

# Lighting Retrofit Case Studies in Brasília

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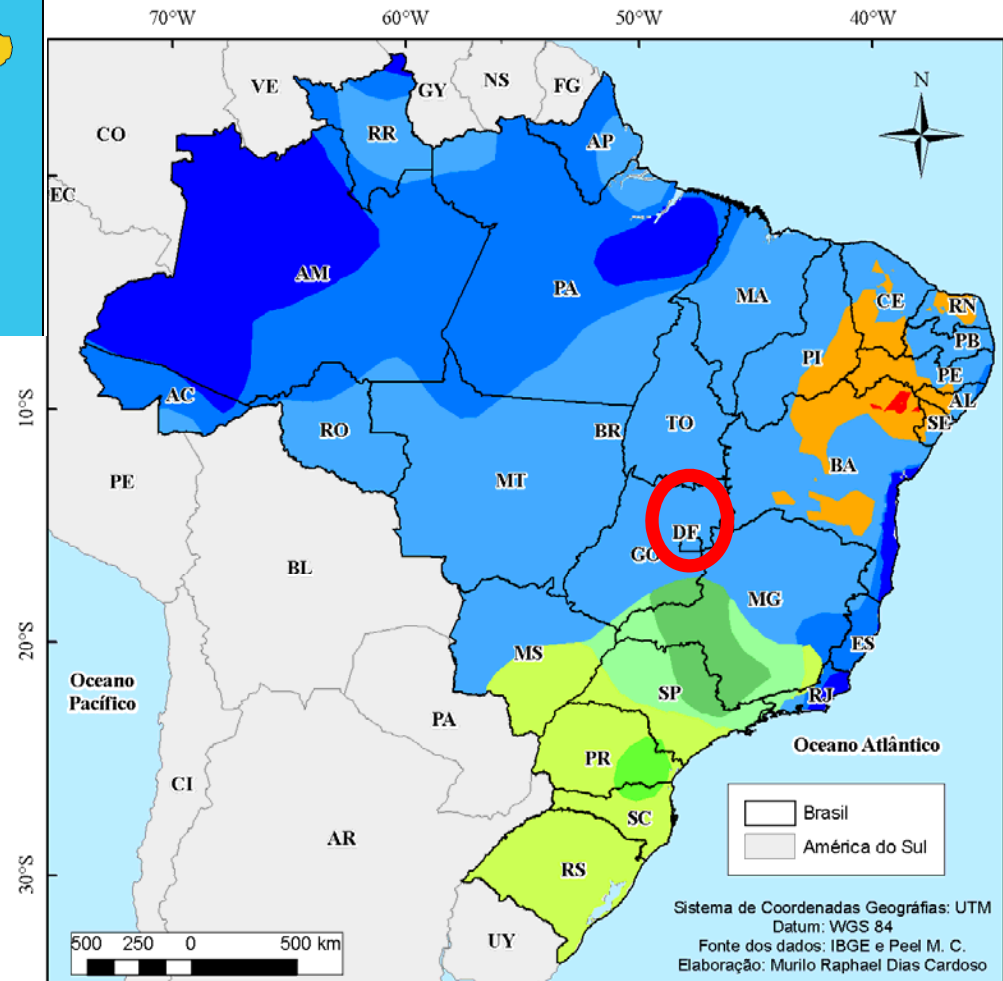
IEA SHC Task 50: "Advanced Lighting Solutions for Retrofitting Buildings"

# BRAZIL

- South America
- **8.515.767,049 km<sup>2</sup>**
- 201.7 million of hab.
- Biggest country in South America, 5th in area and population in the world
- Very different climatic conditions in the territory



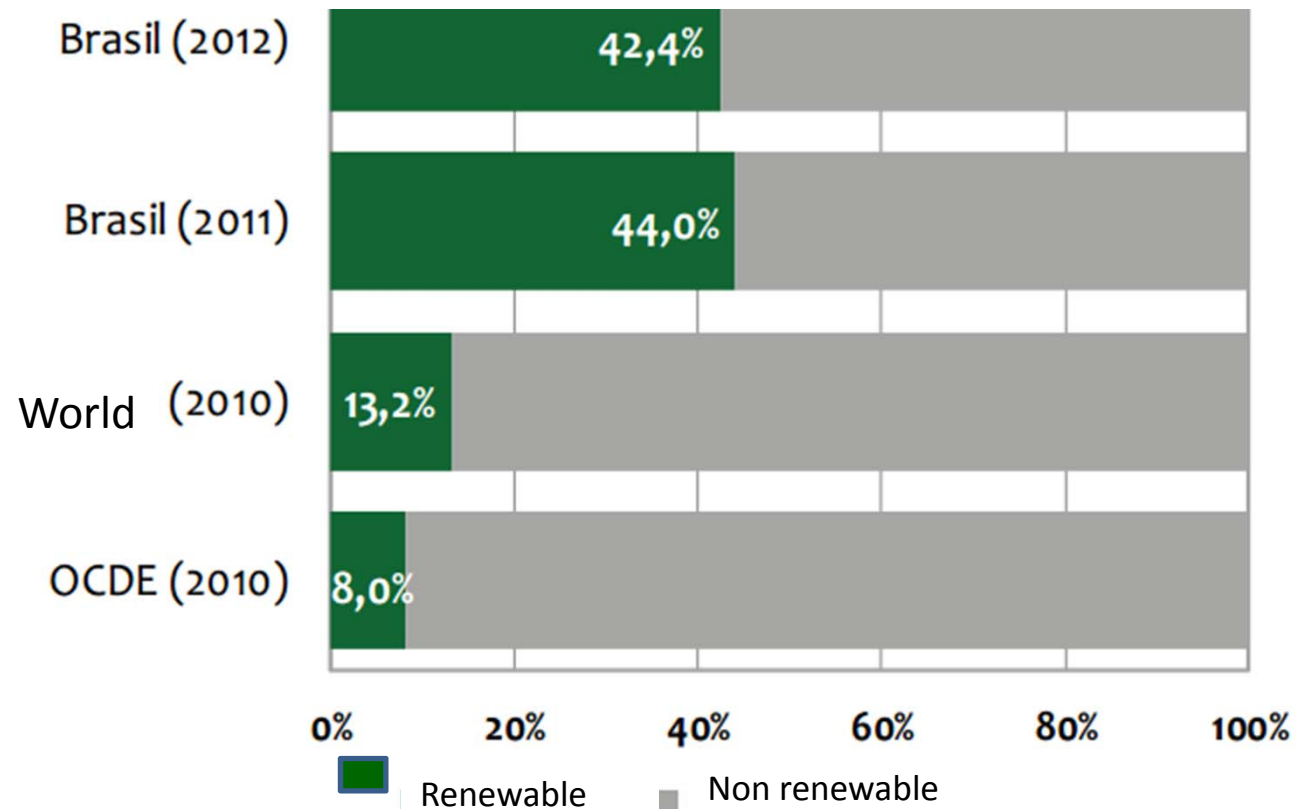
## Climas do Brasil: Classificação de Köppen



