Bureau of Energy Efficiency

सत्यमेव जयते
Government of India
Ministry of Power

german cooperation
DEUTSCHE ZUSAMMENARBEIT

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ANGAN

Augmenting Nature by Green Affordable New-habitat

A Courtyard for Revolutionary Change in Building Energy Efficiency

An International Conference on Building Energy Efficiency

9th-11th September, 2019 | Hotel The LaLiT, New Delhi

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THIS PRESENTATION WAS SHARED BY

Pierre Jaboyedoff

Effinart BEEP

FOR THE SESSION:

"Occupant Comfort: Thermal, Visual, Acoustic, Indoor Air Quality"

DURING ANGAN 2019

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BEEP
BUILDING ENERGY EFFICIENCY PROJECT

Thematic Track 17 Occupant Comfort: Thermal, Visual, Acoustic, Indoor Air Quality

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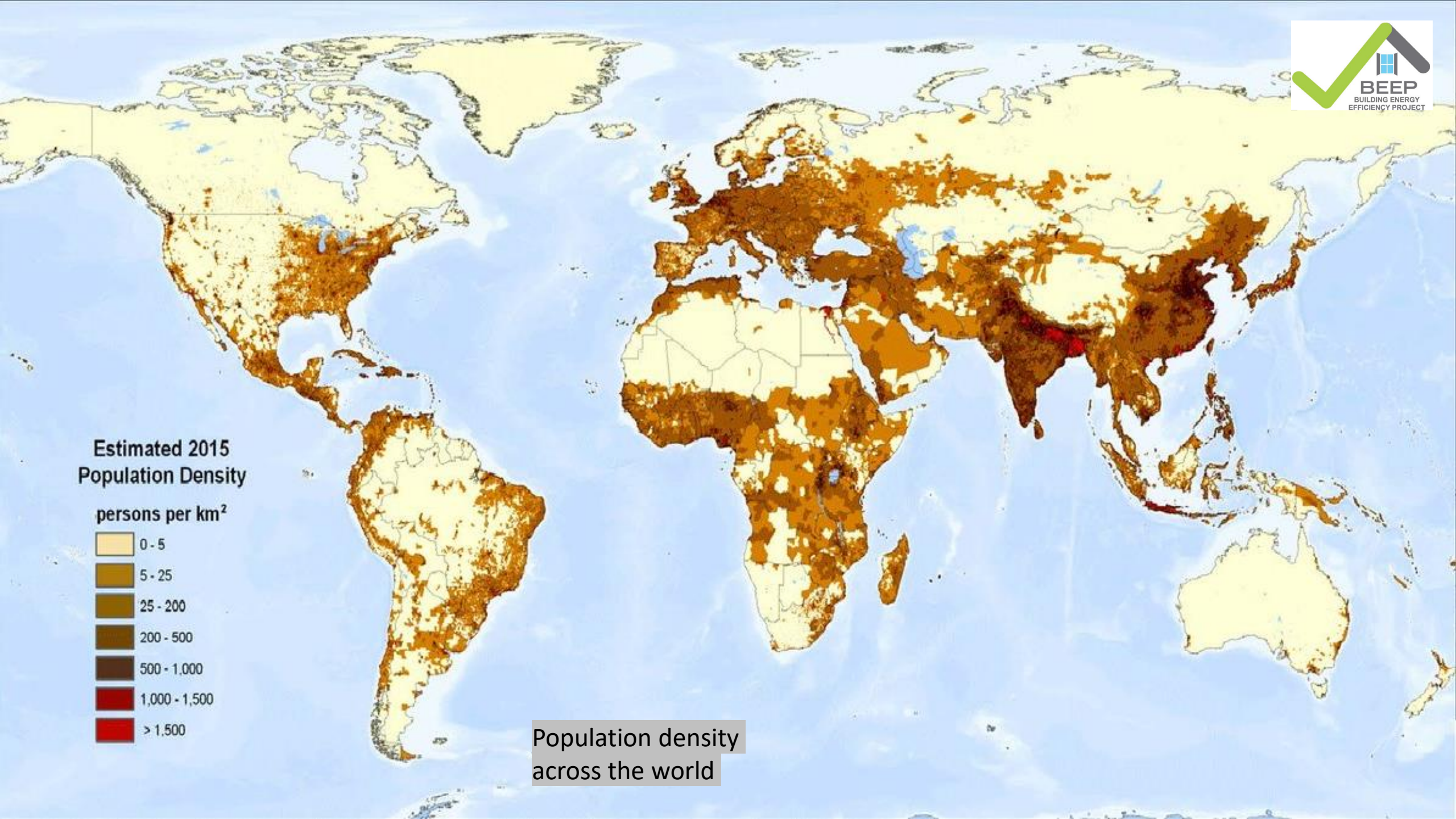
funded by the Swiss Agency for Development and Cooperation (SDC)

