Improving Overall Thermal Transfer Value of Office Tower Building in Malaysia. Case Study: Ministry of Women Family and Community Development, Lot 4G11, Putrajaya

Azman Zainonabidin[1], Amirul Amin Ismail[1]
[1]Department of Architecture, Faculty of Architecture, Planning and Surveying, UniversitiTeknologi MARA (Perak), Malaysia,
Email: azman906@perak.uitm.edu.my

Abstract

This paper presents the Overall Thermal Transfer Value (OTTV) and the energy consumption of air-conditioned office building in Malaysia. The study have been conducted to investigate the OTTV of Ministry of Women Family and Community Development's office block at Lot 4G11, Putrajaya. OTTV calculation, energy consumption and effect of the building parameters on energy consumption have been investigated. OTTV formula in MS1525 and Green Building Index (GBI) rating tool have been used for the OTTV calculation. The study shown that the OTTV of the Lot 4G11 is more than 70W/m^2. In order to comply with MS1525, where the minimum OTTV shall be less than 50W/m^2, improvement of the building envelope have been proposed, and the OTTV have been reduced below 50W/m^2. Since the Government has set that all government buildings in Putrajaya shall be GBI certified, further improvement of building envelope have been made in order to achieve OTTV for Platinum certification. It is found that improving the Window to Wall Ratio (WWR), Shading Coefficient (SC) and U-value for glazing will further reduce the OTTV and improve the energy efficiency of the Lot 4G11. Detailed calculations have been conducted to compare the results in between Building Baseline, MS1525 and Platinum Design.

Keywords:overall thermal transfer value, green building index, energy efficiency

1.0 Introduction

In November 9th2014, the Prime Minister's Department Complex, also known as *Perdana Putra* had received Green Building Index (GBI) Platinum Certification.*Perdana Putra* is the first successful large-scale upgrading of an existing building into the most energy-efficiency building in Malaysia, and has been categorized as a high-performance green building. Based on that achievement, the Government would like to see the entire city of Putrajaya transformed into a green, smart and connected city that will showcase our nation's economic and technological advancements.The Low Energy Office (LEO) of the Ministry of Energy, Water and Communications was completed in September 2004. This building is a new landmark to our achievement in green building as this office is the most energy efficient building in Malaysia with the OTTV score of 31.4 W/m^2.There was a key initiativemade by the Government to turn this into a reality by appointing the specialist consultants to conduct a more holistic approach of GBI assessment into the government office complexes in Putrajaya. Among the important task conducted by the specialist consultant is to carry out an assessment of the current building envelope which contribute to OTTV.The building envelope is an essential element in building components. It does not merely protects the internal spaces but also from natural elements such as rain, sun and wind. It can be likened to an environmental filter as it sieves and intermediates with the external climate to create comfortable internal climate. Apart from acting as an environmental filter, wall envelope is a manifestation and expression of architectural thoughts, aspiration and ideas (Ibrahim, Ahmed & Ahmed, 2004).The building envelope is the interface between the interior of the building and the outdoor environment, including the foundation, roof, walls, doors and windows. By acting as a thermal barrier, the building envelope plays an important role in regulating interior temperatures and helps to determine the amount of energy required to maintain thermal comfort. Minimizing heat transfer through the building envelope is crucial for reducing the need for space heating and cooling. (http://www.energyland.emsd.gov, 2015). The use of air conditioning takes a large proportion of total electricity consumption in Hong Kong. Air-conditioning systems attribute about 30% of the total electricity consumption in Hong Kong. Due to increasing population and development, the energy consumption of air conditioning systems will likely continue to grow continuously(http://www.energyland.emsd.gov, 2015).Meanwhile in Malaysia, air-conditioning in typical office building could contribute more than 60% of total energy usage.Therefore, reduction on OTTV will slightly dropped air-conditioning cooling load and possibly lowered the usage of electricity. Thus, it will reduce the

Building Energy Index (BEI) of the building.

