Activitats i línies de recerca

Albert Castell

SEMB research group, Universitat de Lleida

SUSTAINABLE ENERGY MACHINERY & BUILDINGS

www.semb.udl.cat

Sustainable Energy, Machinery and Buildings (SEMB) group.
Universitat de Lleida

Equip investigador

Professors

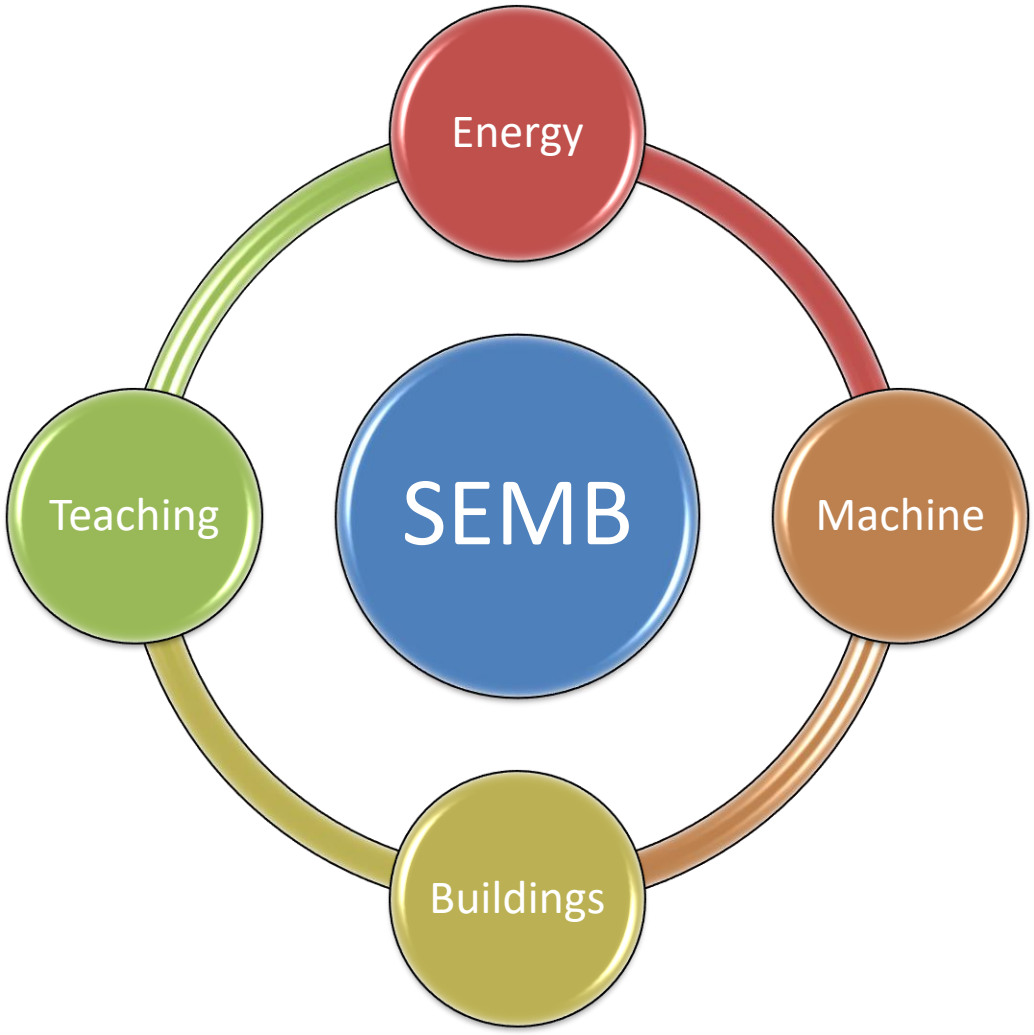
- Dr. Marc Medrano
- Dr. Cristian Solé
- Dra. Ingrid Martorell
- Dr. Albert Castell
- Dra. Lídia Rincón
- Dr. Joan Roca
- Dr. Miquel Nogués
- Dr. Marti Comellas
- Javier Bradineras

Investigadors i col·laboradors

- Sergi Vall
- Ariadna Carrobé
- Giovana Godinho
- Xavier Terribas

- 5 Enginyers Industrials
- 2 Enginyers Químics
- 1 Enginyer Agrònom
- 1 Arquitecta

Línies d'investigació



Sistemes constructius de baix impacte ambiental

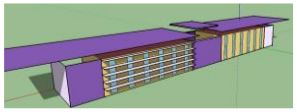
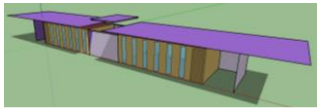
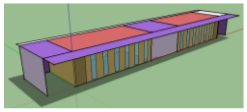
- Construcció amb sistema Earthbag

Emsimision Training Medical Center, Ouagadougou,, Burkina Faso

Taller Campus de Cappont, Lleida, Spain

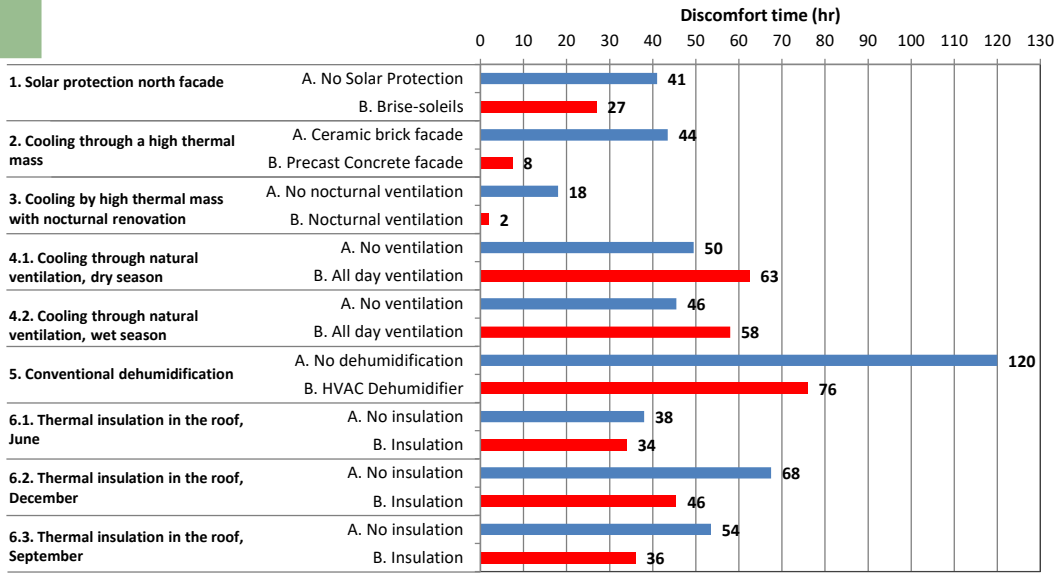
Arquitectura bioclimàtica



1st – Cooling by high thermal mass with nocturnal renovation: 89% improvement.
2nd – Cooling through a high thermal mass: 83% improvement.
3rd – Solar protection on the north facade: 34% improvement.
4th – Thermal insulation in the roof during the Solstice of December and the Equinox of September: 33% improvement.

ASHRAE55 Adaptive Comfort Model
80% Acceptability Limits
Occupied Hours



Confort tèrmic

Ouagadougou, Burkina Faso.

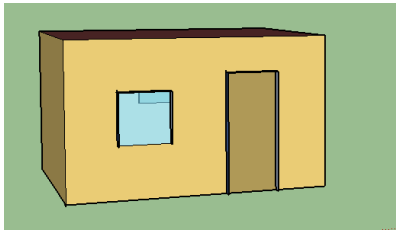
Traditional Burkinabe dwelling
Adobe brick façade (15 cm)
& metal sheet roof

Innovative earthbag building
Rammed earth envelope (32 cm)

Net floor area of 15.90 m^2

Confort tèrmic

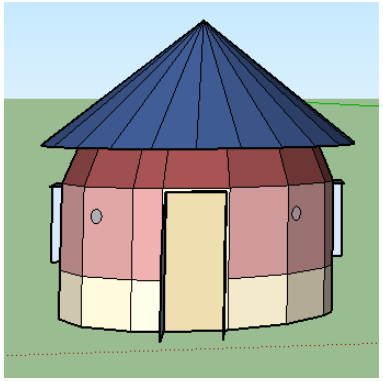
Traditional Burkinabe dwelling



System	Material	Width cm	λ W/mK	Cp J/kgK	ρ kg/m³
Facade	Adobe brick	15	0.95	920	1600
Roof	Metal sheet	0.3	50	450	7800
Exterior Coating	Earthen coating (chalk)	3	1	1000	1600
Interior Coatings	Earthen coating (clay)	1	0.8	1000	1600

Timetable	People activity
6AM-8AM	100 W/pers
8AM – 6PM	-
6PM – 10PM	100 W/pers
10PM – 6AM	80 W/pers

Innovative earthbag building



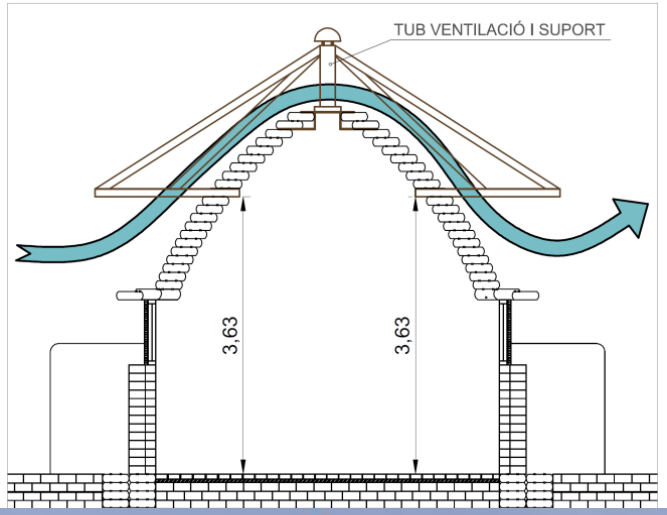
System	Material	Width cm	λ W/mK	Cp J/kgK	ρ kg/m³
Facade	Earthbag	32/64	1,1	1000	2190
Roof	Earthbag	32	1,1	1000	2190
Exterior coating	Earthen coating (chalk)	3	1	1000	1600
Interior coating	Interior coating (clay)	1	0,8	1000	1600

ASHRAE Standard 55 Adaptive Comfort model

Confort tèrmic

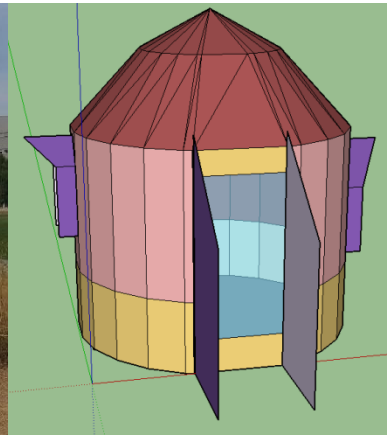
- **Estratègies de disseny bioclimàtic:**

1. Ús de materials amb gran inercia tèrmica a la façana i sostre.
2. Efecte d'ombres sobre l'edifici (doble coberta ventilada).
3. Ús de ventilació creuada nocturna (11 P.M. a 8 A.M.)

