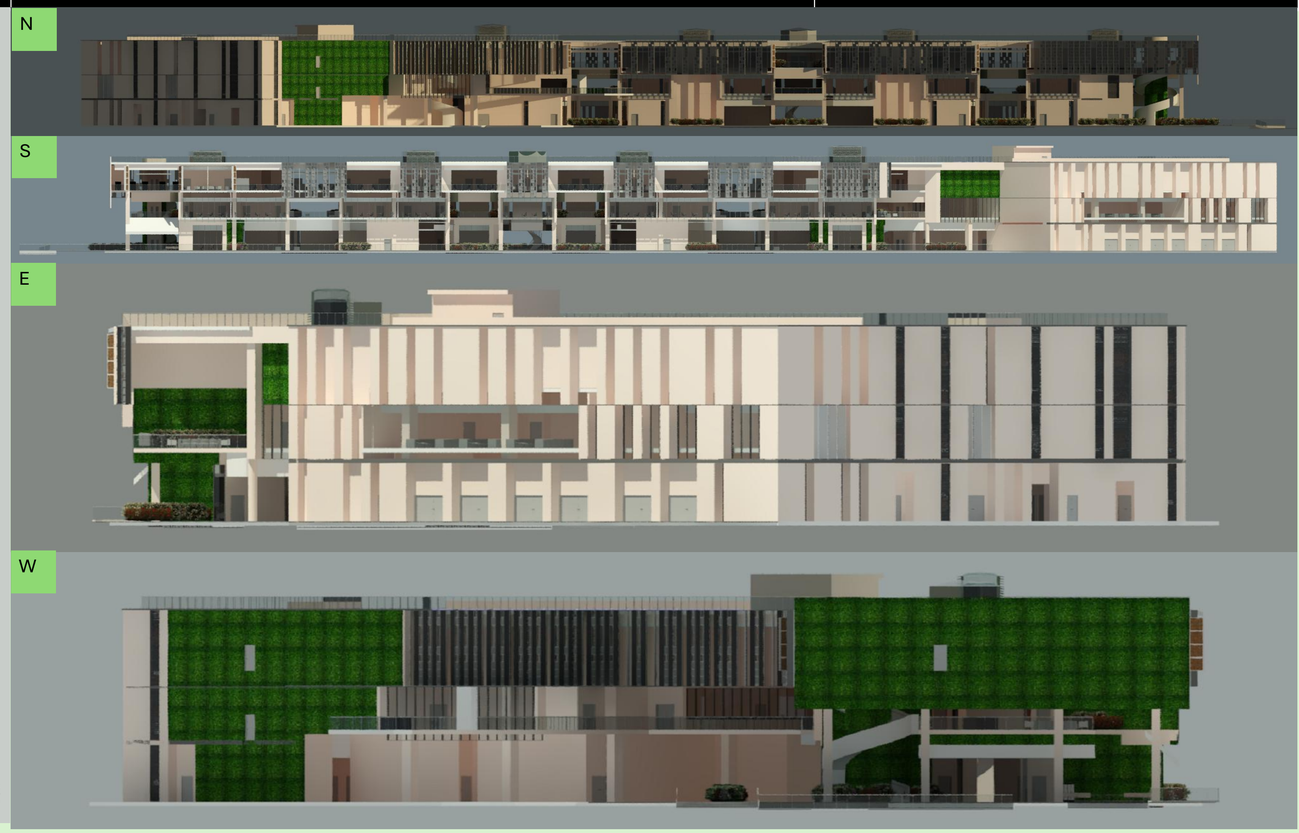
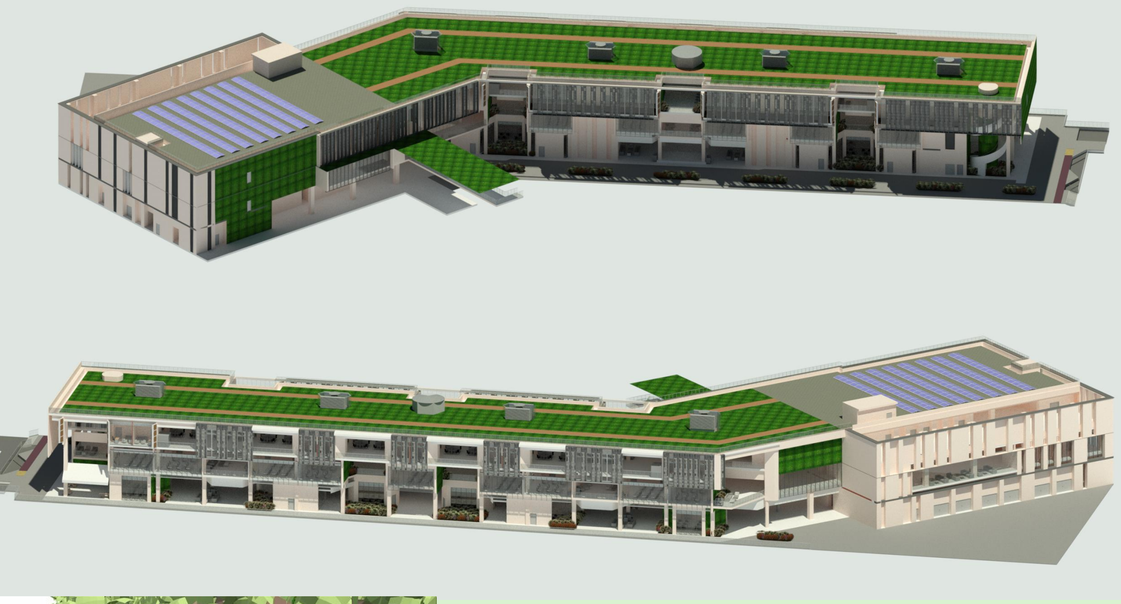
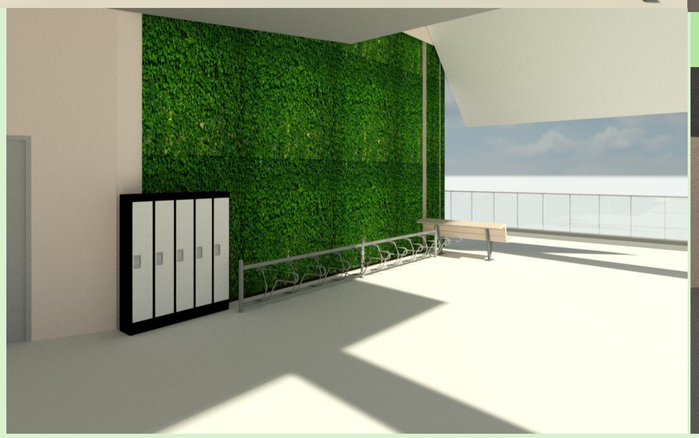


