City of Edinburgh Council's steps towards Net Zero Operational Estate (the story so far)

APSE

Building and Housing Services seminar

Glasgow

February 2024

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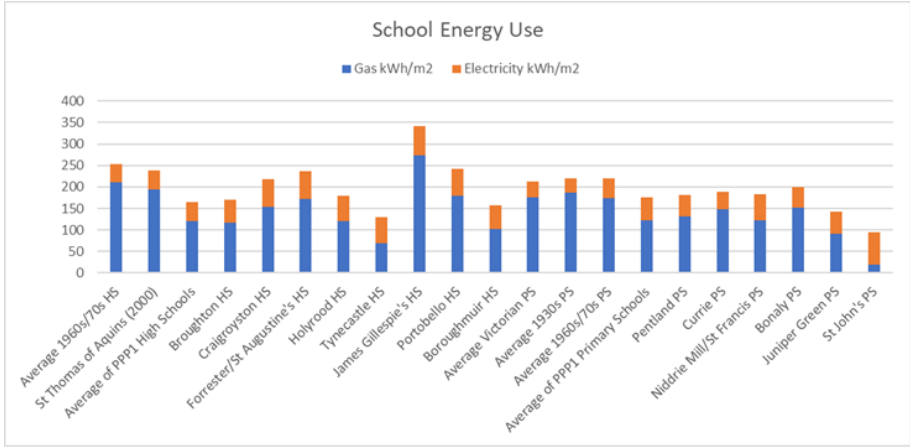
Our journey began in 2018/19
New build: certified passivhaus

Key influencing factors:

- Recognition of industry wide construction quality questions
- Poor comfort standards with respect to air quality and summertime overheating
- Disappointing energy performance of new build schools
- Challenging operational carbon targets to be addressed
- Need for system simplicity where possible



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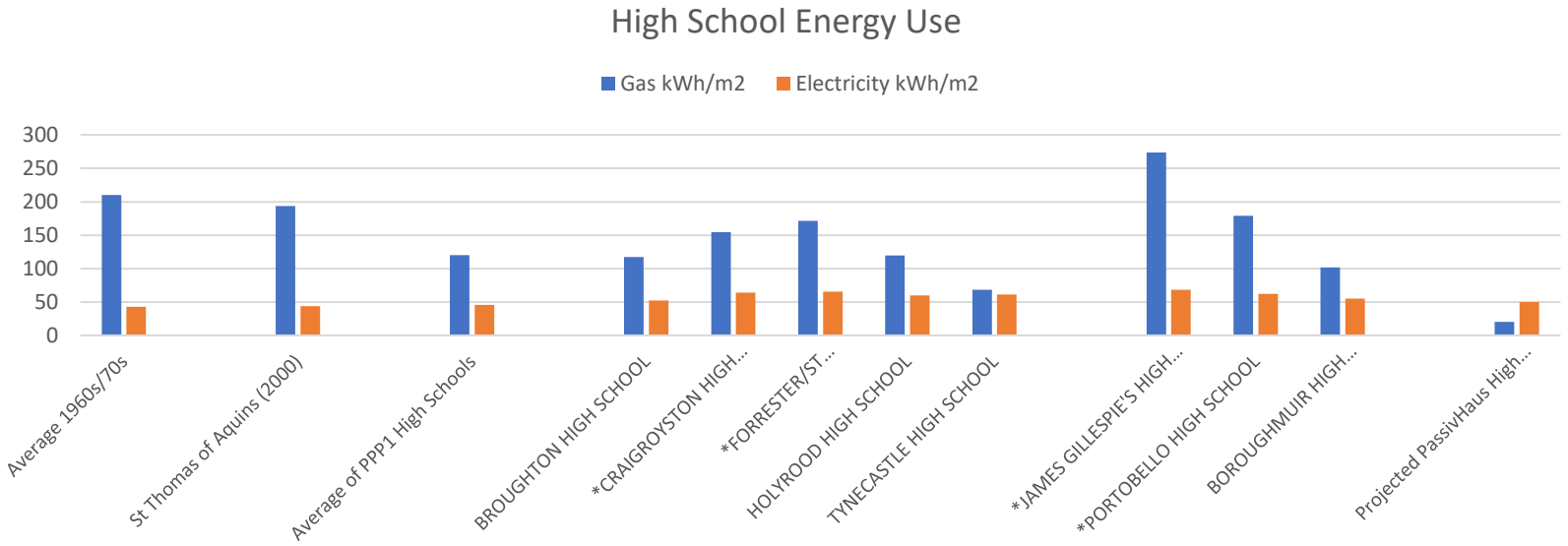
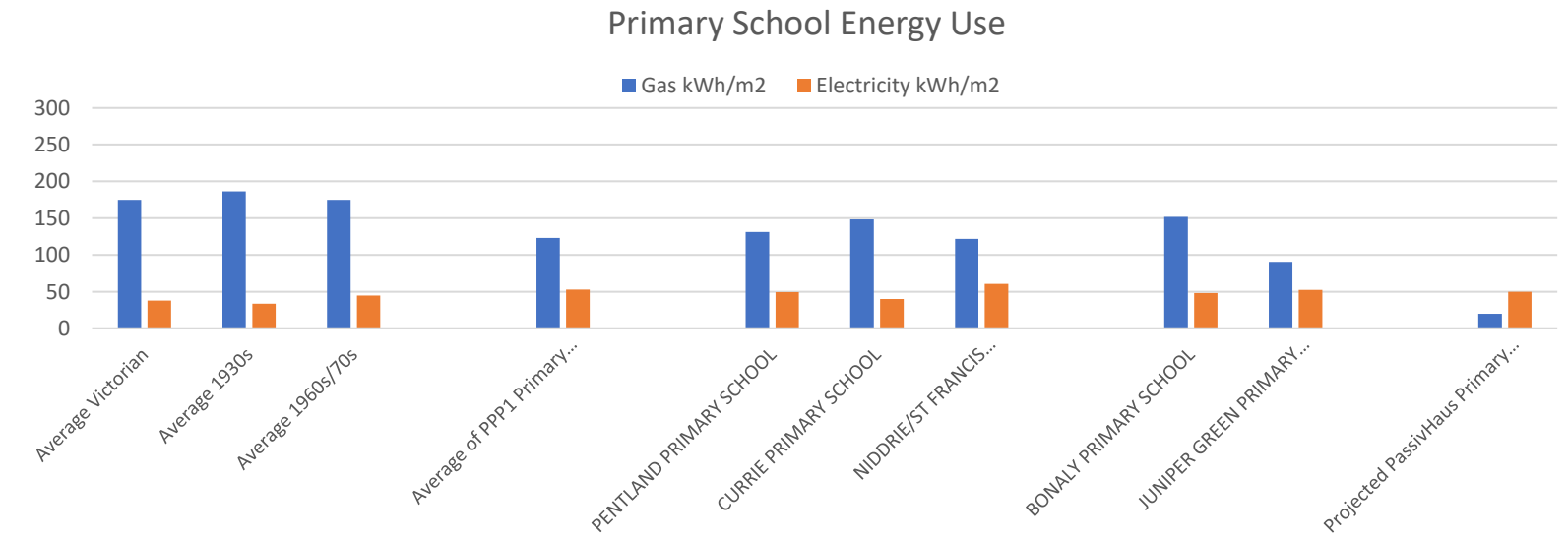
The Energy Performance Gap (CEC 2018/19 data)





Older → Newer

- New build schools were not realising any significant improvements in energy performance.
- This 'performance gap' is a national issue across all sectors.

This is a basic overview for illustrative purposed based on 2018/19 data.

Detailed comparisons have to take account of variable energy consumption factors:
*swimming pools, community use, scale of catering operation, or system operational issues.

Even relatively new budlings could present a Retrofit challenge?

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Passivhaus delivers:

- Benefits from the assurance of expert third party Design and Construction certification process
- Delivers low energy
- Addresses performance gap
- Significantly contributes to construction quality
- Has indoor comfort criteria as a key driver
- A recognised international standard (transferrable knowledge) and avoids dilution of specifications which can be a risk for unproven bespoke approaches.
- Benefits from decades of research and delivery.
- Fabric first approach drives the correct design team behaviours

Market has responded positively: Forward thinking contractors have proved to be very keen to embrace the approach.

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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.

