Enabling energy sufficiency options in the design of buildings and cities

Prof. Pagliano Lorenzo

Teaching:

- Advanced Building Physics and Heat and Mass transfer
- Director of Master RIDEF (Renewable, Efficiency, Energy Planning) www.ridef2.com

Research:

- Director of eERG – end-use Efficiency Research Group www.eerg.it

www.eerg.it

https://azeb.eu

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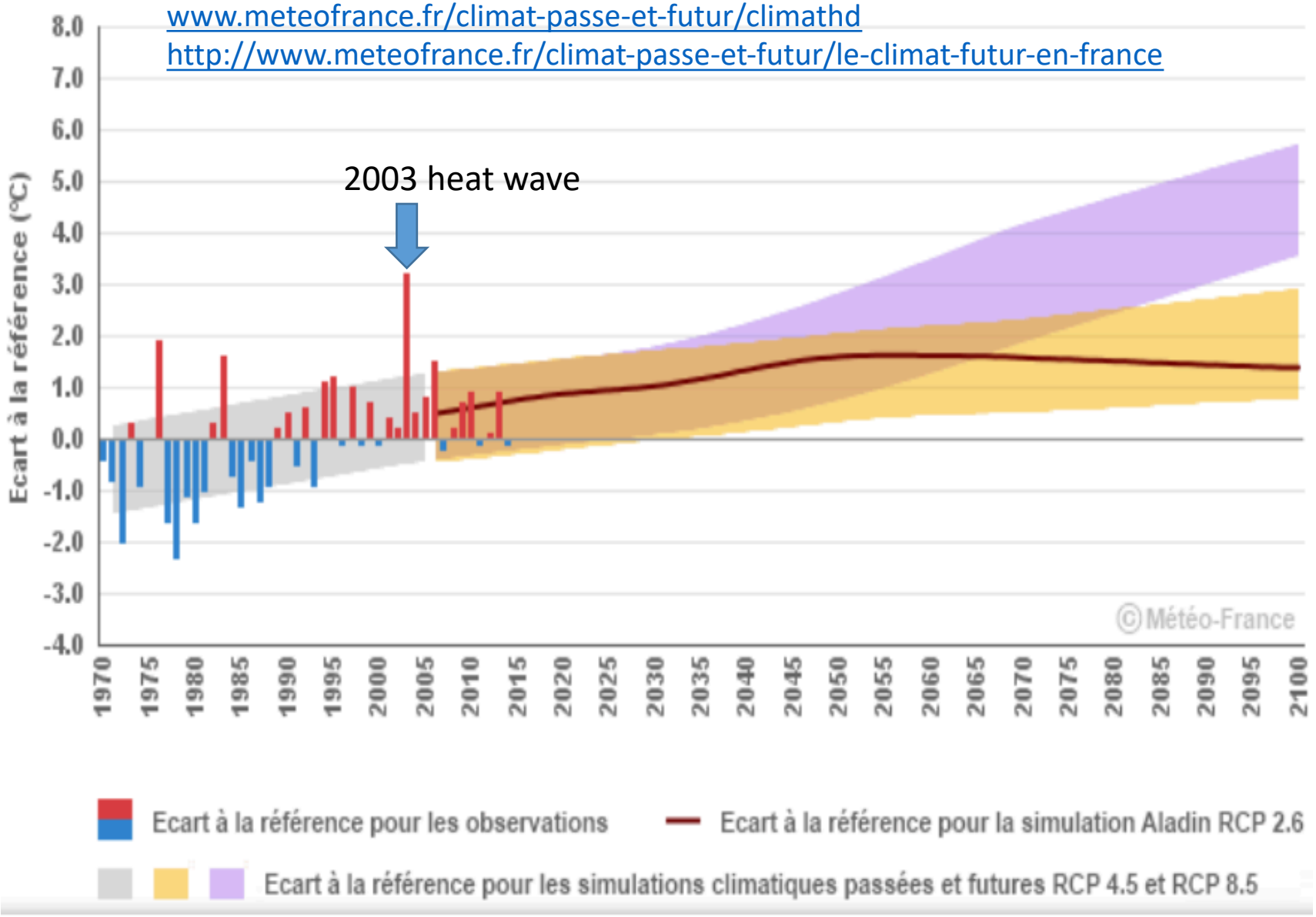
2 Thesis and 1 question:

- Sufficiency (efficiency) actions by individuals are possible ONLY if options / infrastructures / legal frameworks for those actions are created by a collective choices
- Sufficiency (efficiency) actions in buildings are strongly connected with enabling/hindering conditions in cities
- Boundary condition tell us we must use energy sufficiency: would it turn out to be a pleasure?

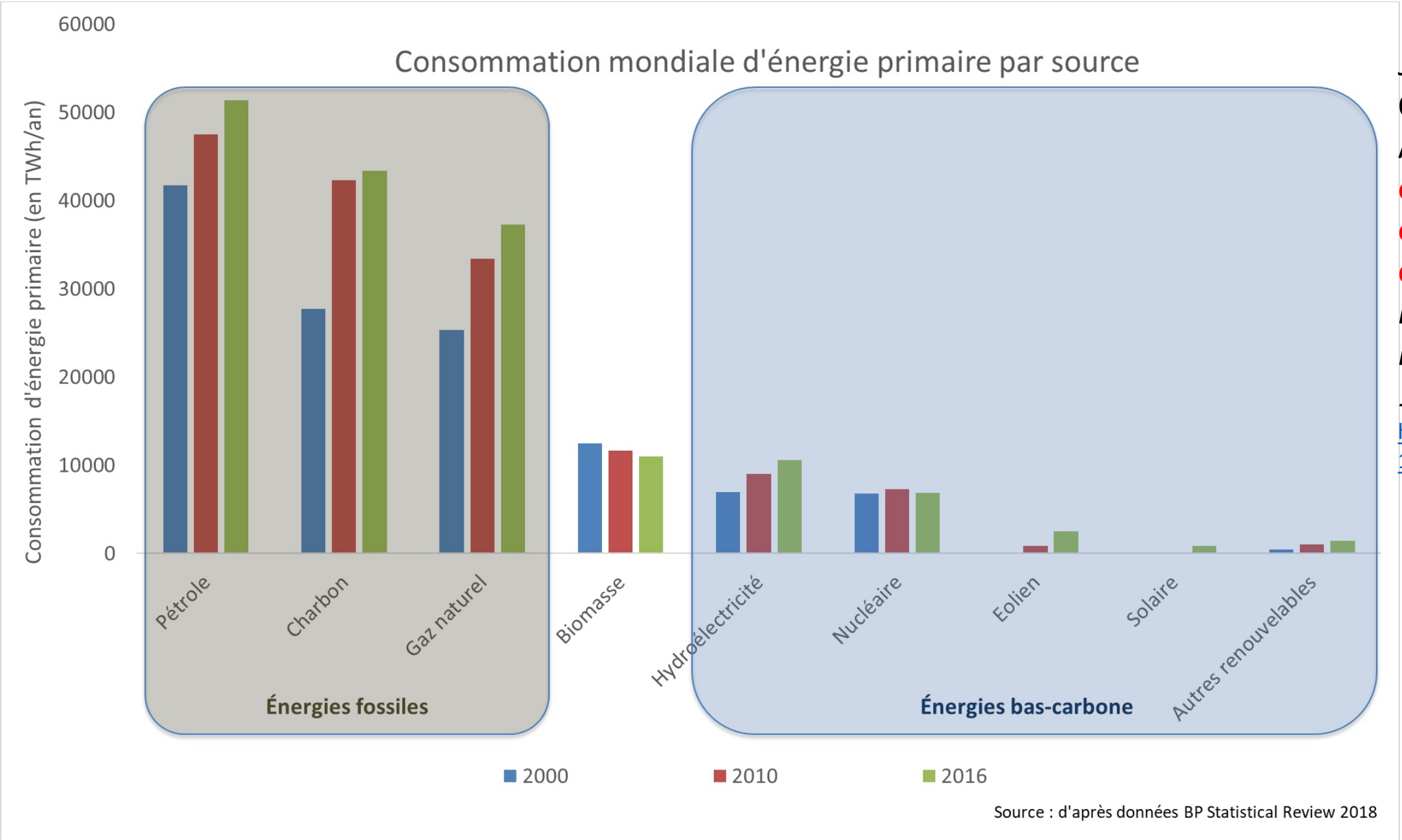
Context 1: Summer extreme temperatures are a serious reality (Paris, Isle de France case)

www.meteofrance.fr/climat-passe-et-futur/climathd
http://www.meteofrance.fr/climat-passe-et-futur/le-climat-futur-en-france



