

appendix d – renewables spreadsheets...

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Calculation Sheet

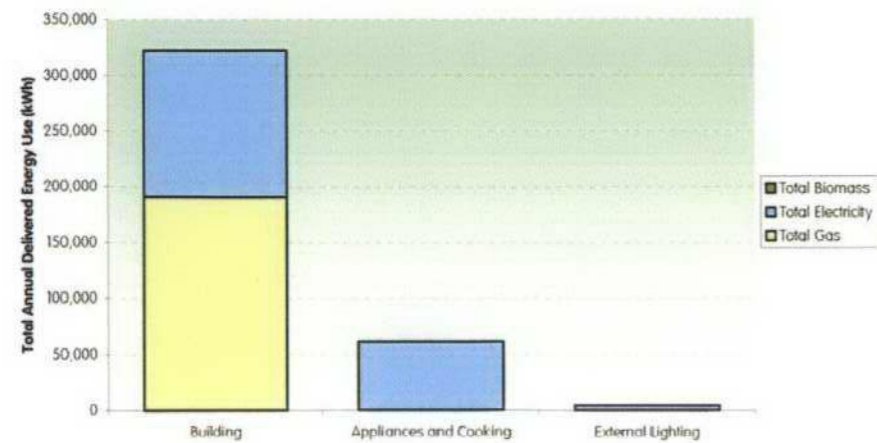
Project: Waldegrave Arms, Teddington Job Number: 3066
 Subject: Renewable Energy Assessment Sheet Number: 3 of 40
 Engineer: Caroline Stanton Date: 24th September 2007
 Checked By: Martin Lawless Date: 24th September 2007

03 SUMMARY OF DELIVERED ENERGY AND CARBON EMISSIONS - BASE CASE 1 OF 6

SUMMARY TABLE - DELIVERED ENERGY BY SITE AREA AND FUEL TYPE

Fuel	Energy End Use	Area/Block			TOTAL kWh
		Building kWh	Appl./Cook kWh	Ext. Lig. kWh	
Gas	Space Heating Gas	137,174			137,174
	Hot Water Gas	53,356			53,356
	Space Heating and Hot Water Gas	190,530	0	0	190,530
	Other Gas				0
	Total Gas	190,530	0	0	190,530
Electricity	Space Heating Electricity				0
	Hot Water Electricity				0
	Space Heating and Hot Water Elec	0	0	0	0
	Cooling/Refrigeration Electricity	56,273			56,273
	Fans, Pumps, Controls and Other E				0
	Lighting	75,647		4,380	80,027
	Appliances		28,219		28,219
	Cooking		32,558		32,558
Total Electricity	131,920	60,778	4,380	197,078	
Biomass	Space Heating Biomass				0
	Water Heating Biomass				0
	Electricity Biomass				0
Total Biomass	0	0	0	0	
All Fuels		322,450	60,778	4,380	387,608

SUMMARY GRAPH - DELIVERED ENERGY BY SITE AREA AND FUEL TYPE

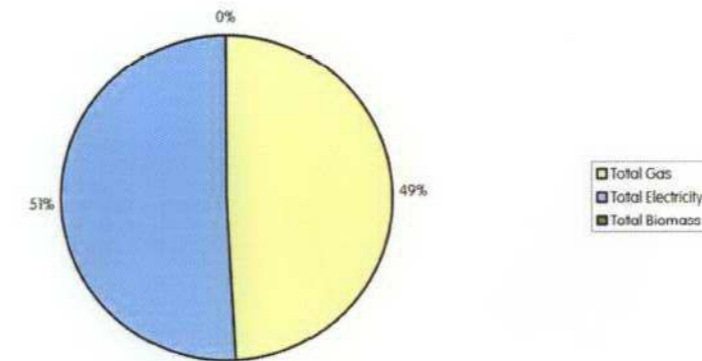


Calculation Sheet

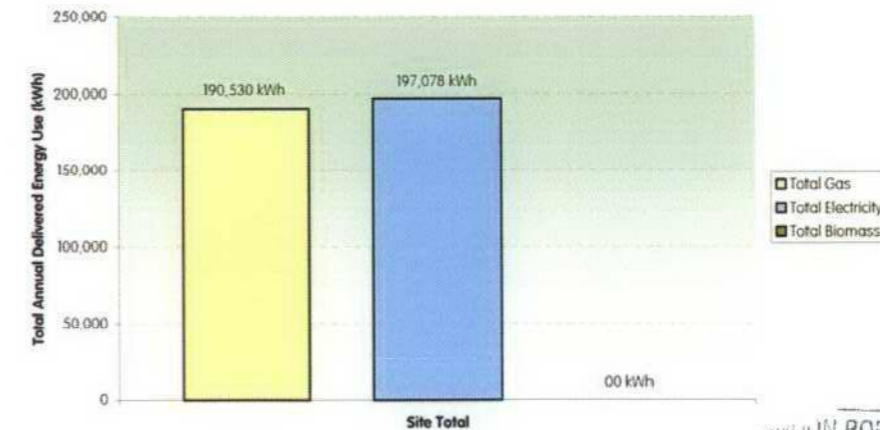
Project: Waldegrave Arms, Teddington Job Number: 3066
 Subject: Renewable Energy Assessment Sheet Number: 4 of 40
 Engineer: Caroline Stanton Date: 24th September 2007
 Checked By: Martin Lawless Date: 24th September 2007

