



DISPARITY IN LPD BY OPTIMIZATION OF DAYLIGHT & ARTIFICIAL LIGHT IN EAST & WEST CLIMATE ZONE OF INDIA

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ABSTRACT

Concerns about global warming are increasing, hence, the urgency to cut carbon emissions. Reducing energy consumption, including lighting energy, is seen as the primary solution. Yet, solving the environmental factor should not come at the cost of other pillars of sustainable development. Rather, maximizing the total value of the building should be the focus. Maximizing value in the context of lighting entails improving the quality of the lighting. This study has investigated how daylighting and artificial light simulation could help in achieving better lighting quality. In this paper the effect on the annual artificial lighting demand is investigated by employing detailed simulations of lighting conditions in office rooms lit by daylight and artificial. The detailed simulations includes studies of the resolution of Hot & Dry and warm & humid weather data sets in climate-based daylight modeling. Finally, explore the impact of longitude line angle on Lux level and also comparatively study of daylight Lux level availability within the building in different time slot in Hot & Dry and warm & humid climate zone of India and compare with required Lux level according to NBC norms for particular space. Also compare and optimize artificial light Lux level to available daylight Lux inside the building. By this study conclude that luminance requirement in a particular space type. The intent of this study is to justify whether the space wise LPD is the right approach to achieve proper energy efficiency and work plane sustainability and define the luminance requirement per sq. ft.

INTRODUCTION

Now a days the challenge or task for engineers and architecture to reduce the energy consumption of commercial building without compromising the building feature, envelop [1]. By the developing country like USA, CHINA and UK, start many study to reduce the energy consumption in building, and many technology are adopt to improve building efficiency and lightning [2,3]. By the present day technology, and

proper energy utilization, building energy efficient can be optimized. By the study of building in different climate zone conclude that to adopt the optimization of daylight and artificial light system by according to each than climate zone than we can save the energy [4,5]. To change building equipment and construction strategy can achieve the energy efficiency also reduce the peak load demand and adopt the peak load saving [6]. If construct the sustainable building than more than 30%



energy can be saved. To move toward sustainable in commercial building optimize the building envelop, HVAC, and lightning [7, 8]. Proper applying day lightning system, and artificial lightning integration system 35% of lightning load can be reduced and 13% of overall energy consumption are reduced. The electrical energy used to power lights can easily be reduced by eliminating unwanted electrical fixtures [9, 10]. Simple modifications of lighting systems can greatly reduce the energy used while still providing quality and illumination needed for various purposes [11, 12]. The simulation tools for the building that are used early that reduced the energy demand of new constructed building. [13].

METHODOLOGY

It is a experimental based case study of office building having surface area 350sq. ft. this study focus the optimization of artificial light and daylight by the simulation on Dilux Evo 8.2 and eQUEST software and reducing the LPD (lightning power density). According to experimental procedure firstly calculate the daylight availability inside the building on work plane height at

working office time between 10:00Am to 5:00Pm in Hot & Dry and Warm & Humid climate zone. Compare the available lux with the NBC lux level benchmark for particular space type. Now two condition are occur for annually lightning consumption

1. If the available daylight lux below the NBC (350 lux) benchmark lux than need artificial light than adopt artificial light and calculate annually energy consumption for both climate zone with or without lightning sensor.
2. In this condition select artificial lighting fixture having lower wattage and similar luminance level and then calculate annually energy consumption for both climate zone with or without lightning sensor.

SIMULATION/ EXPERIMENTAL WORK

This project Ayukta imagineers & construction office building, located in Gujarat, India. This is an single floor office room having 350sq. ft. area with attached washroom. The original figure are shown.

