Study Carried Out for the CA Group

The SolarWall™

BATTLE McCARTHY
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1.0 INTRODUCTION

This report summarizes the findings of two independent studies.

a) Warehouse SolarWall™ study for ProLogis Park Sideway by Battle McCarthy.
b) SolarWall™ Monitoring Report from CA Roll Mill, by BSRIA.

Both reports were carried out independently and this document brings these two studies together in a single assessment. There are some differences in the manner in which the individual analyses were carried out and these are noted below.

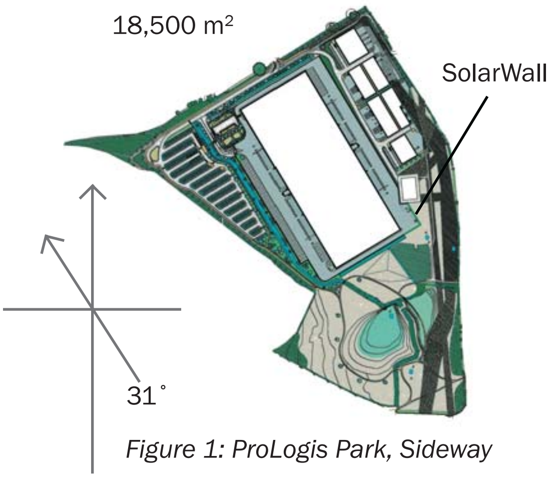


Figure 1: ProLogis Park, Sideway


Figure 2: A completed SolarWall™

- Computer desktop study
- Modelled arounf real development, “Sideway, Stoke”
- Orientation towards South East
- Shed area - 18,500 m²
- SolarWall area - 1579 m²

- 12 month monitoring
- 2100 m² shed
- 410m² SolarWall™
- South facing
- Orientation towards South

Despite these differences, this report attempts to reconcile the results and present a clear summary of the performance of SolarWall™.

2.0 SUMMARY OF SOLARWALL™ STUDY BY BATTLE MCCARTHY

2.1 Introduction

This study was carried out using desktop dynamic thermal modelling and is based around a real development for ProLogis UK, at Sideway in Stoke-on-Trent. A detailed analysis was carried out to explore the potential heating contribution of the SolarWall™ for two applications.

i) Frost protected warehouse (5ºC minimum)
ii) Heated warehouse (15ºC minimum)

For each heating scenario, two ventilation options were examined:

a) Fan on/off as heating required.
b) Mechanical ventilation system to provide fresh air to the factory.

For each heating scenario and ventilation option, various shed permeabilities were examined as follows:

Fabric Permeability $m^3/m^2.h$ @ 50 Pa	Peak Infiltration Rate		
	Sheltered	Normal	Exposed
20 (Leaky or open door policy	0.30	0.45	0.68
10 (Part L 2002)	0.17	0.25	0.38
7 (Part L 2005)	0.10	0.15	0.23
5	0.10	0.15	0.23
3	0.07	0.10	0.15

Table 1. Relationship between fabric permeability and infiltration rate

The particular shed analysed was for the real case scenario in Sideway. This shows that the SolarWall™ is not installed in the ideal orientation but 30º off south towards the East (i.e. South East)

2.2 Summary of Results

Below are presented the results for a shed operated under average conditions with good airtightness – equivalent to $0.5ach^{-1}$.

	Scenario 1		Scenario 2		Scenario 3	
Building heating loads (MWh)	Frost protection		Heated to 15˚C (7 am - 7 pm)		Ventilated and heated to 15˚C	
	MWh	kWh/m^2	MWh	kWh/m^2	MWh	kWh/m^2
Heating requirement	50	2.7	1690	91	1690	91
Heating requirement with SolarWall	34		1510		1350	
Saving	16	0.95	180	9.7	340	18.3%
Saving %	35%		11%		20%	

Table 2 - Energy and comparison for different shed operation scenarios

Nb. Scenario 3 most closely resembles the monitoring activities carried out by BSRIA and appears to correlate with their results (see section 3.0).

2.3 Energy Cost savings

Potential energy cost savings have been calculated for the various scenarios:

25 year cost saving	Warehouse Scenario			
	Airtight construction (0.1 ach)	Part L 2006 (0.3 ach)	Open doors (0.5 ach) Scenario 3	Additional Ventilation (0.5 ach)
5˚C frost protected warehouse	£261	£6,483	£21,017	£19,686
1 5˚C heated warehouse inc. destratification savings	£280,729	£371,250	£397,604	£618,575

Table 3. Potential energy cost savings – South facing SolarWall™

2.4 Conclusions from the study

The analysis indicates the following:

For a *frost protected shed* of average construction standards and operation, the heating contribution of the SolarWall™ is about 35%. This rises to 100% in a well-built and maintained shed. In overall terms this equates to approximately 5% of the total energy consumption including lighting (assumes a daylit shed) although it should be noted that the SolarWall™ cannot be used to replace the need for sprinkler freeze protection.