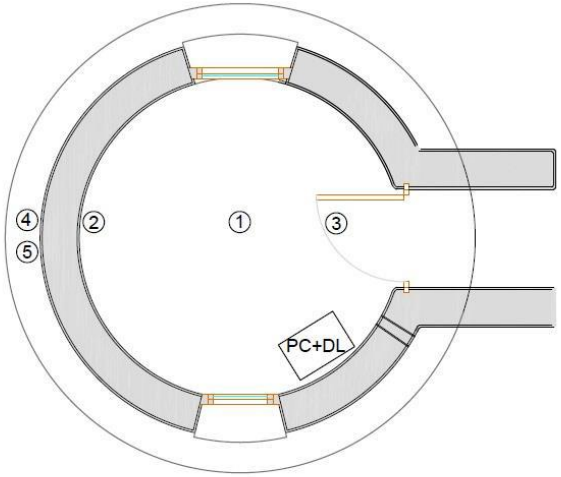


Confort tèrmic

Validació experimental

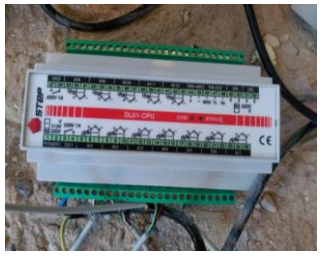


- Contrafuerte 64 cm
- Fachada 32 cm
- Cubierta 32 cm
- Elementos de sombra



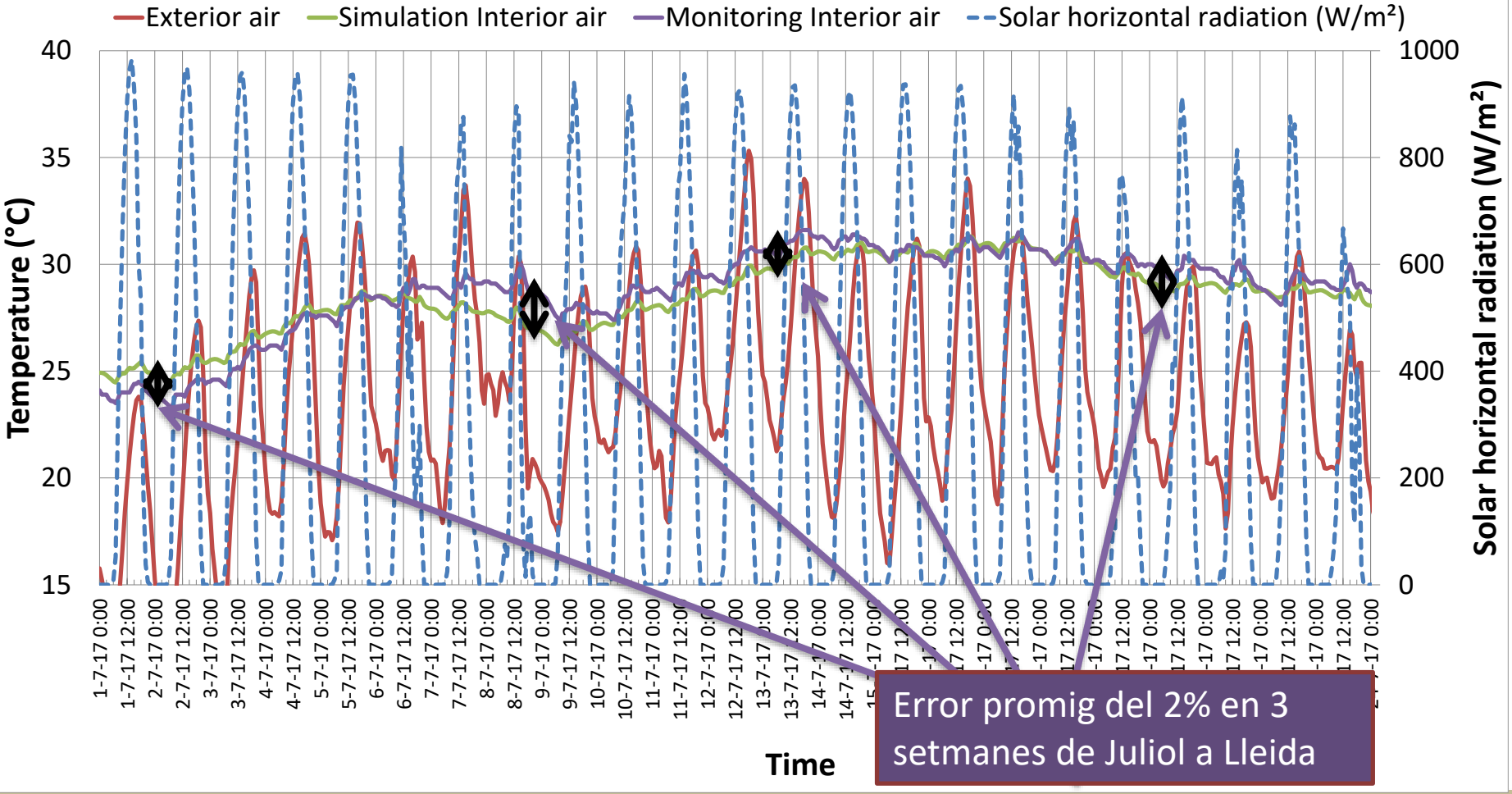
Temperatures:

1. Interior air: at 1.50 m high.
2. North wall inside: at 1.50 m high.
3. South wall inside: at 2.20 m high.
4. North wall outside: at 1.50 m high.
5. Exterior air: at 1.50 m high.



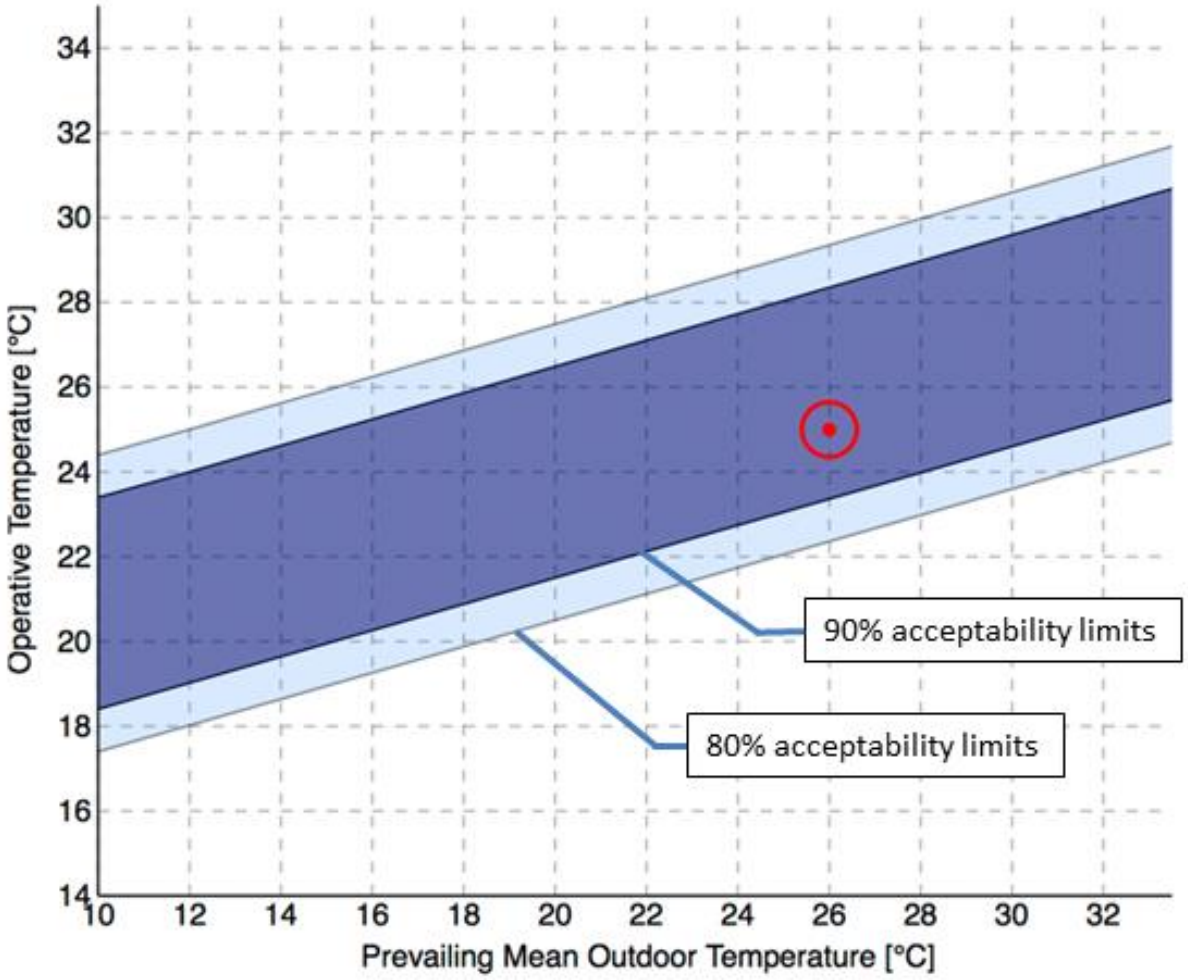
Línies d'investigació – Energia i Edificis

Confort tèrmic



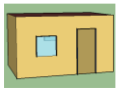
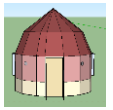
Confort tèrmic

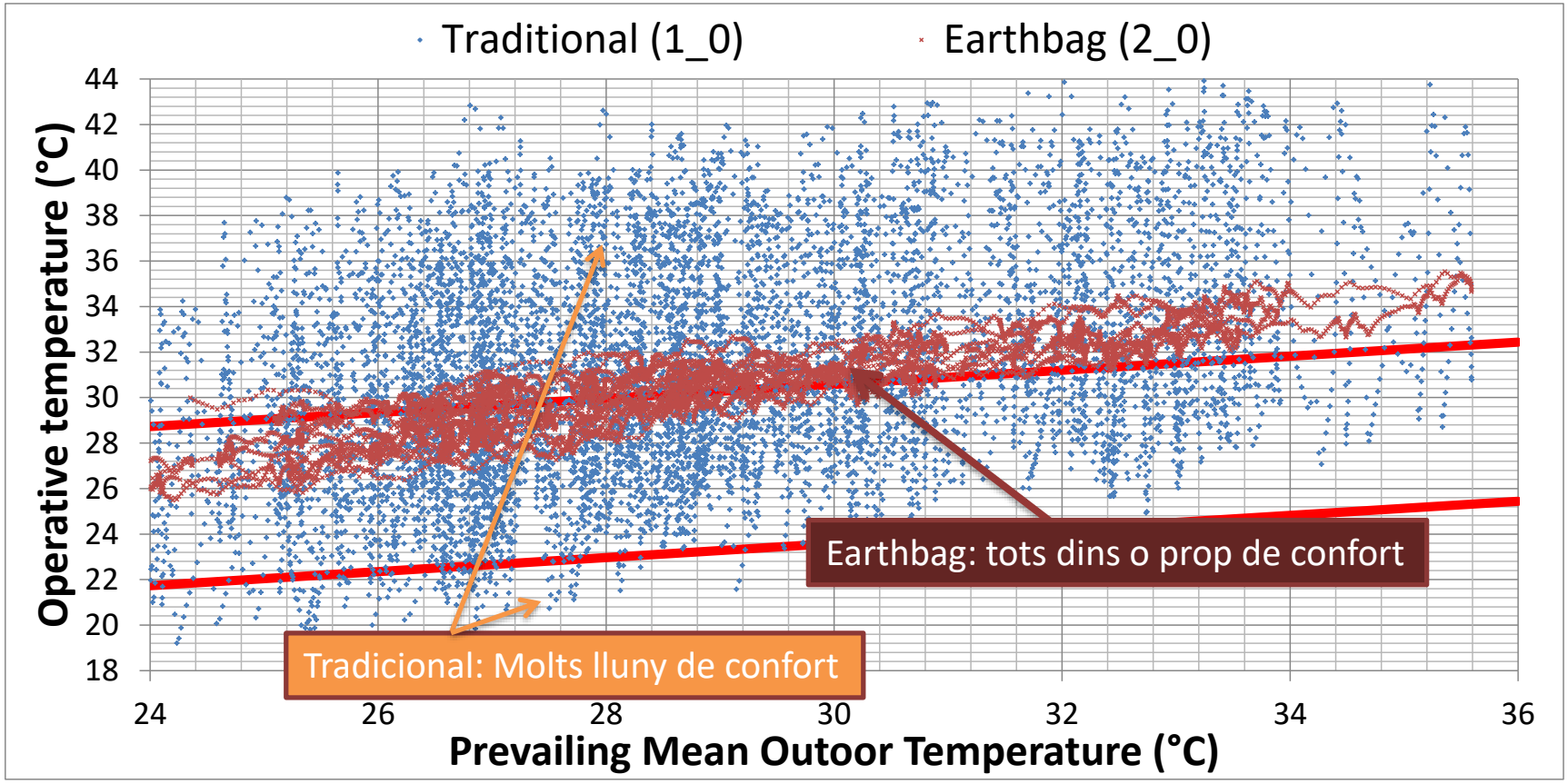
Adaptive Comfort, ASHRAE Standard 55



Confort tèrmic

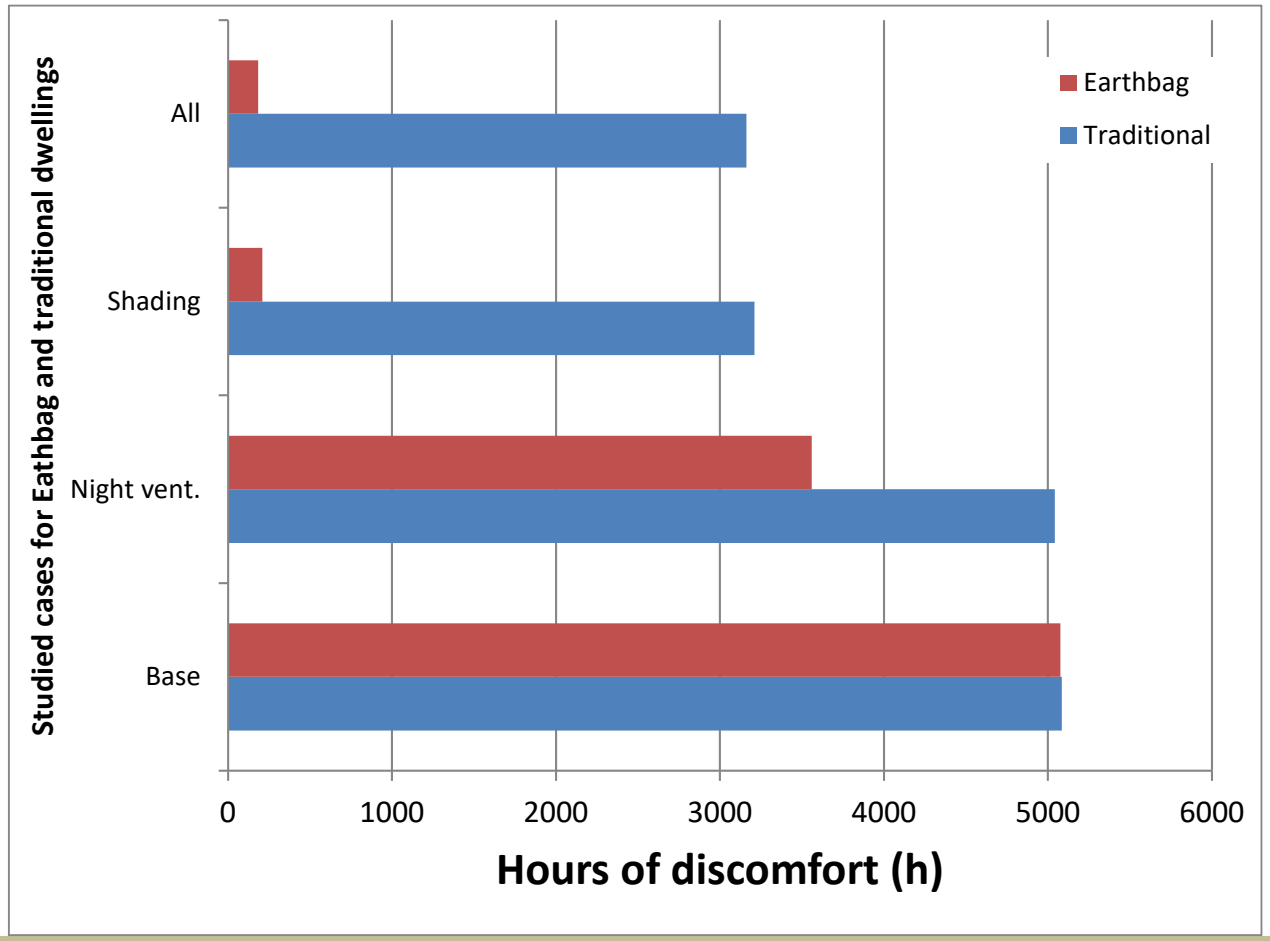
Temperaturas operativas vs temperatura media exterior

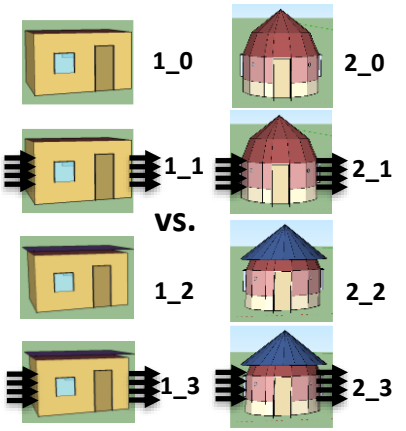

vs.