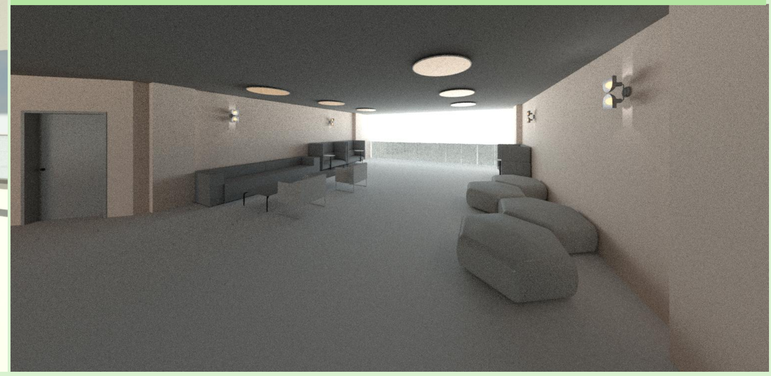


Level 1 resting area + Bicycle lot

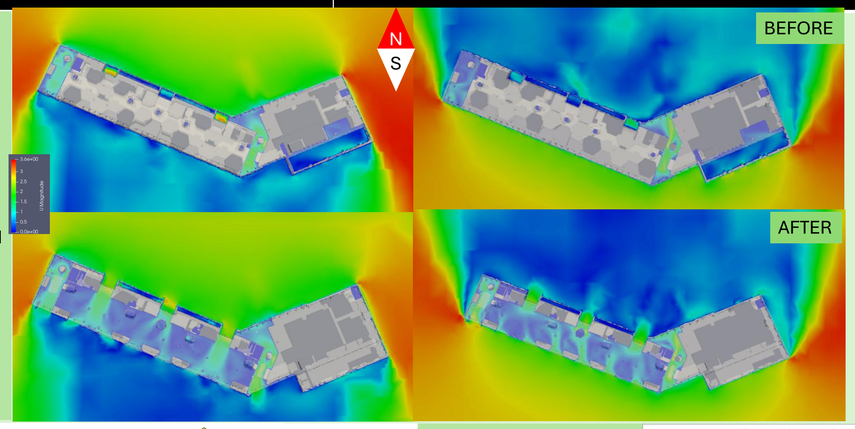


Level 2 Classroom

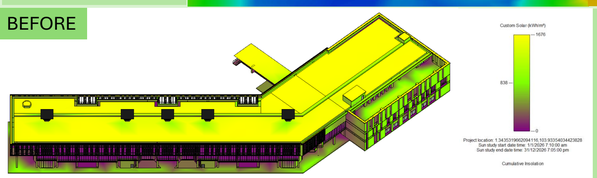
Level 2 Rest Stop area



Wind Simulations – Increased natural ventilation of the overall building by removing façade to allow for wind to flow.
Level 3 was redesigned from a fully air-conditioned floor to a naturally ventilated space, reducing reliance on mechanical cooling while improving indoor comfort.



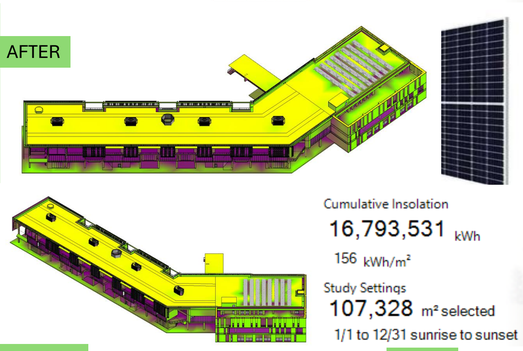
BEFORE



Cumulative Insolation
18,988,407 kWh
157 kWh/m²
Study Settings
120,712 m² selected
1/1 to 12/31 sunrise to sunset

Solar Radiation – The kWh/m2 decreased from 157kWh/m2 to 156kWh/m2 when comparing the original building to the redesigned building. The changes were not significant but the solar radiation was maintained even when the facades were removed for wind flow.

AFTER



Cumulative Insolation
16,793,531 kWh
156 kWh/m²
Study Settings
107,328 m² selected
1/1 to 12/31 sunrise to sunset

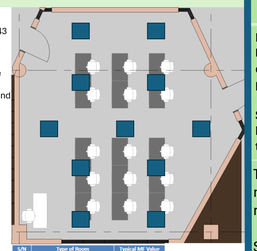
Solar Panel – From the solar radiation simulation, the roof level has high exposure of sunlight which is the most suitable spot to put 410W monocrystalline half-cell solar panels to generate energy and offset the total energy used in the building. Singapore experiences around 4.38h/day of peak sun hours. There is space on the roof to put 120 solar panels. The total energy produces by the solar panels will be 215.5kWh/day and will be 78,656.04kWh/year.

Lighting Power Budget

Level 1 - Classroom

(Philips lighting) GreenPerform Panel RC099V G3 - 911401533343

From SS-531 Code Lux for classroom is 500\lux
Area of classroom is 85.3square metre.
Lighting fixture is 5600 lumens and 43watt.
Utilization factor (UF) is 0.9
Maintenance factor (MF) is 0.8
Number of lamps in each luminaire is 1
Total fitting is 11



https://www.lighting.philips.com.sg/p/indoor-luminaires/recessed/greenperform-panel-rc099v-g3/LP_CF_RC099V_EU/family/page/1/filter=FG_LP_APP_AREA%3AFK_LP_APP_AREA_OFF

Order Code	Full Product Name	Correlated Color Temperature (Nom)	Color rendering index (CRI)	Luminous Efficacy (rated) (Nom)	Luminous Flux
911401533343	RC099X G3 LED56/840 LW W60L120	4000 K	80	130 lm/W	5,600 lm

Order Code	Full Product Name	Protection class IEC	Power Consumption
	RC099X G3 LED56/840 LW W60L120	Safety class II	43 W

S/N	Type of Room	Typical MF Value
1	Enclosed or Air-Conditioned Room / Room which is clean	0.8
2	Average Condition Room	0.7
3	Open Room / Dirty Room	0.6

