

Form finding

This exercise showed interesting results and changes that influenced form and massing in the design development stages.

Iteration 1

EDUCATIONAL LICENCE, NOT FOR PROFESSIONAL USE (expires in 75 days)
 Climate: GB0005a - Exeter
 Building type: School
 12.2 kWh/m²a
 TFA 901 m² (Direct entry)
 Heat Loss Form Factor 4.13

Heat balance

Category	Losses (kWh/m ² a)	Gains (kWh/m ² a)
Transmission heat loss (opaque surfaces)	18.9	18.4
Transmission heat loss (windows)	13.5	15.0
Transmission heat loss (thermal bridges)	17.9	9.4
Transmission heat loss (ventilation)	15.0	0.2
Solar heat gains	0.0	16.9
Internal heat gains	0.0	5.1
Non-useful heat gains	0.0	0.2
Specific ann. heat demand	0.0	3.2
Internal heat gains	0.0	5.1
Solar heat gains	0.0	16.9

The step forward - Improvement to typical Passivhaus U-values for thermal elements, including best performance windows and doors PH certified products.

Iteration 2

EDUCATIONAL LICENCE, NOT FOR PROFESSIONAL USE (expires in 75 days)
 Climate: GB0005a - Exeter
 Building type: School
 15.5 kWh/m²a
 TFA 901 m² (Direct entry)
 Heat Loss Form Factor 3.57

Heat balance

Category	Losses (kWh/m ² a)	Gains (kWh/m ² a)
Transmission heat loss (opaque surfaces)	2.6	19.4
Transmission heat loss (windows)	17.1	13.5
Transmission heat loss (thermal bridges)	20.0	9.4
Transmission heat loss (ventilation)	15.0	0.2
Solar heat gains	0.0	16.9
Internal heat gains	0.0	5.1
Non-useful heat gains	0.0	0.2
Specific ann. heat demand	0.0	3.2
Internal heat gains	0.0	5.1
Solar heat gains	0.0	16.9

The step forward - Reducing the glazing surface areas to rooflights and south-facing/south-west facing windows, adjusting window reveals and adding external shading devices.

EDUCATIONAL LICENCE, NOT FOR PROFESSIONAL USE (expires in 70 days)
 Climate: GB0005a - Exeter
 Building type: Office / Admin. building
 9.4 kWh/m²a
 TFA 885 m² (Drawn TFA surfaces)
 Heat Loss Form Factor 3.74

Overview Results Heat balance Climate Vent.+IHG Areas U-value editor Assemblies Components Shading

Transmission heat loss (opaque surfaces)

Area group	Total area (m ²)	Area weighted U-value (W/m ² K)	Av. temp. factor	Ann. Htg. degree hours (kWh/a)	Transmission heat losses (kWh/a)	Q _t (kWh/m ² a)
7 - External Door	15.51	0.55	1.00	60.00	504.49	3.29
8 - External Wall - Ambient	399.69	0.10	1.00	60.00	2399.39	2.71
9 - External Wall - Ground	0.00	0.00	1.00	60.00	0.00	0.00
10 - Roof/Ceiling - Ambient	1666.95	0.09	1.00	60.00	9600.14	10.17
11 - Floor slab / Basement ceiling	990.43	0.11	0.60	60.00	3912.45	4.42
12 -	0.00	0.00	1.00	60.00	0.00	0.00
13 -	0.00	0.00	1.00	60.00	0.00	0.00
14 - Temperature zone X	0.00	0.00	1.00	60.00	0.00	0.00
15 - Partition Wall to Neighbour	0.00	0.00	1.00	60.00	0.00	0.00
Total	3072.98				18026.48	17.89

Transmission heat loss (windows)

Area group	Total area (m ²)	Area weighted U-value (W/m ² K)	Av. temp. factor	Ann. Htg. degree hours (kWh/a)	Transmission heat losses (kWh/a)	Q _t (kWh/m ² a)
2 - North Windows	78.56	0.85	1.00	60.00	4024.85	4.58
3 - East Windows	41.86	0.93	1.00	60.00	2338.32	2.63
4 - South Windows	20.66	0.93	1.00	60.00	1152.80	1.30
5 - West Windows	41.95	0.87	1.00	60.00	2191.23	2.49
6 - Horizontal Windows	54.00	0.97	1.00	60.00	3166.72	3.58
Total	237.04				12863.93	14.53

Transmission heat loss (thermal bridges)

