Influence of User Behaviour on the Impact of Solar Orientation on the Thermal Performance of Houses

Supplementary Material

1. Monitoration

Occupation pattern																										
Name:												**Date:**														
Address:												**Location of environments:**														
Environment	**Days of the week**	**Total number of people in the environment**	Fill in the number of occupants depending on the time: "**number**" of people. Leave **blank** when there are no occupants at the indicated time.																							
			0h	**1h**	**2h**	**3h**	**4h**	**5h**	**6h**	**7h**	**8h**	**9h**	**10h**	**11h**	**12h**	**13h**	**14h**	**15h**	**16h**	**17h**	**18h**	**19h**	**20h**	**21h**	**22h**	**23h**
Living room 1	Mon-Fri																									
	Sat-Sund																									
Living room 2	Mon-Fri																									
	Sat-Sund																									
Kitchen	Mon-Fri																									
	Sat-Sund																									
Bedroom 1	Mon-Fri																									
	Sat-Sund																									
Bedroom 2	Mon-Fri																									
	Sat-Sund																									
Bedroom 3	Mon-Fri																									
	Sat-Sund																									

Window operation pattern																										
Environment	**Days of the week**	Put "**F**" at times when the window is fully open; Put "**C**" when the window is completely closed; and put "**PO**" at times when the window is partially open.																								
		0h	**1h**	**2h**	**3h**	**4h**	**5h**	**6h**	**7h**	**8h**	**9h**	**10h**	**11h**	**12h**	**13h**	**14h**	**15h**	**16h**	**17h**	**18h**	**19h**	**20h**	**21h**	**22h**	**23h**
Living room 1	Monday - Friday																									
	Saturday - Sunday																									
Living room 2	Monday - Friday																									
	Saturday - Sunday																									
Kitchen	Monday - Friday																									
	Saturday - Sunday																									
Bedroom 1	Monday - Friday																									
	Saturday - Sunday																									
Bedroom 2	Monday - Friday																									
	Saturday - Sunday																									
Bedroom 3	Monday - Friday																									
	Saturday - Sunday																									

Door operation pattern																										
Environment	**Days of the week**	Put "**F**" at times when the door is fully open; Put "**C**" when the door is completely closed; and put **"PO**" at times when the door is partially open.																								
		0h	**1h**	**2h**	**3h**	**4h**	**5h**	**6h**	**7h**	**8h**	**9h**	**10h**	**11h**	**12h**	**13h**	**14h**	**15h**	**16h**	**17h**	**18h**	**19h**	**20h**	**21h**	**22h**	**23h**
Living room 1	Monday - Friday																									
	Saturday - Sunday																									
Living room 2	Monday - Friday																									
	Saturday - Sunday																									
Kitchen	Monday - Friday																									
	Saturday - Sunday																									
Bedroom 1	Monday - Friday																									
	Saturday - Sunday																									
Bedroom 2	Monday - Friday																									
	Saturday - Sunday																									
Bedroom 3	Monday - Friday																									
	Saturday - Sunday																									

Figure S1. Questionnaire.

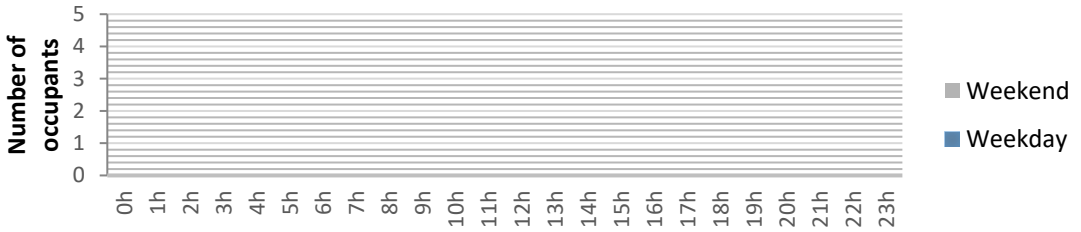
Lighting usage pattern																									
Environment	Days of the week	Put "**x**" when the light is on; leave **blank** when the light is turned off.																							
		0h	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	11h	12h	13h	14h	15h	16h	17h	18h	19h	20h	21h	22h	23h
Living room 1	Monday - Friday																								
	Saturday - Sunday																								
Living room 2	Monday - Friday																								
	Saturday - Sunday																								
Kitchen	Monday - Friday																								
	Saturday - Sunday																								
Bedroom 1	Monday - Friday																								
	Saturday - Sunday																								
Bedroom 2	Monday - Friday																								
	Saturday - Sunday																								
Bedroom 3	Monday - Friday																								
	Saturday - Sunday																								

Electrical equipment usage pattern																									
Equipament	Environment	Frequency. number of times a week	Period of use of equipment: "**On**" corresponds to the full hour on; "**number in minutes**" when the equipment was turned on at that time; leave it **blank** when the device is turn off or when the device is not in the room.																						
			0h	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	11h	12h	13h	14h	15h	16h	17h	18h	19h	20h	21h	22h	23h
	Living room 1																								
	Living room 2																								
	Kitchen																								
	Bedroom 1																								
	Bedroom 2																								
	Bedroom 3																								

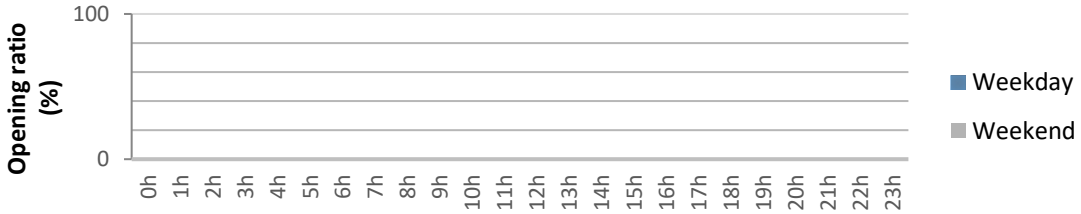
Equipment characteristics							
Equipament	Brand	Model	Product type	Temperature	Velocity	Refrigerating capacity	Potency
Televison					x		
Air conditioning					x		
Fan					High / Medium / Low		
Computer					x		
Lamp					x		
Refrigerator					x		
Others					x		

Figure S2. Questionnaire (continuation).

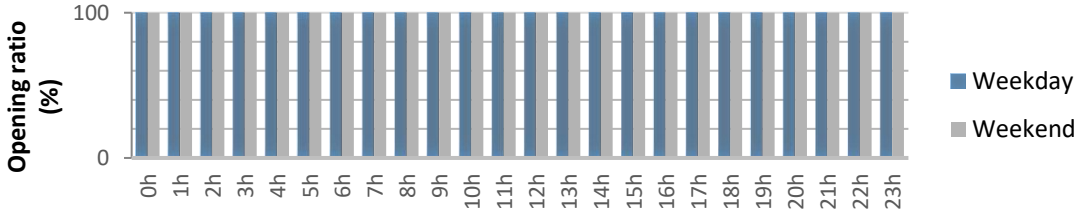
2. Determination of use patterns



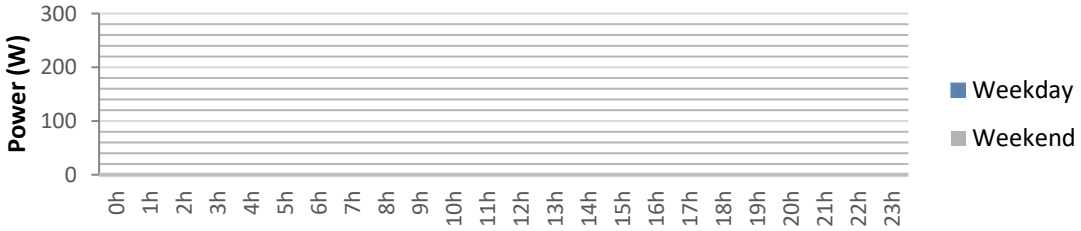
a) Occupation pattern



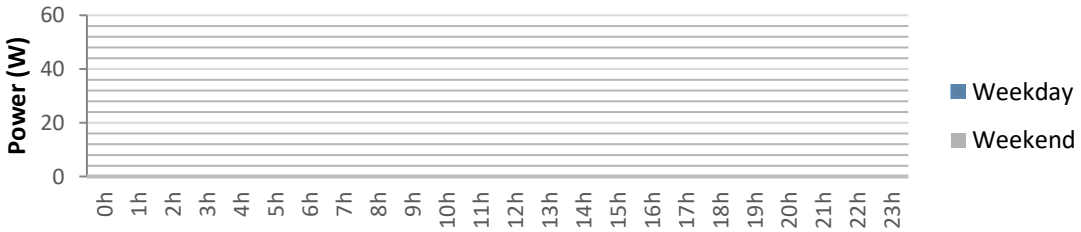
b) Window operation pattern



c) Door operation pattern

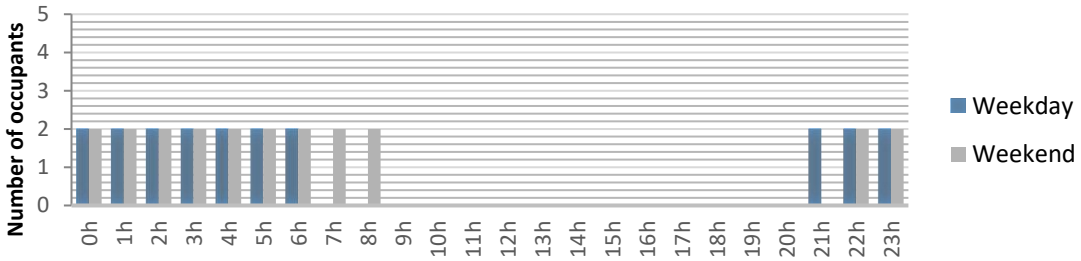


d) Electrical equipment usage pattern

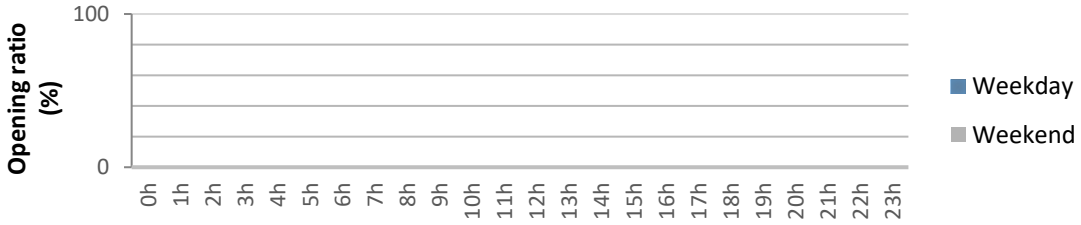


e) Lighting usage pattern

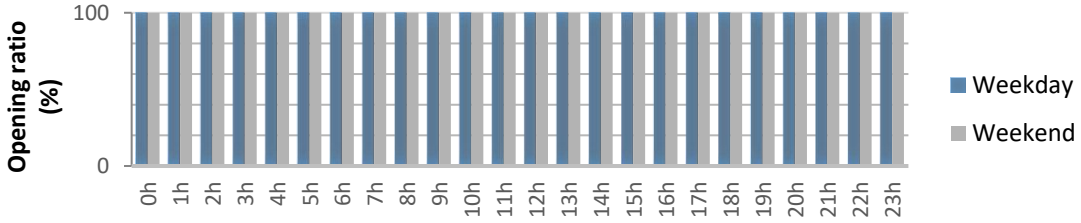
Figure S2. Patterns of occupation and use of equipment in bedroom 1 with representative pattern A.



