

Building Performance Evaluation

A design approach for refurbishment of a small traditional building in Scotland

Janice Foster BEng (Hons), MSc Arch
Researcher

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Land Sea and Islands Centre - Arisaig

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SAM FOSTER
ARCHITECTS

Drivers

- EU Energy Performance of Buildings Directive
- Climate change and CO₂ emission targets
- National Planning Framework recognition of conservation of historic environment
- LSIC appointed architect with experience of refurbishment of existing buildings
- Climate Challenge Fund to improve energy efficiency
- Goal 75% reduction CO₂ emissions
- Model for similar buildings – domestic and non-domestic in rural setting
- Architect required understanding of pre-refurbishment performance
- Innovation Voucher from Scottish Funding Council Pre-refurbishment (BPE)
- Funding from Zero Waste Scotland Post-refurbishment (BPE)

BPE - Work Undertaken

- Questionnaires with volunteers
- Airtightness test with thermography
- In-situ U-value testing
- Indoor environment monitoring
- Electrical energy monitoring



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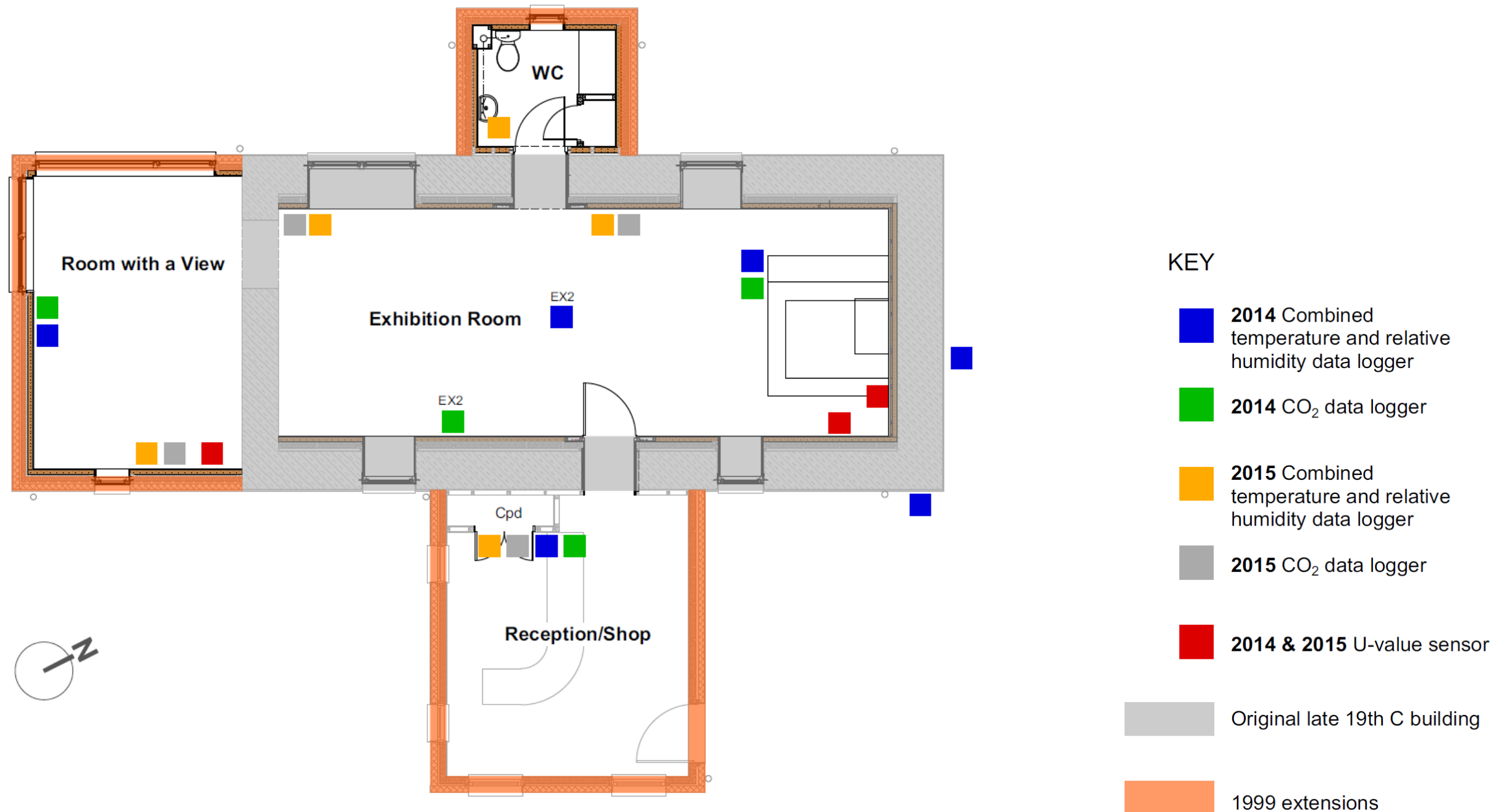


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BPE – Monitored Rooms



Results – Building Users

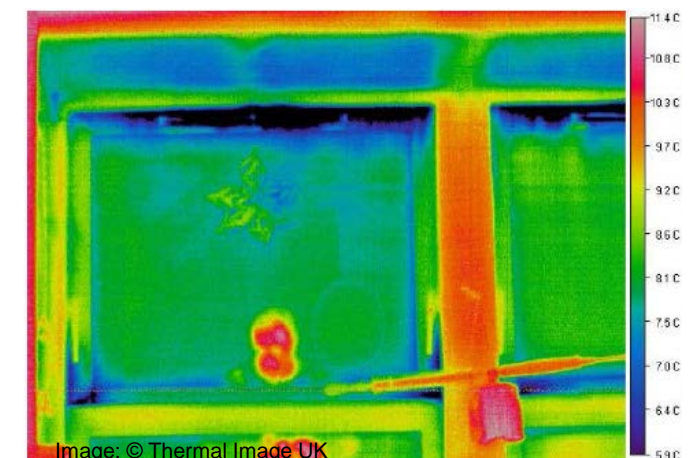
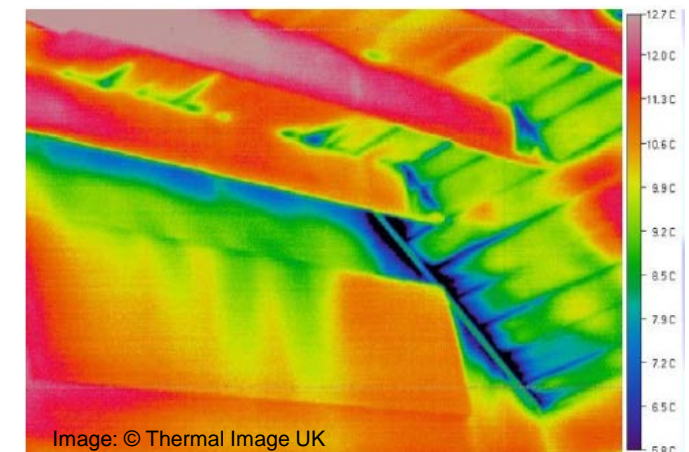
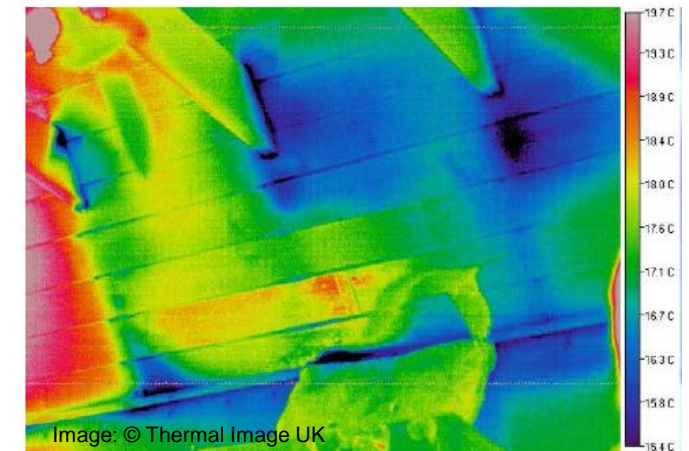
- Internal temperature too cold
- Bulk up with layers in winter
- Building too draughty in winter
- Heating on all of the time
- Condensation forming on some windows
- Not certain how to operate all controls in the building



Photo: © MEARU

Results - Airtightness

- Joist ends
- Wall junctions
- Window heads and sills
- Pipe penetrations
- Electrical penetrations
- Air permeability - 18.04 m³/h.m² @ 50Pa
- Air changes per hour ~ 0.9ACH



Results – In-situ U-Value

Room	Building Element	Approx Orientation	Theoretical U-Value (W/m ² K)	In-situ U-Value (W/m ² K)	1999 Elemental U-Values (W/m ² K)	2013 Elemental U-Values (W/m ² K)
Room with a View	Ceiling	East	0.43	0.72	0.20	0.20
Room with a View	Wall	East	0.49	0.40	0.30	0.27
Exhibition	Lined Wall	East	0.49	0.25	0.30	0.27
Exhibition	Stone Wall	North	1.64	0.93	n/a	0.27

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Results – Indoor Environment

