

# Indoor Environment Quality (IEQ) of School Building in Warm-humid Climate

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Effective Passive Strategies to achieve Thermal Comfort

# IEQ and Its importance

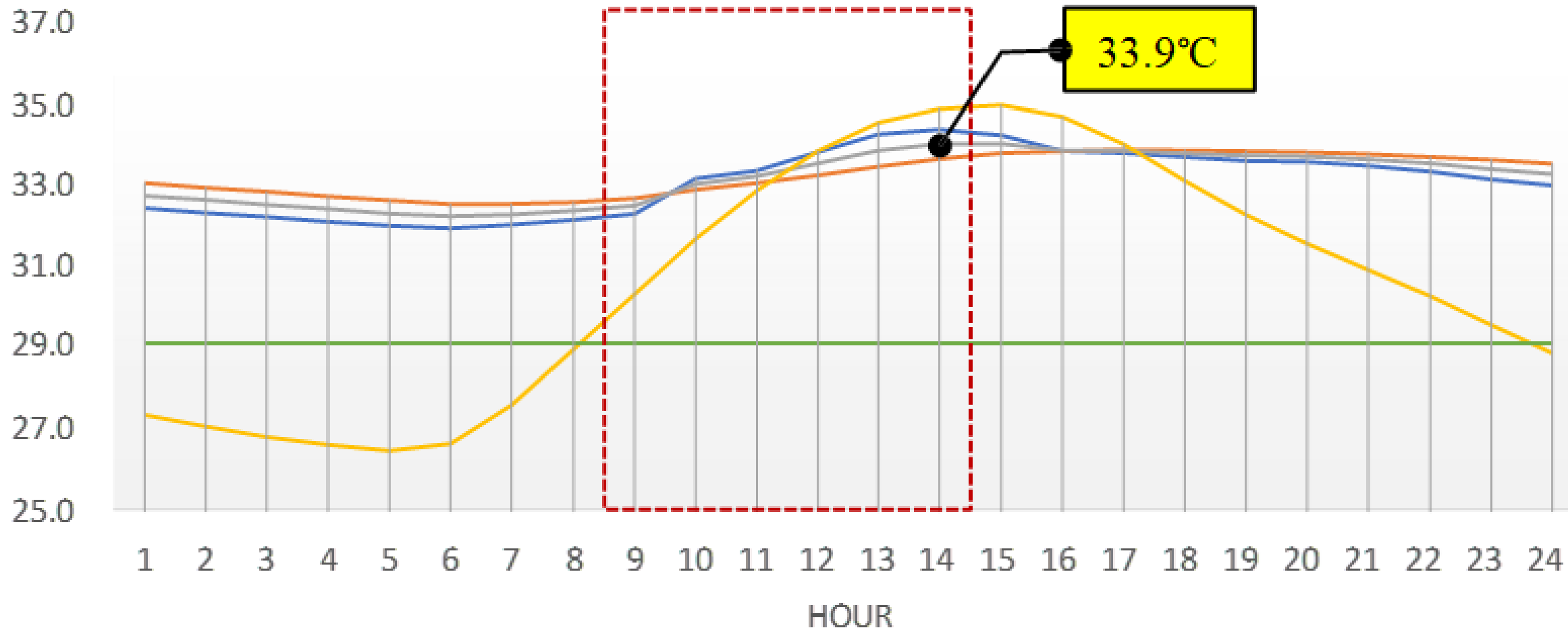


# Literature – Effective passive cooling strategies

S/N	Passive Cooling Strategies	Type	Heat	Energy	Effectiveness
1	Orientation	Building Design	Prevents Heating	Free Cooling	Max ST ↓ 4.0°C to 32.5°C from 36.5°C
2	Corridor Position				Max AT ↓ 4.4°C to 30.8 from 35.2°C
3	Shading Device				Avg. OT ↓ 0.2°C to 29.4°C from 29.6°C
4	Opening Ratio				Max AT ