

This As Built submission has been carried out by an Authorised SAP Assessor. The Assessor has confirmed any changes from the Design Submission with the builder.

**Assessor Name** Mr Andrew J Ball **Assessor Number** 3474  
**Client** Andy Ball  
**Date Last Modified** 03/02/2009  
**Address** 4 Kings Orchard, Upper Churchfields, Cradley, MALVERN, Worcestershire, WR13 5LJ

**1. Overall dwelling dimensions**

	Area (m <sup>2</sup> )		Average storey height (m)		Volume (m <sup>3</sup> )
Ground Floor	82.13 (1a)	×	2.40	=	197.11 (1)
First Floor	73.13 (2a)	×	2.60	=	190.14 (2)
Total floor area (1a)+(2a)+(3a)+(4a)+(4b)+(4d)+(4f)+(4h) =	155.26 (5)				
Dwelling volume				(1)+(2)+(3)+(4)+(4c)+(4e)+(4g)+(4i) =	387.25 (6)

**2. Ventilation rate**

			m <sup>3</sup> per hour		
Number of chimneys	0	×	40 =	0 (7)	
Number of open flues	0	×	20 =	0 (8)	
Number of intermittent fans or passive vents	0	×	10 =	0 (9)	
Number of flueless gas fires	0	×	40 =	0 (9a)	
Infiltration due to chimneys, flues and fans = (7)+(8)+(9)+(9a) =				0	÷ box (6) = 0.00 (10)
<i>If a pressurisation test has been carried out, proceed to box (19)</i>					
Number of storeys in the dwelling				2 (11)	
Additional infiltration					[(11) - 1] × 0.1 = 0.10 (12)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction					0.35 (13)
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0					0.00 (14)
If no draught lobby, enter 0.05, else enter 0					0.05 (15)
Percentage of windows and doors draught stripped				100.00 (16)	
<i>Enter 100 in box (16) for new dwellings which are to comply with Building Regulations</i>					
Window infiltration				0.25 - [0.2 × (16) ÷ 100] =	0.05 (17)
Infiltration rate				(10)+(12)+(13)+(14)+(15)+(17) =	0.55 (18)
If based on air permeability value, then [ $\frac{1}{250} \times \text{value}$ ] + (10) in box (19), otherwise (19) = (18)					0.55 (19)
<i>Air permeability value applies if a pressurisation test has been done or the design air permeability is being used</i>					
Number of sides on which sheltered					0 (20)
<i>(Enter 2 in box (20) for new dwellings where location is not shown)</i>					



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Shelter factor		$1 - [0.075 \times (20)] =$	<input type="text" value="1.00"/>	(21)
Adjusted infiltration rate		$(19) \times (21) =$	<input type="text" value="0.55"/>	(22)
Calculate effective air change rate for the applicable case				
If balanced whole house mechanical ventilation system		air throughput (ach) =	<input type="text" value="N/A"/>	(22a)
If balanced with heat recovery		efficiency in % allowing for in-use factor =	<input type="text" value="N/A"/>	(22b)
a) If balanced whole house mechanical ventilation with heat recovery		$(22) + (22a) \times [1 - (22b) / 100] =$	<input type="text" value="N/A"/>	(23)
b) If balanced whole house mechanical ventilation without heat recovery		$(22) + (22a) =$	<input type="text" value="N/A"/>	(23a)
c) If whole house extract ventilation or positive input ventilation from outside			<input type="text" value="N/A"/>	(23b)
		<i>if (22) &lt; 0.25, then (23b) = 0.5; otherwise (23b) = 0.25 + (22)</i>		
d) If natural ventilation or whole house positive input ventilation from loft			<input type="text" value="0.65"/>	(24)
		<i>if (22) ≥ 1, then (24) = (22); otherwise (24) = 0.5 + [(22)² × 0.5]</i>		
<b>Effective air change rate - enter (23) or (23a) or (23b) or (24) in box (25)</b>			<input type="text" value="0.65"/>	(25)

**3. Heat losses and heat loss parameter**

ELEMENT	Area (m²)		U - value		AXU (W/K)	
Windows *	<input type="text" value="33.53"/>	×	<input type="text" value="2.76"/>	=	<input type="text" value="92.46"/>	(27)
Doors	<input type="text" value="1.89"/>	×	<input type="text" value="2.90"/>	=	<input type="text" value="5.48"/>	(26)
Ground Floor	<input type="text" value="82.13"/>	×	<input type="text" value="0.61"/>	=	<input type="text" value="50.10"/>	(28)
Walls	<input type="text" value="152.99"/>	×	<input type="text" value="0.40"/>	=	<input type="text" value="61.19"/>	(29)
Roof	<input type="text" value="82.13"/>	×	<input type="text" value="0.15"/>	=	<input type="text" value="12.32"/>	(30)
Total area of elements ΣA, m²	<input type="text" value="352.66"/>	(32)				

\* for windows and rooflights, use effective window U-value calculated as given in paragraph 3.2

Fabric heat loss, W/K	$(26)+(27)+(27a)+(27b)+(28)+(29)+(29a)+(30)+(30a)+(31) =$	<input type="text" value="221.56"/>	(33)
Thermal bridges - Σ (lxΨ) calculated using Appendix K		<input type="text" value="52.90"/>	(34)
	<i>if details of thermal bridging are not known calculate y × (32) [see Appendix K] and enter in box (34)</i>		
Total fabric heat loss	$(33)+(34) =$	<input type="text" value="274.45"/>	(35)
Ventilation heat loss	$(25) \times 0.33 \times (6) =$	<input type="text" value="83.22"/>	(36)
Heat loss coefficient, W/K	$(35)+(36) =$	<input type="text" value="357.68"/>	(37)
Heat loss parameter (HLP), W/m²K	$(37) \div (5) =$	<input type="text" value="2.30"/>	(38)

**4. Water heating energy requirement**
**kWh/year**

Energy content of hot water used from Table 1 column (b)	<input type="text" value="2737.17"/>	(39)
Distribution loss from Table 1 column (c)	<input type="text" value="483.03"/>	(40)
	<i>If instantaneous water heating at point of use, enter "0" in boxes (40) to (45)</i>	
	<i>For community heating use Table 1 (c) whether or not hot water tank is present</i>	
Water storage loss:		
a) If manufacturer's declared loss factor is known (kWh/day):	<input type="text" value="N/A"/>	(41)
Temperature factor from Table 2b	<input type="text" value="N/A"/>	(41a)



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Energy lost from water storage, kWh/year	$(41) \times (41a) \times 365 =$	<input type="text" value="N/A"/>	(42)
b) If manufacturer's declared cylinder loss factor is not known:			
Cylinder volume (litres) including any solar storage within same cylinder		<input type="text" value="140.00"/>	(43)
<i>If community heating and no tank in dwelling, enter 110 litres in box (43)</i>			
<i>Otherwise, if no stored hot water (this includes instantaneous combi boilers), enter '0' in box (43)</i>			
Hot water storage loss factor from Table 2 (kWh/litre/day)		<input type="text" value="0.02"/>	(44)
<i>If community heating and no tank in dwelling, use cylinder loss from Table 2 for 50 mm factory insulation in box (44)</i>			
Volume factor from Table 2a		<input type="text" value="0.95"/>	(44a)
Temperature factor from Table 2b		<input type="text" value="0.54"/>	(44b)
Energy lost from water storage, kWh/year	$(43) \times (44) \times (44a) \times (44b) \times 365 =$	<input type="text" value="628.18"/>	(45)
Enter (42) or (45) in box (46)			
		<input type="text" value="628.18"/>	(46)
If cylinder contains dedicated solar storage, box (47) = (46) × [(43) - (H11)] / (43), else (47) = (46)			
		<input type="text" value="628.18"/>	(47)
Primary circuit loss from Table 3		<input type="text" value="610.00"/>	(48)
Combi loss from Table 3a (enter "0" if no combi boiler)		<input type="text" value="0.00"/>	(49)
Solar DHW input calculated using Appendix H (enter "0" if no solar collector)		<input type="text" value="0.00"/>	(50)
Output from water heater, kWh/year	$(39) + (40) + (47) + (48) + (49) - (50) =$	<input type="text" value="4458.39"/>	(51)
Heat gains from water heating	$0.25 \times [(39) + (49)] + 0.8 \times [(40) + (47) + (48)] =$	<input type="text" value="2061.26"/>	(52)
<i>include (47) in calculation of (52) only if cylinder is in the dwelling or hot water is from community heating</i>			

**5. Internal gains**

		Watts	
Lights, appliances, cooking and metabolic (Table 5)		<input type="text" value="828.11"/>	(53)
Reduction of internal gains due to low energy lighting (calculated in Appendix L)		<input type="text" value="93.20"/>	(53a)
Additional gains from Table 5a		<input type="text" value="10.00"/>	(53b)
Water heating	$(52) \div 8.76 =$	<input type="text" value="235.30"/>	(54)
Total internal gains	$(53) + (53b) + (54) - (53a) =$	<input type="text" value="980.21"/>	(55)

**6. Solar gains**

	Access factor Table 6d	Area m <sup>2</sup>	Flux Table 6a	g Table 6b	FF Table 6c	Gains (W)	
West	<input type="text" value="0.77"/>	<input type="text" value="7.43"/>	<input type="text" value="48.00"/>	<input type="text" value="0.76"/>	<input type="text" value="0.70"/>	<input type="text" value="131.53"/>	(57)
West	<input type="text" value="1.00"/>	<input type="text" value="3.78"/>	<input type="text" value="48.00"/>	<input type="text" value="0.76"/>	<input type="text" value="0.70"/>	<input type="text" value="86.87"/>	(57)
East	<input type="text" value="0.77"/>	<input type="text" value="14.42"/>	<input type="text" value="48.00"/>	<input type="text" value="0.76"/>	<input type="text" value="0.70"/>	<input type="text" value="255.09"/>	(59)
North	<input type="text" value="0.77"/>	<input type="text" value="6.01"/>	<input type="text" value="29.00"/>	<input type="text" value="0.76"/>	<input type="text" value="0.70"/>	<input type="text" value="64.23"/>	(60)
South	<input type="text" value="1.00"/>	<input type="text" value="1.89"/>	<input type="text" value="72.00"/>	<input type="text" value="0.76"/>	<input type="text" value="0.70"/>	<input type="text" value="65.16"/>	(62)
Total solar gains:						<input type="text" value="602.88"/>	(65)

Note: for new dwellings where overshadowing is not known, the solar access factor is '0.77'



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Total gains, W	$(55) + (65) =$	<input type="text" value="1583.09"/>	(66)
Gain/loss ratio (GLR)	$(66) \div (37) =$	<input type="text" value="4.43"/>	(67)
Utilisation factor (Table 7, using GLR in box (67))		<input type="text" value="0.98"/>	(68)
Useful gains, W	$(66) \times (68) =$	<input type="text" value="1555.97"/>	(69)

**7. Mean internal temperature**

		°C	
Mean internal temperature of the living area (Table 8)		<input type="text" value="18.83"/>	(70)
Temperature adjustment from Table 4e, where appropriate		<input type="text" value="0.00"/>	(71)
Adjustment for gains <i>R is obtained from the 'responsiveness' column of Table 4a or Table 4d</i>	$\{[(69) \div (37)] - 4.0\} \times 0.2 \times R =$	<input type="text" value="0.07"/>	(72)
Adjusted living room temperature	$(70) + (71) + (72) =$	<input type="text" value="18.90"/>	(73)
Temperature difference between zones (Table 9)		<input type="text" value="1.62"/>	(74)
Living area fraction (0 to 1.0)	living room area $\div$ (5) =	<input type="text" value="0.26"/>	(75)
Rest-of-house fraction	$1 - (75) =$	<input type="text" value="0.74"/>	(76)
Mean internal temperature	$(73) - [(74) \times (76)] =$	<input type="text" value="17.69"/>	(77)

**8. Degree days**

Temperature rise from gains	$(69) \div (37) =$	<input type="text" value="4.35"/>	(78)
Base temperature	$(77) - (78) =$	<input type="text" value="13.34"/>	(79)
Degree-days, use box (79) and Table 10		<input type="text" value="1635.67"/>	(80)

