Paul Bastick Associates

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London W11 2PD

Site: 12-13 Kings Mews | **Made by JWL**
Job: SAPS | **Page 1**
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Building Summary

			Orient	Area m^2 Gross	Open	U-value	Total heat loss W/K
Wall	1:	ground / first front	F	42.00	12.91	0.27	33.11
	2:	side wall	L	48.00	0.00	0.27	13.15
	3:	rear (sx)	B	35.00	1.89	0.27	12.41
GdFlr	1:	ground floor	N/A	56.00	0.00	0.06	3.41
Roof	1:	first floor	?	56.00	0.00	0.13	7.03
							Total: 69.10

Breakdown by element type:		Area		
Wall	kings mews existing	110.19	0.27	29.75
Gd floor	U-value based on shape factor	56.00	0.06	3.41
Roof	coach house flat roof	56.00	0.13	7.03
Window	DG wood 16mm gap argon low-E (en=0.15)	12.91	1.77	22.86
Door	Solid wood	1.89	3.00	5.67

Window U-values include curtain factor adjustment (SAP-2005 §3.2)

Average/maximum U-values: Walls: 0.27/0.27; Floors: 0.06/0.06
Roofs: 0.13/0.13; Openings: 2.04/3.00

Floor area: 112.00m^2 Living area fraction: 0.43 Internal volume: 280m^3

Front faces: NE

Storeys: 2 Chimneys: 1 Flues: 0 Fans: 5 Flueless gas heaters: 0 Sheltered sides: 1

Pressure test: None - default infiltration used:
Masonry construction; no draught lobby; 100% draught stripping:

Natural ventilation with intermittent extract fans

Low energy lighting: 70% of fixed lighting points (30% assumed for DER/TER calculations)

Primary heating system: Air-to-air heat pump warm air system
Zone control (delayed start stat)
Fuel: Electricity (standard tariff)

Secondary heating system: Closed room heater- HETAS approved
Fuel: Wood pellets (bagged)

Domestic hot water supply: Dual immersion heater
200 litre cylinder, 100mm factory-insulated
Electricity (standard tariff)

SAP 2005 Rating 64 Band D
EI Rating 78 Band C

Total CO_2 emissions = 2.57 tonnes/year

These calculations should not be accepted without first checking the input data

Important design features
One or more walls has a U-value of less than 0.28
One or more floors has a U-value of less than 0.20
One or more roofs has a U-value of less than 0.15

Elements of construction used in building

Walls

kings mews existing

1	:	25mm	External rendering	25/0.57x1000 = 0.044
2	:	75mm	kingspan	75/0.022x1000 = 3.409
3	:	225mm	Brickwork (outer leaf)	225/0.77x1000 = 0.292
4	:	12.5mm	Plasterboard 9.5mm	9.5/0.21x1000 = 0.045
5	:	3	Plaster (lightweight)	3/0.18x1000 = 0.017
6	:	N/A	Wall inside surface	0.13 = 0.130
				3.937
				Unadjusted U-value = 1/3.937 = 0.254

Add correction(s) to U-value (Table A4)

External insulation fixed with screws or nails penetrating insulation: 0.020

Adjusted U-value = 0.27

Ground floor

U-value has been calculated using BS EN 13370:1998

Location: ground floor
Solid ground floor: three exposed edges (2x70.00m + 80.00m)
Exposed perimeter = 220.00m Area = 5600.00m^2
B = 5600.00/(0.5 x 220.00) = 50.909
Subsoil type: Clay/unknown λ = 1.5 External wall thickness: 300mm
O/A insulation: 75mm kingspan
Thermal resistance of insulation, R_f = 75x1/0.022x1000 = 3.409
U-value of floor without edge insulation, U_f = 0.06
Horizontal edge insulation: 75mm kingspan, 75mm wide
Thermal resistance of edge insulation, 75x1/0.022x1000 = 3.41
Additional thermal resistance for edge insulation R' = 3.409 - 0.075/1.5 = 3.359
Additional equivalent thickness, d' = 3.359 x 1.5 = 5.039
d_f = 5.73m.
Edge insulation reduction factor, $\Delta\psi$ = 0.003
ΔU for edge insulation = 2 x 0.003/50.909 = 0.000
U-value of insulated floor = 0.06 - 0.00 = 0.06