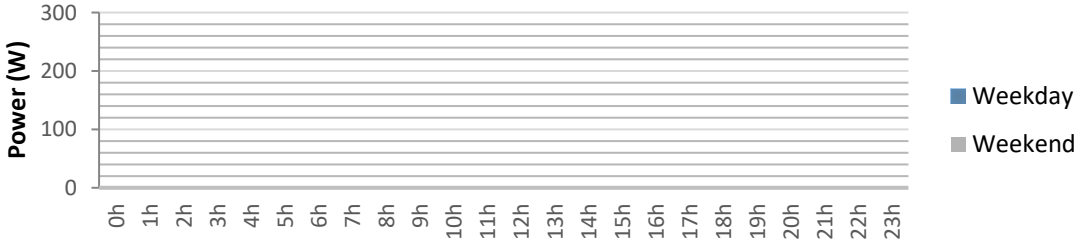
a) Occupation pattern



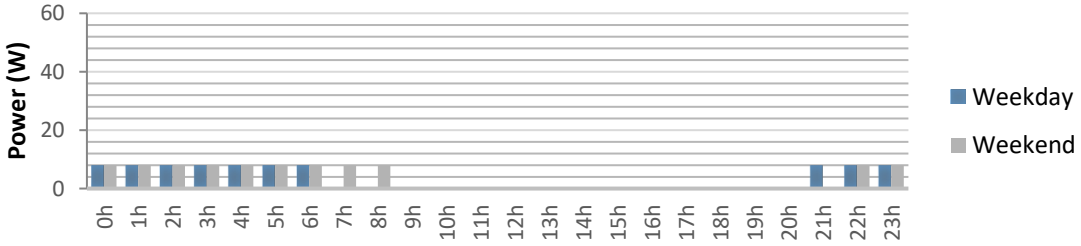
b) Window operation pattern



c) Door operation pattern

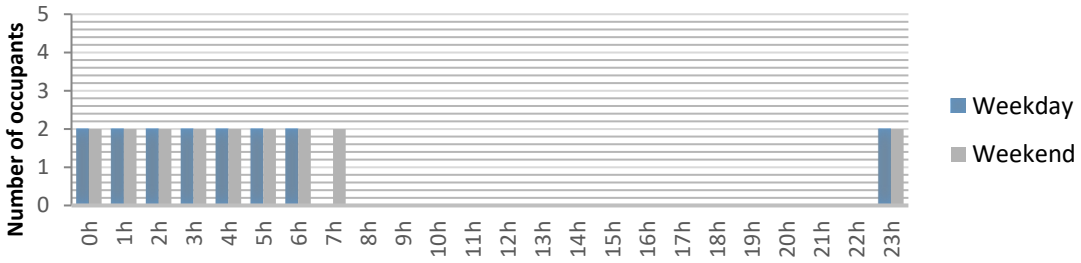


d) Electrical equipment usage pattern

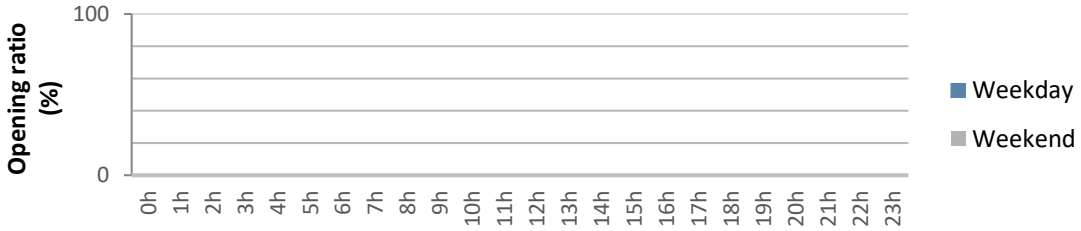


e) Lighting usage pattern

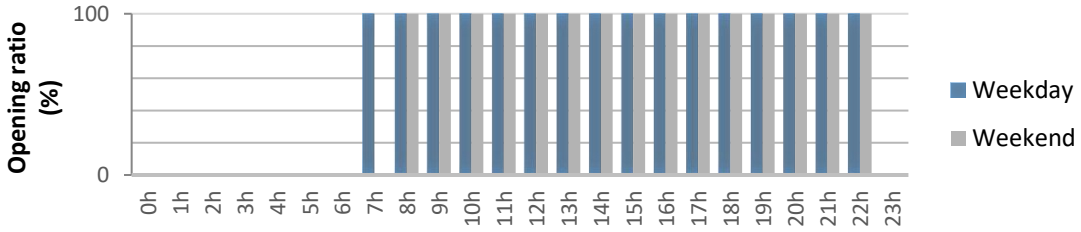
Figure S3. Patterns of occupation and use of equipment in bedroom 1 with representative pattern B.



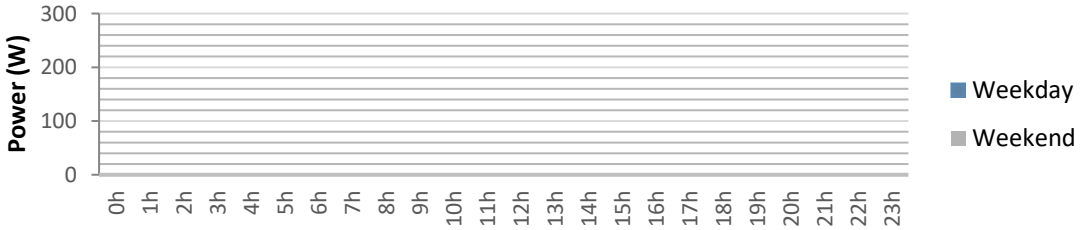
a) Occupation pattern



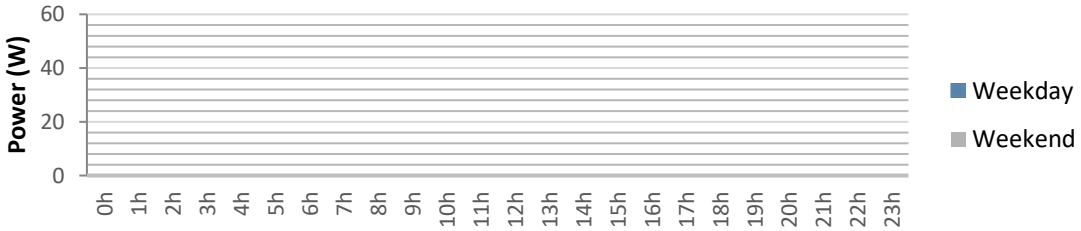
b) Window operation pattern



c) Door operation pattern

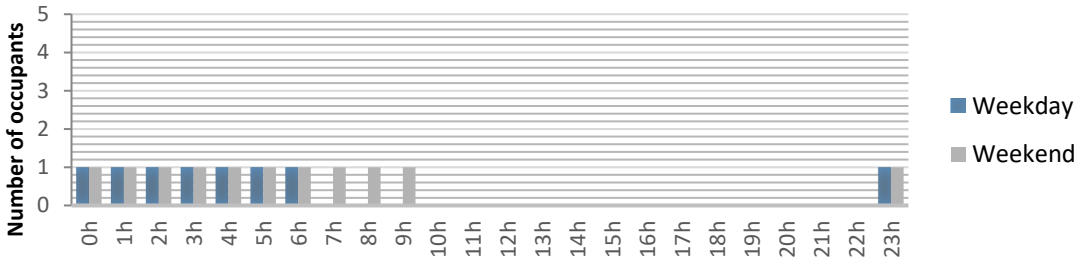


d) Electrical equipment usage pattern



e) Lighting usage pattern

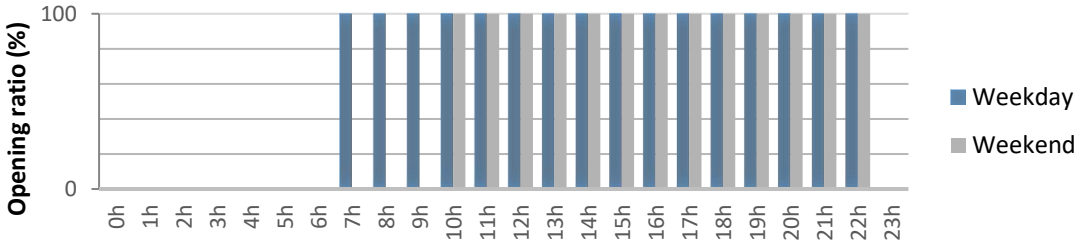
Figure S4. Patterns of occupation and use of equipment in bedroom 2 with representative pattern A.



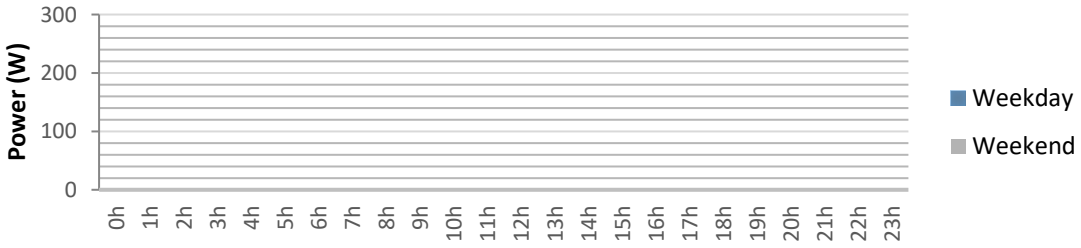
a) Occupation pattern



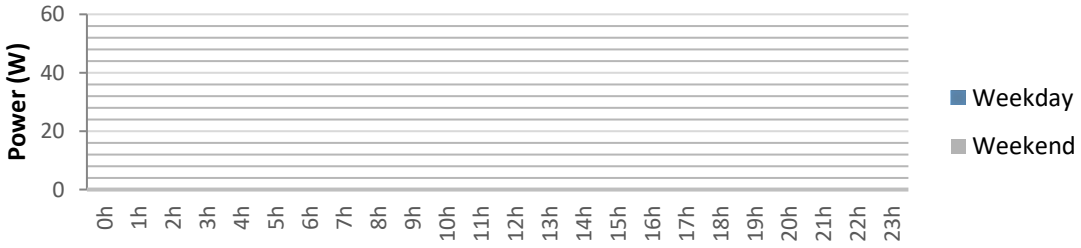
b) Window operation pattern



c) Door operation pattern

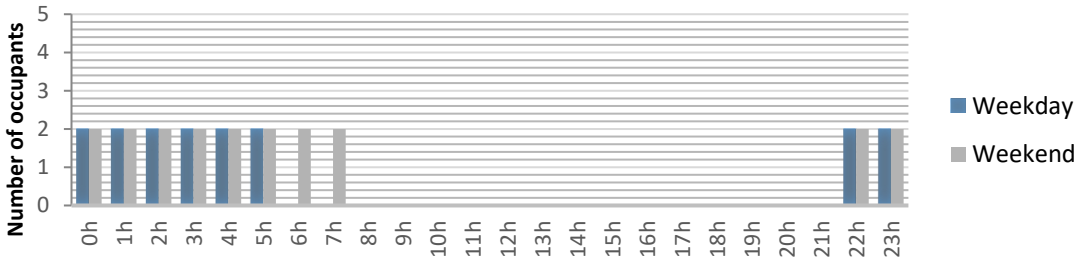


d) Electrical equipment usage pattern

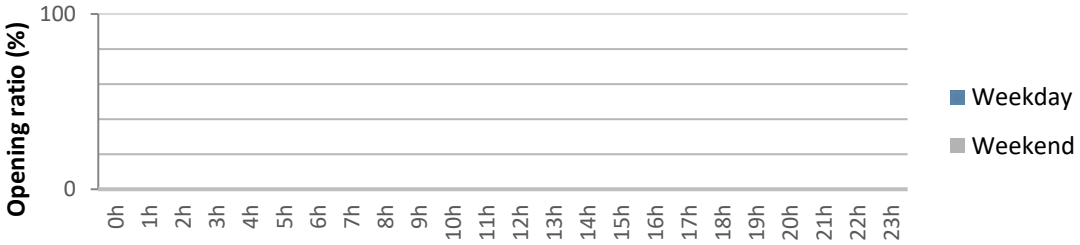


e) Lighting usage pattern

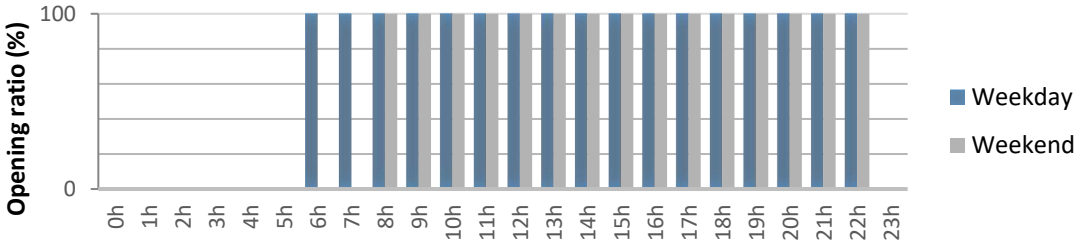
Figure S5. Patterns of occupation and use of equipment in bedroom 2 with representative pattern B.