### Classificação Climática: Köppen

Af - Clima tropical úmido ou Clima Equatorial	Cfa - Clima temperado úmido com Verão quente
Am - Clima de monção	Cfb - Clima temperado úmido com Verão temperado
Aw - Clima Tropical com Estação seca no inverno	Cwa - Clima temperado úmido com Inverno seco e Verão quente
BSh - Clima das estepes quentes de baixa latitude e altitude	Cwb - Clima temperado úmido com Inverno seco e Verão temperado
BWh - Clima das regiões desérticas quentes de baixa latitude e altitude	

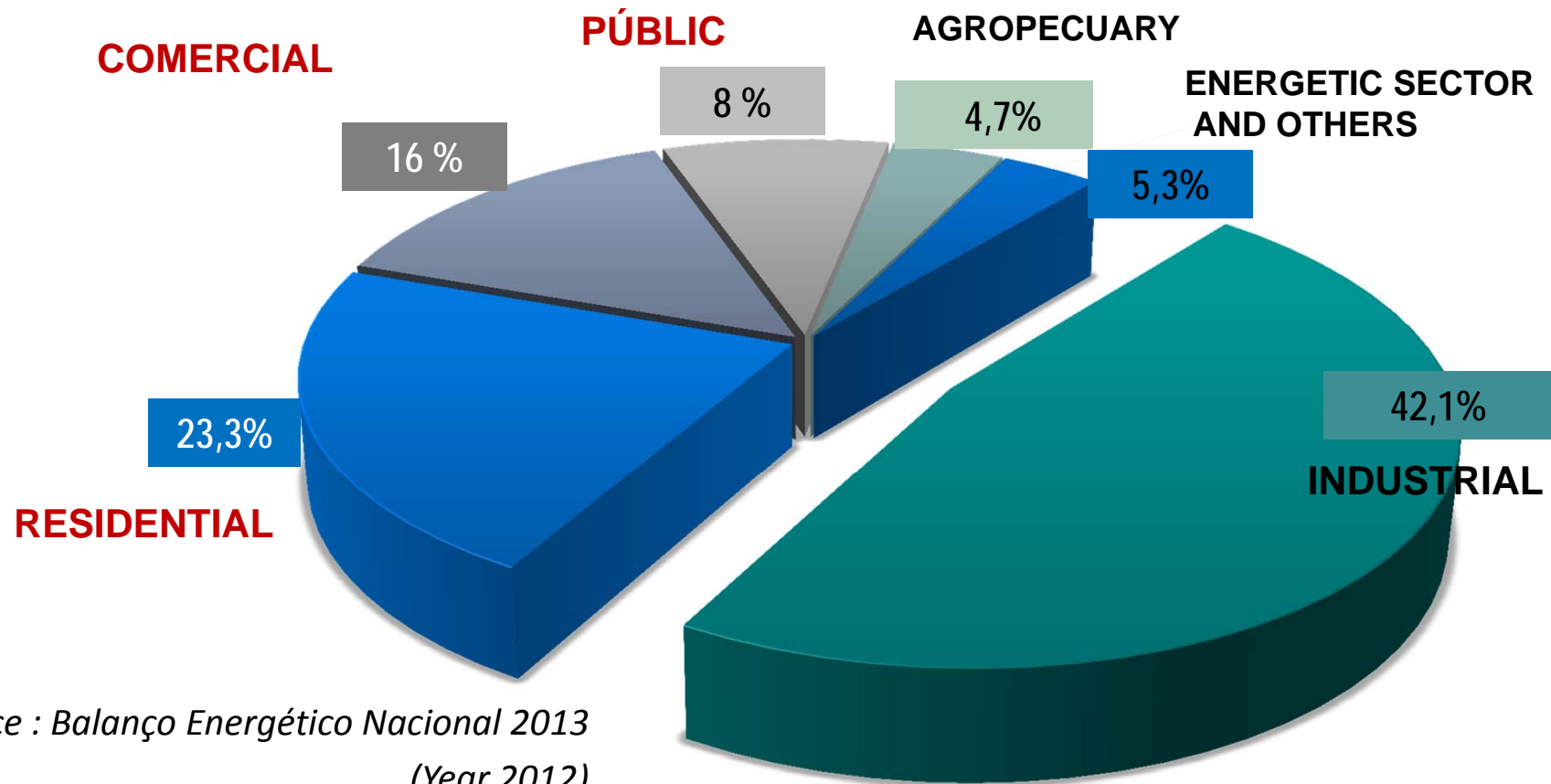
# Brazil: renewable fuel on energy (hydroelectric and ethanol)