Roof

coach house flat roof

1	:	N/A	Roof outside surface	0.04 = 0.040		0.040
2	:	13mm	Stone chippings	13/2.0x1000 = 0.007		0.007
3	:	3mm	Felt/bitumen roofing	3/0.23x1000 = 0.013		0.013
4	:	150mm	Phenolic foam slab 30kg/m3	150/0.025x1000 = 6.000		6.000
5	:	200mm	Timber floor/deck/sheathing	200/0.13x1000 = 1.538		1.538
6 A	:	150mm	Flat roof void	0.16 = 0.160	0.900)	
6 B	:	150mm	Timber floor/deck/sheathing	150/0.13x1000 = 1.154	0.100)-	0.175
7	:	N/A	Plasterboard 12.5mm	12.5/0.21x1000 = 0.060		0.060
8	:		Roof inside surface	0.10 = 0.100		0.100
				Proportion/Resistance		R_{lower} = 7.933
				Heat path A: 0.900/7.918 = 0.114		
				B: 0.100/8.911 = 0.011		
				R_{upper} = 1/(0.114+0.011) = 8.007		

Total resistance, R_T = (8.007+7.933)/2 = 7.970 U-value = 1/7.970 = 0.13

Add correction(s) to U-value (Table A4)

Insulation between and over joists or rafters: 0.000

Adjusted U-value = 0.13

Doors and windows	*U-value*	*Solar Transmittance*	*Frame Factor*
DG wood frame window 16mm gap argon low-E (en=0.15)	1.90	0.72	0.70
Solid wood door	3.00	0.00	0.70

Building heat loss calculations

Building use: **Existing dwelling**

Walls

Location: **ground / first front** Orientation: F

kings mews existing U-Value = 0.274

Areas (m^2) :- Gross: 42.00 Opening(s): 12.91 Net: 29.09

	Area x U-value	W/K
Heat loss through solid area	29.09 x 0.274 =	7.97
Heat loss through openings:		
1: DG wood frame window 16mm gap argon low-E (en=0.15)	2x1.2x1.05 = 2.52 x 1.766 (1.9) =	4.45
2: DG wood frame window 16mm gap argon low-E (en=0.15)	0.9x1.05 = 0.94 x 1.766 (1.9) =	1.67
3: DG wood frame window 16mm gap argon low-E (en=0.15)	2x2.0x1.8 = 7.20 x 1.766 (1.9) =	12.71
4: DG wood frame window 16mm gap argon low-E (en=0.15)	0.9x0.4 = 0.36 x 1.766 (1.9) =	0.64
5: Solid wood door	0.9x2.1 = 1.89 x 3.0 =	5.67
	Total heat loss =	**33.11**

Location: **side wall** Orientation: L

kings mews existing U-Value = 0.274

Area = 48.00 m^2 **Heat loss = 48.00 x 0.274 = 13.15 W/K**

Location: **rear** Orientation: B

kings mews existing U-Value = 0.274

Areas (m^2) :- Gross: 35.00 Opening(s): 1.89 Net: 33.11

	Area x U-value	W/K
Heat loss through solid area	33.11 x 0.274 =	9.07
Heat loss through openings:		
1: DG wood frame window 16mm gap argon low-E (en=0.15)	2x0.9x1.05 = 1.89 x 1.766 (1.9) =	3.34
	Total heat loss =	**12.41**

Ground Floor

Location: **ground floor**

Floor type: Solid ground floor: three exposed edges (2x70.00m + 80.00m)
O/A insulation: 75mm kingspan
Horizontal edge insulation: 75mm kingspan, 75mm wide
U-value of insulated floor = 0.06