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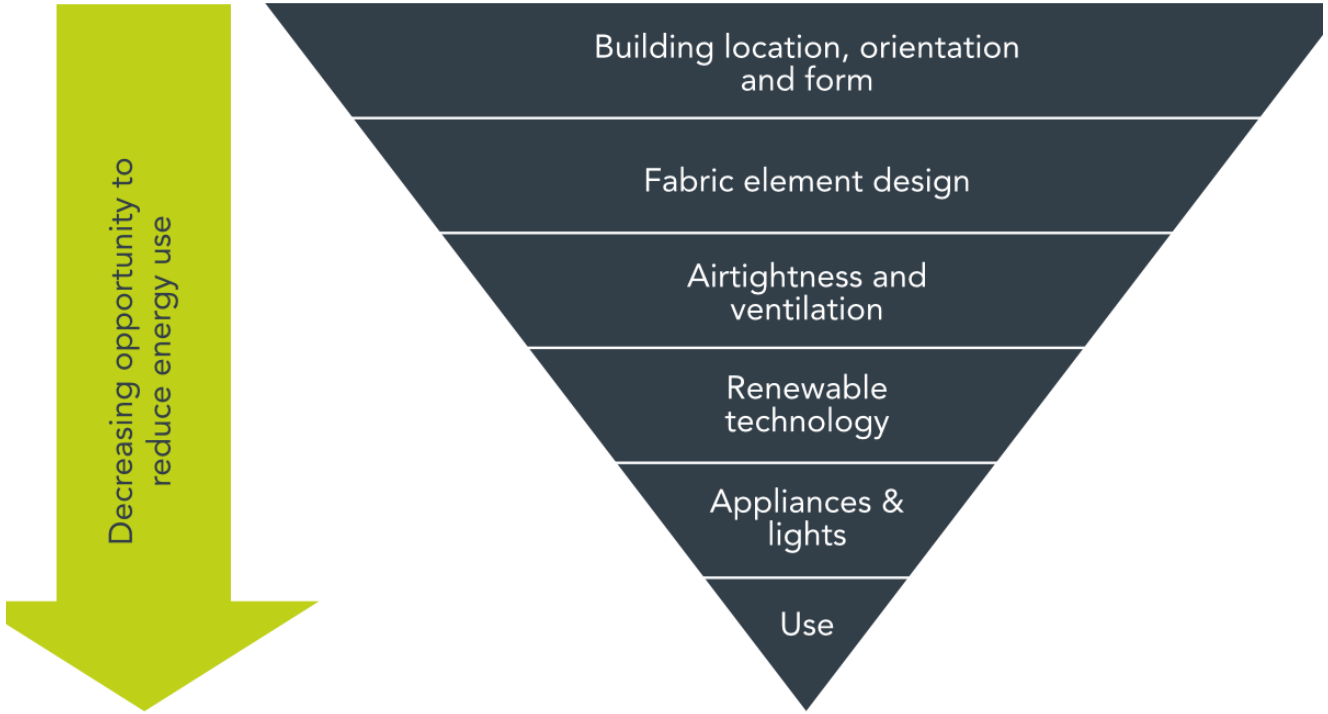
The challenge in addressing existing buildings

- 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 a robust analytical approach to addressing building fabric.
- For retrofit of existing buildings the Passivhaus standard is Enerphit.
- Enerphit is a very deep level of retrofit and not affordable across the Estate
- However, CEC's Passivhaus experience with PHPP modelling pointed to PHPP as a key tool to inform any retrofit process.



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Learning from Passivhaus delivery, the power of PHPP modelling was identified (EiRP development)

PHPP provides:

Value in steering design decisions

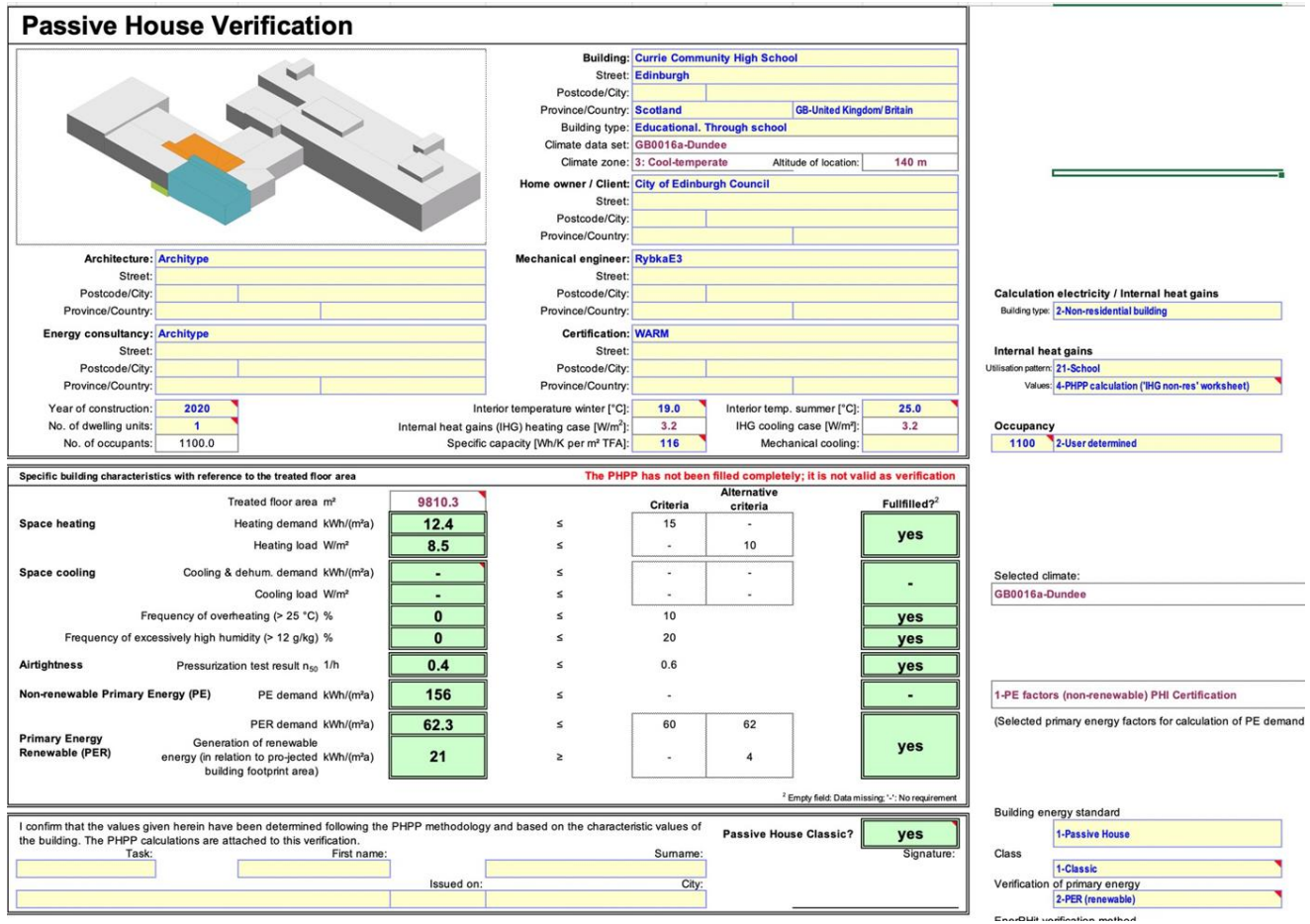
Encourages iterative analysis

Robust

Accessible

Potential to inform retrofit

An Enerphit informed Retrofit Plan (EiRP) approach was developed with experts in this area. This approach delivers the required building analysis, setting out potential interventions to reduce energy consumption prior to support deployment of ZDEH primary plant (or connection to a local Heat Network etc.)



Passive House Verification

Building: Currie Community High School
Street: Edinburgh
Postcode/City:
Province/Country: Scotland | GB-United Kingdom/ Britain
Building type: Educational. Through school
Climate data set: GB0016a-Dundee
Climate zone: 3: Cool-temperate | Altitude of location: 140 m
Home owner / Client: City of Edinburgh Council
Street:
Postcode/City:
Province/Country:

Architecture: Architype
Street:
Postcode/City:
Province/Country:
Energy consultancy: Architype
Street:
Postcode/City:
Province/Country:
Mechanical engineer: RybkaE3
Street:
Postcode/City:
Province/Country:
Certification: WARM
Street:
Postcode/City:
Province/Country:

Year of construction: 2020
No. of dwelling units: 1
No. of occupants: 1100.0
Interior temperature winter [°C]: 19.0
Internal heat gains (IHG) heating case [W/m²]: 3.2
Specific capacity [Wh/K per m² TFA]: 116
Interior temp. summer [°C]: 25.0
IHG cooling case [W/m²]: 3.2
Mechanical cooling:

Specific building characteristics with reference to the treated floor area — The PHPP has not been filled completely; it is not valid as verification

				Criteria	Alternative criteria	Fulfilled?[2]
	Treated floor area m²	9810.3				
Space heating	Heating demand kWh/(m²a)	12.4	≤	15	-	yes
	Heating load W/m²	8.5	≤	-	10	
Space cooling	Cooling & dehum. demand kWh/(m²a)	-	≤	-	-	-
	Cooling load W/m²	-	≤	-	-	
	Frequency of overheating (> 25 °C) %	0	≤	10		yes
	Frequency of excessively high humidity (> 12 g/kg) %	0	≤	20		yes
Airtightness	Pressurization test result n_{50} 1/h	0.4	≤	0.6		yes
Non-renewable Primary Energy (PE)	PE demand kWh/(m²a)	156	≤	-		-
	PER demand kWh/(m²a)	62.3	≤	60	62	yes
Primary Energy Renewable (PER)	Generation of renewable energy (in relation to pro-jected building footprint area) kWh/(m²a)	21	≥	-	4	

[2] Empty field: Data missing; '-': No requirement

I confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The PHPP calculations are attached to this verification.
Passive House Classic? yes
Task: First name: Surname: Signature:
Issued on: City:

Calculation electricity / Internal heat gains
Building type: 2-Non-residential building
Internal heat gains
Utilisation pattern: 21-School
Values: 4-PHPP calculation ('IHG non-res' worksheet)
Occupancy
1100 2-User determined
Selected climate:
GB0016a-Dundee
1-PE factors (non-renewable) PHI Certification
(Selected primary energy factors for calculation of PE demand
Building energy standard
1-Passive House
Class
1-Classic
Verification of primary energy
2-PER (renewable)

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Pilot Study initiated July 2020