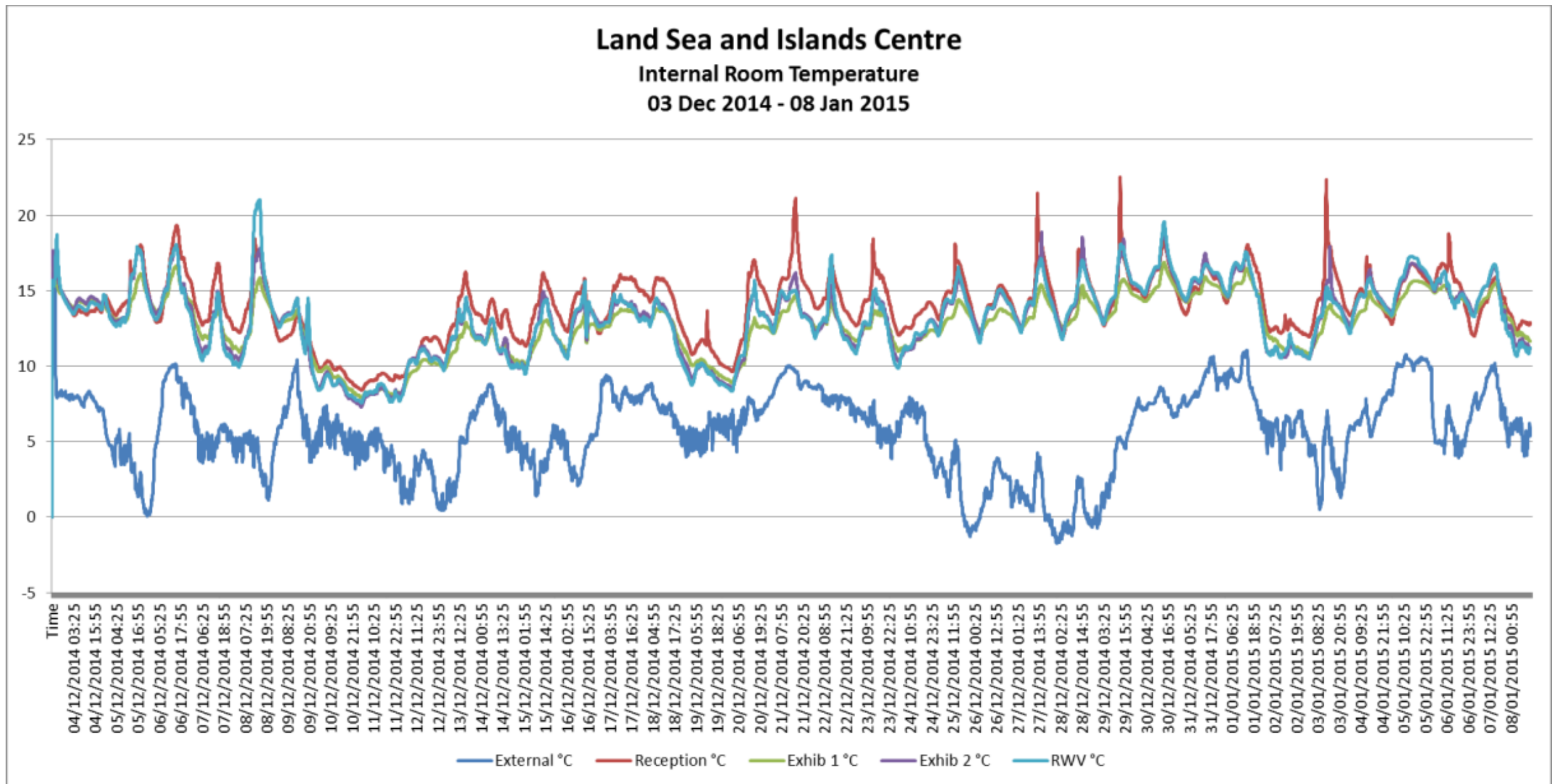
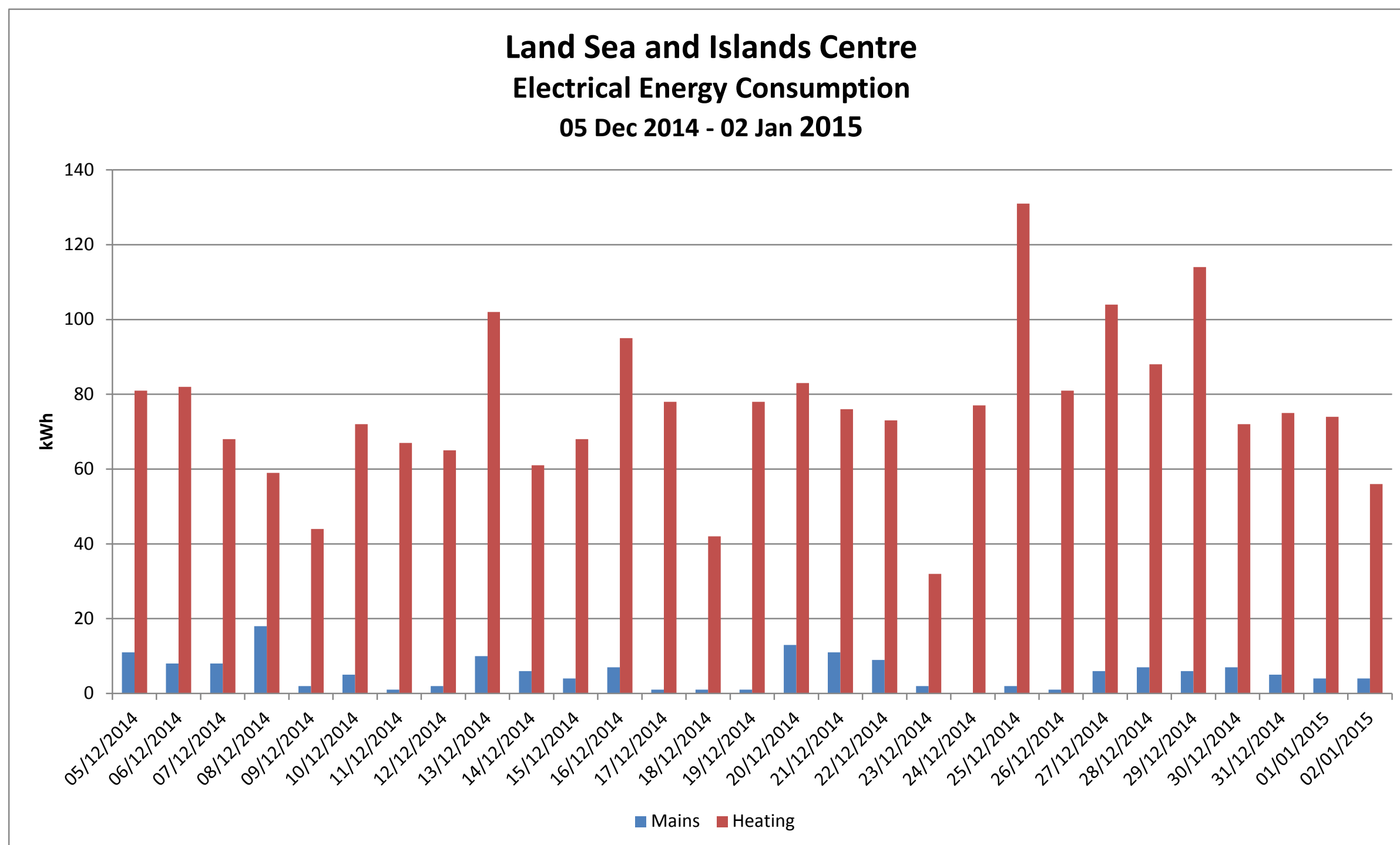