Fonte: EPE; Agência Internacional de Energia. Elaboração: EPE

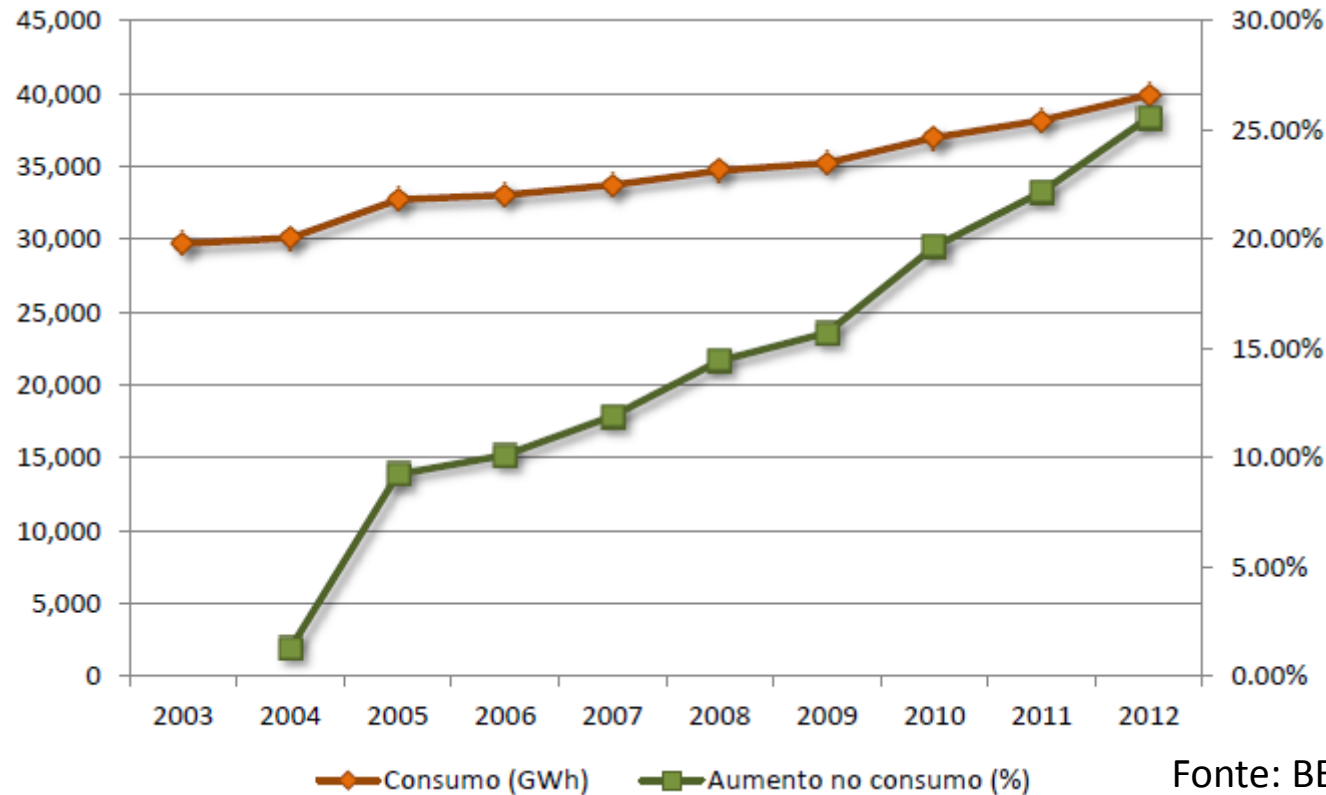
# Electricity consumption in Brazil

47,6% of consumption is in buildings



Source : *Balanço Energético Nacional 2013*  
(Year 2012)

