



Energy and low income tropical housing

Daylighting for Low and Medium Income House

Energy and Low Income Tropical Houses Project

Joint Graduate School of Energy and Environment
(JGSEE)

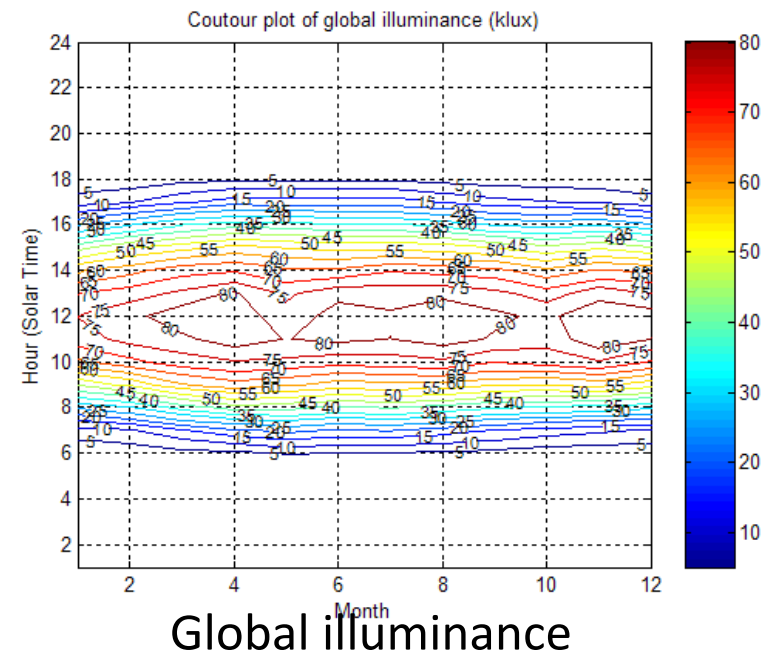
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Introduction

- In Thailand, daylight is abundant and daytime is long over the year.
- Global illuminance exceeds 40,000 lux during 8:00-16:00.
- General lighting requires 100-300 lux.
- Solar radiation is intense and the sun travel in all orientations.



Daylight measurement station





National Housing Authority



Window Configuration

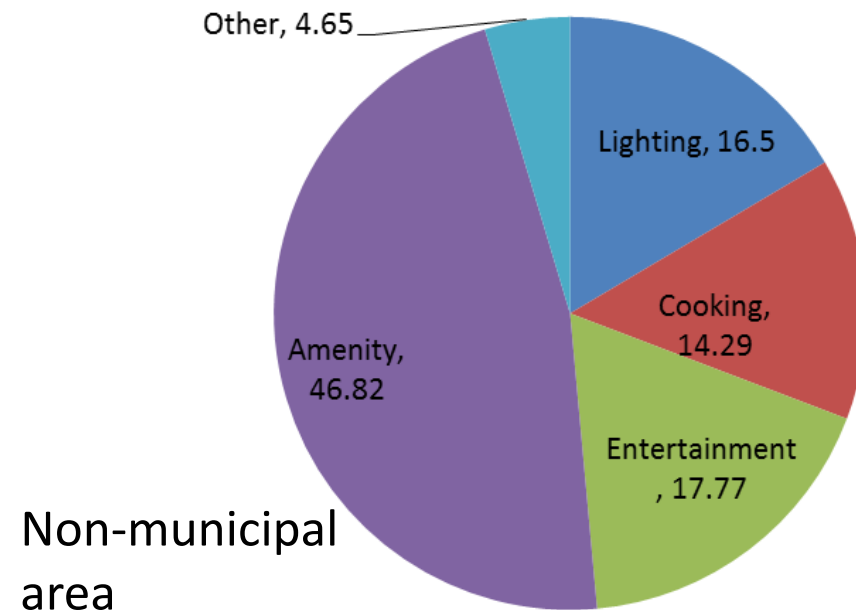
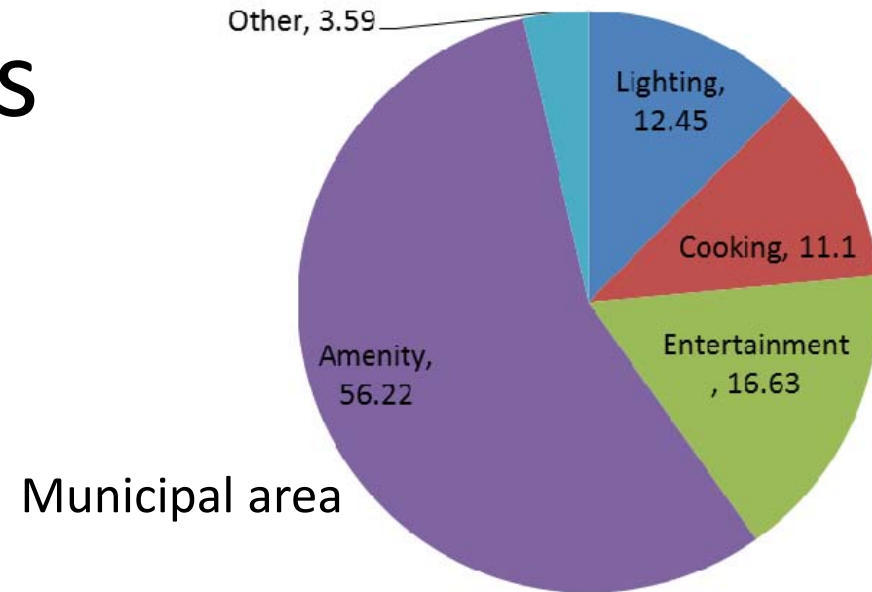
- Large windows with no external shading are used in commercial and residential buildings.
- Glazing with dark color is chosen for the windows to prevent excessive solar gain.
- Electric lamps are the sole source for interior lighting, even daylight is sufficient.
- The occupants also lose the connectedness to exterior scene.
- Dark color glazing absorbed more solar radiation, thus raising its temperature and cause thermal discomfort.



