

This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Miss Michelle Wang	Assessor number	2018
Client		Last modified	05/11/2019
Address	Manor Road Richmond Block 3, Richmond, TW9		

### 1. Overall dwelling dimensions

	Area (m <sup>2</sup> )	Average storey height (m)	Volume (m <sup>3</sup> )
Lowest occupied	<input type="text" value="78.71"/> (1a)	<input type="text" value="2.60"/> (2a)	<input type="text" value="204.65"/> (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =		<input type="text" value="78.71"/> (4)
Dwelling volume	(3a) + (3b) + (3c) + (3d)...(3n) =		<input type="text" value="204.65"/> (5)

### 2. Ventilation rate

		m <sup>3</sup> per hour
Number of chimneys	<input type="text" value="0"/>	<input type="text" value="0"/> (6a)
Number of open flues	<input type="text" value="0"/>	<input type="text" value="0"/> (6b)
Number of intermittent fans	<input type="text" value="0"/>	<input type="text" value="0"/> (7a)
Number of passive vents	<input type="text" value="0"/>	<input type="text" value="0"/> (7b)
Number of flueless gas fires	<input type="text" value="0"/>	<input type="text" value="0"/> (7c)

	Air changes per hour
Infiltration due to chimneys, flues, fans, PSVs	<input type="text" value="0"/> (8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q <sub>50</sub> , expressed in cubic metres per hour per square metre of envelope area	<input type="text" value="3.00"/> (17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	<input type="text" value="0.15"/> (18)
Number of sides on which the dwelling is sheltered	<input type="text" value="2"/> (19)
Shelter factor	<input type="text" value="0.85"/> (20)
Infiltration rate incorporating shelter factor	<input type="text" value="0.13"/> (21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table U2	<input type="text" value="5.10"/>	<input type="text" value="5.00"/>	<input type="text" value="4.90"/>	<input type="text" value="4.40"/>	<input type="text" value="4.30"/>	<input type="text" value="3.80"/>	<input type="text" value="3.80"/>	<input type="text" value="3.70"/>	<input type="text" value="4.00"/>	<input type="text" value="4.30"/>	<input type="text" value="4.50"/>	<input type="text" value="4.70"/> (22)

Wind factor (22)m ÷ 4

	<input type="text" value="1.28"/>	<input type="text" value="1.25"/>	<input type="text" value="1.23"/>	<input type="text" value="1.10"/>	<input type="text" value="1.08"/>	<input type="text" value="0.95"/>	<input type="text" value="0.95"/>	<input type="text" value="0.93"/>	<input type="text" value="1.00"/>	<input type="text" value="1.08"/>	<input type="text" value="1.13"/>	<input type="text" value="1.18"/> (22a)
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m

	<input type="text" value="0.16"/>	<input type="text" value="0.16"/>	<input type="text" value="0.16"/>	<input type="text" value="0.14"/>	<input type="text" value="0.14"/>	<input type="text" value="0.12"/>	<input type="text" value="0.12"/>	<input type="text" value="0.12"/>	<input type="text" value="0.13"/>	<input type="text" value="0.14"/>	<input type="text" value="0.14"/>	<input type="text" value="0.15"/> (22b)
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Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system  (23a)

If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h  (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]

	<input type="text" value="0.28"/>	<input type="text" value="0.28"/>	<input type="text" value="0.27"/>	<input type="text" value="0.26"/>	<input type="text" value="0.25"/>	<input type="text" value="0.24"/>	<input type="text" value="0.24"/>	<input type="text" value="0.24"/>	<input type="text" value="0.25"/>	<input type="text" value="0.25"/>	<input type="text" value="0.26"/>	<input type="text" value="0.27"/> (24a)
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

	<input type="text" value="0.28"/>	<input type="text" value="0.28"/>	<input type="text" value="0.27"/>	<input type="text" value="0.26"/>	<input type="text" value="0.25"/>	<input type="text" value="0.24"/>	<input type="text" value="0.24"/>	<input type="text" value="0.24"/>	<input type="text" value="0.25"/>	<input type="text" value="0.25"/>	<input type="text" value="0.26"/>	<input type="text" value="0.27"/> (25)
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### 3. Heat losses and heat loss parameter