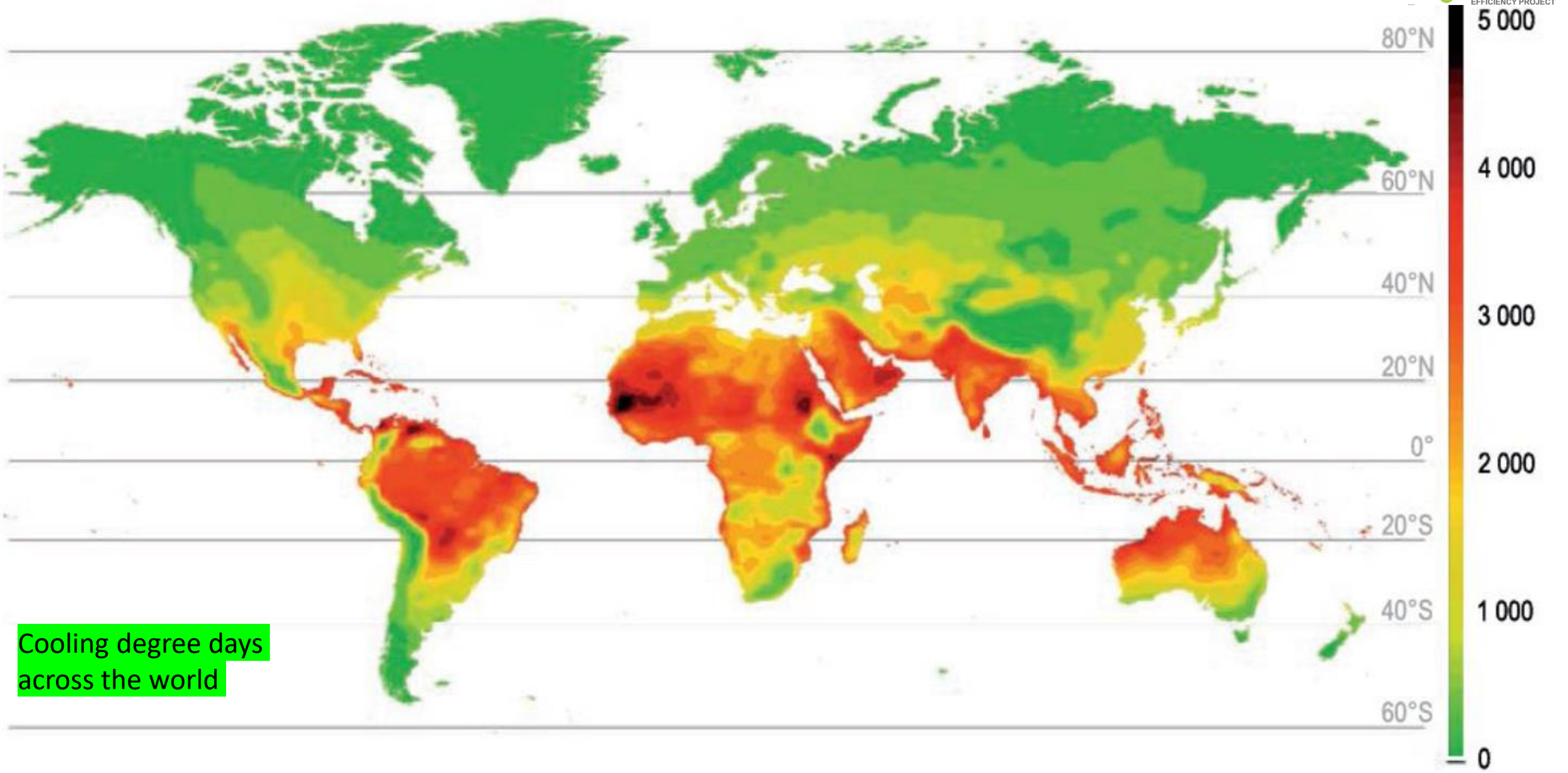
www.beepindia.org

- Part of the development team of the new ECBC-R
  - 1st part building envelope
  - Effinart and Greentech Knowledge Solutions Pvt. Ltd, Delhi

