Climate-responsive residential buildings in India. Just a drop in the ocean?

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Introduction: Indian building background

- The Indian rapid economic development brought an increase of middle classes' standards of living and expectations
- A ferocious rhythm of construction and qualitatively poor and climate inappropriate architectural solutions characterize the building sector in India

Air conditioners	2000	2001	2002	2003	2004	2005	2006	2007	2008	2014
millions(Roy et al.)	5,6	6,4	7,2	8	8,9	9,9	11,1	12,3	13,7	17,5
% of increase (1 year)		14,30%	12,50%	11,10%	11,30%	11,20%	12,10%	10,80%	11,40%	
% of increase (9 and 14 years)									144,60%	212,50%

Introduction: Indian building background

The case of Kolkata

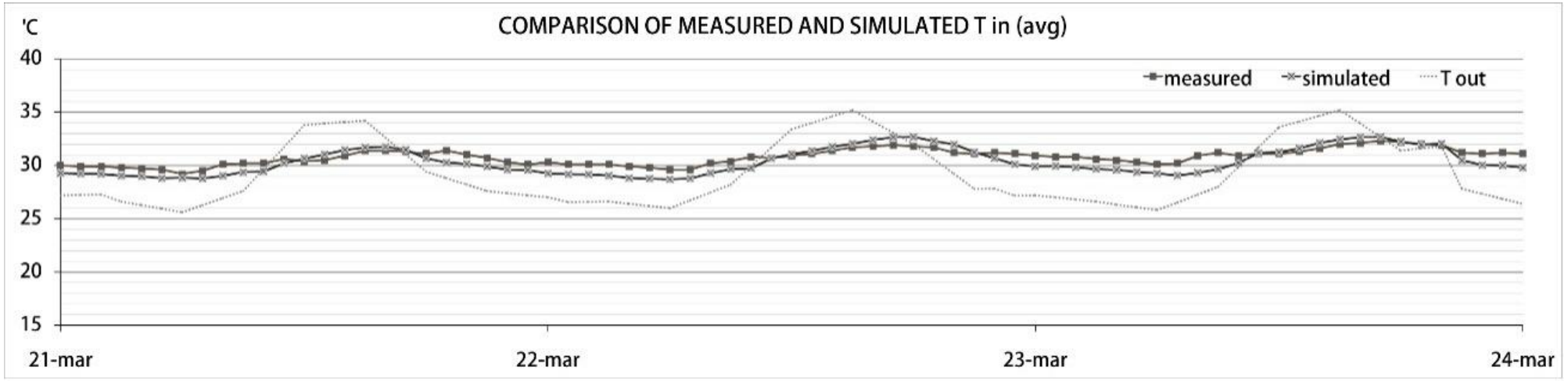
- 1-2 stories buildings considerably diminishing, while 3-4 stories building increasingly continue to be built
- Thin walls, lack of shading systems, lack of insulation especially on the roof

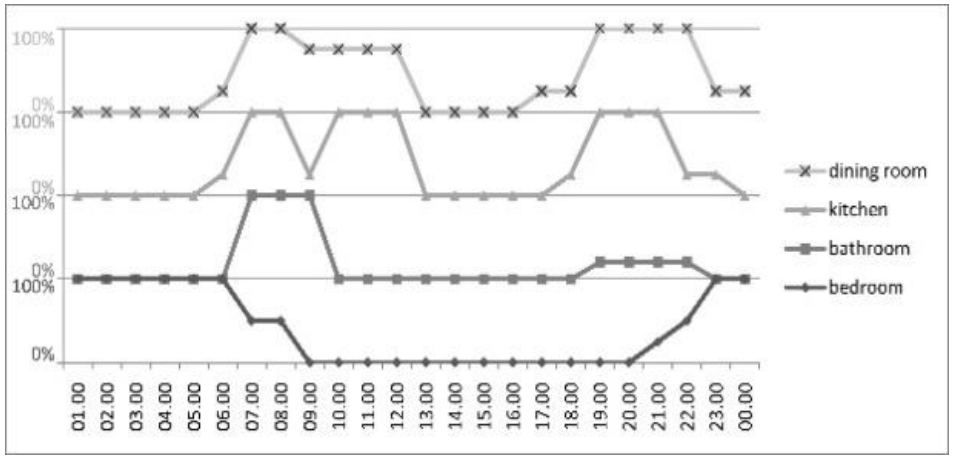
Building TYPO	N.	% TOT	2000-1	2002-3	2004-5	2006-7	2008-9	% (2000-1 /2008-9)	2014-15	Addition to existing
1-2 st.	16184	47,2	4029	3636	3131	2057	2117	-47%	290	3937
3-4 st.	17485	51	1749	2702	3665	3083	4311	146%	5850	1369
5-10 st.	493	1,5	22	35	61	46	54	145%	81	26
11-20 st.	79	0,2	3	11	16	18	15	400%	28	11
21-55 st.	17	0,1	1	2	3	2	3	200%	6	6
TOT	34258	100	5804	6386	6876	5206	6500			5349