Confort tèrmic

1_0 to 1_3 vs 2_0 to 2_3, hores anuals de desconfort



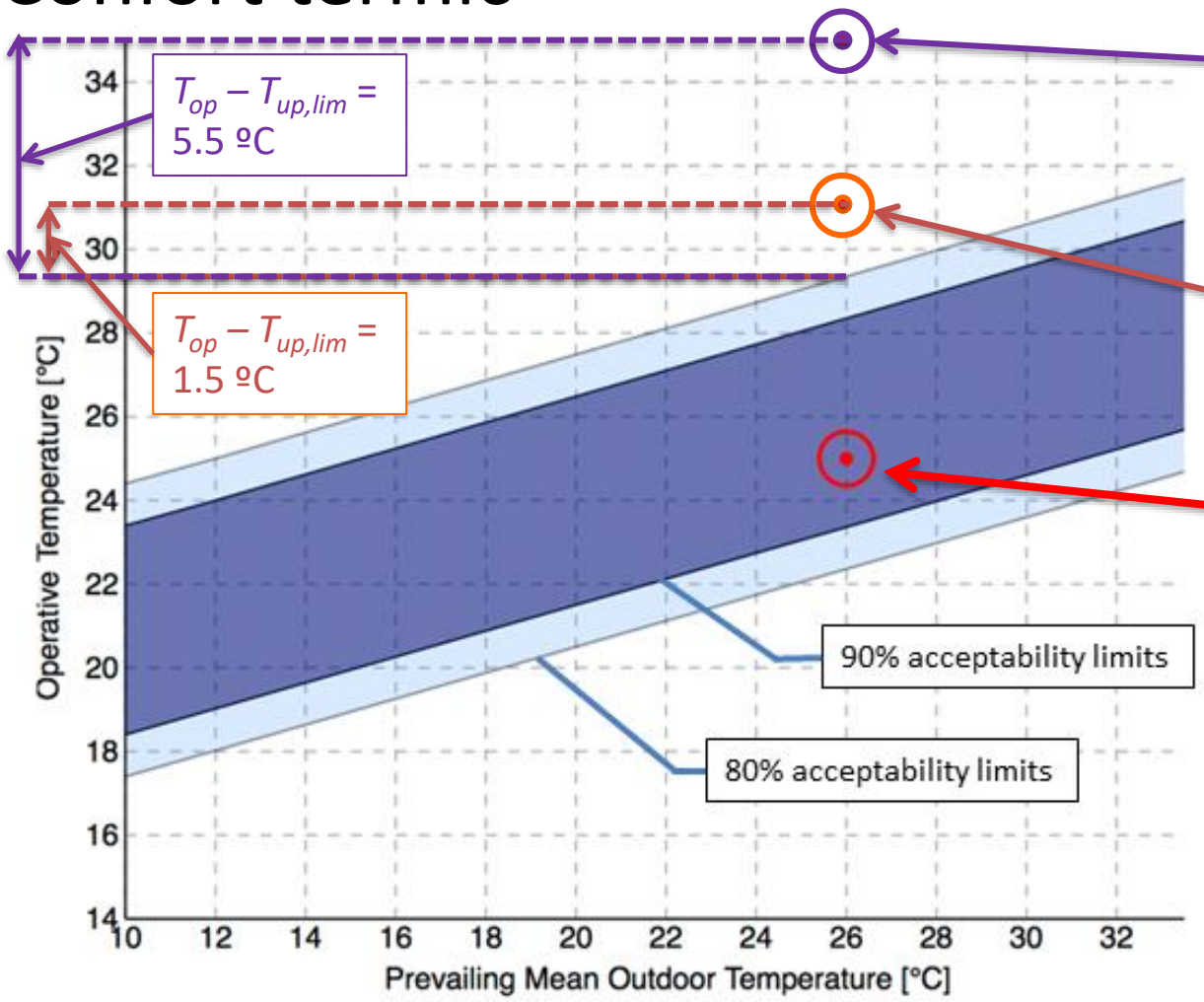


Confort tèrmic

- Proposta d'un **nou paràmetre:** graus dia de desconfort (**DDD**).
- S'inspira en la definició clàssica de graus dia, però en base als límits de confort adaptatiu.
- Intenta capturar el major grau de desconfort si la temperatura operativa està més allunyada dels límits de confort.

$$DDD = \frac{\sum_{1}^{8760} \left(T_{op} - T_{up,\lim}\right)_{\left(\left(T_{op} - T_{up,\lim}\right) > 0\right)} + \sum_{1}^{8760} \left(T_{low,\lim} - T_{op}\right)_{\left(\left(T_{low,\lim} - T_{op}\right) > 0\right)}}{24}$$

Confort tèrmic



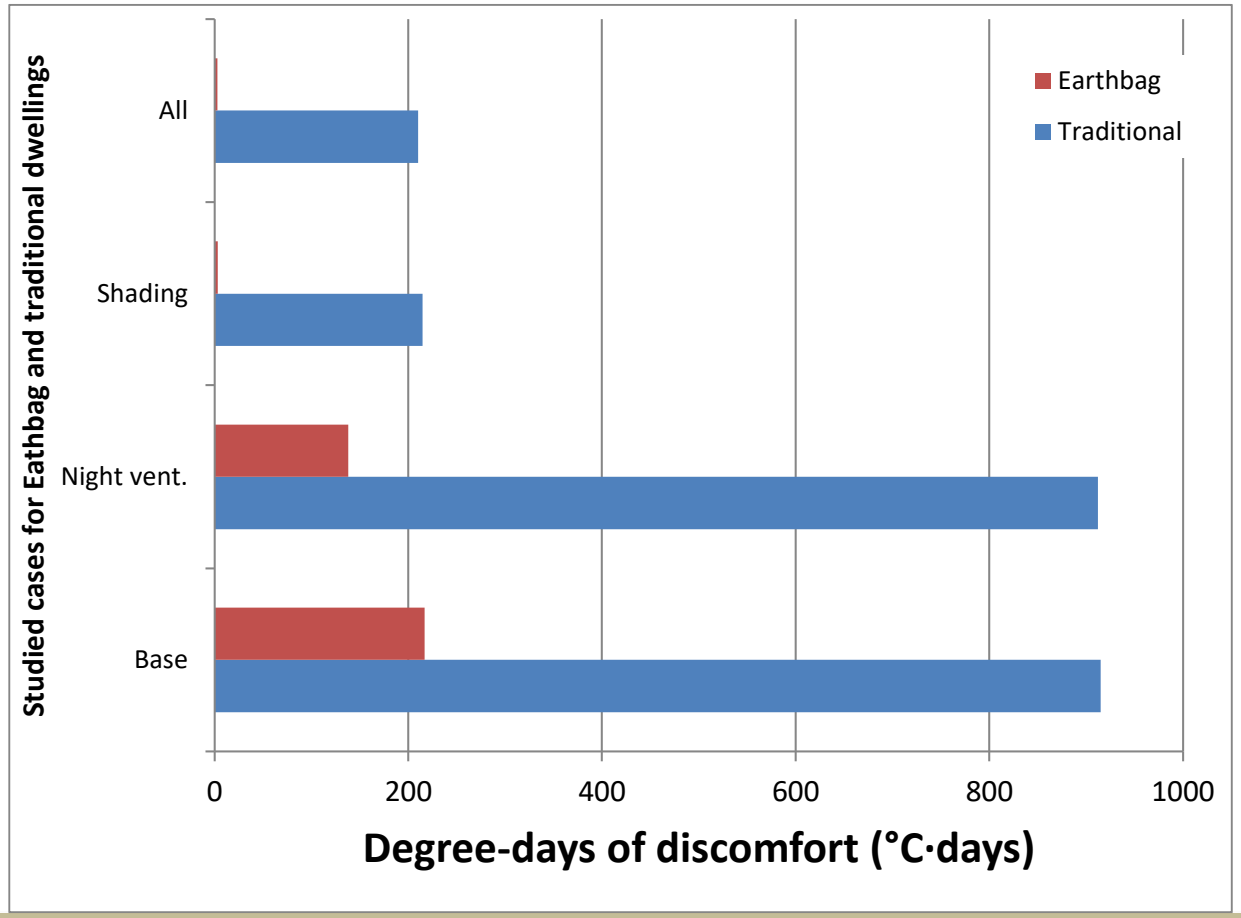
Més fora de límits
Major desconfort
DDD = 5.5/24

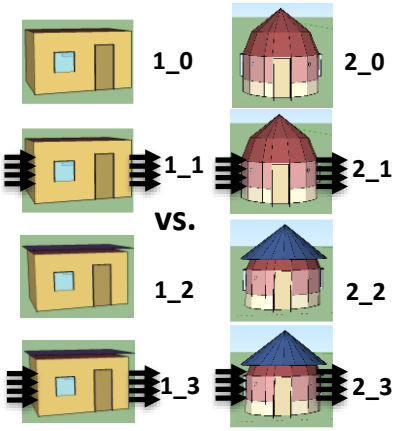
Fora de límits
Lleuger desconfort
DDD = 1.5/24

Dins de límits
DDD = 0

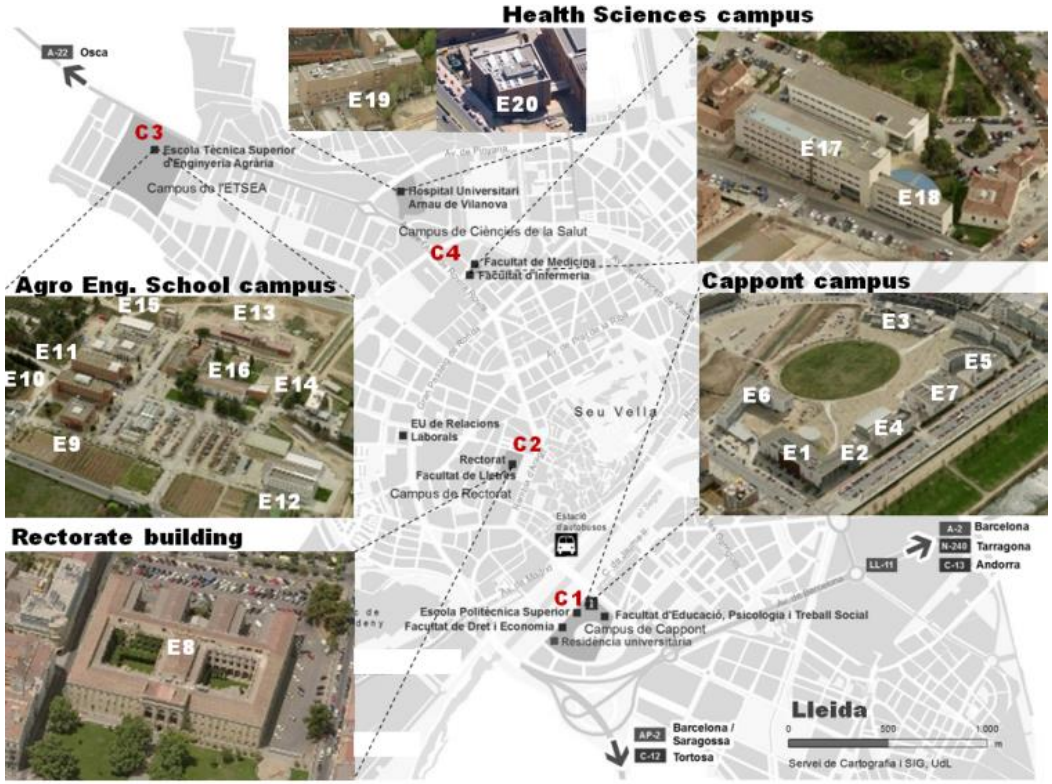
Confort tèrmic

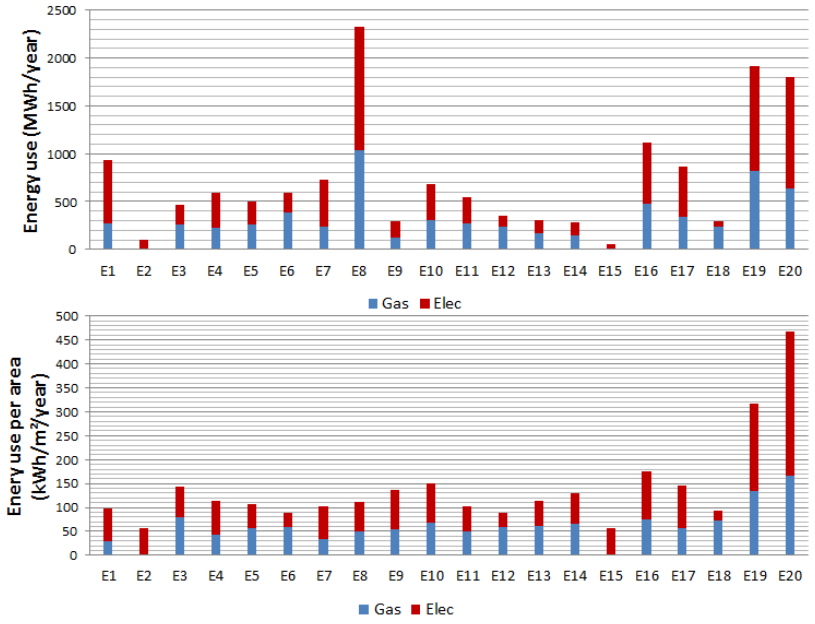
1_0 to 1_3 vs 2_0 to 2_3, graus dia anuals de desconfort