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

- Initial site investigations
- Liberton Nursery analysis, options/costs
- Brunstane PS analysis, options/costs
- EiRP rolled out across increasing number of CEC buildings
- Methodology and brief shared on collaborative basis with Forum
- Approach adopted by number of other Scottish Local Authorities
- The flexibility of the process (PHPP modelling)
- Next steps around typologies and information sharing

Graphs and images in this presentation have been extracted from reports for CEC developed by the identified delivery team. The majority of tables and images are attributable to Architype

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Pilot Study , on site investigations

Two buildings selected for the Pilot to take to a 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

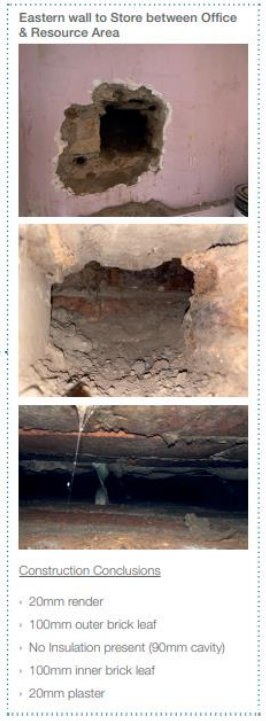
  Opening up to have certainty of main fabric element make up

  Thermal imaging

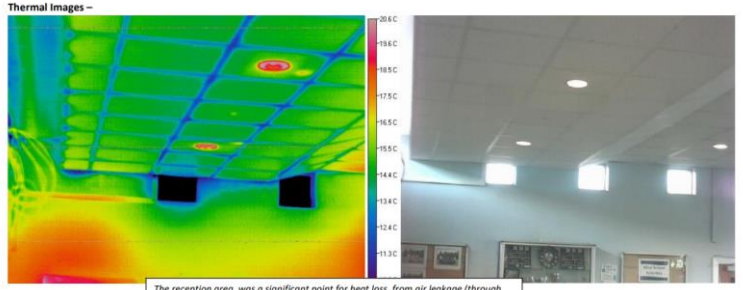
  Insulation (U value) on site testing

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

Fan set up at Brunstane Primary School



Thermal Images –



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

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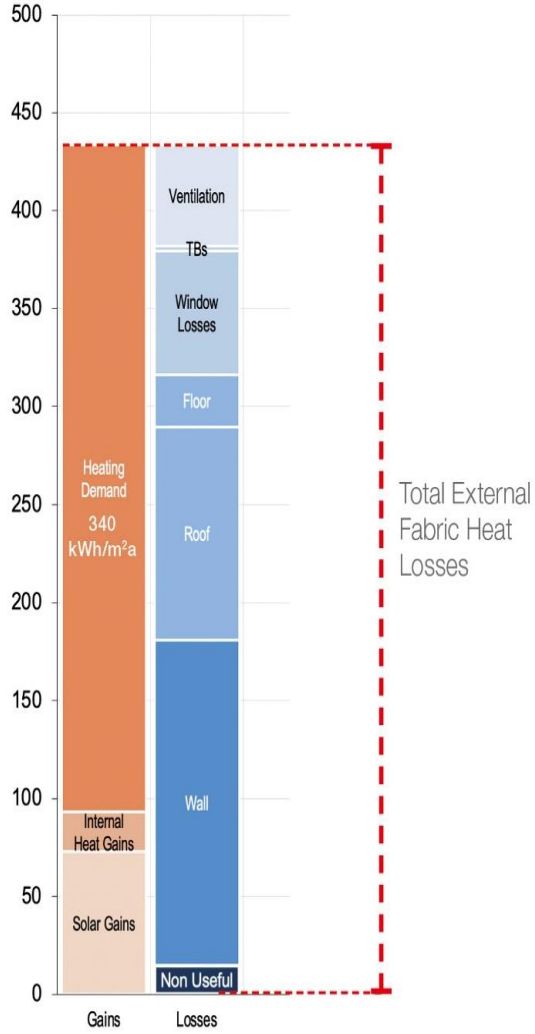
Liberton Nursery

Heat Losses through External Fabric



Existing Base Case (13.2°, Doors closed)

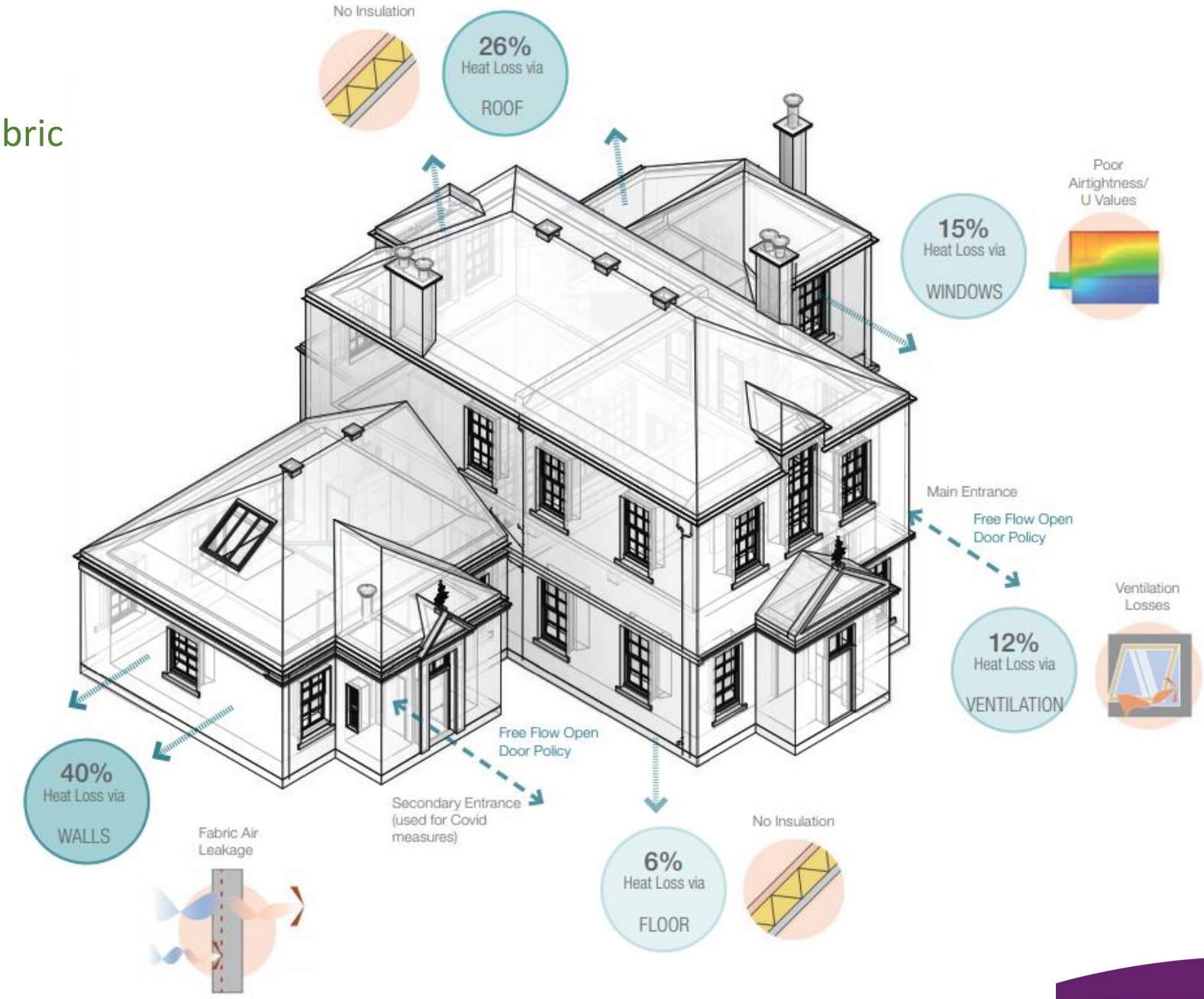


Fig. 109 / Heat loss distribution by building component in Liberton Nursery.