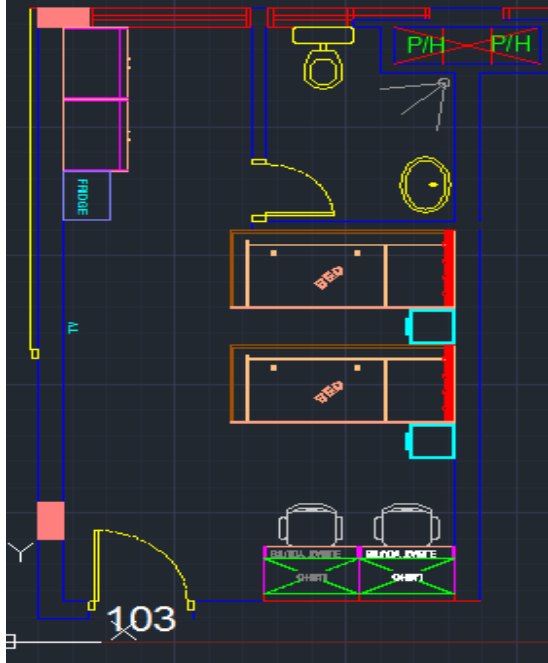


Figure 1: Auto-Cad Drawing of the project

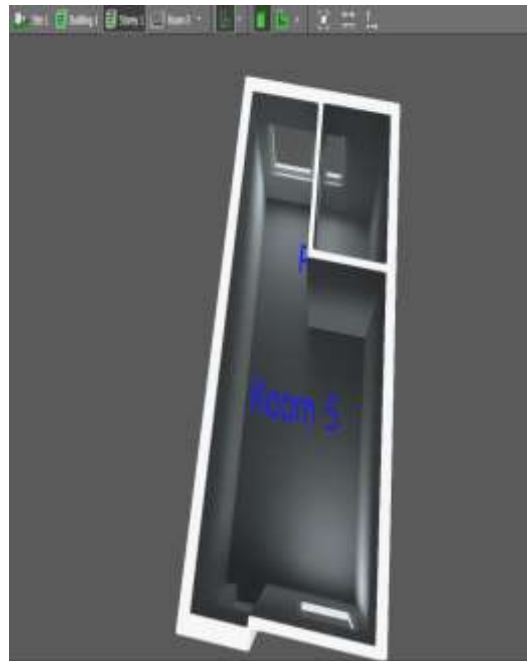


Figure 2: Dilux evo daylight simulation top view

DAYLIGHT ANALYSIS OF A BUILDING IN GUJARAT

Daylight simulation input will be taken from ECBC 2017 (Energy Conservation Building Code).

According to methodology, initially calculate available daylight Lux level inside the office room between office hour 10:00AM to 5:00pm. for this simulation hot and dry climate zone the Longitude is 71.19 degree and altitude is 22.26 degree. Put these value and import the



DiLux evo file and calculate Lux level. The result are shown in given table.

Table 1: Available Daylight Lux level in different time slot

SR. NO	TIME	LUX LEVEL GUJARAT
1	10 AM	483
2	11 AM	539
3	12 PM	564
4	01 PM	557
5	02 PM	518
6	03 PM	451
7	04 PM	358
8	05 PM	248

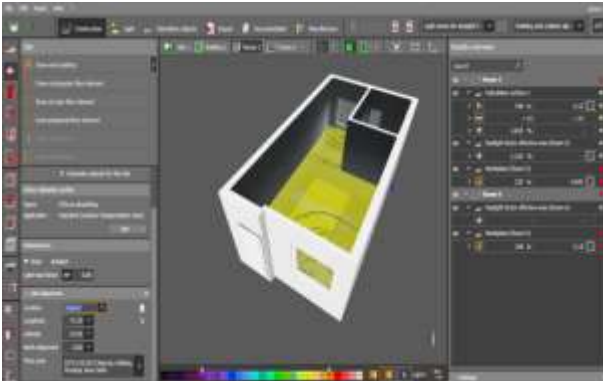


Figure 3: Putting the value of Altitude and Longitude



Figure 4: Available daylight Lux level at 03:00 Pm



Figure 5: Available daylight Lux level at 04:00 PM



Figure 6: Available daylight Lux level at 05:00 PM

DAYLIGHT ANALYSIS OF A BUILDING IN ARUNACHAL PRADESH

According to Methodology, Initially calculate available daylight Lux level inside the office room between office hour 10:00AM to 5:00 PM. for this

simulation, Warm and Humid climate zone the longitude is 97.73 degree and altitude is 28.22 degree. Put these value and import the diLux evo file and calculate Lux level. The result are shown in given table.