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Results – Electrical Energy



Refurbishment



Photo: © Sam Foster Architects



Photo: © Sam Foster Architects



Photo: © Sam Foster Architects

Refurbishment



Photo: © Sam Foster Architects



Photo: © Sam Foster Architects

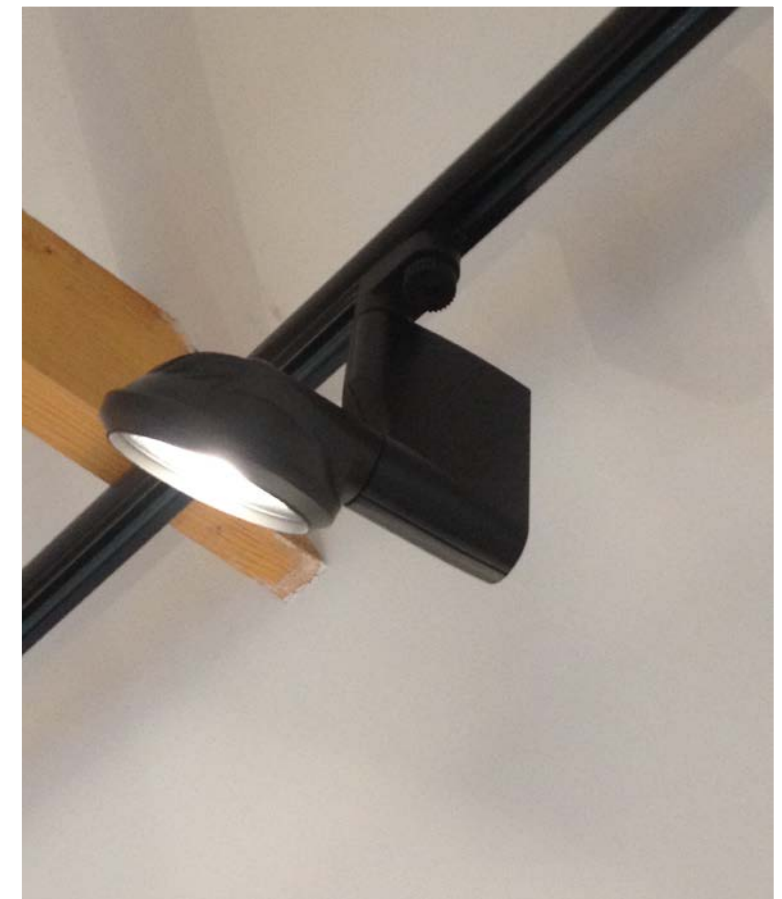


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BPE - Work Undertaken

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Photo: © MEARU

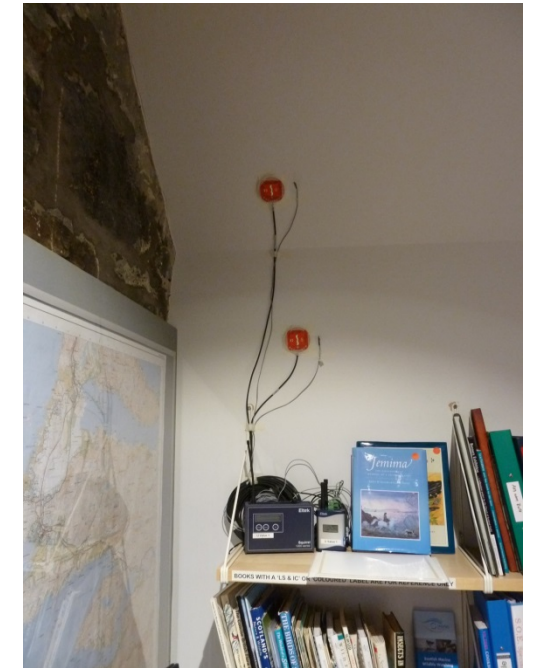