# Energy consumption on public sector

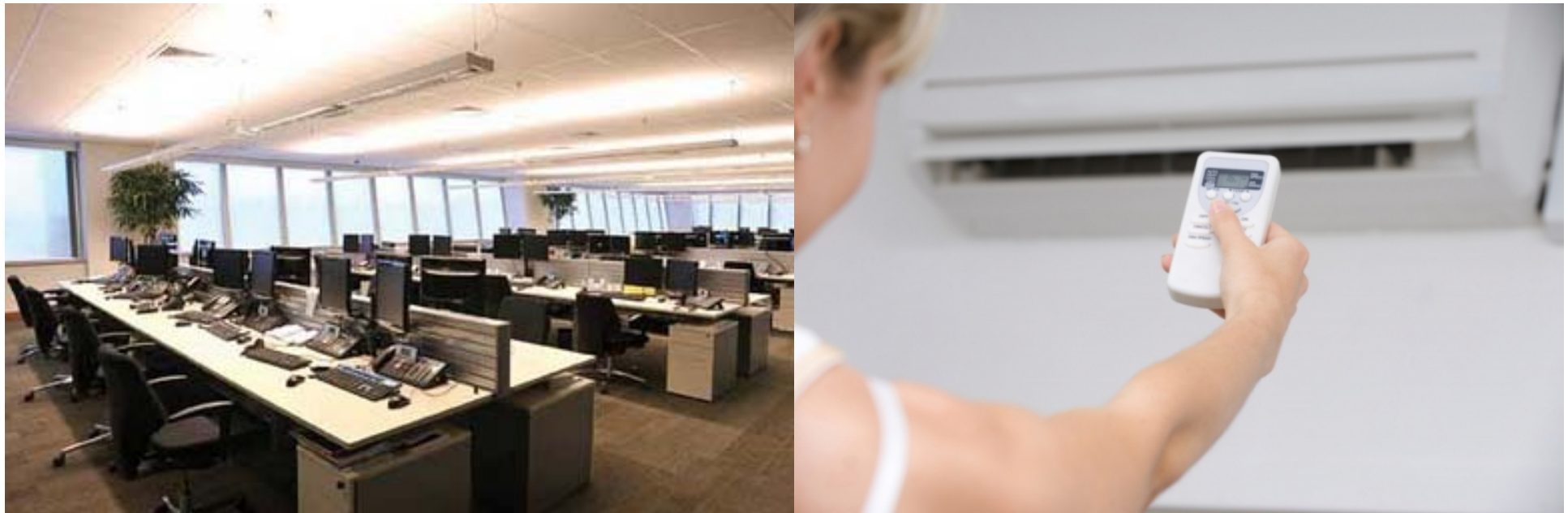


- Consumption and energy prices are growing!!!
- Rains are scarce!

# Final uses of energy in non residential buildings in Brazil:

- 20% a 35% ARTIFICIAL LIGHTING
- 40% a 55% AIR CONDITIONING (Geller, 1991; Correia, 2007)

Large part of energy consumed to provide environmental comfort!






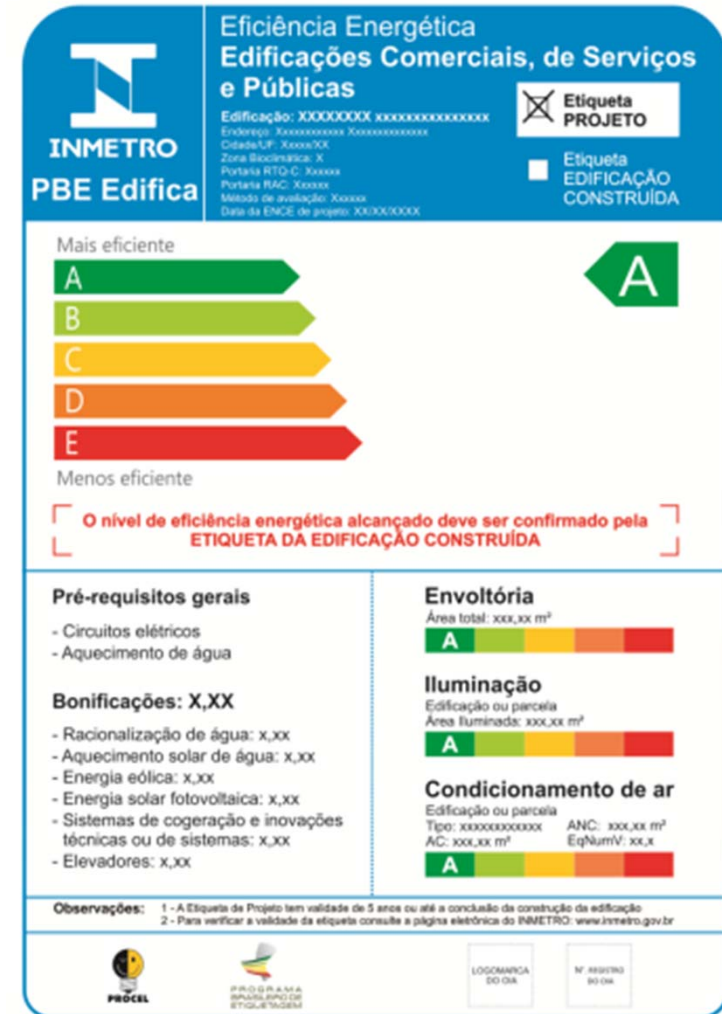
# PBE EDIFICA

## Energy efficiency labelling of buildings

New or existing buildings

From August 2014, obligatory to Federal public buildings!

-  **Building skin (30%)**
-  **Lighting (30%)**
-  **Air conditioning (40%)**



# Brasilia

- 1960
- Planned by Lucio Costa and Oscar Niemeyer

Designed for 500.000 hab -> (  
***2.200.000 hab (2015)***)