SR. NO	TIME	LUX LEVEL ARUNCHAL PRADESH
1	10 AM	556
2	11 AM	562
3	12 PM	538
4	01 PM	485
5	02 PM	407
6	03 PM	308
7	04 PM	197
8	05 PM	79.1

Table 2: Available Daylight Lux level in different time slot

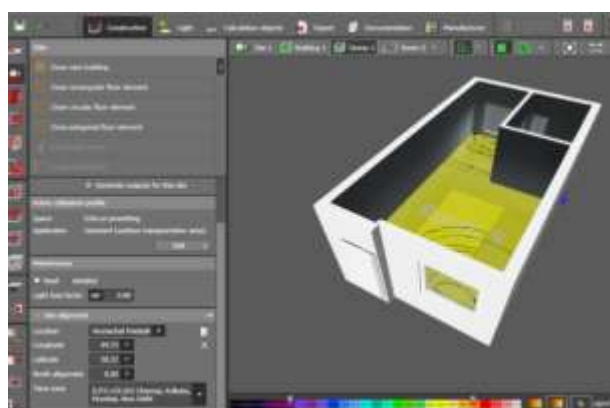


Figure 7: Putting the value of Altitude and Longitude

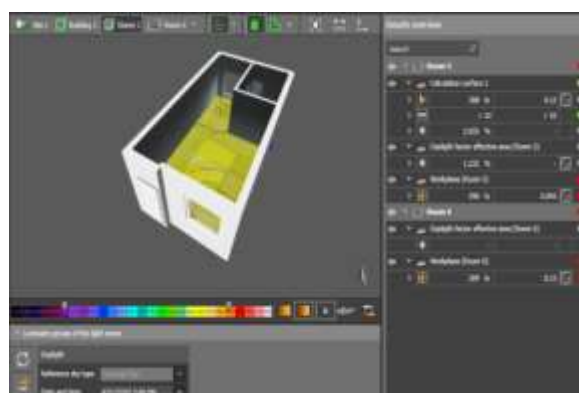


Figure 8: Available daylight Lux level at 03:00 Pm

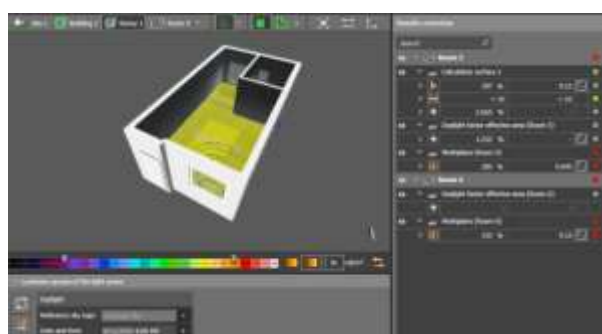


Figure 9: Available daylight Lux level at 03:00 Pm

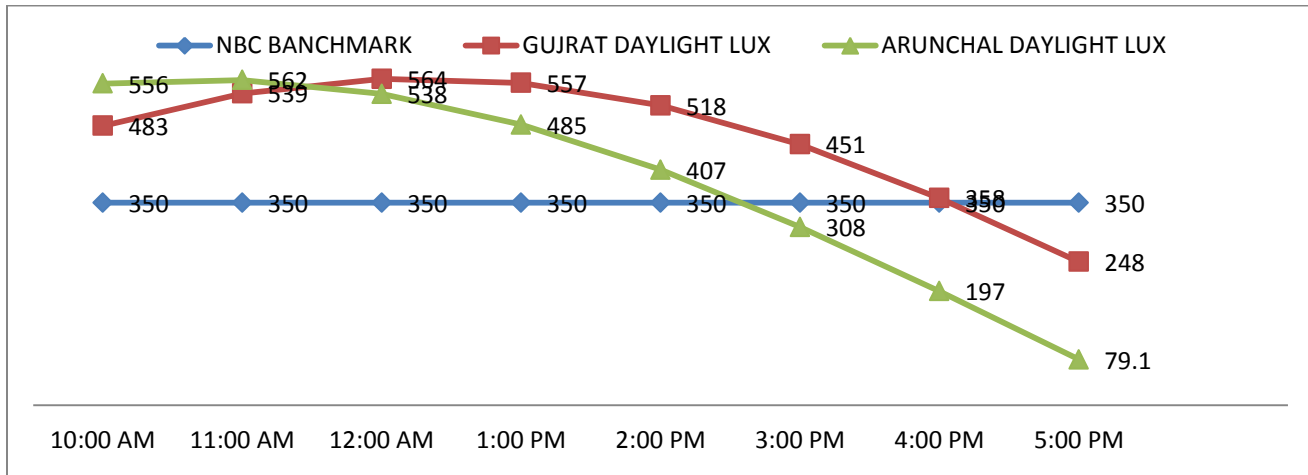


Figure 10: Available daylight Lux level at 03:00 Pm

NEED ARTIFICIAL LIGHT

According to NBC (National Building Code) in a small office building minimum Lux level are required at work lane height should be 350 Lux. So Compare

with available Lux level to NBC benchmark, if the available Lux inside the office building below the 350 Lux than required artificial light. By the simulation result two condition are occur.



Comparison graph available lux to the NBC benchmark (350 LUX)

1. If the office building are allocated in Hot & Dry climate zone than artificial light required between 4:30 Pm
2. If the office are allocated warm & humid climate zone than artificial light required between 3:00m to 5:00Pm

So by these result conclude that in annually energy consumption a measure difference are occur. To calculate the energy consumption use eQUEST software.

ENERGY CALCULATION

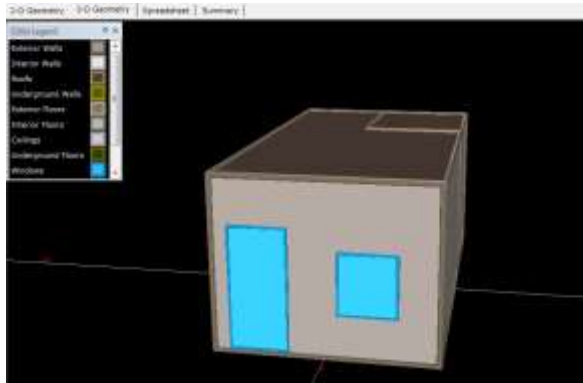


Figure 11: eQUEST simulation modal climate zone

To evaluate optimized energy performance of the Building a computer simulation model is used to assess and identify the most cost effective energy