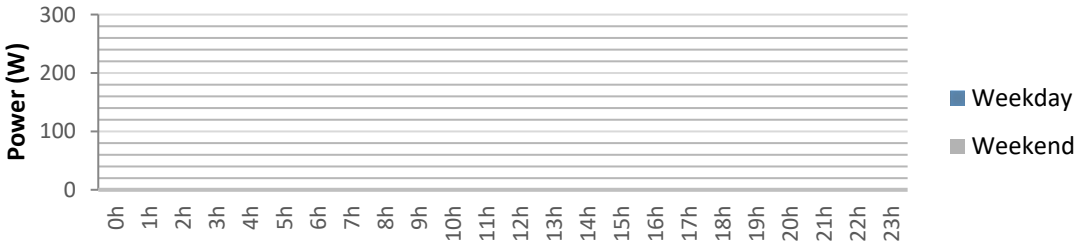
a) Occupation pattern



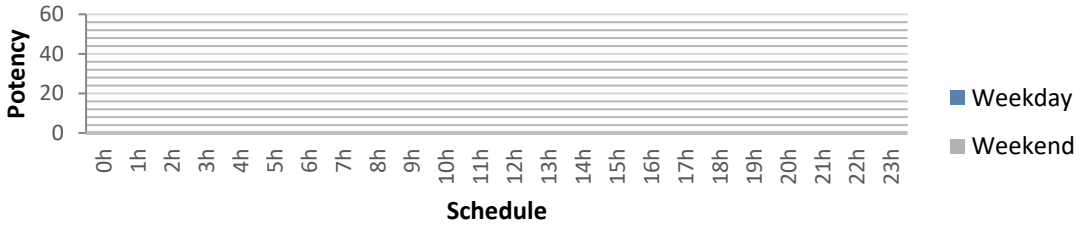
b) Window operation pattern



c) Door operation pattern

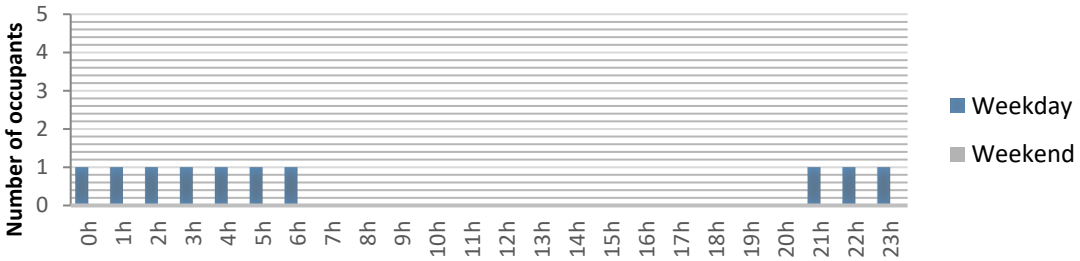


d) Electrical equipment usage pattern

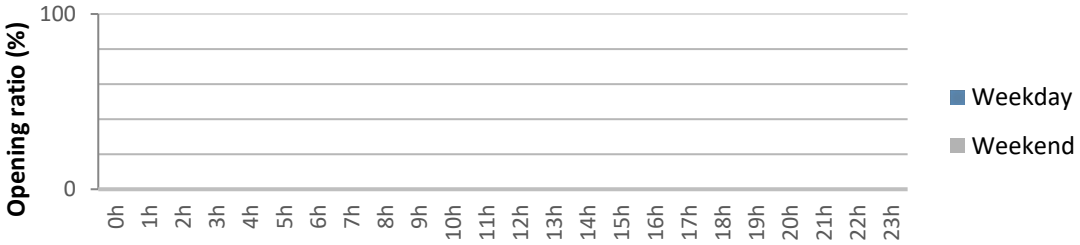


e) Lighting usage pattern

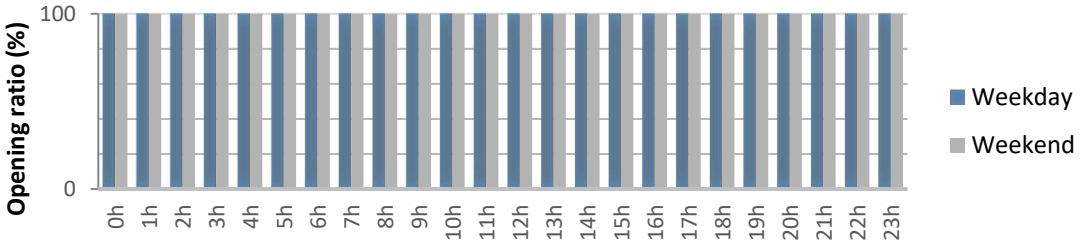
Figure S6. Patterns of occupation and use of equipment in bedroom 2 with representative pattern C.



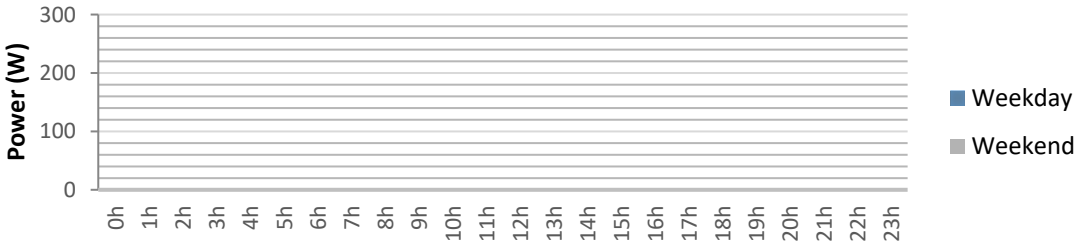
a) Occupation pattern



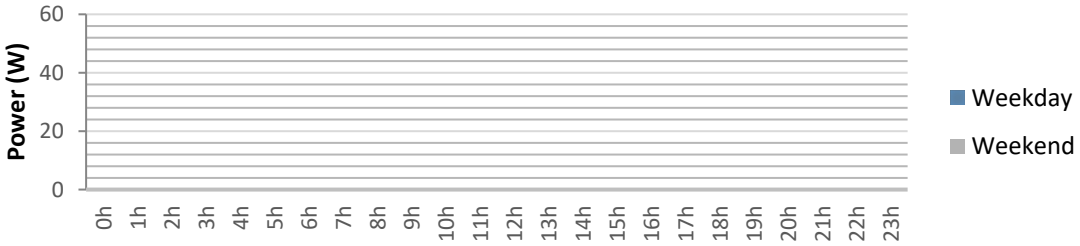
b) Window operation pattern



c) Door operation pattern

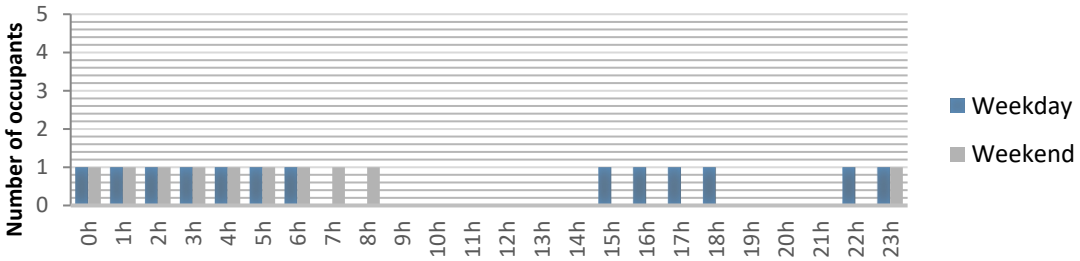


d) Electrical equipment usage pattern

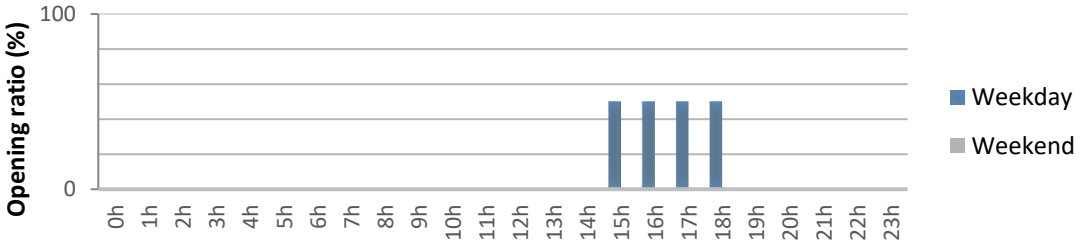


e) Lighting usage pattern

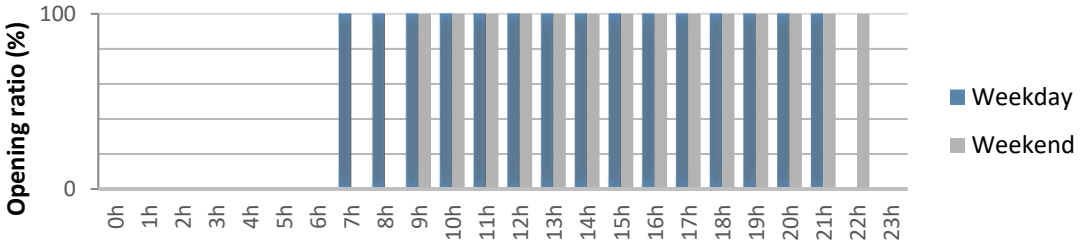
Figure S7. Patterns of occupation and use of equipment in bedroom 3 with representative pattern A.



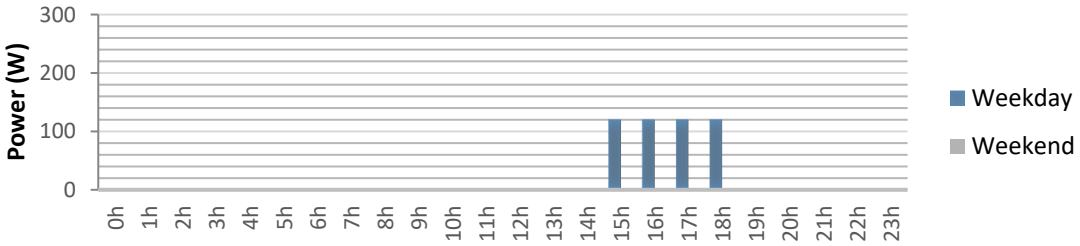
a) Occupation pattern



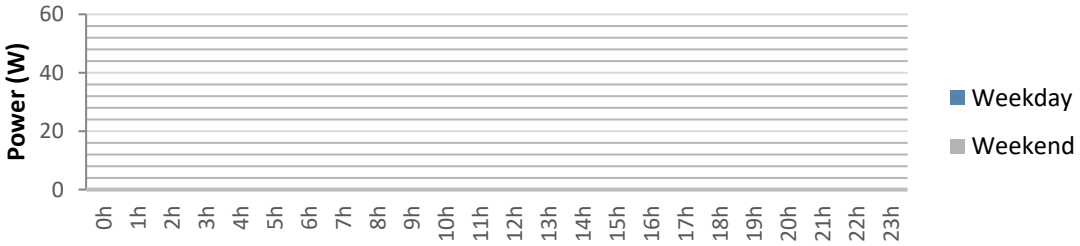
b) Window operation pattern



c) Door operation pattern

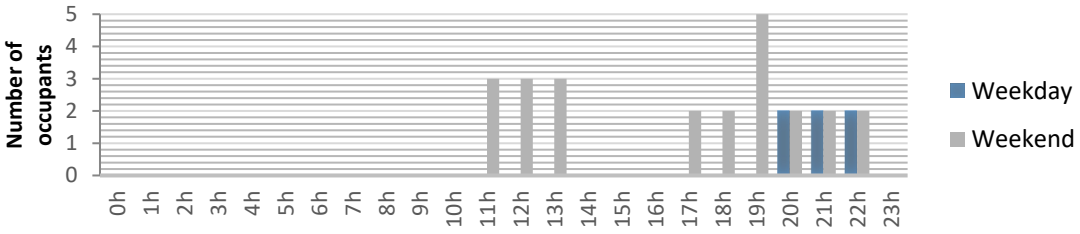


d) Electrical equipment usage pattern

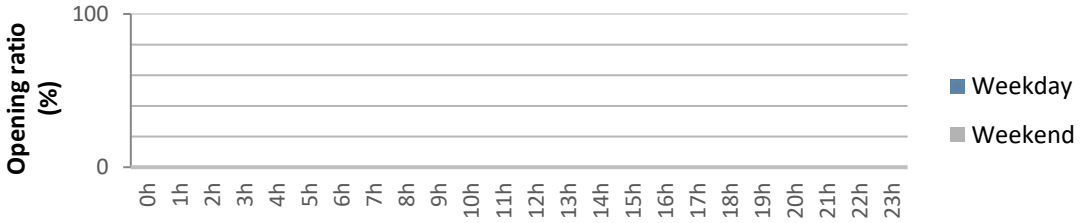


e) Lighting usage pattern

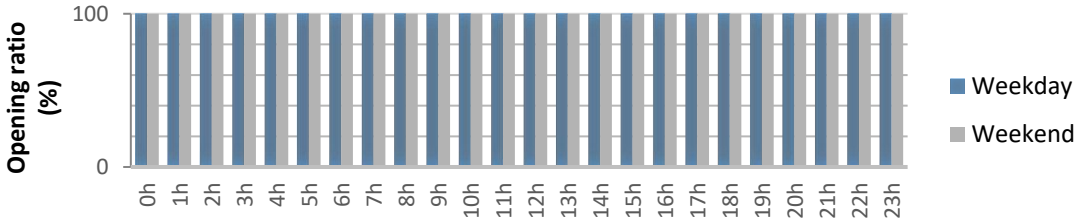
Figure S8. Patterns of occupation and use of equipment in bedroom 3 with representative pattern B.