Building Energy Index (BEI) is the global yearly energy consumption of the entire building divided by the air conditioned floor area. The target of the LEO was 100 kWh/m²/yr, and the reference value is 275 kWh/m²/yr. In the "Guidelines for Energy Efficiency in Buildings-1989" published by the then Ministry of Energy, Telecommunications and Posts (1989), four typical buildings are defined to represent different expected levels of energy use in Malaysia.

a) The worst case represents buildings that are among the most energy intensive buildings that might be encountered in Malaysia today. BEI = 240 kWh/m²/yr.;
b) The base case building reflect a typical range of construction and energy use features now prevalent in Malaysian new commercial building construction. BEI = 166 kWh/m²/yr.;
c) The proposed standard reflects the level of energy efficiency expected to be achieved by the proposed Guidelines. BEI = 136 kWh/m²/yr.;
d) The good practice represents a combination of energy efficient practice (including daylighting) that surpasses the requirements of the Guidelines proposed. BEI = 98 kWh/m²/yr.

2.0 Concept of OTTV

Overall Thermal Transfer Value (OTTV) is an index for comparing the thermal performance of building. It is a measure tool of the average heat gain into a building through the building envelope. The concept of OTTV is based on assumption that the envelope of the building is completely enclosed. The solar heat gain through the building envelope constitutes a substantial share of cooling load in an air-conditioned buildings. The OTTV aims at achieving the design of building envelope to cut down external heat gain and hence reduce the cooling load of the air-conditioning system.The OTTV consists of three major components such as; conduction through opaque walls, conduction through window glass, and solar radiation through window glass.OTTV of the building envelope for a building, having a total air-conditioned area exceeding 4000m^2 and above, should not exceed 50 W/ m^2, and the visible transmittance of the daylight fenestration system should not be less than 50%. (MS125, 2007)

Clause 4.5 of MS1525 (2007) stated that the exterior wall and cladding systems should be design to provide an integrated solution for the provision of view, daylight control, passive and active solar energy collection, and moisture management systems while minimizing heat gain.

Clause 5.1 of MS1525 (2007) stated that fundamentally, the building envelope has to block out heat gain into buildings via conduction and radiation. While Clause 3.1 states that the external portions of a building through which thermal energy is transferred; and this thermal transfer is the major factor affecting interior comfort level and energy usage.Therefore, improving OTTV of the building is very important because it will provide thermal comfort and also energy efficiency, thus will establish long term energy saving.

3.0 OTTV Formula

In the OTTV formulation, the following items are not considered:

a) Internal shading devices, e.g. curtains, blinds;
b) Solar reflection or shading from adjacent buildings;
c) Green walls

OTTV formula shall be as follow (MS1525, 2007):

$$\mathbf{OTTV = [15\,\alpha\,(1\text{-}WWR)Uw] + [6(WWR)Uf] + [194 \times CF \times WWR \times SC]}$$

α = Solar absorption (colour of the wall)
WWR = Window to Wall Ratio
Uw = U-value of the wall
Uf = U-value of the window (Refer to glass specification)
CF = Correction Factor (Table 4 MS1525)
SC = Shading Coefficient (Table 5, 6 & 7)

Solar heat gain through windows contribute more than 70% thermal transfer into the building

4.0 Ways to Improve OTTV

GBI has identified ways to improve OTTV as stated below:

1. Identify which component contributes the most OTTV. Glazing material always contribute most OTTV to the building;
2. Review Solar Correction Factors (CF) in Table 4 of MS1525. Table 4 specifies CF for the various orientation of fenestration. A fenestration system may consist of glazing material, a shading device and a combination of both;
3. Review glass selection& its Shading Coefficient (SC). To choose glass with lower U-value, but shall not reduce the Visible Light Transmittance (VLT);
4. Review sunshades &Shading Coefficient (SC) in Table 5, 6 and 7 of MS1525.Table 5, 6 and 7 specifies SC of external shading devices (horizontal projections, vertical projections and egg-crate louvres).External shading devices can be proposed or improved especially to the façade which contribute most OTTV;
5. Review Window-to-Wall Ratio (WWR). The WWR can be improved by reducing window area especially to the west façade. Spandrel glass also can be introduced.