04 SUMMARY OF DELIVERED ENERGY AND CARBON EMISSIONS - BASE CASE 2 OF 6

SUMMARY GRAPH - DELIVERED ENERGY BY FUEL TYPE



SUMMARY GRAPH - DELIVERED ENERGY BY SITE AREA



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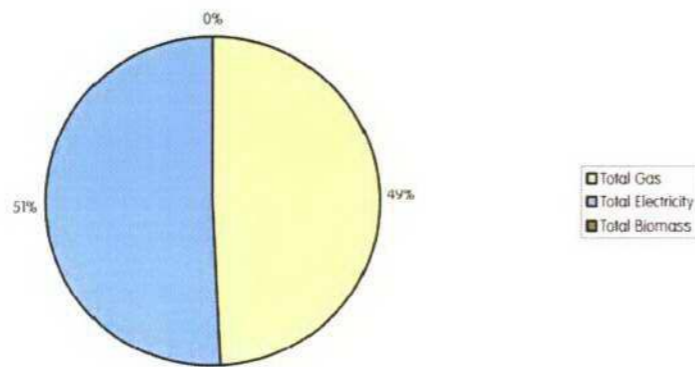
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Calculation Sheet

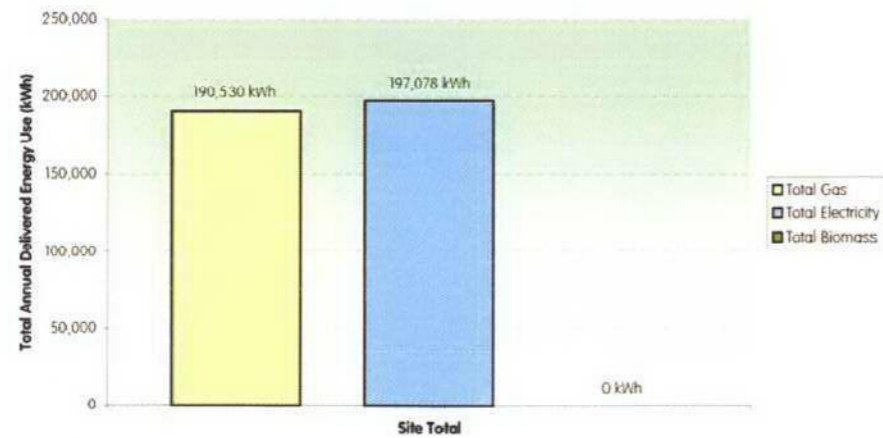
Project: Waldegrave Arms, Teddington Job Number: 3066
 Subject: Renewable Energy Assessment Sheet Number: 5 of 40
 Engineer: Caroline Stanton Date: 24th September 2007
 Checked By: Martin Lawless Date: 24th September 2007

05 SUMMARY OF DELIVERED ENERGY AND CARBON EMISSIONS - BASE CASE 3 OF 6

SUMMARY GRAPH - DELIVERED ENERGY BY FUEL TYPE



SUMMARY GRAPH - DELIVERED ENERGY BY SITE AREA



Calculation Sheet

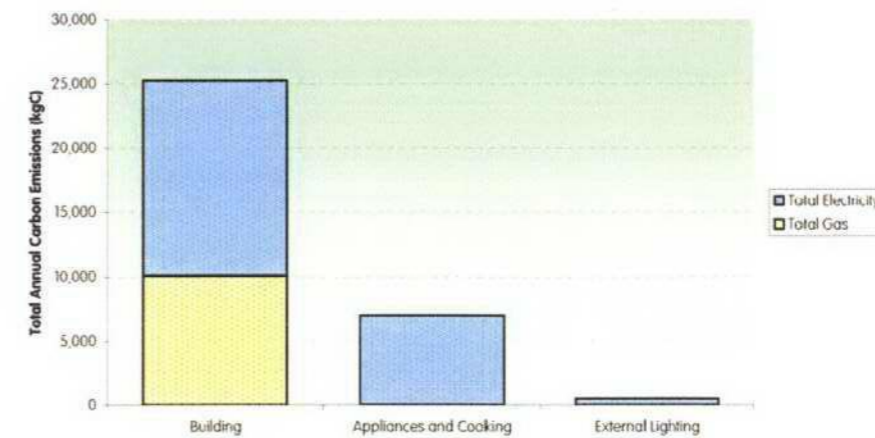
Project: Waldegrave Arms, Teddington Job Number: 3066
 Subject: Renewable Energy Assessment Sheet Number: 6 of 40
 Engineer: Caroline Stanton Date: 24th September 2007
 Checked By: Martin Lawless Date: 24th September 2007

06 SUMMARY OF DELIVERED ENERGY AND CARBON EMISSIONS - BASE CASE 4 OF 6

SUMMARY TABLE

Fuel	Energy End Use	Area/Block			TOTAL kgC
		Building kgC	Appl/Cook kgC	Ext. Lig. kgC	
Gas	Space Heating Gas	7,258	0	0	7,258
	Hot Water Gas	2,823	0	0	2,823
	Space Heating and Hot Water Gas	10,081	0	0	10,081
	Other Gas	0	0	0	0
	Total Gas	10,081	0	0	10,081
Electricity	Space Heating Electricity	0	0	0	0
	Hot Water Electricity	0	0	0	0
	Space Heating and Hot Water Elec	0	0	0	0
	Cooling/Refrigeration Electricity	6,476	0	0	6,476
	Fans, Pumps, Controls and Other E	0	0	0	0
	Lighting	8,706	0	504	9,210
	Appliances	0	3,248	0	3,248
	Cooking	0	3,747	0	3,747
Total Electricity	15,183	6,995	504	22,682	
All Fuels	25,264	6,995	504	32,763	