Area = 56.00 m^2 **Heat loss = 56.00 x 0.06 = 3.41 W/K**

Roof

Location: **first floor** Orientation: ?

coach house flat roof U-Value = 0.125

Area = 56.00 m^2 **Heat loss = 56.00 x 0.125 = 7.03 W/K**

Total building heat loss = 69.10 W/K *C/F to SAP/DER worksheets [33]*

Thermal bridges: Use default loss of 0.08 x ΣA_{exp} *(Accredited Construction Details)* = 0.08 x 237.00 = **18.96 W/K**
C/F to SAP/DER worksheets [34]

Window U-values include curtain factor adjustment; unadjusted U-value shown in brackets (# denotes user-entered U-value)

Solar-related calculations
Solar gains through openings during heating season

#	Opening	0.9 x Area x Flux x Trans x FF x SAF	Gain (W)
ground / first front	**Orientation: F (NE/NW)**		
1	Double-glazed (Low-E hard coat) window	0.9 x 2.52 x 34 x 0.72 x 0.7 x 0.77 =	30
2	do.	0.9 x 0.94 x 34 x 0.72 x 0.7 x 0.77 =	11
3	do.	0.9 x 7.20 x 34 x 0.72 x 0.7 x 0.77 =	86
4	do.	0.9 x 0.36 x 34 x 0.72 x 0.7 x 0.77 =	4
rear	**Orientation: B (SE/SW)**		
1	Double-glazed (Low-E hard coat) window	0.9 x 1.89 x 64 x 0.72 x 0.7 x 0.54 =	30
		Total Solar Gain *C/F to SAP/DER worksheets [65]*	**161W**

Lighting

Light transmission through windows and rooflights

ground / first front	**Orientation: F (NE/NW)**		
1	DG wood frame window 16mm gap argon low-E (ε_n=0.15)	0.9 x 2.52 x 0.7 x 0.80 x 0.83 =	1.05
2	do.	0.9 x 0.94 x 0.7 x 0.80 x 0.83 =	0.40
3	do.	0.9 x 7.20 x 0.7 x 0.80 x 0.83 =	3.01
4	do.	0.9 x 0.36 x 0.7 x 0.80 x 0.83 =	0.15
5	Solid wood door		0.00
rear	**Orientation: B (SE/SW)**		
1	DG wood frame window 16mm gap argon low-E (ε_n=0.15)	0.9 x 1.89 x 0.7 x 0.80 x 0.67 =	0.64
		Total light input	5.25

G_L = 5.25/112.00 = 0.047 C_2 = 1.082

Low energy lighting fixed outlets: 70% C_1 = 1 - 0.50 x70/100 = 0.65
Electricity used for lighting, $E_l = E_R.TFA.C_1.C_2$ = 9.3 x 112.0 x 0.65 x 1.082 = **732** *C/F to SAP worksheet [93]*
Reduction in energy use due to low energy lights, $\Delta_{El} = E_R.TFA.(1-C_1).C_2$ = 9.3 x 112.0 x (1-0.65) x 1.082 = 394
Reduction in gains, $\Delta_{gains} = 0.15\Delta E_L$ = 0.15 x 394 = **59** *C/F to SAP worksheet [53a]*

DER calculation assumes 30% low energy lighting fixed outlets C_1 = 1 - 0.50 x 30/100 = 0.85
Electricity used for lighting, $E_l = E_R.TFA.C_1.C_2$ = 9.3 x 112.0 x 0.85 x 1.082 = **958** *C/F to DER worksheet [109]*
Reduction in energy use due to low energy lights, $\Delta_{El} = E_R.TFA.(1-C_1).C_2$ = 9.3 x 112.0 x (1-0.85) x 1.082 = 169
Reduction in gains, $\Delta_{gains} = 0.15\Delta E_L$ = 0.15 x 169 = **25** *C/F to DER worksheet [53a]*

Solar Panel: none

Solar gains through openings during summer

No daytime shading assumed
Ventilation: trickle vents only 2-storeys Cross-ventilation possible: Y
Ventilation rate in hot weather = 0.2 ACH
Summer ventilation heat loss = 0.33 x 0.2 x 280.0 [6] = 18
Total summer heat loss = 88 [35] + 18 = 107W/K