Type of interior, task or activity	E_m lux	UGR$_L$	R_a
Classroom for evening classes and adults education	500	19	80

A	B	C	D	E	F	G	H	I	J	K	L	N	R	S	T	U	V
Data Calculation						Luminaire Use			Lamp Data			Power	Lux Level		Proposed/Required		
Floor Level	Area Serve	Area Calculated (SQ M)	Total Fitting Calculated	Actual Fitting Needed	Model Of Fitting	Luminaire Use Lighting Wattage (Watt)	Lumen (lm)	Mode Of Lamp	Lamp Consumption (Watt)	Power Design Power Budget (Watt/M²)	Recommended Lux (SS530)	UF	MF		
		A	B							P = n/a					
LEVEL 1	Classroom	85.3	10.58	11	(Philips lighting) GreenPerform Panel RC099V G3 - 911401533343	43	5600	LED	11x	43.0	5.5	500	0.9	0.8	

Level 2 - Classroom

(Panasonic lighting) Standard Baselight (Pro)

From SS-531 Code Lux for classroom is 500\lux
Area of classroom is 84.54 square metre.
Lighting fixture is 3900 lumens and 36watt.
Utilization factor (UF) is 0.9
Maintenance factor (MF) is 0.8
Number of lamps in each luminaire is 1
Total fitting is 16

https://panasonic.net/electricworks/lighting/en_sg/products/plist.php?lay3=all,300052

Panasonic

Ref. No.	
Type of Luminaire	Baselight
	Standard Baselight (Pro)
	Ex 2G
Set Model No.	NNFC70620LE88

Type of Light Source	LED
Power Input	36W
System Lumen Output	3900 lm
System Efficacy	108 lm/W
Power Voltage	220-240V
Power Factor	0.9
Lifetime	50000H(L70)
CCT	3000K
CRI	80
SDCM	<5

Certificates & Standards
CE / RoHs / CISPR15 / TEC / CB

Type of interior, task or activity	E_m lux	UGR$_L$	R_a
Classroom for evening classes and adults education	500	19	80

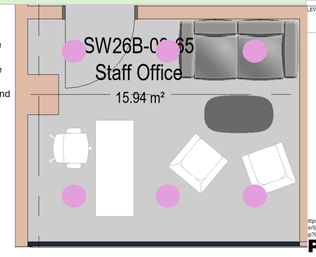
S/N	Type of Room	Typical MF Value
1	Enclosed or Air-Conditioned Room / Room which is clean	0.8
2	Average Condition Room	0.7
3	Open Room / Dirty Room	0.6

A	B	C	D	E	F	G	H	I	J	K	L	N	R	S	T	U	V
Data Calculation						Luminaire Use			Lamp Data			Power	Lux Level		Proposed/Required		
Floor Level	Area Serve	Area Calculated (SQ M)	Total Fitting Calculated	Actual Fitting Needed	Model Of Fitting	Luminaire Use Lighting Wattage (Watt)	Lumen (lm)	Mode Of Lamp	Lamp Consumption (Watt)	Power Design Power Budget (Watt/M²)	Recommended Lux (SS530)	UF	MF		
LEVEL 2	Classroom	84.5	15.05	16	(Panasonic lighting) Baselight (Pro)	36	3900	LED	11x	36.0	6.8	500	0.9	0.8	

Level 3 - Office

(Philips) TrueCircle Recessed - 912401483433

From SS-531 Code Lux for Office Room is 500\lux
Area of classroom is 15.9 square metre.
Lighting fixture is 2000 lumens and 19.5 watt.
Utilization factor (UF) is 0.9
Maintenance factor (MF) is 0.8
Number of lamps in each luminaire is 1
Total fitting is 6



Versions

TrueCircle Recessed RC250B PSP WH D380_SPP

https://www.lighting.philips.com/p/indoor-luminaires/recessed/truecircle-recessed/LP_CF_RC250B_EU/family

Order Code	Full Product Name	Correlated Color Temperature (Nom)	Luminous Efficacy (rated) (Nom)	Luminous Flux	Optic type
912401483433	RC250B 20S/830 PSU PSP D380 WH	3000 K	102 lm/W	2,000 lm	Wide Beam