SUMMARY GRAPH - ANNUAL CARBON EMISSIONS BY SITE AREA AND FUEL TYPE



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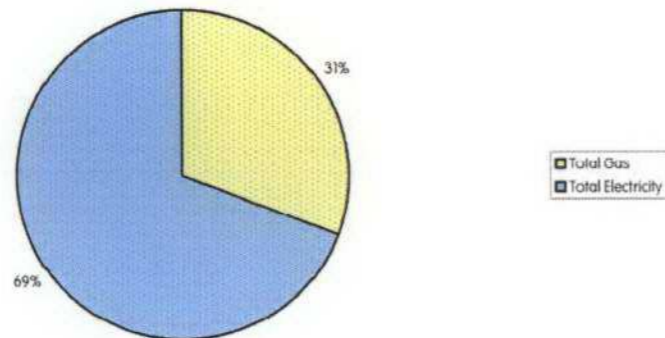
Calculation Sheet

Project: Waldegrave Arms, Teddington
 Subject: Renewable Energy Assessment
 Engineer: Caroline Stanton
 Checked By: Martin Lawless

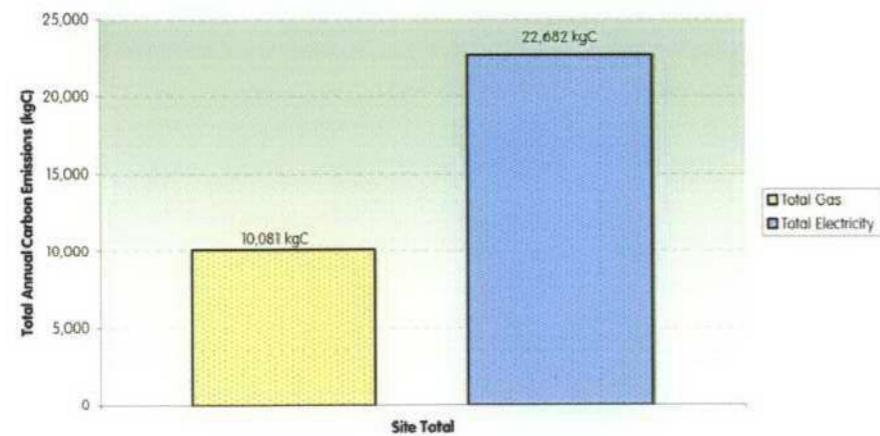
Job Number: 3066
 Sheet Number: 7 of 40
 Date: 24th September 2007
 Date: 24th September 2007

07 SUMMARY OF DELIVERED ENERGY AND CARBON EMISSIONS - BASE CASE 5 OF 6

SUMMARY GRAPH - CARBON EMISSIONS BY FUEL TYPE



SUMMARY GRAPH - CARBON EMISSIONS BY SITE AREA



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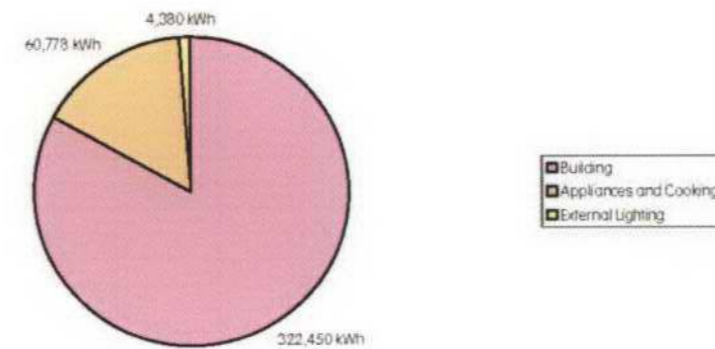
Calculation Sheet

Project: Waldegrave Arms, Teddington
 Subject: Renewable Energy Assessment
 Engineer: Caroline Stanton
 Checked By: Martin Lawless

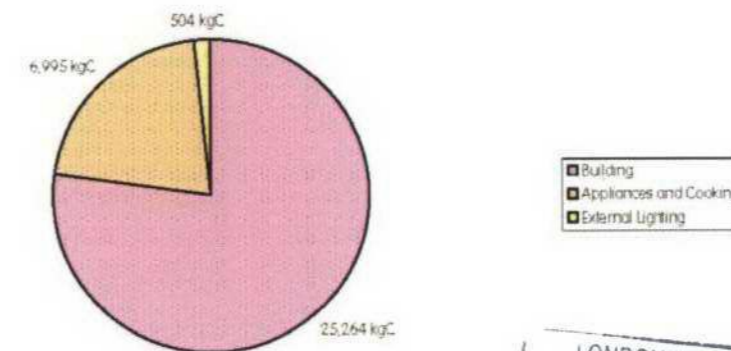
Job Number: 3066
 Sheet Number: 8 of 40
 Date: 24th September 2007
 Date: 24th September 2007

08 SUMMARY OF DELIVERED ENERGY AND CARBON EMISSIONS - BASE CASE 6 OF 6

SUMMARY GRAPH - ANNUAL DELIVERED ENERGY BY SITE AREA



SUMMARY GRAPH - ANNUAL CARBON EMISSIONS BY SITE AREA



LONDON BOROUGH OF RICHMOND UPON THAMES
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Calculation Sheet

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Project: Waldegrave Arms, Teddington Job Number: 3066
 Subject: Renewable Energy Assessment Sheet Number: 9 of 40
 Engineer: Caroline Stanton Date: 24th September 2007
 Checked By: Martin Lawless Date: 24th September 2007