Aim of minimum energy efficiency performance is to ensure building envelope to achieve minimum performance to reduce energy consumption in buildings and reducing CO2 emission to the atmosphere. This aim is to encourage high performance glazing such as Low emissivity (Low-e) and solar control glass. Low-e glass can help provide high levels of thermal insulation. To minimize overheating in hot climates and reduce CO2 emissions associated with air-conditioning, solar control performance glass can be proposed.

5.0 Case Study: Ministry of Women Family and Community Development, Lot 4G11, Putrajaya

Office for Ministry of Women Family and Community Development, also known as Lot 4G11 located at Precinct 4 Putrajaya, consists of 38 storeys office block with three levels basement car park.The building specifications for Baseline Building Design are as follows;

a) External wall colour - white spray paint;
b) External wall construction- 125mm precast concrete panels, U-value= 0.80;
c) Glazing- laminated double glazing glass unit 8.76mm thick. (4mm thick body tint-blue green + 0.76 PVB + 4mm thick. Clear with low-E heat strengthened glass); SC= 0.70, U-value= 5.1 & Visible Light Transmittance (VLT)= 0.47

The strategy is to upgrade the building envelope with high performance façade design, without compromising the original architectural appearance of the building.

6.0 Methodology

The calculation of the OTTV will be based on Baseline Design (existing condition of the building envelope), MS1525 Design (mandatory compliance for GBI certification) and Platinum Design (as required by the Government for all government buildings in Putrajaya).In order to reduce the OTTV, two methods have been established. First, reducing the U-value of the glass as shown in Table 1, and second, improving Window to Wall Ratio (WWR) of the building envelope without affecting the original façade of the building as shown in Table 2 and 3. Therefore, 30% of spandrel glass with same appearance with vision glass have been proposed.

Table 1: Proposed Glazing Material for the Building Envelope

Design	Base Line	MS15245	Platinum
Glass Types	Laminated double glazing glass unit	Pilkington Eclipse Advantage™ Arctic Blue monolithic glass#2	Pilkington Eclipse Advantage™ Blue-GreenInsulating K glass™ #3
Thickness	8.76mm (4mm Blue-green tint + 0.76 PVB + 4mm Clear with Low E Heat Strengthened)	12mm	28mm
Shading Coefficient	0.7	0.41	0.40

U-value (W/m2K)	5.1	3.8	1.3
Colour	Blue-green	Arctic Blue	Blue-Green
Visible Light Transmittance, VLT	0.47	0.39	0.47

Table 1 above showsthe U-value of the glass have been reduced from 5.1Wm2/k (Baseline Design) to 3.8Wm2/k (MS1525 Design), and further reduce to 1.3Wm2/k (Platinum Design). To maintain the same appearance of the façade, same glass colour andVLT has been proposed for Platinum Design. Source: Zainonabidin (2015)

Table 2: Window to Wall Ratio of South and North Facade

	South Facade			**North Facade**		
	Baseline	**MS1525**	**Platinum**	**Baseline**	**MS1525**	**Platinum**
Total Facade Area	6,332.38 sqm			2,684.55 sqm		
With Shading Devices	2,535.40 sqm		1,774.78 sqm	1,679.49 sqm		1,175.64 sqm
	73.06 sqm		51.14 sqm	52.88 sqm		37.02 sqm
Without Shading Devices	1,380.74 sqm		966.52 sqm	415.02 sqm		290.51 sqm
Total Window Area	3,989.20 sqm		2,792.44 sqm	2,147.39 sqm		1,503.17 sqm
Spandrel Glass	-		1,196.76 sqm	-		644.22 sqm
Window to Wall Ratio (WWR)	0.63		0.44	0.80		0.56

Table 2 above indicatesthe WWR for South façade have been reduced from 0.63 to 0.44, and WWR for North façade have been reduced from 0.80 to 0.56.Source: Zainonabidin (2015)

Table 3: Window to Wall Ratio of East and West Facade

	East Facade			**West Facade**		
	Baseline	**MS1525**	**Platinum**	**Baseline**	**MS1525**	**Platinum**
Total Facade Area	7,077.16sqm			7,077.16 sqm		
With Shading Devices	1,795.68 sqm		1,256.98 sqm	1,795.68 sqm		1,256.98 sqm
	118.57 sqm		83.00 sqm	118.57 sqm		83.00 sqm
Without Shading Devices	1,306.17 sqm		914.32 sqm	1,306.17 sqm		914.32 sqm
Total Window Area	3,220.42 sqm		2,254.29 sqm	3,220.42 sqm		2,254.29 sqm
Spandrel Glass	-		966.13sqm	-		966.13sqm
Window to Wall Ratio (WWR)	0.46		0.32	0.46		0.32

