SYNOPSIS of dissertation entitled "Comparative Analysis of Daylight Performance of Remote Source Lighting Systems: Case Study of The Use of HLS (Hybrid Lighting System) and TDGS (Tubular Daylight Guidance System) at CEREB"

The dissertation was submitted in partial fulfilment of the university requirements of London South Bank University for a Master's degree in the Faculty of Engineering Science and the Built Environment

The latest data from the Digest of UK Energy Statistics (DUKES) indicate that lighting accounted for 7% of the total UK primary energy equivalent in 2008. A portion of that lighting energy could be displaced by using daylight in the form of either Tubular Lighting Guidance System (TDGS) or the Fibre Optic Solar Lighting (FOSL) component of a Hybrid Lighting System (HLS). This would assist in meeting the Climate Change Act 2008 Green House Gas (GHG) emissions reduction target of 80% by 2050 compared to 1990s emissions levels,

A comparative analysis of the lighting, environmental and cost performances of these two technologies was carried out in the context of the real-life installation at the Centre for Efficient and Renewable Energy in Buildings (CEREB), LSBU.

A HLS is installed at CEREB demonstration room, but no TDGS is installed. The analysis compared the performance of the installed HLS to that of a modelled TDGS capable of providing an equivalent lighting performance.

The daylight performance of the installed HLS was analysed by recording external and internal illuminance lighting levels at the CEREB demonstration room using a light meter over a 7-day monitoring period. Lighting cost and environmental impact was analysed based on data obtained from the luminaires manufacturers and CEREB building design team. The daylight performance of an equivalent TDGS was obtained using Jenkins-Muneer semi-empirical predictive model.

All acquired datasets were validated by comparing them to independently generated datasets from the UK Meteorological Office, the Satel-Light European Database of Daylight and Solar Radiation and Dialux lighting computer program as well as datasets from the CEREB BMS system.

It was found that the FOSL component of HLS performs significantly worse in terms of lighting, environmental and cost factors when compared to TDGS. The lighting performance was poor not only because FOSL relies on direct sunlight only whereas TDGS relies on both sunlight and skylight but also because of the limitations of the installed diffusers. Besides the high frequency of intermediate skies (partly overcast), which is a feature of the UK climate, reduces the opportunity of electric lighting displacement for FOSL. This is not the case for TDGS.

It was also noted that the limitation of the adopted methodology as recommended by SLL results in a lighting performance far worse than was observed by the author. This is because the methodology precludes the measurements of the illuminance straight down below a light source when evaluating the average illuminance within a space. This was compounded by the fact that the installed HLS diffusers did not spread the collected daylight sufficiently across the length of the diffusers. However, the CEREB demonstration room had a day lit appearance on the few occasions when the sky conditions were sunny.

The environmental performance of FOSL was poor when compared to TDGS because significantly more raw materials were required to provide sufficient daylight within the room. Hence, FOSL had more embedded carbon than TDGS.

The cost of FOSL at CEREB was found to be over 45 times more than the cost of a TDGS designed to produce an equivalent lighting performance. The considerable capital cost is a major obstacle to any wider adoption of FOSL.

However, FOSL offers a significantly better prospect for retrofit with its easy of installation and minimal disruption when compared to TDGS. The refurbishment of the existing building stock will need to be seriously considered given that a significant proportion of the buildings that will be standing in 2050 have already been built. Therefore, FOSL is a technology that could assist the UK in achieving its challenging and legally binding carbon reduction commitments, provided FOSL whole life cycle cost becomes economically viable.

LIGHTING PERFORMANCE COMPARISON

	External	FOSL component of HLS			TDGS			FOSL AS PERCENTAGE OF TDGS		
Internal		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Lighting Internal Daylight Illuminance [lx] / Daylight Factor ( )	Mean	32 (0.06%)	12 (0.03%)	54 (0.07%)	389 (0.70%)	245 (0.69%)	505 (0.69%)	8.35%	4.93%	10.76%
	Min	0.152 (0.00%)	0.001 (0.00%)	0.152 (0.00%)	34 (0.15%)	16 (0.16%)	47 (0.14%)	0.44%	0.01%	0.32%
	Max	106 (0.12%)	75 (0.10%)	149 (0.15%)	1674 (1.93%)	1415 (1.93%)	1908 (1.91%)	6.33%	5.27%	7.81%

ENVIRONMENTAL PERFORMANCE COMPARISON

Performance		FOSL component of HLS	TDGS	Percentage Difference
Environmental	Raw Materials	3no. 0.98 x 0.98 x 0.18m Aluminium panel and tempered glass; 3 x 4no. 9.5m long PMMA optical cables	1no. 1.25m long aluminium tubing; 0.535m diameter polycarbonate dome	More FOSL raw material
	In operation	Daylight + power for sun tracking device	Daylight only	Small electric power consumption by FOSL

DISPLACED ENERGY COMPARISON

Performance		FOSL component of HLS	TDGS	Percentage Difference
Financial	Operational expenditure	Displaced electrical energy only when direct sunlight is available	Displaced electrical energy whenever sunlight a or skylight is available	FOSL displacement lower than that of TDGS in line with difference between frequency of sunny skies and frequency of intermediate skies.

CAPITAL COST COMPARISON

System	No. of Items	Capital Cost [£]	Capital and Installation Costs, inc. optic panels, controls, cabling and containment [£]	Running Costs [£]
TDGS	1	465.00	235.9 (**Error! Reference source not found.**)	N/A
Parans HLS	12	-	32,566.41	N/A

INSTALLATION COST

Performance		Parans HLS	TDGS	Percentage Difference
Financial	Capital and installation expenditure [£]	32,566.41	700.90	4646%

SAMPLE PICTURES