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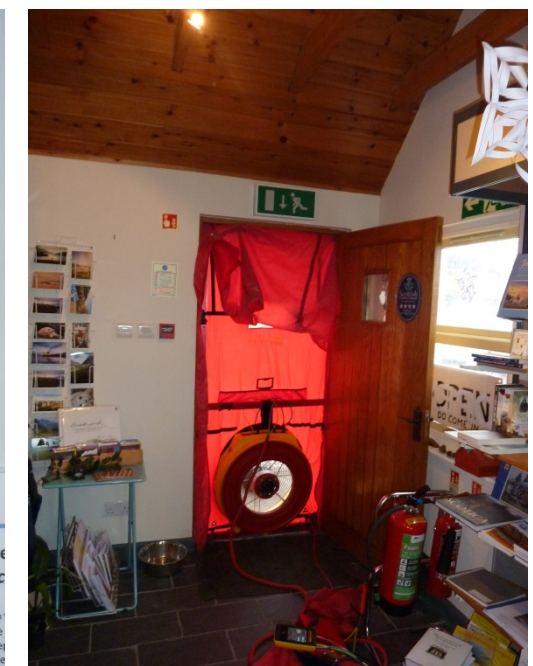


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Results – Building Users

- Comfortable internal temperature
- Only two radiators used for thermal comfort
- Windows now opened to ventilate
- All trained in how to operate systems
- Visitors remain in the building for longer
- Hosting more community events
- Building now used through the winter!



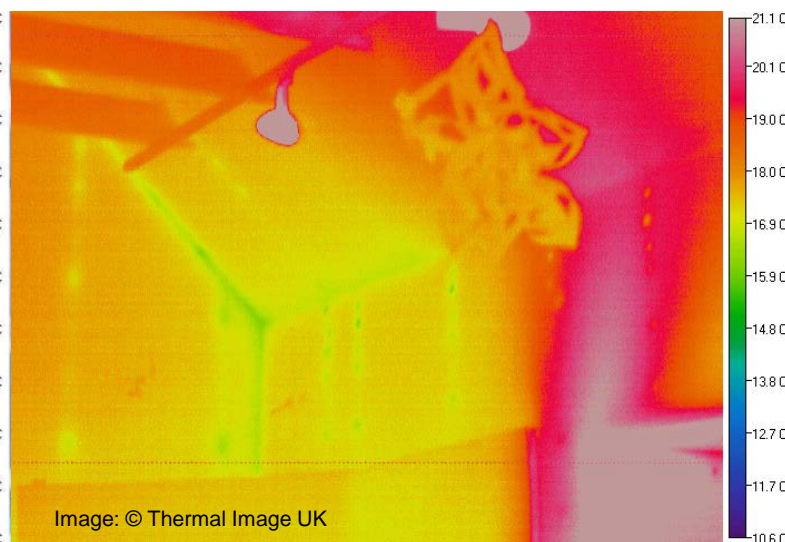
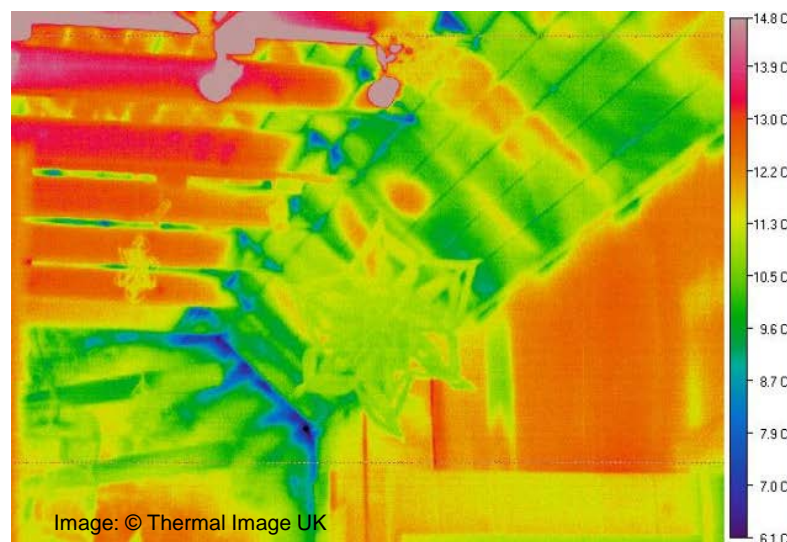
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Results – Airtightness