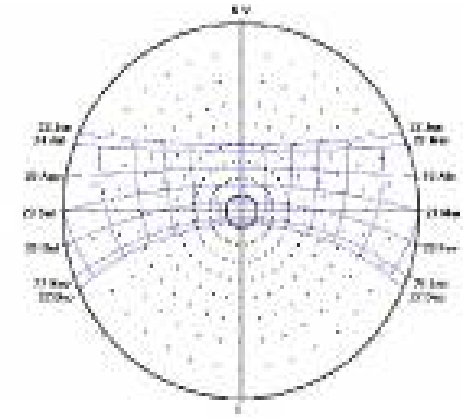


# Climate – tropical savanna (Aw)

Latitude 15,55 S

Long. 48 W

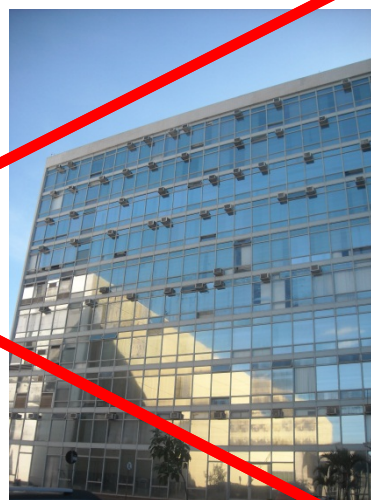
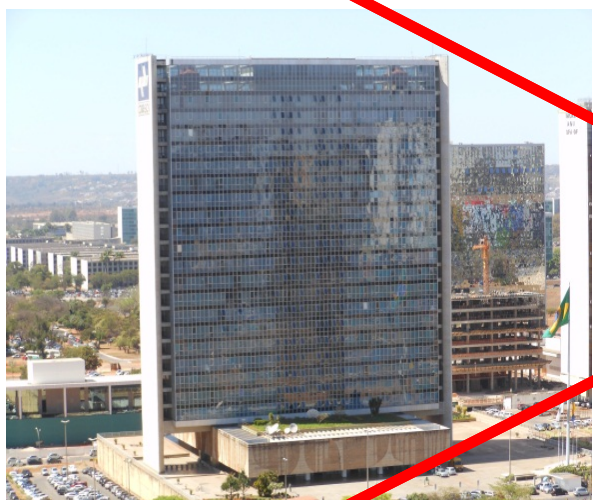
\*dry winter, humid summer



	jan	fev	mar*	abr	mai	jun**	jul	ago	set	out*	nov*	dez	ano
T mmês (°C)	21,6	21,8	22,0	21,4	20,2	19,1	19,1	21,2	22,5	22,1	21,7	21,5	21,2
T mmax (°C)	26,9	26,7	27,1	26,6	25,7	25,2	25,1	27,3	28,3	27,5	26,6	26,2	26,6
Tm min (°C)	17,4	17,4	17,5	16,8	15	13,3	12,9	14,6	16	17,4	17,5	17,5	16,1
Amp.méd (°C)	9,5	9,3	9,6	9,8	10,7	11,9	12,2	12,7	12,3	10,1	9,1	8,7	11,2
Precipit. tot(mm)	241,4	214,7	188,9	123,8	39,3	8,8	11,8	12,8	51,9	172	238	248,6	1552
UR média (%)	76	77	76	75	68	61	56	49	53	66	75	79	67
Insolaç. tot(hor.)	157,4	157,5	180,9	201,1	234,3	253,4	265,3	262,9	203,	168,2	142,5	138,1	2365
Nebulos. (0-10)	7	7	6	5	3	3	3	4	7	8	8	8	6
Vel. vent. ( m/s)	2,8	2,6	2,3	2,4	2,4	2,7	2,9	3,0	2,9	2,6	2,6	2,7	2,7
Direção ventos	NW	C-NE	E	E	E	E	E	E	E	C-NE	C-NW	NW	E



## Building skin



Tropical architecture?

# RETROFIT...

Before



Original brise soleil



Glazing facades

After...



# Case studies

BUILDING NAME	DATE OF MONITORING
<del>0. TCU</del>	02/07/2014 <b>eliminated</b>
<b>1. TJDFT</b>	<b>1.1.</b> 25 and 27/06/2014 (winter -clear sky)
	<b>1.2.</b> 16/01/2015 ( summer – overcast sky)
<b>2. MMA</b>	<b>2.1.</b> 27/02/2015 (summer – overcast sky)
	<b>2.2.</b> 30/06/2015 (winter – clear sky)
<b>3. MME</b>	<b>Not monitored – DATA JUST FOR COMPARISON with MMA</b>



# Case Studies

## 1. Forum of the Environment and Public Finance (TJDF-T)



New building - designed by arch. Siegbert Zanettini (2011)



Bilateral daylighting access  
Positive facades  
orientation (Nord/South)  
External solar shading  
systems