Figure 12: Import weather file Hot and Dry

measures. The energy performance has to be quantified and compared to a Base-case Building that complies with ECBC (Energy Conservation Building Code) and ASHRAE Standard 90.1-2010.



Figure 13: Import weather file Warm & Humid climate zone



Figure 14: Input Proposed wall U value

BUILDING ENVELOPE SUMMARY

The project building envelope has a “single glazed glass assembly”. The U-values of building envelope assemblies are less efficient compared to the baseline

requirements. This has a sort of impact on the building’s energy efficiency.

Envelope Parameter's	Base Case, Hot & Dry climate	Base Case, Warm & Humid climate
Roof Assembly	Proposed Construction consists in order from exterior to interior as high SRI tiles 10mm, concrete screed 25mm, Brickbat Coba75 mm, Cement plaster 20mm, RCC Slab 200mm, Rubber Insulation 19mm, with a U-factor of 0.33 (W/m2 .K)	R-15 insulation entirely above deck with a U-factor of 0.33 (W/m2 .K)
Wall Assembly	Proposed Construction Consists of in order from exterior to interior as Stone Cladding 45mm,Plaster of 20mm"Air Gap , brick wall 230 mm and a plaster of 20mm with a U-factor of 0.40 (W/m2 .K)	Proposed Construction Consists of in order from exterior to interior as Stone Cladding 45mm,Plaster of 20mm"Air Gap , brick wall 230 mm and a plaster of 20mm with a U-factor of 0.40 (W/m2 .K).
Glass Construction (SHGC)	“Single Glazed glass with a VLT of 0.27	Single Glazed glass with a VLT of 0.27
Window Wall Ratio (WWR)	5%	5%