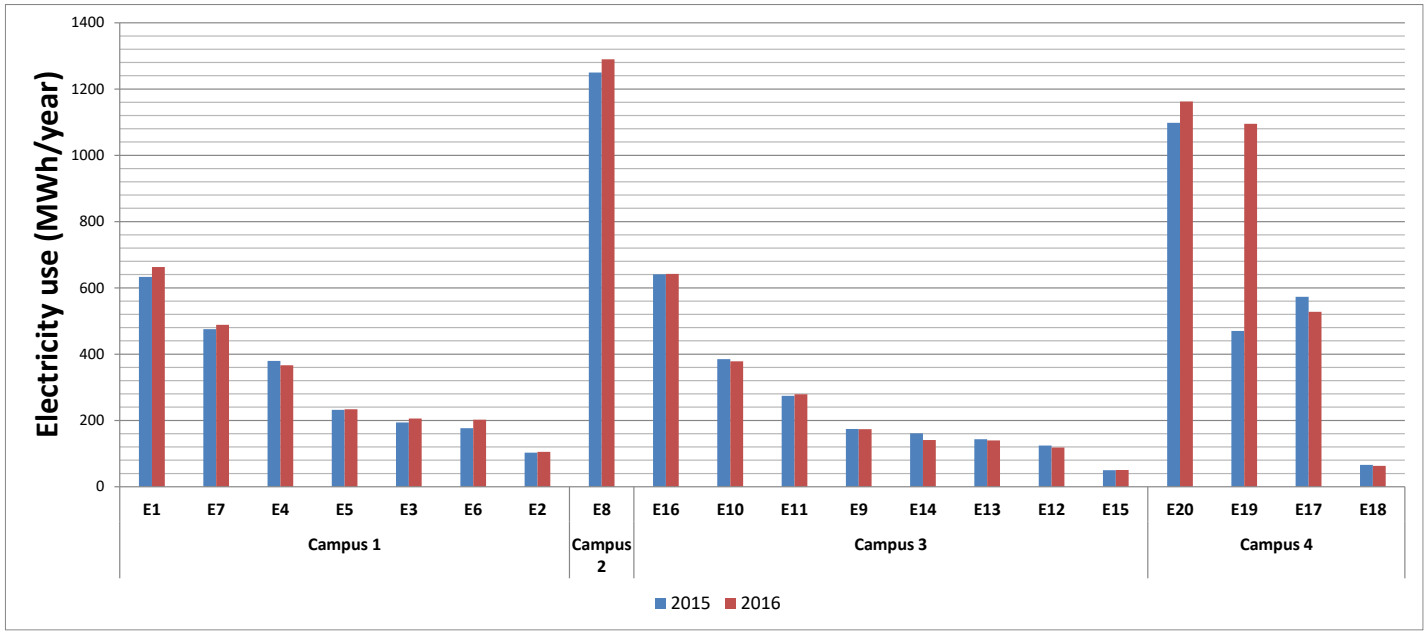
Edificis de consum d'energia gairebé nul (nZEB)

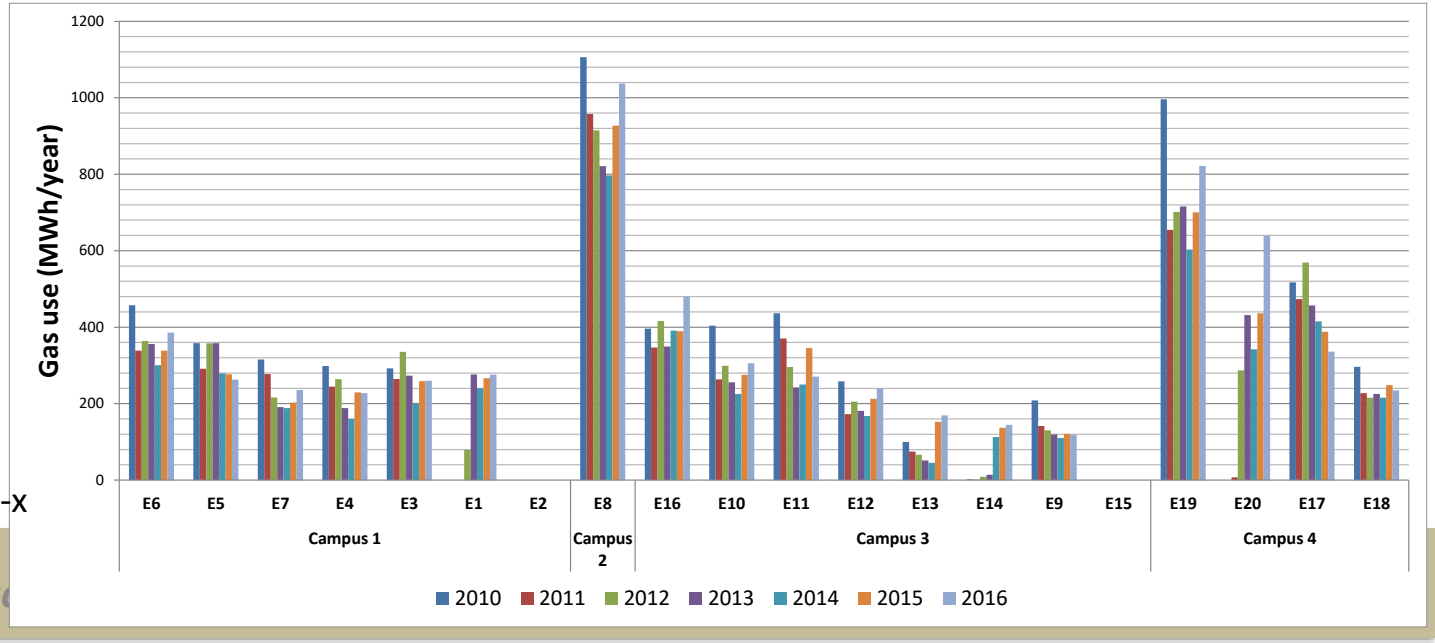




M. Medrano, J.M. Martí, L. Rincón, G. Mor, J. Cipriano, M. Farid. Assessing the nearly zero-energy building gap in university campuses with a feature extraction methodology applied to a case study in Spain, International Journal of Energy and Environmental Engineering 9 (3), (2018) 227-247. DOI: 10.1007/s40095-018-0264-x

Línies d'investigació – Energia i Edificis

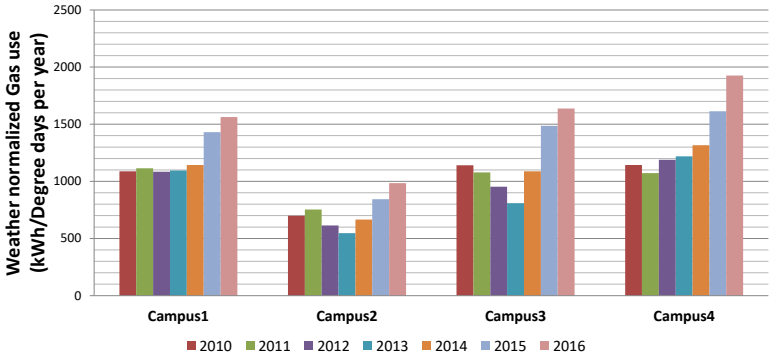


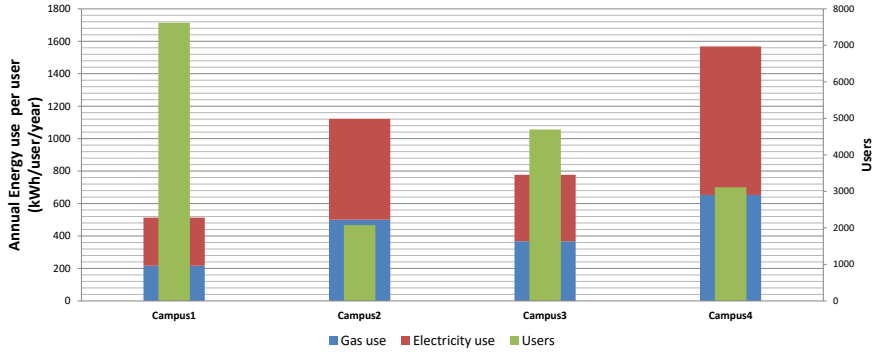


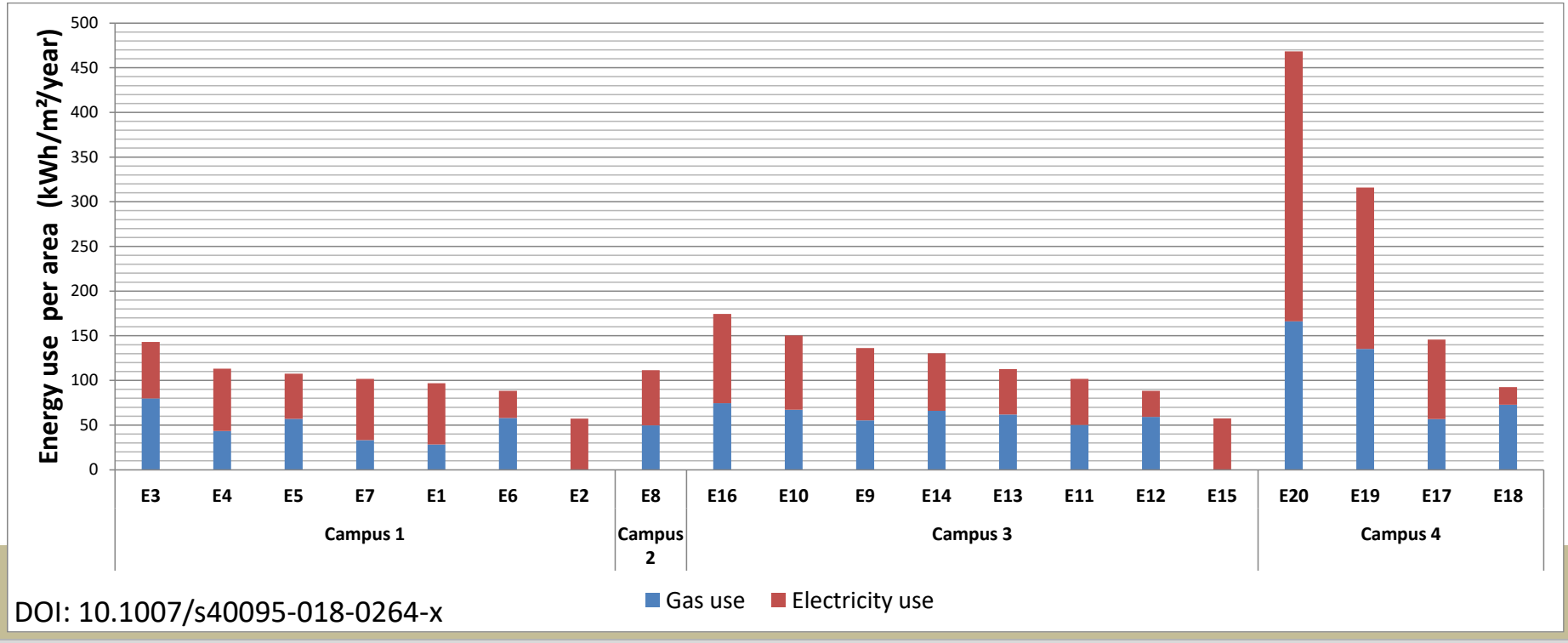
DOI: 10.1007/s40095-018-0264-x

Línies d'investigació – Energia i Edificis

Edificis de consum d'energia gairebé nul (nZEB)







