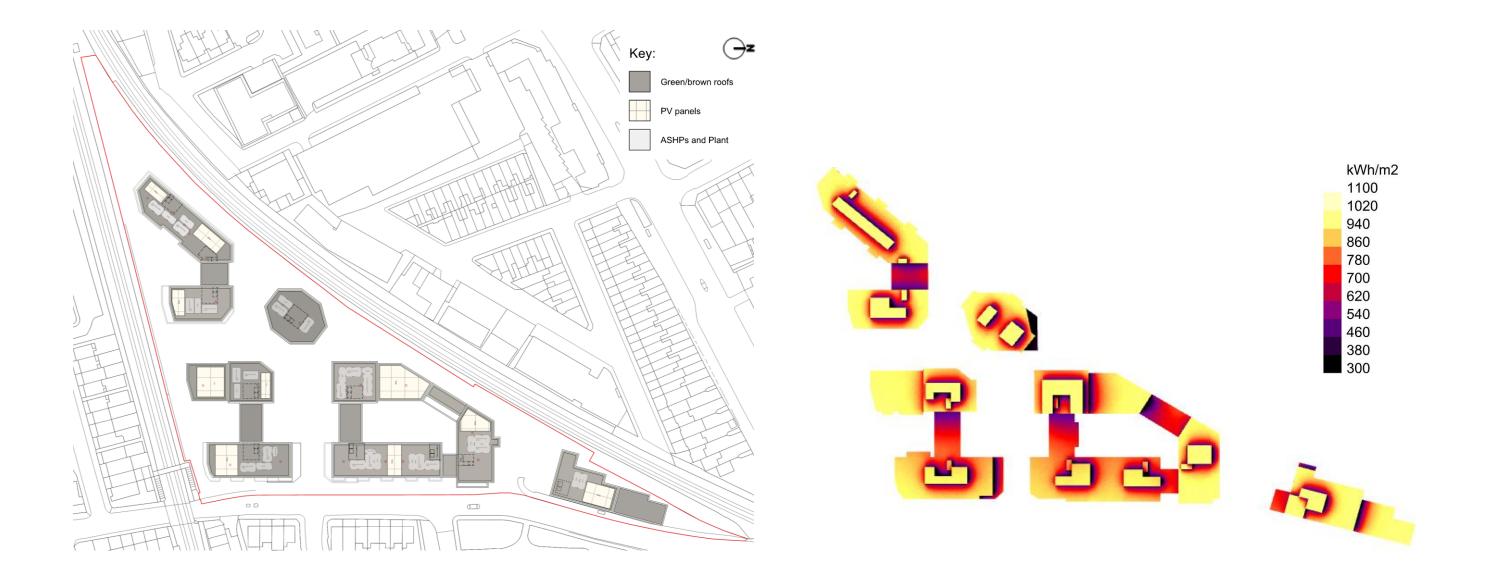
SUSTAINABILITY REVISED ENERGY STRATEGY – REV. 04

Appendix G: Roof area appraisal.

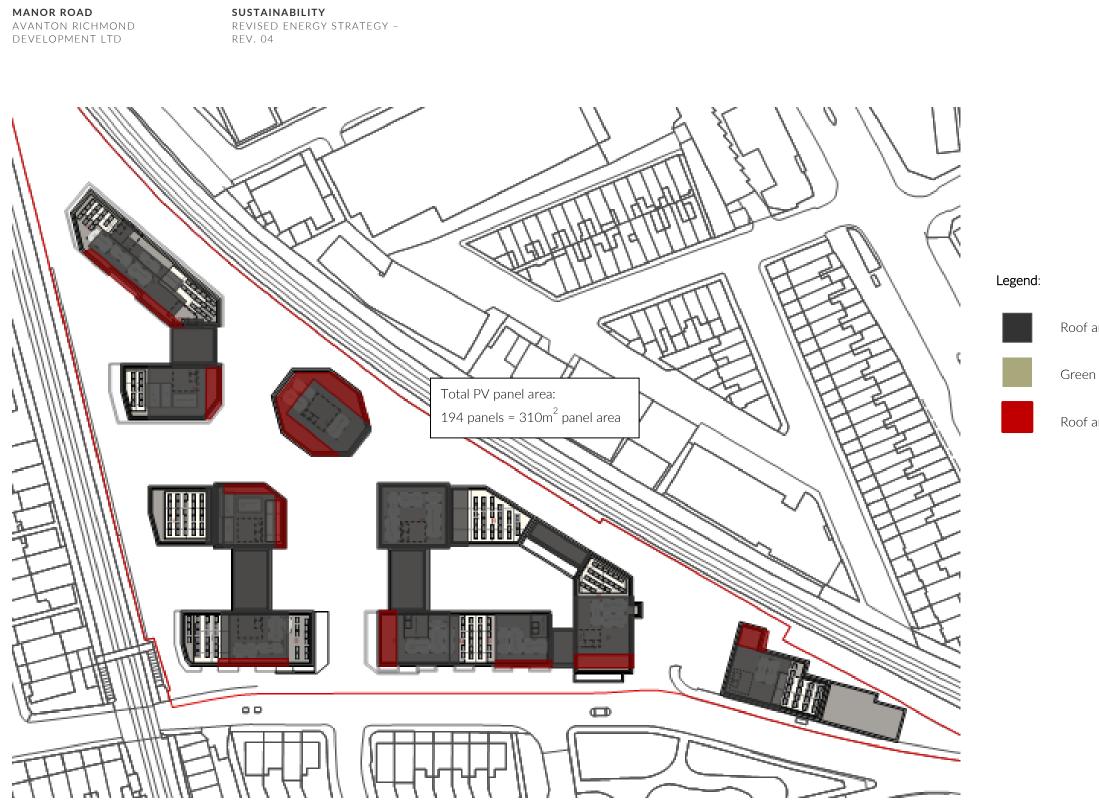


Proposed Development Roof Plan (source: Assael Architecture)

Annual solar irradiance on roofs



Total PV panel area: 194 panels = 310m² panel area



Resulting Proposed PV array

Roof area allocated for plant, or overshaded area

Green / brown roof / PVs

Roof area deemed too small for PV panel array

SUSTAINABILITY REVISED ENERGY STRATEGY – REV. 04

Appendix H: SAP worksheets.