- J. Guiot, (CNRS Climate Laboratory, interview FanceInter 31 October 2016): "Heat waves like the one of 2003 (20 000 deaths in Italy)
- could occur every 5 years in the most favorable scenario and every year in the scenario more unfavorable "

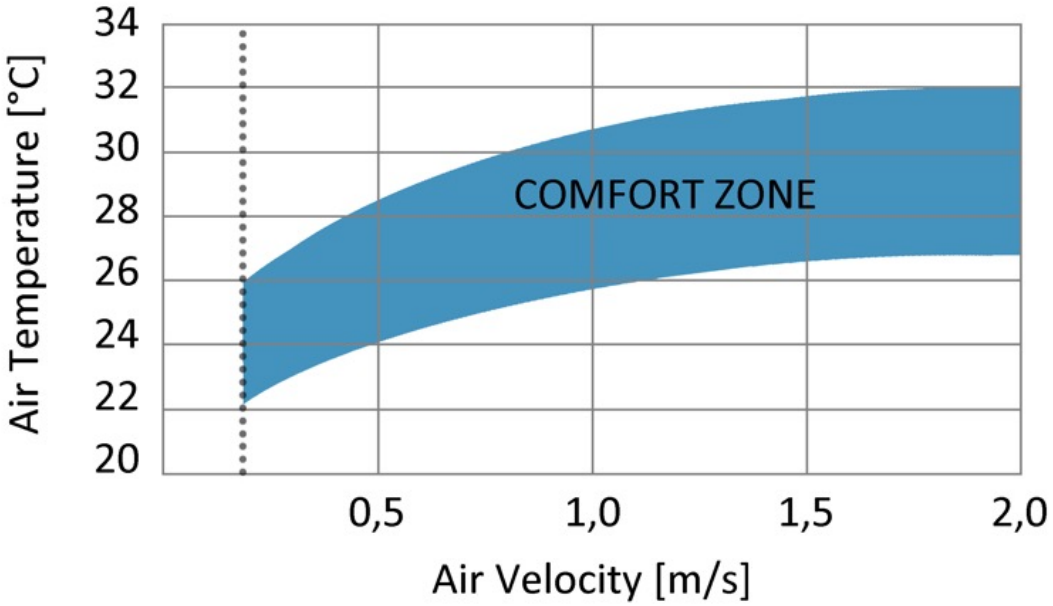
Context 2: We are ADDING energy use, rather than substituting fossil

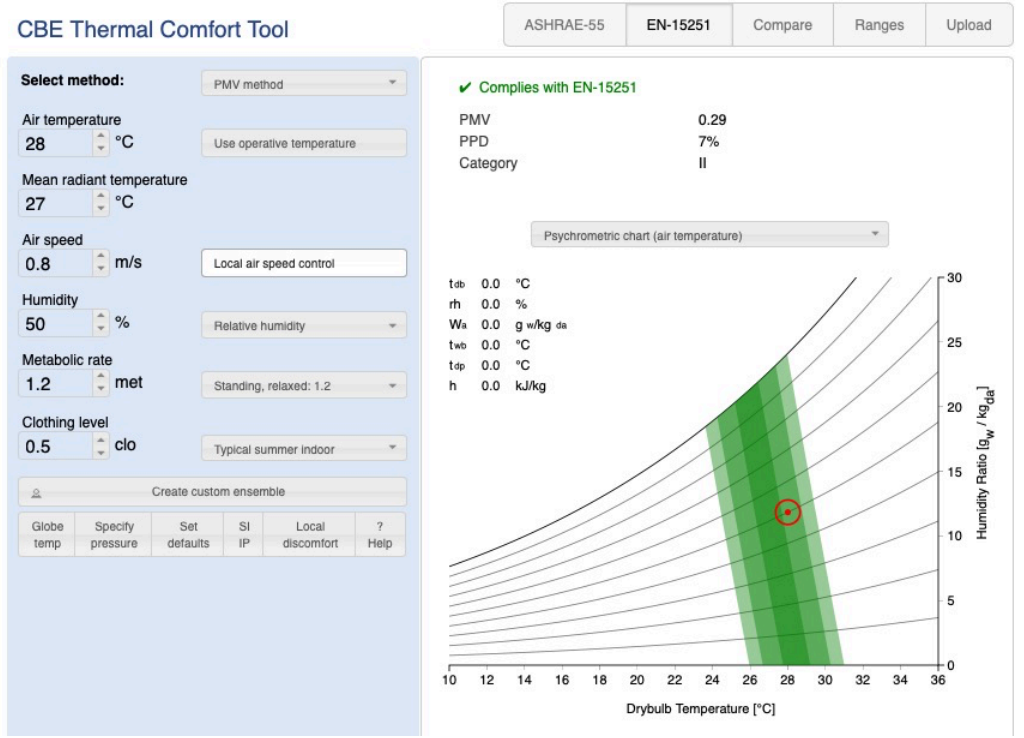


Jackson, R. B., Le Quéré, C., et Al(2018). Global energy growth is outpacing decarbonization. *Environmental Research Letters*, *13*(12), 120401. https://doi.org/10.1088/1748-9326/aaf303

Sufficiency actions in Building →	**Summer night ventilation + ceiling fans** (vs. Air Conditioning)	**Summer night ventilation (vs. Air Conditioning)**	Adequate m2 per capita floor space	**Adopt "sufficient" mobility modes: bicycle, walk, public transport**	**Line drying and water / hot water saving**
In order to perform sufficiency actions, **inhabitants would need:** →	**Silence at night, clean air**	**External air temperature < 20°C at night**	Pleasant common indoor/outdoor spaces to reduce need for individual volumes	Easy access to services, schools, work, Independence for children and elders	**Well designed spaces for line-drying, Water saving devices**
Presently Cities create constraints: →	noise, mainly from cars and motorcycles. PM10, PM2,5 pollution and other air contaminants	asphalt, city canyons	inhospitable districts, obligation for car parking spaces at buildings, free car parking on streets	distance between functions, unacceptable risks for cyclists, pedestrians, handicapped	Dust in air
Cities should offer potentialities: →	Car-free residential districts, zones at 20 or 30 km/h	white/cool surfaces. Geometries facilitating air movement. Water surfaces	walkable, cyclabile districts, green spaces, spaces for playing, spaces in the building for common activities	equitable access to street space, equal access to various transportation modes	Information campaigns on water saving devices, and on the high quality of drinking water from the tap
Legislation and Regulation should address: →	Objective and adequate temperature and humidity set-points in regulation	Mandatory white/cool surfaces, mandatory external solar protections (as e.g. in Switzerland)	Minimum requirements of green spaces, of common spaces for meetings	EPBD (and National build codes): mandatory space for bicycles... in buildings	Mandatory spaces for line drying, mandatory labelling of low-flow water devices

Air movement (e.g. by ceiling fan) allows for summer comfort at relatively high temperatures, according to international Standards ASHRAE 55 2017 and EN 15251.





H. Tyler, S. Stefano, P. Alberto, C. Toby, M. Dustin, and Kyle, 2017, CBE Thermal Comfort Tool. Center for the Built Environment, University of California Berkeley, http://comfort.cbe.berkeley.edu/

ENERGY STAR Most Efficient 2018 — Ceiling Fans

Haiku K3150-X2-PW-04-03-C

- Aerodynamic design (10 times less energy use than a conventional fan, already low)
- Accurate mechanical balancing of blades ensures silent operation
- Incorporates high efficiency – high colour quality LED lighting
- Passive Infrared presence sensor turns off the fan when room unoccupied
- Remote control via smartphone

Humidity has a low effect on Comfort

(ISO 7730)

Földváry Ličina, V., Pagliano, L. et Al. (2018).