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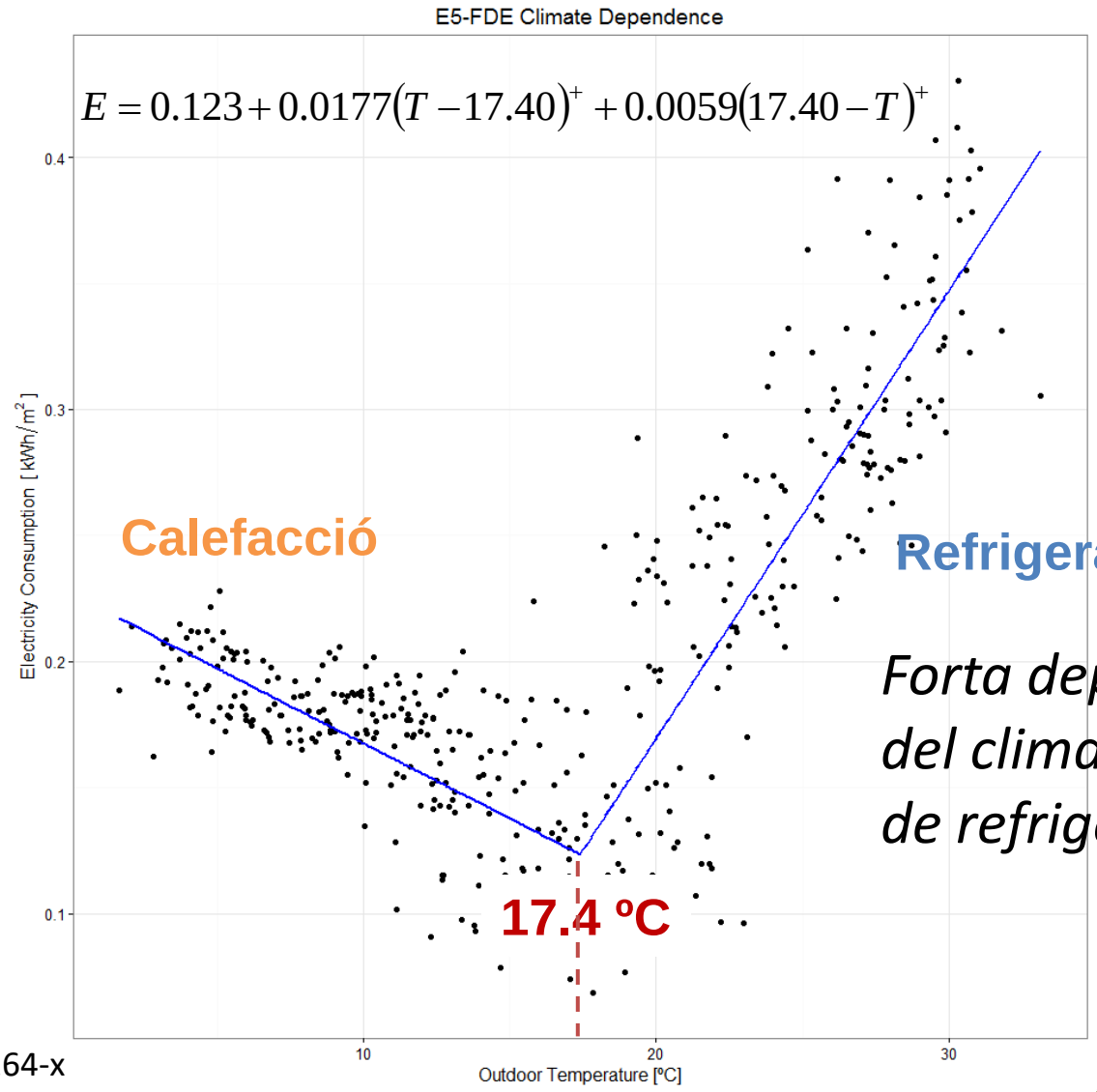
Línies d'investigació – Energia i Edificis

Exemple de model 4P 4-paràmetres

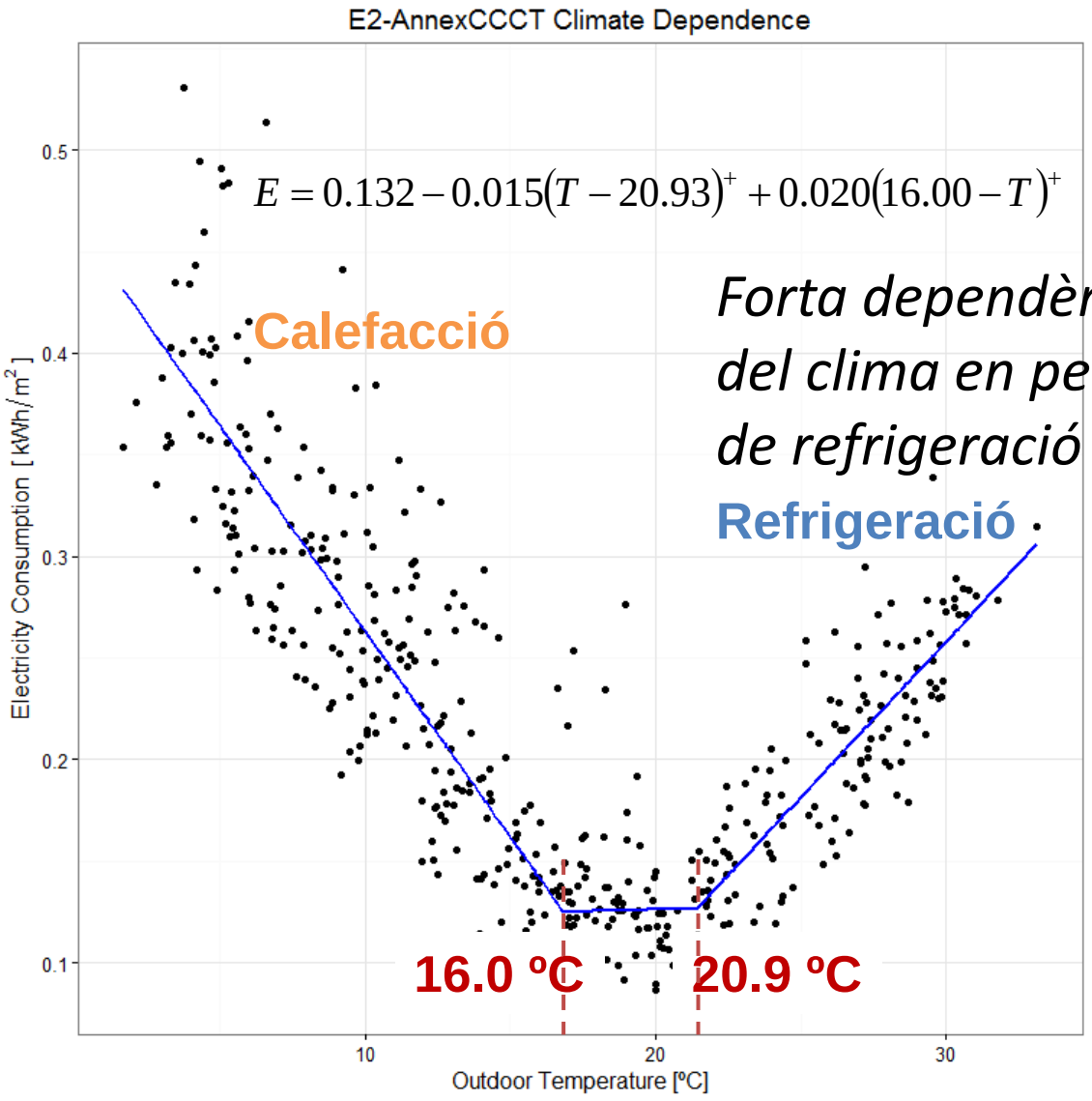


Forta dependència del clima en períodes de refrigeració

DOI: 10.1007/s40095-018-0264-x

Línies d'investigació – Energia i Edificis

Exemple de model 5P 5-paràmetres



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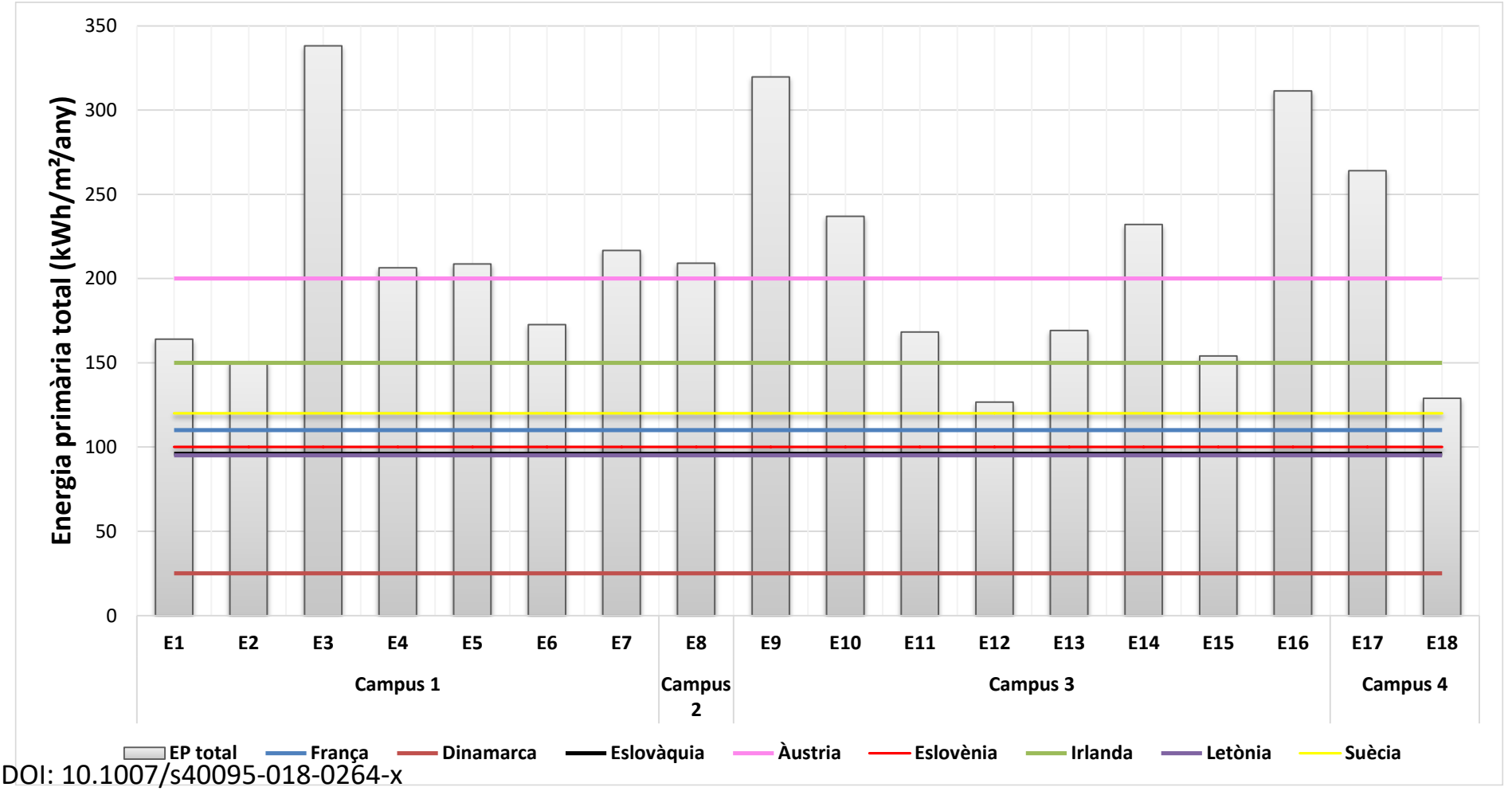
Edificis de consum d'energia gairebé nul (nZEB)



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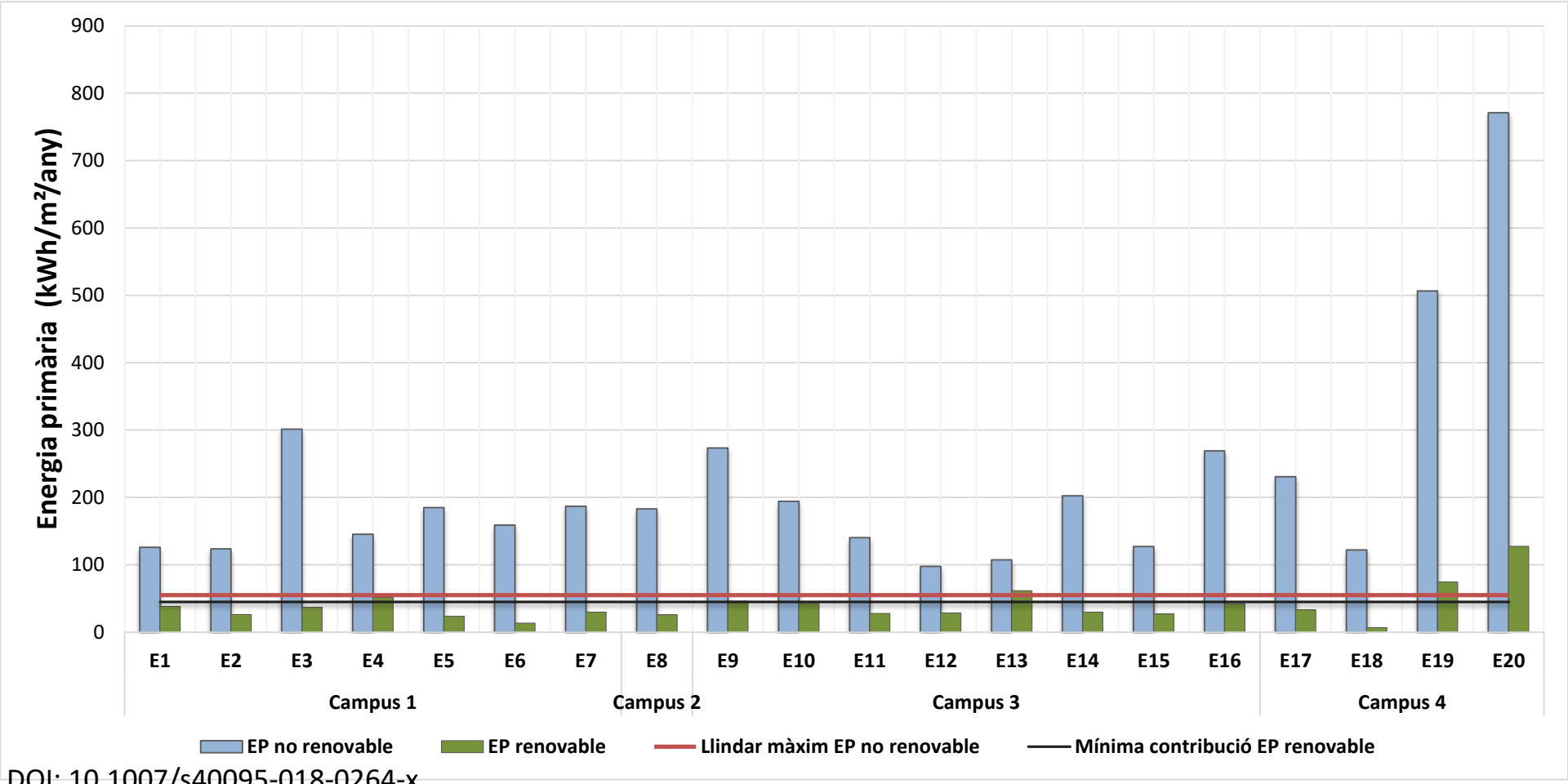