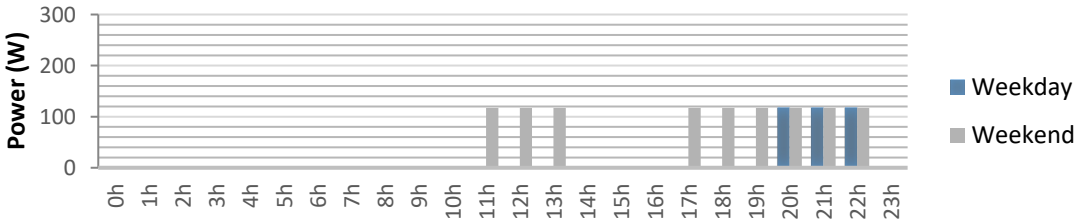
a) Occupation pattern



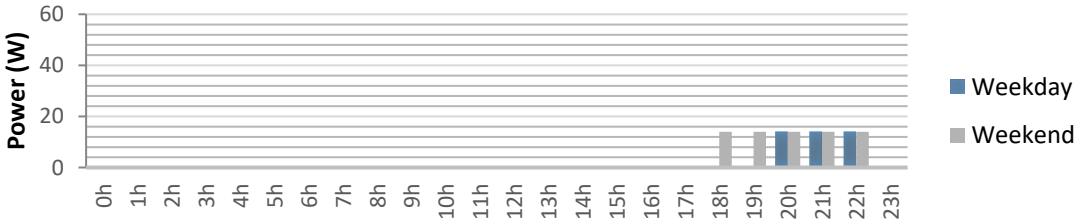
b) Window operation pattern



c) Door operation pattern

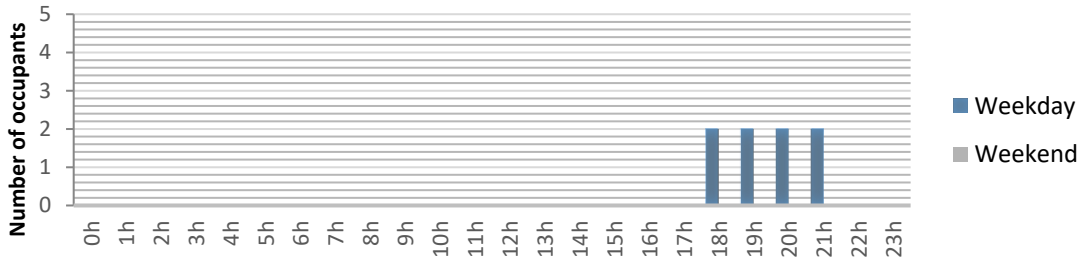


d) Electrical equipment usage pattern

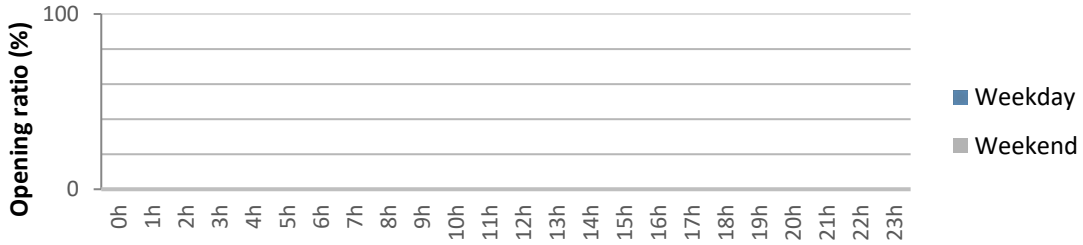


e) Lighting usage pattern

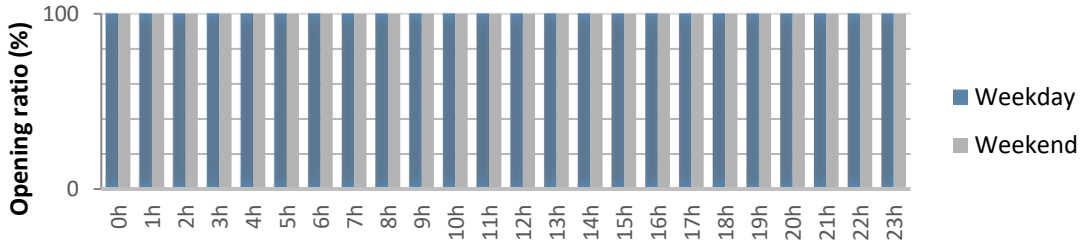
Figure S9. Patterns of occupation and use of equipment in living room 1 with representative pattern A.



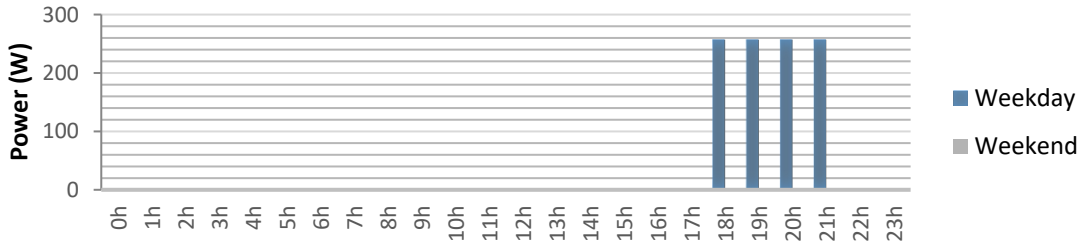
a) Occupation pattern



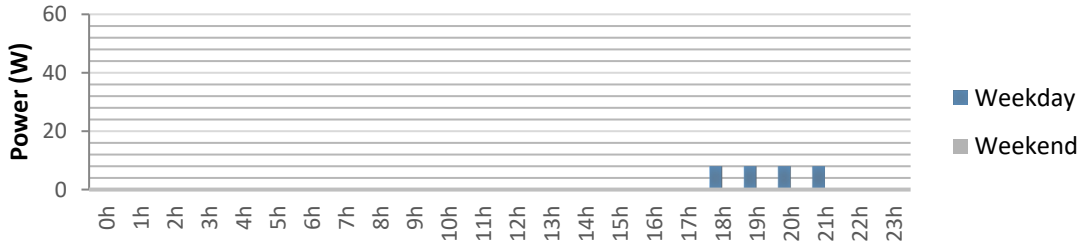
b) Window operation pattern



c) Door operation pattern

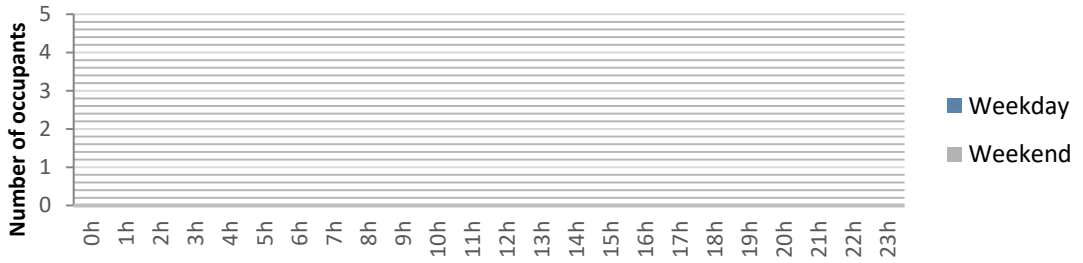


d) Electrical equipment usage pattern

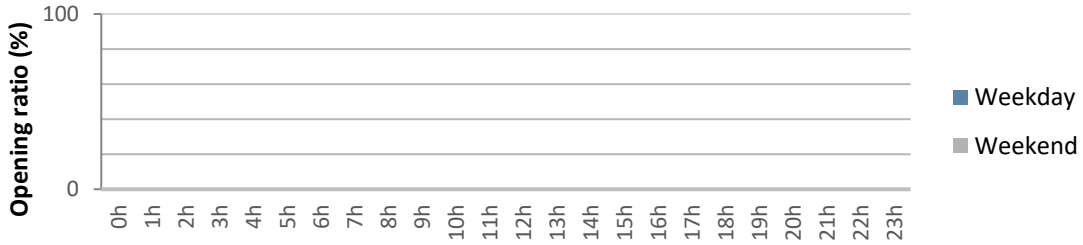


e) Lighting usage pattern

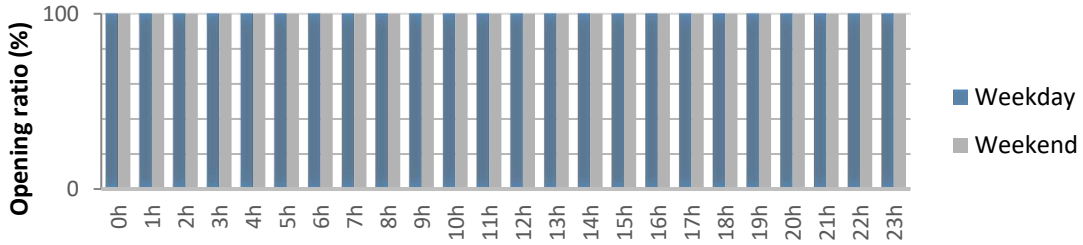
Figure S10. Patterns of occupation and use of equipment in living room 1 with representative pattern B.



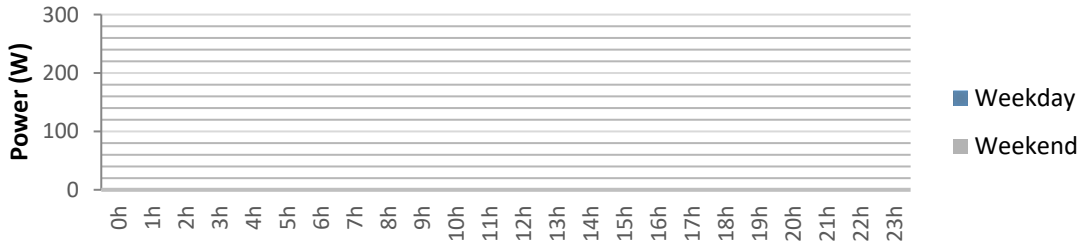
a) Occupation pattern



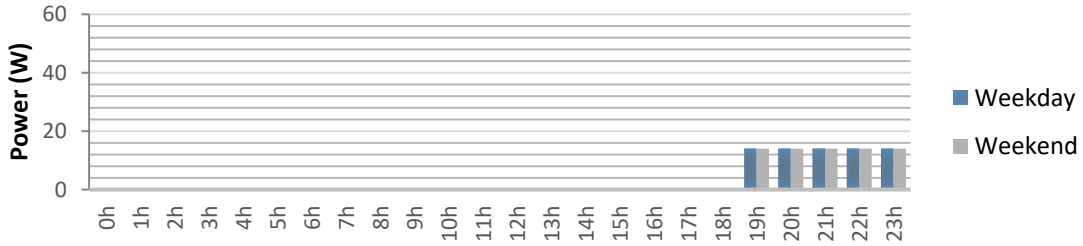
b) Window operation pattern



c) Door operation pattern

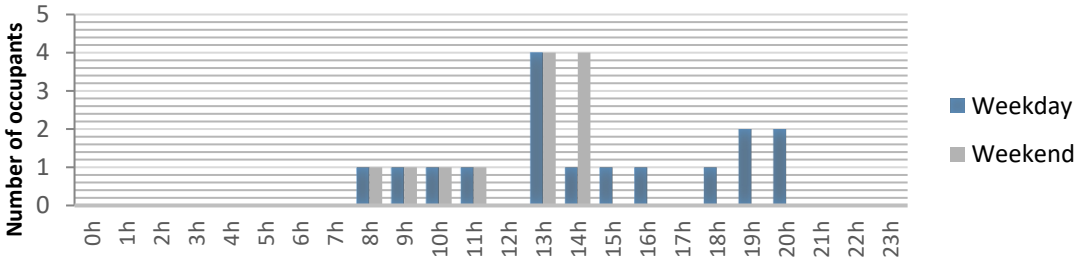


d) Electrical equipment usage pattern

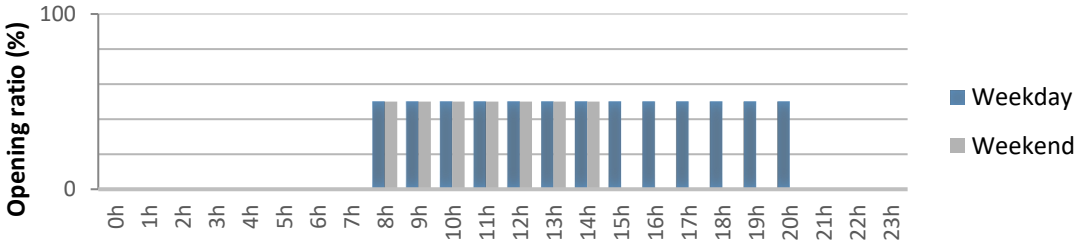


e) Lighting usage pattern

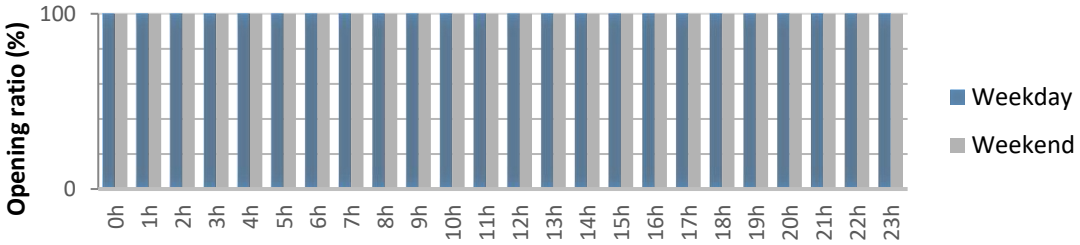
Figure S11. Patterns of occupation and use of equipment in living room 2 with representative pattern A.