#	Opening	0.9 x Area x Flux x Trans x FF x SAF	Gain (W)
ground / first front	**Orientation: F (NE/NW)**		
1	Double-glazed (Low-E hard coat) window	Average: 0.9 x 2.52 x 89 x 0.72 x 0.7 x 0.90 =	92
2	do.	Average: 0.9 x 0.94 x 89 x 0.72 x 0.7 x 0.90 =	34
3	do.	Average: 0.9 x 7.20 x 89 x 0.72 x 0.7 x 0.90 =	262
4	do.	Average: 0.9 x 0.36 x 89 x 0.72 x 0.7 x 0.90 =	13
5	Solid door		0
rear	**Orientation: B (SE/SW)**		
1	Double-glazed (Low-E hard coat) window	More: 0.9 x 1.89 x 112 x 0.72 x 0.7 x 0.70 =	67
		Total Solar Gain	**468W**

Total summer gains, G = 468 + 725 [55] = 1192

Summer Gain/Loss ratio = 1192/107 = 11.19
Region: South East Mean summer air temperature = 16℃
Thermal mass parameter, TMP = 11 (Table P7)
$\Delta T_{mass} = 0$
$T_{threshold} = 16.00 + 11.19 + 0 = 27.19℃$
Likelihood of high internal temperatures during summer weather: **HIGH !**

SAP Worksheet (Version 9.80)

Calculation of Energy Rating

Overall Dwelling Dimensions

	Area m^2	Avg ht m.	Vol. m^3	
Ground/entrance level:	56.00	2.70	151.20	[1]
First:	56.00	2.30	128.80	[2]
	Total floor area: 112.00 [5]		Volume: 280.00	[6]

Ventilation Rate	ACH	
Chimneys:	1 x 40/280.00 = 0.14	[7]
Fans and passive vents:	5 x 10/280.00 = 0.18	[9]
Infiltration due to chimneys, flues and fans:	0.32	[10]
2 storeys: additional infiltration:	(2 - 1) x 0.1 = 0.10	[12]
Structural infiltration (masonry):	0.35	[13]
Additional infiltration due to no draught lobby:	0.05	[15]
100% of windows and doors are draught stripped:		[16]
Resulting infiltration:	0.25-(0.2 x 100/100) = 0.05	[17]
Infiltration rate:	0.87	[19]
1 sheltered side: shelter factor = 0.925		[21]
Adjusted infiltration rate = 0.87 x 0.93	0.81	[22]
Natural ventilation:		
Effective air change rate	0.82	[24]
	0.82	[25]

Heat Loss Summary	W/K	
Heat loss through structure (b/f from building summary):	69.10	[33]
Thermal bridges 0.08 x 237.00:	18.96	[34]
Total fabric heat loss:	88.06	[35]
Ventilation heat loss:	0.82 [25] x 0.33 x 280.00 [6] = 76.22	[36]
Specific heat loss:	164.28	[37]
Heat loss parameter:	164.28/112.0 = 1.47	[38]

Water Heating Energy Requirements	kWh/year	
Source: Dual immersion heater		
Fuel: Electricity (standard tariff)		
Energy content of heated water (Table 1a N=3.443):	2249	[39]
Distribution loss (Table 1b):	397	[40]
Cylinder volume = 200 litres		[43]
Cylinder loss factor: 0.0103 (Table 2)		[44]
Volume factor: 0.8434 (Table 2a)		[44a]
Temperature factor: 0.6 (Table 2b)		[44b]
Energy lost from store:	200 x 0.0103 x 0.8434 x 0.6 x 365 = 380	[47]
Primary circuit loss :	0	[48]
Solar input:	0	[50]
Required output from water heater:	3026	[51]
Heat gains from water heating:	0.25 x 2249 + 0.8 x (397+380) = 1184	[52]