Case study

A typique 3-storey building located in the Jadavpur area in the South part of Kolkata

Case study: en+ model validation





Validation keypoints:

- the measured indoor air temperatures were more stable than the simulated ones with initial guess
- night natural ventilation has a central effect on the buildings thermal performance: the actual use of this technique was less intense than expected

Strategies

Code		Description
1		selective glass
2	.1	outdoor blind
	.2	Indoor blind
3	.1	Low level wall insulation (5cm)
	.2	Low level wall insulation (15cm)
	.3	Low level wall insulation (25cm)
4	.1	Natural night ventilation
	.2	Natural daytime ventilation
	.3	Natural 24h ventilation

Simulation results

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1		selective glass
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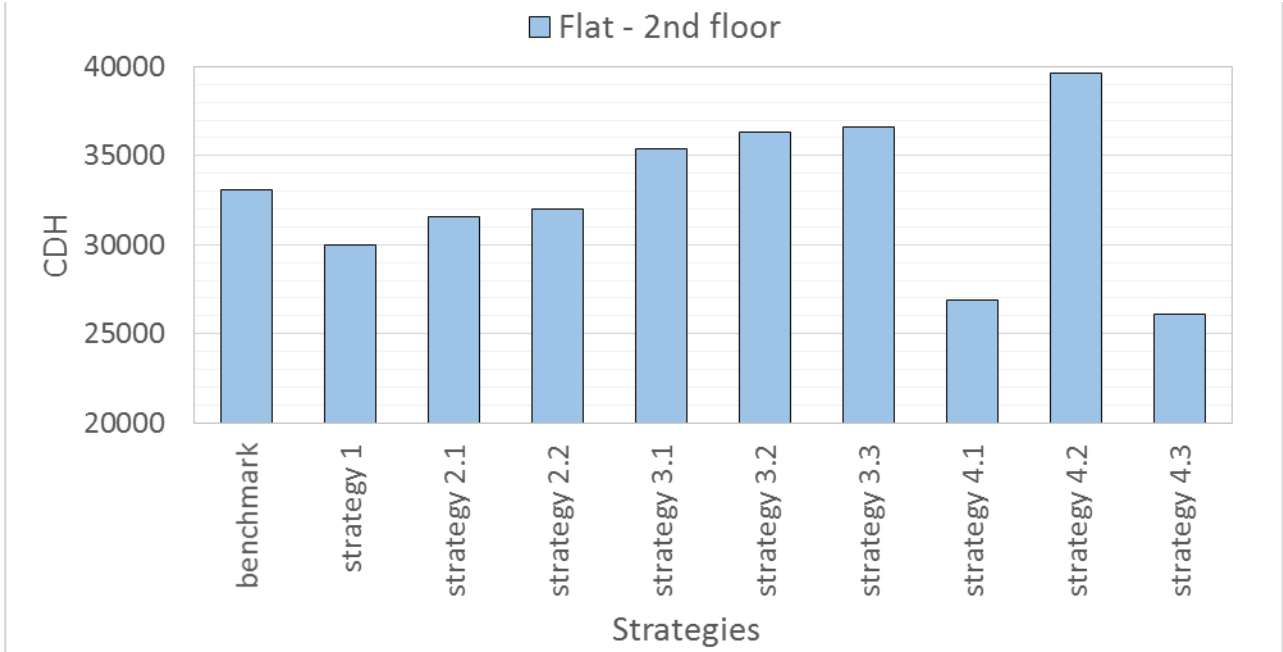
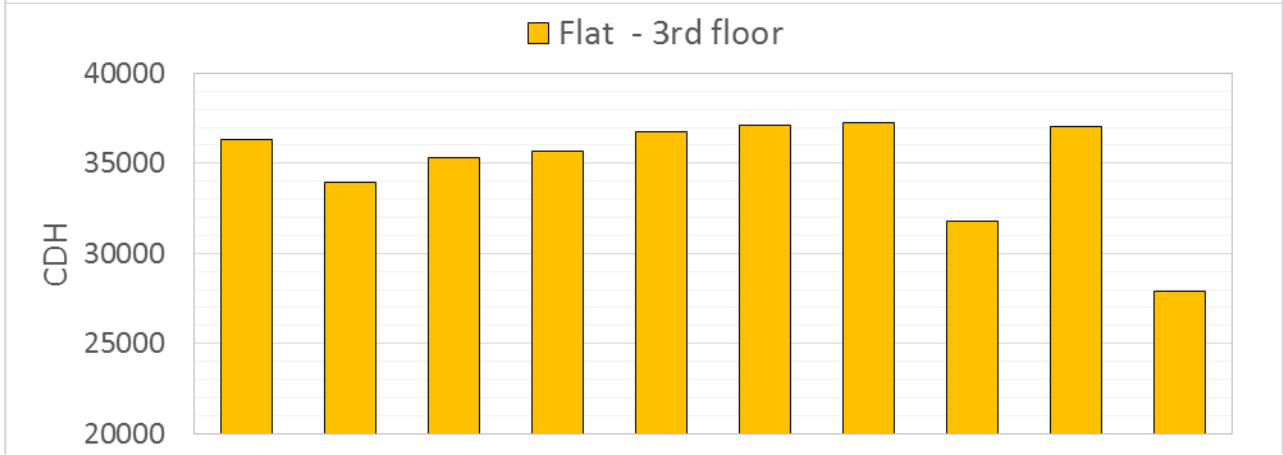
$$CDH = \sum(T_{in,op} - 26)$$