Development of the ASHRAE Global Thermal Comfort Database II. Building and Environment, 142, 502–512. https://doi.org/10.1016/j.buildenv.2018.06.022

Fig. 3. Location of the field studies contained in the ASHRAE Global Thermal Comfort Database II.

Building and Environment

2018 Best Paper Award

CBE Thermal Comfort Tool

ASHRAE-55 | EN-15251 | Compare | Ranges | Upload

CBE Thermal Comfort Tool

ASHRAE-55 | EN-15251 | Compare | Ranges | Upload

Select method: PMV method

Air temperature: 27 °C — Use operative temperature

Mean radiant temperature: 27 °C

Air speed: 0.6 m/s — Local air speed control

Humidity: 80 % — Relative humidity

Metabolic rate: 1.2 met — Standing, relaxed: 1.2

Clothing level: 0.5 clo — Typical summer indoor

Create custom ensemble

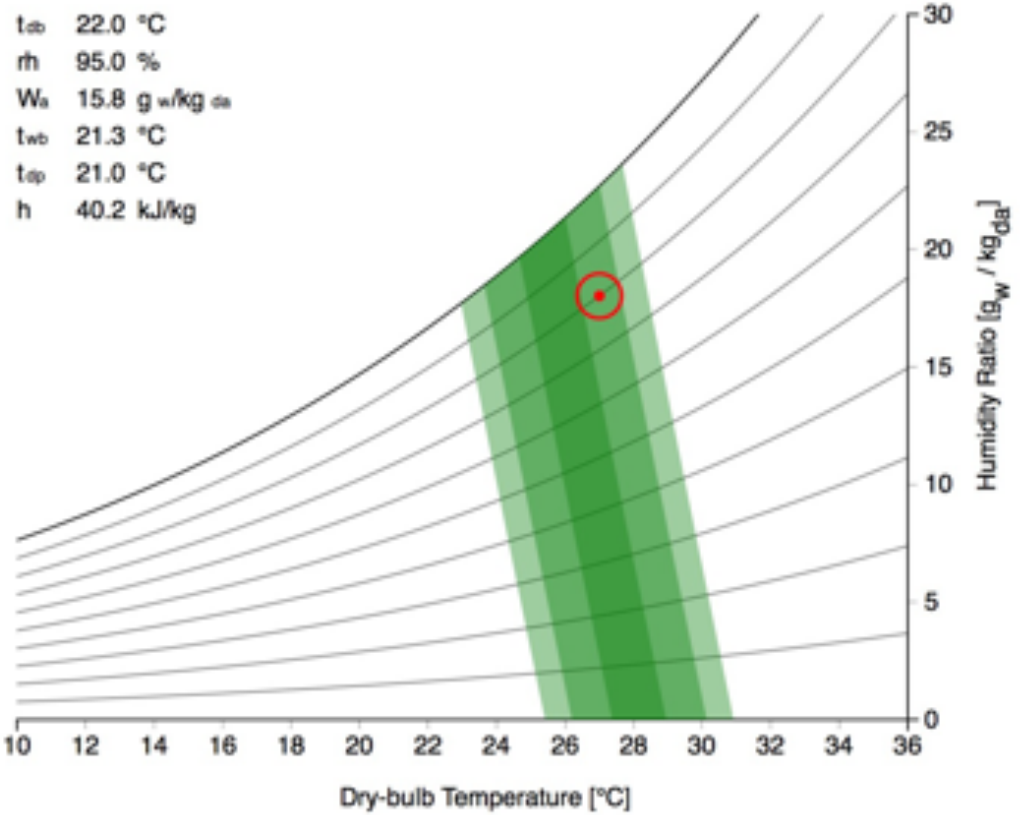
Globe temp | Specify pressure | Set defaults | SI IP | Local discomfort | ? Help

✔ Complies with EN-15251

PMV	0.34
PPD	7%
Category	II

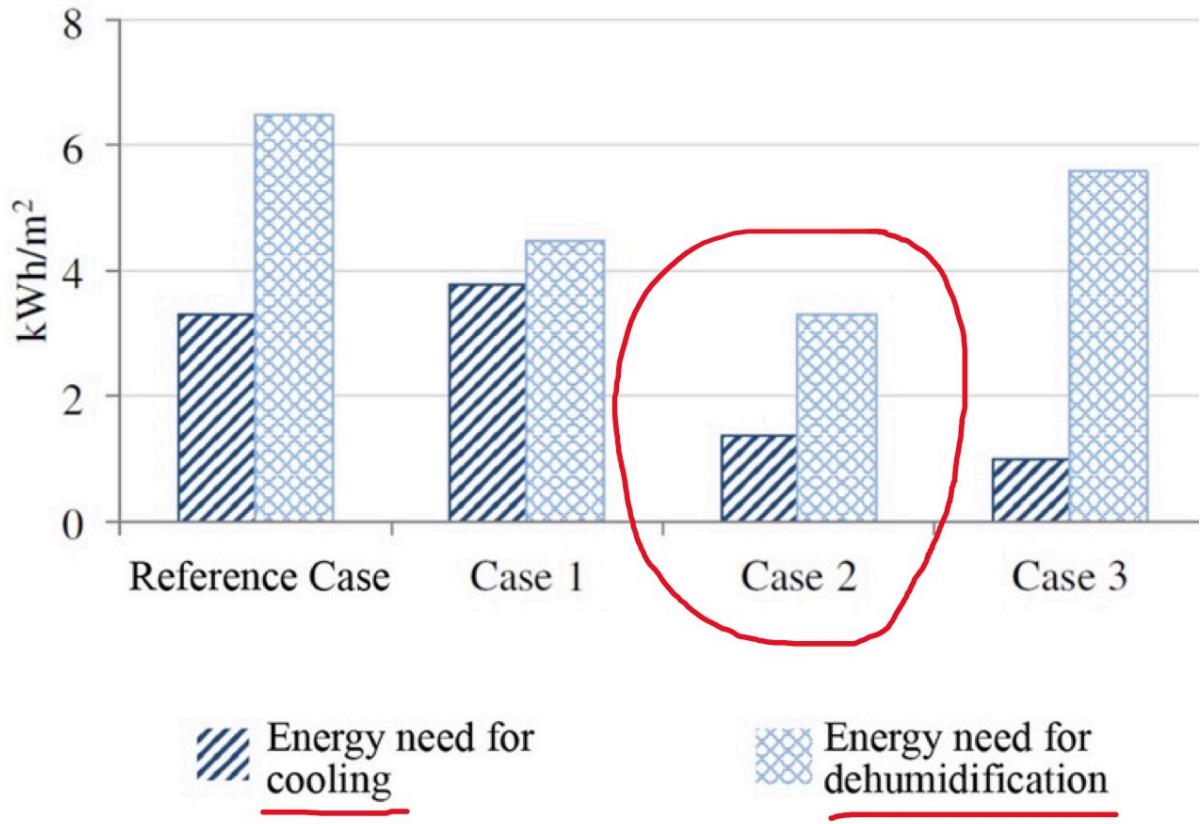
Psychrometric chart (air temperature)

t_{db}	22.0 °C
rh	95.0 %
W_a	15.8 g w/kg da
t_{wb}	21.3 °C
t_{dp}	21.0 °C
h	40.2 kJ/kg



SIMULATION	Top	R.U.	v	PMV	clo	met
	°C	%	m/s	-	-	-
Reference case	26	60	0.01	0.5	0.5	1.2
Case 1	25.7	70	0.01	0.5	0.5	1.2
Case 2	27.3	70	0.5	0.5	0.5	1.2
Case 3	27.6	60	0.5	0.5	0.5	1.2