09 DETAIL OF DELIVERED ENERGY BY FUEL AND END USE - SAP LOADS (SPACE/WATER HTG, FPC, LTG)

SUMMARY TABLE

Fuel	Energy End Use	Rate kWh/m ²	Area m ²	DELIVERED Energy kWh	Symbol	Note
Gas	Space Heating Gas			137,174		
	Hot Water Gas			53,356		
	Space Heating and Hot Water Gas			190,530		Sub Total
	Other Gas (catering)			-		
	Total Gas			190,530		Total
Electricity	Space Heating Electricity			-		
	Hot Water Electricity			-		
	Space Heating and Hot Water Electricity			-		Sub Total
	Lighting			75,647		
	Cellar Cooling			56,273		
	Appliances			-		
	Cooking			-		
Total Electricity			131,920			
All Fuels	GRAND TOTAL			322,450		G. Total

NOTES

- 1 Based on Building Regulations Part L1A Calculation for Residential Areas
- 2 Taken from Introduction to Energy Efficiency in Catering establishments. Energy Efficiency Booklet EEB 002 (Action Energy) (1994)
- 3 Taken from Good Practice Guide 153. Energy Efficiency of Public Houses - cellar services. BRECSU
- 4 Based on DLG 2006 - A guide to Sustainability of Existing Buildings. Energy Efficiency in Dwellings

Calculation Sheet

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Project: Waldegrave Arms, Teddington Job Number: 3066
 Subject: Renewable Energy Assessment Sheet Number: 10 of 40
 Engineer: Caroline Stanton Date: 24th September 2007
 Checked By: Martin Lawless Date: 24th September 2007

10 DETAIL OF DELIVERED ENERGY BY FUEL AND END USE - BUILDINGS

SUMMARY TABLE

Fuel	Energy End Use	Rate kWh/m ²	Area m ²	DELIVERED Energy kWh	Symbol	Note
Gas	Space Heating Gas					
	Hot Water Gas					
	Space Heating and Hot Water Gas					1. Sub Total
	Other Gas (catering)					
	Total Gas			-		Total
Electricity	Space Heating Electricity					
	Hot Water Electricity					
	Space Heating and Hot Water Electricity					Sub Total
	Lighting					
	Cellar Cooling					1.
	Appliances				28,219	2.
	Cooking				32,558	
Total Electricity				60,778		
All Fuels	GRAND TOTAL			60,778		G. Total

NOTES

- 1 Based on Building Regulations Part L1A Calculation for Residential Areas
- 2 Taken from Introduction to Energy Efficiency in Catering establishments. Energy Efficiency Booklet EEB 002 (Action Energy) (1994)
- 3 Taken from Good Practice Guide 153. Energy Efficiency of Public Houses - cellar services. BRECSU
- 4 Based on DLG 2006 - A guide to Sustainability of Existing Buildings. Energy Efficiency in Dwellings

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Calculation Sheet

Project: Waldegrave Arms, Teddington Job Number: 3066
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 Engineer: Caroline Stanton Date: 24th September 2007
 Checked By: Martin Lawless Date: 24th September 2007

11 DETAIL OF DELIVERED ENERGY BY FUEL AND END USE - EXTERNAL LIGHTING

CALCULATION

Total Ancillary Area 600 m² (estimated area)
 Installed Lighting Load 1,200 W Note 1
 3,650 hours per year Note 2
Annual Delivered Energy 4,380 kWh/year E

NOTES

1. Based on industry benchmarks for car park lighting design.
2. Based on 10 hours operation per day/365 days per year.

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Calculation Sheet

Project: Waldegrave Arms, Teddington Job Number: 3066
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 Engineer: Caroline Stanton Date: 24th September 2007
 Checked By: Martin Lawless Date: 24th September 2007

12 WIND TURBINE - ENERGY AND CARBON EMISSIONS SAVING EVALUATION

Description of Calculation Step	Value	Unit	Step	Calculation/Note
Determine annual energy output per unit of rated turbine power output at average wind speeds	1,556	kWh/kW	(1)	1
Determine inverter efficiency	90	%	(2)	
Calculate resulting annual kWh turbine Electricity output from 1kW of rated output	1,400	kWh/year	(3)	(1) x (2)
Look up Carbon Emissions factor for Electricity	0.115091	kgC/kWh	(4)	
Calculate annual Carbon Emissions reduction from 1kW rated output	161	kgC/year	(5)	(3) x (4)
Specify rated power output of proposed turbine	15	kW	(6)	2
Calculate DELIVERED Electricity requirement substituted by Electricity generated Wind Turbine	21,006	kWh/year	(7)	3
Calculate reduction in Carbon Emissions due to application of proposed Wind Turbine	2,418	kgC/year	(8)	(4) x (7)
Determine total DELIVERED Gas energy in base development	190,530	kWh/year	(9)	5
Look up Carbon Emissions factor for Gas	0.05291	kgC/kWh	(10)	
Calculate Carbon Emissions due to DELIVERED Gas in development with Wind Turbine (same as base development)	10,081	kgC	(11)	(9) x (10)
Determine total DELIVERED Electricity in base development	197,078	kWh/year	(12)	2
Calculate DELIVERED Electricity requirement for site with proposed Wind Turbine	176,072	kWh/year	(13)	(12) - (11)
Calculate Carbon Emissions due to DELIVERED Electricity for site with proposed Wind Turbine	20,264	kgC/year	(14)	(13) x (4)
Calculate base site total Carbon Emissions	32,763	kgC/year	(15)	(11) + (12) x (4)
Calculate total site Carbon Emissions for site with proposed Wind Turbine	30,345	kgC/year	(16)	(11) + (14)
Calculate percentage Energy Reduction due to proposed Wind Turbine	5.42	%	(17)	(8) / (14)
Calculate percentage Carbon Emissions reduction due to proposed Wind Turbine	7.38	%	(17)	(8) / (14)