Gains	Watts	
Lighting, appliance & metabolic gains (Table 5 N=3.443):	632	[53]
Reduction due to low energy lighting (70%):	-59	[53a]
Heating system fan: 16.8		
Total additional gains	17	[53b]
Water heating:	1184/8.72 = 135	[54]
Total internal gains:	725	[55]
Total solar gains (B/F from solar-related report):	161	[65]
Total gains	885	[66]
Gains/Loss ratio (GLR) = 885/164.3 [37] = 5.389		[67]
Utilisation factor (Table 7): 0.96		[68]
Useful gains:	885 x 0.96 = 854	[69]

Mean internal temperature ºC

Living area mean temperature: Table 8 col.1; HLP [38] = 1.47		18.88	[70]
Control adjustment (Table 4e)		-0.15	[71]
Heating system responsiveness (R) = 1.00 (Table 4a)			
Adjustment for gains:	0.2 x R x ((854 [69]/164.3 [37]) - 4.0) =	0.24	[72]
Adjusted living room temperature:		18.97	[73]
Temperature difference between zones : (Table 9 col 3)		1.91	[74]
Living area fraction: 0.43			[75]
Rest-of-house fraction: 0.57			[76]
Mean internal temperature:	18.97 - (1.91 x 0.57) =	17.88	[77]

Degree Days

Temperature rise from gains:	854 [69]/164.3 [37] =	5.20	[78]
Base temperature:	17.88 - 5.20 =	12.68	[79]
Degree days (Table 10):		1490	[80]

Space heating requirements kWh/year

Energy requirement (useful):	0.024 x 1490 x 164.3 [37] =	5874	[81]
Heat from secondary system: 10% (Table 11)			[82]
Primary system: Air-to-air heat pump warm air system Controls: Zone control Fuel: Electricity (standard tariff) Efficiency: 250% (Table 4a)			[83]
Fuel required:	5874 x 0.90 x 100/250 =	2115	[85]
Secondary system: Closed room heater- HETAS approved Fuel: Wood pellets (bagged) Efficiency: 65% (Table 4a)			[84]
Fuel required:	5874 x 0.10 x 100/65 =	904	[85a]
Water heating energy requirement (net): 3026 kW [51] Source: Dual immersion heater Efficiency : 100%			[86]
Energy required:	3026 [51] x 100/100 =	3026	[86a]
Electricity for pumps & fans:		168	[87]
Electricity for lighting (B/F from Solar report)		732	

Fuel Costs £/year

Space heating:	Primary system:	2115 x 7.12p =	150.56	[88]
	Secondary system:	904 x 5.00p =	45.18	[89]
Water heating:		3026 x 7.12p =	215.45	[91b]
Pump/fan energy cost:		168 x 7.12p =	11.96	[92]
Lighting energy cost:		732 x 7.12p =	52.15	[93]
Total heating cost:			475.31	[97]

SAP Rating

Energy cost deflator (Table 12, footnote 2):		0.91	[98]
Energy cost factor (ECF) £/m^2:	(475.31 x 0.91 - 30)/(112.00 + 45.0) =	2.56	[99]
SAP value = 64.2083			[100]

SAP Rating = 64 Band D

CO_2 Emissions kg/year

Primary heating system (electricity)	2115 [85] x 0.422 =	892	[101]
Secondary heating system (wood)	904 [85a] x 0.025 =	23	[102]
Water heating (electricity)	3026 [86a] x 0.422 =	1277	[103]
Total for space and water heating		2192	[107]
Electricity for pumps and fans	168 [87] x 0.422 =	71	[108]
Electricity for lighting, C_L	732 x 0.422 =	309	[109]
New technology: None:			
	Total:	2,572	[112]