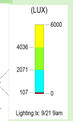
Order Code	Full Product Name	Power Consumption
912401483433	RC250B 20S/830 PSU PSP D380 WH	19.5 W

Type of interior, task or activity	E_m lux	UGR$_L$	R_a
Conference and meeting rooms	500	19	80

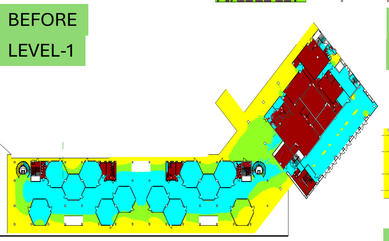
S/N	Type of Room	Typical MF Value
1	Enclosed or Air-Conditioned Room / Room which is clean	0.8
2	Average Condition Room	0.7
3	Open Room / Dirty Room	0.6

A	B	C	D	E	F	G	H	I	J	K	L	N	R	S	T	U	V
Data Calculation						Luminaire Use			Lamp Data			Power	Lux Level		Proposed/Required		
Floor Level	Area Serve	Area Calculated (SQ M)	Total Fitting Calculated	Actual Fitting Needed	Model Of Fitting	Luminaire Use Lighting Wattage (Watt)	Lumen	Mode Of Lamp	Lamp Consumption (Watt)	Power Design Power Budget (Watt/M²)	Recommended Lux (SS530)	UF	MF		
LEVEL 3	Office Room	15.9	5.52	6	(Philips lighting) TrueCircle Recessed - 912404483433	19.5	2000	LED	1x	19.5	7.4	500	0.9	0.8	

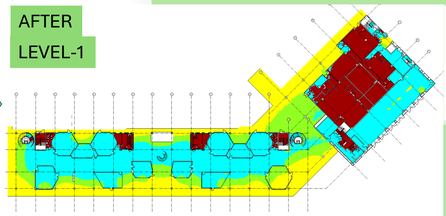
Carbon Calculations



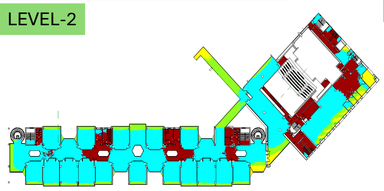
BEFORE
LEVEL-1



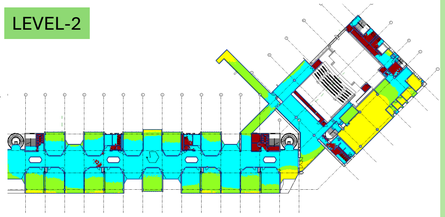
AFTER
LEVEL-1



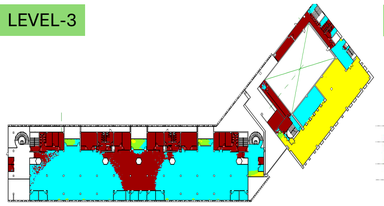
LEVEL-2



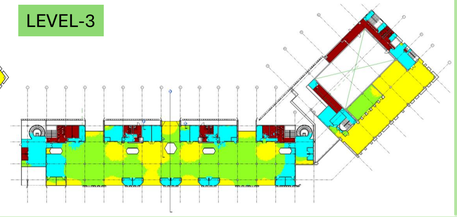
LEVEL-2



LEVEL-3



LEVEL-3



Daylighting Analysis – The increased size of the light shaft allow more daylight to enter the lowly lit areas near the center of the building such as level 2 and level 3. Additionally, removing certain facades of the building allow more light to enter the building and increase natural ventilation. There is no possible solution to increase daylighting in the building near the right side as it is an auditorium but I was able to change some walls into glass curtain wall for daylight to enter at level 2.

Sustainable Materials

Bicycle parking lot is located on the Level 1 west side of Block 26B. The area is equipped with bicycle racks, lockers for occupants to store bicycle-related items, and benches that allow users to rest, change footwear, or organize their belongings before and after cycling. There is also a slanted shading device to provide shading to the parked bicycle and occupants.

Sustainable materials such as recycled steel with a powder-coated finish can be use to make the bicycle rack as it has high structural strength and durability. The material is sustainable as recycled steel reduces embodied carbon to normal steel and can be sourced from demolished buildings further extending its lifespan.

The classrooms are located on Levels 1 and 2 and are designed with large windows to allow ample natural daylight to enter. This enhances visual comfort and supports students' natural circadian rhythms, contributing to improved well-being, focus, and learning performance.