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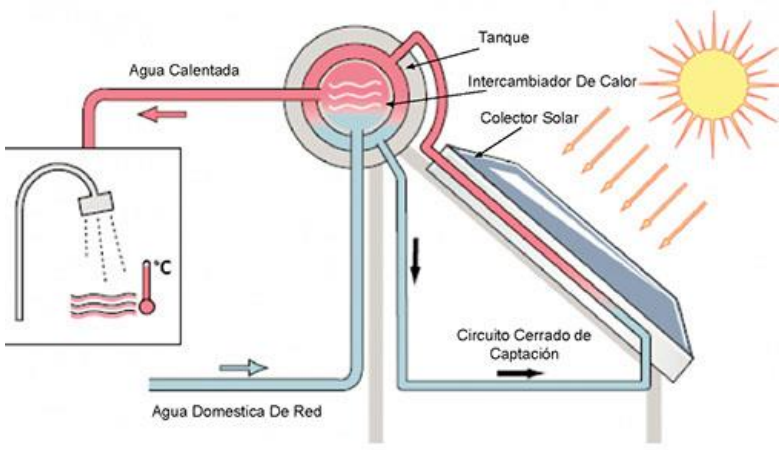
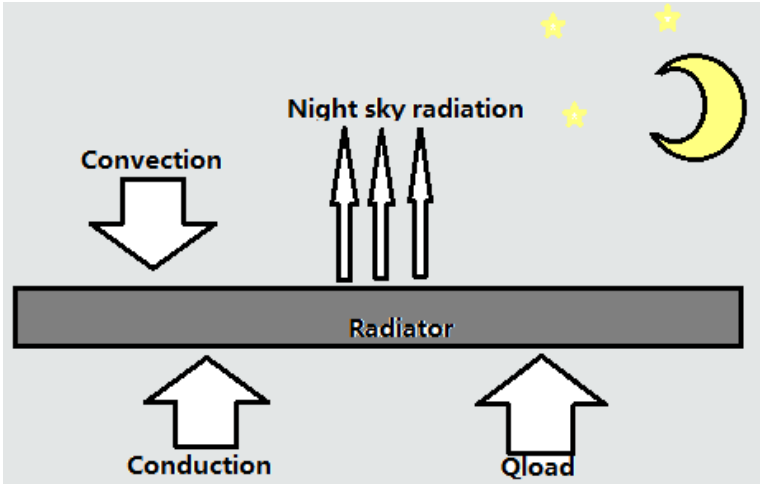
Energies renovables – Refrigeració radiant

- Energia solar



✓ Tecnologia comercial

- Refrigeració radiant



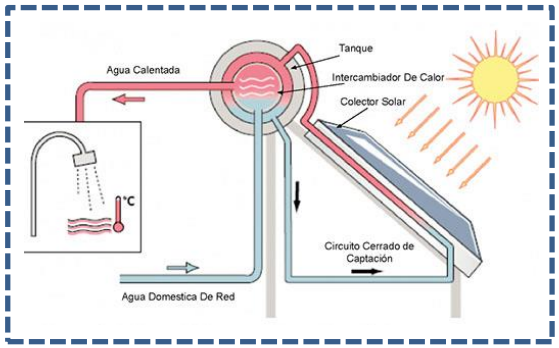
☞ En desenvolupament

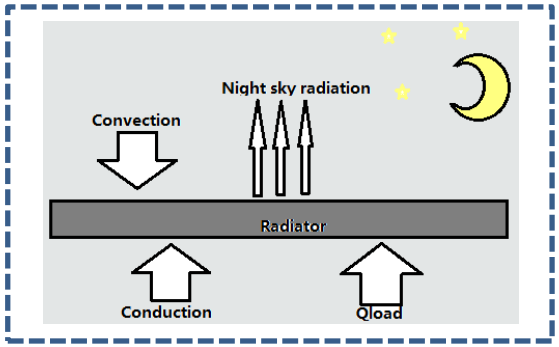
Radiative Collector and Emitter (RCE)

S. Vall, A. Castell. Radiative cooling as low grade energy source: A literature review. Renewable and Sustainable Energy Reviews, 77 (2017) 803-820.

Energies renovables – Refrigeració radiant

✓ Renovable





Cubierta adaptativa

Radiative Collector and Emitter (RCE)

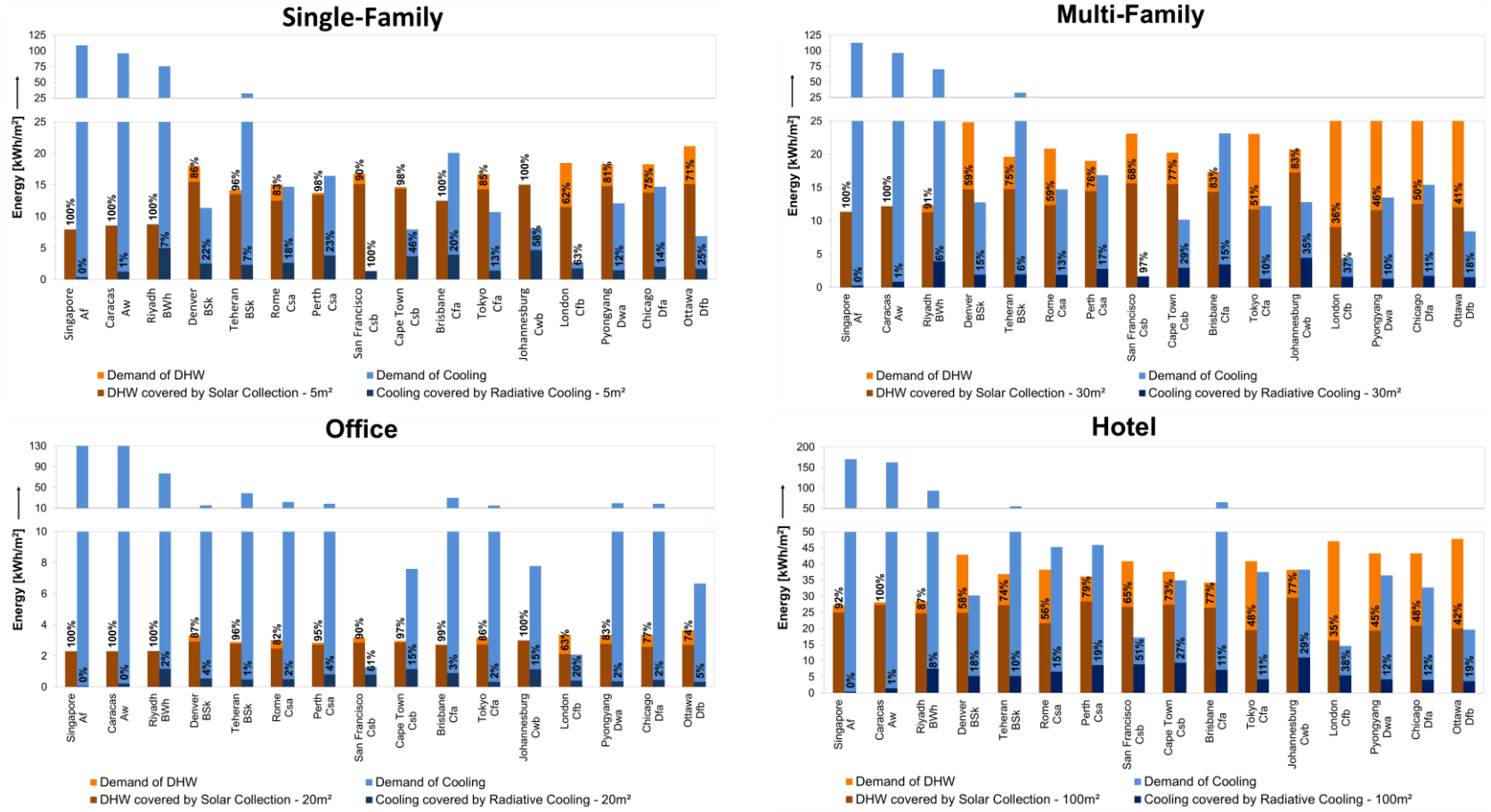
Refrigeración

ACS

Calefacción

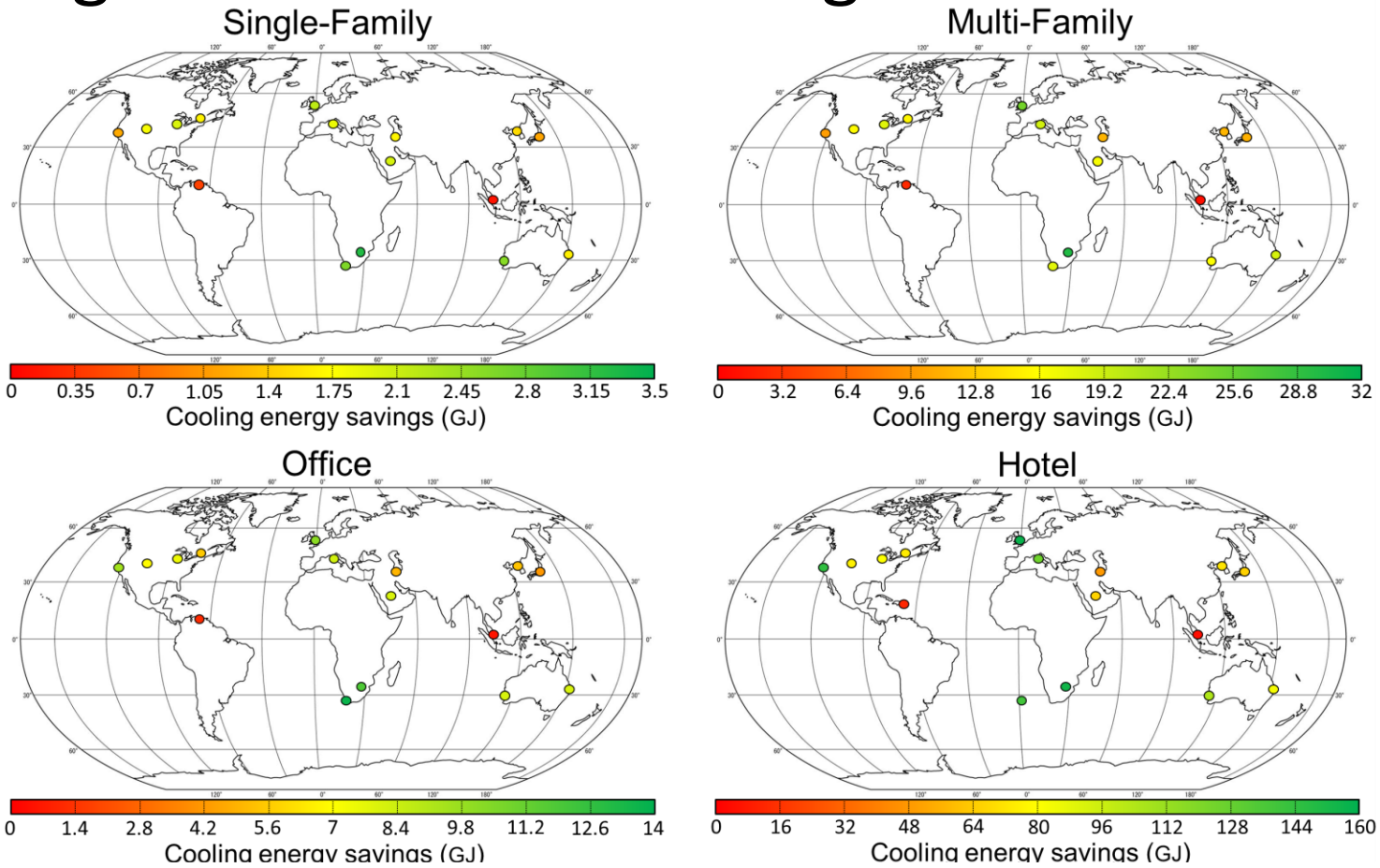
Línies d'investigació - Energia

Energies renovables – Refrigeració radiant



S. Vall, A. Castell, M. Medrano. Energy savings potential of a novel radiative cooling and solar thermal collection concept in buildings for various world climates. Energy Technology 6 (2018), 2200-2209.