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Liberton Nursery

Comparison of Retrofit Approaches

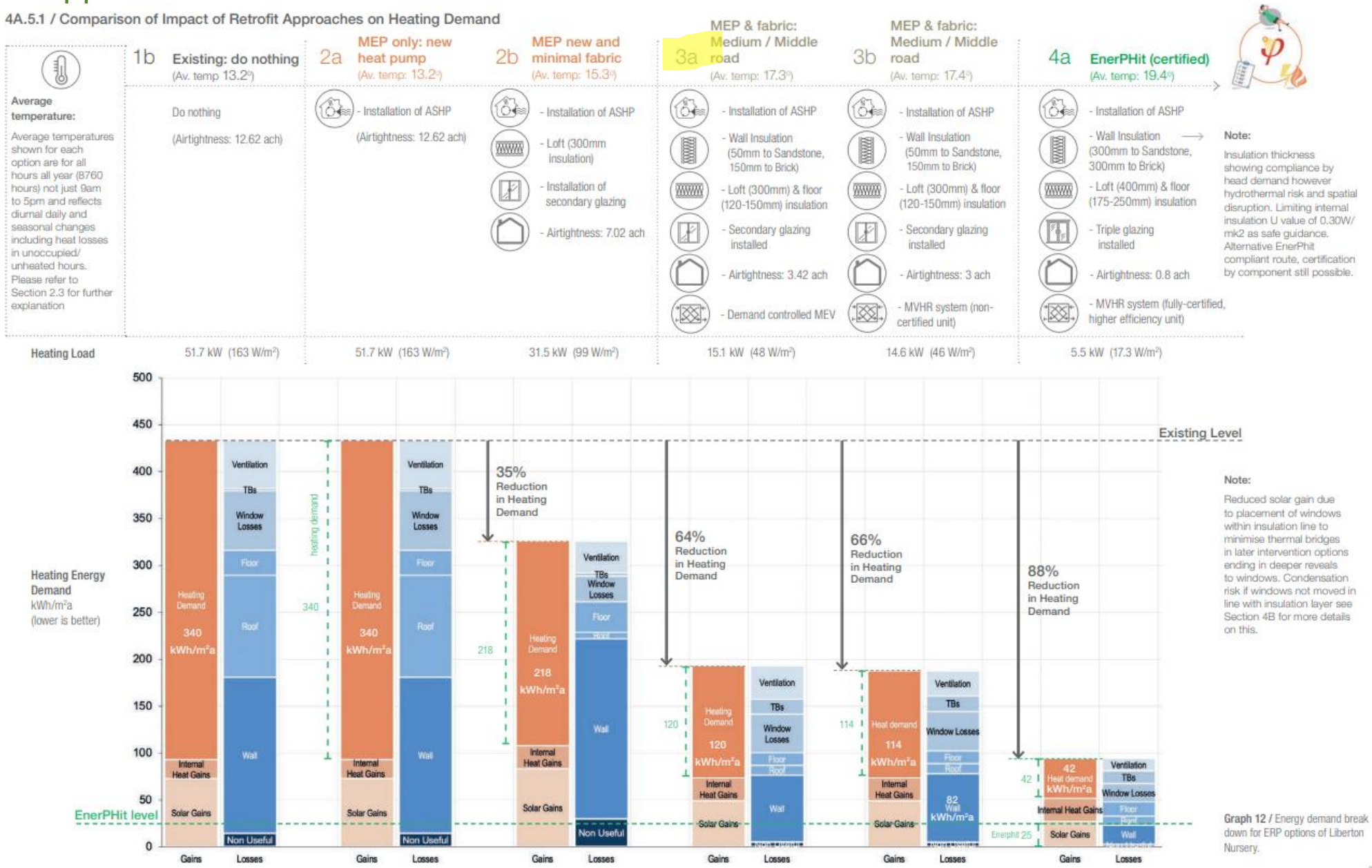
Note:

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)



Graph 12 / Energy demand break down for ERP options of Liberton Nursery.

Liberton Nursery

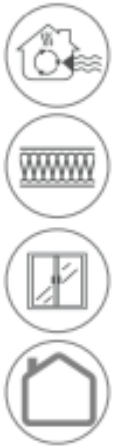
Comparison of Retrofit Approaches (zoom in)

2a MEP only: new heat pump
(Av. temp: 13.2°)

- Installation of ASHP

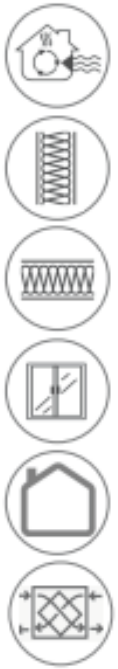
(Airtightness: 12.62 ach)

2b MEP new and minimal fabric
(Av. temp: 15.3°)



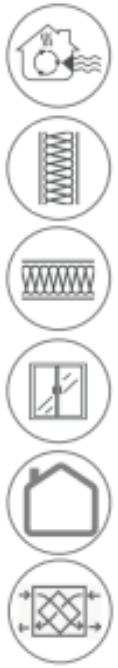
- Installation of ASHP
- Loft (300mm insulation)
- Installation of secondary glazing
- Airtightness: 7.02 ach

3a MEP & fabric: Medium / Middle road
(Av. temp: 17.3°)



- Installation of ASHP
- Wall Insulation (50mm to Sandstone, 150mm to Brick)
- Loft (300mm) & floor (120-150mm) insulation
- Secondary glazing installed
- Airtightness: 3.42 ach
- Demand controlled MEV

3b MEP & fabric: Medium / Middle road
(Av. temp: 17.4°)

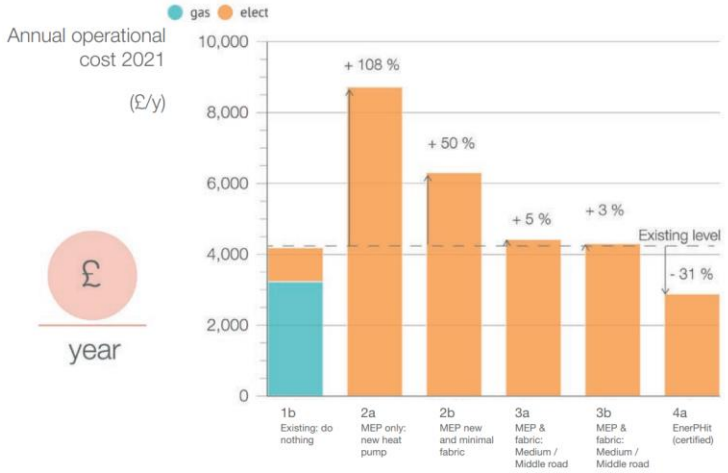


- Installation of ASHP
- Wall Insulation (50mm to Sandstone, 150mm to Brick)
- Loft (300mm) & floor (120-150mm) insulation
- Secondary glazing installed
- Airtightness: 3 ach
- MVHR system (non-certified unit)

4a EnerPHit (certified)
(Av. temp: 19.4°)

- Installation of ASHP
- Wall Insulation (300mm to Sandstone, 300mm to Brick)
- Loft (400mm) & floor (175-250mm) insulation
- Triple glazing installed
- Airtightness: 0.8 ach
- MVHR system (fully-certifi higher efficiency unit)

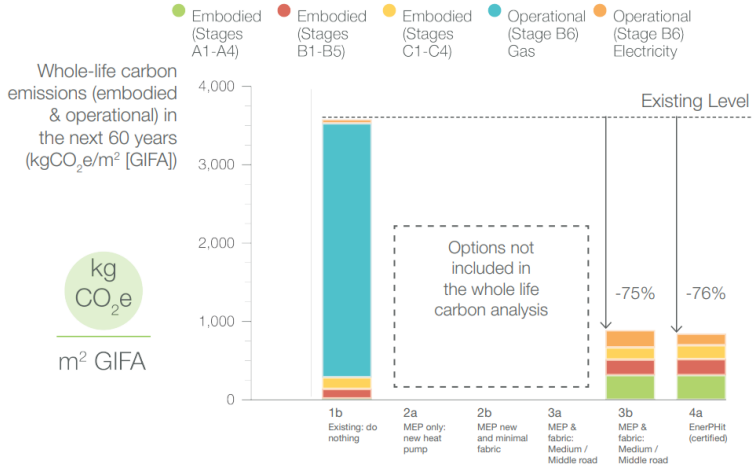
Wider Analysis undertaken: Liberton Nursery



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).

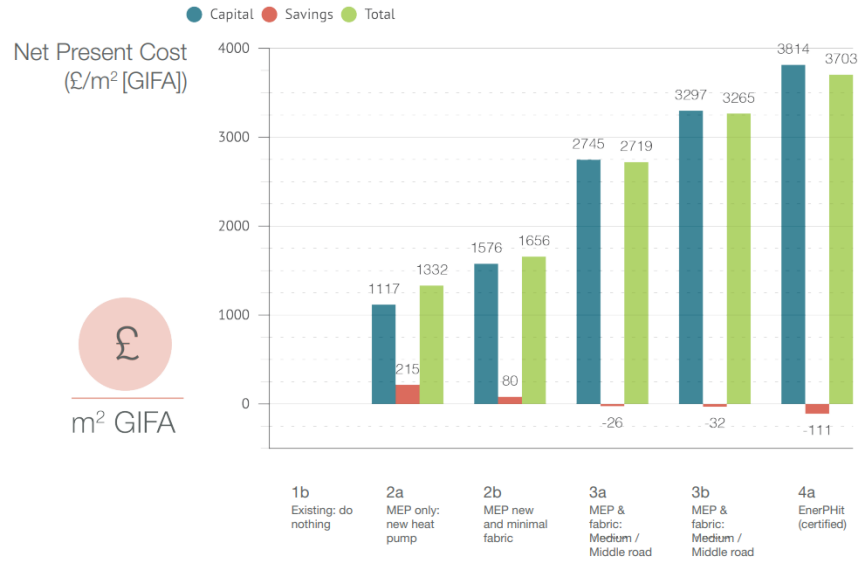
2021 data



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.