While humidity control in summer has important effects on energy use



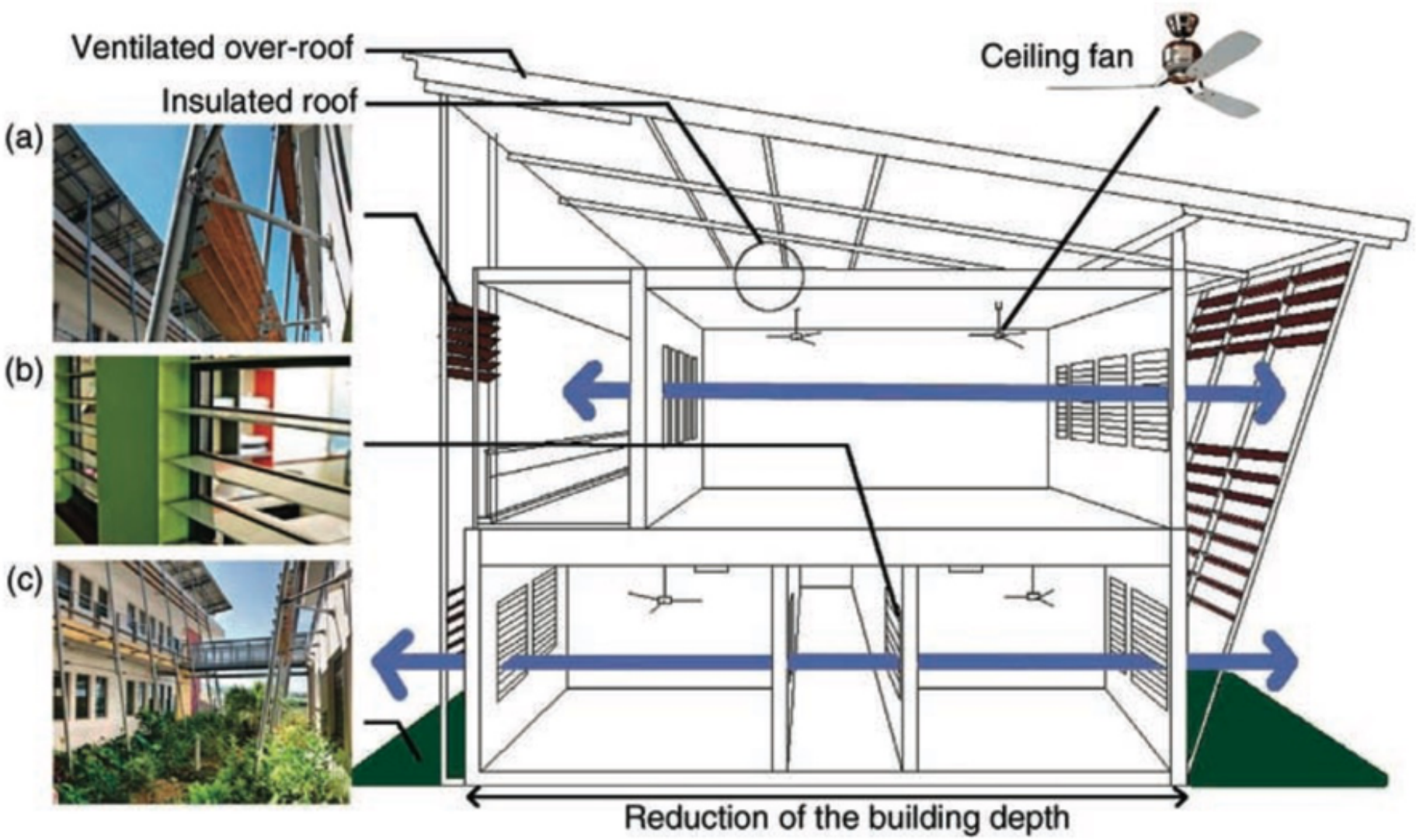
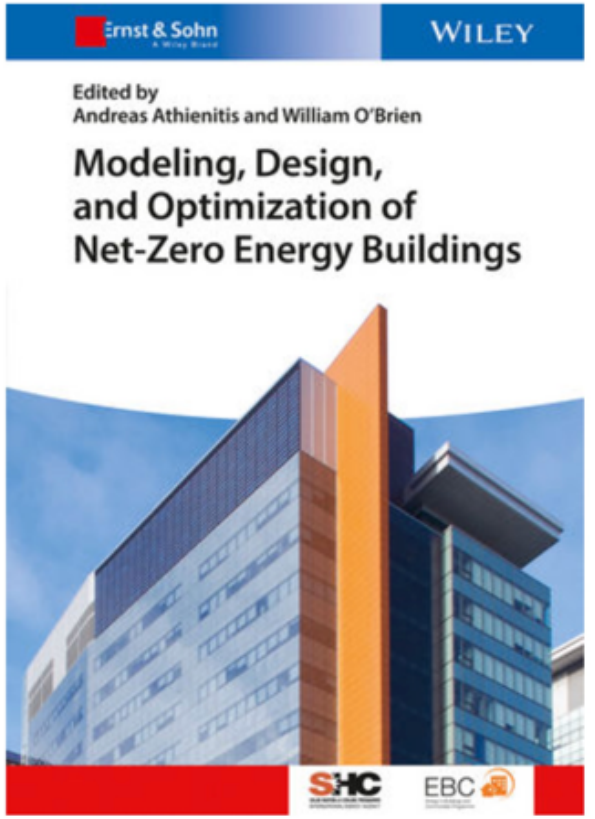


Fig. 7.73 Main features of the Net ZEB design of the ENERPOS building: (a) Exterior fixed sol

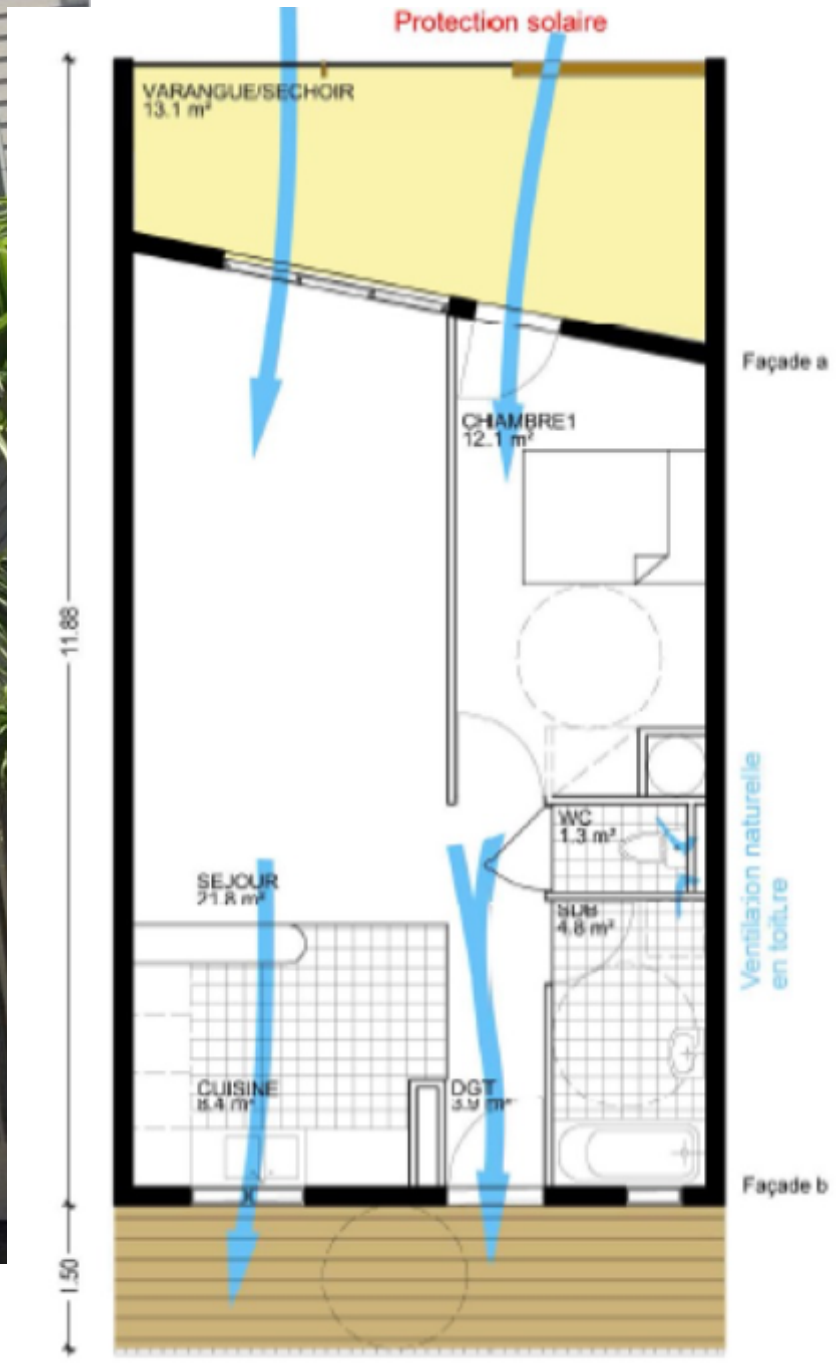
5 min



- 85% reduction in energy use for cooling vs other buildings on campus,
- high majority of comfort votes by students