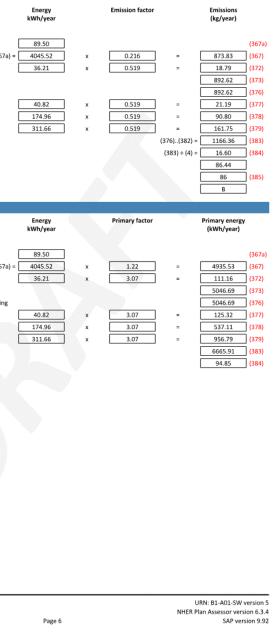
Be Lean example data sheet – DER & TER

DER Workshee				3. Heat losses and heat loss parameter				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)
	L		■ NHER	Element Gross	Openings N	let area U-value A x U	W/K к-value, Ахк,	Combi loss for each month from Table 3a, 3b or 3c	
Design - Draft				area, m		A, m ² W/m ² K	kJ/m ² .K kJ/K	-	0.00 0.00 0.00 0.00 0.00 0.00 (61)
				Window	Г	21.01 x 1.33 = 27.	85 (27)	Total heat required for water heating calculated for each month 0.85	· · · · · · · · · · · · · · · ·
	been carried out using Approved SAP software. It has been prepared	d from plans and specification	ns and may not reflect the	External wall		39.72 x 0.15 = 5.9			
property as constructed.									44.70 139.58 152.32 151.79 170.10 179.09 191.77 (62)
Assessor name	Miss Michelle Wang	Assessor number	2018	External wall		5.37 x 0.01 = 0.0		Solar DHW input calculated using Appendix G or Appendix H	
Assessor name	Miss Michelle Wang			Party wall		33.79 x 0.00 = 0.0		0.00 0.00 0.00 0.00 0.00	0.00 0.00 0.00 0.00 0.00 0.00 (63)
Client		Last modified	23/10/2019	Total area of external elements ∑A, m ²	L	66.10	(31)	Output from water heater for each month (kWh/month) (62)m + (63)	/m
Address	Manor Road Richmond Block 1, Richmond, TW9			Fabric heat loss, $W/K = \sum (A \times U)$			(26)(30) + (32) = 33.87 (33)	196.28 173.19 182.33 164.07 161.23	144.70 139.58 152.32 151.79 170.10 179.09 191.77
				Heat capacity Cm = Σ(A x κ)		(28)(30) + (32	2) + (32a)(32e) = N/A (34)		Σ(64)112 = 2006.45 (64)
1. Overall dwelling dimen	sions			Thermal mass parameter (TMP) in kJ/m ² K			100.00 (35)	Heat gains from water heating (kWh/month) 0.25 × (0.85 × (45)m + (6	61)m] + 0.8 × [(46)m + (57)m + (59)m]
	Area (m²)	Average storey	Volume (m ³)	Thermal bridges: ∑(L x Ψ) calculated using Appendix K			11.02 (36)	90.14 80.05 85.50 78.62 78.48	72.19 71.29 75.52 74.54 81.43 83.62 88.64 (65)
		height (m)		Total fabric heat loss			(33) + (36) = 44.89 (37)		
Lowest occupied	70.28 (1a) x	2.65 (2a) =	186.24 (3a)	Jan Feb Mar Ap	r May Jun	Jul Aug Sep	Oct Nov Dec	5. Internal gains	
Total floor area	(1a) + (1b) + (1c) + (1d)(1n) = 70.28 (4)			Ventilation heat loss calculated monthly 0.33 x (25)m x	(5)	. V V		Jan Feb Mar Apr May	Jun Jul Aug Sep Oct Nov Dec
	(1a) + (1b) + (1c) + (1d)(1n) = 70.28 (4)	12 1 - 12 1 - 12 1 - 12 1	(2) [(2) [(2)]		. ,	1 14 67 1 14 47 1 15 06	15.65 16.04 16.43 (38)	Metabolic gains (Table 5)	
Dwelling volume		(3a) + (3b) + (3c) + (3d)	.(3n) = <u>186.24</u> (5)	La construction de la constructi	54 15.65 14.67	/ 14.6/ 14.4/ 15.06	15.65 16.04 16.43 (58)		112.65 112.65 112.65 112.65 112.65 112.65 112.65 (66)
2. Ventilation rate				Heat transfer coefficient, W/K (37)m + (38)m				Lighting gains (calculated in Appendix L, equation L9 or L9a), also see	
			m ³ per hour	62.10 61.90 61.71 60.7	73 60.53 59.55	5127/2011/000, /C			6.09 6.58 8.55 11.48 14.58 17.01 18.14 (67)
Number of 11						Average	= Σ(39)112/12 = 60.68 (39)	Appliance gains (calculated in Appendix L. equation L13 or L13a), also	
Number of chimneys		0 x 40	/	Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)					
Number of open flues		0 × 20		0.88 0.88 0.88 0.8	6 0.86 0.85	0.85 0.84 0.85	0.86 0.87 0.87		0 156.82 148.09 146.04 151.21 162.23 176.14 189.22 (68)
Number of intermittent far	15	0 × 10				Average	= Σ(40)112/12 = 0.86 (40)	Cooking gains (calculated in Appendix L, equation L15 or L15a), also se	
Number of passive vents		0 x 10) = 0 (7b)	Number of days in month (Table 1a)					34.26 34.26 34.26 34.26 34.26 34.26 (69)
Number of flueless gas fire	s	0 x 40		31.00 28.00 31.00 30.0	00 31.00 30.00	31.00 31.00 30.00	31.00 30.00 31.00 (40)	Pump and fan gains (Table 5a)	
			Air changes per					0.00 0.00 0.00 0.00 0.00	0.00 0.00 0.00 0.00 0.00 0.00 (70)
			hour	4. Water heating energy requirement				Losses e.g. evaporation (Table 5)	
Infiltration due to chimney) = 0.00 (8)	Assumed occupancy, N			2.25 (42)	-90.12 -90.12 -90.12 -90.12 -90.12	-90.12 -90.12 -90.12 -90.12 -90.12 -90.12 (71)
If a pressurisation test has	been carried out or is intended, proceed to (17), otherwise continue f	from (9) to (16)		Annual average hot water usage in litres per day Vd, aver	rage = (25 x N) + 36		87.71 (43)	Water heating gains (Table 5)	
Air permeability value, q50	, expressed in cubic metres per hour per square metre of envelope a	area	3.00 (17)	Jan Feb Mar Ap	r May Jun	Jul Aug Sep	Oct Nov Dec	121.15 119.13 114.92 109.20 105.49	100.26 95.81 101.51 103.53 109.45 116.14 119.14 (72)
If based on air permeability	value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.15 (18)	Hot water usage in litres per day for each month Vd,m =	factor from Table 1c x	(43)		Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m +	(72)m
Number of sides on which	the dwelling is sheltered		2 (19)	96.48 92.97 89.46 85.5	95 82.44 78.94	1 78.94 82.44 85.95	89.46 92.97 96.48	393.54 391.60 379.29 359.45 339.39	319.97 307.28 312.89 323.02 343.05 366.09 383.28 (73)
Shelter factor		1 - [0.075 x ((19)] = 0.85 (20)				Σ(44)112 = 1052.48 (44)		
Infiltration rate incorporati	ng shelter factor	(18) x	(20) = 0.13 (21)	Energy content of hot water used = 4.18 x Vd,m x nm x 1	rm/3600 kWh/month (s	see Tables 1b, 1c 1d)		6. Solar gains	
Infiltration rate modified for	or monthly wind speed:			143.07 125.13 129.13 112.	57 108.02 93.21	86.37 99.12 100.30	116.89 127.59 138.56	Access factor Area	Solar flux g FF Gains
Jan	Feb Mar Apr May Jun Jul	Aug Sep Oct	Nov Dec				$\Sigma(45)112 = 1379.96$ (45)	Table 6d m ²	W/m ² specific data specific data W or Table 6b or Table 6c
Monthly average wind spe	ed from Table U2			Distribution loss 0.15 x (45)m			2(15)		
	5.00 4.90 4.40 4.30 3.80 3.80	3 70 4 00 4 30	450 470 (22)		0 16 20 1 12 05	12 12 06 14 97 15 04	17.53 19.14 20.78 (46)	SouthEast 0.77 x 5.25	
Wind factor (22)m ÷ 4	500 150 110 150 500 500	5170 4100 4100	100 110 (22)	Storage volume (litres) including any solar or WWHRS st			194.00 (47)	SouthWest 0.54 x 3.68	
	1.25 1.23 1.10 1.08 0.95 0.95	0.02 1.00 1.09	1 12 1 18 (22a)	Water storage loss:	orage within same vess	e	194.00 (47)	SouthWest 0.77 x 5.78	
	llowing for shelter and wind factor) (21) x (22a)m	0.55 1.00 1.08	1.15 1.16 (228)					NorthWest 0.77 x 6.30	x 11.28 x 0.9 x 0.40 x 0.90 = 17.73 (81)
				a) If manufacturer's declared loss factor is known (kWh/	day)		1.61 (48)	Solar gains in watts ∑(74)m(82)m	
	0.16 0.16 0.14 0.14 0.12 0.12	0.12 0.13 0.14	0.14 0.15 (22b)	Temperature factor from Table 2b			0.60 (49)	142.67 248.91 356.22 467.60 547.69	554.25 529.98 468.62 394.54 279.32 171.96 121.40 (83)
	ge rate for the applicable case:			Energy lost from water storage (kWh/day) (48) x (49)		0.97 (50)	Total gains - internal and solar (73)m + (83)m	
	n: air change rate through system		0.50 (23a)	Enter (50) or (54) in (55)			0.97 (55)	536.22 640.51 735.51 827.05 887.08	8 874.22 837.26 781.51 717.56 622.37 538.05 504.69 (84)
	covery: efficiency in % allowing for in-use factor from Table 4h		76.50 (23c)	Water storage loss calculated for each month (55) x (41)m				
	al ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) -			29.95 27.05 29.95 28.5	29.95 28.98	3 29.95 29.95 28.98	29.95 28.98 29.95 (56)	7. Mean internal temperature (heating season)	
	0.28 0.27 0.26 0.25 0.24 0.24	0.24 0.25 0.25	0.26 0.27 (24a)	If the vessel contains dedicated solar storage or dedicated	ed WWHRS (56)m x [(47	7) - Vs] ÷ (47), else (56)		Temperature during heating periods in the living area from Table 9, The	h1(°C) 21.00 (85)
Effective air change rate - e	nter (24a) or (24b) or (24c) or (24d) in (25)			29.95 27.05 29.95 28.9	98 29.95 28.98	3 29.95 29.95 28.98	29.95 28.98 29.95 (57)	Jan Feb Mar Apr May	Jun Jul Aug Sep Oct Nov Dec
0.28	0.28 0.27 0.26 0.25 0.24 0.24	0.24 0.25 0.25	0.26 0.27 (25)	Primary circuit loss for each month from Table 3				Utilisation factor for gains for living area n1,m (see Table 9a)	
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MANOR ROAD