Figure 15: Proposed Roof U value



Figure 16: Proposed Glass Input value

LIGHTNING LOAD SUMMARY

The project lighting is designed with the “Building Area” method of lighting. The high efficiency interior LED lighting specified has a significant impact on the overall energy savings of the project. Baseline Lighting Power Density (LPD) is taken Per ECBC Standards. The “lighting power

density” for baseline case is being taken as 0.95 W/ft². The building is installed with occupancy sensor and daylight sensor as per the mandatory requirements of ECBC and ASHRAE 90.1 2010 Section 8.4. Savings for occupancy sensor is claimed by running zones with OS on a different schedule.

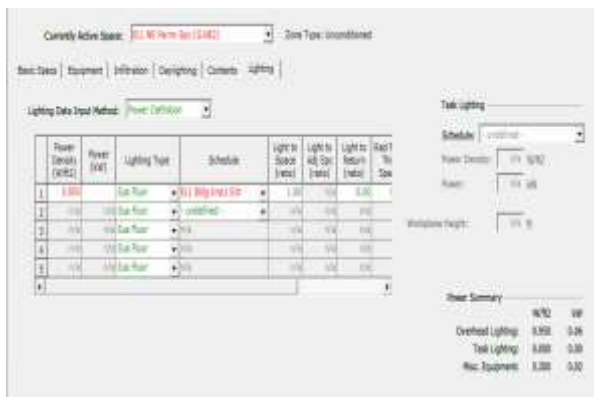


Figure 17: Input LPD value

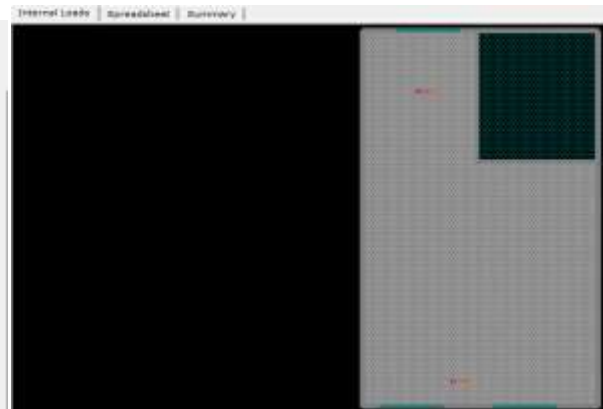


Figure 18: eQUEST modal with lightning sensor



Energy Consumption without lightning sensor in Hot & Dry climate zone (Gujarat)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0	0	0	0	0	0	0	0	0	0
Heat Reject.	0	0	0	0	0	0	0	0	0	0	0	0	0
Refrigeration	0	0	0	0	0	0	0	0	0	0	0	0	0
Space Heat	0	0	0	0	0	0	0	0	0	0	0	0	0
HP Supp.	0	0	0	0	0	0	0	0	0	0	0	0	0
Hot Water	0	0	0	0	0	0	0	0	0	0	0	0	0
Vent. Fans	0	0	0	0	0	0	0	0	0	0	0	0	0
Pumps & Aux.	0	0	0	0	0	0	0	0	0	0	0	0	0
Ext. Usage	0	0	0	0	0	0	0	0	0	0	0	0	0
Misc. Equip.	27.4	24.9	27.7	28.3	27.7	27.3	28.5	27.7	27.3	28.5	24.4	28.5	328.1
Task Lights	0	0	0	0	0	0	0	0	0	0	0	0	0
Area Lights	70.1	62.8	70.8	74.3	71.2	70.5	73.8	69.9	70.5	74.2	60.8	73.8	842.7
Total	101	91.5	101.5	105	101.5	100.7	105.3	101.5	100.7	105.3	88.2	105.3	1,170.80

Condition-2

Selection of artificial light:

Selection of Artificial light: As per methodology select artificial light that have low wattage and high luminance level. For the simulation import catalog chart of Philips in Dilux evo software. Select 36wattage fixture.