Area group	Total length (m)	Average Psi-value (W/mK)	Av. temp. factor	Ann. Htg. degree hours (kWh/a)	Transmission heat losses (kWh/a)	Q _t (kWh/m ² a)
15 - Thermal Bridges Ambient	79.23	0.04	1.00	60.00	180.56	0.20
16 - Penetrator Thermal Bridges	0.00	0.00	1.00	60.00	0.00	0.00
17 - Thermal Bridges Floor Slab / Basement Ceiling	0.00	0.00	1.00	60.00	0.00	0.00
Total	79.23				180.56	0.20

Ventilation heat losses

Ventilation system	Energy effective air change rate (1/h)	Ventilation volume (m ³)	Heat capacity of air	Ann. Htg. degree hours (kWh/a)	Ventilation heat losses (kWh/a)	Q _v (kWh/m ² a)
Infiltration	0.0455	2478.56	0.33	60.00	2234.49	2.52
Infiltration	0.0462	2478.56	0.33	60.00	2267.29	2.56
Total	0.0917				4501.78	5.09

Solar heat gains

Area group	Win. area (m ²)	Glazing area (m ²)	g-value	Reduction factor	Radiation, Q _s (kWh/a)	Solar heat gains (kWh/a)	Q _s (kWh/m ² a)
2 - North Windows	78.56	52.19	0.50	0.44	101.72	1747.02	1.97
3 - East Windows	41.86	27.67	0.50	0.45	299.20	2038.81	3.21
4 - South Windows	20.66	12.32	0.50	0.33	356.24	1220.94	1.40
5 - West Windows	41.95	29.34	0.50	0.38	169.25	1364.07	1.54
6 - Horizontal Windows	54.00	40.68	0.50	0.59	336.99	574.96	6.52
Total	237.04	162.20			1296.30	14.66	

Internal heat gains

Treated Floor Area (m ²)	Internal heat gain rate (W/m ²)	Heating period (days)	Heating period (h/a)	Internal heat gains (kWh/a)	Q _i (kWh/m ² a)
885.20	3.50	201.00	4.82	14945.74	16.88

Iteration 3

Heat balance

Heat flows (kWh/m²a)

Category	Value (kWh/m ² a)
Transmission heat loss (opaque surfaces)	3.2
Transmission heat loss (thermal bridges)	14.5
Ventilation heat losses	5.1
Transmission heat loss (windows)	17.9
Non-useful heat gains	0.2
Specific ann. heat demand	3.2
Internal heat gains	16.9
Solar heat gains	9.4

Project overview

Climate: Exeter
 Building type: Office / Admin. building

Annual heat demand (Q_d): 9.4 kWh/m²a
 Treated Floor Area (TFA): 885 m² (Drawn TFA surfaces)
 Thermal envelope area: 3311 m²
 Heat Loss Form Factor: 3.74
 Projected building footprint: --- m²

Number of windows: 82
 Number of thermal surfaces: 91
 Number of thermal bridges: 15

Thermal envelope checks
 The thermal envelope appears to be complete!

Glazing (user-defined)

ID	Description	g-value	U-value (W/m ² K)
01ud	Windows	0.5	0.65
02ud	External doors	0.6	0.66
03ud	Rooflights	0.6	0.65

U-value editor

Assembly ID: 02ud

Layer	Material	Thickness (m)	U-value (W/m ² K)
1	External door	0.08	0.66
2	External door	0.08	0.66
3	External door	0.08	0.66
4	External door	0.08	0.66
5	External door	0.08	0.66
6	External door	0.08	0.66
7	External door	0.08	0.66
8	External door	0.08	0.66

Results tracker - Chart (stacked)

Heat flows (kWh/m²a)

- Transmission heat loss (opaque surfaces)
- Transmission heat loss (thermal bridges)
- Ventilation heat losses
- Transmission heat loss (windows)
- Non-useful heat gains
- Specific ann. heat demand
- Internal heat gains
- Solar heat gains



DAYANA ANASTASOVA

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Design & development:

- The scheme comprises of a cluster of buildings situated on a floating pontoon. For the Design PH analysis only the thermal elements, i.e. the buildings are taken into calculations.
- The orientation was initially determined via analysis results, 46 degrees to the north-west axis achieved best performance. The design development explored manipulations in massing according to the heat loss factor results - the greater the treated floor area and fewer external walls secured better performance. The glazing surfaces were minimised to reduce heat losses. External shading features are added to south and south-west facing façades to prevent unwanted overheating.