Carbon Factor, CF = 2572/(112.00 + 45) = 16.38 EI = 78.00

EI Rating = 78 Band C

Primary energy	Energy kWh/Yr	Primary Factor	P.Energy kWh/yr	
Space heating	2115	2.80	5921	[101]
Secondary heating	904	1.10	994	[102]
Water heating	3026	2.80	8473	[103]
Electricity for pumps and fans	168	2.80	470	[108]
Electricity for lighting	732	2.80	2051	[109]
New Technology: Energy saved	0	0.00	0	[110]
New Technology: Energy used	0	0.00	0	[111]
	Primary energy kWh/year		**17,909**	[112]
	Primary energy kWh/year/m^2		**160**	[113]

SAP Worksheet (Version 9.80)

Dwelling Carbon Dioxide Emission Rate (DER) Calculation

Overall Dwelling Dimensions

	Area m^2	Avg ht m.	Vol. m^3	
Ground/entrance level:	56.00	2.70	151.20	[1]
First:	56.00	2.30	128.80	[2]
Total floor area:	112.00 [5]	Volume:	280.00	[6]

Ventilation Rate	ACH	
Chimneys:	1 x 40/280.00 = 0.14	[7]
Fans and passive vents:	5 x 10/280.00 = 0.18	[9]
Infiltration due to chimneys, flues and fans:	0.32	[10]
2 storeys: additional infiltration:	(2 - 1) x 0.1 = 0.10	[12]
Structural infiltration (masonry):	0.35	[13]
Additional infiltration due to no draught lobby:	0.05	[15]
100% of windows and doors are draught stripped:		[16]
Resulting infiltration:	0.25-(0.2 x 100/100) = 0.05	[17]
Infiltration rate:	0.87	[19]
1 sheltered side: shelter factor = 0.925		[21]
Adjusted infiltration rate = 0.87 x 0.93	0.81	[22]
Natural ventilation:		
Effective air change rate	0.82	[24]
	0.82	[25]

Heat Loss Summary	W/K	
Heat loss through structure (b/f from building summary):	69.10	[33]
Thermal bridges 0.08 x 237.00:	18.96	[34]
Total fabric heat loss:	88.06	[35]
Ventilation heat loss:	0.82 [25] x 0.33 x 280.00 [6] = 76.22	[36]
Specific heat loss:	164.28	[37]
Heat loss parameter:	164.28/112.0 = 1.47	[38]

Water Heating Energy Requirements	kWh/year	
Source: Dual immersion heater		
Fuel: Electricity (standard tariff)		
Energy content of heated water (Table 1a N=3.443):	2249	[39]
Distribution loss (Table 1b):	397	[40]
Cylinder volume = 200 litres		[43]
Cylinder loss factor: 0.0103 (Table 2)		[44]
Volume factor: 0.8434 (Table 2a)		[44a]
Temperature factor: 0.6 (Table 2b)		[44b]
Energy lost from store:	200 x 0.0103 x 0.8434 x 0.6 x 365 = 380	[47]
Primary circuit loss :	0	[48]
Solar input:	0	[50]
Required output from water heater:	3026	[51]
Heat gains from water heating:	0.25 x 2249 + 0.8 x (397+380) = 1184	[52]

Gains	Watts	
Lighting, appliance & metabolic gains (Table 5 N=3.443):	632	[53]
Reduction due to low energy lighting (30% assumed):	-25	[53a]
Heating system fan: 16.8		
Total additional gains	17	[53b]
Water heating:	1184/8.72 = 135	[54]
Total internal gains:	758	[55]
Total solar gains (B/F from solar-related report):	161	[65]
Total gains	919	[66]
Gains/Loss ratio (GLR) = 919/164.3 [37] = 5.594		[67]
Utilisation factor (Table 7): 0.96		[68]
Useful gains:	919 x 0.96 = 882	[69]

Mean internal temperature °C

Living area mean temperature: Table 8 col.1; HLP [38] = 1.47	18.88	[70]
Control adjustment (Table 4e)	-0.15	[71]
Heating system responsiveness (R) = 1.00 (Table 4a)		
Adjustment for gains:	0.2 x R x ((882 [69]/164.3 [37]) - 4.0) = 0.27	[72]
Adjusted living room temperature:	19.00	[73]
Temperature difference between zones : (Table 9 col 3)	1.91	[74]
Living area fraction: 0.43		[75]
Rest-of-house fraction: 0.57		[76]
Mean internal temperature:	19.00 - (1.91 x 0.57) = 17.91	[77]