Table 3 above shows that the WWR for East and West façade have been reduced from 0.46 to 0.32 which is more than 30% of glazing material have been changed to spandrel glass.Source: Zainonabidin (2015)

7.0 Analysis and Discussion

Baseline Building Design

OTTV for Baseline Building Design is 77.43 W/m2, which is above minimum OTTV as stated in MS1525. Table 4shows that OTTV for Baseline Building Design is 77.43 W/m2, which is more than mandatory requirements as specified in MS1525.

MS1525 Design

Further improvement on the building envelope, i.e. on glass specification as per Table 1, in order to comply with mandatory requirement for OTTV as stated in MS 1525 (The OTTV for air-conditioned building shall not exceed 50 W/m2).

U-value of the glass has been changed from 5.1 to 3.8, and VLT have been reduced from 0.47 to 0.39. The OTTV base on new glass specification is 48.45 W/m2, which is complied with minimum requirement in MS 1525. Table 5shows that by improving the glass U-value, the OTTV is only 48.45 W/m2 and comply with MS1525.

Platinum Design

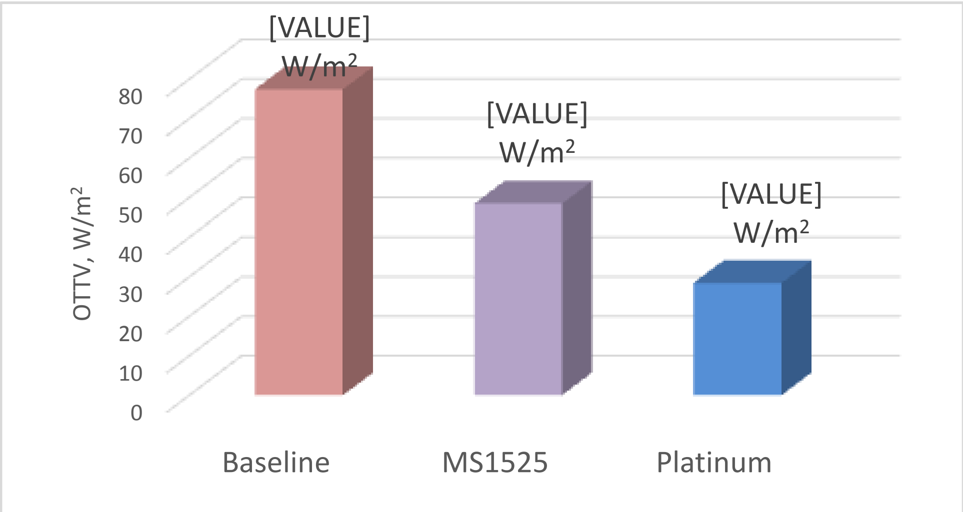
To achieve OTTV with Platinum Design, the following approach have been made:

a) Reduce the U-value of the glass from 3.8 to 1.4 as per Table 1;

b) Reduce total window area by 30%, and replaced with spandrel glass, thus will further reduce the Wall to Window Ratio (WWR) as per Table 2 and 3;

The changes has further reduced the OTTV to 28.43 W/m2 as shown in Table 6.