NOTES

1. Based on Proven WT15000 Turbine (15kW)
2. Based on 15kW turbines
3. from Weibull Calculation



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Calculation Sheet

Project: Waldegrave Arms, Teddington
 Subject: Renewable Energy Assessment
 Engineer: Caroline Stanton
 Checked By: Martin Lawless

Job Number: 3066
 Sheet Number: 13 of 40
 Date: 24th September 2007
 Date: 24th September 2007

13 WIND TURBINE - PREDICTED PAYBACK PERIOD

Description of Calculation Step	Value	Unit	Step	Calculation/Note
DELIVERED Gas energy requirement in the base site	190,530	kWh/year	(1)	
DELIVERED Gas requirement for site with proposed Wind Turbine	190,530	kWh/year	(2)	
Net Gas energy saving with proposed Wind Turbine	0	kWh/year	(3)	
DELIVERED Electricity to BASE development	197,078	kWh/year	(5)	
DELIVERED Electricity with proposed Wind Turbine	176,072	kWh/year	(7)	
Net Electricity energy saving with proposed Wind Turbine	21,006	kWh/year	(8)	
Energy price for Gas to serve proposed Wind Turbine	1.63	p/kWh	(4)	
Energy price for Electricity to serve proposed Wind Turbine	3.65	p/kWh	(6)	
Annual Gas energy cost change with Wind Turbine incorporated	0.00	£/year	(9)	
Annual Electricity energy cost change with Wind Turbine incorporated	766.72	£/year	(10)	
Annual Total energy cost change with Wind Turbine incorporated	766.72	£/year	(10)	
Cost of proposed Wind Turbine	30,000	£	(11)	
Payback period for proposed Solar Water Heating	39.13	years	(12)	

NOTES

1. Based on Table 4.5.6 on the Renewables Toolkit
- 2.

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Calculation Sheet

Project: Waldegrave Arms, Teddington
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 Date: 24th September 2007
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14 PHOTOVOLTAICS - ENERGY AND CARBON EMISSIONS SAVING EVALUATION

Description of Calculation Step	Value	Unit	Step	Calculation/Note
Determine maximum annual irradiation at the specific location	102.2	kWh/m ² /year	(1)	1
Determine module conversion efficiency	-		(2)	2
Determine positioning factor based on system's tilt and orientation	-		(3)	
Determine inverter efficiency	-		(4)	
Determine system losses factor	-		(5)	
Determine packing density factor	-		(6)	
Calculate resulting annual kWh system Electricity output from 1m ² of panel	76.65	kWh/year	(7)	
Look up Carbon Emissions factor for Electricity	0.115091	kgC/kWh	(8)	3
Calculate annual carbon saving from 1m ² of panel	8.8	kgC/year	(9)	(7) x (8)
Specify panel area of proposed rooftop PV array	340	m ²	(10)	
Calculate DELIVERED Electricity requirement substituted by Electricity generated by PV	26,061	kWh/year	(11)	(7) x (10)
Calculate reduction in Carbon Emissions due to application of PV array	2,999	kgC/year	(12)	(8) x (11)
Determine total DELIVERED Gas energy in base site	190,530	kWh/year	(13)	
Look up Carbon Emissions factor for Gas	0.052909	kgC/kWh	(14)	
Calculate Carbon Emissions due to DELIVERED Gas in site with PV (same as base site)	10,061	kgC/year	(15)	(13) x (14)
Determine total DELIVERED Electricity in base site	197,078	kWh/year	(16)	
Calculate DELIVERED Electricity requirement for site with proposed PV array	171,017	kWh/year	(17)	(16) - (11)
Calculate Carbon Emissions due to DELIVERED Electricity in site with proposed PV array	19,682	kgC/year	(18)	(17) x (8)
Calculate base site total Carbon Emissions	32,763	kgC/year	(19)	(15) + (18) x (8)
Calculate total site Carbon Emissions in site with proposed PV array	29,763	kgC/year	(20)	(15) + (18)
Calculate percentage Carbon Emissions reduction due to proposed PV array	10.08	%	(21)	(19) / (20)

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Calculation Sheet

Project: Waldegrave Arms, Teddington
Subject: Renewable Energy Assessment
Engineer: Caroline Stanton
Checked By: Martin Lawless
Job Number: 3066
Sheet Number: 15 of 40
Date: 24th September 2007
Date: 24th September 2007

15 PHOTOVOLTAICS - PREDICTED PAYBACK PERIOD

Description of Calculation Step	Value	Unit	Step	Calculation/Note
DELIVERED Gas energy requirement in the base site for end uses served by PV	190,530	kWh/year	(1)	
DELIVERED Gas requirement for site with proposed PV	190,530	kWh/year	(2)	
Net Gas energy saving with proposed PV	0	kWh/year	(3)	
DELIVERED Electricity to BASE development	197,078	kWh/year	(5)	
DELIVERED Electricity with proposed PV	171,017	kWh/year	(7)	
Net Electricity energy saving with proposed PV	26,061	kWh/year	(3)	
Energy price for Gas to serve proposed PV	1.63	p/kWh	(4)	
Energy price for Electricity to serve proposed PV	3.65	p/kWh	(8)	
Annual Gas energy cost change with PV incorporated	0.00	£/year	(9)	
Annual Electricity energy cost change with PV incorporated	951.23	£/year	(10)	
Annual Total energy cost change with PV incorporated	951.23	£/year	(11)	
Cost of proposed PV	340,000	£	(12)	
Payback period for proposed PV	357.43	years	(13)	