Degree Days

Temperature rise from gains:	882 [69]/164.3 [37] = 5.37	[78]
Base temperature:	17.91 - 5.37 = 12.54	[79]
Degree days (Table 10):	1459	[80]

Space heating requirements kWh/year

Energy requirement (useful):	0.024 x 1459 x 164.3 [37] = 5754	[81]
Heat from secondary system: 10% (Table 11)		[82]
Primary system: Air-to-air heat pump warm air system Controls: Zone control Fuel: Electricity (standard tariff) Efficiency: 250% (Table 4a)		[83]
Fuel required:	5754 x 0.90 x 100/250 = 2072	[85]
Secondary system: Closed room heater- HETAS approved Fuel: Wood pellets (bagged) Efficiency: 65% (Table 4a)		[84]
Fuel required:	5754 x 0.10 x 100/65 = 885	[85a]
Water heating energy requirement (net): 3026 kW [51] Source: Dual immersion heater Efficiency : 100%		[86]
Energy required:	3026 [51] x 100/100 = 3026	[86a]
Electricity for pumps & fans:	168	[87]
Electricity for lighting (B/F from Solar report)	958	

CO_2 Emissions kg/year

Primary heating system (electricity)	2072 [85] x 0.422 =	874	[101]
Secondary heating system (wood)	885 [85a] x 0.025 =	22	[102]
Water heating (electricity)	3026 [86a] x 0.422 =	1277	[103]
Total for space and water heating		2173	[107]
Electricity for pumps and fans	168 [87] x 0.422 =	71	[108]
Electricity for lighting, C_L	958 x 0.422 =	404	[109]
New technology: None:			
	Total:	2,648	[112]

Dwelling Carbon Dioxide Emission Rate (DER) = 23.65 (2,648/112.00)

SAP Worksheet (Version 9.80)

Target Carbon Dioxide Emission Rate (TER) Calculation

	Area	U-Value	Heat Loss W/K
Walls (net)	97.00	0.35	33.95
DG wood frame window 16mm gap low-E glass (en=0.2)	26.15	2.00	48.43
Solid wood door	1.85	2.00	3.70
Floors	56.00	0.25	14.00
Roofs	56.00	0.16	8.96
Total heat loss (C/F to [33]			109.04

Overall Dwelling Dimensions

	Area m^2	Avg ht m.	Vol. m^3	
Ground/entrance level:	56.00	2.70	151.20	[1]
First:	56.00	2.30	128.80	[2]
Total floor area:	112.00 [5]	Volume:	280.00	[6]

Ventilation Rate	ACH	
Fans and passive vents:	3 x 10/280.00 = 0.11	[9]
Infiltration due to chimneys, flues and fans:	0.11	[10]
Default q_{50} value = 10.00	10.00/20 = 0.50	
Infiltration rate:	0.61	[19]
2 sheltered sides: shelter factor = 0.85		[21]
Adjusted infiltration rate = 0.61 x 0.85	0.52	[22]
Natural ventilation:		
Effective air change rate	0.63	[24]
	0.63	[25]

Heat Loss Summary	W/K	
Heat loss through structure (from above):	109.04	[33]
Thermal bridges 0.11 x 237.00:	26.07	[34]
Total fabric heat loss:	135.11	[35]
Ventilation heat loss:	0.63 [25] x 0.33 x 280.00 [6] = 58.50	[36]
Specific heat loss:	193.61	[37]
Heat loss parameter:	193.61/112.0 = 1.73	[38]