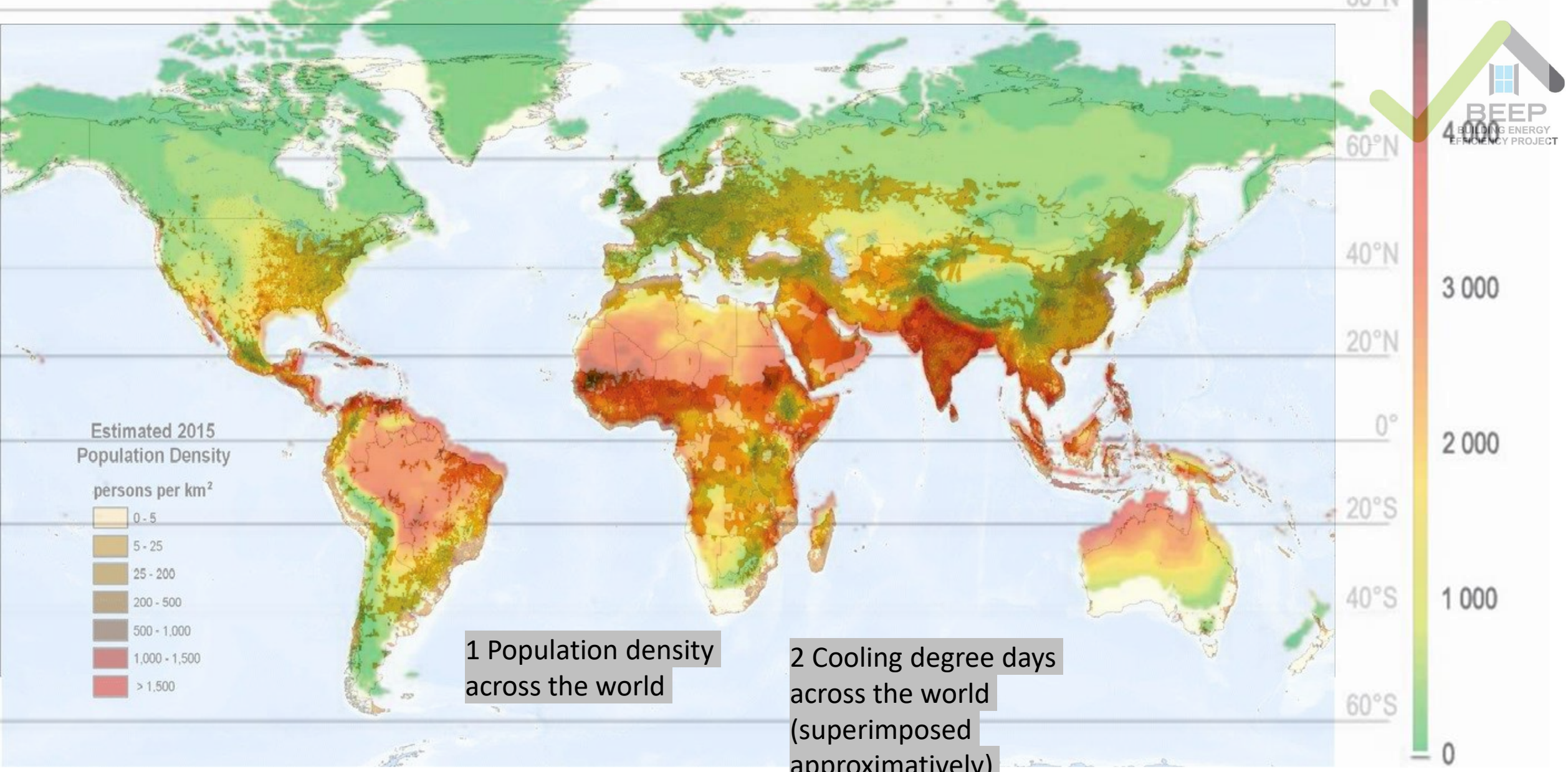


Population density across the world

Map 2.1 • CDDs across the world, mean annual average 2007-17



Cooling degree days across the world



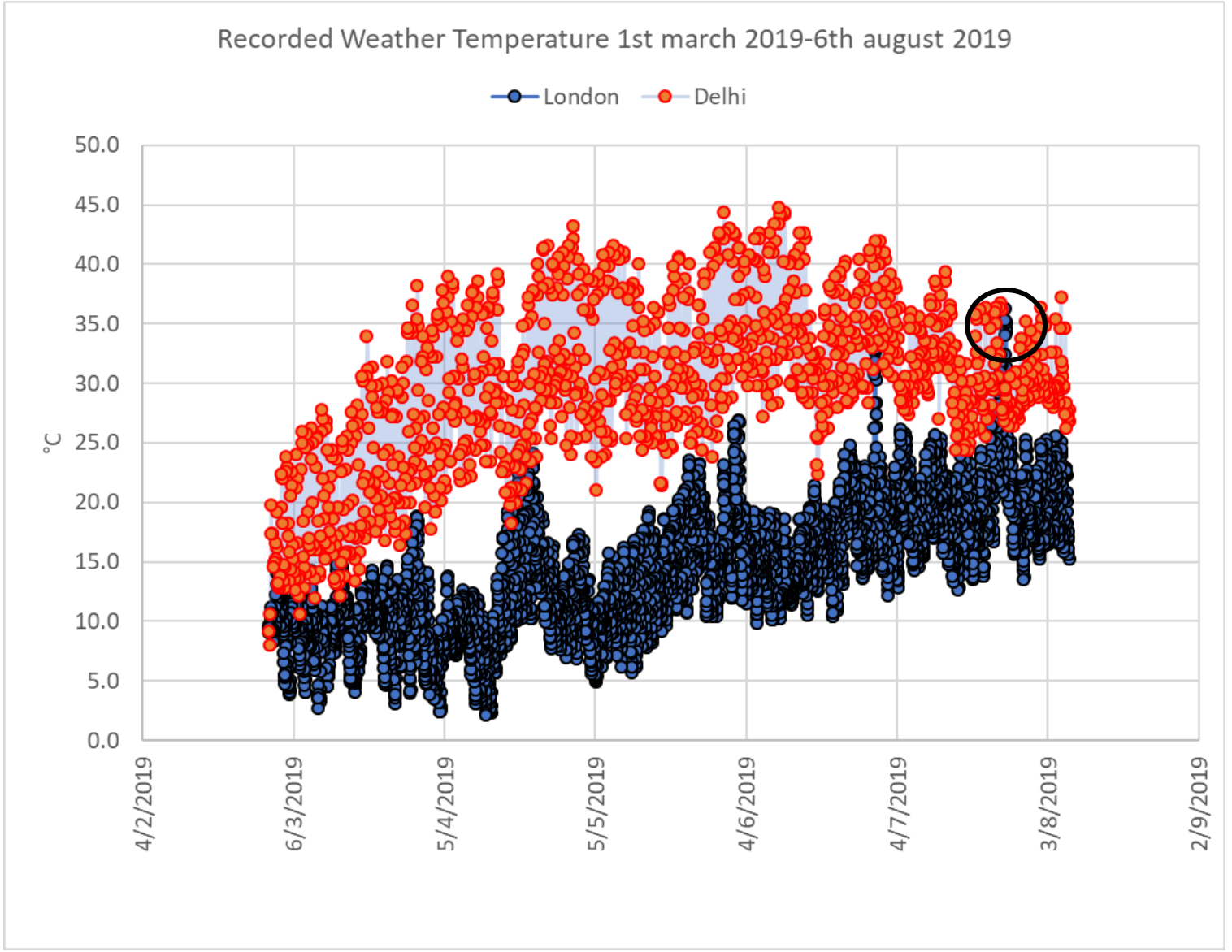
1 Population density across the world

2 Cooling degree days across the world (superimposed approximatively)

What about real weather recent data ?

- The picture shows two extremes
  - Regular temperature of summer in Delhi
    - (April-early July → daily > 40°C
    - night “cooling” at 25-28°C
  - Heat wave in UK ?
    - 2-3 days with a maximum at 37 °C once …