**9. Space heating requirements**

Space heating requirement (useful), kWh/year	$0.024 \times (80) \times (37) =$	<input type="text" value="14041.13"/>	(81)
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For range cooker boilers where efficiency is obtained from the Boiler Efficiency Database or manufacturer's declared value, multiply the result in box (81) by  $(1 - \Phi_{\text{case}}/\Phi_{\text{water}})$  where  $\Phi_{\text{case}}$  is the heat emission from the case of the range cooker at fullload (in kW); and  $\Phi_{\text{water}}$  is the heat transferred to water at full load (in kW).  $\Phi_{\text{case}}$  and  $\Phi_{\text{water}}$  are obtained from the database record for the range cooker boiler or manufacturer's declared value.

**9a. Energy requirements - individual heating systems, including micro-CHP**

Note: when space and water heating is provided by community heating use the alternative worksheet 9b

**Space heating:**

Fraction of heat from secondary/supplementary system ( use value from Table 11, Table 12a or Appendix F)		<input type="text" value="0.00"/>	(82)
Efficiency of main heating system, %		<input type="text" value="65.00"/>	(83)
<i>(SEDBUK or from Table 4a or 4b, adjusted where appropriate by the amount shown in the 'efficiency adjustment' column of Table 4c)</i>			
Efficiency of secondary/supplementary heating system, % (use value from Table 4a or Appendix E)		<input type="text" value="0.00"/>	(84)
Space heating fuel (main) requirement, kWh/year	$[1 - (82)] \times (81) \times 100 \div (83) =$	<input type="text" value="21601.74"/>	(85)
Space heating fuel (secondary), kWh/year	$(82) \times (81) \times 100 \div (84) =$	<input type="text" value="N/A"/>	(85a)

**Water heating:**


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 Efficiency of water heater, %  (86)  
*(SEDBUK or from Table 4a or 4b, adjusted where appropriate by the amount shown in the 'efficiency adjustment' column of Table 4c)*

 Energy required for water heating, kWh/year  $(51) \times 100 \div (86) =$   (86a)
**Electricity for pumps and fans:**

 each central heating pump, (Table 4f)  (87a)

 each boiler with a fan-assisted flue (Table 4f)  (87b)

 warm air heating system fans (Table 4f)  (87c)

 mechanical ventilation -balanced, extract or positive input from outside (Table 4f)  (87d)

 maintaining keep-hot facility for gas combi boiler (Table 4f)  (87e)

 pump for solar water heating (Table 4f)  (87f)

 Total electricity for the above equipment, kWh/year  $(87a)+(87b)+(87c)+(87d)+(87e)+(87f) =$   (87)
**10a. Fuel costs - individual heating systems**

	Fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating - main system	(85)	×	<input type="text" value="1.63"/>	×0.01 =	<input type="text" value="352.11"/>	(88)
Space heating - secondary	(85a)	×	<input type="text" value="N/A"/>	× 0.01 =	<input type="text" value="0.00"/>	(89)

**Water heating**

Water heating cost (electric, off-peak tariff)

 On-peak fraction (Table 13, or Appendix F for electric CPSUs)  (90)

 Off-peak fraction  $1.0 - (90) =$   (90a)

			Fuel price			
On-peak cost	(86a) × (90)	×	<input type="text" value="N/A"/>	× 0.01 =	<input type="text" value="0.00"/>	(91)
Off-peak cost	(86a) × (90a)	×	<input type="text" value="N/A"/>	× 0.01 =	<input type="text" value="0.00"/>	(91a)
Water heating cost (other fuel)	(86a)	×	<input type="text" value="1.63"/>	× 0.01 =	<input type="text" value="111.80"/>	(91b)
Pump and fan energy cost	(87)	×	<input type="text" value="7.12"/>	× 0.01 =	<input type="text" value="9.26"/>	(92)
Energy for lighting (calculated in Appendix L)	<input type="text" value="764.75"/>	×	<input type="text" value="7.12"/>	× 0.01 =	<input type="text" value="54.45"/>	(93)
Additional standing charges (Table 12)					<input type="text" value="34.00"/>	(94)