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

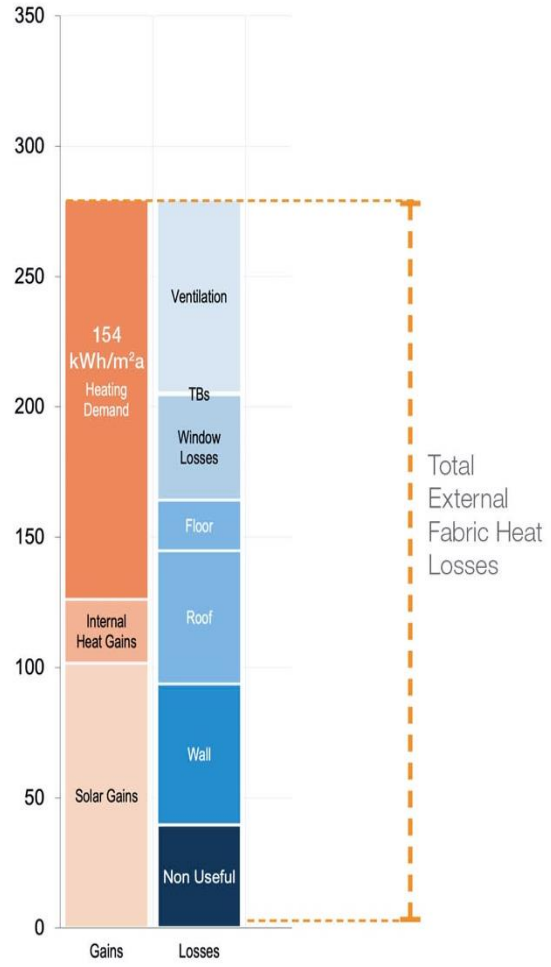
- Annual 0perational costs £/year for each level of Retrofit
  Based on a conservative ASHP SCOP of 2.4 there is a need for a significant level of retrofit to deliver costs similar to current gas fired solutions
- Whole-life carbon kgCO2e/m2(GIFA)
  Additional embodied carbon for deeper retrofits is offset by operational carbon reduction
- Net Present cost (offset of capital investment over 39 years)
  Based on 2021energy costs, this is not a building specific return on investment decision, **more a carbon decision.**

Liberton Nursery (summary to inform investment decision)

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**

Brunstane Primary

Heat Losses Through External Fabric



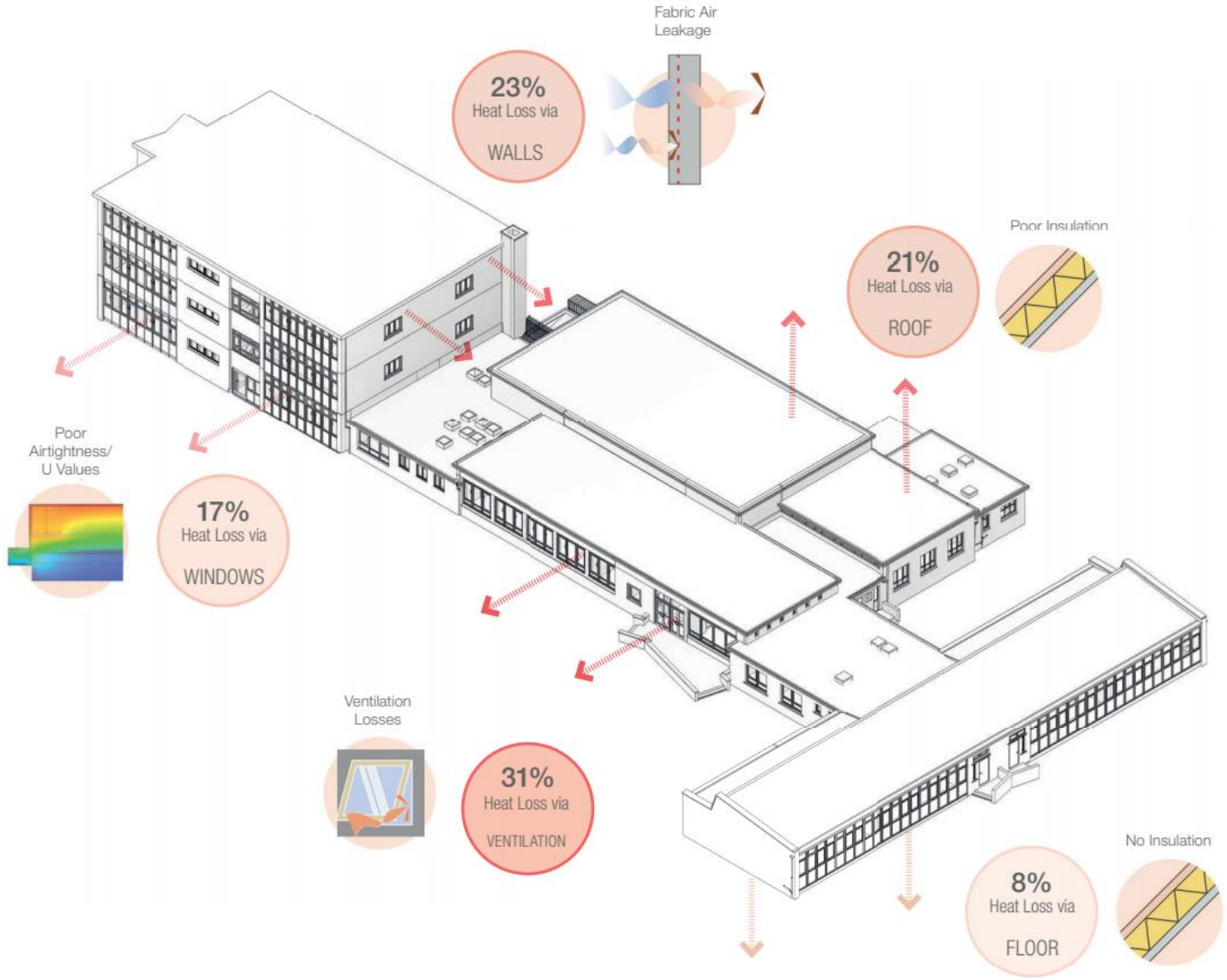


Fig. 133 / Heat loss break down for Brunstane Primary school.

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Brunstane Primary

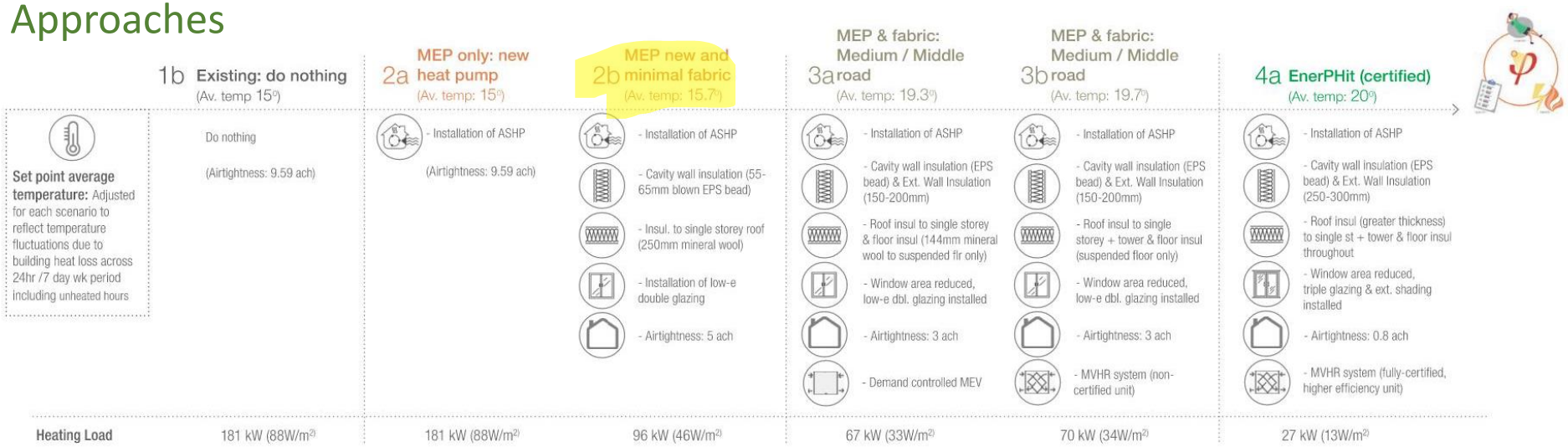
Comparison of Retrofit Approaches

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.



Graph 20 / Energy demand break down for ERP options of Brunstane Primary School

Brunstane Primary

Comparison of Retrofit Approaches (zoom in)

2a MEP only: new heat pump
(Av. temp: 15°)

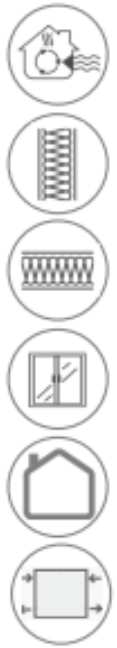
- Installation of ASHP

(Airtightness: 9.59 ach)

2b MEP new and minimal fabric
(Av. temp: 15.7°)

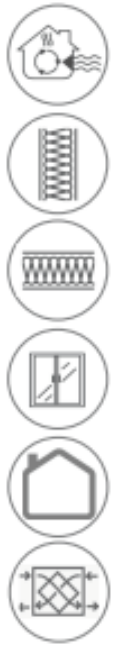
- Installation of ASHP
- Cavity wall insulation (55-65mm blown EPS bead)
- Insul. to single storey roof (250mm mineral wool)
- Installation of low-e double glazing
- Airtightness: 5 ach

3a MEP & fabric: Medium / Middle road
(Av. temp: 19.3°)



- Installation of ASHP
- Cavity wall insulation (EPS bead) & Ext. Wall Insulation (150-200mm)
- Roof insul to single storey & floor insul (144mm mineral wool to suspended flr only)
- Window area reduced, low-e dbl. glazing installed
- Airtightness: 3 ach
- Demand controlled MEV

3b MEP & fabric: Medium / Middle road
(Av. temp: 19.7°)



- Installation of ASHP
- Cavity wall insulation (EPS bead) & Ext. Wall Insulation (150-200mm)
- Roof insul to single storey + tower & floor insul (suspended floor only)
- Window area reduced, low-e dbl. glazing installed
- Airtightness: 3 ach
- MVHR system (non-certified unit)

4a EnerPHit (certified)
(Av. temp: 20°)