Energy Consumption without lightning sensor in Warm & Humid Climate Zone (Arunachal Pradesh)													
Misc. Equip.	27.4	24.9	27.7	28.3	27.7	27.3	28.5	27.7	27.3	28.5	24.4	28.5	328.1
Task Lights	0	0	0	0	0	0	0	0	0	0	0	0	0
Area Lights	73.5	66.6	73.8	76.7	73.8	73.4	76.8	73.8	73.4	76.8	63.8	76.8	879.5
Total	101	91.5	101.5	105	101.5	100.7	105.3	101.5	100.7	105.3	88.2	105.3	1,207.60
Energy Consumption with lightning sensor in Hot & Dry climate zone (Gujarat)													
Misc. Equip.	27.4	24.9	27.72	28.33	27.69	27.29	28.46	27.69	27.29	28.46	24.4	28.46	328.07
Task Lights	0	0	0	0	0	0	0	0	0	0	0	0	0
Area Lights	34	29.7	33.04	32.61	30.45	30.08	32.81	31.85	32.14	34.73	29	35.71	386.05
Total	61.4	54.6	60.76	60.94	58.14	57.36	61.26	59.54	59.43	63.19	53.3	64.17	714.11
Energy Consumption with lightning sensor in Warm & Humid Climate Zone (Arunachal Pradesh)													
Misc. Equip.	27.4	24.9	27.72	28.33	27.69	27.29	28.46	27.69	27.29	28.46	24.4	28.46	328.07
Task Lights	0	0	0	0	0	0	0	0	0	0	0	0	0
Area Lights	44.3	38	40.49	40.55	37.92	37.58	39.79	39.04	39.54	43.59	38.2	46.74	485.64
Total	71.7	62.9	68.2	68.88	65.61	64.87	68.25	66.73	66.83	72.05	62.6	75.2	813.7

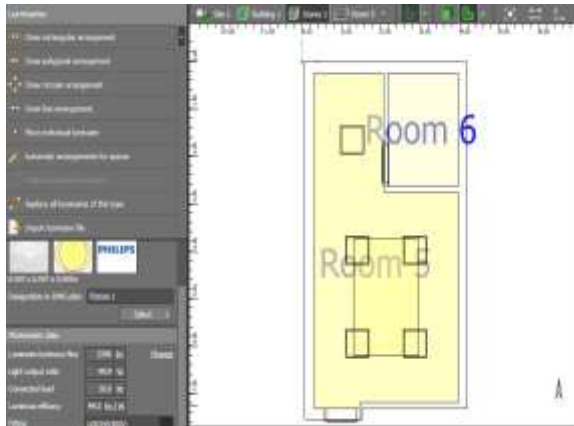


Figure 19: Adopt 36 watt fixture



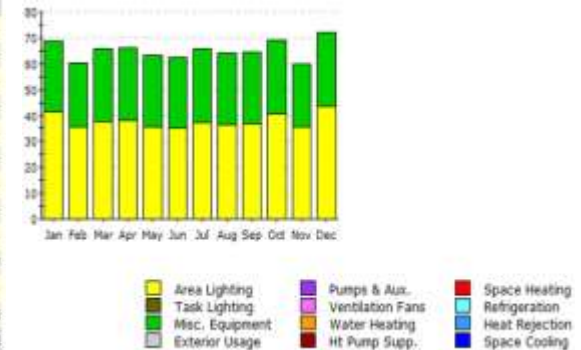
figure 20: after simulation available Lux

After Simulation achieved 439 Lux in all time of the day that lux level fulfill the NBC benchmark lux level for the office building. By these lightning load calculate LPD value. And get 0.83 watt/ft sq. Now put

this LPD value into eQUEST as an lighting input. And then calculate annually energy demand in both climate zone. This process are repeat by selecting different lightning fixture