AVANTON RICHMOND DEVELOPMENT LTD

1		
0.93 0.89 0.83 0.71 0.57 0.42 0.31 0.34 0.53 0.76 0.90 0.94 (86)	0.00 0.00 0.00 0.00 52.61 59.70 53.01 0.00 0.00 0.00 0.00	
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	$\Sigma(107)68 = 165.32 $ (107)	Emissions from other sources (space heating)
19.50 19.81 20.19 20.59 20.84 20.96 20.98 20.90 20.56 19.97 19.44 (87) Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)	Space cooling requirement kWh/m ¹ /year $(107) \div (4) = 2.35$ (108)	Efficiency of boilers
20.18 20.19 20.20 20.20 20.21 20.21 20.21 20.21 20.20 20.19 (88)	9b. Energy requirements - community heating scheme	CO2 emissions from boilers [(307a)+(310a)] x 100 ÷ (367a)
Utilisation factor for gains for rest of dwelling n2,m	Fraction of space heat from secondary/supplementary system (table 11) '0' if none 0.00 (301)	Electrical energy for community heat distribution
0.92 0.88 0.81 0.68 0.53 0.37 0.25 0.29 0.48 0.73 0.88 0.93 (89)	Fraction of space heat from community system 1 - (301) = 1.00 (302)	Total CO2 associated with community systems
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	Fraction of community heat from boilers 1.00 (303a) Fraction of total space heat from community boilers (302) x (303a) = 1.00 (304a)	Total CO2 associated with space and water heating
18.17 18.61 19.15 19.70 20.02 20.17 20.20 20.21 19.68 18.86 18.10 (90)	Fraction of total space heat from community boilers (302) x (303a) = 1.00 (304a) Factor for control and charging method (Table 4c(3)) for community space heating 1.00 (305)	Space cooling Pumps and fans
Living area \div (4) = 0.51 (91)	Factor for charging method (Table 4c(3)) for community space nearing 1.00 (305a)	Pumps and fans Electricity for lighting
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2	Distribution loss factor (Table 12c) for community whet needing system	Total CO ₂ , kg/year
18.84 19.22 19.68 20.15 20.43 20.57 20.60 20.51 20.13 19.42 18.78 (92) Apply adjustment to the mean internal temperature from Table 4e where appropriate 6 6 6 6 6 7 6 7		Dwelling CO ₂ emission rate
18.84 19.22 19.68 20.15 20.43 20.57 20.60 20.51 20.13 19.42 18.78 (93)	Space heating	El value
20.04 20.22 20.00 20.00 20.00 20.00 20.00 20.00 20.00 (00)	Annual space heating requirement [1441.87] (98)	El rating (section 14)
8. Space heating requirement	Space heat from boilers (98) x (304a) x (305) x (306) = 1513.96 (307a)	El band
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec		13b. Primary energy - community heating scheme
Utilisation factor for gains, nm	Water heating	230. Finnary chergy - community neutring scheme
0.91 0.86 0.79 0.68 0.54 0.39 0.28 0.31 0.50 0.73 0.87 0.92 (94) Useful gains, ηmGm, W (94)m x (84)m	Annual water heating requirement 2006.45 (64) Water heat from boilers (64) x (303a) x (305a) x (306) = 2106.77 (310a)	
487.02 552.42 583.41 564.02 481.32 343.16 235.12 244.69 357.84 453.98 466.36 463.94 (95)	Water heat from boilers (64) x (303a) x (305a) x (306) = 2106.77 (310a) Electricity used for heat distribution 0.01 x ((307a)(307e) + (310a)(310e)) = 36.21 (313)	Primary energy from other sources (space heating)
Monthly average external temperature from Table U1		Efficiency of boilers
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)	Cooling System Energy Efficiency Ratio (314)	Primary energy from boilers [(307a)+(310a)] x 100 ÷ (367a)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	Space cooling (if there is a fixed cooling system, if not enter 0) (107) ÷ (314) 40.82 (315)	Electrical energy for community heat distribution
903.03 886.28 813.22 683.18 528.69 355.44 238.25 249.13 384.49 576.79 750.84 893.76 (97)	Electricity for pumps, fans and electric keep-hot (Table 4f)	Total primary energy associated with community systems Total primary energy associated with space and water heating
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	mechanical ventilation fans - balanced, extract or positive input from outside 174.96 (330a)	Space cooling
309.52 224.35 170.98 85.80 35.24 0.00 0.00 0.00 91.37 204.82 319.78	Total electricity for the above, kWh/year [331]	Pumps and fans
Σ(98)15, 1012 = 1441.87 (98) Space heating requirement kWh/m ² /year (98) ÷ (4) 20.52 (99)	Electricity for lighting (Appendix L) 311.66 (332)	Electricity for lighting
Space heating requirement kWh/m ² /year (98) ÷ (4) 20.52 (99)	Total delivered energy for all uses (307) + (309) + (310) + (312) + (315) + (331) + (332)(337b) = 4148.17 (338)	Primary energy kWh/year
8c. Space cooling requirement	10b. Fuel costs - community heating scheme	Dwelling primary energy rate kWh/m2/year
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec	Fuel Fuel price Fuel kWh/year cost £/year	
Heat loss rate Lm 0.00 0.00 0.00 0.00 559.78 440.68 451.10 0.00 0.00 0.00 (100)	Space heating from boilers 1513.96 x 4.24 x 0.01 = 64.19 (340a)	
Utilisation factor for loss nm	Water heating from boilers 2106.77 x 4.24 x 0.01 = 89.33 (342a)	
0.00 0.00 0.00 0.00 0.00 0.94 0.96 0.95 0.00 0.00 0.00 (101)	Space cooling 40.82 x 13.19 x 0.01 = 5.38 (348)	
Useful loss ŋmLm (watts) (100)m x (101)m	Pumps and fans 174.96 x 13.19 x 0.01 = 23.08 (349)	
0.00 0.00 0.00 0.00 0.00 526.03 424.47 430.53 0.00 0.00 0.00 (102)	Electricity for lighting 311.66 x 13.19 x 0.01 = 41.11 (350)	
Gains	Additional standing charges [120.00] (351)	
0.00 0.00 0.00 0.00 1102.90 1057.93 992.99 0.00 0.00 0.00 0.00 (103)	Total energy cost (340a)(342e) + (345)(354) = 343.09 (355)	
Space cooling requirement, whole dwelling, continuous (kWh) 0.024 x [(103)m - (102)m] x (41)m	11b. SAP rating - community heating scheme	
0.00 0.00 0.00 0.00 415.35 471.29 418.47 0.00 0.00 0.00 0.00 (104)	Energy cost deflator (Table 12) 0.42 (356)	
Σ(104)68 = 1305.12 (104) Cooled fraction cooled area ÷ (4) = 0.51 (105)	Energy cost factor (ECF) 1.25 (357)	
Intermittency factor (Table 10)	SAP value 82.56	
0.00 0.00 0.00 0.00 0.00 0.25 0.25 0.25	SAP rating (section 13) (358)	
$\Sigma(106)68 = 0.75$ (106)	SAP band B	
Space cooling requirement (104)m x (105) x (106)m	12b. CO ₂ emissions - community heating scheme	
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NHER Plan Assessor version 6.3.4	NHER Plan Assessor version 6.3.4	
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TER Worksheet			
Design - Draft			■ NHER
Design - Drait			
	een carried out using Approved SAP software. It has be	en prepared from plans and specifications	and may not reflect the
property as constructed.			
Assessor name	Miss Michelle Wang	Assessor number	2018
Client		Last modified	23/10/2019
		Last modified	23/10/2019
Address	Manor Road Richmond Block 1, Richmond, TW9		
1. Overall dwelling dimension	ions		
	Area (m²)	Average storey	Volume (m ³)
1		height (m)	
Lowest occupied	70.28	(1a) x 2.65 (2a) =	186.24 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)(1n) = 70.28	(4)	
Dwelling volume		(3a) + (3b) + (3c) + (3d)(3n) = <u>186.24</u> (5)
2. Ventilation rate			
			m ³ per hour
Number of chimneys		0 x 40	= 0 (6a)
Number of open flues		0 × 20	= 0 (6b)
Number of intermittent fans		3 × 10	= <u>30</u> (7a)
Number of passive vents		0 x 10	= 0 (7b)
Number of flueless gas fires		0 x 40	
			Air changes per hour
Infiltration due to chimneys, f	flues, fans, PSVs (6a) + (6b) + (7a)	+ (7b) + (7c) = 30 ÷ (5)	
	een carried out or is intended, proceed to (17), otherwise		- 0.16 (6)
	expressed in cubic metres per hour per square metre of		5.00 (17)
	value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.41 (18)
Number of sides on which the	e dwelling is sheltered		2 (19)
Shelter factor		1 - [0.075 x (19)] = 0.85 (20)
Infiltration rate incorporating	g shelter factor	(18) ×	20) = 0.35 (21)
Infiltration rate modified for r	monthly wind speed:		
Jan	Feb Mar Apr May Jun	Jul Aug Sep Oct	Nov Dec
Monthly average wind speed			
5.10	5.00 4.90 4.40 4.30 3.80	3.80 3.70 4.00 4.30	4.50 4.70 (22)
Wind factor (22)m ÷ 4		0.05 0.00 1.00 1.00	
	1.25 1.23 1.10 1.08 0.95 owing for shelter and wind factor) (21) x (22a)m	0.95 0.93 1.00 1.08	1.13 1.18 (22a)
	0.44 0.43 0.38 0.38 0.33	0.33 0.32 0.35 0.38	0.39 0.41 (22b)
Calculate effective air change		0.55 0.52 0.55 0.38	0.00 0.41 (220)
	air change rate through system		N/A (23a)
	overy: efficiency in % allowing for in-use factor from Tab	ble 4h	N/A (23c)
	whole house positive input ventilation from loft		
0.60	0.60 0.59 0.57 0.57 0.56	0.56 0.55 0.56 0.57	0.58 0.58 (24d)
Effective air change rate - ent	ter (24a) or (24b) or (24c) or (24d) in (25)		
0.60	0.60 0.59 0.57 0.57 0.56	0.56 0.55 0.56 0.57	0.58 0.58 (25)
(BSI)			URN: B1-A01-SW version 5
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0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)
nonth 0.85	x (45)m + (4	6)m + (57)n	n + (59)m +	+ (61)m				
158.45	142.01	136.80	149.54	149.10	167.32	176.39	188.99	(62)
н								
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)
62)m + (63)ı								
158.45	142.01	136.80	149.54	149.10	167.32	176.39	188.99	
(45)					∑(64)1	12 = 1	973.70	(64)
× (45)m + (6 76.26	1)m] + 0.8 × 70.03	[(46)m + (9 69.06	57)m + (59) 73.30	[m] 72.39	79.21	81.47	86.41	(07)
76.26	70.03	69.06	73.30	72.39	79.21	81.47	86.41	(65)
May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
112.65	112.65	112.65	112.65	112.65	112.65	112.65	112.65	(66)
), also see T	-		1					
7.21	6.09	6.58	8.55	11.48	14.58	17.01	18.14	(67)
L13a), also s		110.05			460.05	476.4.1		100
169.90	156.82	148.09	146.04	151.21	162.23	176.14	189.22	(68)
15a), also se 34.26	a lable 5 34.26	34.26	34.26	34.26	34.26	34.26	34.26	(69)
54.20	34.20	34.20	34.20	34.20	34.20	34.20	34.20	(09)
3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
5.00	0.00	0100	0.00		5100	5100	0.00	1.01
-90.12	-90.12	-90.12	-90.12	-90.12	-90.12	-90.12	-90.12	(71)
102.50	97.27	92.82	98.52	100.54	106.46	113.15	116.15	(72)
n + (71)m +	(72)m							
339.40	319.98	307.29	312.90	323.03	343.06	366.10	383.29	(73)
1999		10/					_	
Area	Sol	ar flux		g	FF		Gains	
m²		//m²		ific data	specific o		w	
_		,	_	able 6b	or Table			
4.39	11110			0.63		┛╴┝		(77)
3.08				0.63		╡╘		(79)
4.84				0.63		╡╏┝	54.42	(79)
5.26	x 1	1.28 ×	0.9 x (0.63	0.70	=	18.14	(81)
561.11	567.82	542.96	480.13	404.26	286.23	176.23	124.42	(83)
501.11	307.02	342.30	+00.13	404.20	200.23	1/0.23	124.42	(03)
900.51	887.80	850.25	793.03	727.29	629.30	542.32	507.71	(84)
	007.00	300.20	799.99		010.00	2-14104		(1)
Table 9, Th								(85)
May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
a)								
0.71	0.51	0.37	0.41	0.66	0.91	0.98	1.00	(86)
							1-A01-SW ve	
	Page 3				NH	ER Plan As	sessor versio SAP versi	
	1082.3						374 12131	0.1.010%