For a *heated and ventilated shed,* the SolarWall™ contribution to the heating load is approximately 20%. This equates to approximately 10% of the overall energy consumption of a shed, assuming a daylit shed.

3.0 SUMMARY OF BSRIA SOLARWALL™ MONITORING STUDY

3.1 Introduction

BSRIA monitored a SolarWall™ installation on the CA Group Roll Mill in Evenwood, County Durham for 12 months during the period April 2006 to March 2007. The monitoring comprised of a number of measuring points in the wall, delivery ducts, plus a pyranometer (solar radiation) on the plane of the SolarWall™.

Figure 3: SolarWall™ showing thermocouples before placement of sheeting

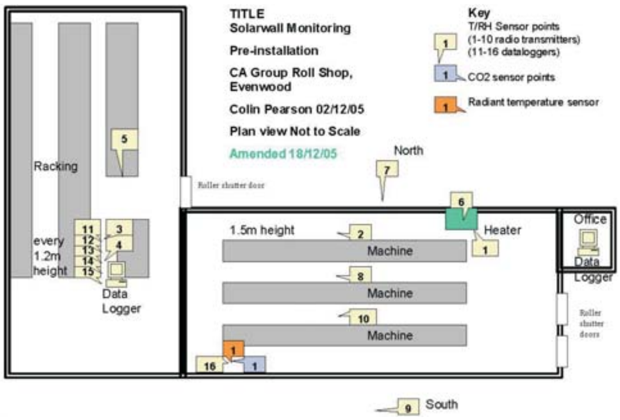


Figure 4: Roll Mill monitoring sensor locations, Solarwall™ and Pyranometer

A detailed description of the monitoring installation and findings are included in the BSRIA Report in the Appendix.

3.2 Control System

The control system was set up to function as follows:

a) SolarWall™ operational — Toutside < 16°C
Tinside < 18°C
TSolarWalls > 2°C about Tinside

b) SolarWall™ bypass (fresh air output) — Tinside > 18°C
Toutside < 2°C below Tinside

c) Recirculated air — Tinside < 18°C
TSolarWall < Tinside

d) 0700 – 1900 — Tinside set point 18°C
1900 – 0700 — Tinside set point 14°C

3.3 SUMMARY OF RESULTS

After adjustment for degree day data the following observations were made:

- The total saving has been 27,260 cubic metres of gas or 303,543 KWh or (58.9 tonnes of CO_2).
- After taking into account the fact that 2006/07 was a slightly warmer year than 2005/06 (there were fewer degree-days of heating requirement) this is equivalent to a 50% drop in gas heating demand per degree-day.

- This substantial saving is partly attributable to destratification, which is effective in reducing heat demand even when the SolarWall™ is not supplying heat.
- It is also partly due to positive pressurisation of the building, preventing cold air blowing in directly through open doors.
- The total delivered heat energy (gas plus SolarWall™) was 37% less in 2006/07 than in 2005/06.
- A significant amount of energy has been collected by the SolarWall™. 79,191 KWh was produced by the SolarWall™ representing 21% of the total heating demand of the building in the year 2006/7.

Month	2005/06 consumed (KWh)	2006/07 consumed (KWh)	2005/06 degree days	2006/07 degree days	KWh/degree day 2005/06-2006/07		Saving in KWh/dd compared to 2005/06	SolarWall Energy delivered, KWh
Apr	64754	40,000	223	221	290	181	38%	9396
May	41357	6,709	152	147	272	46	83%	4776
Jun	6700	1,023	66	58	102	18	83%	1626
Jul	0	62	38	26	0	2	0%	902
Aug	1729	85	45	37	38	2	94%	1438
Sep	9948	52	69	34	144	2	99%	2892
Oct	37541	13,980	102	102	368	137	63%	7661
Nov	74563	45,446	288	225	259	202	22%	9072
Dec	75316	36,855	345	306	218	120	45%	25075
Jan	90721	56,930	358	274	253	208	18%	4428
Feb	96076	44,976	306	281	314	160	49%	2310
Mar	100751	49,796	353	264	285	189	34%	9616
Total	599,456	295,913	2345	1975	2545	1266	50%	79191

Table 4. Reduction in gas use and SolarWall™ Energy delivered

3.4 Conclusions

In 2005/06 the building consumed approximately 600,000 KWh for heating. This is equivalent to 285 KWh/m2. This is equivalent to a shed that has an airtightness of 20 m3/m2/hr and would be considered ‘very leaky’, or has doors open for operational purposes almost permanently throughout the winter months (see BM report 5.2.1 and 5.2.2).