NOTES

- Based on Table 4.5.6 on the Renewables Toolkit
- Based on 340m² solar panel area

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Calculation Sheet

Project: Waldegrave Arms, Teddington
Subject: Renewable Energy Assessment
Engineer: Caroline Stanton
Checked By: Martin Lawless
Job Number: 3066
Sheet Number: 16 of 40
Date: 24th September 2007
Date: 24th September 2007

16 SOLAR WATER HEATING - ENERGY AND CARBON EMISSIONS SAVING EVALUATION

Description of Calculation Step	Value	Unit	Step	Calculation/Note
Determine total DELIVERED Gas energy in development for hot water served by solar water heating	53,356	kWh/year	(1)	N
Determine hot water system efficiency in site	90	%	(2)	
Calculate end use DEMAND met accounting for system efficiency	48,021	kWh/kW	(3)	(1) x (2)
Specify proportion of end use DEMAND for hot water met by solar water heating	75	%	(4)	(4)
Calculate annual energy DEMAND for hot water met by solar water heating	36,016	kWh/year	(5)	(3) x (4)
Determine total DELIVERED Gas energy in base development for all end uses	190,530	kWh/year	(6)	S
Calculate DELIVERED Gas requirement substituted by solar water heating	40,017	kWh/year	(7)	(5) / (2)
Calculate remaining requirement for DELIVERED Gas after application of solar water heating	150,513	kWh/year	(8)	(6) - (7)
Look up Carbon Emissions factor for Gas	0.05291	kgC/kWh	(9)	
Calculate Carbon Emissions due to DELIVERED Gas in site with solar water heating	7,964	kgC/year	(10)	(8) x (9)
Determine total DELIVERED Electricity in base development	197,078	kWh/year	(11)	Z
Calculate DELIVERED Electricity required by the solar water heating circulation pump	350.4	kWh/year	(12)	
Calculate DELIVERED Electricity requirement for site with solar water heating	197,428	kWh/year	(13)	(11) + (12)
Look up Carbon Emissions factor for Electricity	0.1151	kgC/kWh	(14)	
Calculate Carbon Emissions due to DELIVERED Electricity in site with solar water heating	22,722	kgC/year	(15)	(13) x (14)
Calculate total site Carbon Emissions in site with solar water heating	30,686	kgC/year	(16)	(10) + (15)
Calculate base development total Carbon Emissions	32,763	kgC/year	(17)	(6) x (9) + (11) x (14)
Calculate reduction in Carbon Emissions due to application of solar water heating	2,077	kgC/year	(18)	(17) - (16)
Calculate percentage Energy Reduction due to application of solar water heating	10.23%	%	(20)	(8) + (13) / (6) + (11)
Calculate percentage Carbon Emissions reduction due to application of solar water heating	6.34%	%	(19)	(18) / (16)

NOTES

- Based on 2 No. 30W pump, 16hrs/day operation



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Calculation Sheet

Project: Waldegrave Arms, Teddington Job Number: 3066
 Subject: Renewable Energy Assessment Sheet Number: 17 of 40
 Engineer: Caroline Stanton Date: 24th September 2007
 Checked By: Martin Lawless Date: 24th September 2007

17 SOLAR WATER HEATING - PREDICTED PAYBACK PERIOD

Description of Calculation Step	Value	Unit	Step	Calculation/Note
DELIVERED Gas energy requirement in the base site for end uses served by Solar Water Heating	53,356	kWh/year	(1)	
DELIVERED Gas requirement for site with proposed Solar Water Heating	40,017	kWh/year	(2)	
Net Gas energy saving with proposed Solar Water Heating	13,339	kWh/year	(3)	
DELIVERED Electricity to BASE development	197,078	kWh/year	(4)	
DELIVERED Electricity with proposed Solar Water Heating	197,428	kWh/year	(5)	
Net Electricity energy saving with proposed Solar Water Heating	-350.40	kWh/year	(6)	
Energy price for Gas	1.63	p/kWh	(7)	
Energy price for Electricity	3.65	p/kWh	(8)	
Annual Gas energy cost change with Solar Water Heating incorporated	217.43	£/year	(9)	
Annual Electricity energy cost change with Solar Water Heating incorporated	-12.79	£/year	(10)	
Annual Total energy cost change with Solar Water Heating incorporated	204.64	£/year	(11)	
Cost of proposed Solar Water Heating	114,000	£	(12)	
Payback period for proposed Solar Water Heating	557.08	years	(13)	

NOTES

- Based on 33m² solar panel area

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Calculation Sheet

Project: Waldegrave Arms, Teddington Job Number: 3066
 Subject: Renewable Energy Assessment Sheet Number: 18 of 40
 Engineer: Caroline Stanton Date: 24th September 2007
 Checked By: Martin Lawless Date: 24th September 2007