Element	Gross area, m <sup>2</sup>	Openings m <sup>2</sup>	Net area A, m <sup>2</sup>	U-value W/m <sup>2</sup> K	A x U W/K	κ-value, kJ/m <sup>2</sup> .K	A x κ, kJ/K						
Window			19.43	1.33	25.76		(27)						
External wall			28.77	0.15	4.32		(29a)						
External wall			11.46	0.01	0.11		(29a)						
Party wall			48.81	0.00	0.00		(32)						
Total area of external elements ΣA, m <sup>2</sup>			59.66				(31)						
Fabric heat loss, W/K = Σ(A x U)					(26)...(30) + (32) =	30.19	(33)						
Heat capacity Cm = Σ(A x κ)					(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)						
Thermal mass parameter (TMP) in kJ/m <sup>2</sup> K						100.00	(35)						
Thermal bridges: Σ(L x Ψ) calculated using Appendix K						9.96	(36)						
Total fabric heat loss						(33) + (36) =	40.15 (37)						
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	18.91	18.70	18.48	17.41	17.19	16.12	16.12	15.90	16.55	17.19	17.62	18.05	(38)
Heat transfer coefficient, W/K (37)m + (38)m	59.06	58.85	58.63	57.56	57.34	56.27	56.27	56.05	56.70	57.34	57.77	58.20	
	Average = Σ(39)1...12/12 =											57.50 (39)	
Heat loss parameter (HLP), W/m <sup>2</sup> K (39)m ÷ (4)	0.75	0.75	0.74	0.73	0.73	0.71	0.71	0.71	0.72	0.73	0.73	0.74	
	Average = Σ(40)1...12/12 =											0.73 (40)	
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

### 4. Water heating energy requirement

Assumed occupancy, N													2.44	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36														92.10 (43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	101.31	97.63	93.94	90.26	86.57	82.89	82.89	86.57	90.26	93.94	97.63	101.31		
	Σ(44)1...12 =											1105.21 (44)		
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	150.24	131.40	135.59	118.21	113.43	97.88	90.70	104.08	105.32	122.75	133.99	145.50		
	Σ(45)1...12 =											1449.10 (45)		
Distribution loss 0.15 x (45)m	22.54	19.71	20.34	17.73	17.01	14.68	13.61	15.61	15.80	18.41	20.10	21.83		(46)
Storage volume (litres) including any solar or WWHRS storage within same vessel														145.00 (47)
Water storage loss:														
a) If manufacturer's declared loss factor is known (kWh/day)														1.30 (48)
Temperature factor from Table 2b														0.60 (49)
Energy lost from water storage (kWh/day) (48) x (49)														0.78 (50)
Enter (50) or (54) in (55)														0.78 (55)
Water storage loss calculated for each month (55) x (41)m	24.18	21.84	24.18	23.40	24.18	23.40	24.18	24.18	23.40	24.18	23.40	24.18		(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	24.18	21.84	24.18	23.40	24.18	23.40	24.18	24.18	23.40	24.18	23.40	24.18		(57)
Primary circuit loss for each month from Table 3														

23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)
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Combi loss for each month from Table 3a, 3b or 3c

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)
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Total heat required for water heating calculated for each month  $0.85 \times (45)m + (46)m + (57)m + (59)m + (61)m$

197.68	174.25	183.04	164.13	160.87	143.79	138.14	151.52	151.24	170.19	179.90	192.94	(62)
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Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)
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Output from water heater for each month (kWh/month) (62)m + (63)m

197.68	174.25	183.04	164.13	160.87	143.79	138.14	151.52	151.24	170.19	179.90	192.94	
$\Sigma(64)1...12 =$											2007.70	(64)

Heat gains from water heating (kWh/month)  $0.25 \times [0.85 \times (45)m + (61)m] + 0.8 \times [(46)m + (57)m + (59)m]$

87.91	77.97	83.04	76.04	75.67	69.28	68.11	72.56	71.75	78.77	81.28	86.33	(65)
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## 5. Internal gains

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Metabolic gains (Table 5)

121.90	121.90	121.90	121.90	121.90	121.90	121.90	121.90	121.90	121.90	121.90	121.90	(66)
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Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

19.32	17.16	13.96	10.57	7.90	6.67	7.20	9.37	12.57	15.96	18.63	19.86	(67)
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Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

216.72	218.97	213.31	201.24	186.01	171.70	162.13	159.89	165.55	177.62	192.85	207.16	(68)
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Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

35.19	35.19	35.19	35.19	35.19	35.19	35.19	35.19	35.19	35.19	35.19	35.19	(69)
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Pump and fan gains (Table 5a)

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
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Losses e.g. evaporation (Table 5)

-97.52	-97.52	-97.52	-97.52	-97.52	-97.52	-97.52	-97.52	-97.52	-97.52	-97.52	-97.52	(71)
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Water heating gains (Table 5)