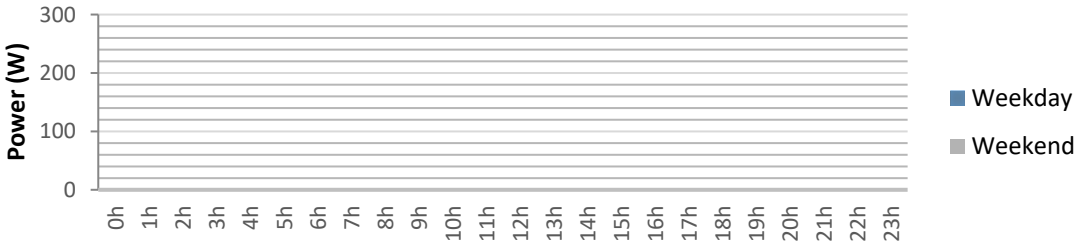
a) Occupation pattern



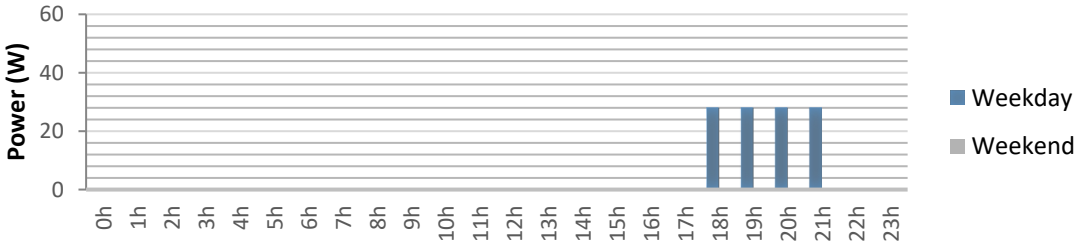
b) Window operation pattern



c) Door operation pattern

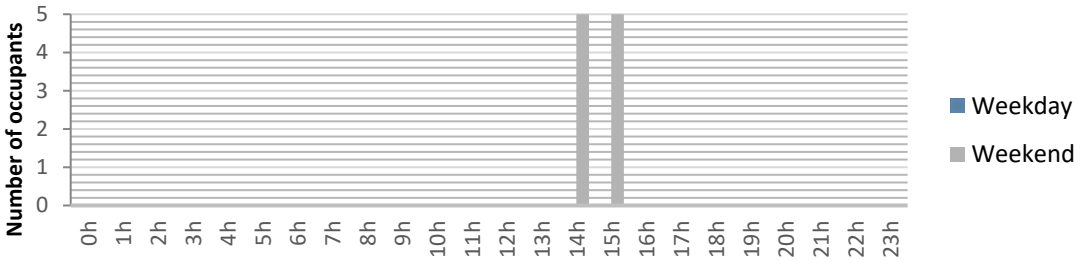


d) Electrical equipment usage pattern

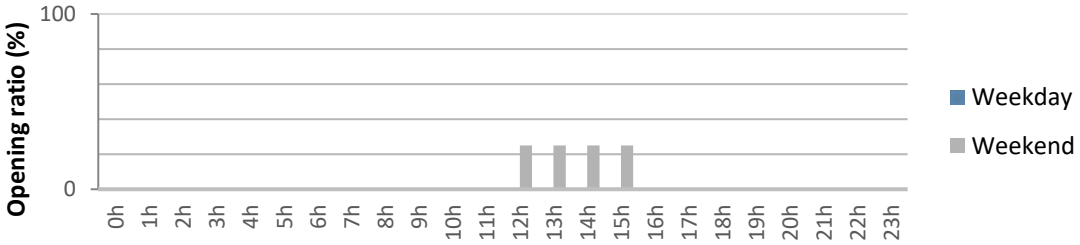


e) Lighting usage pattern

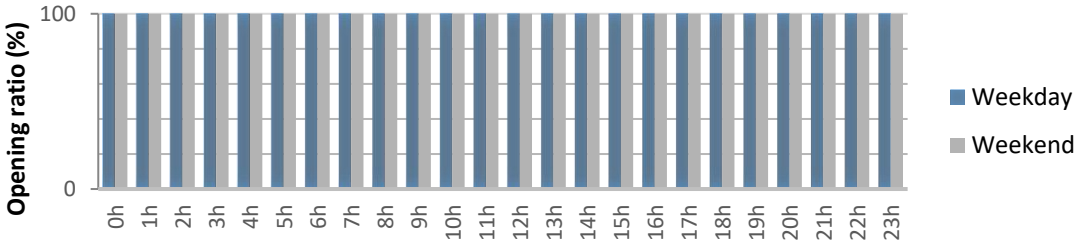
Figure S12. Patterns of occupation and use of equipment in living room 2 with representative pattern B.



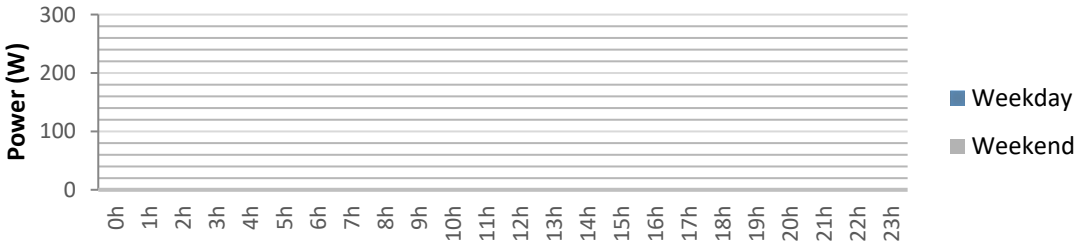
a) Occupation pattern



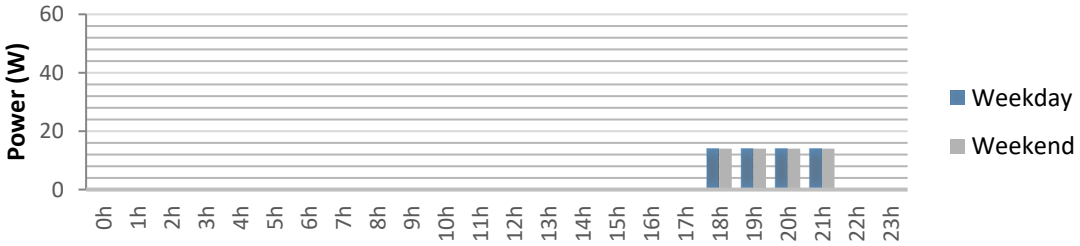
b) Window operation pattern



c) Door operation pattern

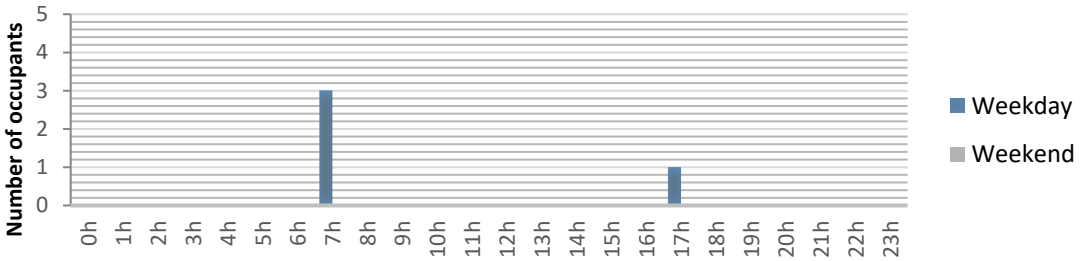


d) Electrical equipment usage pattern

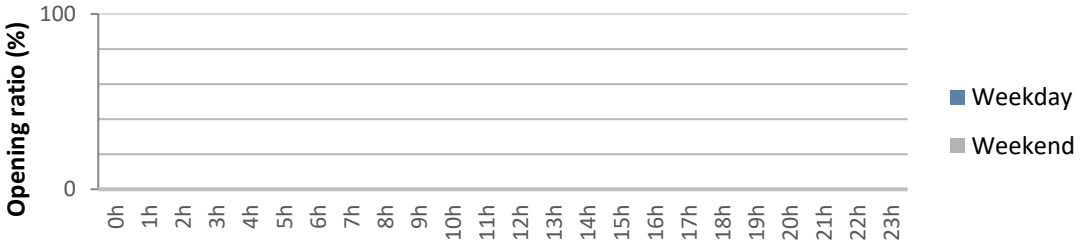


e) Lighting usage pattern

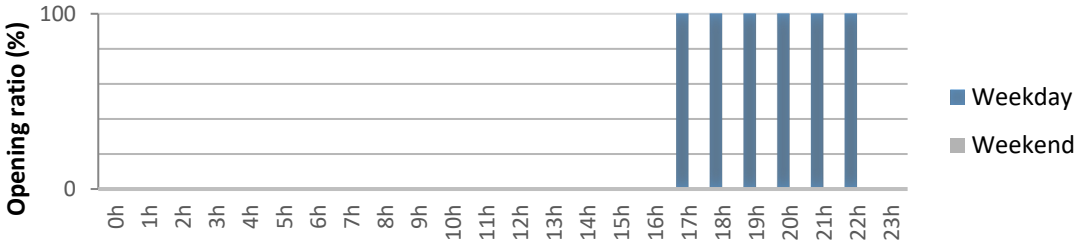
Figure S13. Patterns of occupation and use of equipment in living room 2 with representative pattern C.