Bar Chart: Summary of OTTV for Lot 4G11



The bar chart above demonstrates that improving glass U-value can reduce 37% of OTTV (comparison between Baseline and MS1525). While, improving glass U-value and WWR can reduce 63% of OTTV (comparison between Baseline and Platinum), and 41% of OTTV (comparison between MS1525 and Platinum). Source: Zainonabidin (2015)

Table 4: OTTV Calculation of Baseline Building Design

OTTV Calculation: Baseline												
	ELEVATION	Façade Area (A)	Window Area	Constant	Solar Absorption Factor (α) - colour of wall *	Window to Wall Ratio (WWR)	(1 - WWR)	U-Value W/m2k (Uv)	Orientation Correction Factor (CF) - (refer to MS 1525 table 4)	Shading Coeff $SC = SC_1 \times SC_2$	Thermal Transfer Value (OTTV)	A x OTTV
HEAT CONDUCTION THROUGH WALLS	South Facade (Front Elevation)	6,332.38	3,989.20	15.00	0.25	0.63	0.37	0.63	n/a	n/a	0.88	5,548.95
	North Façade (Rear Elevation)	2,684.55	2,147.39	15.00	0.25	0.80	0.20	0.63	n/a	n/a	0.47	1,272.06
	East Facade (Left Elevation)	7,077.16	3,220.42	15.00	0.25	0.46	0.54	0.63	n/a	n/a	1.29	9,133.25
	West Facade (Right Elevation)	7,077.16	3,220.42	15.00	0.25	0.46	0.54	0.63	n/a	n/a	1.29	9,133.25
	TOTAL WALL OTTV					15 X α X (1 - WWR) Uw					3.93	**25,087.52**
HEAT CONDUCTION THROUGH WINDOWS	South Facade (Front Elevation)	6,332.38	3,989.20	6.00	n/a	0.63	n/a	5.10	n/a	n/a	19.28	122,069.52
	North Façade (Rear Elevation)	2,684.55	2,147.39	6.00	n/a	0.80	n/a	5.10	n/a	n/a	24.48	65,710.13
	East Facade (Left Elevation)	7,077.16	3,220.42	6.00	n/a	0.46	n/a	5.10	n/a	n/a	13.92	98,544.85
	West Facade (Right Elevation)	7,077.16	3,220.42	6.00	n/a	0.46	n/a	5.10	n/a	n/a	13.92	98,544.85
	TOTAL WINDOW OTTV					6 x WWR x Uf					71.60	**384,869.36**
SOLAR HEAT GAIN THROUGH WINDOWS			2,535.40	194.00	n/a	0.40	n/a	n/a	0.92	0.54	38.52	
	South Facade (Front Elevation)	6,332.38	73.06	194.00	n/a	0.01	n/a	n/a	0.92	0.46	0.94	422,344.52
			1,380.74	194.00	n/a	0.22	n/a	n/a	0.92	0.70	27.24	
			1,679.49	194.00	n/a	0.63	n/a	n/a	0.90	0.54	58.88	
	North Façade (Rear Elevation)	2,684.55	52.88	194.00	n/a	0.02	n/a	n/a	0.90	0.46	1.56	212,980.49
			415.02	194.00	n/a	0.15	n/a	n/a	0.90	0.70	18.89	
			1,795.68	194.00	n/a	0.25	n/a	n/a	1.23	0.42	25.43	
	East Facade (Left Elevation)	7,077.16	118.57	194.00	n/a	0.02	n/a	n/a	1.23	0.70	2.80	417,943.79
			1,306.17	194.00	n/a	0.18	n/a	n/a	1.23	0.70	30.83	
			1,795.68	194.00	n/a	0.25	n/a	n/a	0.94	0.46	21.05	
	West Facade (Right Elevation)	7,077.16	118.57	194.00	n/a	0.02	n/a	n/a	0.94	0.70	2.14	330,865.30
			1,306.17	194.00	n/a	0.18	n/a	n/a	0.94	0.70	23.56	
	TOTAL SOLAR HEAT GAIN		12,577.43			194 x WWR x CF x SC					251.84	**1,384,134.10**
OVERALL BUILDING OTTV		**23,171.25**									**77.43**	**1,794,090.98**

Table 4 above analysesOTTV Calculation of Baseline Building Design with the overall value of 77.43. Source: Zainonabidin (2015)