118.16	116.03	111.61	105.61	101.71	96.22	91.55	97.53	99.65	105.87	112.89	116.04	(72)
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Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

413.77	411.73	398.44	376.98	355.18	334.15	320.46	326.35	337.34	359.02	383.93	402.63	(73)
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## 6. Solar gains

	Access factor Table 6d	Area m <sup>2</sup>	Solar flux W/m <sup>2</sup>	g specific data or Table 6b	FF specific data or Table 6c	Gains W
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SouthWest  $0.77 \times 6.83 \times 36.79 \times 0.9 \times 0.40 \times 0.90 = 62.69$  (79)

SouthEast  $0.77 \times 12.60 \times 36.79 \times 0.9 \times 0.40 \times 0.90 = 115.66$  (77)

Solar gains in watts  $\Sigma(74)m...(82)m$

178.35	303.80	415.68	515.04	576.89	572.72	552.16	506.02	450.09	335.77	213.63	152.63	(83)
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Total gains - internal and solar (73)m + (83)m

592.12	715.54	814.12	892.02	932.08	906.87	872.62	832.37	787.43	694.78	597.56	555.26	(84)
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## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(°C)

21.00 (85)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Utilisation factor for gains for living area n1,m (see Table 9a)

0.92	0.87	0.79	0.67	0.54	0.39	0.28	0.31	0.48	0.72	0.88	0.94	(86)
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Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

19.84	20.15	20.46	20.75	20.91	20.98	20.99	20.99	20.95	20.74	20.26	19.79	(87)
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Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)

20.30	20.30	20.30	20.31	20.32	20.33	20.33	20.33	20.32	20.32	20.31	20.31	(88)
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Utilisation factor for gains for rest of dwelling n2,m

0.92	0.86	0.77	0.65	0.50	0.35	0.24	0.26	0.43	0.69	0.86	0.93	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

18.74	19.17	19.61	20.01	20.21	20.31	20.32	20.32	20.28	20.01	19.35	18.67	(90)
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Living area fraction

Living area ÷ (4) =  (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2

19.19	19.56	19.95	20.31	20.50	20.58	20.59	20.59	20.55	20.30	19.72	19.12	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

19.19	19.56	19.95	20.31	20.50	20.58	20.59	20.59	20.55	20.30	19.72	19.12	(93)
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### 8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Utilisation factor for gains, ηm

0.90	0.84	0.76	0.65	0.51	0.36	0.26	0.28	0.45	0.69	0.85	0.91	(94)
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Useful gains, ηmGm, W (94)m x (84)m

532.93	603.28	622.55	578.39	476.32	330.32	223.50	233.33	352.72	476.93	507.38	507.07	(95)
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Monthly average external temperature from Table U1

4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
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Heat loss rate for mean internal temperature, Lm, W [(39)m x ((93)m - (96)m)]

879.31	862.97	788.88	656.60	504.33	336.40	224.78	235.12	365.79	556.31	728.96	868.47	(97)
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Space heating requirement, kWh/month 0.024 x ((97)m - (95)m) x (41)m

257.71	174.51	123.75	56.31	20.84	0.00	0.00	0.00	0.00	59.06	159.53	268.88	(98)
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Σ(98)1...5, 10...12 =  (98)

Space heating requirement kWh/m<sup>2</sup>/year

(98) ÷ (4) =  (99)

### 8c. Space cooling requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Heat loss rate Lm

0.00	0.00	0.00	0.00	0.00	528.90	416.37	425.99	0.00	0.00	0.00	0.00	(100)
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Utilisation factor for loss ηm

0.00	0.00	0.00	0.00	0.00	0.96	0.98	0.98	0.00	0.00	0.00	0.00	(101)
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Useful loss ηmLm (watts) (100)m x (101)m

0.00	0.00	0.00	0.00	0.00	510.34	408.32	416.05	0.00	0.00	0.00	0.00	(102)
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Gains

0.00	0.00	0.00	0.00	0.00	1139.39	1097.76	1051.85	0.00	0.00	0.00	0.00	(103)
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Space cooling requirement, whole dwelling, continuous (kWh) 0.024 x ((103)m - (102)m) x (41)m

0.00	0.00	0.00	0.00	0.00	452.92	512.95	473.04	0.00	0.00	0.00	0.00	(104)
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Σ(104)6...8 =  (104)

Cooled fraction

cooled area ÷ (4) =  (105)

Intermittency factor (Table 10)

0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.25	0.00	0.00	0.00	0.00	(106)
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Σ(106)6...8 =  (106)