Against this background the SolarWall™ has performed extremely well.

- Total reduction in heating energy (sun + destratification) — 303,543 KWh; 51% compared to 2005/06
- Total heating contribution from solar energy — 79,191 KWh (37 KWh/m^2); 21% compared to 2005/06
- This indicates that as measured the SolarWall™ would have exceeded the 10% requirement for on-site renewable energy generation.

We may conclude the following;

- For a ventilated, heated shed the results indicate that it should be possible to make at least a 20% saving on direct heating. This increases as the control temperature goes up from 15°C to 10°C.
- The SolarWall™ has the potential to make s significant contribution in heating the shed through destratification. This will only work however for short span sheds or ducted systems.
- The SolarWall™ makes a greater contribution for an inefficient shed with open door policy.

For a frost protected shed the SolarWall™ will provide 100% of the heating, although it will not be a substitute for *frost* protection.

4.0 COMPARISON OF RESULTS AND DISCUSSION

4.1 Introduction

The two studies have some differences, as follows:

- Set point temperatures for the heated shed vary – BSRIA (18°C) and Battle McCarthy (15°C)
- Control scenarios are different

In order to usefully compare the results and to make an assessment of the potential contribution of the SolarWall™, the results have been normalised.

4.2 Normalisation of Data

By way of comparison, the two studies were as follows:
Nb. Battle McCarthy Study has been corrected for South facing wall

	Area of SolarWall			Area of shed	Contribution	kWh/m² of wall	kWh/m² of building
	L (m²)	W (m)	m²	m²	kWh (solar and heat)		
BM study			1579	18,500	180,000	114	9.7
CA Group study	700		410	1900	79,191	193	42
Average						163	

Table 5:

Observations

- The Solar output of both studies appear to correlate
- The contribution of the SolarWall™ for the CA Group building is significantly higher because the shed is area small compared to the total area of the wall