Electric Consumption (kWh)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	27.40	24.90	27.72	28.33	27.69	27.29	28.46	27.69	27.29	28.46	24.39	28.46	328.07
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	41.31	35.49	37.90	38.01	35.58	35.27	37.33	36.59	37.04	40.76	35.66	43.61	454.58
Total	68.71	60.39	65.62	66.34	63.27	62.55	65.79	64.28	64.33	69.22	60.05	72.07	782.63



Energy Consumption (KWh) in warm & Humid climate zone with daylighting sensor (applied artificial light of 36 watt each)

Misc. Equip.	27.4	24.9	27.72	28.33	27.69	27.29	28.46	27.69	27.29	28.46	24.39	28.46	328.07
Task Lights	0	0	0	0	0	0	0	0	0	0	0	0	0
Area Lights	41.31	35.49	37.9	38.01	35.58	35.27	37.33	36.59	37.04	40.76	35.66	43.61	454.56
Total	68.71	60.39	65.62	66.34	63.27	62.55	65.79	64.28	64.33	69.22	60.05	72.07	782.63

Energy Consumption (KWh) in warm & Hot & Dry zone with daylighting sensor (applied artificial light of 36 watt each)

Misc. Equip.	27.4	24.9	27.72	28.33	27.69	27.29	28.46	27.69	27.29	28.46	24.39	28.46	328.07
Task Lights	0	0	0	0	0	0	0	0	0	0	0	0	0
Area Lights	32.31	29.50	30.9	31.01	28.58	28.01	31.33	30.59	32.04	34.76	29.66	36.61	375.03
Total	59.71	54.04	58.62	59.34	56.27	55.3	59.79	58.28	59.33	63.22	54.05	65.07	703.1



RESULT & DISCUSSION

India have longitudes 68°7'E and 97°25'E. it mean from East (Gujarat) to West (Arunachal Pradesh) having 30 degree difference and sun take 4 minute to cross one degree altitude angle that's why there is a time lag of two hours. So due to this variation are occur in daylight lux level of both region. The same concept are applied in this paper.

When determine the daylight lux availability inside the building in office time for the both climate zone and compare this lux level to the NBC benchmark

for the particular space type than observe that in Ho & Dry climate zone required artificial light only 1.5 hour but in warm and humid climate required artificial light in 3 hour of a day. Due to this variation are occur in annually energy demand. If applied the lightning sensor than this variation become too large.

If we select lower wattage fixture than value of LPD are also decrease that's why annually energy demand variation become more in both climate zone.

Climate Zone	City	LPD (Lightning Power Density)	Annually Energy Demand Without Lighting Sensor	Annually Energy Demand With Lighting Sensor
Hot & Dry	Ahmadabad	0.95 watt/ft. sq.	1170.80	714.11
Warm and Humid	Arunachal Pradesh	0.95 watt/ft.sq.	1207.60	813.7
Difference in Annually energy demand in KWh.			36.8	99.53
Warm and Humid	Arunachal Pradesh	0.86 watt/ft.sq.	782.63	
Hot & Dry	Ahmadabad	0.86 watt/ft. sq.	703.01	
Difference in Annually energy demand in KWh.			79.62	

CONCLUSION

Energy Saving is the major task in every sector to move toward sustainability, Building sector is the biggest sector where energy are utilize and in this sector we can save more energy and adopt the sustainability. By this study, conclude some result

1. Before to construct the building we can analysis the whole building annually energy consumption demand in terms of lightning.
2. ECBC say's for lightning that lightning should be fulfill the criteria of LPD that is in watt/ft.sq. but by this case study it's prove that if we design proper lightning in building in any climate zone that LPD value may vary so lightning s\design should be in luminance/sq.ft. or its may be a fixed value of Lux.
3. ECBC say's that lightning sensor is mandatory requirement for lightning simulation but sensor modulate only lux level not wattage. So it's a challenge for ECBC code that lightning design should be depend only lumens per sq.ft..

4. If we design proper lighting than achieved comfort and reduced HVAC load of the building.

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