Data extracted from the Russian weather server RP5.ru and post-processed

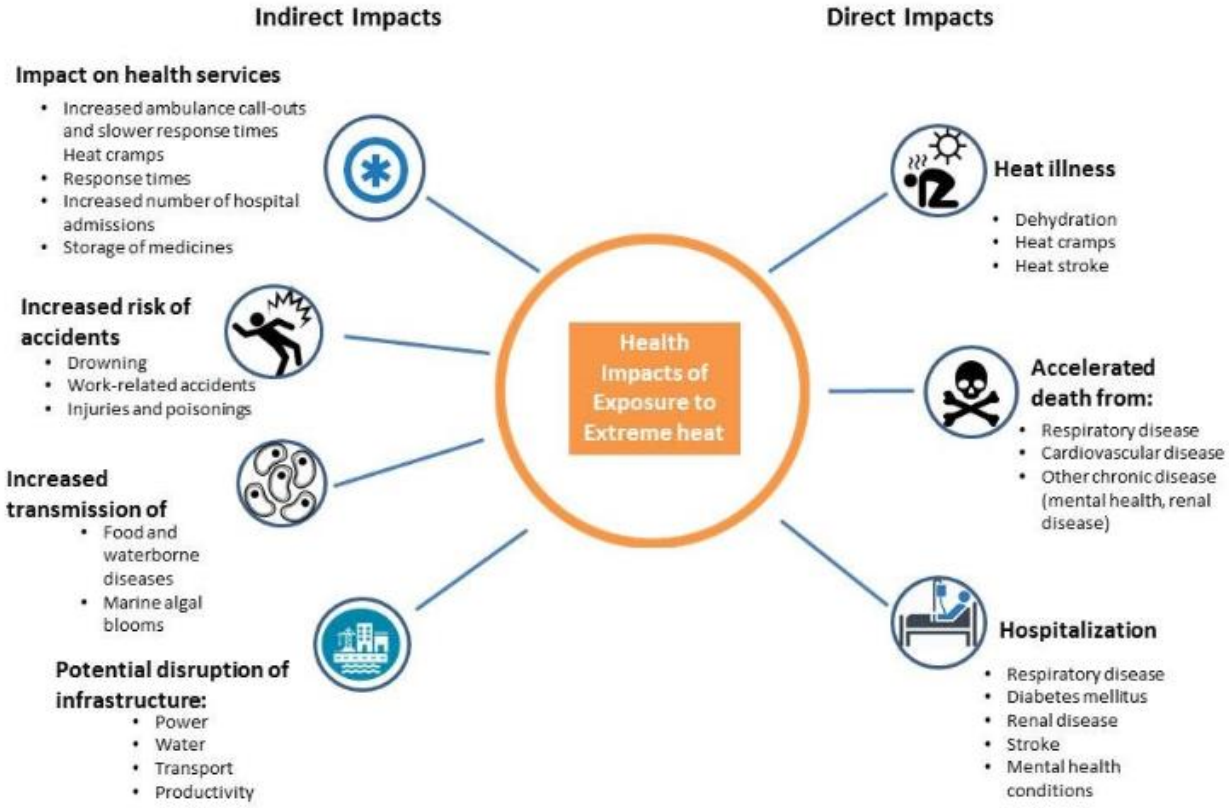


Some learnings looking at the global issues related to climate change

- The CO2 concentration can be considered as evenly distributed the world over (who ever emits influence the rest of the world)
- The highest number of people affected by serious climate changes are located in the hot and dry or humid climates where highly density is the norm
- The health related impact there are immense as more and more deadly climate period are reached in countries like Nigeria, Pakistan, India, Bangladesh, Indonesia, Philipines, China to name few
- The main increase in CO2 emissions is now often coming from the same countries with are and will suffer the most. In these countries the level of equipment in air conditioning for the population is increasing very fast but still under 10%, therefore the importance to make sound building with passive design for better thermal comfort

Thermal Comfort

- 90 % of the apartments are not actively cooled …
- Health and ability to work
  - High temperature in the apartments > 35 °C ?
  - Aim to keep your living space cool. Check the room temperature between 08:00 and 10:00, at 13:00 and at night after 22:00. Ideally, the room temperature should be kept below 32 °C during the day and 24 °C during the night. This is especially important for infants or people who are over 60 years of age or have chronic health conditions.
- Passive measures
  - Building envelope
    - Reduction of heat gains across the envelope
    - Enforcement of ECBC-R Eco Nivas Samhita (mandatory compliance)
    - Retrofit on existing building with application of External Movable Shading
- Active thermal comfort measures
  - Low energy assisted cross ventilation at night (~1 W/m2, solar powered)
  - Evaporative coolings
  - Active cooling
  - Dehumidification



Example of a measured flat in a low cost housing in Rajkot, India Monitoring of Smart Ghar III, 1200 dwellings, no AC

- Low cost housing without additional cost as compared to the business as usual projects
  - Low Window to Wall Ratio
  - Partly opaque windows/shutters
  - Casement windows with large natural ventilation openings