**Renewable and energy-saving technologies (Appendices M and N)**
**PV**

 Energy produced or saved, kWh/year  (95)

 Cost of energy produced or saved, £/year  $(95) \times$   × 0.01 =  (95a)
**Wind**

 Energy produced or saved, kWh/year  (95b1)

 Cost of energy produced or saved, £/year  $(95b1) \times$   × 0.01 =  (95b)
**Micro CHP**

 Energy produced or saved, kWh/year  (95c1)

 Cost of energy produced or saved, £/year  $(95c1) \times$   × 0.01 =  (95c)


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Energy consumed by the technology, kWh/year	<input type="text" value="N/A"/> (96)				
Cost of energy consumed, £/year	(96)	×	<input type="text" value="N/A"/>	× 0.01 =	<input type="text" value="N/A"/> (96a)

**Special features (Appendix Q)**

Energy produced or saved, kWh/year	<input type="text" value="N/A"/> (s1)				
Cost of energy produced or saved, £/year	(s1)	×	<input type="text" value="N/A"/>	× 0.01 =	<input type="text" value="N/A"/> (s1a)

Energy consumed by the technology, kWh/year	<input type="text" value="N/A"/> (s2)				
Cost of energy consumed, £/year	(s2)	×	<input type="text" value="N/A"/>	× 0.01 =	<input type="text" value="N/A"/> (s2a)

**Total energy cost** (88)+(89)+(91)+(91a)+(91b)+(92)+(93)+(94)-(95a)-(95b)-(95c)+(96a)-(s1a)+(s2a) =  (97)

**11a. SAP rating - individual heating systems**

Energy cost deflator (SAP 2005)				<input type="text" value="0.91"/> (98)
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Energy cost factor (ECF)			{[(97) × (98)] - 30.0} ÷ {(5) + 45.0} =	<input type="text" value="2.40"/> (99)
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<b>SAP rating (Table 14)</b>				<input type="text" value="66"/> (100)
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<b>SAP band</b>				<input type="text" value="D"/>
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**12a. Carbon dioxide emissions rate for individual heating systems (including micro-CHP) and community heating without CHP**

Individual heating system:	Energy kWh/year		Emission factor kg CO <sub>2</sub> /kWh		Emissions kgCO <sub>2</sub> /year
Space heating main from box (85)	<input type="text" value="21601.74"/>	×	<input type="text" value="0.194"/>	=	<input type="text" value="4190.74"/> (101)
Space heating secondary from box (85a)	<input type="text" value="N/A"/>	×	<input type="text" value="N/A"/>	=	<input type="text" value="0.00"/> (102)
Energy for water heating from box (86a)	<input type="text" value="6859.06"/>	×	<input type="text" value="0.194"/>	=	<input type="text" value="1330.66"/> (103)
Energy for water heating (51) or [(87b*) × 100 ÷ (104)] =	<input type="text" value="N/A"/>	×	<input type="text" value="N/A"/>	=	<input type="text" value="N/A"/> (106)
Space and water heating	[(101) + (102) + (103)] or [(105) + (106)] =				<input type="text" value="5521.39"/> (107)
Energy for water heating (Type 1 fraction) × (87*) × 100 ÷ (104a) =	<input type="text" value="N/A"/>	×	<input type="text" value="N/A"/>	=	<input type="text" value="N/A"/> (106a)
Energy for water heating (Type 2 fraction) × (87*) × 100 ÷ (104b) =	<input type="text" value="N/A"/>	×	<input type="text" value="0.000"/>	=	<input type="text" value="N/A"/> (106b)
Space and water heating	[(105a) + (106a) + (105b) + (106b)] =				<input type="text" value="5521.39"/> (107)
Electricity for pumps and fans from box (87) or (88*)	<input type="text" value="130.00"/>	×	<input type="text" value="0.422"/>	=	<input type="text" value="54.86"/> (108)
Energy for lighting from Appendix L	<input type="text" value="764.75"/>	×	<input type="text" value="0.422"/>	=	<input type="text" value="322.72"/> (109)
Energy produced or saved in dwelling (Appendices M and N)					
PV energy produced or saved (95) or (95*)		×	<input type="text" value="N/A"/>	=	<input type="text" value="N/A"/> (110)
Wind energy produced or saved (95b1) or (95b1*)		×	<input type="text" value="N/A"/>	=	<input type="text" value="N/A"/> (110b)
Micro-CHP energy produced or saved (95c1) or (95c1*)		×	<input type="text" value="N/A"/>	=	<input type="text" value="N/A"/> (110c)
Micro-CHP energy consumed (96) or (96*)		×	<input type="text" value="N/A"/>	=	<input type="text" value="0.00"/> (111)