Table 5: OTTV Calculation of MS1525 Design

OTTV Calculation: MS1525												
	ELEVATION	Façade Area (A)	Window Area	Constant	Solar Absorption Factor (α) - colour of wall *	Window to Wall Ratio (WWR)	(1 - WWR)	U-Value W/m2k (Uv)	Orientation Correction Factor (CF) - (refer to MS 1525 table 4)	Shading Coeff SC = SC_1 x SC_2	Thermal Transfer Value (OTTV)	A x OTTV
HEAT CONDUCTION THROUGH WALLS	South Facade (Front Elevation)	6,332.38	3,989.20	15.00	0.25	0.63	0.37	0.63	n/a	n/a	0.88	5,548.95
	North Façade (Rear Elevation)	2,684.55	2,147.39	15.00	0.25	0.80	0.20	0.63	n/a	n/a	0.47	1,272.06
	East Facade (Left Elevation)	7,077.16	3,220.42	15.00	0.25	0.46	0.54	0.63	n/a	n/a	1.29	9,133.25
	West Facade (Right Elevation)	7,077.16	3,220.42	15.00	0.25	0.46	0.54	0.63	n/a	n/a	1.29	9,133.25
	TOTAL WALL OTTV					**15 X α X (1 - WWR) Uw**					3.93	**25,087.52**
HEAT CONDUCTION THROUGH WINDOWS	South Facade (Front Elevation)	6,332.38	3,989.20	6.00	n/a	0.63	n/a	3.80	n/a	n/a	14.36	90,953.76
	North Façade (Rear Elevation)	2,684.55	2,147.39	6.00	n/a	0.80	n/a	3.80	n/a	n/a	18.24	48,960.49
	East Facade (Left Elevation)	7,077.16	3,220.42	6.00	n/a	0.46	n/a	3.80	n/a	n/a	10.38	73,425.58
	West Facade (Right Elevation)	7,077.16	3,220.42	6.00	n/a	0.46	n/a	3.80	n/a	n/a	10.38	73,425.58
	TOTAL WINDOW OTTV					**6 x WWR x Uf**					53.35	**286,765.40**
SOLAR HEAT GAIN THROUGH WINDOWS			2,535.40	194.00	n/a	0.40	n/a	n/a	0.92	0.32	22.56	
	South Facade (Front Elevation)	6,332.38	73.06	194.00	n/a	0.01	n/a	n/a	0.92	0.27	0.55	247,373.22
			1,380.74	194.00	n/a	0.22	n/a	n/a	0.92	0.41	15.96	
			1,679.49	194.00	n/a	0.63	n/a	n/a	0.90	0.32	34.48	
	North Façade (Rear Elevation)	2,684.55	52.88	194.00	n/a	0.02	n/a	n/a	0.90	0.27	0.92	124,745.71
			415.02	194.00	n/a	0.15	n/a	n/a	0.90	0.41	11.07	
			1,795.68	194.00	n/a	0.25	n/a	n/a	1.23	0.25	14.89	
	East Facade (Left Elevation)	7,077.16	118.57	194.00	n/a	0.02	n/a	n/a	1.23	0.41	1.64	244,795.65
			1,306.17	194.00	n/a	0.18	n/a	n/a	1.23	0.41	18.06	
			1,795.68	194.00	n/a	0.25	n/a	n/a	0.94	0.27	12.33	
	West Facade (Right Elevation)	7,077.16	118.57	194.00	n/a	0.02	n/a	n/a	0.94	0.41	1.25	193,792.54
			1,306.17	194.00	n/a	0.18	n/a	n/a	0.94	0.41	13.80	
	TOTAL SOLAR HEAT GAIN		12,577.43			**194 x WWR x CF x SC**					147.51	**810,707.12**
OVERALL BUILDING OTTV		**23,171.25**									**48.45**	**1,122,560.04**

Table 5 above analysesOTTV Calculation of MS1525 Design with the overall value of 48.45. Source: Zainonabidin (2015)