Energy use in houses

Shares of electrical energy uses in residential houses

Activity	Appliance
Lighting	Fluorescent lamp, incandescent lamp
Cooking	Rice cooker, stove, microwave, kettle
Entertainment	TV, VDO player, stereo, radio, computer
Amenity	Air-conditioner, fan, refrigerator, washing machine, iron, pump





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House survey in northern region

- Lighting energy is 9.9% of the total electricity consumption.
- Daylight in the living quarters and bedroom was measured.
- Most values are as expected but are on the slightly low side.
- Wooden walls are not painted and their color appears dull brown.
- Spaces enclosed by such walls would tend to be less illuminated.
- One occupant in house no.7 was ill and so windows were intentionally closed to reduce light. The occupant in house no.8 did not reside in the house and windows were closed.

Space	House number										Average
	1	2	3	4	5	6	7	8	9	10	
Living quarter	-	225	200	740	-	-	42	70	250	424	278
Bedroom	-	-	-	-	-	-	-	-	-	265	165



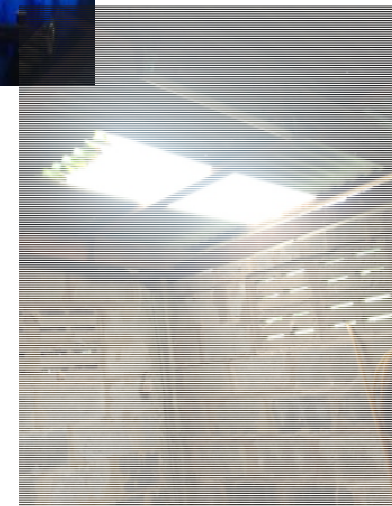


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House survey in northeastern region

House No.	Illuminances (lux)			
	Living room	Bedroom	Toilet	Kitchen
1	96	45	530	
2	80			
3	200	25	660	46
4	42		9	290
6	200			
9	110		1,235	1,224
10	80	78	3,130	
11	12		1,189	28
12	81			
Avg	100	49	1,126	397



No measurement for house No. 5, 7, 8

- The interior daylight in the surveyed houses in northeastern is lower than that of the northern.
- Curtain is used to reduce excessive daylight.
- Daylight in toilet and kitchen is high from the transmitted daylight through translucent roof.