18 BIOMASS HEATING - ENERGY AND CARBON EMISSIONS SAVING EVALUATION

Description of Calculation Step	Value	Unit	Step	Calculation/Note
Determine the total DELIVERED Gas energy requirement in the base site for end uses that are to be served by Biomass	92,053	kWh/year	(1)	Q
Determine the heating system efficiency in base site	90	%	(2)	
Calculate end use DEMAND met accounting for system efficiency in base site	82,848	kWh/year	(3)	(1) x (2)
Specify the proportion of end use DEMAND met by Biomass heating	100	%	(4)	
Calculate annual energy DEMAND for heating met by Biomass heating	82,848	kWh/year	(5)	(3) x (4)
Determine the Biomass heating system efficiency	80	%	(6)	
Calculate annual DELIVERED Biomass heating	103,560	kWh/year	(7)	(5) x (6)
Determine total DELIVERED Gas energy in base development	190,530	kWh/year	(8)	S
Look up Biofuel Carbon Emissions	0.00682	kgC/kWh	(9)	
Calculate DELIVERED Gas requirement substituted by Biomass heating	92,053	kWh/year	(10)	(5) / (2)
Calculate Carbon Emissions due to DELIVERED Biofuel in site with Biomass heating	706	kgC/year	(11)	
Calculate the remaining requirement for DELIVERED Gas after application of Biomass heating	98,477	kWh/year	(12)	(8) - (10)
Look up Carbon Emissions for Gas	0.06291	kgC/kWh	(13)	
Calculate Carbon Emissions due to DELIVERED Gas in development with Biomass heating	5210	kgC/year	(14)	(12) x (13)
Calculate total DELIVERED Electricity in base site	197,078	kWh/year	(15)	Z
Look up Carbon Emissions for Electricity	0.1151	kgC/kWh	(16)	
Calculate Carbon Emissions due to DELIVERED Electricity in site with Biomass heating (same as base site)	22,682	kgC/year	(17)	(15) x (16)
Calculate total site Carbon Emissions in site with Biomass heating	28,598	kgC/year	(18)	(11) + (14) + (17)
Calculate base development total Carbon Emissions	32,763	kgC/year	(19)	(8) x (13) + (15) x (16)
Calculate reduction in Carbon Emissions due to application of Biomass heating	4,164	kgC/year	(20)	(19) - (18)
Calculate percentage Carbon Emissions reduction due to application of Biomass heating	12.71	%	(21)	(20) / (19)

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Calculation Sheet

Project: Waldegrave Arms, Teddington Job Number: 3066
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 Engineer: Caroline Stanton Date: 24th September 2007
 Checked By: Martin Lawless Date: 24th September 2007

19 BIOMASS HEATING - PREDICTED PAYBACK PERIOD

Description of Calculation Step	Value	Unit	Step	Calculation/Note
DELIVERED Gas energy requirement in the base site for end uses served by Biomass	190,530	kWh/year	(1)	
DELIVERED Gas requirement for site with proposed Biomass	98,477	kWh/year	(2)	
Net Gas energy saving with proposed Biomass	92,053	kWh/year	(3)	
DELIVERED Electricity to BASE development	197,078	kWh/year	(5)	
DELIVERED Electricity with proposed Biomass	197,078	kWh/year	(7)	
Net Electricity energy saving with proposed Biomass	0.00	kWh/year	(3)	
Energy price for Gas	1.63	p/kWh	(4)	
Energy price for Electricity	3.65	p/kWh	(8)	
Energy price for Biomass	3.00	p/kWh	(8)	
Annual Gas energy cost change with Biomass incorporated	-1,500.47	£/year	(9)	
Annual Electricity energy cost change with Biomass incorporated	0.00	£/year	(10)	
Annual Biomass energy cost change with Biomass incorporated	2,761.59	£/year	(10)	
Annual Total energy cost change with Biomass incorporated	1,261.13	£/year	(10)	
Cost of proposed Biomass	24,000	£	(11)	
Payback period for proposed Biomass	NA	years	(13)	

MTT/SUSTAIN

Calculation Sheet

Project: Waldegrave Arms, Teddington Job Number: 3066
 Subject: Renewable Energy Assessment Sheet Number: 20 of 40
 Engineer: Caroline Stanton Date: 24th September 2007
 Checked By: Martin Lawless Date: 24th September 2007

20 BIOMASS HEATING - STORAGE AREAS

Description of Calculation Step	Value	Unit	Step	Calculation/Note
Determine the total DELIVERED Gas energy requirement in the base site for end uses that are to be served by Biomass	92,053	kWh/year	(1)	(1)
Determine the heating system efficiency in base site	90	%	(2)	
Calculate end use DEMAND met accounting for system efficiency in base site	82,848	kWh/year	(3)	(1) x (2)
Specify the proportion of end use DEMAND met by Biomass heating	100	%	(4)	
Calculate annual energy DEMAND for heating met by Biomass heating	82,848	kWh/year	(5)	(3) x (4)
Number of deliveries of fuel per year required	12	-	(6)	
Energy density by mass of WOOD CHIP	2	kWh/kg	(7)	
Calculate the weight of WOOD CHIP required to power the boiler per delivery of fuel	3,452	kg/delivery	(8)	(5) / (6) / (7)
Energy density by mass of WOOD PELLETS	5	kWh/kg	(9)	
Calculate the weight of WOOD PELLETS required to power the boiler per delivery of fuel	1,381	kg/delivery	(10)	(5) / (6) / (9)
Height of storage hopper in building	2	m	(13)	
Determine the weight per unit volume of WOOD CHIP	175	kg/m ³	(14)	
Volume of storage required to store WOOD CHIP per delivery	20	m ³	(15)	(8) x (14)
Determine the weight per unit volume of WOOD PELLETS	600	kg/m ³	(16)	
Volume of storage required to store WOOD PELLETS per delivery	2	m ³	(17)	(10) x (16)
Determine the storage area required for the storage of WOOD CHIP with the required storage height	10	m ²	(20)	(15) x (13)
Determine the storage area required for the storage of WOOD PELLETS with the required storage height	1	m ²	(21)	(17) x (13)
Energy price for Biomass WOOD CHIP	2.1	p/kWh	(22)	
Determine the annual cost of WOOD CHIP	1,740	£/year	(23)	(5) x (22)
Energy price for Biomass WOOD PELLETS	3.5	p/kWh	(24)	
Determine the annual cost of WOOD PELLETS	2,900	£/year	(25)	(5) x (24)



appendix d – renewables spreadsheets...