Test	Air Permeability Measurements (m ³ /h.m ² @ 50Pa)		
	Negative	Positive	Mean
Pre-Refurbishment	16.76	19.32	18.04
Post-Refurbishment	2.61	2.79	2.70

Table: © MEARU

Air permeability – 85% Reduction infiltration to the building



Results – In-situ U-Value

Room	Building Element	Approx Orientation	Theoretical U-Value (W/m ² K)	In-situ U-Value 2014 (W/m ² K)	In-situ U-Value 2015 (W/m ² K)	Reduction (%)
Room with a View	Ceiling	East	0.43	0.72	0.26	63
Room with a View	Wall	East	0.49	0.40	0.22	45
Exhibition	Lined Wall	East	0.49	0.25	0.21	16
Exhibition	Stone Wall	North	1.64	0.93	0.40	57

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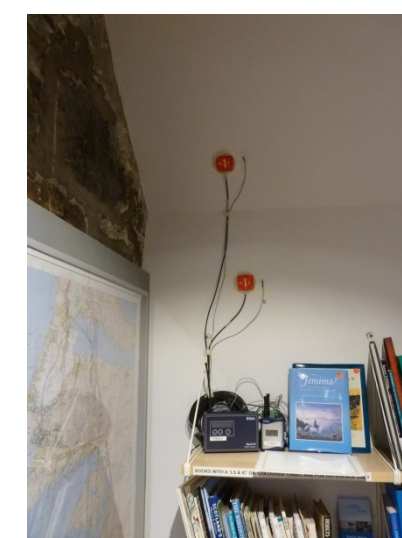


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Results – Indoor Environment