N



# Monitored room

- Illuminances

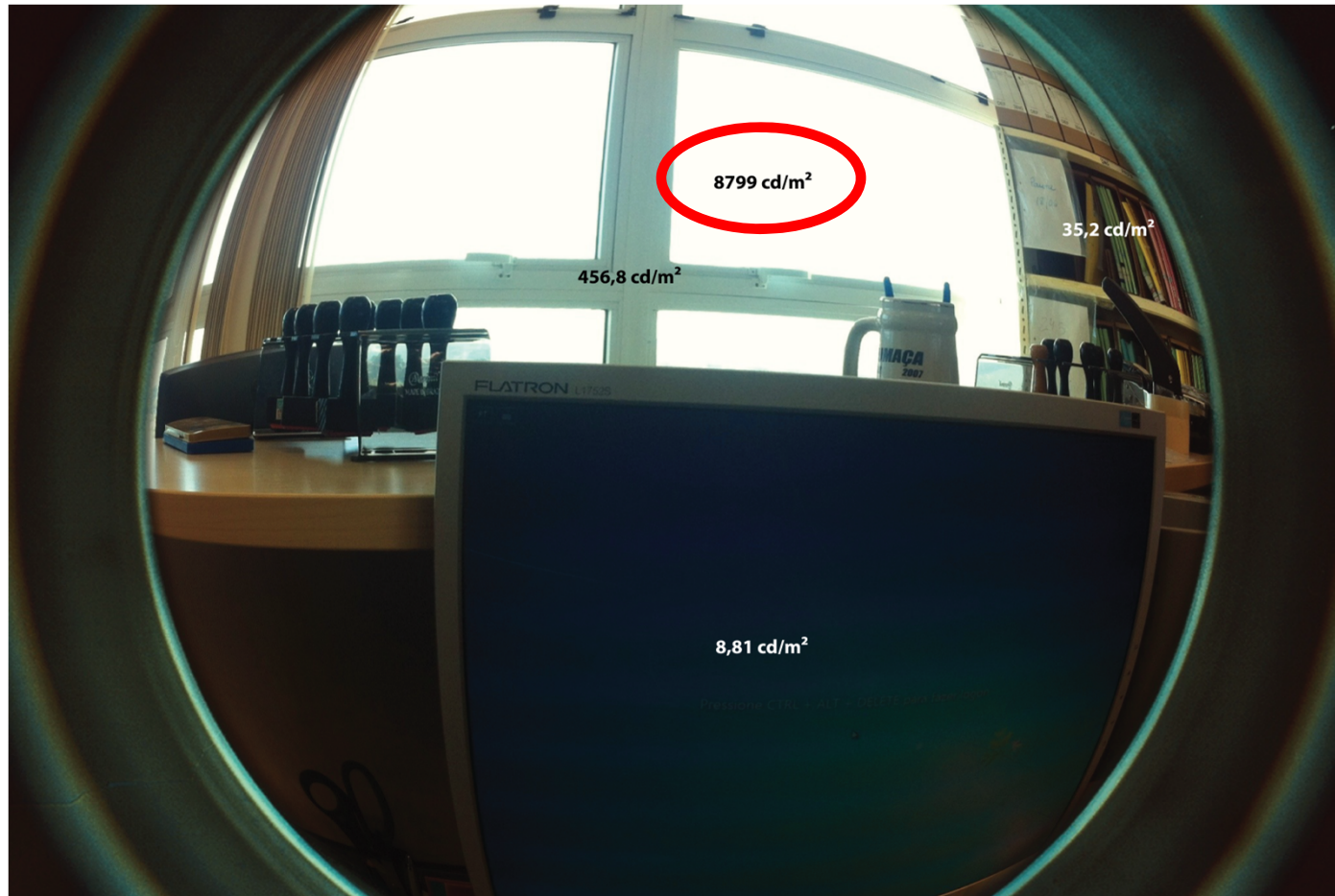


Window



Window

- Luminances



June 9 hs



- Directionality



## User's satisfaction:

- 60 questionnaires (June and January- Slightly different)



Internal curtains  
always closed, artificial lighting on

## 2. Ministry of Environment (MMA) and Ministry of Energy (MME)



# Case studies in Esplanade of Ministries –Brasilia

Ministry of Environment (MMA)

Ministry of Energy (MME)



**17 almost identical buildings (1958/1960 – arch. Oscar Niemeyer)**

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Total area: 19.873 m<sup>2</sup> (17,52 x 102,75 m) 9 floors + 3 underground

**MMA**



**EAST FACADE: NO EXTERNAL SOLAR PROTECTION**



**WEST FACADE: BRISE SOLEIL**

**MME**



IEA SHC Task 50: "Advanced Lighting Solutions for Retrofitting Buildings"

# Lighting retrofit MMA (monitored)

- Luminaires with T5 fluorescent lamps 4 x 28W
- NO LIGHTING CONTROL SYSTEMS
- Control solar film on facades
- New divisories
- 7th floor – original
- 6 th floor - retrofitted



# Lighting retrofit MME (comparison)

Same lighting fixtures and other  
AUTOMATED LIGHTING CONTROLS with possibility of individual dimming (each luminaire)

# MMA



**Pre retrofit – 7th floor**



**Post retrofit – 6th floor**



26.02.2015 9 a.m  
Global hor illuminance  
50.800 lux  
Difuse 23.700 lux

26.02.2015 15 p.m.  
Global hor il. 38.000 lux  
Difuse 12.000 lux



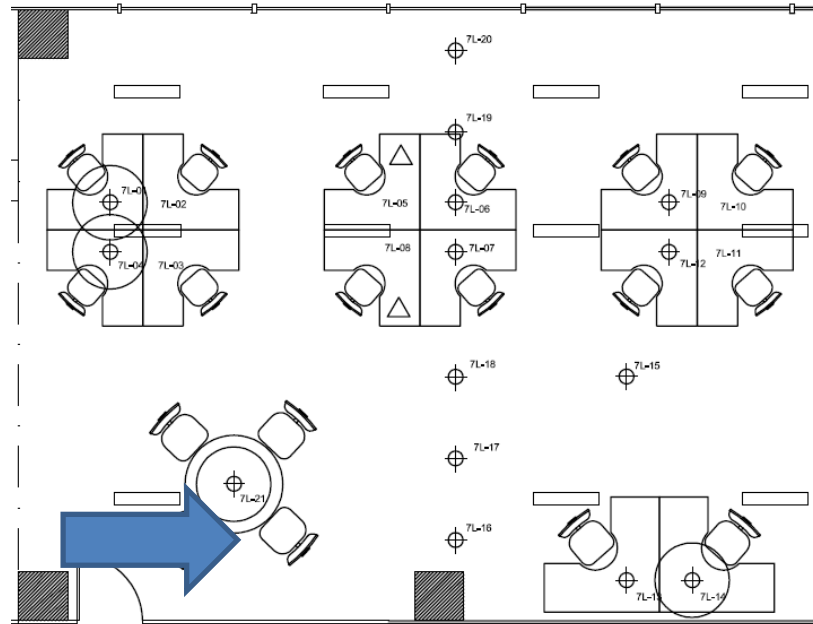
# MMA - Monitored rooms – 7th floor ( pre retrofit)