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Mean internal temp of living area T1 (steps 3 to 7 in Table 9c) 20.04 20.24 20.50 20.79 20.94 20.99 21.00 21.00 20.97 20.75 20.34 20.00 (87)	Space heating fuel - main system 1 2077.32 Water heating fuel 2364.91 Electricity for pumps, fans and electric keep-hot (Table 4f) 2364.91	
20.03 20.04 20.05 20.05 20.06 20.06 20.07 20.06 20.05 20.05 20.04 (88)	central heating pump or water pump within warm air heating unit 30.00 (230c)	
Utilisation factor for gains for rest of dwelling n2,m	boiler flue fan 45.00 (230e)	
0.99 0.98 0.94 0.83 0.65 0.44 0.29 0.33 0.58 0.88 0.98 0.99 (89)	Total electricity for the above, kWh/year 75.00 (231)	
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	Electricity for lighting (Appendix L) 311.66 (232)	
18.76 19.06 19.43 19.82 20.00 20.06 20.06 20.07 20.04 19.79 19.22 18.72 (90)	Total delivered energy for all uses (211)(221) + (232)(237b) = 4828.89 (238)	
Living area fraction $Living area \div (4) = 0.51$ (91)		
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2	10a. Fuel costs - individual heating systems including micro-CHP	
19.41 19.65 19.98 20.31 20.48 20.53 20.54 20.51 20.27 19.79 19.37 (92)	Fuel Fuel price Fuel kWh/year cost £/year	
Apply adjustment to the mean internal temperature from Table 4e where appropriate	Space heating - main system 1 2077.32 x 3.48 x 0.01 = 72.29 (240)	
19.41 19.65 19.98 20.31 20.48 20.53 20.54 20.54 20.51 20.27 19.79 19.37 (93)	Space nearing - main system 1 2077.52 x 3.48 $x \ 0.01 =$ 72.29 (240) Water heating 2364.91 x 3.48 $x \ 0.01 =$ 82.30 (247)	
	Pumps and fans 75.00 x 13.19 x 0.01 = 9.89 (249)	
8. Space heating requirement	Foundation 73.00 x 13.19 x (0.01 = $\begin{pmatrix} 2.95 \\ 9.05 \end{pmatrix}$ Electricity for lighting 311.66 x 13.19 x 0.01 = $\begin{pmatrix} 41.11 \\ (250) \end{pmatrix}$	
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec	Additional standing charges	
Utilisation factor for gains, nm	Total energy cost (240)(242) + (245)(254) = 325.59 (255)	
0.99 0.98 0.94 0.84 0.67 0.48 0.33 0.37 0.62 0.89 0.98 0.99 (94)		
Useful gains, ηmGm, W (94)m x (84)m 534.28 630.63 698.39 706.21 607.11 422.26 282.43 295.73 448.15 559.29 529.87 503.83 (95)	11a. SAP rating - individual heating systems including micro-CHP	
534.28 630.65 698.39 706.21 607.11 422.26 282.43 295.73 448.15 559.29 529.87 503.83 (95) Monthly average external temperature from Table U1	Energy cost deflator (Table 12) 0.42 (256)	
	Energy cost factor (ECF) 1.19 (257)	
4.30 4.90 6.50 8.90 11.70 14.60 16.60 14.10 10.60 7.10 4.20 (96) Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	SAP value 83.45	
1126.31 1096.35 998.21 832.70 638.98 426.11 282.86 296.53 462.91 704.11 928.54 1117.04 (97)	SAP rating (section 13) 83 (258)	
	SAP band B	
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m 440.46 312.97 223.07 91.07 23.71 0.00 0.00 0.00 0.00 107.75 287.04 456.23	12a. CO ₂ emissions - individual heating systems including micro-CHP	
	and a second second	
Σ (98)15, 1012 = 1942.29 (98)	Energy Emission factor Emissions kWh/year kg CO2/kWh kg CO2/year	
Space heating requirement kWh/m²/year (98) ÷ (4) 27.64 (99)		
	Space heating - main system 1 2077.32 x 0.216 = 448.70 (261)	
9a. Energy requirements - individual heating systems including micro-CHP	Space heating - main system 1 2077.32 x 0.216 = 448.70 (261) Water heating 2364.91 x 0.216 = 510.82 (264)	
9a. Energy requirements - individual heating systems including micro-CHP Space heating	Water heating 2364.91 x 0.216 = 510.82 (264)	
	Water heating 2364.91 x 0.216 = 510.82 (264) Space and water heating (261) + (262) + (263) + (264) = 959.52 (265)	
Space heating	Water heating 2364.91 x 0.216 = 510.82 (264) Space and water heating (261) + (262) + (263) + (264) = 959.52 (265) Pumps and fans 75.00 x 0.519 = 38.93 (267)	
Space heating Fraction of space heat from secondary/supplementary system (table 11)	Water heating 2364.91 x 0.216 = 510.82 (264) Space and water heating (261) + (262) + (263) + (264) = 959.52 (265) Pumps and fans 75.00 x 0.519 = 38.93 (267) Electricity for lighting 311.66 x 0.519 = 161.75 (268)	
Space heating 0.00 (201) Fraction of space heat from secondary/supplementary system (table 11) 1 - (201) = 1.00 (202) Fraction of space heat from main system(s) 1 - (201) = 1.00 (202)	Water heating 2364.91 x 0.216 = 510.82 (264) Space and water heating $(261) + (262) + (263) + (264) =$ 959.52 (265) Pumps and fans 75.00 x 0.519 = 38.93 (267) Electricity for lighting 311.66 x 0.519 = 161.75 (268) Total CO ₂ , kg/year (265)(271) = 1160.20 (272)	
Space heating 0.00 (201) Fraction of space heat from secondary/supplementary system (table 11) 1 - (201) = 1.00 (202) Fraction of space heat from main system(s) 1 - (201) = 1.00 (202) Fraction of space heat from main system 2 0.00 (202)	Water heating 2364.91 x 0.216 = 510.82 (264) Space and water heating $(261) + (262) + (263) + (264) =$ 959.52 (265) Pumps and fans 75.00 x 0.519 = 38.93 (267) Electricity for lighting 311.66 x 0.519 = 161.75 (268) Total CO ₂ , kg/year (265)(271) = 1160.20 (272) Dwelling CO ₂ emission rate (272) ÷ (4) = 16.51 (273)	
Space heating 0.00 (201) Fraction of space heat from secondary/supplementary system (table 11) 0.00 (201) Fraction of space heat from main system(s) 1 - (201) = 1.00 (202) Fraction of space heat from main system 2 0.00 (202) Fraction of total space heat from main system 1 (202) x [1 - (203)] = 1.00 (204)	Water heating 2364.91 x 0.216 = 510.82 (264) Space and water heating $(261) + (262) + (263) + (264) = 959.52$ (265) Pumps and fans 75.00 x 0.519 = 38.93 (267) Electricity for lighting 311.66 x 0.519 = 161.75 (268) Total CO ₂ , kg/year (265)(271) = 1160.20 (272) Dwelling CO ₂ emission rate (272) + (4) = 16.51 (273) El value 86.51 86.51	
Space heating 0.00 (201) Fraction of space heat from secondary/supplementary system (table 11) 0.00 (201) Fraction of space heat from main system(s) 1 - (201) = 1.00 (202) Fraction of space heat from main system 2 0.00 (202) Fraction of total space heat from main system 1 (202) x [1- (203)] = 1.00 (204) Fraction of total space heat from main system 2 (202) x (203) = 0.00 (205)	Water heating 2364.91 x 0.216 = 510.82 (264) Space and water heating $(261) + (262) + (263) + (264) = 959.52$ (265) Pumps and fans 75.00 x 0.519 = 38.93 (267) Electricity for lighting 311.66 x 0.519 = 161.75 (268) Total CO ₂ , kg/year (265)(271) = 1160.20 (272) Dwelling CO ₂ emission rate (272) + (4) = 16.51 (273) El value 86.51 86.51	
Space heating 0.00 (201) Fraction of space heat from secondary/supplementary system (table 11) 0.00 (202) Fraction of space heat from main system(s) 1 - (201) = 1.00 (202) Fraction of space heat from main system 2 0.00 (202) Fraction of total space heat from main system 1 (202) x [1- (203)] = 1.00 (204) Fraction of total space heat from main system 2 (202) x [202] (203) = 0.00 (205) Efficiency of main system 1 (%) 93.50 (206)	Water heating 2364.91 x 0.216 = 510.82 (264) Space and water heating $(261) + (262) + (263) + (264) =$ 959.52 (265) Pumps and fans 75.00 x 0.519 = 38.93 (267) Electricity for lighting 311.66 x 0.519 = 161.75 (268) Total CO ₂ , kg/year (265)(271) = 1160.20 (272) Dwelling CO ₂ emission rate (272) + (4) = 16.51 (273) El value 86.51 87 (274)	
Space heating 0.00 (201) Fraction of space heat from main system(s) 1 - (201) = 1.00 (202) Fraction of space heat from main system(s) 1 - (201) = 1.00 (202) Fraction of space heat from main system 2 0.00 (202) Fraction of total space heat from main system 1 (202) x [1 - (203)] = 1.00 (204) Fraction of total space heat from main system 2 (202) x [203] = 0.00 (205) Efficiency of main system 1 (%) 93.50 (206) (206) Jan Feb May Jun Jul Aug Sep Oct Nov Dec	Water heating 2364.91 x 0.216 = 510.82 (264) Space and water heating $(261) + (262) + (263) + (264) =$ 959.52 (265) Pumps and fans 75.00 x 0.519 = 38.93 (267) Electricity for lighting 311.66 x 0.519 = 161.75 (268) Total CO ₂ , kg/year (265)(271) = 1160.20 (272) Dwelling CO ₂ emission rate (272) + (4) = 16.51 (273) El value 86.51 87 (274)	
Space heating 0.00 (201) Fraction of space heat from main system(s) 1 - (201) = 1.00 (202) Fraction of space heat from main system(s) 1 - (201) = 1.00 (202) Fraction of space heat from main system 2 0.00 (202) Fraction of total space heat from main system 1 (202) x (1- (203)] = 1.00 (204) Fraction of total space heat from main system 1 (202) x (203) = 0.00 (205) Efficiency of main system 1 (%) 93.50 (206) 93.50 (206) Jan Feb Mar Apr May Jun Aug Sep Oct Nov Dec Space heating fuel (main system 1), kWh/month U Aug Sep Oct Nov Dec	Water heating 2364.91 x 0.216 = 510.82 (264) Space and water heating $(261) + (262) + (263) + (264) = 959.52$ (225) Pumps and fans 75.00 x 0.519 = 38.93 (267) Electricity for lighting 311.66 x 0.519 = 161.75 (268) Total CO ₂ , kg/year (265)(271) = 1160.20 (272) Dwelling CO ₂ emission rate (272) + (4) = 16.51 (273) El value 86.51 El rating (section 14) 87 (274) El band B 13a. Primary energy - individual heating systems including micro-CHP Finary factor Primary Energy	
<th colspace<="" td=""><td>Water heating 2364.91 x 0.216 = 510.82 (264) Space and water heating (261) + (262) + (263) + (264) = 959.52 (225) Pumps and fans 75.00 x 0.519 = 38.93 (267) Electricity for lighting 311.66 x 0.519 = 161.75 (268) Total CO2, kg/year (265)(271) = 1160.20 (272) Dwelling CO2 emission rate (272) + (4) = 16.51 (273) El value 86.51 El rating (section 14) 87 (274) El band 8 13a. Primary energy - individual heating systems including micro-CHP Energy kWh/year Primary factor Primary Energy kWh/year</td></th>	<td>Water heating 2364.91 x 0.216 = 510.82 (264) Space and water heating (261) + (262) + (263) + (264) = 959.52 (225) Pumps and fans 75.00 x 0.519 = 38.93 (267) Electricity for lighting 311.66 x 0.519 = 161.75 (268) Total CO2, kg/year (265)(271) = 1160.20 (272) Dwelling CO2 emission rate (272) + (4) = 16.51 (273) El value 86.51 El rating (section 14) 87 (274) El band 8 13a. Primary energy - individual heating systems including micro-CHP Energy kWh/year Primary factor Primary Energy kWh/year</td>	Water heating 2364.91 x 0.216 = 510.82 (264) Space and water heating (261) + (262) + (263) + (264) = 959.52 (225) Pumps and fans 75.00 x 0.519 = 38.93 (267) Electricity for lighting 311.66 x 0.519 = 161.75 (268) Total CO2, kg/year (265)(271) = 1160.20 (272) Dwelling CO2 emission rate (272) + (4) = 16.51 (273) El value 86.51 El rating (section 14) 87 (274) El band 8 13a. Primary energy - individual heating systems including micro-CHP Energy kWh/year Primary factor Primary Energy kWh/year
Space heating Graction of space heat from secondary/supplementary system (table 11) 0.00 (201) Fraction of space heat from main system(s) $1 - (201) = 1.00$ (202) Fraction of space heat from main system 2 0.00 (202) Fraction of total space heat from main system 1 $(202) \times [1 - (203)] = 1.00$ (202) Fraction of total space heat from main system 1 $(202) \times [1 - (203)] = 1.00$ (204) Fraction of total space heat from main system 1 $(202) \times [1 - (203)] = 1.00$ (204) Fraction of total space heat from main system 1 $(202) \times [1 - (203)] = 0.00$ (205) Efficiency of main system 1 (%) 0.00 0.00 0.00 (205) Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Space heating fuel (main system 1), kWh/month 471.08 334.72 238.57 97.40 25.36 0.00 0.00 0.00 115.24 307.00 487.95 Space heating fuel (main system 1), kWh/month Space heating fuel (main system 1)	Water heating 2364.91 x 0.216 = 510.82 (264) Space and water heating (261) + (262) + (263) + (264) = 959.52 (225) Pumps and fans 75.00 x 0.519 = 38.93 (267) Electricity for lighting 311.66 x 0.519 = 161.75 (268) Total CO2, kg/year (265)(271) = 1160.20 (272) Dwelling CO2 emission rate (272) + (4) = 16.51 (273) El value 86.51 El rating (section 14) 87 (274) El band 8 8 13a. Primary energy - individual heating systems including micro-CHP Energy kWh/year Space heating - main system 1 2077.32 x 1.22 = 2534.33 (261)	
Space heating Fraction of space heat from secondary/supplementary system (table 11) Fraction of space heat from main system(s) 1 - (201) 1	Water heating 2364.91 x 0.216 = 510.82 (264) Space and water heating (261) + (262) + (263) + (264) = 959.52 (265) Pumps and fans 75.00 x 0.519 = 38.93 (267) Electricity for lighting 311.66 x 0.519 = 161.75 (268) Total CO ₂ , kg/year (265)(271) = 1160.20 (272) Dwelling CO ₂ emission rate (272) + (4) = 165.51 (273) El value 86.51 El rating (section 14) 87 (274) El value 8 8 8 8 13a. Primary energy - individual heating systems including micro-CHP Primary factor Primary Energy KWh/year Space heating - main system 1 2077.32 x 1.22 = 2534.33 (261) Water heating 2364.91 x 1.22 = 285.20 (264)	
Space heating Fraction of space heat from main system(s) I - (201) I - (201)	Water heating 2364.91 x 0.216 = 510.82 (264) Space and water heating (261) + (262) + (263) + (264) = 959.52 (265) Pumps and fans 75.00 x 0.519 = 38.93 (267) Electricity for lighting 311.66 x 0.519 = 161.75 (268) Total CO_2 , kg/year (265)(271) = 1160.20 (272) Dwelling CO_2 emission rate (272) + (4) = 165.51 (273) El value 86.51 [273] [274) [274] El rating (section 14) 87 (274) [274] El band 87 (274) [274] I aband 132	
Space heating Fraction of space heat from main system(s) Image: Space heat from main system 1		

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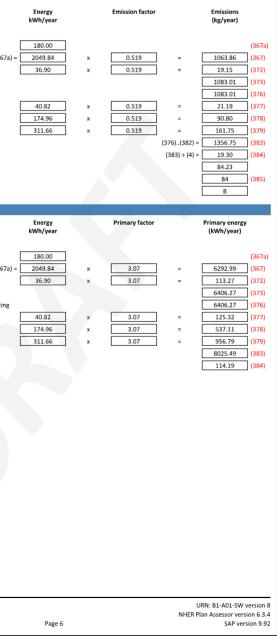
Be Green example data sheet – DER & TER