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Calculation Sheet

Project: Waldegrave Arms, Teddington
 Subject: Renewable Energy Assessment
 Engineer: Caroline Stanton
 Checked By: Martin Lawless

Job Number: 3066
 Sheet Number: 21 of 40
 Date: 10th September 2007
 Date: 24th September 2007

21 BIOMASS COMBINED HEAT AND POWER - ENERGY AND CARBON EMISSIONS SAVING EVALUATION

Description of Calculation Step	Value	Unit	Step	Calculation/Note
Determine the total DELIVERED Gas energy requirement in the base site for end uses that are to be served by Biomass CHP	190,530	kWh/year	(1)	Q
Determine the heating system efficiency in base site	90	%	(2)	
Calculate end use DEMAND met accounting for system efficiency in base site	171,477	kWh/year	(3)	(1) x (2)
Specify the proportion of end use DEMAND met by Biomass CHP	50	%	(4)	
Calculate annual energy DEMAND for heating met by Biomass CHP	85,739	kWh/year	(5)	(3) x (4)
Determine total DELIVERED Gas energy in base development	190,530	kWh/year	(6)	S
Look up Biofuel Carbon Emissions	0.00682	kgC/kWh	(7)	
Calculate DELIVERED Gas requirement substituted by Biomass CHP	95,265	kWh/year	(8)	(1) x (4)
Calculate Carbon Emissions due to DELIVERED Biofuel in site with Biomass CHP	650	kgC/year	(9)	(7) x (8)
Calculate the remaining requirement for DELIVERED Gas after application of Biomass CHP	95,265	kWh/year	(10)	(6) - (8)
Look up Carbon Emissions for Gas	0.05291	kgC/kWh	(11)	
Calculate Carbon Emissions due to DELIVERED Gas in development with Biomass CHP	5690	kgC/year	(12)	(10) x (11) - (9)
Calculate total DELIVERED Electricity in base site	197,078	kWh/year	(13)	Z
Determine ratio of heat to Electricity generated by Biomass CHP system	2		(14)	
Calculate DELIVERED Electricity requirement substituted by Electricity generated by Biomass CHP	42,869	kWh/year	(15)	(2) x (14) / (14)
Calculate remaining requirement for DELIVERED Electricity after application of Biomass CHP	154,208	kWh/year	(16)	(13) - (15)
Look up Carbon Emissions factor for Electricity	0.1151	kgC/kWh	(17)	
Calculate Carbon Emissions due to DELIVERED Electricity in site with Biomass CHP	17,748	kgC/year	(18)	(16) x (17)
Calculate total site Carbon Emissions in site with Biomass CHP	24,087	kgC/year	(19)	(12) + (18)
Calculate base site Total Carbon Emissions	32,763	kgC/year	(20)	(6) x (11) + (12) x (17)
Calculate reduction in Carbon Emissions due to application of Biomass CHP	8,675	kgC/year	(21)	(20) - (19)
Calculate percentage Carbon Emissions reduction due to application of Biomass CHP	26.48	%	(22)	(21) / (20) x 100

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Calculation Sheet

Project: Waldegrave Arms, Teddington
 Subject: Renewable Energy Assessment
 Engineer: Caroline Stanton
 Checked By: Martin Lawless

Job Number: 3066
 Sheet Number: 22 of 40
 Date: 24th September 2007
 Date: 24th September 2007

22 BIOMASS COMBINED HEAT AND POWER - PREDICTED PAYBACK PERIOD

Description of Calculation Step	Value	Unit	Step	Calculation/Note
DELIVERED Gas energy requirement in the base site for end uses served by Biomass CHP	190,530	kWh/year	(1)	
DELIVERED Gas requirement for site with proposed Biomass CHP	95,265	kWh/year	(2)	
Net Gas energy saving with proposed Biomass CHP	95,265.14	kWh/year	(3)	
DELIVERED Electricity to BASE development	197,078	kWh/year	(5)	
DELIVERED Electricity with proposed Biomass CHP	42,869	kWh/year	(7)	
Net Electricity energy saving with proposed Biomass CHP	154,208.37	kWh/year	(3)	
Energy price for Gas	1.63	p/kWh	(4)	
Energy price for Electricity	3.65	p/kWh	(8)	
Energy price for Biomass	3.50	p/kWh	(8)	
Annual Gas energy cost change with Biomass CHP incorporated	1,552.82	£/year	(9)	
Annual Electricity energy cost change with Biomass CHP incorporated	5,628.61	£/year	(10)	
Annual Biomass energy cost change with Biomass CHP incorporated	3,334.28	£/year	(10)	
Annual Total energy cost change with Biomass CHP incorporated	10,515.71	£/year	(10)	
Cost of proposed Biomass CHP	32,000	£	(11)	
Payback period for proposed Biomass CHP	3.04	years	(12)	