Opération Florès Malaca, Le Port, La Réunion

Architectes : Perrau et Reynaud



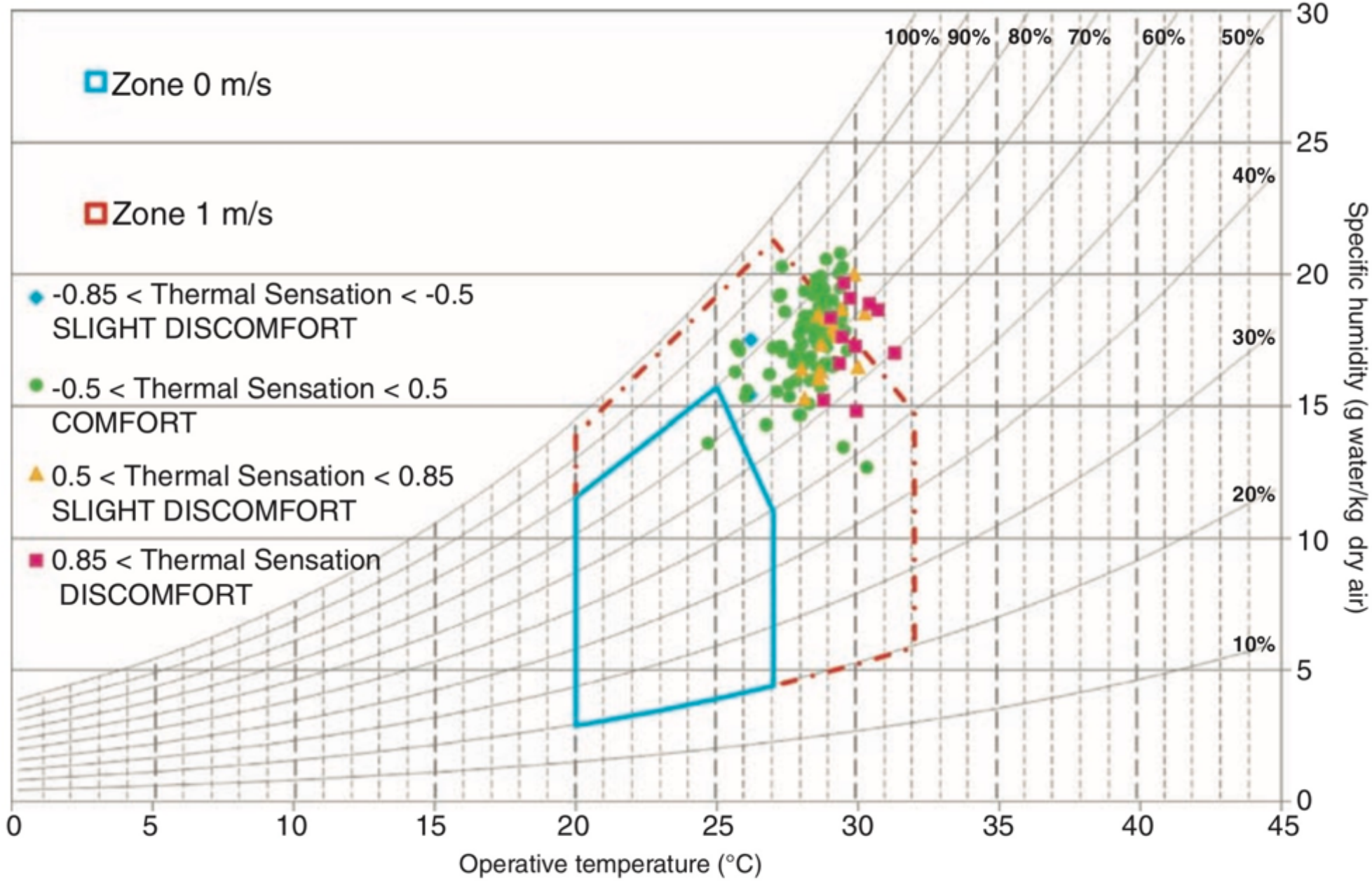
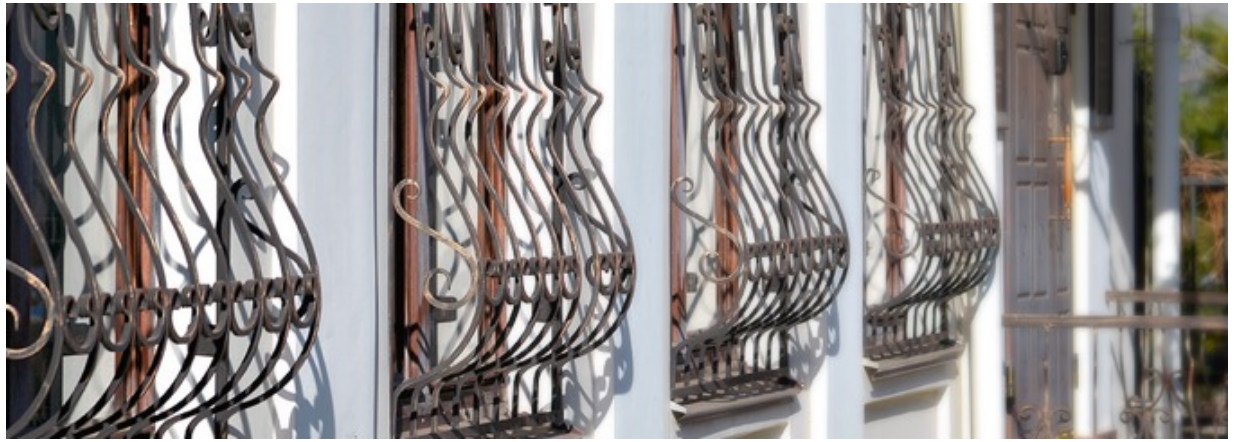


Fig. 7.82 Experimental data from the thermal comfort survey plotted with the Givoni comfort zones

Movable External solar protections devices and well designed ant-intrusion structures to enable night ventilation have long been part of architectural design