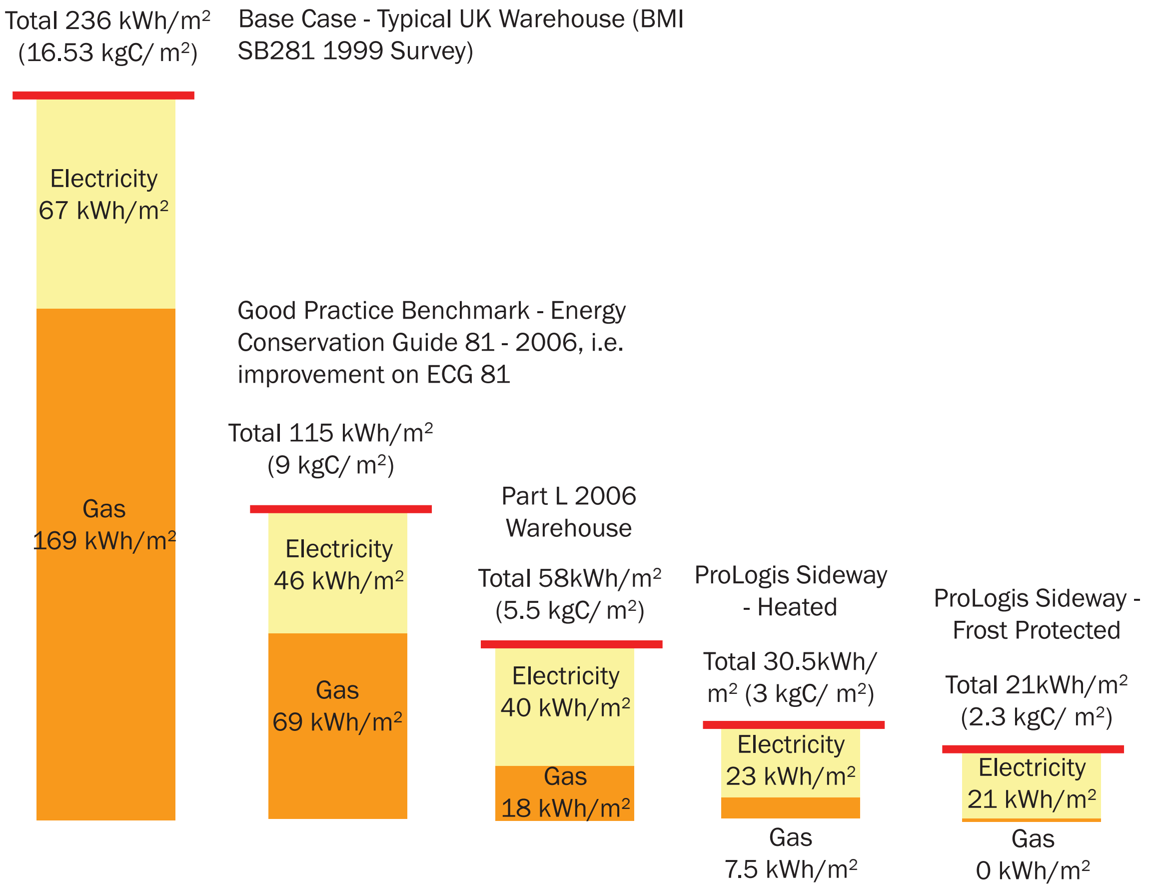
- Wall to Shed Ratio

  BM Study 1:11
  BSRIA Study 1:5

4.2 Shed Energy Consumption

Battle McCarthy has previously carried out detailed studies of the total energy consumption within a typical and low energy shed. These are as below:

The important issues to note are as follows:



- Typical Part L Warehouse (Heated to <5°C)
  Electricity 68% (40 KWh/m²)
  Gas 32% (18 KWh/m²) (Average door policy)

- Low energy Warehouse (Heated to <5°C)
  Electricity 75% (23 KWh/m²)
  Gas 25% (8 KWh/m²) (Good door policy)

- Frost protected shed (>5°C)
  Electricity 99% (23 KWh/m²)
  Gas 1% (2 KWh/m²) (Good door policy)

4.3 Potential Contribution of SolarWall™ to typical UK sheds

The following assumptions have been made for this comparison:

SolarWall™ area	1579 m^2
Energy contribution of SolarWall™	153 KWh/m^2
Total contribution of SolarWall™	242,400 KWh

Over year for a 18,500m^2 shed this equates to 13.1 KWh/m^2 (Day only)

This would (for a shed size 18,500m^2 and assuming frost protected at night) make the following contribution to various shed types,

	Total energy consumption (kWh/m^2)	Heating		SolarWall contribution (kWh/m^2)	Approx Heat (%) contribution	% contribution to total energy contribution
		%	kWh/m^2			
Part L	58	32	18	13.1	70	24
Low energy heated	31	25	8	13.1	100	25
Low energy frost	275	2	1	13.1	100	0.5

Table 6:

4.4 Conclusions

The results of this comparison indicate the following:

1. For a Part L compliant shed, that requires (>15°C), the SolarWall™ will make a significant contribution to both the heating and overall energy consumption.

Heating contribution	50-70%
Overall Energy contribution	20%
Merton rule achieved	Yes

2. For a low energy heated shed the SolarWall™ also makes a substantial contribution.

Heating contribution	70-90%
Overall energy contribution	20%
Merton rule achieved	Yes

3. For a frost protected shed, that is well run (doors kept shut in winter), the SolarWall™ will not contribute much to either energy or heating requirement, because the heating loads are so low.
The SolarWall™ will NOT take the place of frost protection.

Heating contribution	Unknown
Overall energy contribution	<1%
Merton rule achieved	No

4. Frost protected (open door policy)

Many sheds in the UK are designed to be frost protected, but in reality the heating installation is set to a temperature higher than 5°C set point. Doors will be often opened. In this case, the SolarWall™ contribution whilst not as large as the heated shed may still be worthwhile.

Heating contribution	40-50%
Overall energy contribution	8-10%
Merton rule achieved	Yes (Probably)

5.0 OVERALL CONCLUSIONS AND FURTHER STUDIES

These two studies indicate that the SolarWall™ has the potential to make *a significant contribution* to both the heating and overall energy consumption of a typical and low energy distribution centre.

Typical UK heated shed (Part L)	50%
Heating contribution	50-70%
Overall energy contribution	10-20%

In this case the SolarWall™ will also meet the "Merton Rule".

The analysis also indicates that the SolarWall™ has the highest contribution to heated or poorly managed sheds, and this would indicate that it has a real potentially beneficial contribution as a retro fit system to energy sheds.

In sheds that need frost protection only, then the SolarWall™ will not make a significant contribution in overall energy terms and will NOT stand as a substitute for frost protection.

END

6.0 APPENDIX

1. Battle McCarthy SolarWall™ Report

2. BSRIA SolarWall™ Monitory Study