Table 6: OTTV Calculation of Platinum Design

OTTV Calculation: Platinum (Installed Spandrel Glass up to 30%)												
	ELEVATION	Façade Area (A)	Window Area	Constant	Solar Absorption Factor (α) - colour of wall *	Window to Wall Ratio (WWR)	(1 - WWR)	U-Value W/m2k (Uv)	Orientation Correction Factor (CF) - (refer to MS 1525 table 4)	Shading Coeff $SC = SC_1 \times SC_2$	Thermal Transfer Value (OTTV)	A x OTTV
HEAT CONDUCTION THROUGH WALLS	South Facade (Front Elevation)	6,332.38	2,792.44	15.00	0.25	0.44	0.37	0.65	n/a	n/a	0.90	5,694.61
				15.00	0.40		0.19	0.64	n/a	n/a	0.73	4,619.33
	North Façade (Rear Elevation)	2,684.55	1,503.17	15.00	0.25	0.56	0.20	0.65	n/a	n/a	0.49	1,304.96
				15.00	0.40		0.24	0.64	n/a	n/a	0.93	2,487.14
	East Facade (Left Elevation)	7,077.16	2,254.29	15.00	0.25	0.32	0.54	0.65	n/a	n/a	1.31	9,288.55
				15.00	0.40		0.14	0.64	n/a	n/a	0.55	3,863.85
	West Facade (Right Elevation)	7,077.16	2,254.29	15.00	0.25	0.32	0.54	0.65	n/a	n/a	1.31	9,288.55
				15.00	0.40		0.14	0.64	n/a	n/a	0.55	3,863.85
	TOTAL WALL OTTV					**15 X α X (1 - WWR) Uw**					6.21	**36,546.99**
HEAT CONDUCTION THROUGH WINDOWS	South Facade (Front Elevation)	6,332.38	2,792.44	6.00	n/a	0.44	n/a	1.30	n/a	n/a	3.44	21,781.03
	North Façade (Rear Elevation)	2,684.55	1,503.17	6.00	n/a	0.56	n/a	1.30	n/a	n/a	4.37	11,724.75
	East Facade (Left Elevation)	7,077.16	2,254.29	6.00	n/a	0.32	n/a	1.30	n/a	n/a	2.48	17,583.49
	West Facade (Right Elevation)	7,077.16	2,254.29	6.00	n/a	0.32	n/a	1.30	n/a	n/a	2.48	17,583.49
	TOTAL WINDOW OTTV					**6 x WWR x Uf**					12.78	**68,672.77**
SOLAR HEAT GAIN THROUGH WINDOWS			1,774.78	194.00	n/a	0.28	n/a	n/a	0.92	0.31	15.41	
	South Facade (Front Elevation)	6,332.38	51.14	194.00	n/a	0.01	n/a	n/a	0.92	0.26	0.37	168,937.81
			966.52	194.00	n/a	0.15	n/a	n/a	0.92	0.40	10.90	
			1,175.64	194.00	n/a	0.44	n/a	n/a	0.90	0.31	23.55	
	North Façade (Rear Elevation)	2,684.55	37.02	194.00	n/a	0.01	n/a	n/a	0.90	0.26	0.63	85,192.19
			290.51	194.00	n/a	0.11	n/a	n/a	0.90	0.40	7.56	
			1,256.98	194.00	n/a	0.18	n/a	n/a	1.23	0.24	10.17	
	East Facade (Left Elevation)	7,077.16	83.00	194.00	n/a	0.01	n/a	n/a	1.23	0.40	1.12	167,177.52
			914.32	194.00	n/a	0.13	n/a	n/a	1.23	0.40	12.33	
			1,256.98	194.00	n/a	0.18	n/a	n/a	0.94	0.26	8.42	
	West Facade (Right Elevation)	7,077.16	83.00	194.00	n/a	0.01	n/a	n/a	0.94	0.40	0.86	132,346.12
			914.32	194.00	n/a	0.13	n/a	n/a	0.94	0.40	9.42	
	TOTAL SOLAR HEAT GAIN		8,804.20			**194 x WWR x CF x SC**					100.74	**553,653.64**
OVERALL BUILDING OTTV		**23,171.25**									**28.43**	**658,873.40**

Table 6 above analysesOTTV Calculation of Platinum Design with the overall value of 28.43. Source: Zainonabidin (2015)

8.0 Conclusion

It is evident from this exercise that improving the building envelope, especially on glass specifications and Window to Wall Ratio will improve the Overall Thermal Transfer Value (OTTV) of the building. Improving OTTV means will reduce heat gain into the building and thus will help to minimize usage of air conditioning and electricity during office hour. In general, the study will supports the government's recent move for energy efficiency and GBI certified buildings, especially in Putrajaya.

9.0 References

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