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Energy produced or saved in dwelling (Appendix Q)	(s1) or (s1*)	×	N/A	=	0.00	(s1a)
Energy consumed by the technology (Appendix Q)	(s2) or (s2*)	×	N/A	=	0.00	(s2a)
Total CO <sub>2</sub> kg/year	(107) + (108) + (109) - (110) + (111) - (s1a) + (s2a)			=	5898.98	(112)
<b>Carbon dioxide emissions rate</b>	(112) ÷ (5)			=	37.99	(113)
<b>EI rating</b>						60
<b>EI band</b>						D

**13a. Primary energy, for individual heating systems (including micro-CHP) and community heating without CHP**

Individual heating system:	Energy kWh/year	Primary energy factor	Primary energy (kWh/year)
Space heating main from box (85)	21601.74	1.150	24842.00
Space heating secondary from box (85a)	N/A	N/A	0.00
Energy for water heating from box (86a)	6859.06	1.150	7887.91
Energy for water heating (87b*) × 100 ÷ (104) =	N/A	N/A	N/A
Space and water heating			32729.91
Energy for water heating (Type 1 fraction) × (87*) × 100 ÷ (104a) =	N/A	N/A	N/A
Energy for water heating (Type 2 fraction) × (87*) × 100 ÷ (104b) =	N/A	N/A	N/A
Space and water heating			32729.91
Electricity for pumps and fans from box (87) or (88*)	130.00	2.800	364.00
Energy for lighting from Appendix L	764.75	2.800	2141.30
Energy produced or saved in dwelling (Appendices M and N)			
PV energy produced or saved	(95) or (95*)	N/A	N/A
Wind energy produced or saved	(95b1) or (95b1*)	N/A	N/A
Micro-CHP energy produced or saved	(95c1) or (95c1*)	N/A	N/A
Micro-CHP energy consumed	(96) or (96*)	N/A	0.00
Energy produced or saved in dwelling (Appendix Q)	(s1) or (s1*)	N/A	0.00
Energy consumed by the above technology (Appendix Q)	(s2) or (s2*)	N/A	0.00
<b>Primary energy kWh/year</b>			35235.21
<b>Primary energy kWh/m<sup>2</sup>/year</b>			226.94



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Space heating from CHP or recovered/geothermal heat, box (86*)	<input type="text" value="N/A"/>	×	<input type="text" value="N/A"/>	box (107*) =	<input type="text" value="N/A"/>
Space heating from boilers (87*) × 100 ÷ (109*) =	<input type="text" value="N/A"/>	×	<input type="text" value="N/A"/>	Table 12 =	<input type="text" value="-1.00"/>
Electricity for pumps and fans, box (88*)	<input type="text" value="N/A"/>	×	<input type="text" value="N/A"/>	Table 12 =	<input type="text" value="N/A"/>
<b>Total PE associated with boilers, CHP or recovered/geothermal heat</b> <i>If negative, enter "0" in box (115*)</i>	[(108*) + (110*) + ... + (114*)] =				<input type="text" value="-1.00"/>
Energy for lighting from Appendix L	<input type="text" value="764.75"/>	×	<input type="text" value="2.80"/>	Table 12 =	<input type="text" value="2141.30"/>
Energy produced or saved in dwelling (Appendix M)					
PV energy produced or saved (95*)		×	<input type="text" value="N/A"/>	Table 12 =	<input type="text" value="N/A"/>
Wind energy produced or saved (95b1*)		×	<input type="text" value="N/A"/>	Table 12 =	<input type="text" value="N/A"/>


**Submission Reference Number:**
**NB-NES-00003474-09020314160500**