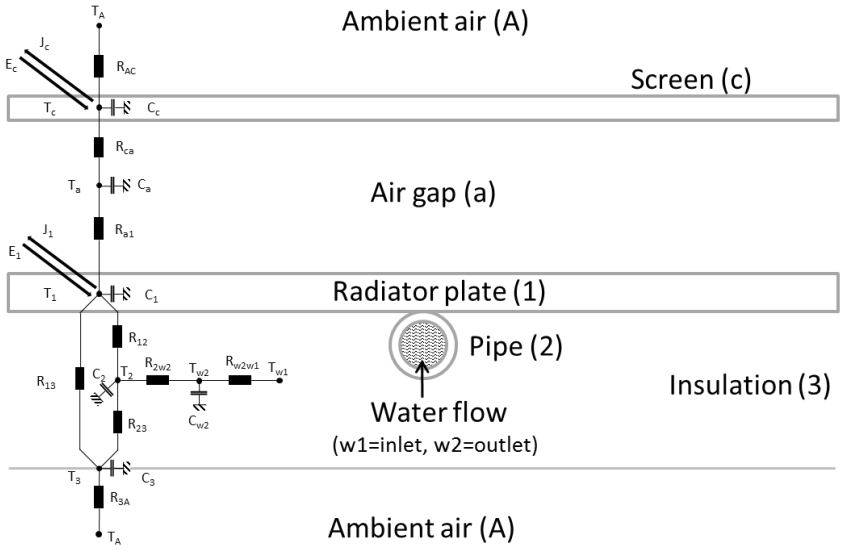
Energies renovables – Refrigeració radiant

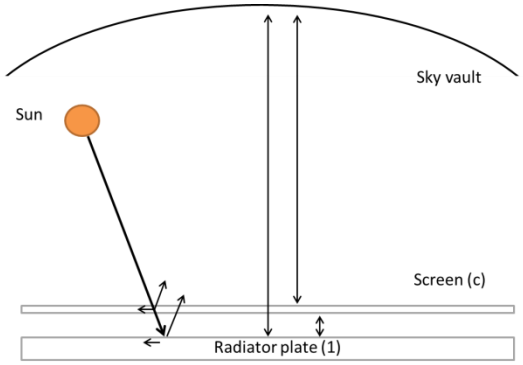


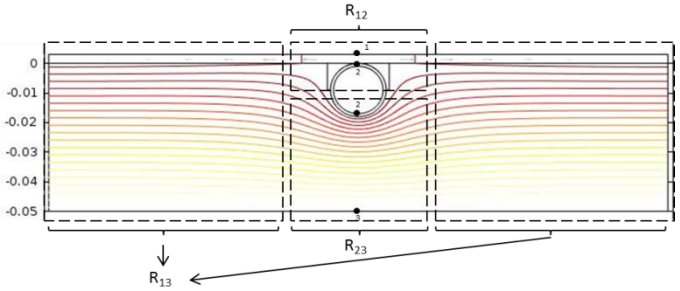
S. Vall, A. Castell, M. Medrano. Energy savings potential of a novel radiative cooling and solar thermal collection concept in buildings for various world climates. Energy Technology 6 (2018), 2200-2209.

Línies d'investigació - Energia

Energies renovables – Refrigeració radiant







$$\dot{Q}_r = E_e - J_e = \int_0^\infty E_{e,\lambda}\,\partial\lambda - \int_0^\infty J_{e,\lambda}\,\partial\lambda$$

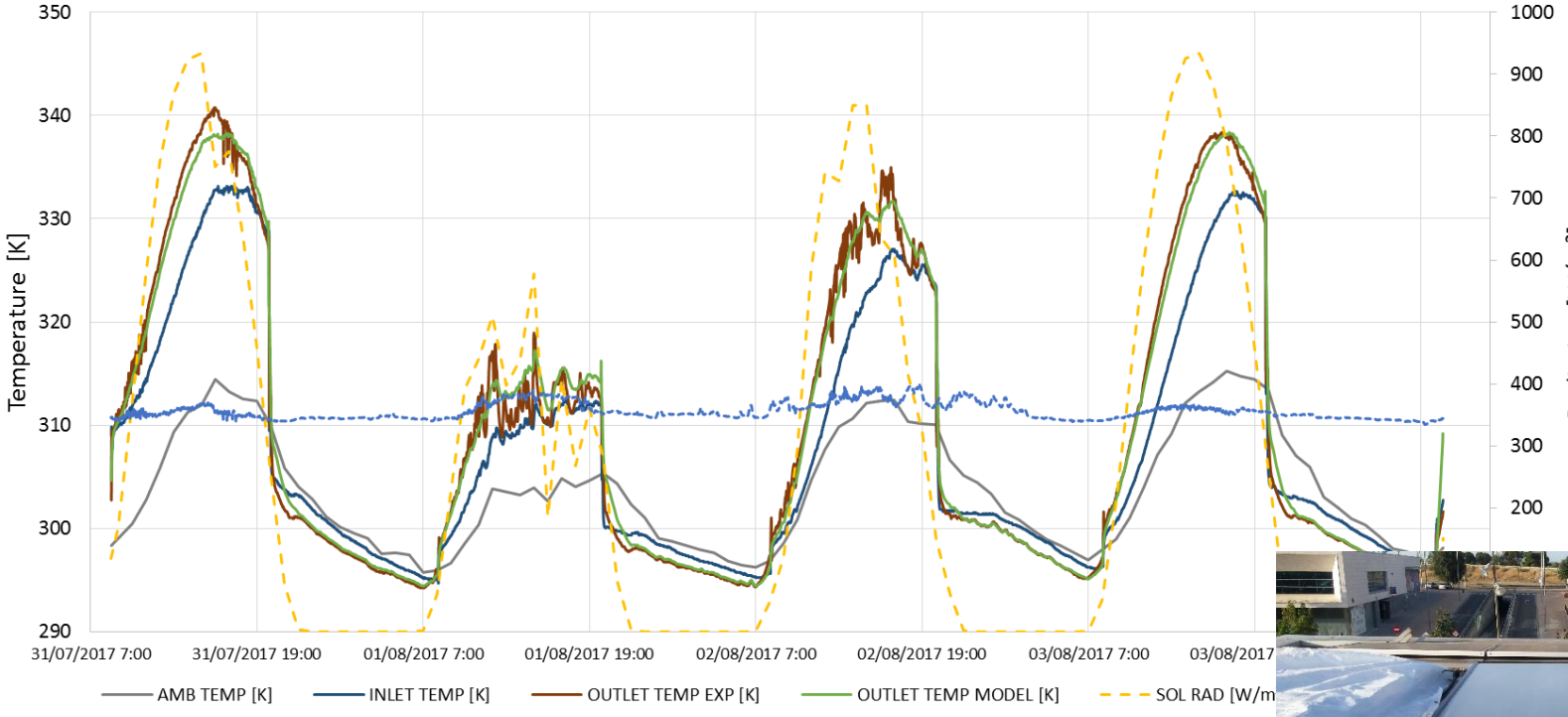
$$J_{e,i} = \varepsilon_i \cdot \sigma \cdot T_i^4 + \rho_i \cdot E_{e,i} + \tau_i \cdot E_{e,i}$$

$$E_{e,i} = \sum_{j=1}^{n} F_{ij} \cdot J_{e,j}$$

S. Vall, K. Johannes, D. David, A. Castell. Flat-plate radiative cooling and solar thermal collector numerical model evaluation. International Conference on Renewable Energies (ICREN) 2018, Barcelona (Spain).

Línies d'investigació - Energia

Energies renovables – Refrigeració radiant

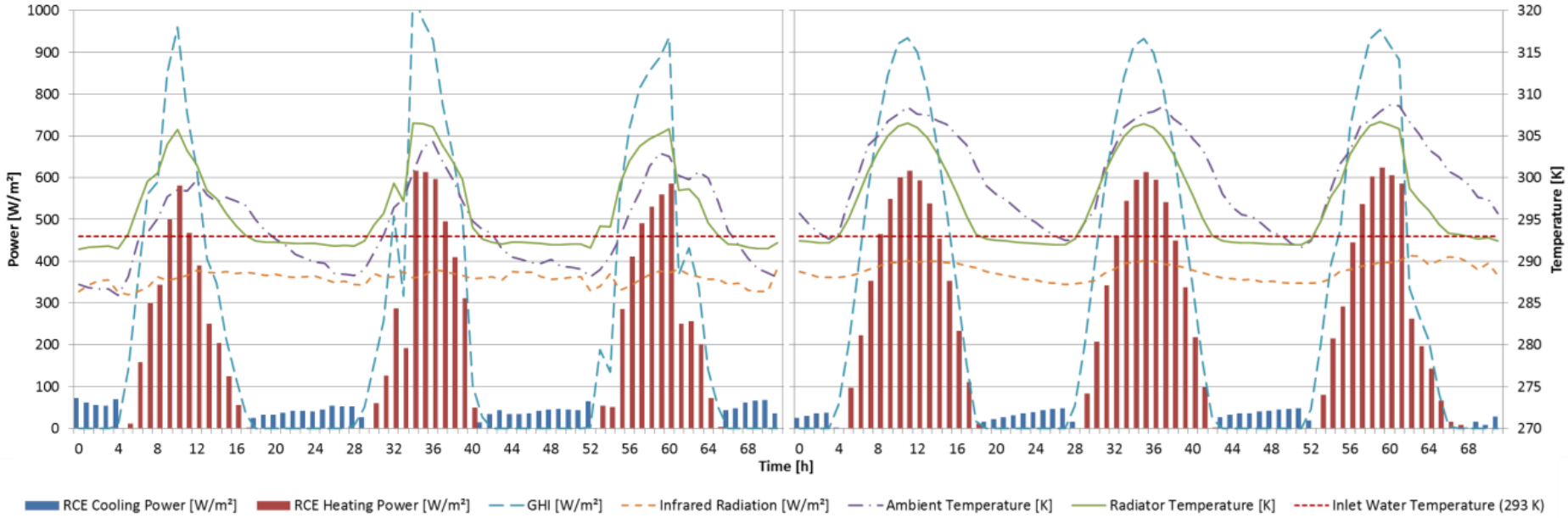


Outlet temperature
(Experimental vs Numerical)

S. Vall, K. Johannes, D. David, A. Castell. Flat-plate radiative cooling and solar thermal collector numerical model evaluation. International Conference on Renewable Energies (ICREN) 2018, Barcelona (Spain).

Línies d'investigació - Energia

Energies renovables – Refrigeració radiant



Potencial en funcionament com a captador solar i com a refrigerador radiant

	Spring	Summer
Solar thermal [kWh/m²]	10.90	14.96
Radiative cooling [kWh/m²]	1.60	0.88

S. Vall, K. Johannes, D. David, A. Castell. Flat-plate radiative cooling and solar thermal collector numerical model evaluation. International Conference on Renewable Energies (ICREN) 2018, Barcelona (Spain).

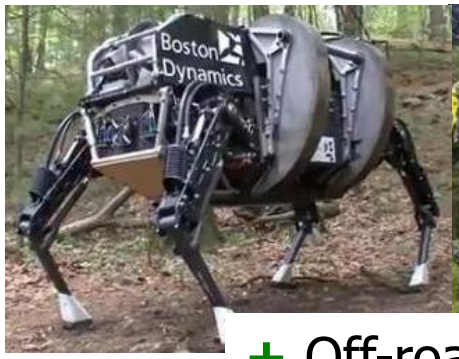
Línies d'investigació - Maquinaria

Vehicle off-road per a tasques forestals

Wheeled vehicles

+ Simplicity + Efficiency

Walking vehicles



+ Off-road ability

Compromise

Technical solutions to improve off-road performance of vehicles with wheels:

Articulated chassis

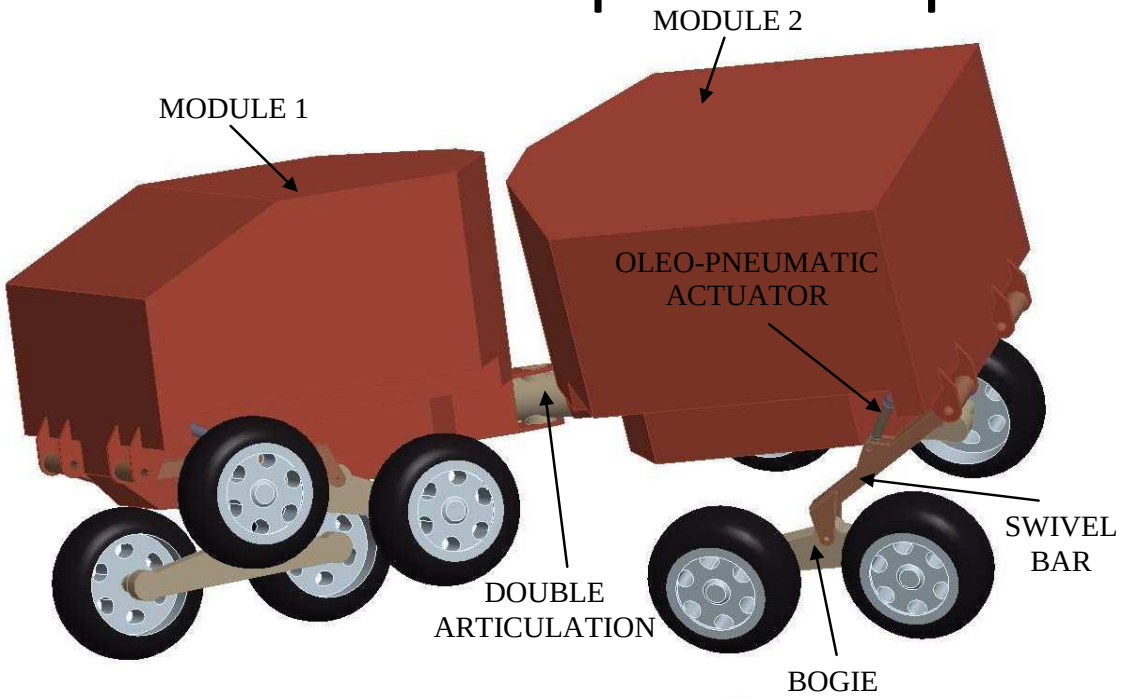
Use of bogies

Vehicle levelling

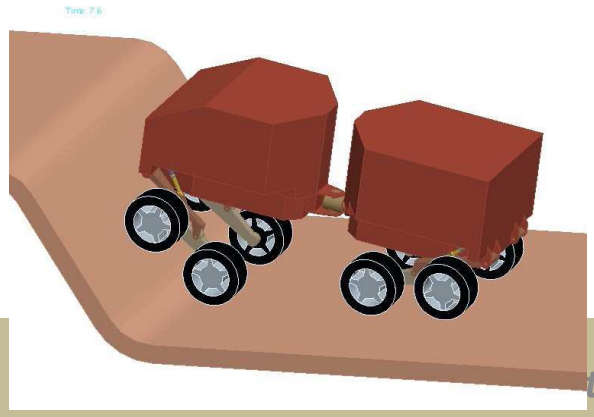
Adaptive suspension

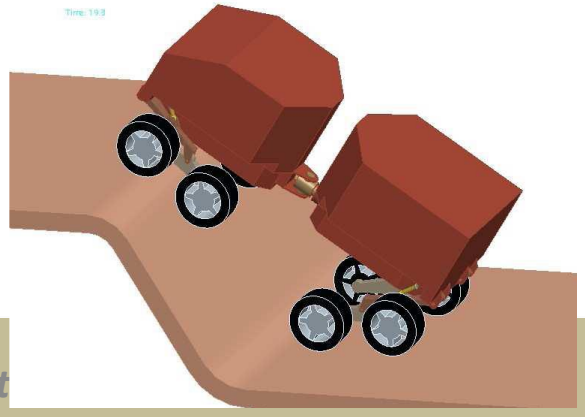
Línies d'investigació - Maquinaria

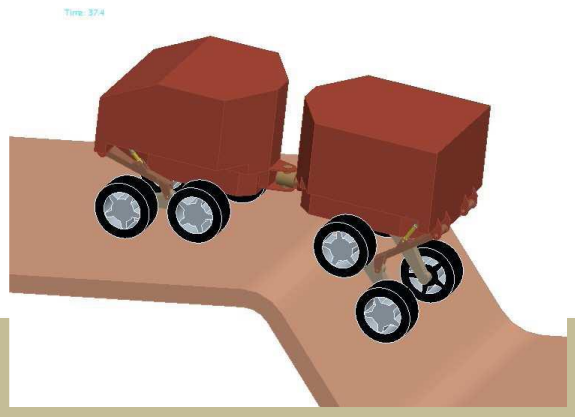
Vehicle off-road per a tasques forestals



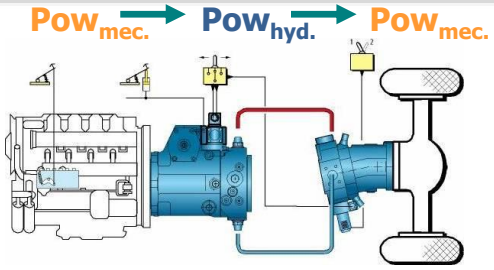
Variable	Value
Length	3,600 mm
Width	1,500 mm
Height	1,800 mm
Wheel diameter	600 mm
Vehicle weight	1,200 kg
Load Capacity	800 kg
Maximum weight	2,000 kg
Maximum speed	30 km/h







Línies d'investigació - Maquinaria



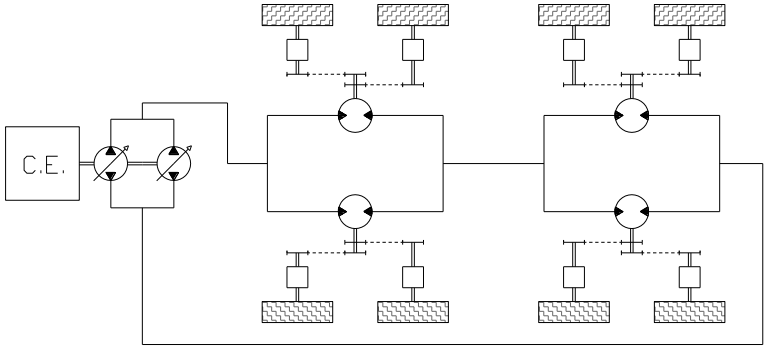
Hydrostatic transmission

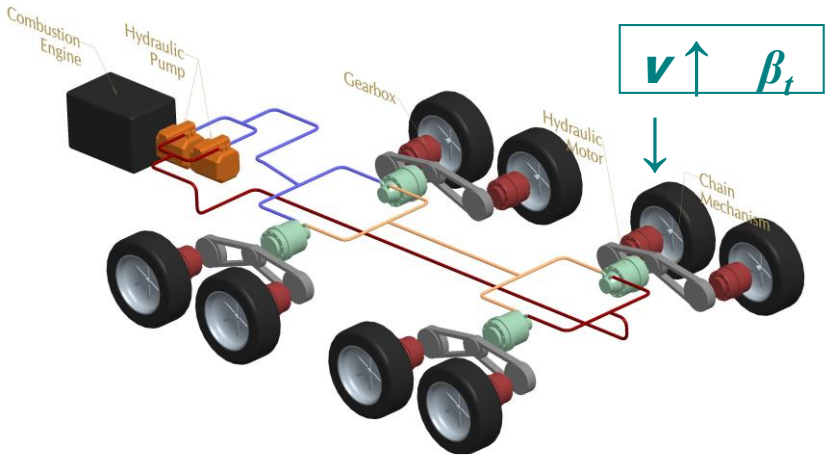
Simple scheme

M. Comellas, J. Pijuan, X. Potau, M. Nogués, J. Roca. Efficiency sensitivity analysis of a hydrostatic transmission for an off-road multiple axle vehicle, Int. J. of Automotive Tech. 14 (1), (2013) 151-161.

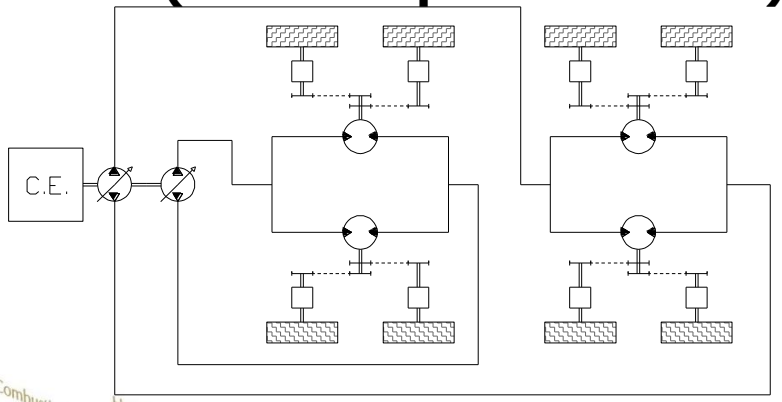
M. Comellas, J. Pijuan, X. Potau, M. Nogués, J. Roca. Analysis of a hydrostatic transmission driveline for its use in off-road multiple axle vehicles, J. of Terramechanics 49 (5), (2012) 245-254.

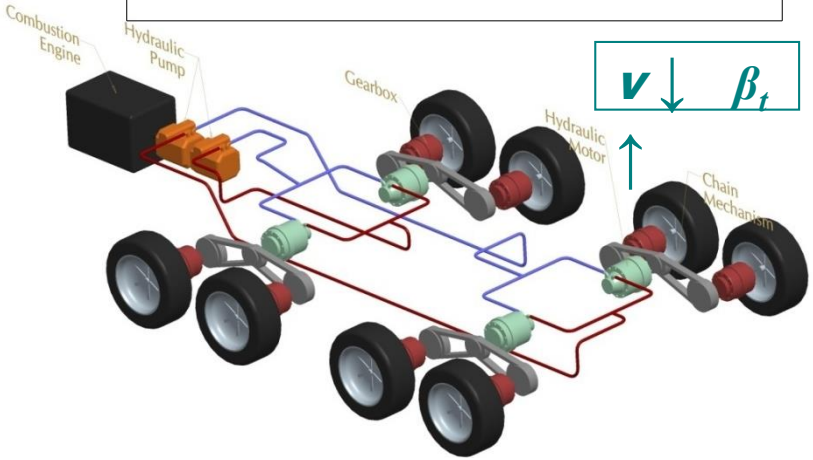
S.O.M. (Series Operation Mode)





P.O.M. (Parallel Operation Mode)

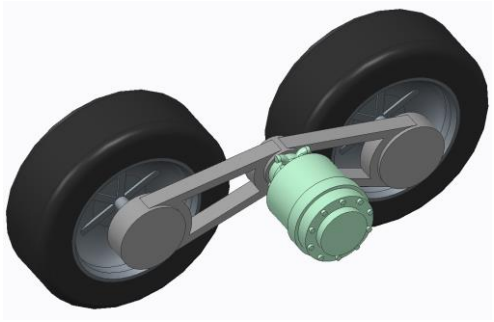


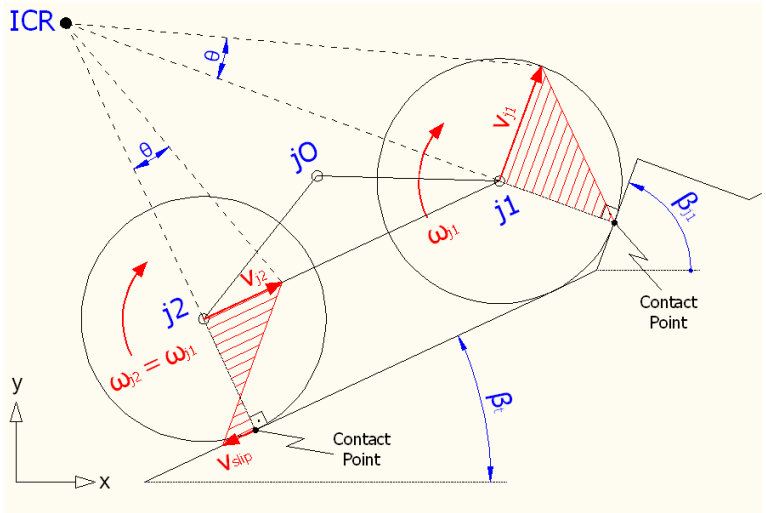


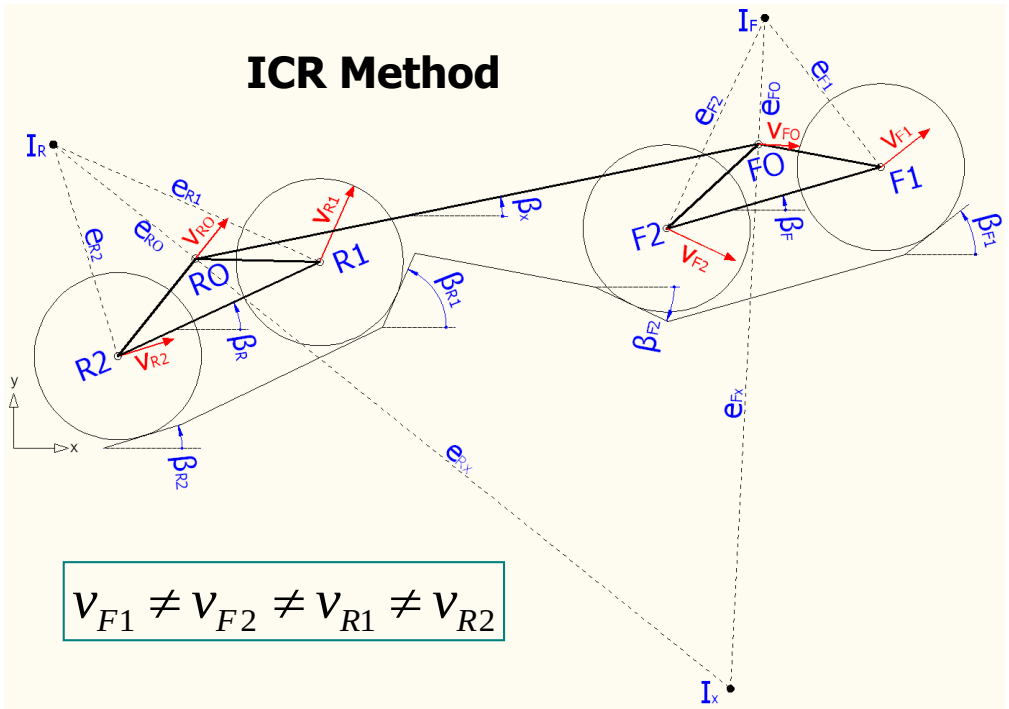
Vehicle off-road per a tasques forestals

If: $\beta_{j1} \neq \beta_{j2} \rightarrow |v_{j1}| \neq |v_{j2}|$

At least 1 Wheel slips







$$v_{F1} \neq v_{F2} \neq v_{R1} \neq v_{R2}$$

M. Comellas, J. Pijuan, M. Nogués, J. Roca, X. Potau. Active bogies and chassis levelling for a vehicle operating in rough terrain, Journal of Terramechanics 49 (3-4), (2012) 161-171.

X. Potau, M. Comellas, M. Nogués, J. Roca. Comparison of different bogie configurations for a vehicle operating in rough terrain, Journal of Terramechanics 48 (1), (2011) 75-84.

Gràcies per la seva atenció

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