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House survey in central region

House No.	Illuminance (lux)				
	Living	Bed 1	Bed 2	Toilet	Kitchen
1	140	48	80		
2	45			164	
3	160	6	60		420
4	90				
5	60				
6	190	70			
7	250				160
8	30				
9	70				
10	220	300		70	60
11					
12	400	40			
13	170			50	1000
14	120			60	230
15	20				
16	400				
17	170				380
18					
19	5	55			
20	51	30	170		114
21	8				55
22	40	100			
23	60			5	189
24	50	52			
Avg	35.7	59.3	170.0	5.0	119.3

- Lighting consume electrical energy of about 8% of the total consumption





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House survey in southern region

House no.	Illuminance				
	Living room	Bedroom 1	Bedroom 2	Toilet	Kitchen
1	65	60			
2	100				
3	30			147	
4	373	140	150	247	3,880
5	41	58	340	8	144
6	300	225	253	171	2,400
7	66	88	40	228	770
8	100	80	40	45	3,020
9	550	178	147		
10	59				
Avg	168	118	162	141	2,043



- Lighting energy is 7.3% of the total consumption.
- Daylight illuminance in house is insufficient due to small windows and openings.
- Daylight in toilet and kitchen is high from the transmitted daylight through translucent roof.

NHA House survey

- The interior daylight is low by closing windows for privacy of the residents.
- The open space where daylight is introduced through the windows were covered later with large roof to increase the utilization space.

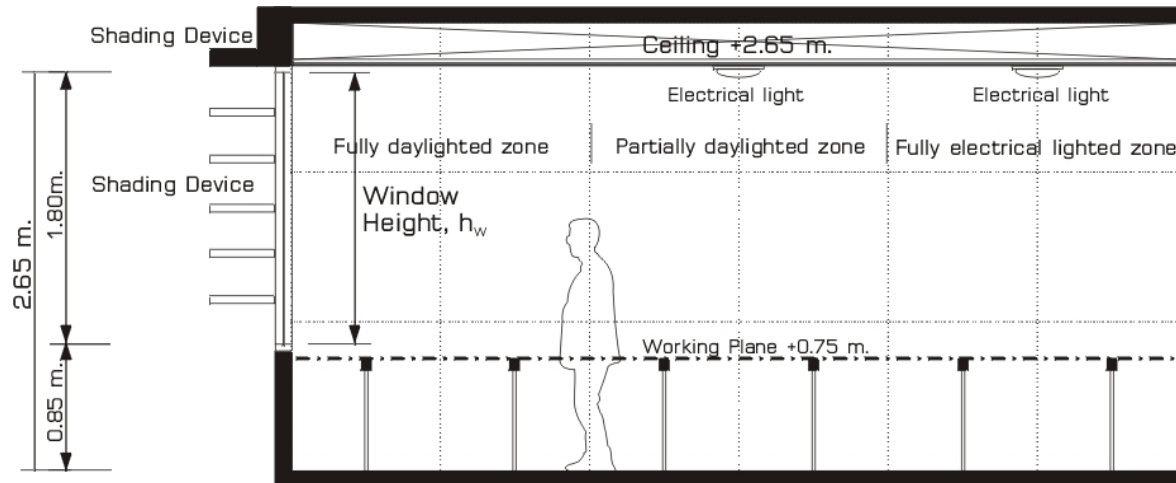
Type	Detach		Twin		Townhouse		Condo	
Lighting cons.	7 lamps 142 kWh (4%)		5 lamps 136 kWh (7%)		13 lamps 352 kWh (6%)		15 lamps 264 kWh (8%)	
	Daylight illuminance (lux)							
	Range	Average	Range	Average	Range	Average	Range	Average
Living	17-170	81	40-83	56	5-160	67	7-170	69
Bed	12-113	63	30-170	78	12-113	65	5-80	70
Toilet	2-4	3	4	4	2-4	3	18-20	19
Kitchen	6-380	147	114-200	152	6-143	75	96-140	122

Windows with Shadings

- Appropriate windows introduce daylight for interior illumination without excessive heat and glare.
- Window possesses about 30% of the total wall area is enough for the daylighting. External shading is also required to prevent the direct sunlight.
- External horizontal slats are simple device that effectively shade the direct sunlight for north and south walls.
- It allows diffuse skylight entering the buildings; offering the view to exterior scene.