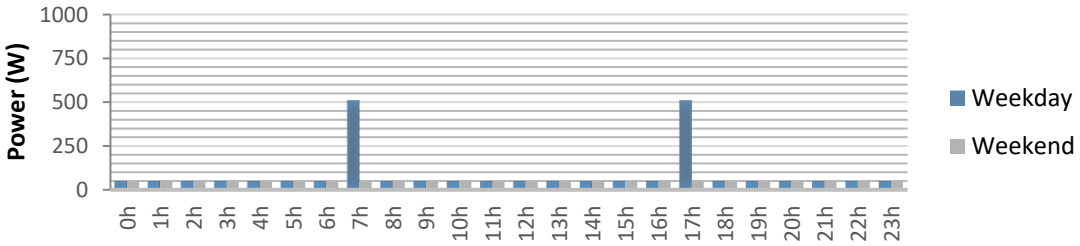
a) Occupation pattern



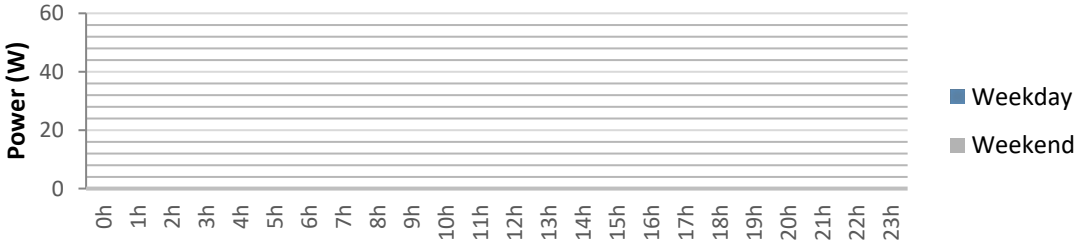
b) Window operation pattern



c) Door operation pattern

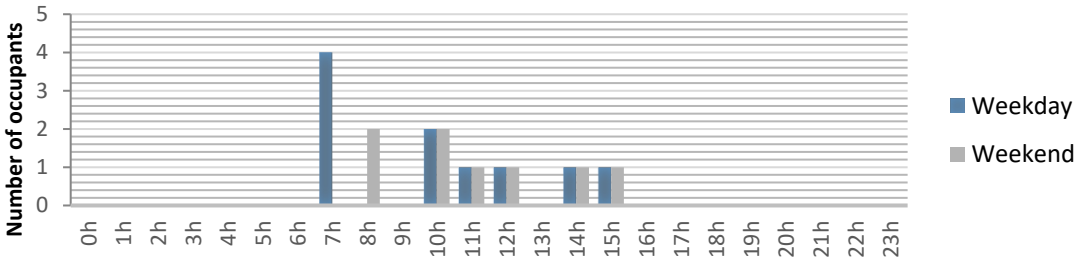


d) Electrical equipment usage pattern

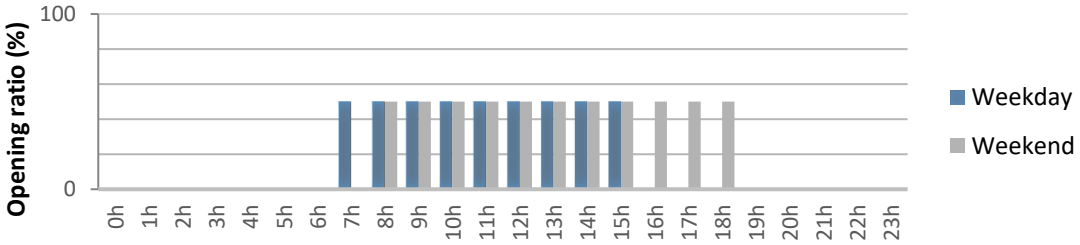


e) Lighting usage pattern

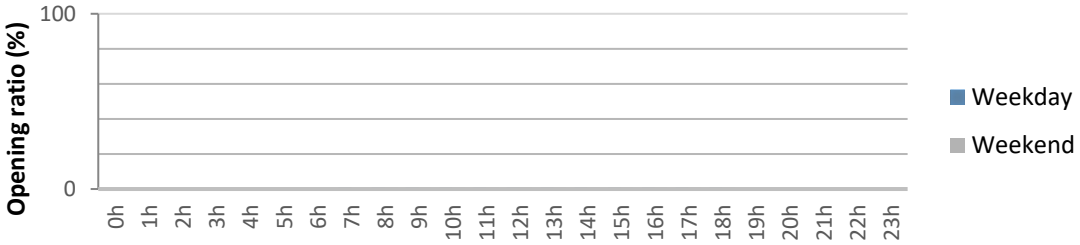
Figure S14. Patterns of occupation and use of equipment in kitchen with representative pattern A.



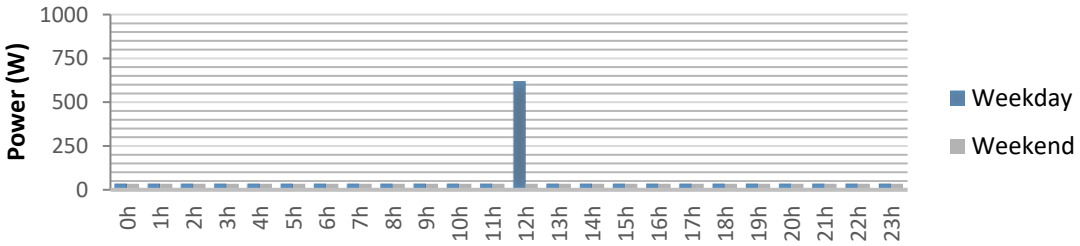
a) Occupation pattern



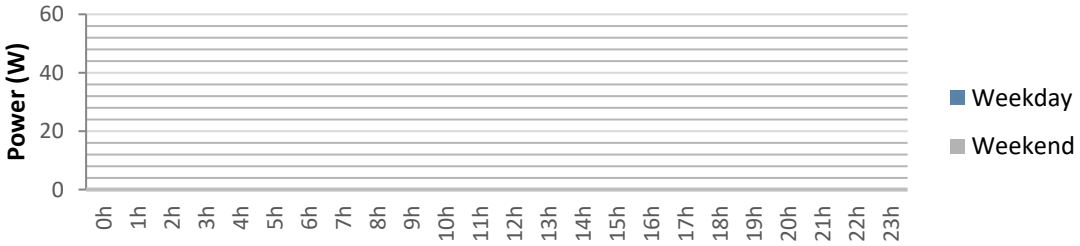
b) Window operation pattern



c) Door operation pattern

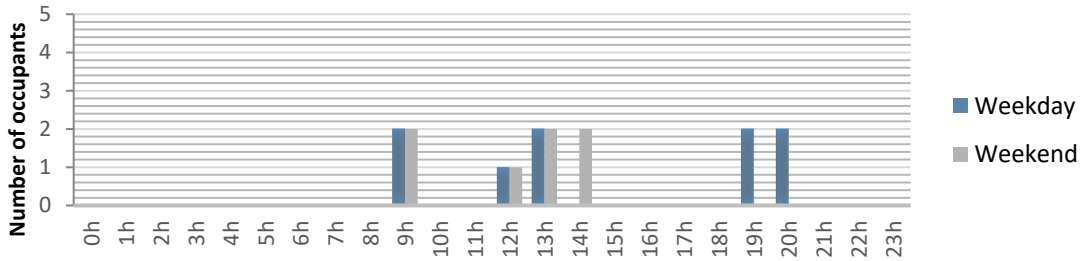


d) Electrical equipment usage pattern

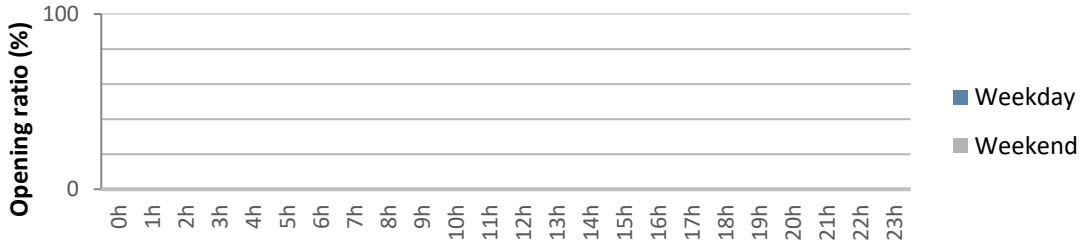


e) Lighting usage pattern

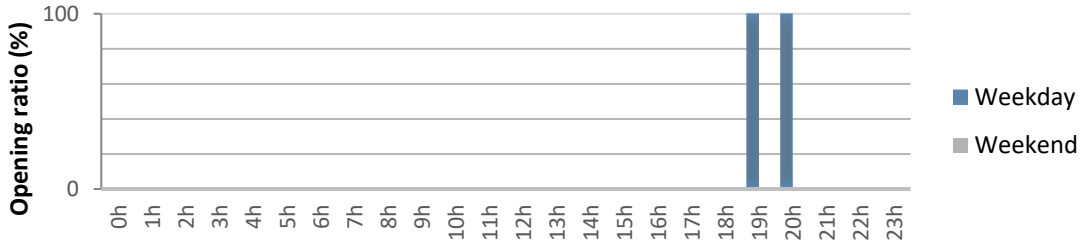
Figure S15. Patterns of occupation and use of equipment in kitchen with representative pattern B.



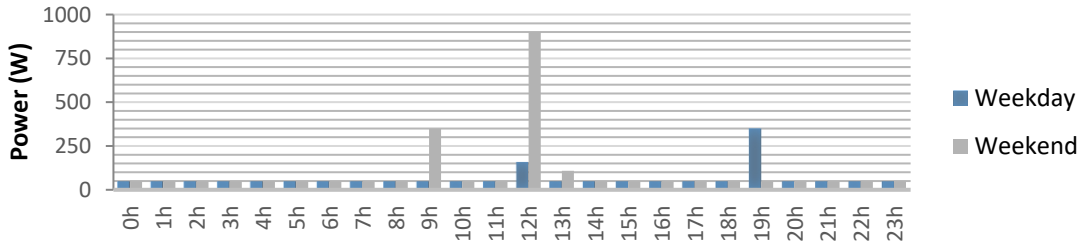
a) Occupation pattern



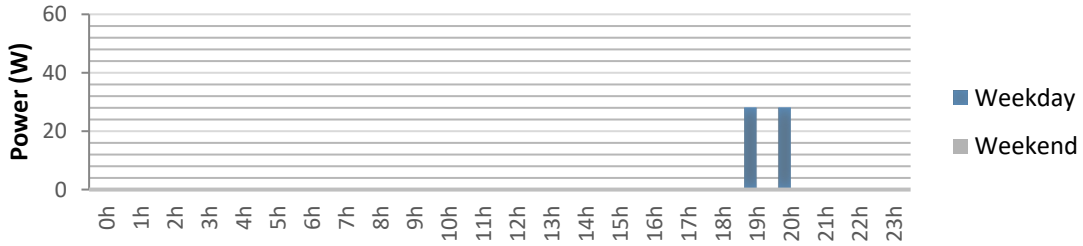
b) Window operation pattern



c) Door operation pattern

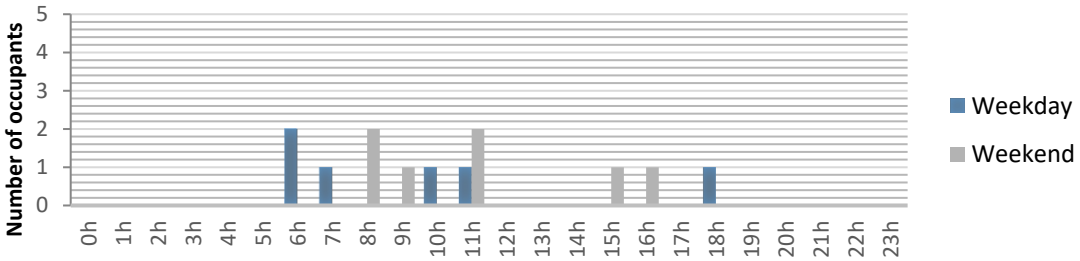


d) Electrical equipment usage pattern

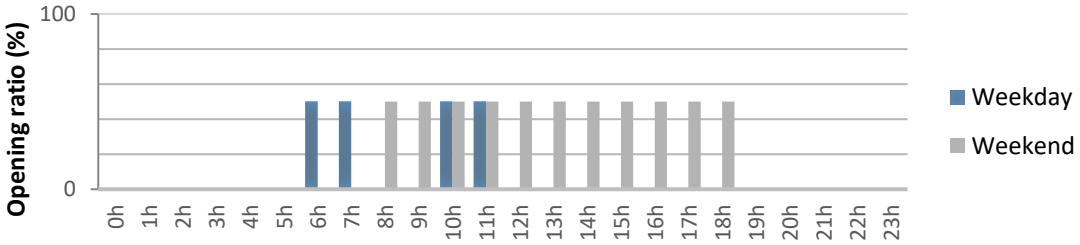


e) Lighting usage pattern

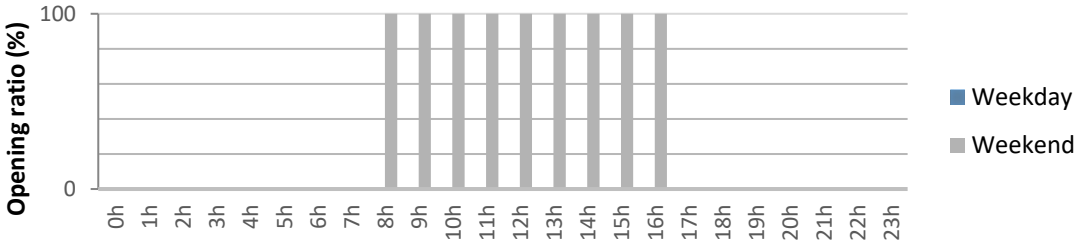
Figure S16. Patterns of occupation and use of equipment in kitchen with representative pattern C.