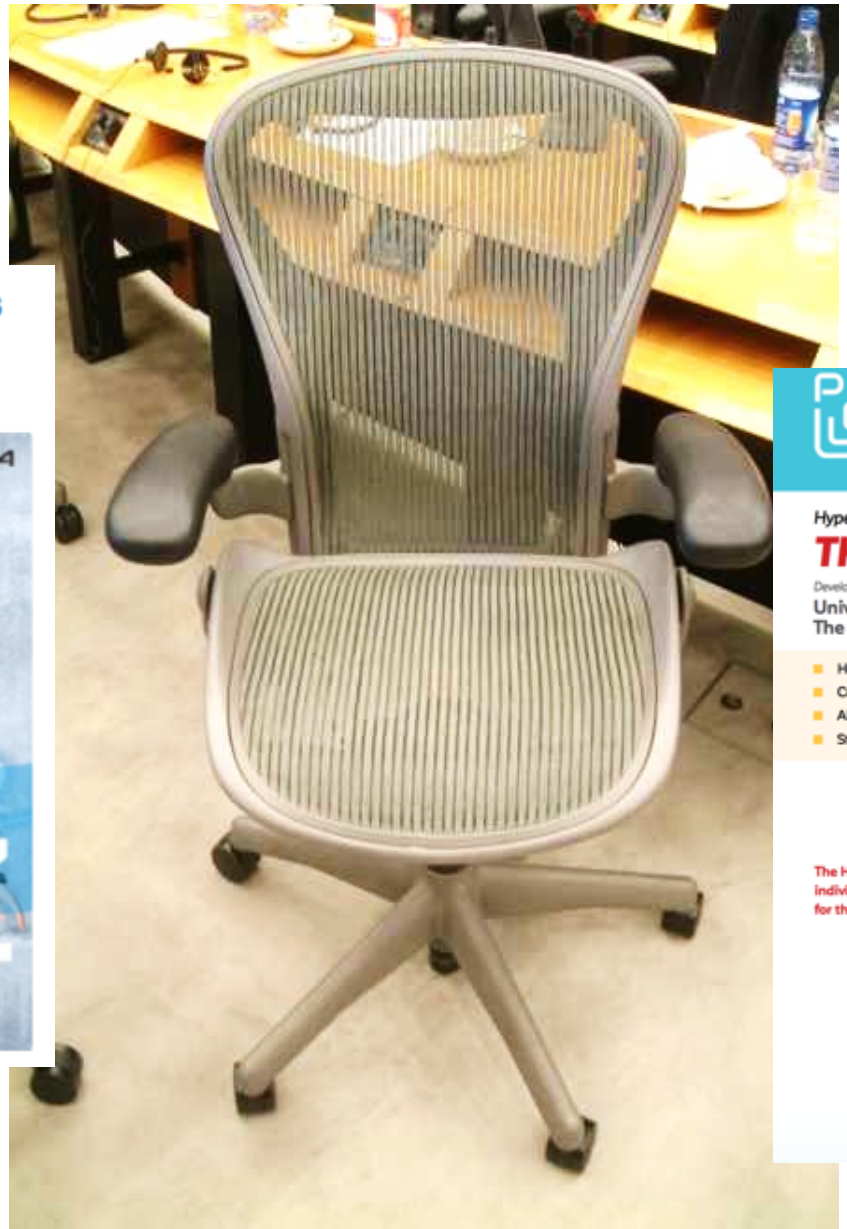
- Swiss regulation (SIA):
- Winter: high termal insulation levels, high performance windows…
- Summer: active air conditioning systems are authorized only after verification that building fabric has been done right (thermal insulation, thermal mass, solar protections, night ventilation)
- external solar protections (with specified total solar transmittance value) are mandatory by law.
- City of **Zurich** verifies (via the public energy utility) the peak summer demand and compares with authorization to install Air Conditioning (private communication at IEA annex meeting)

Solar protection of public spaces can reduce outdoor temperature -->

- outdoor comfort
- enabling ventilative cooling in buildings

Reduction of insulation around the body, as evaluated by ISO7730 & EN15251

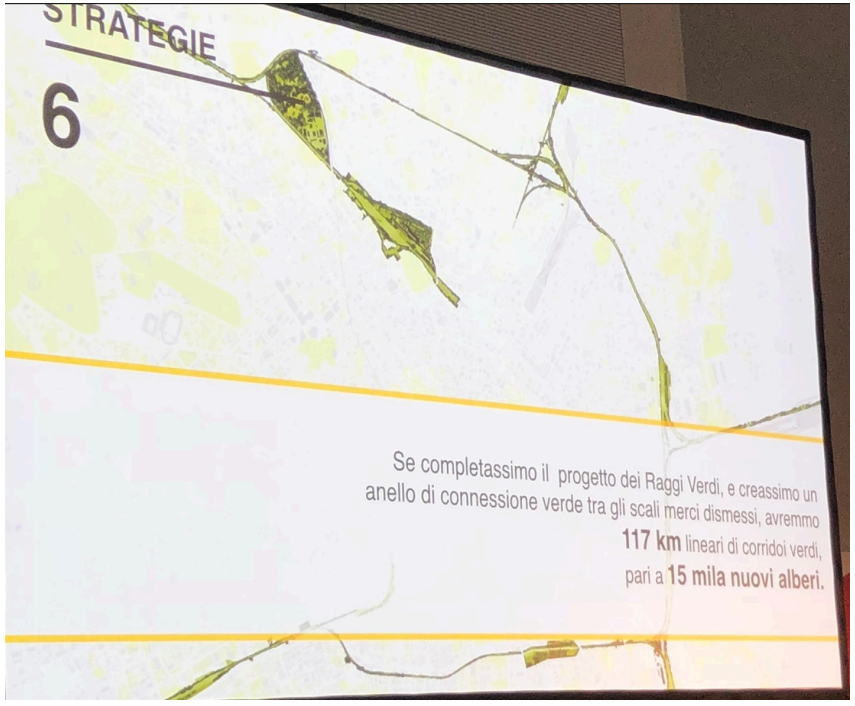
- Flexible clothing code (i.e. Japan, United Nations,…)



- Chair with low thermal resistance (ISO 7730)

City of Milano to add 3 million new trees by 2030 ?

- green canopy in Milano is just 7% of the urban area.
- Frankfurt is at 21.5% , Amsterdam at 21 % Paris at 9 % (World Economic Forum's Green View Index).
- In Milano the night-time temperature can be 6 °C higher than in the surrounding area.
- Milan endures 35 tropical nights (> 20 °C) a year.
- Are the planned new green areas sufficient ?



For individuals to practice night ventilation, external air should be at < 20-22°C --> need for cool surfaces, free of cars

224 C. DE MUNCK *et al.*

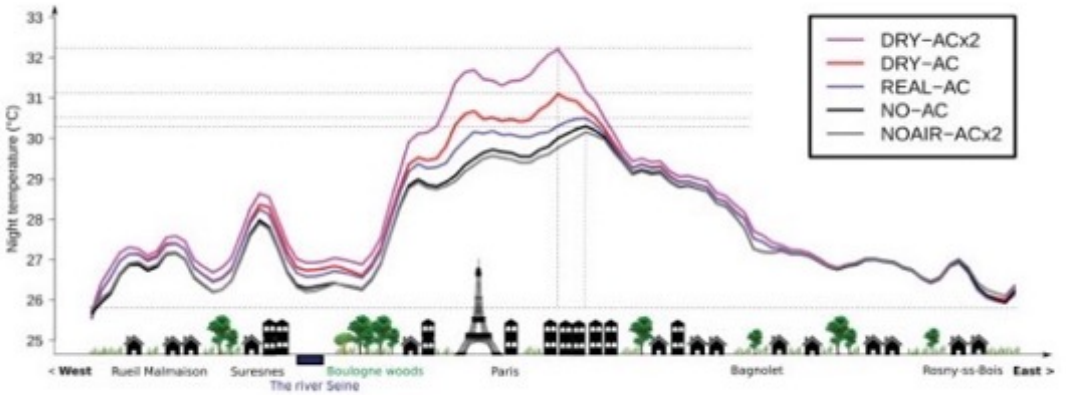
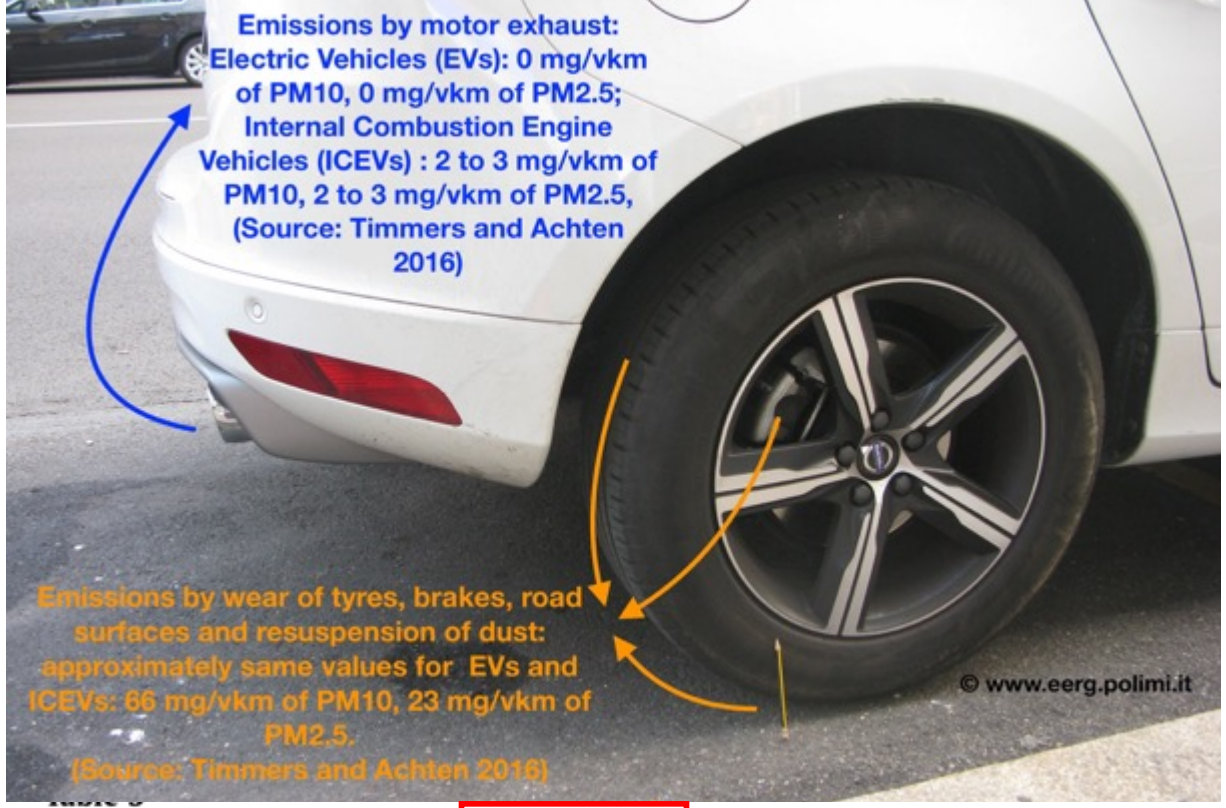