# ILLUMINANCES: MMA

Ambiente: Sala 724

Dia: 27/02/15 e 04/03/15 (medição noturna)



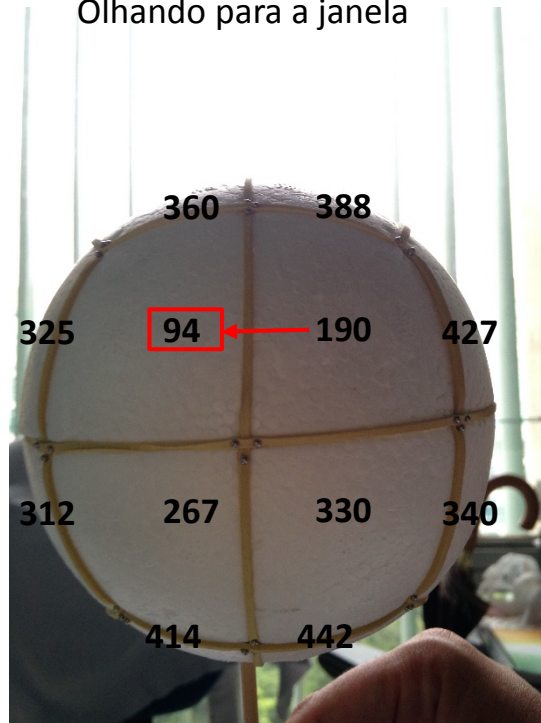
PONTO/HORÁRIO	09:07 h	12:20 h	15:01 h	19:10 h
	(luz natural)	(luz natural)	(luz natural)	(luz artificial)
7L-01	541	855	320	227
7L-02	1188	982	205	
7L-03	220	277	102	
7L-04	176	282	155	253
7L-05	1090	1212	185	
7L-06	840	1127	233	387
7L-07	245	367	94	325
7L-08	252	305	105	
7L-09	840	1220	190	318
7L-10	571	901	115	
7L-11	208	200	60	
7L-12	233	311	78	314
7L-13	219	213	87	332
7L-14	164	138	73	361
7L-15	355	281	120	258
7L-16	293	272	180	178
7L-17	302	396	149	180
7L-18	381	468	132	190
7L-19	3340	3160	666	369
7L-20	4180	4920	840	185
7L-21	292	318	145	250
média	758,57	866,90	201,62	275,13