Space cooling requirement (104)m x (105) x (106)m

0.00	0.00	0.00	0.00	0.00	39.00	44.17	40.73	0.00	0.00	0.00	0.00	(107)
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Σ(107)6...8 =  (107)

Space cooling requirement kWh/m<sup>2</sup>/year (107) ÷ (4) = 1.57 (108)

### 9b. Energy requirements - community heating scheme

Fraction of space heat from secondary/supplementary system (table 11)	'0' if none	0.00	(301)
Fraction of space heat from community system	1 - (301) =	1.00	(302)
Fraction of community heat from heat pump		1.00	(303a)
Fraction of total space heat from community heat pump	(302) x (303a) =	1.00	(304a)
Factor for control and charging method (Table 4c(3)) for community space heating		1.00	(305)
Factor for charging method (Table 4c(3)) for community water heating		1.00	(305a)
Distribution loss factor (Table 12c) for community heating system		1.07	(306)

#### Space heating

Annual space heating requirement	1120.59	(98)
Space heat from heat pump	(98) x (304a) x (305) x (306) =	1199.04 (307a)

#### Water heating

Annual water heating requirement	2007.70	(64)
Water heat from heat pump	(64) x (303a) x (305a) x (306) =	2148.24 (310a)
Electricity used for heat distribution	0.01 x [(307a)...(307e) + (310a)...(310e)] =	33.47 (313)

Cooling System Energy Efficiency Ratio	4.05	(314)
Space cooling (if there is a fixed cooling system, if not enter 0)	(107) ÷ (314)	30.59 (315)
Electricity for pumps, fans and electric keep-hot (Table 4f)		
mechanical ventilation fans - balanced, extract or positive input from outside	192.24	(330a)
Total electricity for the above, kWh/year	192.24	(331)
Electricity for lighting (Appendix L)	341.22	(332)
Total delivered energy for all uses	(307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =	3911.33 (338)

### 10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from heat pump	1199.04	x	4.24	x 0.01 =	50.84	(340a)
Water heating from heat pump	2148.24	x	4.24	x 0.01 =	91.09	(342a)
Space cooling	30.59	x	13.19	x 0.01 =	4.04	(348)
Pumps and fans	192.24	x	13.19	x 0.01 =	25.36	(349)
Electricity for lighting	341.22	x	13.19	x 0.01 =	45.01	(350)
Additional standing charges					120.00	(351)
Total energy cost				(340a)...(342e) + (345)...(354) =	336.32	(355)

### 11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.14	(357)
SAP value	84.07	
SAP rating (section 13)	84	(358)
SAP band	B	

### 12b. CO<sub>2</sub> emissions - community heating scheme

	Energy kWh/year	Emission factor	Emissions (kg/year)
Emissions from other sources (space heating)			

Efficiency of heat pump	180.00								(367a)
CO2 emissions from heat pump $[(307a)+(310a)] \times 100 \div (367a) =$	1859.60	x	0.519	=	965.13				(367)
Electrical energy for community heat distribution	33.47	x	0.519	=	17.37				(372)
Total CO2 associated with community systems					982.50				(373)
Total CO2 associated with space and water heating					982.50				(376)
Space cooling	30.59	x	0.519	=	15.88				(377)
Pumps and fans	192.24	x	0.519	=	99.77				(378)
Electricity for lighting	341.22	x	0.519	=	177.09				(379)
Total CO <sub>2</sub> , kg/year						(376)..(382) =	1275.25		(383)
Dwelling CO <sub>2</sub> emission rate						(383) ÷ (4) =	16.20		(384)
El value							86.19		
El rating (section 14)							86		(385)
El band							B		

### 13b. Primary energy - community heating scheme

	Energy kWh/year		Primary factor		Primary energy (kWh/year)				
Primary energy from other sources (space heating)									
Efficiency of heat pump	180.00								(367a)
Primary energy from heat pump $[(307a)+(310a)] \times 100 \div (367a) =$	1859.60	x	3.07	=	5708.96				(367)
Electrical energy for community heat distribution	33.47	x	3.07	=	102.76				(372)
Total primary energy associated with community systems					5811.72				(373)
Total primary energy associated with space and water heating					5811.72				(376)
Space cooling	30.59	x	3.07	=	93.92				(377)
Pumps and fans	192.24	x	3.07	=	590.19				(378)
Electricity for lighting	341.22	x	3.07	=	1047.53				(379)
Primary energy kWh/year							7543.37		(383)
Dwelling primary energy rate kWh/m <sup>2</sup> /year							95.84		(384)