DER Worksheet	3. Heat losses and heat loss parameter	23.26 21.01 23.26 22.51 23.26 22.51 23.26 23.26 22.51 23.26 23.26 25.51 23.26 25.51 25.51 25.51 25.51 25.51 25.51 25.51 25.51 25.51 25.26 25.51 <th< th=""></th<>
	Element Gross Openings Net area U-value A x U W/K ĸ-value, A x ĸ,	Combi loss for each month from Table 3a, 3b or 3c
Design - Draft	area, m ² m ² A, m ² W/m ² K kJ/m ² .K kJ/K	0.00 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)
This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the	Window 21.01 x 1.33 = 27.85 (27)	Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m
property as constructed.	External wall 39.72 x 0.15 = 5.96 (29a)	196.28 173.19 182.33 164.07 161.23 144.70 139.58 152.32 151.79 170.10 179.09 191.77 (62)
	External wall 5.37 x 0.01 = 0.05 (29a)	Solar DHW input calculated using Appendix G or Appendix H
Assessor name Miss Michelle Wang Assessor number 2018	Party wall 33.79 x 0.00 = 0.00 (32)	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)
Client Last modified 05/11/2019	Total area of external elements ΣA, m ² 66.10 (31)	Output from water heater for each month (kWh/month) (62)m + (63)m
Address Manor Road Richmond Block 1, Richmond, TW9	Fabric heat loss, W/K = ∑(A × U) (26)(30) + (32) = 33.87 (33)	196.28 173.19 182.33 164.07 161.23 144.70 139.58 152.32 151.79 170.10 179.09 191.77
	Heat capacity $Cm = \sum (A \times K)$ (28)(30) + (32) + (32a)(32e) = N/A (34)	Σ (64)112 = 2006.45 (64)
1. Overall dwelling dimensions	Thermal mass parameter (TMP) in kJ/m ² K	Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]
Area (m²) Average storey Volume (m³)	Thermal bridges: Σ(L x Ψ) calculated using Appendix K	90.14 80.05 85.50 78.62 78.48 72.19 71.29 75.52 74.54 81.43 83.62 88.64 (65)
height (m)	Total fabric heat loss (33) + (36) = 44.89 (37)	5. Internal gains
Lowest occupied 70.28 (1a) x 2.65 (2a) = 186.24 (3a)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec	5. Internal gains Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Total floor area (1a) + (1b) + (1c) + (1d)(1n) = 70.28 (4)	Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Metabolic gains (Table 5)
Dwelling volume (3a) + (3c) + (3d)(3n) = 186.24 (5)	17.21 17.02 16.82 15.84 15.65 14.67 14.47 15.06 15.65 16.04 16.43 (38)	Metabolic gains (Table 5) 112.65 112.65 112.65 112.65 112.65 112.65 112.65 112.65 112.65 112.65 112.65 112.65 112.65 112.65 112.65 (66)
2. Ventilation rate	Heat transfer coefficient, W/K (37)m + (38)m	Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
m ³ per hour	62.10 61.90 61.71 60.73 60.53 59.55 59.36 59.94 60.53 60.92 61.31	17.65 15.67 12.75 9.65 7.21 6.09 6.58 8.55 11.48 14.58 17.01 18.14 (67)
	Average = $\Sigma(39)112/12 = 60.68$ (39)	Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
Number of chimneys 0 x 40 = 0 (6a) Number of come flows 0 x 30 = 0 (6b)	Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	Appriance gains (actuated in Appendix), equation 13 of c13a), also see rate 5 197.95 200.00 194.83 183.81 169.90 156.82 148.09 146.04 151.21 162.23 176.14 189.22 (68)
Number of open flues 0 x 20 = 0 (6b) Number of intermittent fans 0 x 10 = 0 (7a)	0.88 0.88 0.88 0.86 0.86 0.85 0.85 0.84 0.85 0.86 0.87 0.87	Light 200.00 194.83 103.01 109.90 130.82 146.09 140.04 151.21 102.23 170.14 109.22 (06) Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
Number of intermittent rans 0 $x_{10} = 0$ (7a) Number of passive vents 0 $x_{10} = 0$ (7b)	Average = $\Sigma(40)112/12 = 0.86$ (40)	34.26 34.26 34.26 34.26 34.26 34.26 34.26 34.26 (69)
Number of flueless gas fires $0 \times 40 = 0$ (7c)	Number of days in month (Table 1a)	Pump and fan gains (Table 5a)
Air changes per	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)	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0
hour	4. Water heating energy requirement	Losses e.g. evaporation (Table 5)
Infiltration due to chimneys, flues, fans, PSVs (6a) + (6b) + (7a) + (7b) + (7c) = 0 ÷ (5) = 0.00 (8)	Assumed occupancy, N 2.25 (42)	-90.12 -90.12 -90.12 -90.12 -90.12 -90.12 -90.12 -90.12 -90.12 -90.12 -90.12 -90.12 -90.12 (71)
If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)	Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 87.71 (43)	Water heating gains (Table 5)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area 3.00 (17)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec	121.15 119.13 114.92 109.20 105.49 100.26 95.81 101.51 103.53 109.45 116.14 119.14 (72)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m
Number of sides on which the dwelling is sheltered [19]	96.48 92.97 89.46 85.95 82.44 78.94 78.94 82.44 85.95 89.46 92.97 96.48	393.54 391.60 379.29 359.45 339.39 319.97 307.28 312.89 323.02 343.05 366.09 383.28 (73)
Shelter factor 1 - [0.075 x (19)] = 0.85 (20)	$\Sigma(44)112 = 1052.48 $ (44)	
Infiltration rate incorporating shelter factor (18) x (20) = 0.13 (21)	Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	6. Solar gains
Infiltration rate modified for monthly wind speed:	143.07 125.13 129.13 112.57 108.02 93.21 86.37 99.12 100.30 116.89 127.59 138.56	Access factor Area Solar flux g FF Gains Table 6d m ² W/m ² specific data specific data W
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec	Σ(45)112 = <u>1379.96</u> (45)	or Table 6c
Monthly average wind speed from Table U2	Distribution loss 0.15 x (45)m	SouthEast 0.77 x 5.25 x 36.79 x 0.9 x 0.9 x 0.90 = 48.19 (77)
5.10 5.00 4.90 4.40 4.30 3.80 3.70 4.00 4.30 4.70 (22)	21.46 18.77 19.37 16.89 16.20 13.98 12.96 14.87 15.04 17.53 19.14 20.78 (46)	SouthWest 0.54 x 3.68 x 36.79 x 0.9x 0.40 x 0.90 = 23.69 (79)
Wind factor (22)m ÷ 4	Storage volume (litres) including any solar or WWHRS storage within same vessel 194.00 (47)	SouthWest 0.77 x 5.78 x 36.79 x 0.9x 0.40 x 0.90 = 53.06 (79)
1.28 1.25 1.23 1.10 1.08 0.95 0.95 0.93 1.00 1.08 1.13 1.18 (22a)	Water storage loss:	NorthWest 0.77 x 6.30 x 11.28 x 0.9 x 0.40 x 0.90 = 17.73 (81)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	a) If manufacturer's declared loss factor is known (kWh/day) 1.61 (48)	Solar gains in watts ∑(74)m(82)m
0.16 0.16 0.16 0.14 0.14 0.12 0.12 0.12 0.13 0.14 0.14 0.15 (22b)	Temperature factor from Table 2b (49)	142.67 248.91 356.22 467.60 547.69 554.25 529.98 468.62 394.54 279.32 171.96 121.40 (83)
Calculate effective air change rate for the applicable case:	Energy lost from water storage (kWh/day) (48) x (49) 0.97 (50)	Total gains - internal and solar (73)m + (83)m
If mechanical ventilation: air change rate through system 0.50 (23a)	Enter (50) or (54) in (55) 0.97 (55)	536.22 640.51 735.51 827.05 887.08 874.22 837.26 781.51 717.56 622.37 538.05 504.69 (84)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h 76.50 (23c)	Water storage loss calculated for each month (55) x (41)m	
a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]	29.95 27.05 29.95 28.98 29.95 28.98 29.95 28.98 29.95 28.98 29.95 28.98 29.95 28.98 29.95 28.98 29.95 28.98 29.95 28.98 29.95 28.98 29.95 28.98 29.95 28.98 29.95 28.98 29.95 28.98 29.95 28.98 29.95 28.98 29.95 28.98 29.95 28.98 29.95 (56)	7. Mean internal temperature (heating season)
0.28 0.28 0.27 0.26 0.25 0.24 0.24 0.24 0.25 0.25 0.26 0.27 (24a)	If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] + (47), else (56)	Temperature during heating periods in the living area from Table 9, Th1(°C) (85)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	29.95 27.05 29.95 28.98 29.95 28.98 29.95 28.98 29.95 28.98 29.95 (57)	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.28 0.28 0.27 0.26 0.25 0.24 0.24 0.24 0.25 0.25 0.26 0.27 (25)	Primary circuit loss for each month from Table 3	Utilisation factor for gains for living area n1,m (see Table 9a)
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MANOR ROAD