Water Heating Energy Requirements	kWh/year	
Source: Primary heating system (Gas boiler, automatic ignition, 1998 or later)		
Fuel: Mains Gas		
Energy content of heated water (Table 1a N=3.443):	2249	[39]
Distribution loss (Table 1b):	397	[40]
Cylinder volume = 150 litres		[43]
Cylinder loss factor: 0.0191 (Table 2)		[44]
Volume factor: 0.9283 (Table 2a)		[44a]
Temperature factor: 0.54 (Table 2b)		[44b]
Energy lost from store:	150 x 0.0191 x 0.9283 x 0.54 x 365 = 524	[47]
Primary circuit loss :	610	[48]
Solar input:	0	[50]
Required output from water heater:	3780	[51]
Heat gains from water heating:	0.25 x 2249 + 0.8 x (397+524+610) = 1787	[52]

Gains	Watts	
Lighting, appliance & metabolic gains (Table 5 N=3.443):	632	[53]
Reduction due to low energy lighting (30% assumed):	-22	[53a]
Central heating pump: 10.0		
Total additional gains	10	[53b]
Water heating:	1787/8.72 = 204	[54]
Total internal gains:	823	[55]

Total solar gains (B/F from solar-related report):		438	[65]
Total gains		1,262	[66]
Gains/Loss ratio (GLR) = 1262/193.6 [37] = 6.517			[67]
Utilisation factor (Table 7): 0.94			[68]
Useful gains:	1262 x 0.94 =	1,182	[69]
Mean internal temperature		ºC	
Living area mean temperature: Table 8 col.1; HLP [38] = 1.73		18.87	[70]
Control adjustment (Table 4e)		0.00	[71]
Heating system responsiveness (R) = 1.00 (Table 4d)			
Adjustment for gains:	0.2 x R x ((1182 [69]/193.6 [37]) - 4.0) =	0.42	[72]
Adjusted living room temperature:		19.29	[73]
Temperature difference between zones : (Table 9 col 2)		1.53	[74]
Living area fraction: 0.43			[75]
Rest-of-house fraction: 0.57			[76]
Mean internal temperature:	19.29 - (1.53 x 0.57) =	18.42	[77]
Degree Days			
Temperature rise from gains:	1182 [69]/193.6 [37] =	6.11	[78]
Base temperature:	18.42 - 6.11 =	12.31	[79]
Degree days (Table 10):		1410	[80]
Space heating requirements		kWh/year	
Energy requirement (useful):	0.024 x 1410 x 193.6 [37] =	6552	[81]
Heat from secondary system: 10% (Table 11)			[82]
Primary system: Gas boiler, automatic ignition, 1998 or later Controls: Programmer + roomstat + TRV's Fuel: Mains Gas Notional efficiency: 78%			[83]
Fuel required:	6552 x 0.90 x 100/78 =	7560	[85]
Secondary system: Portable electric heaters Fuel: Electricity (standard tariff) Efficiency: 100% (Table 4a)			[84]
Fuel required:	6552 x 0.10 x 100/100 =	655	[85a]
Water heating energy requirement (net): 3780 kW [51]			
Source: Primary heating system			
Efficiency : 78% (Manufacturer's declared value)			[86]
Energy required:	3780 [51] x 100/78 =	4846	[86a]
Electricity for pumps & fans:		175	[87]
Electricity for lighting (B/F from Solar report)		850	
CO_2 Emissions			kg/year
Primary heating system (mains gas)	7560 [85] x 0.194 =	1,467	[101]
Secondary heating system (electricity)	655 [85a] x 0.422 =	276	[102]
Water heating (mains gas)	4846 [86a] x 0.194 =	940	[103]
Total for space and water heating		2683	[107]
Electricity for pumps and fans	175 [87] x 0.422 =	74	[108]
Electricity for lighting, C_L	850 x 0.422 =	359	[109]
New technology: None			
	Total:	3,116	[112]

C_H = (2683 + 74)/112.00 = 24.62 C_L = 359/112.00 = 3.20

Fuel: Electricity (standard tariff) : Fuel Factor = 1.47 Improvement Factor = 0.20

Target CO_2 Emission Rate (TER) = (C_H x Fuel Factor + C_L) x (1 - imp factor)
= (24.62 x 1.47 + 3.20) x (1 - 0.20) = **31.51**