Figure 11. Temperature profiles showing Paris UHI for a west-to-east section passing through the warmest districts of inner Paris (8, 9 and 10, as shown by the black line in Figure 7 for the NO-AC scenario).

10 min

The Praça do Toural, Portugal.



Night ventilation (5-10 Ach) requires clean air and this requires less and lighter cars, independently of the motor

Contents lists available at ScienceDirect

Atmospheric Environment

journal homepage: www.elsevier.com/locate/atmosenv

Review article

Non-exhaust PM emissions from electric vehicles

Victor R.J.H. Timmers [a, *], Peter A.J. Achten [b]

Comparison between expected PM_{10} emissions of EVs, gasoline and diesel ICEVs.

Vehicle technology	Exhaust	Tyre wear	Brake wear	Road wear	Resuspension	Total
EV	0 mg/vkm	7.2 mg/vkm	0 mg/vkm	8.9 mg/vkm	49.6 mg/vkm	**65.7 mg/vkm**
Gasoline ICEV	3.1 mg/vkm	6.1 mg/vkm	9.3 mg/vkm	7.5 mg/vkm	40 mg/vkm	**66.0 mg/vkm**
Diesel ICEV	2.4 mg/vkm	6.1 mg/vkm	9.3 mg/vkm	7.5 mg/vkm	40 mg/vkm	**65.3 mg/vkm**

Table 6

Comparison between expected $PM_{2.5}$ emissions of EVs, gasoline and diesel ICEVs.

Vehicle technology	Exhaust	Tyre wear	Brake wear	Road wear	Resuspension	Total
EV	0 mg/vkm	3.7 mg/vkm	0 mg/vkm	3.8 mg/vkm	14.9 mg/vkm	**22.4 mg/vkm**
Gasoline ICEV	3.0 mg/vkm	2.9 mg/vkm	2.2 mg/vkm	3.1 mg/vkm	12.0 mg/km	**23.2 mg/vkm**
Diesel ICEV	2.4 mg/vkm	2.9 mg/vkm	2.2 mg/vkm	3.1 mg/vkm	12.0 mg/vkm	**22.6 mg/vkm**

La stratégie d'Oslo pour réduire, voire éliminer, les voitures personnelles

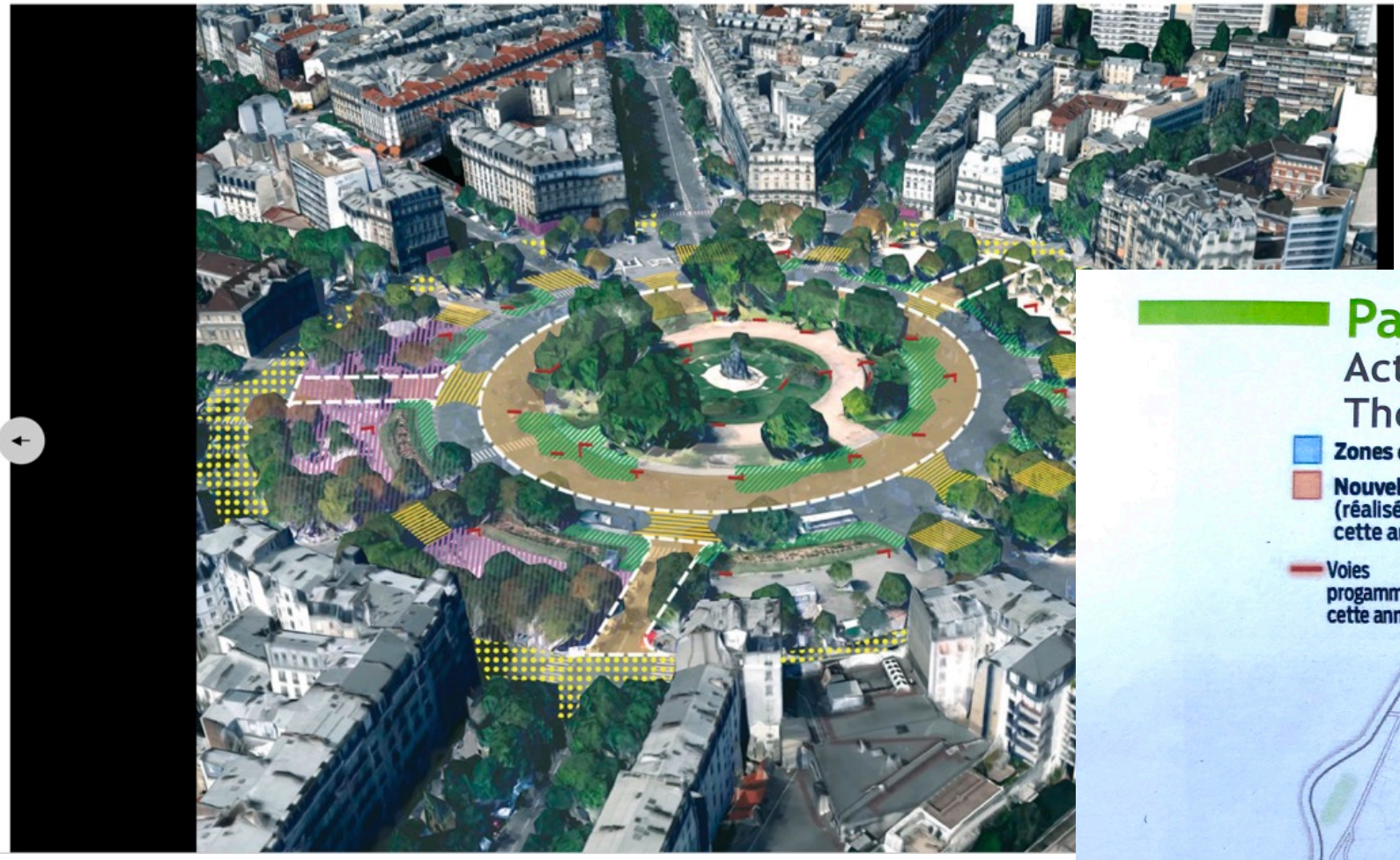
La capitale norvégienne abandonne la notion de transport public pour se lancer dans la « mobilité comme service ». Objectif : supprimer la voiture.