Windows with Shadings

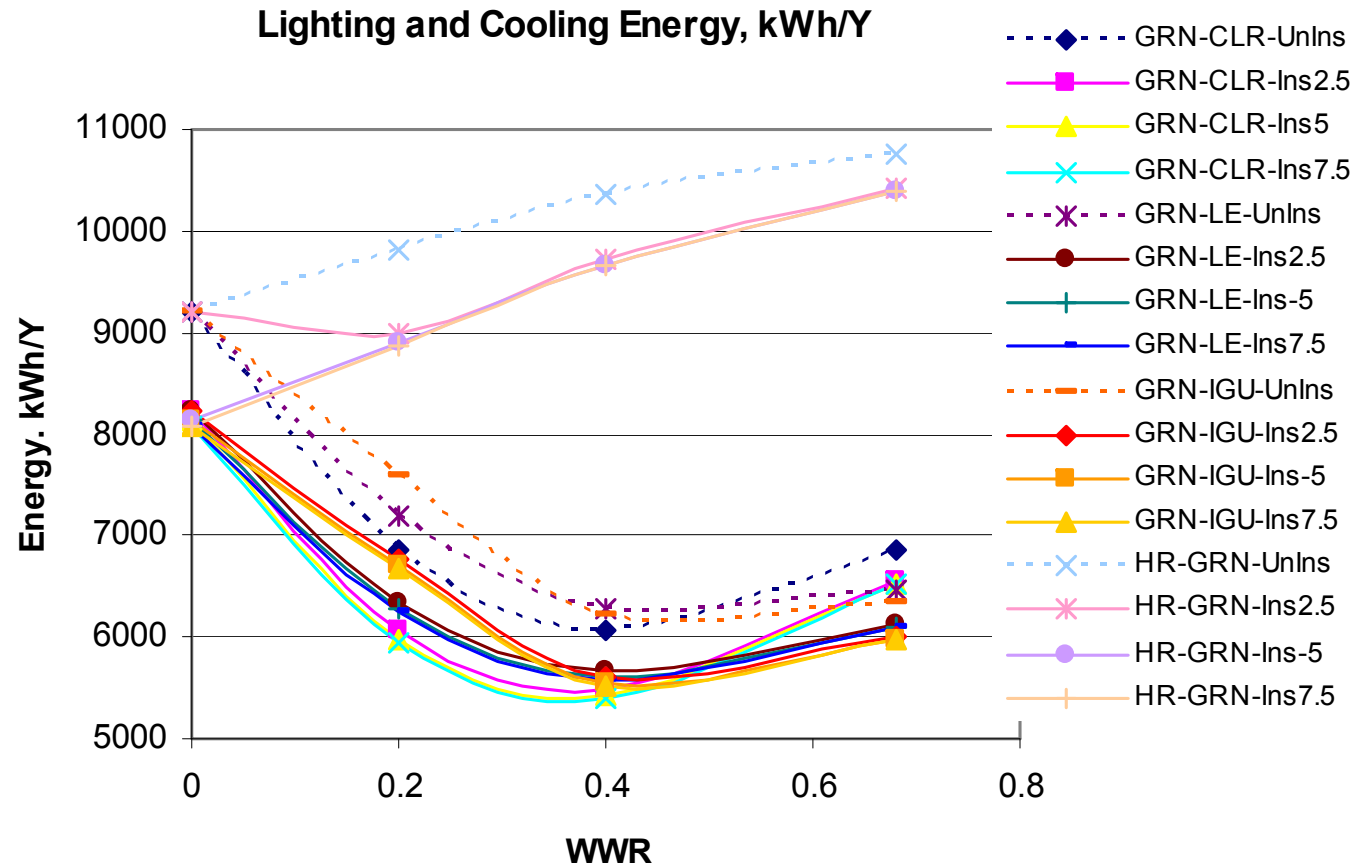


DL depth = daylight penetration depth

Lamp “on” = number of rows that electric lamps need to be “on”

Glazing type	DL depth & No. rows	WWR			
		0	0.2	0.4	0.7
GRN-CLR	DL depth (m)	0	7	11	12
	Lamp “on” (row)	9	6	4.5	4.5
HR-GRN	DL depth (m)	0	0	1	2
	Lamp “on” (row)	9	9	9	8

Windows with Shadings



Electric lighting and cooling energy (kWh/Y)

Windows with Shadings

- For east and west facades, the windows are shaded effectively by the vertical slats.
- Experiments were conducted to evaluate the energy performance of the daylighting from the slat equipped with an east window.
- The results showed that during the sun due north, the slat should be rotated in such a way with its outer edge towards south at 45° .