AVANTON RICHMOND DEVELOPMENT LTD

0.93 0.89 0.83 0.71 0.57 0.42 0.31 0.34 0.53 0.76 0.90 0.94 (86)	0.00 0.00 0.00 0.00 52.61 59.70 53.01 0.00 0.00 0.00 0.00	
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	Σ(107)68 = 165.32 (107)	
19.50 19.81 20.19 20.59 20.84 20.96 20.99 20.98 20.90 20.56 19.97 19.44 (87)	Space cooling requirement kWh/m ² /year $(107) \div (4) = 2.35$ (108)	Emissions from other sources (space heating)
Temperature during heating periods in the rest of dwelling from Table 9, Th2('C)		Efficiency of heat pump
20.18 20.18 20.19 20.20 20.20 20.21 20.21 20.21 20.21 20.21 20.20 20.20 20.19 (88)	9b. Energy requirements - community heating scheme	CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367
Utilisation factor for gains for rest of dwelling n2,m	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)	Electrical energy for community heat distribution
0.92 0.88 0.81 0.68 0.53 0.37 0.25 0.29 0.48 0.73 0.88 0.93 (89)	Fraction of space heat from community system 1 - (301) = 1.00 (302) Fraction of community heat from heat pump 1.00 (303a)	Total CO2 associated with community systems
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	Fraction of community near pump (302) x (303a) = 1.00 (304a)	Total CO2 associated with space and water heating
18.17 18.61 19.15 19.70 20.02 20.17 20.20 20.11 19.68 18.86 18.10 (90)	Factor for control and charging method (Table 4c(3)) for community space heating [302) X (303) = [1.00 (305)]	Space cooling
Living area fraction Living area ÷ (4) = 0.51 (91)	Factor for charging method (Table 4c(3)) for community space neating 1.00 (305a)	Pumps and fans
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2	Distribution loss factor (Table 12c) for community heating system [1.07] (306)	Electricity for lighting Total CO ₂ , kg/year
18.84 19.22 19.68 20.15 20.43 20.57 20.60 20.60 20.51 20.13 19.42 18.78 (92)		Dwelling CO ₂ emission rate
Apply adjustment to the mean internal temperature from Table 4e where appropriate	Space heating	Fl value
18.84 19.22 19.68 20.15 20.43 20.57 20.60 20.60 20.51 20.13 19.42 18.78 (93)	Annual space heating requirement [1441.87] (98)	El rating (section 14)
8. Space heating requirement	Space heat from heat pump (98) x (306) x (306) = 1542.80 (307a)	El band
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec		
Utilisation factor for gains, nm	Water heating	13b. Primary energy - community heating scheme
0.91 0.86 0.79 0.68 0.54 0.39 0.28 0.31 0.50 0.73 0.87 0.92 (94)	Annual water heating requirement 2006.45 (64)	
Useful gains, ŋmGm, W (94)m x (84)m	Water heat from heat pump (64) x (303a) x (305a) x (306) = 2146.90 (310a)	
487.02 552.42 583.41 564.02 481.32 343.16 235.12 244.69 357.84 453.98 466.36 463.94 (95)	Electricity used for heat distribution 0.01 × [(307a)(307e) + (310a)(310e)] = 36.90 (313)	Primary energy from other sources (space heating)
Monthly average external temperature from Table U1		Efficiency of heat pump Primary energy from heat pump ((307a)+(310a)) x 100 ÷ (367
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)	Cooling System Energy Efficiency Ratio 4.05 (314)	Electrical energy for community heat distribution
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	Space cooling (if there is a fixed cooling system, if not enter 0) (107) ÷ (314) 40.82 (315)	Total primary energy associated with community systems
903.03 886.28 813.22 683.18 528.69 355.44 238.25 249.13 384.49 576.79 750.84 893.76 (97)	Electricity for pumps, fans and electric keep-hot (Table 4f)	Total primary energy associated with community systems
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	mechanical ventilation fans - balanced, extract or positive input from outside [174.96] (330a)	Space cooling
309.52 224.35 170.98 85.80 35.24 0.00 0.00 0.00 91.37 204.82 319.78	Total electricity for the above, kWh/year [174.96] (331)	Pumps and fans
$\Sigma(98)15, 1012 = 1441.87$ (98)	Electricity for lighting (Appendix L) 311.66 (332)	Electricity for lighting
Space heating requirement kWh/m ² /year (98) ÷ (4) 20.52 (99)	Total delivered energy for all uses $(307) + (309) + (310) + (312) + (331) + (332) \dots (337b) = 4217.14$ (338)	Primary energy kWh/year
8c. Space cooling requirement	10b. Fuel costs - community heating scheme	Dwelling primary energy rate kWh/m2/year
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec	Fuel Fuel price Fuel	
Heat loss rate Lm	kWh/year cost £/year	
0.00 0.00 0.00 0.00 0.00 559.78 440.68 451.10 0.00 0.00 0.00 0.00 (100)	Space heating from heat pump 1542.80 x 4.24 x 0.01 = 65.41 (340a)	
Utilisation factor for loss nm	Water heating from heat pump 2146.90 x 4.24 x 0.01 = 91.03 (342a)	
0.00 0.00 0.00 0.00 0.00 0.94 0.96 0.95 0.00 0.00 0.00 (101)	Space cooling 40.82 x 13.19 x 0.01 = 5.38 (348)	
Useful loss ŋmLm (watts) (100)m x (101)m	Pumps and fans 174.96 x 13.19 x 0.01 = 23.08 (349)	
0.00 0.00 0.00 0.00 0.00 526.03 424.47 430.53 0.00 0.00 0.00 0.00 (102)	Electricity for lighting 311.66 x 13.19 x 0.01 = 41.11 (350)	
Gains	Additional standing charges 120.00 (351) Total energy cost (340a)(342e) + (345)(354) = 346.01 (355)	
0.00 0.00 0.00 0.00 1102.90 1057.93 992.99 0.00 0.00 0.00 (103)	(340a)(342e) + (345)(554) = 340.01 (555)	
Space cooling requirement, whole dwelling, continuous (kWh) 0.024 x [(103)m - (102)m] x (41)m 0.00 0.00 0.00 415.35 471.29 418.47 0.00 0.00 0.00	11b. SAP rating - community heating scheme	
0.00 0.00 0.00 0.00 415.35 471.29 418.47 0.00 0.00 0.00 0.00 .000 .000 .000 .	Energy cost deflator (Table 12) 0.42 (356)	
Cooled fraction $2(104)_{08} = 1305.12$ (104) Cooled area \div (4) = 0.51 (105)	Energy cost factor (ECF) 1.26 (357)	
copied area + (4) = 0.51 (105) Intermittency factor (Table 10)	SAP value 82.41	
0.00 0.00 0.00 0.00 0.00 0.25 0.25 0.25	SAP rating (section 13) [358]	
Σ(106)68 = 0.75 (106)	SAP band B	
Space cooling requirement (104)m x (105) x (106)m	12b. CO ₂ emissions - community heating scheme	
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TER Worksheet 3. Heat losses and heat loss parameter
Design - Draft Gross Openings Net area U-value A x U W/K K-value, A x K, Element area.m ² m ² A.m ² W/m ² K k/m ² K
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 Total area of external elements ΣA, m ² 66.07 (32)
Client Last modified 05/11/2019 Fabric heat loss, W/K = ∑(A × U) (26)(30) + (32) = 32.02 (31)
Address Manor Road Richmond Block 1, Richmond, TW9 (20)(30) + (32) + (324)(329) - (1/A) (34) Thermal mass parameter (TMP) in kJ/m ³ K (20)(30) + (32) + (324)(329) - (1/A) (34)
1. Overall dwelling dimensions Thermal bridges: $\Sigma(L \times \Psi)$ calculated using Appendix K 5.69 (36)
Area (m²) Average storey Volume (m³) Total fabric heat loss (33) + (36) = 37.71 (37)
height (m) Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Lowest occupied 70.28 (1a) x 2.65 (2a) = 186.24 (3a) Ventilation heat loss calculated monthly 0.33 x (25)m x (5)
Total floor area (1a)+(1b)+(1c)+(1d)(1n) = 70.28 (4) (36.83 36.59 36.36 35.27 35.07 34.12 33.94 34.48 35.07 35.48 35.91 (38)
Dwelling volume (3a) + (3b) + (3c) + (3d)(3n) = 186.24 (5) Heat transfer coefficient, W/K (37)m + (38)m
74.54 74.31 74.07 72.98 72.78 71.83 71.65 72.20 72.78 73.19 73.62 2. Ventilation rate
Average = $\chi(3)$ 112/12 = 12.35 (39)
near toss parameter (nLr), with r (35)in + (4)
Number of open flues 0 $x 20 =$ 0 (6b) Average = $\underline{5}(40)112/12 =$ 1.04 (40) Number of intermittent fans 3 $x 10 =$ 30 (7a) Number of days in month (Table 1a) (40)
Number of passive vents 0 x 10 = 0 (7b) 31.00 28.00 31.00 30.00 31.00
Number of flueless gas fires 0 x 40 = 0 (7c)
Air changes per 4. Water heating energy requirement
hour Assumed occupancy, N 2.25 (42)
Infiltration due to chimneys, flues, fans, PSVs (6a) + (7b) + (7c) = 30 + (5) = 0.16 (8) Annual average hot water usage in litres per day Vd, average = (25 x N) + 36 87.71 (43)
If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area 5.00 (17) Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)
If based on air permeability value, then (18) = [(17) + 20] + (8), otherwise (18) = (16) 0.41 (18) 96.48 92.97 89.46 85.95 82.44 78.94 78.94 82.44 92.97 96.48 Number of sides on which the dwelling is sheltered 2 (19) 5 5 5 82.44 78.94 78.94 82.44 92.97 96.48
Number of sides on which the dwelling is sheltered 2 (19) Σ(44)112 = 1052.48 (44) Shelter factor 1 - [0.075 x (19)] = 0.85 (20) Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) (44)
$1 - [0.073 \times (15)] - [0.033 \times (20)] = [0.033 \times (20)]$ Infiltration rate incorporating shelter factor (18) × (20) = [0.35] (21) (18) × (20) = [0.35
Infiltration rate modified for monthly wind speed: $\sum_{i=1,2,3,3} \sum_{i=1,2,3,3} \sum_{i$
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Distribution loss 0.15 x (45)m
Monthly average wind speed from Table U2 21.46 18.77 19.37 16.89 16.20 13.98 12.96 14.87 15.04 17.53 19.14 20.78 (46)
5.10 5.00 4.90 4.40 4.30 3.80 3.80 3.70 4.00 4.30 4.50 4.70 (22) Storage volume (litres) including any solar or WWHRS storage within same vessel 194.00 (47)
Wind factor (22)m ÷ 4 Water storage loss:
1.28 1.25 1.23 1.10 1.08 0.95 0.95 0.93 1.00 1.08 1.13 1.18 (22a) a) If manufacturer's declared loss factor is known (kWh/day) 1.62 (48)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m
0.45 0.44 0.43 0.38 0.38 0.33 0.32 0.35 0.38 0.39 0.41 (22b) Energy lost from water storage (kWh/day) (48) x (49) 0.88 (50)
Calculate effective air change rate for the applicable case:
If mechanical ventilation: air change rate through system N/A (23a) Water storage loss calculated for each month (55) x (41)m
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h N/A (23c) 27.16 26.29 27.16 27.16 26.29 27
d) natural ventilation or whole house positive input ventilation from loft
0.60 0.60 0.59 0.57 0.57 0.56 0.56 0.55 0.56 0.57 0.58 0.58 (24) 27.16 24.54 27.16 26.29 27.16 26.29 27.16 26.29 27.16 26.29 27.16 26.29 27.16 26.29 27.16 26.29 27.16 (57)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) Primary circuit loss for each month from Table 3 Primary circuit loss for each month from Table 3
0.60 0.60 0.59 0.57 0.56 0.56 0.55 0.56 0.57 0.58 0.58 (25) 23.26 21.01 23.26 22.51 23.26 23.26 23.26 23.26 22.51 23.26 22.51 23.26 (59)
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0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)
onth 0.85 x		5)m + (57)m	n + (59)m +	(61)m				
158.45	142.01	136.80	149.54	149.10	167.32	176.39	188.99	(62)
H	0.00	0.00	0.00	0.00	0.00	0.00		(63)
0.00 52)m + (63)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)
158.45	142.01	136.80	149.54	149.10	167.32	176.39	188.99	
130.43	142.01	130.00	249.94	145.10	Σ(64)1			(64)
(45)m + (61	.)m] + 0.8 ×	[(46)m + (5	7)m + (59)	m]		<u>ئ</u>		
76.26	70.03	69.06	73.30	72.39	79.21	81.47	86.41	(65)
May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
112.65	112.65	112.65	112.65	112.65	112.65	112.65	112.65	(66)
), also see Ta	able 5		1				_	
7.21	6.09	6.58	8.55	11.48	14.58	17.01	18.14	(67)
L13a), also se								
169.90	156.82	148.09	146.04	151.21	162.23	176.14	189.22	(68)
5a), also see		34.26	34.26	24.26	34.26	24.26	24.26	(60)
34.26	34.26	34.20	34.20	34.26	34.20	34.26	34.26	(69)
3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
-90.12	-90.12	-90.12	-90.12	-90.12	-90.12	-90.12	-90.12	(71)
102.50	97.27	92.82	98.52	100.54	106.46	113.15	116.15	(72)
n + (71)m + (7								
339.40	319.98	307.29	312.90	323.03	343.06	366.10	383.29	(73)
212100000		12						
Area m ²		ar flux //m²		g ific data	FF specific d		Gains W	
m-	Ň	///1-		able 6b	or Table		w	
4.39	x 3	6.79 x (0.9 x 🚺).63 x	0.70	=	49.36	(77)
3.08	x 3	6.79 x (0.9 x 🗌).63 x	0.70	=	24.29	(79)
4.84	x 3	6.79 x (D.9 x 🗌 🤇	0.63 x	0.70	=	54.42	(79)
5.26	x 1	1.28 x (0.9 x 🛛 🤇).63 x	0.70	=	18.14	(81)
561.11	567.82	542.96	480.13	404.26	286.23	176.23	124.42	(83)
900.51	887.80	850.25	793.03	727.29	629.30	542.32	507.71	(84)
500.51	307.00	550.25	, 33.05	121.23	525.50	542.52	307.71	(0-1)
Table 9, Th1				_	_			(85)
May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
a) 0.71	0.51	0.37	0.41	0.66	0.91	0.98	1.00	(86)
0.71	0.51	0.37	0.41	0.00	0.91	0.98	1.00	(00)
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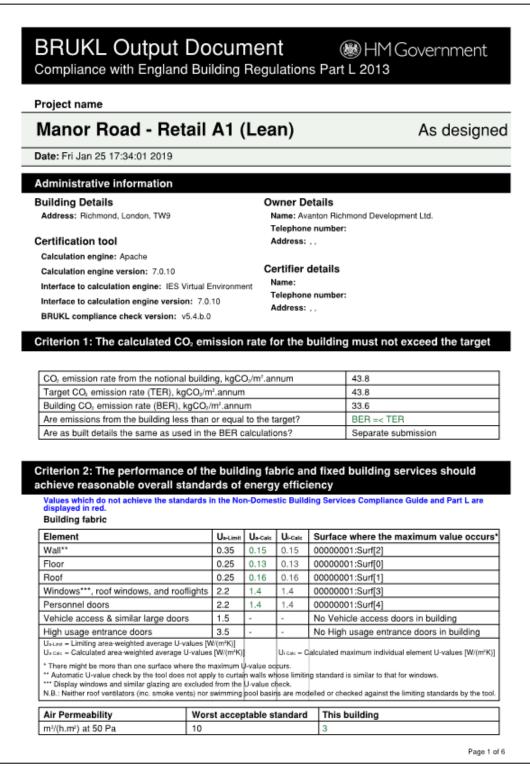
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Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	Space heating fuel - main system 1				2077.32
20.04 20.24 20.50 20.79 20.94 20.99 21.00 21.00 20.97 20.75 20.34 20.00 (87)	Water heating fuel				2364.91
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)	Electricity for pumps, fans and electric keep-hot (Table 4f)				
20.03 20.04 20.04 20.05 20.05 20.06 20.06 20.07 20.06 20.05 20.05 20.04 (88)	central heating pump or water pump within warm air heatin	ng unit	[30.00	(230c)
Utilisation factor for gains for rest of dwelling n2,m	boiler flue fan		[45.00	(230e)
0.99 0.98 0.94 0.83 0.65 0.44 0.29 0.33 0.58 0.88 0.98 0.99 (89)	Total electricity for the above, kWh/year				75.00 (231)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	Electricity for lighting (Appendix L)				311.66 (232)
18.76 19.06 19.43 19.82 20.00 20.06 20.07 20.04 19.79 19.22 18.72 (90)	Total delivered energy for all uses		(211)	.(221) + (231) + (232)(237b) = 4828.89 (238)
Living area \div (4) = 0.51 (91)					
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2	10a. Fuel costs - individual heating systems including micro-C				
19.41 19.65 19.98 20.31 20.48 20.53 20.54 20.51 20.27 19.79 19.37 (92)		Fuel kWh/year		Fuel price	Fuel cost £/year
Apply adjustment to the mean internal temperature from Table 4e where appropriate	Space heating - main system 1	2077.32	νΓ	3.48 x 0.01 =	72.29 (240)
19.41 19.65 19.98 20.31 20.48 20.53 20.54 20.51 20.27 19.79 19.37 (93)	Water heating	2364.91	, L	3.48 x 0.01 =	82.30 (247)
	Pumps and fans	75.00	Ĵ	13.19 x 0.01 =	9.89 (249)
8. Space heating requirement	Electricity for lighting	311.66	Ĵ	13.19 x 0.01 =	41.11 (250)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec	Additional standing charges	511.00	ĵ l	X0.01 -	120.00 (251)
Utilisation factor for gains, nm	Total energy cost			(240)(242) + (245)(254	
0.99 0.98 0.94 0.84 0.67 0.48 0.33 0.37 0.62 0.89 0.98 0.99 (94)	Total energy cost			(240)(242) + (243)(234	- <u>323.35</u> (233)
Useful gains, ηmGm, W (94)m x (84)m	11a. SAP rating - individual heating systems including micro-C	СНР			
534.28 630.63 698.39 706.21 607.11 422.26 282.43 295.73 448.15 559.29 529.87 503.83 (95)	Energy cost deflator (Table 12)				0.42 (256)
Monthly average external temperature from Table U1	Energy cost factor (ECF)				1.19 (257)
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)	SAP value				83.45
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	SAP rating (section 13)				83 (258)
1126.31 1096.35 998.21 832.70 638.98 426.11 282.86 296.53 462.91 704.11 928.54 1117.04 (97)	SAP band				В
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m					
440.46 312.97 223.07 91.07 23.71 0.00 0.00 0.00 0.00 107.75 287.04 456.23	12a. CO ₂ emissions - individual heating systems including mic	CHP			
Σ(98)15, 1012 = <u>1942.29</u> (98)		Energy		Emission factor	Emissions
$\Sigma(98)15, 1012 = 1942.29 (98)$ Space heating requirement kWh/m ² /year (98) + (4) 27.64 (99)		Energy kWh/year	, r	kg CO ₂ /kWh	kg CO ₂ /year
Space heating requirement kWh/m ² /year (98) + (4) 27.64 (99)	Space heating - main system 1	Energy kWh/year 2077.32	× [kg CO ₂ /kWh 0.216 =	kg CO ₂ /year 448.70 (261)
Space heating requirement kWh/m²/year (98) + (4) 27.64 (99) 9a. Energy requirements - individual heating systems including micro-CHP	Space heating - main system 1 Water heating	Energy kWh/year	x [x [x [kg CO ₂ /kWh 0.216 = 0.216 =	kg CO ₂ /year 448.70 (261) 510.82 (264)
Space heating requirement kWh/m²/year (98) + (4) 27.64 (99) 9a. Energy requirements - individual heating systems including micro-CHP Space heating	Space heating - main system 1 Water heating Space and water heating	Energy kWh/year 2077.32 2364.91	× [× [× [kg CO ₂ /kWh 0.216 = 0.216 = (261) + (262) + (263) + (264)	kg CO ₂ /year 448.70 (261) 510.82 (264)) = 959.52 (265)
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Appendix I: BRUKL summary

