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**The Palestra Building**

London, England



**APPENDIX E: Solar Energy Calculations**

# RETScreen® Solar Resource and System Load Calculation - Photovoltaic Project

Site Latitude and PV Array Orientation		Estimate	Notes/Range
Nearest location for weather data		London	<a href="#">See Weather Database</a>
Latitude of project location	°N	51.5	-90.0 to 90.0
PV array tracking mode	-	Fixed	
Slope of PV array	°	30.0	0.0 to 90.0
Azimuth of PV array	°	0.0	0.0 to 180.0

Monthly Inputs					
Month	Fraction of month used (0 - 1)	Monthly average daily radiation on horizontal surface (kWh/m <sup>2</sup> /d)	Monthly average temperature (°C)	Monthly average daily radiation in plane of PV array (kWh/m <sup>2</sup> /d)	Monthly solar fraction (%)
January	1.00	0.56	3.9	0.98	-
February	1.00	1.10	3.9	1.50	-
March	1.00	2.07	6.1	2.48	-
April	1.00	3.04	7.8	3.28	-
May	1.00	4.12	11.1	4.17	-
June	1.00	4.99	14.4	4.90	-
July	1.00	4.38	16.7	4.35	-
August	1.00	3.62	16.7	3.82	-
September	1.00	2.71	13.9	3.18	-
October	1.00	1.56	10.6	2.11	-
November	1.00	0.81	6.7	1.24	-
December	1.00	0.47	5.6	0.89	-
			<b>Annual</b>	<b>Season of use</b>	
Solar radiation (horizontal)		MWh/m <sup>2</sup>	0.90	0.90	
Solar radiation (tilted surface)		MWh/m <sup>2</sup>	1.00	1.00	
Average temperature		°C	9.8	9.8	

Load Characteristics		Estimate
Application type	-	On-grid

[Return to Energy Model sheet](#)

RETScreen® Cost Analysis - Photovoltaic Project

Type of analysis: Pre-feasibility

Currency: £

Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
<b>Feasibility Study</b>							
Other - Feasibility study	Cost	0	£ 10,000	£ -	-	-	-
Sub-total :				£ -	0.0%	-	-
<b>Development</b>							
Other - Development	Cost	0	£ 15,000	£ -	-	-	-
Sub-total :				£ -	0.0%	-	-
<b>Engineering</b>							
Other - Engineering	Cost	0	£ 55,000	£ -	-	-	-
Sub-total :				£ -	0.0%	-	-
<b>Energy Equipment</b>							
PV module(s)	kWp	24.80	£ 5,750	£ 142,600	-	-	-
Transportation	project	0	£ -	£ -	-	-	-
Other - Energy equipment	Cost	0	£ -	£ -	-	-	-
Credit - Energy equipment	Credit	0	£ -	£ -	-	-	-
Sub-total :				£ 142,600	50.0%	-	-
<b>Balance of Equipment</b>							
Module support structure	m <sup>2</sup>	195.3	£ 100	£ 19,528	-	-	-
Inverter	kW AC	72.0	£ 1,000	£ 72,000	-	-	-
Other electrical equipment	kWp	24.80	£ -	£ -	-	-	-
System installation	kWp	24.80	£ 1,500	£ 37,200	-	-	-
Transportation	project	0	£ -	£ -	-	-	-
Other - Balance of equipment	Cost	0	£ -	£ -	-	-	-
Credit - Balance of equipment	Credit	0	£ -	£ -	-	-	-
Sub-total :				£ 128,728	45.1%	-	-
<b>Miscellaneous</b>							
Training	p-h	6	£ 65	£ 390	-	-	-
Contingencies	%	5%	£ 271,718	£ 13,586	-	-	-
Sub-total :				£ 13,976	4.9%	-	-
<b>Initial Costs - Total</b>				£ 285,303	100.0%	-	-

Annual Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
<b>O&amp;M</b>							
Property taxes/Insurance	project	0	£ -	£ -	-	-	-
O&M labour	p-h	16	£ 55	£ 880	-	-	-
Other - O&M	Cost	0	£ -	£ -	-	-	-
Credit - O&M	Credit	0	£ -	£ -	-	-	-
Contingencies	%	0%	£ 880	£ -	-	-	-
Sub-total :				£ 880	100.0%	-	-
<b>Annual Costs - Total</b>				£ 880	100.0%	-	-

Periodic Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Interval Range	Unit Cost Range
Inverter Repair/Replacement	Cost	12 yr	£ 50,000	£ 50,000	-	-
			£ -	£ -	-	-
			£ -	£ -	-	-
End of project life		-	£ -	£ -	-	-

[Go to GHG Analysis sheet](#)

Site Conditions		Estimate	Notes/Range
Project name		Palestra Building	<a href="#">See Online Manual</a>
Project location		London, England	
Nearest location for weather data	-	London	→ <a href="#">Complete SR&amp;SL sheet</a>
Latitude of project location	°N	51.5	-90.0 to 90.0
Annual solar radiation (tilted surface)	MWh/m <sup>2</sup>	1.00	
Annual average temperature	°C	9.8	-20.0 to 30.0