Strategy	% of CDH variation (2nd floor)	% of CDH variation (3rd floor)
None (Benchmark)	0%	0%
Strategy 1	-7%	-9%
Strategy 2.1	-3%	-5%
Strategy 2.2	-2%	-3%
Strategy 3.1	+1%	+7%
Strategy 3.2	+2%	+10%
Strategy 3.3	+3%	+11%
Strategy 4.1	-13%	-19%
Strategy 4.2	+2%	+20%
Strategy 4.3	-23%	-21,00%





Impact of strategies on urban scenario

Scenario	# of new flats in Kolkota 2000-2015	Flat Electricity consumption for A/C [kWh/y]	Total electricity consumption [MWh/y]	Electricity per capita [kWh/y]	All India per capita 2014-15* [kWh/y]	Specific electricity consumption [kWh/m2/y]	A reference european benchmark [kWh/m2/y]
As it is + full A/C	326'600	3'900	1'273'740	1'300	1'010	57	30 (Turin city code)
Strategy 1 + 4.1		2'535	827'931	845		37	

** "Growth of Electricity Sector in India from 1947-2015". CEA, India. Retrieved 13 June 2015.*

Conclusions

- Low cost interventions can drastically reduce the energy consumption for cooling, when A/C systems are installed, and decrease the temperature discomfort , when no A/C system is present
- Application of natural ventilation, outdoor blinds and selective glasses are good low cost interventions for typical india modern residential buildings
- These strategies, even if simple and related to single interventions on a building, can have a very high impact on the energy consumption of the building sector, especially if applied to 3-4 stories buildings
- When one or more strategies are applied, not only they reduce the consumptions or improve the comfort of a single family: like several drops join in an ocean, a really significant impact on savings and environment could be achieved with the diffusion of these technique, especially in a fast growing scenario as India construction sector is.