Example of a measured flat in a low cost housing in Rajkot, India
Monitoring

- During hot summer in Rajkot (40-41°C max every day)
- Inside temperature between 30-32°C → 8-9°C below outside without any cooling
- Compliant with the National Building Code thermal comfort of India with ceiling fan

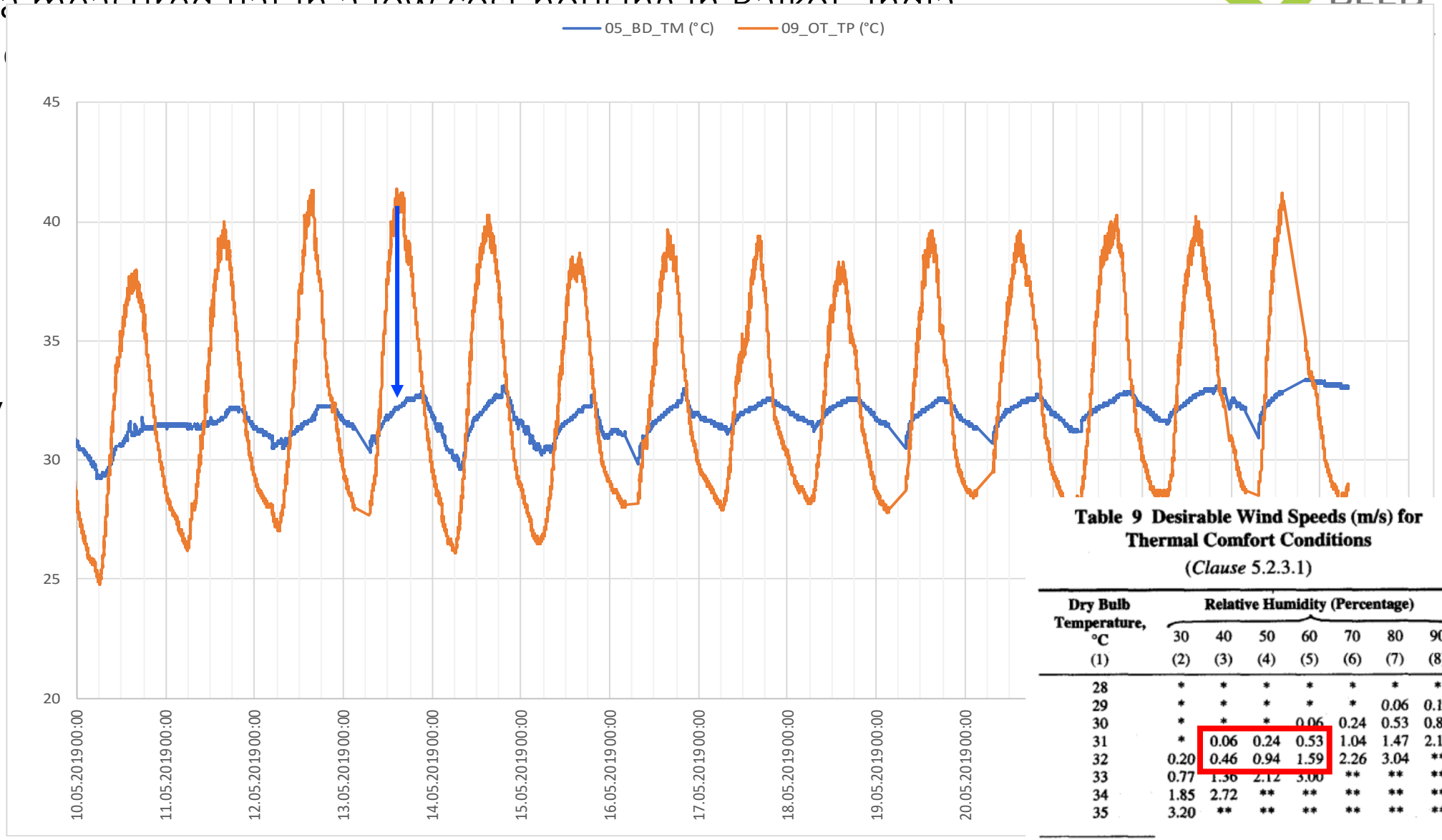


Table 9 Desirable Wind Speeds (m/s) for Thermal Comfort Conditions

(*Clause* 5.2.3.1)