System Characteristics		Estimate	Notes/Range
Application type	-	On-grid	
Grid type	-	Isolated-grid	
PV energy absorption rate	%	95.0%	
<b>PV Array</b>			
PV module type	-	mono-Si	
PV module manufacturer / model #		BP Solar/ BP 5160 S	<a href="#">See Product Database</a>
Nominal PV module efficiency	%	12.7%	4.0% to 15.0%
NOCT	°C	45	40 to 55
PV temperature coefficient	% / °C	0.40%	0.10% to 0.50%
Miscellaneous PV array losses	%	5.0%	0.0% to 20.0%
Nominal PV array power	kWp	24.80	
PV array area	m <sup>2</sup>	195.3	
<b>Power Conditioning</b>			
Average inverter efficiency	%	90%	80% to 95%
Suggested inverter (DC to AC) capacity	kW (AC)	22.3	
Inverter capacity	kW (AC)	72.0	
Miscellaneous power conditioning losses	%	0%	0% to 10%

Annual Energy Production (12.00 months analysed)		Estimate	Notes/Range
Specific yield	kWh/m <sup>2</sup>	102.4	
Overall PV system efficiency	%	10.2%	
PV system capacity factor	%	9.2%	
Renewable energy collected	MWh	23.386	
Renewable energy delivered	MWh	<b>19.995</b>	
	kWh	19,995	
Excess RE available	MWh	<b>1.052</b>	<a href="#">Complete Cost Analysis sheet</a>

## RETScreen® Financial Summary - Photovoltaic Project

Annual Energy Balance					
Project name	Palestra Building				
Project location	London, England		Nominal PV array power	kWp	24.80
Renewable energy delivered	MWh	19,995			
Excess RE available	MWh	1,052			
Firm RE capacity	kW	-			
Application type	On-grid				

Financial Parameters					
Avoided cost of energy	£/kWh	0.858	Debt ratio	%	60.0%
RE production credit	£/kWh	0.750	Debt interest rate	%	8.5%
RE production credit duration	yr	25	Debt term	yr	25
RE credit escalation rate	%	2.0%	Income tax analysis?	yes/no	No
Avoided cost of excess energy	£/kWh	-			
Energy cost escalation rate	%	5.0%			
Inflation rate	%	2.5%			
Discount rate	%	9.0%			
Project life	yr	25			

Project Costs and Savings					
<b>Initial Costs</b>			<b>Annual Costs and Debt</b>		
Feasibility study	0.0%	£ -	O&M	£	880
Development	0.0%	£ -	Fuel	£	-
Engineering	0.0%	£ -	Debt payments - 25 yrs	£	16,726
Energy equipment	50.0%	£ 142,600	<b>Annual Costs and Debt - Total</b>	<b>£</b>	<b>17,606</b>
Balance of equipment	45.1%	£ 128,728	<b>Annual Savings or Income</b>		
Miscellaneous	4.9%	£ 13,976	Energy savings/income	£	17,156
<b>Initial Costs - Total</b>	<b>100.0%</b>	<b>£ 285,303</b>	RE production credit income - 25 yr	£	14,996
Incentives/Grants	£	-	<b>Annual Savings - Total</b>	<b>£</b>	<b>32,152</b>
<b>Periodic Costs (Credits)</b>			Schedule yr # 12,24		
Inverter Repair/Replacement	£	50,000			
	£	-			
	£	-			
End of project life -	£	-			

Financial Feasibility					
Pre-tax IRR and ROI	%	18.3%	Calculate energy production cost?	yes/no	No
After-tax IRR and ROI	%	18.3%			
Simple Payback	yr	9.1	Project equity	£	114,121
Year-to-positive cash flow	yr	6.1	Project debt	£	171,182
Net Present Value - NPV	£	125,778	Debt payments	£/yr	16,726
Annual Life Cycle Savings	£	12,805	Debt service coverage	-	1.94
Benefit-Cost (B-C) ratio	-	2.10			