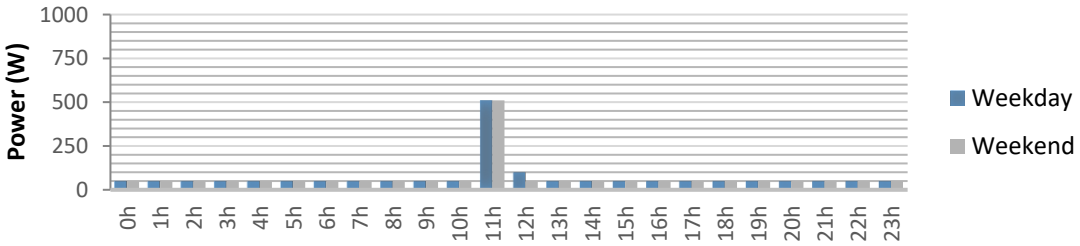
a) Occupation pattern



b) Window operation pattern



c) Door operation pattern



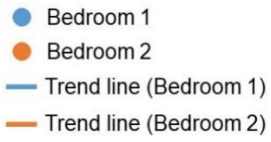
d) Electrical equipment usage pattern



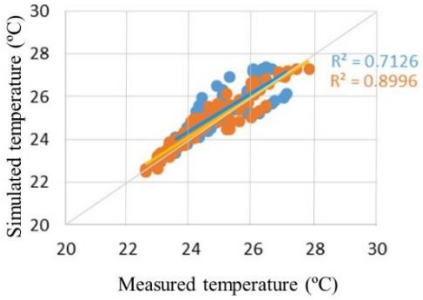
e) Lighting usage pattern

Figure S17. Patterns of occupation and use of equipment in kitchen with representative pattern D.

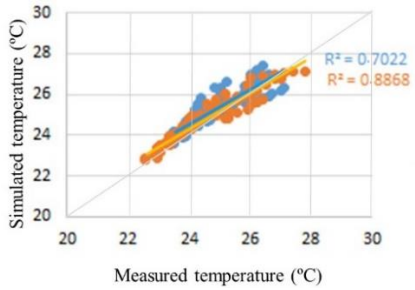
3. Model calibration



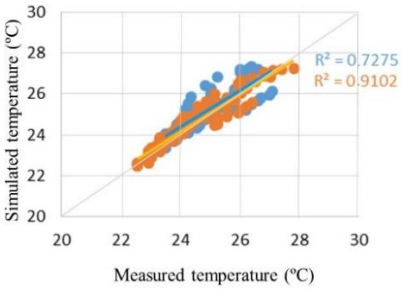
Legend:



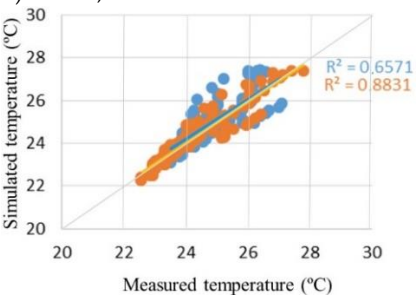
a) Case 1, base case.



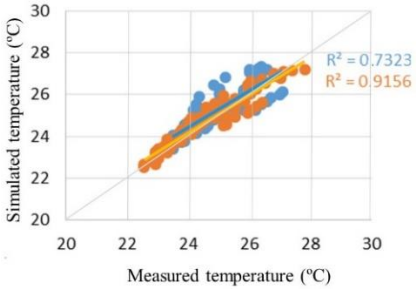
b) Case 2, roof alteration.



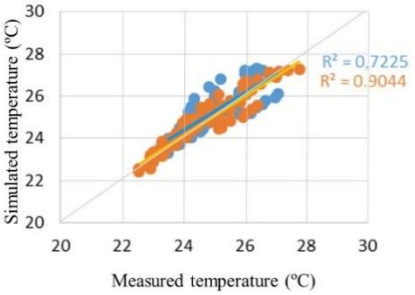
c) Case 3, the addition of the surroundings.



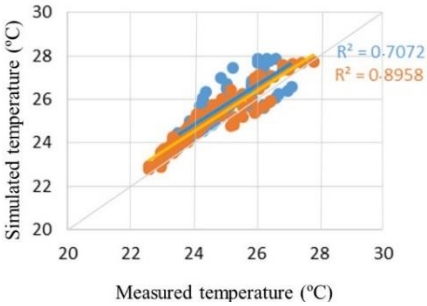
d) Case 4, alteration of air infiltration.



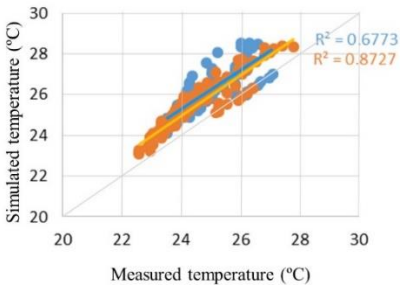
e) Case 5, alteration of thermal resistance of the envelope in +15%.



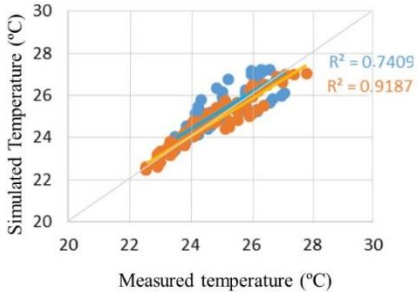
f) Case 6, alteration of thermal resistance of the envelope in -15%.



g) Case 7, alteration of envelope absorptance associated an error equal to zero



h) Case 8, alteration of envelope absorptance associated an error equal to +0.10.



i) Case 9, alteration of envelope absorptance associated an error equal to -0.10.

Figure S18. Correlation between monitored and simulated temperatures in bedrooms 1 and 2.

4. Hours of discomfort due to cold and heat, considering the whole year

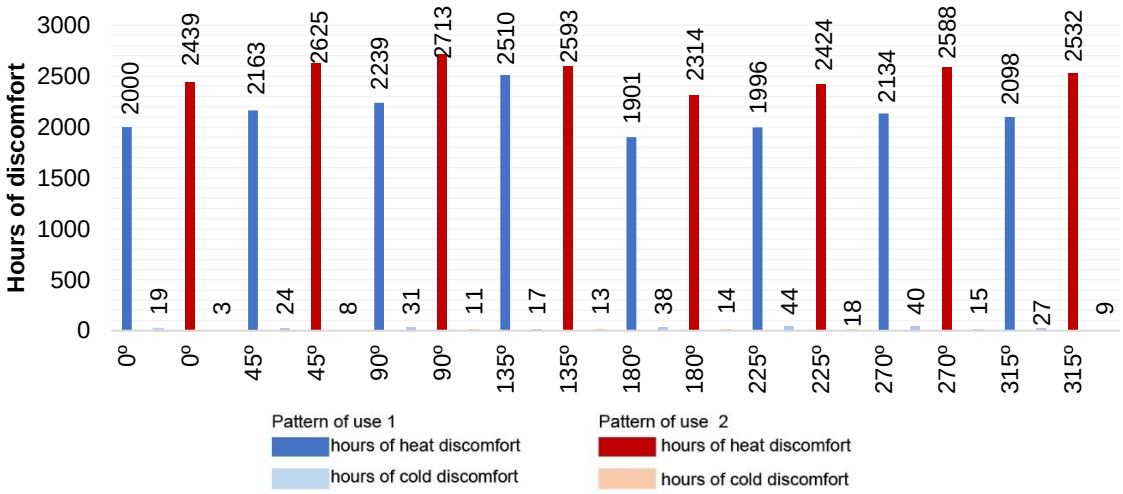


Figure S19. Hours of discomfort in bedroom 1 considering the whole year.

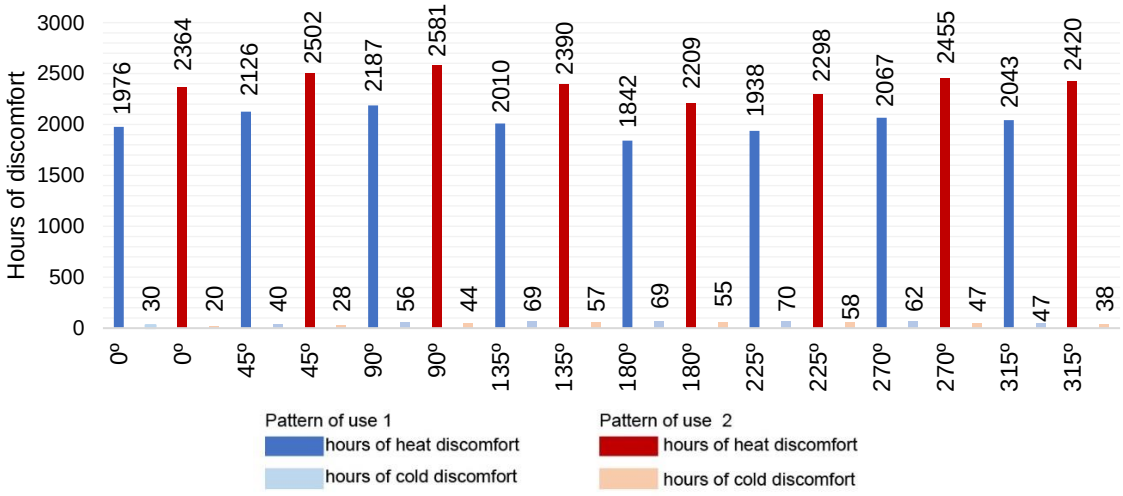


Figure S20. Hours of discomfort in bedroom 3 considering the whole year.

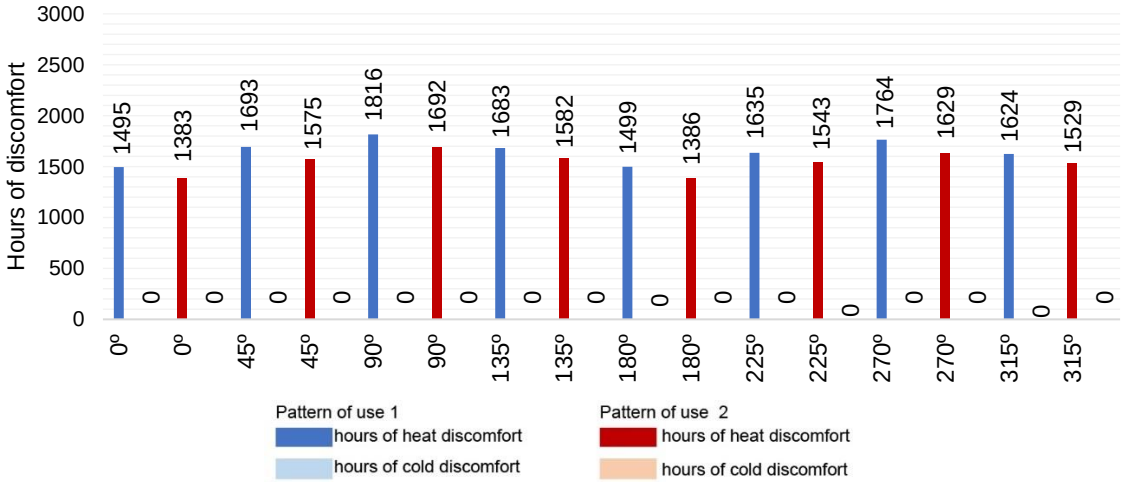


Figure S21. Hours of discomfort in living room 1 considering the whole year.

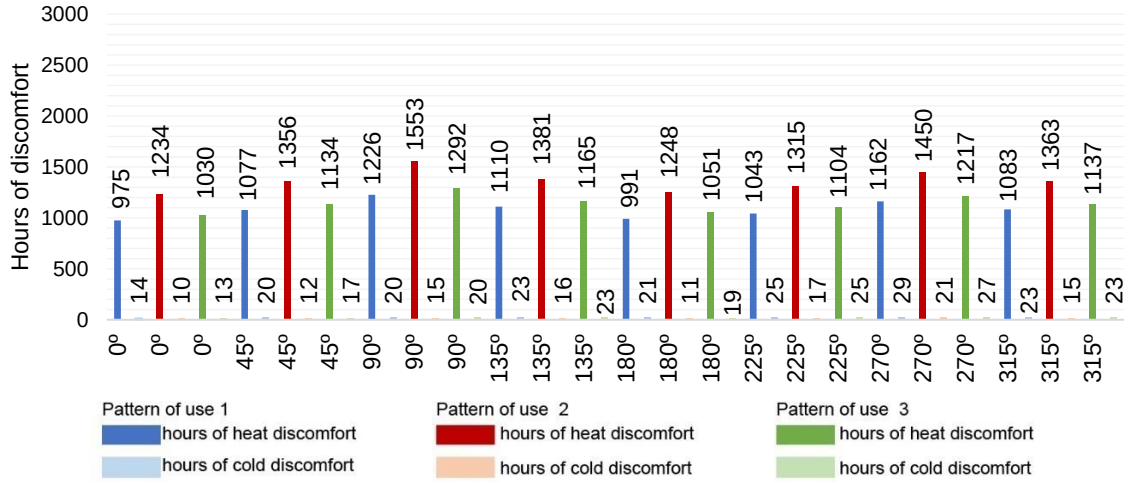


Figure S22. Hours of discomfort in living room 2 considering the whole year.