Sustainable materials such as using Low-VOC paint can lead to better indoor air quality by reducing harmful chemical emissions and it is sustainable as it is a water based paint and requiring less energy to produce and apply.

Sustainable materials such as MET (Mass Engineered Timber) can be use for the façade of the building as the material is renewable and can be regrown from trees. It can also have a long lifespan when the MET is properly detailed. Another sustainable material that can be used is double or triple glazed glass being use for the windows or curtainwalls of the building as the glass can reduce heat transfer which can lead to lower cooling loads of the building and saving energy and the glass can be taken from deconstructed building and making it more sustainable.

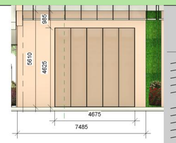
Rest stop area is located at level 2, The rest stop area provides a space for students to rest or socialize with their friends during their break. This area also allows for natural ventilation.

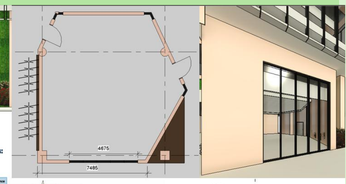
Sustainable materials such as bamboo frame can be used for the couches and tables as bamboo can grow extremely fast and absorbs carbon during growth.

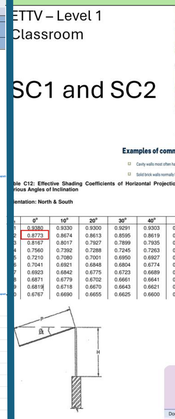
ETTV Calculations

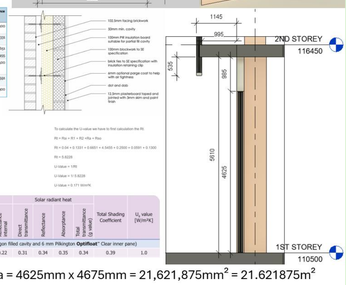
ETTV – Level 1 Classroom

SC1 and SC2









= 0.995m
= 4.625m
1 = P/H = 0.995/4.625 = 0.2151351351
C for shading device is 0.8773

Window Area = 4625mm x 4675mm = 21,621,875mm² = 21.621875m²
Wall Area = 5610mm x 7485mm = 41,990,850mm² = 41.990850m²
WWR = 21.621875m²/41.990850m² = 0.51491872634 = 51.491872634%

ETTV – Level 1 Classroom calculation

ETTV Calculation (Level 1 Classroom) — AFTER

	Façade	North	East	South	West
1	**Uw**				
	Uw1 (Wall)	0.0000	0.0000	0.1710	0.0000
	Uw2 (Door)	0.0000	0.0000	0.0000	0.0000
2	**Uf**				
	Uf1 (Glass)	0.0000	0.0000	1.0000	0.0000
3	**SC**				
	SC1	0.0000	0.0000	0.3900	0.0000
	SC2	0.0000	0.0000	0.8773	0.0000
	SCf1(Glass)	0.0000	0.0000	0.3421	0.0000
4	**CF (From Table C1)**	0.8	1.13	0.83	1.23
5	**Areas of Air-Conditioned Wall/Façade**				
	Window area (A/C), Af1	0	0	21.621875	0
	W1 (A/C), Aw1 (Opaque Wall)	0	0	20.368975	0
	W2 (A/C), Aw2 (Door)	0	0	0	0
	Wall/Facade area (A/C), Ao	0	0	41.99085	0
6	**ETTV=12(Aw1xUw1+Aw2xUw2)/Aw+3.4(Af1xUf1+Af2xUf2)Ao+211(Af1xSCf1+Af2xSCf2)(CF)/Ao**				
	ETTV for each wall/façade	0.00	0.00	33.60	0.00
7	**Overall ETTV=(Ao1xETTVo1+Ao2xETTVo2+Ao3xETTVo3+Ao4xETTVo4)/(Ao1+Ao2+Ao3+Ao4)**				33.60

Building Type	Maximum ETTV (EE Pathway 2)		
	Gold^{PLUS} EE >50%	Platinum EE ≥55%	SLE EE ≥60%
Institute of Higher Learning	40 W/m²	38 W/m²	38 W/m²

ETTV of 33.60W/m² is considered Super low energy.