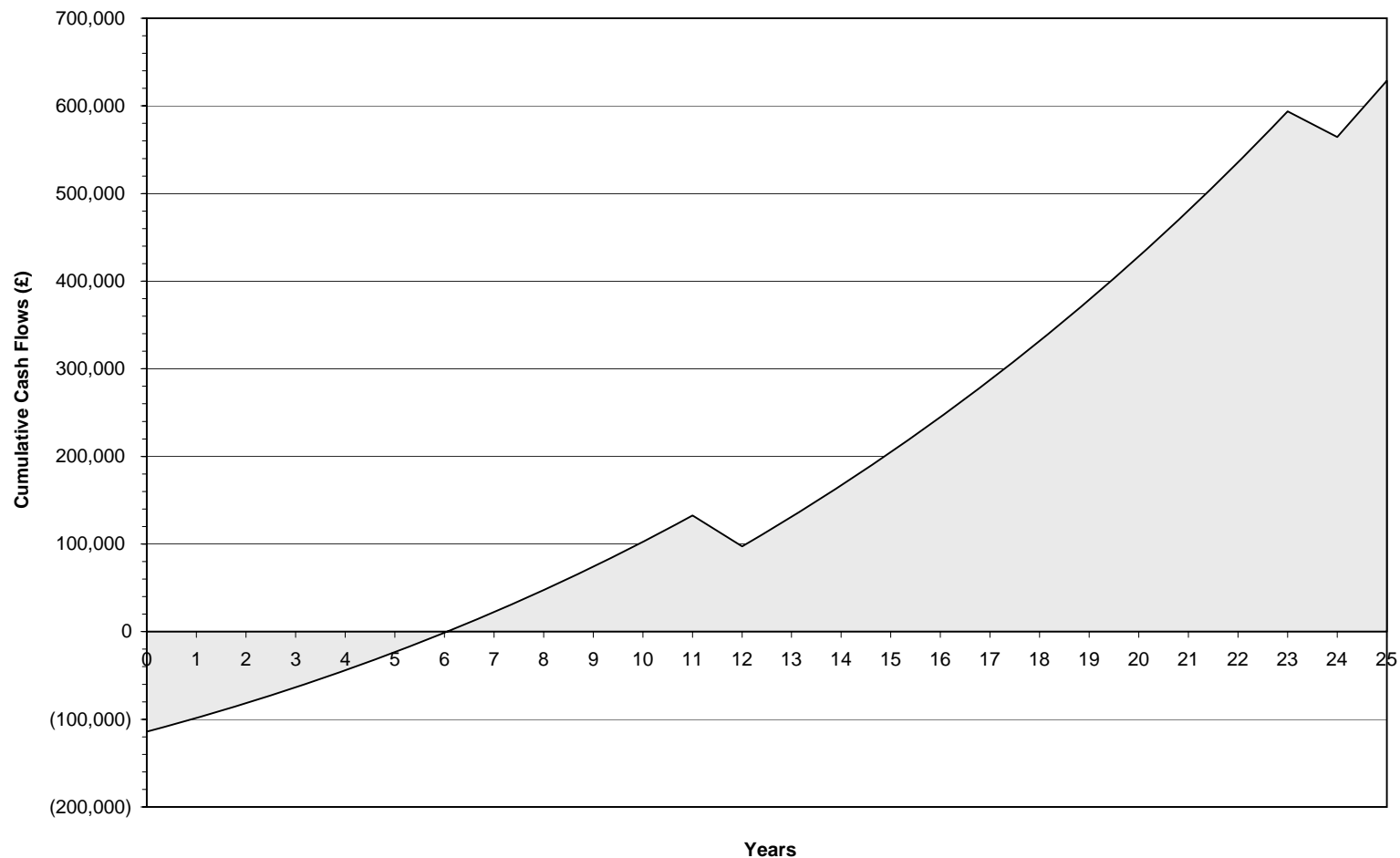
Yearly Cash Flows			
Year #	Pre-tax £	After-tax £	Cumulative £
0	(114,121)	(114,121)	(114,121)
1	15,681	15,681	(98,440)
2	16,865	16,865	(81,575)
3	18,100	18,100	(63,475)
4	19,388	19,388	(44,087)
5	20,731	20,731	(23,357)
6	22,132	22,132	(1,225)
7	23,593	23,593	22,368
8	25,119	25,119	47,487
9	26,711	26,711	74,198
10	28,372	28,372	102,570
11	30,107	30,107	132,677
12	(35,326)	(35,326)	97,351
13	33,809	33,809	131,160
14	35,785	35,785	166,945
15	37,848	37,848	204,792
16	40,003	40,003	244,795
17	42,254	42,254	287,049
18	44,607	44,607	331,656
19	47,065	47,065	378,721
20	49,635	49,635	428,356
21	52,320	52,320	480,676
22	55,128	55,128	535,803
23	58,063	58,063	593,866
24	(29,305)	(29,305)	564,561
25	64,340	64,340	628,902

Cumulative Cash Flows Graph

### Photovoltaic Project Cumulative Cash Flows Palestra Building, London, England

Renewable energy delivered (MWh/yr): 19.995

Total Initial Costs: £ 285,303



IRR and ROI: 18.3%

Year-to-positive cash flow: 6.1 yr

Net Present Value: £ 125,778

**The Palestra Building**  
London, England



**Solar PV Panel Specifications**

<b>BP Solar BP 5160 S/L</b>	
Manufacturer	<b>BP Solar</b>
Name	<b>BP 5160 S/L</b>
<b>Technical specifications</b>	
Nominal output	160 watt
Max. panel voltage	1000 V
Length	1596 mm
Width	790 mm
Height	0 mm
Short circuit current	4.7 A
Max. panel voltage	1000 V
MPP voltage	36 V
MPP current	4.44 A
Temperature coefficient off-load voltage	-160 mV / °C
Temperature coefficient MPP voltage	-160 mV / °C
	Quality of data ★★
<b>Description</b>	