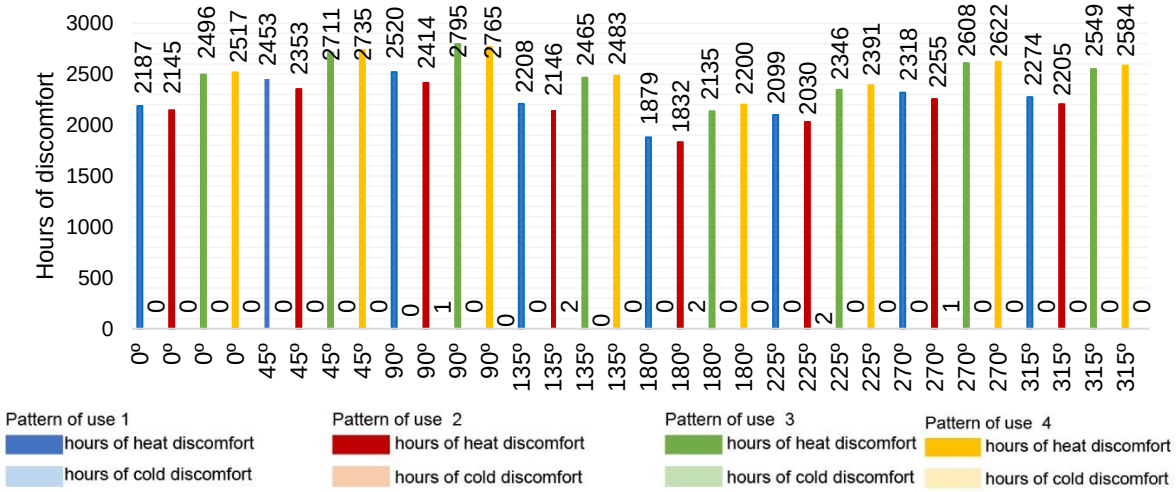
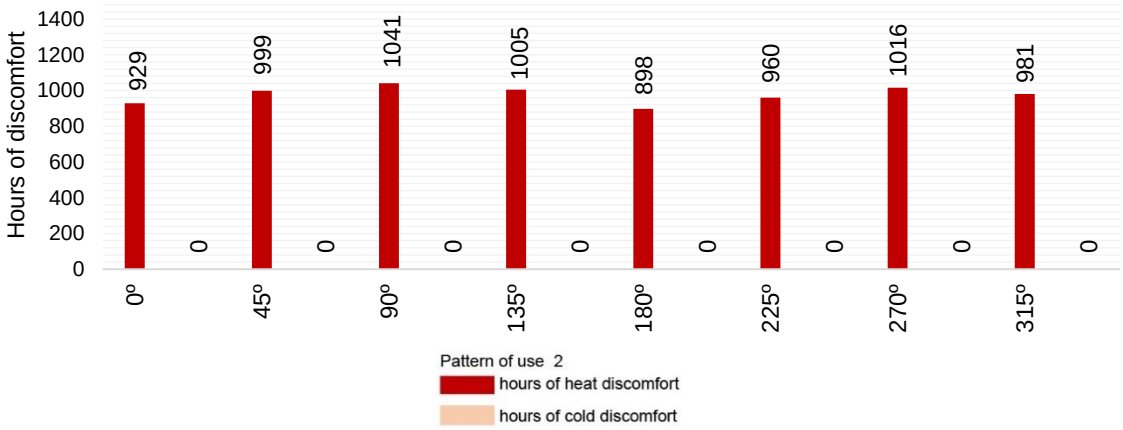


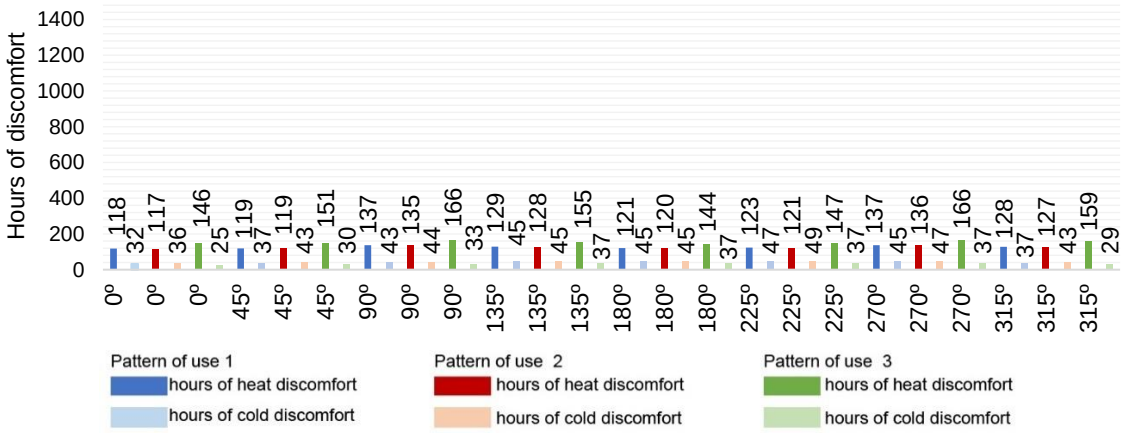
Figure S23. Hours of discomfort in kitchen considering the whole year.

5. Hours of discomfort due to cold and heat, considering only the period the rooms are occupied



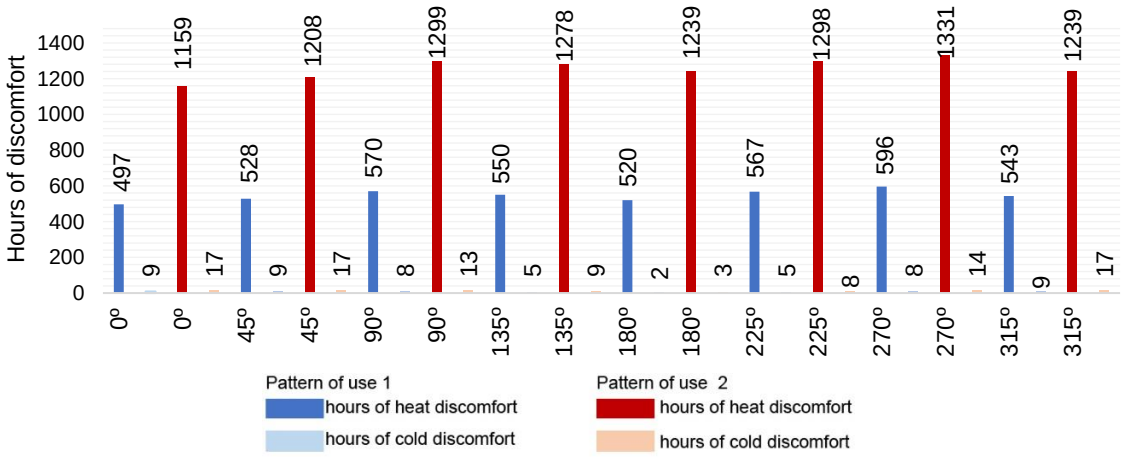
(3754 occupied hours)

Figure S24. Hours of discomfort in bedroom 1 considering only the period the environment is occupied.



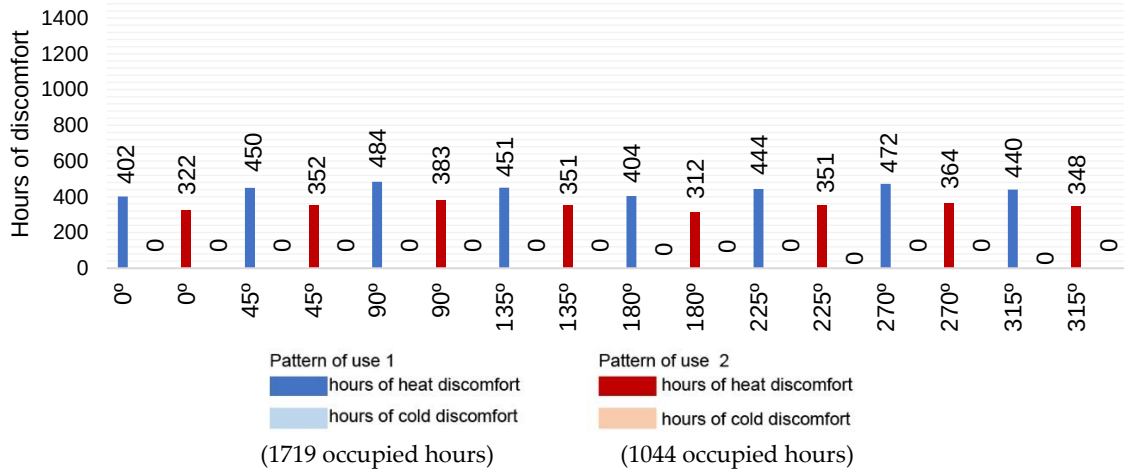
(3024 occupied hours) (3232 occupied hours) (3128 occupied hours)

Figure S25. Hours of discomfort in bedroom 2 considering only the period the environment is occupied.



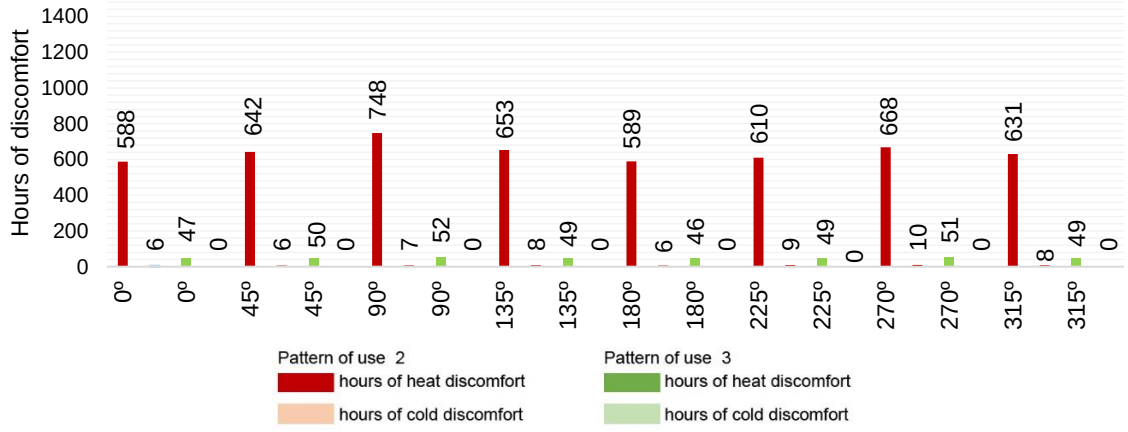
(2610 occupied hours) (4433 occupied hours)

Figure S26. Hours of discomfort in bedroom 3 considering only the period the environment is occupied.



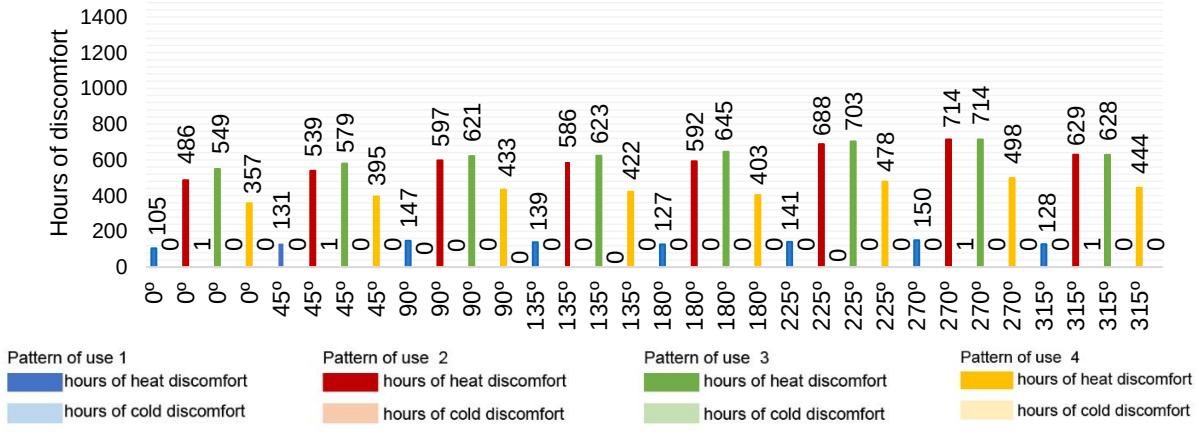
(1719 occupied hours) (1044 occupied hours)

Figure S27. Hours of discomfort in living room 1 considering only the period the environment is occupied.



(3495 occupied hours) (208 occupied hours)

Figure S28. Hours of discomfort in living room 2 considering only the period the environment is occupied.



(522 occupied hours) (2190 occupied hours) (1721 occupied hours) (1887 occupied hours)

Figure S29. Hours of discomfort in kitchen considering only the period the environment is occupied.