working

CEC have established a Passivhaus Delivery Forum, currently 7 other Scottish Local Authorities attend.

3 of the above 6 Authorities are planning to undertake feasibility work in same Enerphit Informed basis. The plan is to share findings adding to the pooled data set

Edinburgh Partnership Board (Public Buildings collaboration forum)



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