Be lean BRUKL



Technical Data Sheet (Actual vs. Notional Building)

Building Global Par	rameters		Building Use
	Actual	Notional	% Area Building Type
Area [m²]	434.5	434.5	100 A1/A2 Retail/Financial and Professional services
External area [m ²]	965.6	965.6	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
Weather	LON	LON	B1 Offices and Workshop businesses B2 to B7 General Industrial and Special Industrial Groups
Infiltration [m3/hm2@ 50Pa]	3	3	B8 Storage or Distribution
Average conductance [W/K]	311.82	399.49	C1 Hotels
Average U-value [W/m²K]	0.32	0.41	C2 Residential Institutions: Hospitals and Care Homes
Alpha value* [%]	10	10	C2 Residential Institutions: Residential schools C2 Residential Institutions: Universities and colleges
			D1 Non-residential Institutions: Libraries, Museums, and Galleries D1 Non-residential Institutions: Education D1 Non-residential Institutions: Primary Health Care Building D1 Non-residential Institutions: Crown and County Courts D2 General Assembly and Leisure, Night Clubs, and Theatres Others: Passenger terminals Others: Emergency services Others: Miscellaneous 24hr activities Others: Gar Parks 24 hrs Others: Stand alone utility block
Energy Consumption	on by En	d Use [kWh/m	

Energy	Consumption by End Use [kWh/m ²	1
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	Actual	Notional
Heating	11.55	13.15
Cooling	5.88	8.82
Auxiliary	16.97	17.66
Lighting	37.77	53.7
Hot water	1.86	1.86
Equipment*	20.26	20.26
TOTAL**	74.04	95.19

* Energy used by equipment does not count towards the total for consumption or calculating emit ** Total is not of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m ²]				
	Actual	Notional		
Photovoltaic systems	0	0		
Wind turbines	0	0		
CHP generators	0	0		
Solar thermal systems	0	0		

Energy & CO	D, Emissions Sum	mary

	Actual	Notional
Heating + cooling demand [MJ/m ²]	127.99	161.17
Primary energy* [kWh/m ²]	197.83	258.32
Total emissions [kg/m ²]	33.6	43.8

Printery energy is net of any electrical energy displaced by CHP generators, if applicable.

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Be green BRUKL

BRUKL Output Document HM Government Compliance with England Building Regulations Part L 2013 Project name Manor Road - Retail A1 (Green) As designed Date: Fri Jan 25 17:39:38 2019 Administrative information **Building Details Owner Details** Address: Richmond, London, TW9 Name: Avanton Richmond Development Ltd. Telephone number: Certification tool Address: , , Calculation engine: Apache Certifier details Calculation engine version: 7.0.10 Name: Interface to calculation engine: IES Virtual Environment Telephone number: Interface to calculation engine version: 7.0.10 Address: , , BRUKL compliance check version: v5.4.b.0 Criterion 1: The calculated CO₂ emission rate for the building must not exceed the target CO₂ emission rate from the notional building, kgCO₂/m².annum 36 Target CO₂ emission rate (TER), kgCO₂/m².annum 36 Building CO₂ emission rate (BER), kgCO₂/m².annum 27.3 Are emissions from the building less than or equal to the target? BER =< TER Are as built details the same as used in the BER calculations? Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red. Building fabric

Element	Ua-Limit	Un-Calc	Ul-Calc	Surface where the maximum value occurs
Wall**		0.15	0.15	0000001:Surf[2]
Floor	0.25	0.13	0.13	00000001:Surf[0]
Roof	0.25	0.16	0.16	0000001:Surf[1]
Windows***, roof windows, and roof	lights 2.2	1.4	1.4	0000001:Surf[3]
Personnel doors	2.2	1.4	1.4	00000001:Surf[4]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building
$\label{eq:Ustarded} \begin{array}{l} U_{a,t,\mathrm{inst}} = Limiting \mbox{ area-weighted average } U\mbox{-val}\\ U_{a,Calc} = Calculated \mbox{ area-weighted average } U \end{array}$		1	Ui-Cale = Cé	Iculated maximum individual element U-values [W/(m*K)]
* There might be more than one surface when ** Automatic U-value check by the tool does n *** Display windows and similar glazing are e N.B.: Neither roof ventilators (inc. smoke ven	not apply to curtai xcluded from the	n walls wf U-value c	iose limiting heck.	standard is similar to that for windows. Illed or checked against the limiting standards by the tool
Air Permeability Worst acceptable standard This building				
		0		3

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters		Buildi	ing Use	
	Actual	Notional	% Area	Building Type
Area (m²)	434.5	434.5	100	A1/A2 Retail/Financial and Professional services
xternal area [m²] 965 /eather LO /illtration [m²/hm²@ 50Pa] 3 verage conductance [W/K] 311	965.6	965.6		A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
Weather	LON	LON		B1 Offices and Workshop businesses
Infiltration [m³/hm²@ 50Pa]	3	3		B2 to B7 General Industrial and Special Industrial Groups B8 Storage or Distribution
Average conductance [W/K]	311.82	399.49		C1 Hotels
Average U-value [W/m²K]	0.32	0.41		C2 Residential Institutions: Hospitals and Care Homes
Alpha value* [%]	10	10		C2 Residential Institutions: Residential schools C2 Residential Institutions: Universities and colleges
* Percentage of the building's average heat har	pha value* [%] 10 10 croontage of the building's average heat transfer coefficient which is due to thermal bridging			C2A Secure Residential Institutions Residential spaces D1 Non-residential Institutions: Community/Day Centre D1 Non-residential Institutions: Libraries, Museums, and Galleries D1 Non-residential Institutions: Education D1 Non-residential Institutions: Primary Health Care Building D1 Non-residential Institutions: Crown and County Courts D2 General Assembly and Leisure, Night Clubs, and Theatres Others: Passenger terminals Others: Emergency services Others: Care Parks 24 hrs

Energy Con	sumption by En	a Use [kwn/m ⁻]
	Actual	Notional
Heating	1.98	4.43
Cooling	5.32	8.82
Auxiliary	7.13	3.06
Lighting	37.77	53.7
Hot water	1.7	1.86
Equipment*	20.26	20.26
TOTAL**	53.9	71.88

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators. It applicable.