Dry Bulb Temperature, °C	Relative Humidity (Percentage)						
	30	40	50	60	70	80	90
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
28	*	*	*	*	*	*	*
29	*	*	*	*	*	0.06	0.19
30	*	*	*	0.06	0.24	0.53	0.85
31	*	0.06	0.24	0.53	1.04	1.47	2.10
32	0.20	0.46	0.94	1.59	2.26	3.04	**
33	0.77	1.36	2.12	3.00	**	**	**
34	1.85	2.72	**	**	**	**	**
35	3.20	**	**	**	**	**	**

* None

** Higher than those acceptable in practice.

History of External Mobile Shading sYstemS (EMSYS)

- Some of the earliest examples of EMSYS used include awnings, shutters and jalousies

Lyon Jalousies, France

- The jalousies appeared at the end of the 18th century and are frequent in the buildings of report in Lyon in France.
- They share the urban landscape of the old centres with the shutters.
- These examples of external shading can be seen throughout Lyon on buildings from the 18th century to the 20th century.
- Jealousies are a shading system characteristic of the Lyonnais and part of the Rhône and are regarded as a precious heritage to keep

Some examples of Lyonaise Jalousies in use even today

History of EMSYS (Example of Spain and also awnings in the U.S.)

- Awnings were widely used in U.S. during early 20th century, until the advent of A.C. during the 1940s
- Simple shutters have been in use in Europe traditionally

Traditional louvered wooden shutters, Spain

Early 20th century wooden louvered shutters

Awnings in Brooklyn in 1920s

Example of awnings used in Chicago till 1940s

Shading History in India

Jaipur library with its louvered shutters

Different types of external shadings can be seen in old 'heritage' homes in Kolkata

- Numerous examples of external shading can be seen in historical Indian architecture through the ages
- EMSYS has been consciously used for controlling heat gains in buildings.
- Some of these buildings can still be seen throughout the country and are even regarded as ‘heritage’.

Effin'Art
The Art of Energy Efficiency

EMPA experimental study on External Shading, Switzerland 1979 (pioneering times)

BEEP
BUILDING ENERGY EFFICIENCY PROJECT

- Study and testing on external lamella (louver)

AUSSENLAMELLENSTOREN, ROLLADEN, AUSSENSTOREN				
SONNENSCHUTZANLAGE			GLAS	Sonnenschu auf anfallen de Energie bezogen
ART	FARBE	Stellung/ Art		f2h
Klarglas IV (4 + 12 + 4)mm				0,72
RAFFLAMELLENSTOREN, AUSSENMONTAGE				
Aluminium, 80er-Lam. (Fig. 1)	weiss	Lam. geschl.	Klarglas IV (4+12+4)mm	0,13
		Lam. 45°		0,15
	alu	Lam. geschl.		0,14
Aluminium, 80er-Lam. (Fig.1)	dunkelbr.	Lam.geschl.		0,19
		Lam. 45°		0,23
Ganzmetall Lam. 97mm (Fig.2) Aluminium	hellgrau	Lam. geschl.		0,13
		Lam. 45°		0,15
ROLLADEN				
Aluminium, doppel—	hellgrau	geschlossen		0,09

Experimental study done by LBNL (2009) shows reduction in cooling loads by up to 80-87% by use of external shading and better visual comfort

Table 1: Monitored Performance of Innovative Shading Systems

South-facing, large-area window, dimmable lighting controls, Berkeley, California

		Interior Shades		Exterior Shades	
		Manual	Automated	Manual	Automated
Lighting Energy Use	(kWh/ft²-yr)	1.04 - 1.13	0.92 - 1.11	1.12 - 1.41	1.0 - 1.27
Lighting Energy Savings*	(%)	62 - 65%	62 - 69%	53 - 63%	58 - 67%
Cooling Load Savings**	(%)	Up to 15%	Up to 22%	78 - 94%	80 - 87%
Peak Cooling Load	(W/ft²-floor)	8.0 - 9.4	8.0 - 9.8	1.6 - 3.1	2.0 - 2.5
Avg time uncomfortable***	(hours/day)	2.3 - 3.7	0 - 1.1	0.7 - 3.8	0.2 - 3.0

Note: Shading systems are differentiated based on level of visual discomfort. Successful systems yield both comfort and energy efficiency.

Exterior view of the LBNL Windows Testbed Facility with the VB-E1n and VB-E3opt systems installed on the left and middle test chamber windows, respectively. The reference case with an interior Venetian blind (reference-VB) is on the right-most chamber window.