# DIRECTIONALITY: MMA

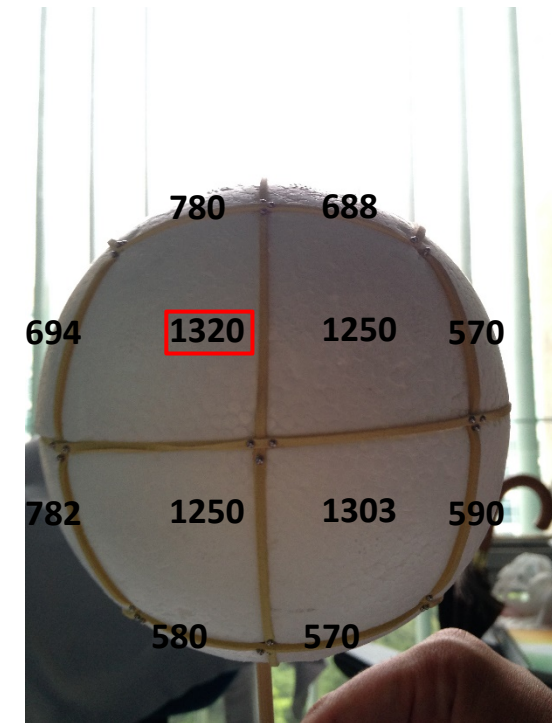
SALA 724 – ESFERA PERTO DA JANELA

Horário: 09:34 h

Olhando para a janela



Olhando contra a janela



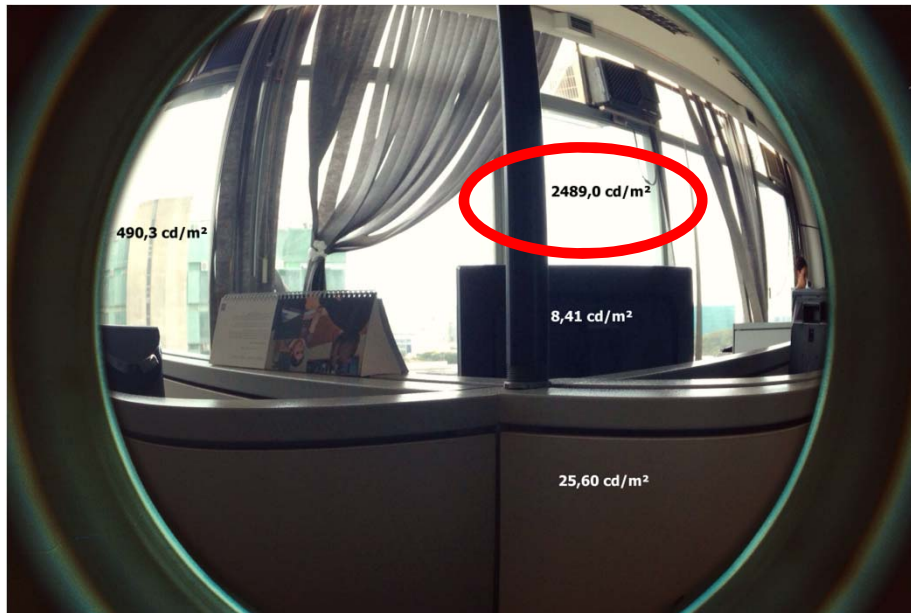
$E_{max} = 1320 \text{ lux (4605 cd/m}^2\text{)}$

$E_{min} = 94 \text{ lux (327 cd/m}^2\text{)}$

$E(v) = 4277 \text{ cd/m}^2$

$\backslash E(s) = 594 \text{ lux (2072 cd/m}^2\text{)}$   $(v)/E(s) = 2,06$  (entre 2.0 e 2.5) – Forte

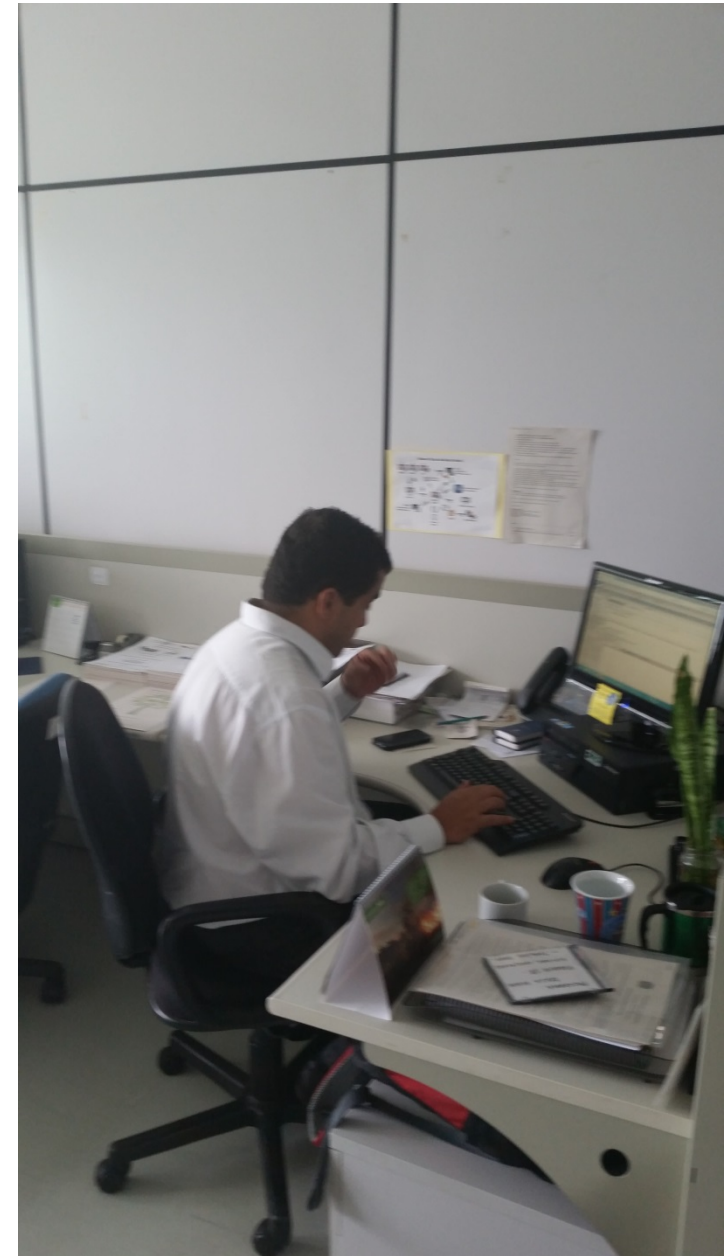
- Luminances



Users try to control glare

# User's satisfaction:

- 120 questionnaires in **four different situations:**
  - East facade pre and post retrofit
  - West facade pre and post retrofit



# MME

- In 2013, a new effort was made to improve the lighting system: sensors, dimming in all lamps, automated and individual controls (lamps dimming) – Eco-System (Quantum) LUTRON
- Savings prevision: 9% /year

**TO BE EVALUATED...**



# Preliminary results

- ***In all buildings: glare, privacy, sun spots*** are reasons to use curtains all the time
- Standard curtains are very bad for daylighting use... (there is no possibility to use daylighting from upper part of windows)



# Preliminary Results

- ***High influence of users behaviour*** on energy consumption – even if they have very sophisticated lighting automated controls, they use very few daylighting (artificial lighting always on, closed curtains)
- ***Artificial lighting always on***, even when curtains are opened





Márcia and Ludmilla



Marina R.



Marina R.



Marina P.



Julia

# THE TEAM...

**LACAM – LABORATORY OF ENVIRONMENTAL CONTROL  
FACULTY OF ARCHITECTURE AND URBANISM  
UNIVERSITY OF BRASILIA**



**THANK YOU!**  
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