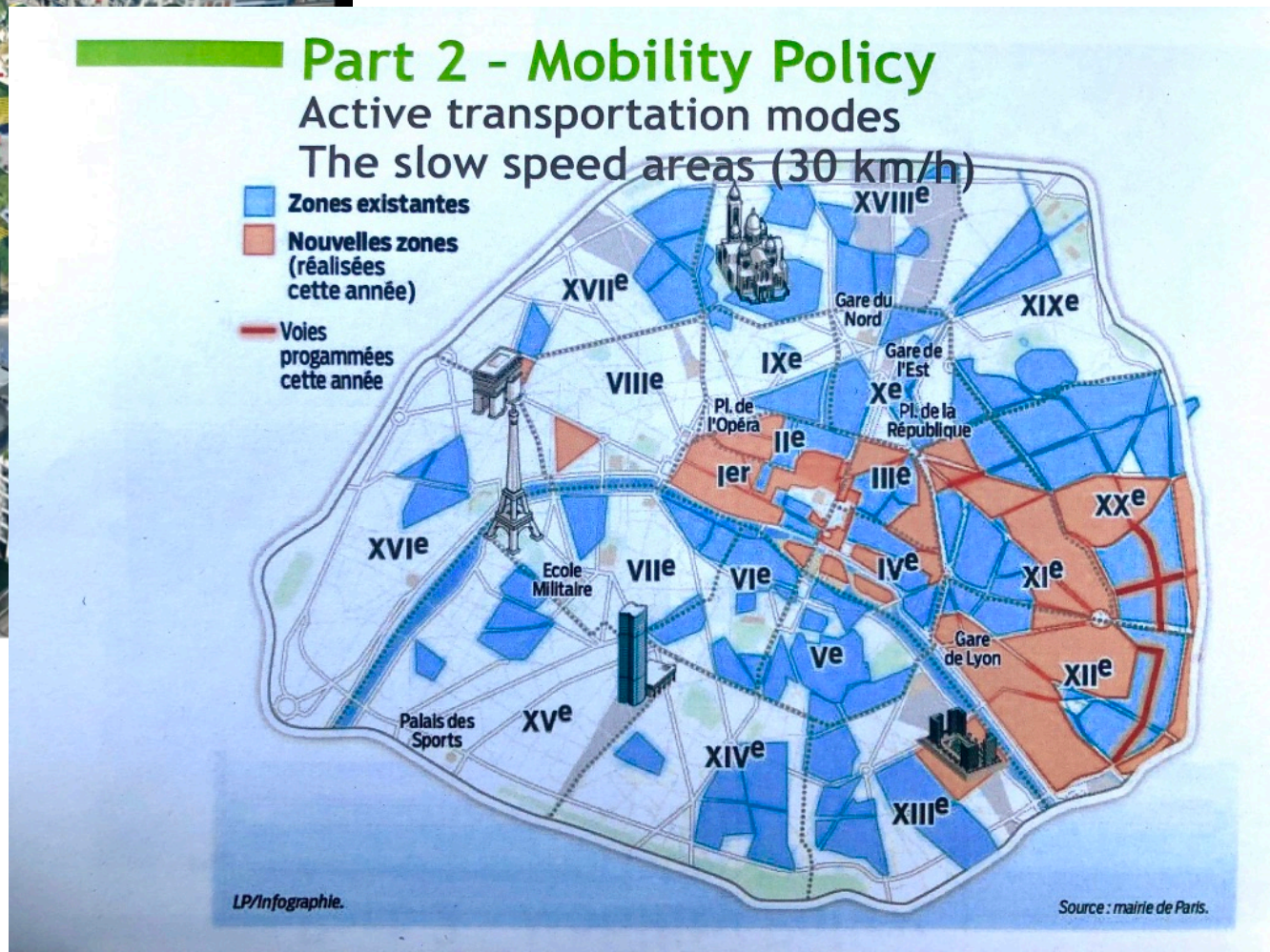
LE MONDE | 03.11.2017 à 17h54 • Mis à jour le 03.11.2017 à 18h18 | Propos recueillis par Francis Pisani

Tramways et piétons dans une rue d'Oslo. Metrocentric - Wikimedia - CC BY 2.0

Paris Is Redesigning Its Major Intersections For Pedestrians, Not Cars

The new designs make sure pedestrians get at least 50% of the public space, lanes of traffic be damned.





https://www.fastcompany.com/3058685/paris-is-redesigning-its-major-intersections-for-pedestrians-not-cars

https://www.paris.fr/velo

Why Paris will be the first post-car metropolis

'The city's parking spaces will become bike or scooter paths, café terraces or playgrounds'

Simon Kuper

SEPTEMBER 7, 2017 by Simon Kuper

Source: Financial Times
https://www.ft.com/content/1b785f3e-9299-11e7-a9e6-11d2f0ebb7f0

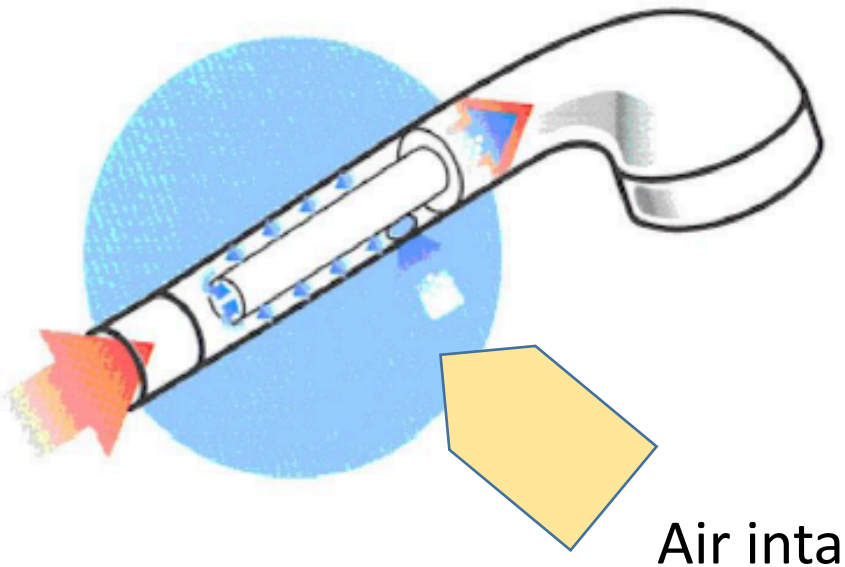
»Sufficient« mobility actions require infrastrucure

- *Proposed Amendement 405 to EPBD:*
  4a.Member States shall ensure that in all new buildings and in all buildings undergoing major renovation, at least a space for bicycles, cargo-bicycles, e-bikes, pedelec, walking frames, wheel-chairs and push-chairs is created; the space shall be common, covered, theft-protected, free of architectural barriers and proportional to the number of users of the building;
- Rejected at the ITRE meeting on October 11, 2017,
- included in milder form in EPBD recitals

In Switzerland, faucets and shower-heads with low water flow are certified by laboratory measures with labeling.

Low flow is e.g. mandatory in Portugal.

	Standard water volume
Class A =	≥ 4 to < 6 litres/minute
Class B =	≥ 6 to < 9 litres/minute
Class C =	≥ 9 to < 12 litres/minute
Class D =	≥ 12 to < 15 litres/minute
Class E =	≥ 15 to < 18 litres/minute
Class F =	≥ 18 to < 21 litres/minute
Class G =	≥ 21 litres/minute



Air intake due to Venturi effect

Line drying requires
- infrastructure
- clean air

- E.g. Venice traditional line drying
- E.g. the loft of Casa Batlló building from Gaudi was a service area with laundry rooms and storage areas. It contains a series of sixty catenary arches
- https://en.wikipedia.org/wiki/Casa_Batlló#/media/File:Casa_Batlló_Parabolic_Arches.jpg

- Brent Toderian (Former Vancouver chief planner, Council for Canadian Urbanism)
- Jan Ghel (Denmark & world): «human scale cities»
- Janette Sadik Kahn (2007-13, New York City's Department of Transportation, 500 km bike lanes)

New New Urbanism in USA

"The goal: resilient, equitable, carbon-neutral cities that *people want to live in*

That's the *new* New Urbanism."

https://medium.com/age-of-awareness/new-urbanism-isnt-dead-but-thanks-to-climate-change-it-is-evolving-de2080b8986b
https://www.cnu.org/resources/what-new-urbanism

https://www.theguardian.com/cities/2018/feb/28/child-friendly-city-indoors-playing-healthy-sociable-outdoors

eERG
end-use Efficiency Research Group
Gruppo di ricerca sull'efficienza negli usi finali dell'energia

POLITECNICO MILANO

www.eerg.it

Thank you for your attention

Some parts of the this presentation have been prepared in the context of the AZEB projects

AZEB
Affordable Zero Energy Buildings

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