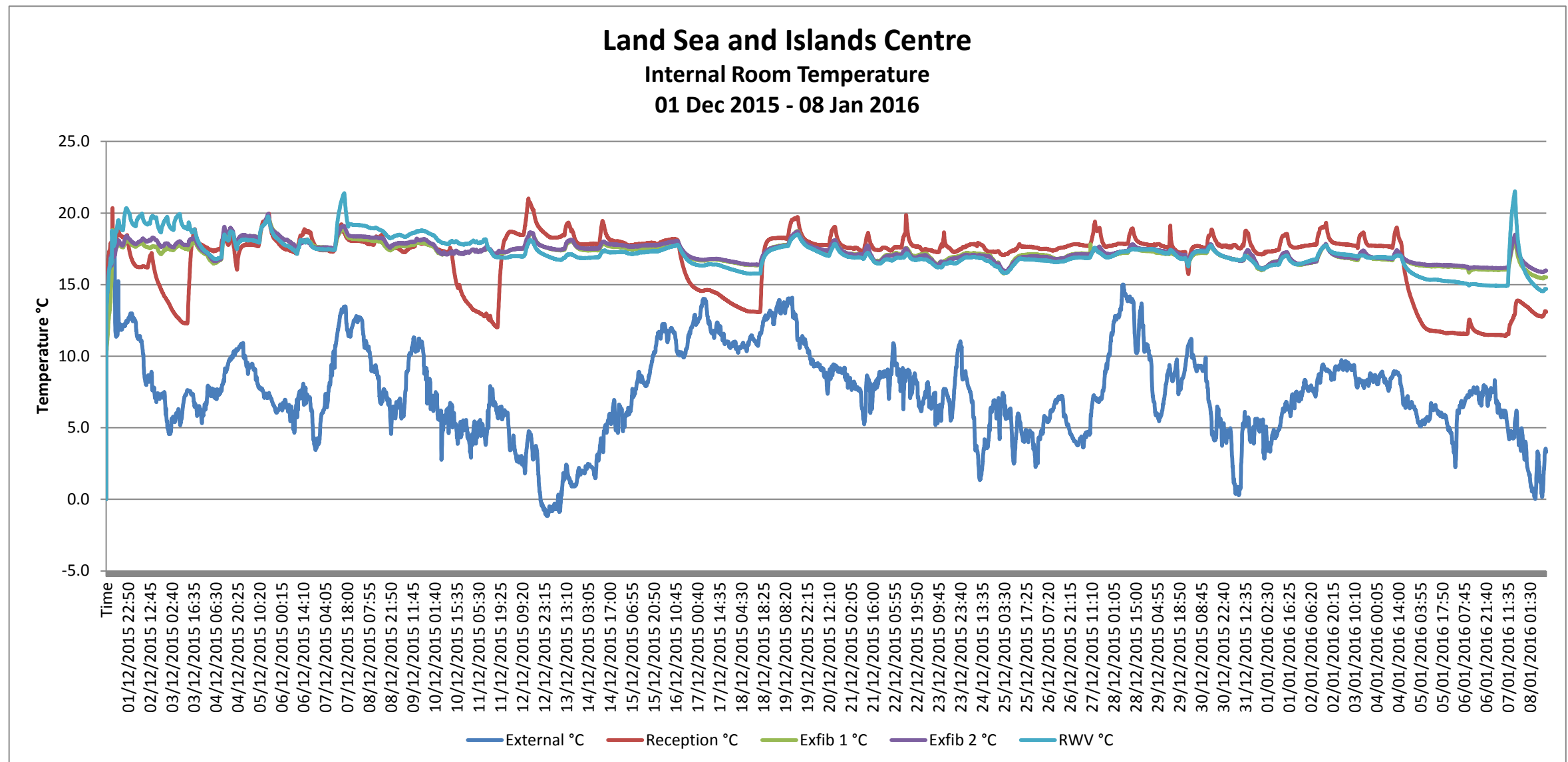


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Results – Temperature

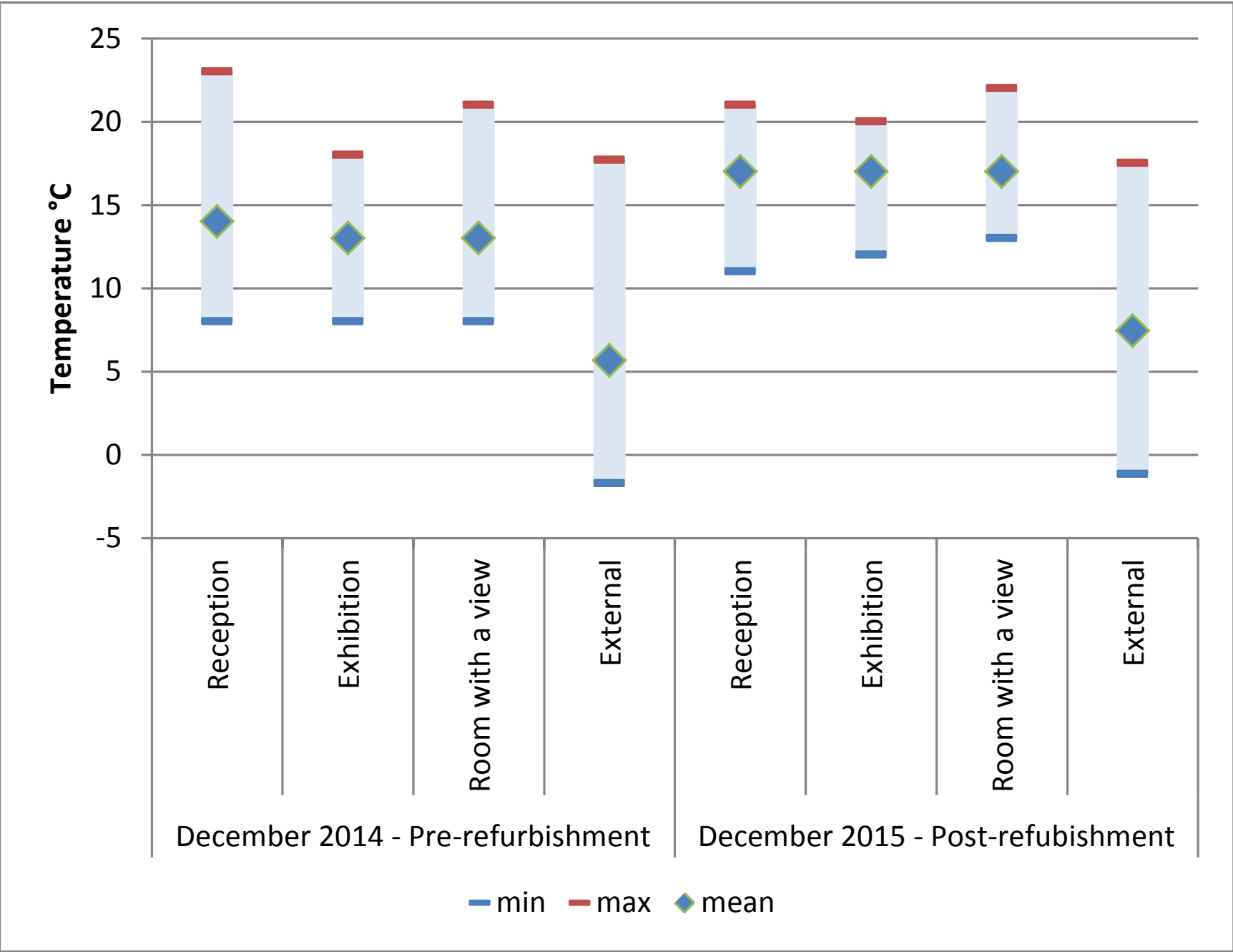


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Results – Electrical Energy

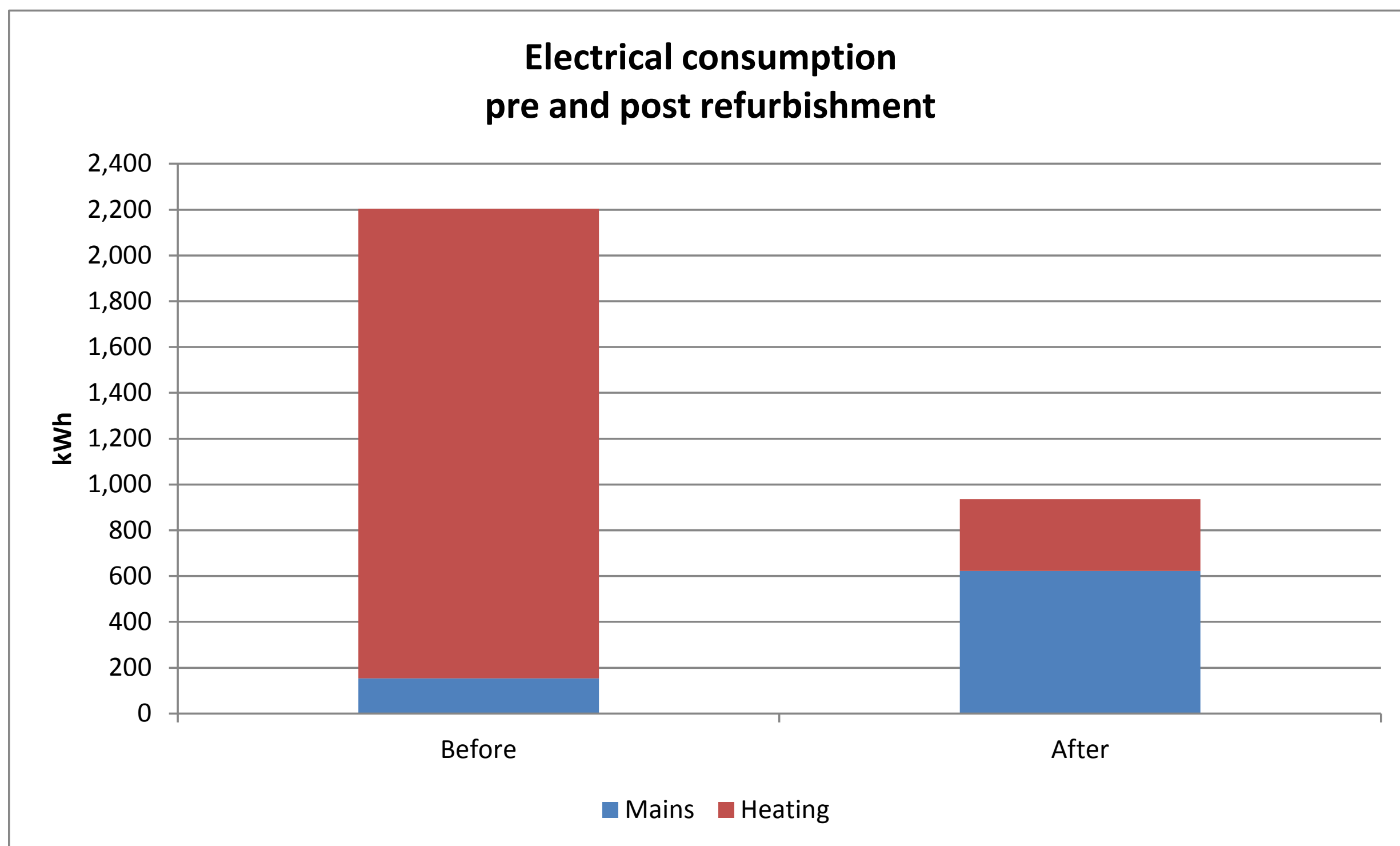




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- Draughts reduced by 85%
- Less heat loss through walls, floor and roofs reduced
- More energy efficient heating and lighting installed
- Energy use reduced by 57%
- Clients can open throughout the year and heat the building to more than 16°C!



Thank You

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Janice Foster j.foster@gsa.ac.uk 0141 353 4536