- Installation of ASHP
- Cavity wall insulation (EPS bead) & Ext. Wall Insulation (250-300mm)
- Roof insul (greater thickness) to single st + tower & floor insul throughout
- Window area reduced, triple glazing & ext. shading installed
- Airtightness: 0.8 ach
- MVHR system (fully-certified, higher efficiency unit)

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Brunstane Primary (summary to inform investment decision)

0	1	2	3	4	5	6	7
	Heating Demand *kWh/m²/yr [GIFA]*	Heating Demand Reduction against Baseline *%*	Annual Operational Cost 2021 *£*	Capital construction Cost *£ and £/m² [GIFA]*	Savings on Annual Operational Cost over 30 years *£/m² [GIFA]*	Reduction in Operational CO_2 Emissions against Baseline	Risk to Indoor health and to Building Fabric
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**

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Enerphit Informed Retrofit feasibility studies delivered to date for **investment decision** on level of retrofit

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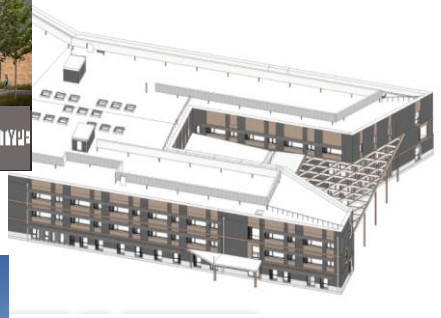
Passivhaus and Retrofit projects in delivery

- New builds are being delivered to certified Passivhaus (with LZC primary plant)

Current commissioned projects	RIBA Stage
Primary School annex building	7
Community High School (inc. pool)	5
Primary School	5
High School (inc. surgery, library, café, police office etc)	5
High School main teaching block	4
Primary school	4
Secondary School main teaching block and an EiRP refurb	3
Primary school	0

- Enerphit informed Retrofits (EiRP):
  Two pilot education properties plus Grade B block on above secondary school



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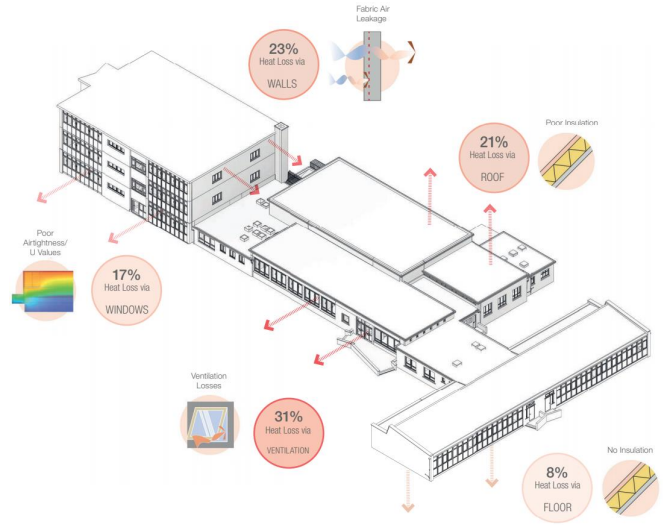
City of Edinburgh Council
3 Pilot Retrofits in Design



I / Heat loss break down for Brunstane Primary school.

Brunstane Primary

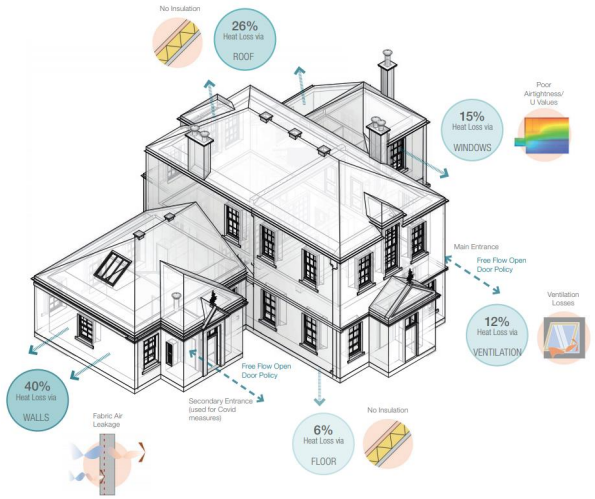


Fig. 109 / Heat loss distribution by building component in Liberton Nursery.

Liberton Nursery

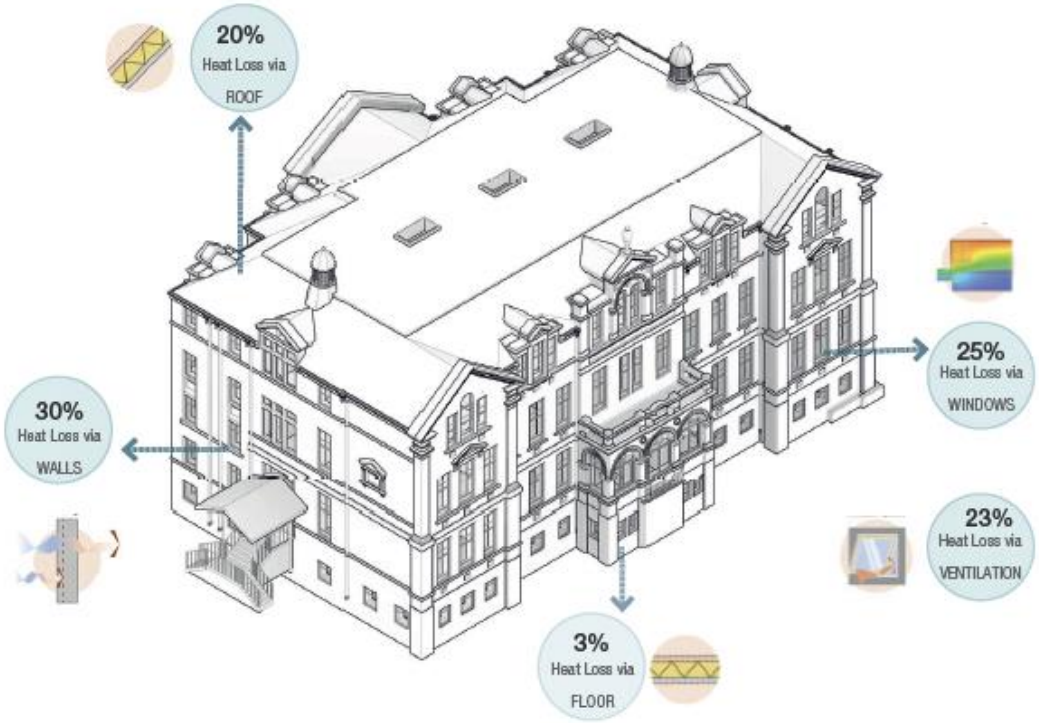


Fig. 35 / Heat loss distribution by building component in Trinity Victorian

Trinity Block A

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CEC's Retrofit Related Workstreams

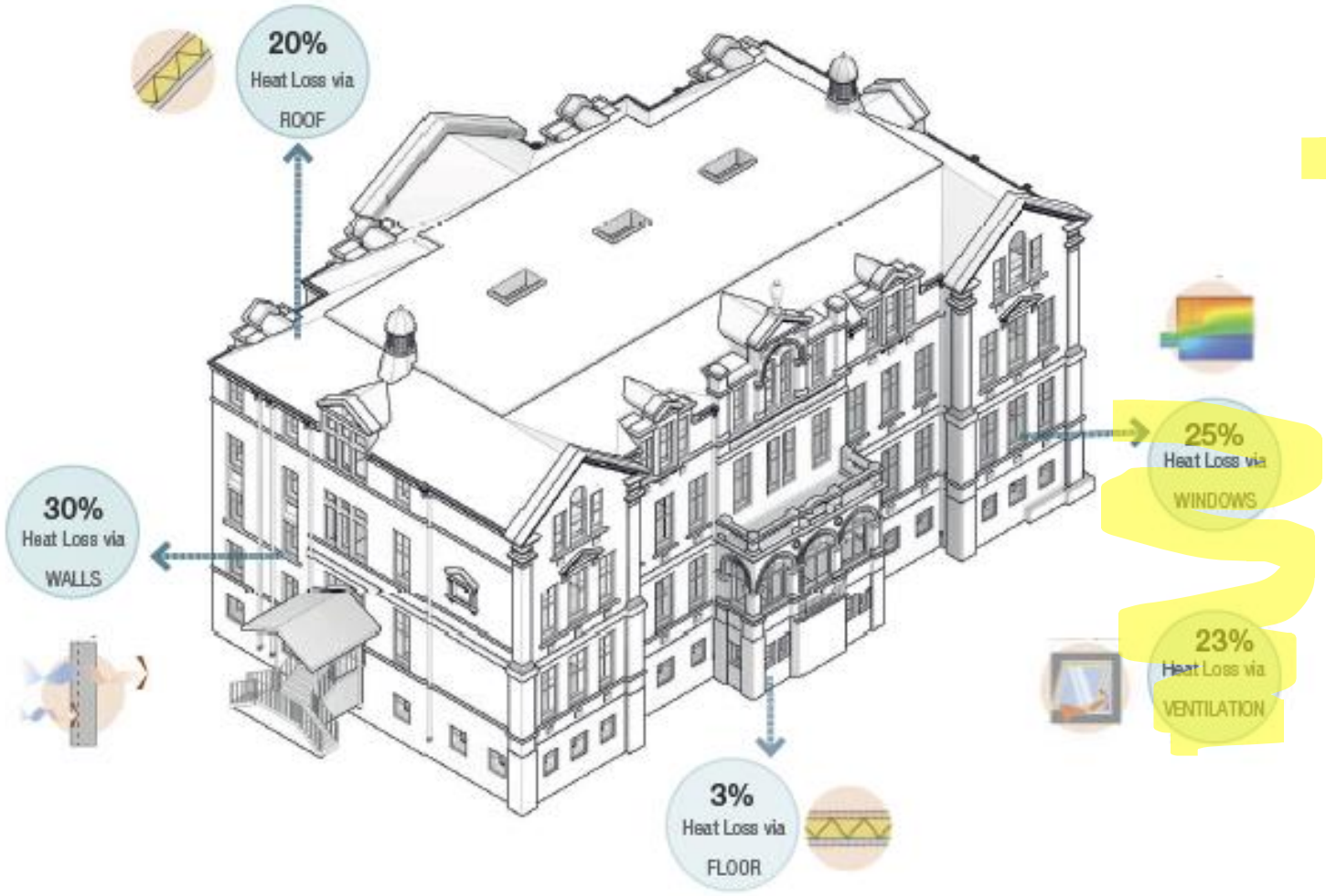

Fig. 35 / Heat loss distribution by building component in Trinity Victorian

Air Tightness Option.