Energy Production by Technology [kWh/m ²]				
	Actual	Notional		
Photovoltaic systems	0	0		
Wind turbines	0	0		
CHP generators	0	0		
Solar thermal systems	0	0		

Energy & CO ₂ Emissions Summary							
	Actual	Notional					
Heating + cooling demand [MJ/m ²]	127.99	161.17					
Primary energy* [kWh/m ²]	167.27	224.88					
Total emissions [kg/m ²]	27.3	36					

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

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Appendix J: Boiler and ASHP operational cost analysis

	Communal gas boiler			ASHP + local storage with immersion			ASHP + local storage with immersion		
	Communal gas boiler			Building-by-building ASHP			Building-by-building ASHP		
	Equivalent heat price	p/kWh	4.0	Equivalent heat price (inc. RHI)	p/kWh	2.4	Equivalent heat price (excl. RHI)	p/kWh	5.2
	Tenant heat demand	kWh/yr	1	Tenant heat demand	kWh/yr	1	Tenant heat demand	kWh/yr	1
	Proportion of demand is space heat	-	0.50	Proportion of demand is space heat	-	0.33	Proportion of demand is space heat	-	0.33
	Proportion of demand is DHW	-	0.50	Proportion of demand is DHW	-	0.67	Proportion of demand is DHW	-	0.67
	Communal distribution heat losses	-	0.30	Building by Building distribution heat losses	-	0.11	Building by Building distribution heat losses	-	0.11
	Communal storage heat losses	-	0.00	Communal storage heat losses	-	0.00	Communal storage heat losses	-	0.00
	Gas boiler efficiency	-	0.95	Gas boiler efficiency	-	-	Gas boiler efficiency	-	-
System Inputs	Pumping energy % of heat generated	-	0.01	Pumping energy % of heat generated	-	0.01	Pumping energy % of heat generated	-	0.01
	Cold water flow temp	C	10	Cold water flow temp	С	10	Cold water flow temp	С	10
	Hot water storage temp	C	-	Hot water storage temp	С	60	Hot water storage temp	С	60
	Communal distribution flow temp	С	70	Communal distribution flow temp	С	55	Communal distribution flow temp	С	55
	Communal distribution return temp	С	40	Communal distribution return temp	С	30	Communal distribution return temp	С	30
				Electric heating efficiency	-	1.00	Electric heating efficiency	-	1.00
				ASHP heating efficiency	-	2.90	ASHP heating efficiency	-	2.90
	Heat generated	kWh/yr	1.429	Percentage of communal hot water	-	0.90	Percentage of communal hot water	-	0.90
				Percentage of local storage hot water	-	0.10	Percentage of local storage hot water	-	0.10
Calculation				ASHP heat generated	kWh/yr	1.049	ASHP heat generated	kWh/yr	1.049
				Electric heat generated	kWh/yr	0.067	Electric heat generated	kWh/yr	0.067
	Landlord gas consumption	kWh/yr	1.504	Landlord gas consumption	kWh/yr	0.000	Landlord gas consumption	kWh/yr	0.000
	Landlord electricity consumption	kWh/yr	0.014	Landlord electricity consumption	kWh/yr	0.372	Landlord electricity consumption	kWh/yr	0.372
	Tenant electricity consumption	kWh/yr	0.000	Tenant electricity consumption	kWh/yr	0.067	Tenant electricity consumption	kWh/yr	0.067
	Total net energy consumption	kWh/yr	1.518	Total net energy consumption	kWh/yr	0.439	Total net energy consumption	kWh/yr	0.439
Output (heat	Landlord gas consumption	n	3.865	Landlord gas consumption	n	0.000	Landlord gas consumption	p	0.000
system)	Landlord electricity consumption	p n	0.158	Landlord electricity consumption	p D	4.108	Landlord electricity consumption	р р	4.108
, .	Landlord RHI	г D	0.000	Landlord RHI	p	-2.821	Landlord RHI	р р	0.000
	Tenant gas consumption	р D	0.000	Tenant gas consumption	р р	0.000	Tenant gas consumption	р р	0.000
	Tenant electricity consumption	г D	0.000	Tenant electricity consumption	b	1.099	Tenant electricity consumption	р р	1.099
	Total energy consumption	p n	4.022	Total energy cost	p n	2.386	Total energy cost	р D	5.207

Table 24: Boiler & ASHP operational cost analysis inputs and results

SUSTAINABILITY REVISED ENERGY STRATEGY – REV. 04

Appendix K: Centralised vs decentralised analysis

Centralised vs decentralised energy strategy analysis. Manor Road, Richmond.

Introduction.

This report has been produced on behalf of Avanton Richmond Development Ltd to assess the implications of providing a centralised district heating network for the proposed development at Manor Road, Richmond.

The energy strategy is based upon a number of decentralised air source heat pumps, which are utilised to generate the heating and hot water for the residential elements of the development.

This report assesses the approximate additional heat losses and power consumption involved in providing a district network, and discusses how a future district heating network could be planned for within the development.

Development proposals.

The proposal for the development is to provide a decentralised energy strategy, with a 'bank' of heat pumps per core. This is primarily due to the absence of a single roof area which can accommodate the heating requirements for the whole development. This is demonstrated in Figure 1. In addition, centralising the heating generation would have other planning implications, including massing, views and acoustics. The heat pump configuration is generally modular, and as such limited benefit is gained from utilising larger central plant.

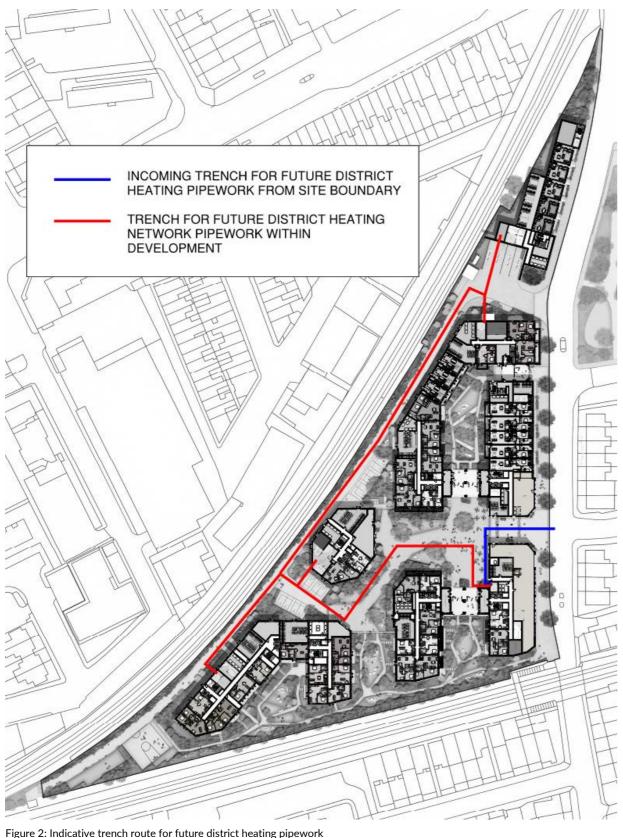
Therefore, the current proposed strategy includes space allocation which has been made for future plate heat exchangers at the ground floor to each building, and the pipework in all risers appropriately sized to be able to serve each building bottom-up in future, in addition to the current top-down arrangement. It is further proposed to include full trenching between all buildings, with space allocation made for future district heating pipework. A further space allocation has been made for a plate heat exchanger at the ground floor near to the site entrance, so that a future potential district energy network would only require one connection point. Pipework sleeves will be included through the building envelope at the location of each future plate heat exchanger to further ease future connection, should a viable option become available in the vicinity of the site in future. This is shown in Figure 2.



Figure 1: Approximate centralised ASHP plant space requirements



MEP ENGINEERING MANOR ROAD, RICHMOND



District network assessment.

This section assesses the viability and the implications of providing a district heating network at day one.

Inter-connectivity

A route has been planned through the development which would allow inter-connectivity between each of the blocks, which would facilitate connection to a district heating network.

A pre-built trench has been planned and safeguarded from the site boundary which allows a single point of connection from a future district heat network to a central future plate heat exchanger. Trenching has been allowed between each of the future district heating plate heat exchangers, which would allow interconnectivity of the blocks in the event of a district network coming on line. Additionally, builderswork has been considered at the boundary of each building, and it is proposed that pre-cast/ pre-installed sleeves will be provided, to allow the pipework to enter the building with minimal disruption, and minimum additional cost incurred to a future network energy provider.

Hydraulic considerations.

It has been considered whether connecting capped pipework between all buildings could be provided at day one. However, this option has been disregarding for the following reasons:

- the risk that the pipework may never be used, therefore the embodied carbon associated with the installed pipework would be spent at no additional benefit to the scheme
- the difficulty in stopping the pipework corroding/ deteriorating over time
- potential warranty issues with connecting to the pipework when it has been left unused for a period of time.

Additional energy consumption

It has also been considered whether connecting, 'live' distribution pipework between all buildings could be provided at day one. However, this option has been disregarding for the following reasons:

Owing to the nature of air source heat pumps being located locally at roof level of each building, for the reasons outlined in the previous section, providing interconnecting pipework at day one will not yield a saving in terms of energy or carbon emissions. The below summary table shows the approximate additional heat and energy demand to the scheme that would be expected to result from inter-connecting the buildings.

Also, given there is very limited non-domestic uses at this development, there is little likelihood of achieving an energy-sharing scenario.

In summary, this would mean that the additional energy lost in the distribution pipework would not be expected to be made up for by any savings from a sitewide connection.

Building Distribution Heat Losses		
Estimated Heat Loss per metre (vertical pipework)	6	W
Estimated Heat Loss per metre (lateral pipework)	4	W
Estimated Annual Heat Loss per core	12089	kWh
Estimated Annual Heat Loss	120888	kWh
District Network Distribution Heat Losses		
Estimated Buried Pipework Length	800	m
Estimated Heat Loss per metre	15	\mathbb{W}
Estimated Heat Loss per PHX	750	\mathbb{W}
Total Annual Heat Loss	137970	kWh
Estimated additional pump power	5000	\mathbb{W}
Total Annual Energy Loss	181770	kWh
Estimated annual total heat demand	1670400	kWh
Estimated district heating distribution losses (without centralised network)	7%	
Estimated district heating distribution losses (without centralised network) Estimated district heating distribution losses (with centralised network) Table 1: Summary of energy losses in centralised and decentralised distribution networks	18%	

Table 1: Summary of energy losses in centralised and decentralised distribution networks

Summary

In summary, it is expected that the operational energy lost in any installed distribution pipework would not be counter-acted by any savings resulting from such a sitewide connection.

It is also not proposed to install capped pipework on day one, as it is known from experience that such pipework often is not fit for purpose once it may come to be used. Further, additional embodied carbon would be expected to result from installing such district energy pipework.

Instead it is proposed to make allocations for heat exchangers, full trenching, and pipework sleeves as described above, in order to facilitate a future energy network connection at minimal disruption to residents, and minimal cost to the installer.



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