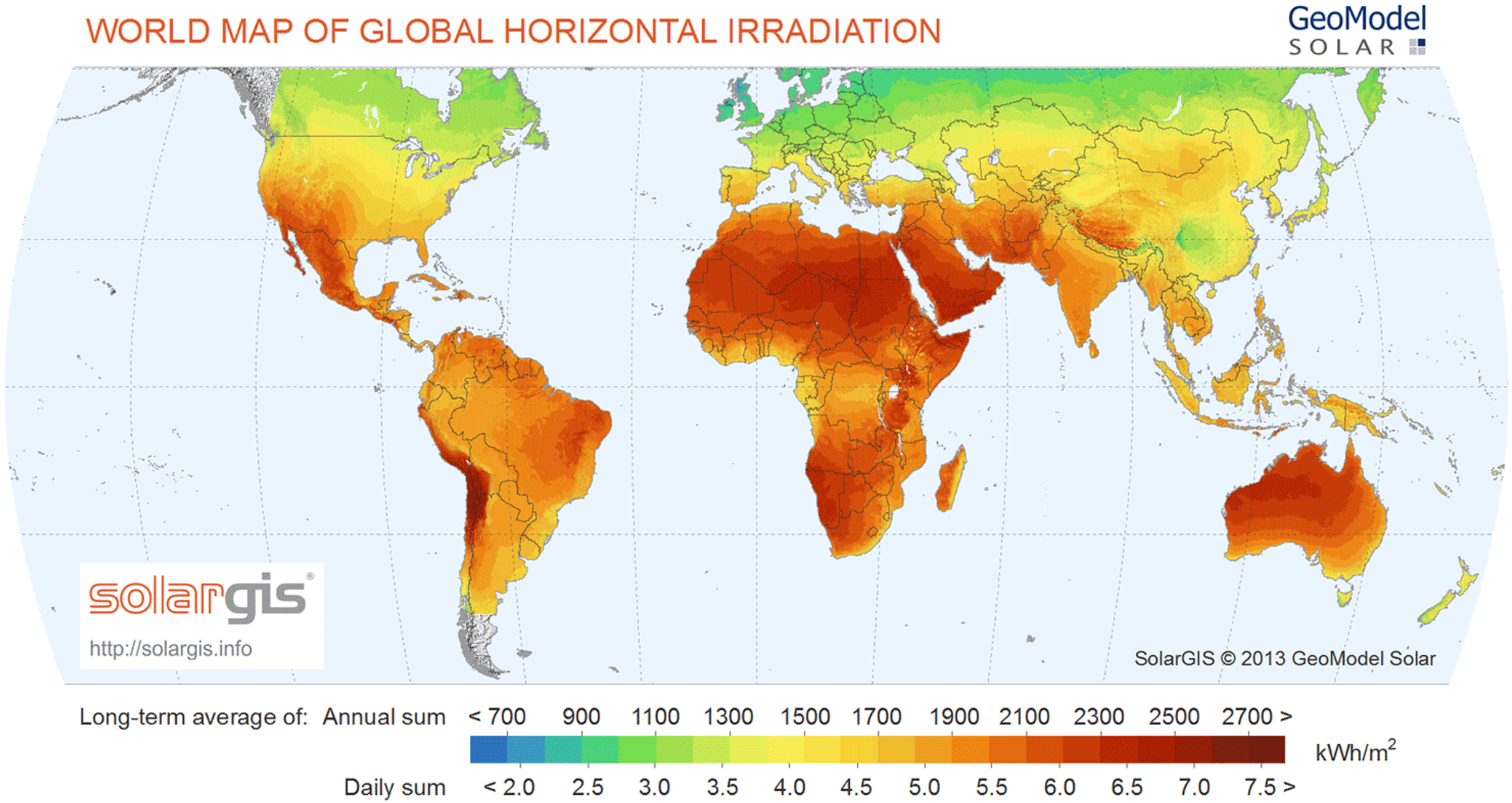
** Savings compared to ASHRAE 90.1-2004 (no daytime controls)*
*** Compared to manually-operated, conventional interior shade*
**** Amount of time when brightness of window caused glare*

Air quality

- Simple low assisted ventilation with air filtration ?
  - Solar powered ?
- Active cooling with air filtration
- Air purifiers

Daylighting

- India well equipped with daylighting (> 5 kWh/m2-day)
- Architectural design



Acoustic

- Non AC residential buildings ?
  - Natural ventilation ?
  - New solutions ?
- AC buildings
  - Better glazing (noise reduction)
  - Other technologies

- Thank you for your attention