Trinity Victorian Block

Revised EiRP (Option 3 Updated) Energy Study

ARCHITYPE

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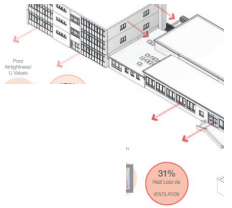
CEC's Retrofit Related Workstreams

Trinity Academy - EiRP Revised (July 2023)

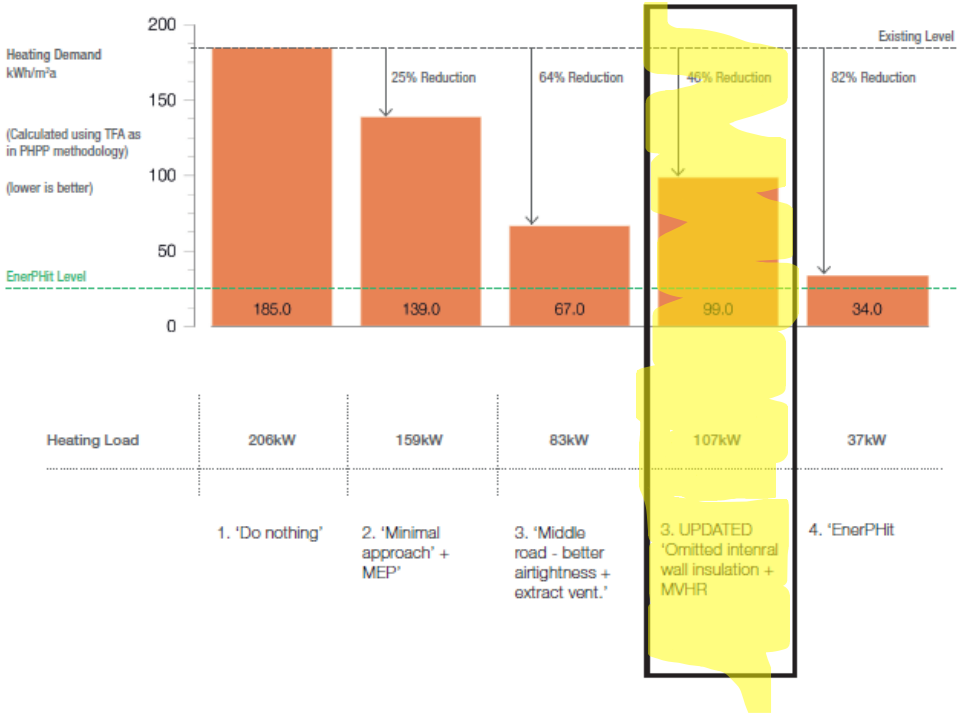
Retrofit Strategies



Air Tightness Option.

Trinity Victorian Block Retrofit Plan

	1 'Do nothing'	2 'Minimal approach + MEP'	3 'Middle road' Better airtightness + extract vent.	3b Middle road' Better roof insulation + Certified MVHR (Omitted internal wall insulation)	4 'EnerPHit Approach' (via component method)	EnerPHit Standard Criteria
Roof insulation	100mm existing mineral wool in some flat roof areas	250mm new mineral wool loft insulation, 50mm PIR insulation in pitched roof areas	300mm new mineral wool loft insulation, 100mm PIR insulation in pitched roof areas. 50mm PIR to dormer cheeks	400mm new mineral wool loft insulation, 200mm PIR insulation in pitched roof areas. 50mm PIR to dormer cheeks	400mm new mineral wool loft insulation, 200mm PIR insulation in pitched roof areas. 50mm PIR to dormer cheeks	
Ground floor insulation	-	-	-	-	200mm XPS. New concrete floor to be added	
Wall insulation**	None	None	50mm wood fibre internally with plasterboard service zone	None	100mm wood fibre internally with plasterboard service zone	
Glazing/ windows intervention	-	Secondary double low-E glazing	Installation of double low-E glazing	Installation of double low-E glazing	Installation of high performance triple glazing (low-E, argon fill)	
Doors	Unimproved U-value of 3 W/m2K	Unimproved U-value of 3 W/m2K	Improve to U-value of 2 W/m2K. Composite timber aluminium doors with glazed panels	Improve to U-value of 2 W/m2K. Composite timber aluminium doors with glazed panels	Improve to U-value of 1 W/m2K. Glazed PH doors with composite frames	
Installation of ASHP	-	Installation of ASHP	Installation of ASHP	Installation of ASHP	Installation of ASHP	
Ventilation Intervention	as existing	updated for minimal compliance	Demand controlled MEV	MVHR (PH certified)	MVHR (PH certified)	
Lighting	12 W/m2	6 W/m2. New LED luminaires	6 W/m2. New LED luminaires	6 W/m2. New LED luminaires	6 W/m2. New LED luminaires	
Average temperature*	14.6 °C	15.6 °C	15.3 °C	15.3 °C	19.3 °C	19.4 °C
Airtightness @50 Pa	6.5 ach	6 ach	3 ach	3 ach	0.8 ach	< 1 ACH
Repairs/ Redecoration		Redecoration throughout. New pipework & emitters	Redecoration throughout. New pipework & emitters	Redecoration throughout. New pipework & emitters	Redecoration throughout. New pipework & emitters	
External Works / Drainage		Repairs to ground and boundary walls required. Repairs to external stepped accesses and ramps.	Repairs to ground and boundary walls required. Repairs to external stepped accesses and ramps.	Repairs to ground and boundary walls required. Repairs to external stepped accesses and ramps.	Repairs to ground and boundary walls required. Repairs to external stepped accesses and ramps.	



Power and accessibility of PHPP modelling

Fig.1 Summary of the retrofit measures for the EiRP options of Trinity Victorian Block

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Collaboration

Passivhaus and Retrofit Delivery Forum

CEC shared outline EiRP briefing document

Passivhaus and Retrofit Delivery Forum
(informal group established and chaired by CEC)

- Aberdeenshire
- CEC*
- East Ayrshire*
- Fife*
- Glasgow
- Highland
- Midlothian*
- Moray
- Renfrewshire*
- Perth and Kinross*
- Angus*

- PHT
- BE_ST
- (SFT)
- HES **(proposed monitoring and technical paper for Liberton Nursery and Trinity Block A)**

* Enerphit Informed Retrofit collaboration and results sharing

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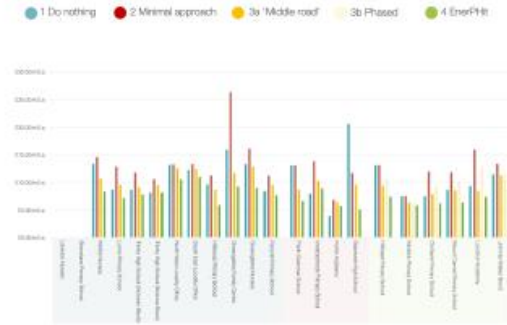
Combined dataset from retrofit studies

4 developed retrofit scenarios x 26 buildings



Graph containing data from retrofit studies already completed for 23 buildings.

As more buildings are added to the dataset the sample power (the probability of correct inferences) increases.

East Ayrshire

Midlothian

East Scotland

Edinburgh

Renfrewshire

Next Steps

Opportunity to further analyse wider findings with aim to share across Public Sector

Extracts from proposal

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Approach

Data analysis of combined dataset (EiRP studies) to determine building typologies to facilitate 'typology based' indicative cost and performance of retrofit interventions.

Present an example set of retrofit measures (say 3 levels of intervention) for each typology represented in the sample

Discuss potential challenges/risks/strengths of each level of intervention for each typology. Also considering characteristics such as internal environmental quality, user disruption (decant), risk to fabric and heritage considerations.

Key that report is in accessible language with technical information and methodology provided in Appendices.

Collaborative culture. All participants have agreed to make their feasibility study findings available for inclusion in the final paper.

Table 1. Buildings from already completed and ongoing EiRP studies included in the combined dataset.

Building	Scale	Construction era
Lorne Primary School - CEC *	Medium scale	Built between 1870-1940
Hillhead Primary School - EAC	(1,500 - 10,000 m²)	Buildings in the sample were built between 1870 and 1900 and in the 1930s. No buildings from the period 1900s - 1920s
Johnnie Walker Bond - EAC *		
Trinity High School (Victorian Block) - CEC *		
Penicuik High School (Older block) - Midlothian Council *		
Moffat Nursery - CEC	Small scale (GIFA < 400 m²)	
Liberton Nursery - CEC		
South East Locality Office - CEC	Medium scale	Built between 1950 and 2000
Inverbrothock Primary School - Angus Council	(1,500 - 10,000 m²)	
Onthank Primary School - EAC		
Brunstane Primary School - CEC		
Mount Carmel Primary School - EAC		
Ferryhill Primary School - CEC		
Trinity High School (Science Block) - CEC		
North West Locality Office - CEC		
Hillwood Primary School - CEC		
Penicuik High School (Newer block) - Midlothian Council		
Greengables Family Centre - CEC	Small scale (GIFA < 400 m²)	
Greengables Nursery - CEC		
Perth Grammar School - HubEC	Large scale (GIFA > 10,000 m²)	Built in the 1970s
Loudoun Academy - EAC		
Balwearie High School - Fife Council *		
Forfar Academy - Angus Council	Large scale	Built in the 2000s
Muirkirk Primary School - EAC	Medium scale	Built after 2010
Brediland Primary School - Renfrewshire		
East Fulton Prmary School - Renfrewshire		
Newmains Primary School - Renfewshire		

* Grade B listed building

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Example of emerging patterns

which may not be initially apparent
when suggesting typologies/archetypes
(e.g., **Form Factor**) :

Form Factor = Total heat loss area ÷ floor area

The Form Factor of a building is key in low energy design because it tells you how thick your insulation has to be. If you can halve the form factor (ie, simplify the building's shape) you can halve the wall insulation you need to get the same thermal performance.

Capital cost (£/m²) for 'Middle road' retrofit option

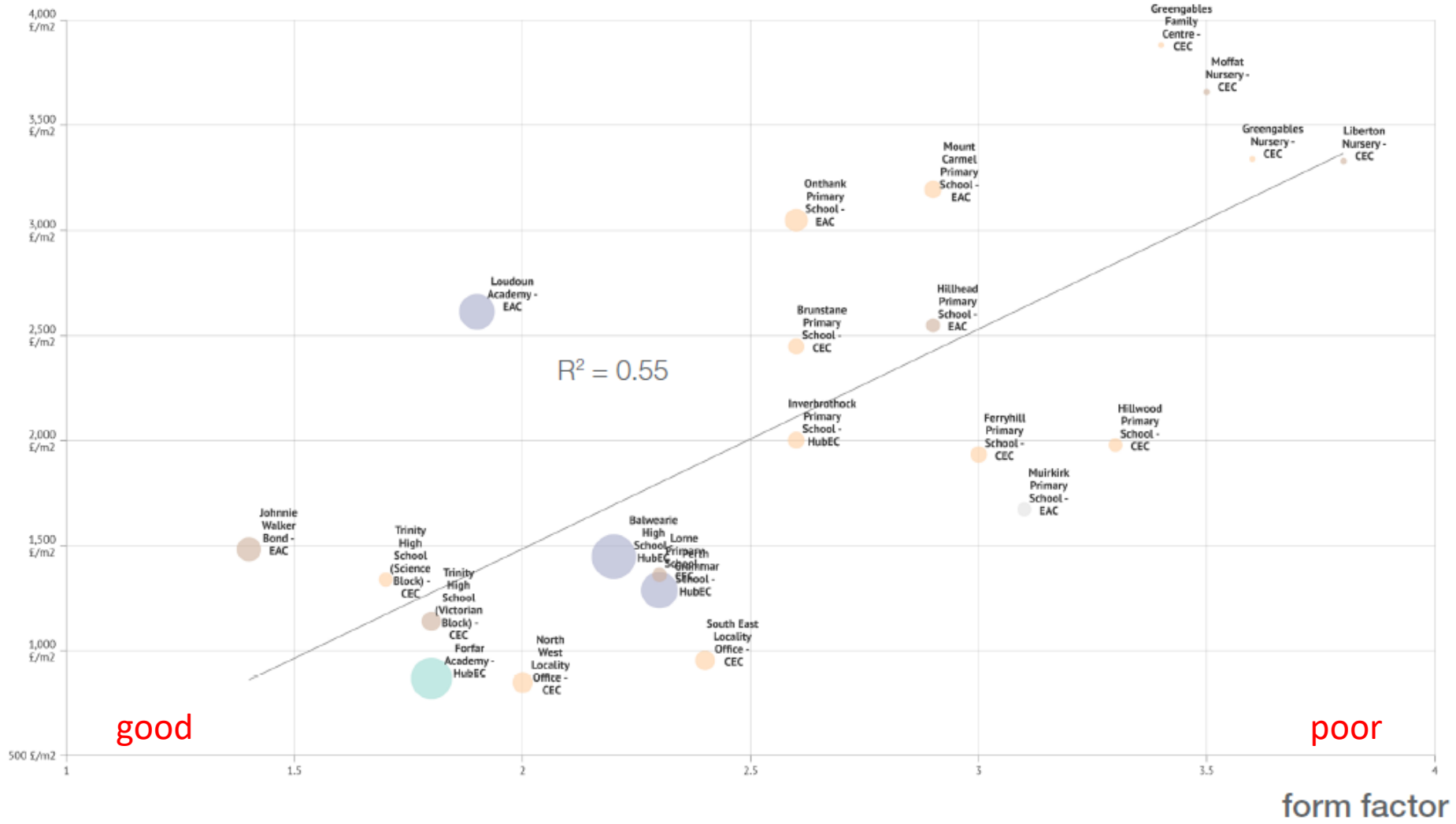


Figure 8. Graph showing capital cost (£/m2) for Middle road option vs. form factor. Marker size represents GIFA (m2) and marker colour represents the building typology (as assigned in preliminary analysis).

CEC's Retrofit Related Workstreams

Heat map in production for CEC buildings identifying anchor loads.

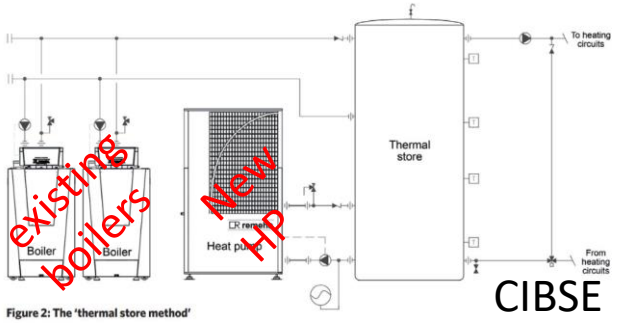
Contribute to wider public sector heat map

Anchor loads (over 500MWh/annum identified)

Funding case being made for Gracemount Heat Network where many buildings in CEC control.

new build and major refurbishment

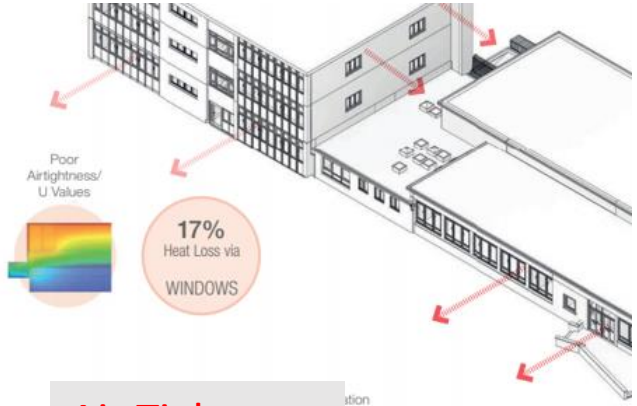
NZPSB for Existing Buildings. 'Beta Test'



CIBSE

Bivalent type Heat Pump deployment ('fast and dirty' interim approach).

Elemental Retrofit approach.



Air Tightness Option.

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CEC Challenges/Observations so far:

New build (Passivhaus):

Optimise any new builds. This is the 'easy' opportunity. CEC have adopted Certified Passivhaus.

The market/supply chain has responded positively.

Some parts of the sector promote a Passivhaus 'Principles' approach ducking the rigour of certification etc. This has potential risk of diluting the approach and repeating the Performance Gap. The Performance Gap is more of an issue for clients and building operators and not an issue for 'new build' delivery teams who promote the approach.

Embodied carbon and more critically the circular economy is the emerging area of increased focus.

Retrofit (EiRP):

Any mid -level or deep Retrofit costs are **significant!**

All retrofits will attract risk of scope creep (condition and suitability)

Retrofit is not the normal return on investment thinking, it's a cost to transition to low carbon

How deep to take a retrofit remains a challenge

Low carbon solutions are not necessarily low energy solutions. Low carbon can be readily delivered but with risk to electricity network capacity.

User disruption will be significant, challenging schools and residential care facilities.

Need to be open and responsive to changing knowledge and technologies / Betamax fear

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Going forward

- New build: Passivhaus with deployment of ZEDH primary plant or Heat Network connection.
- There will be ongoing challenge around construction/retrofit related costs and associated operational costs.
- Embodied carbon (and circular economy) will be area of increasing focus
- We expect greater focus on the case for Refurbishment where possible rather than new build. PHPP EiRP can inform the investment decision.
- Recognise a need to be flexible in responding to emerging technologies, emerging best practices and opportunities.

Picture taken at early days of CEC journey
(March 2019 student climate protests Holyrood, 5 years ago)

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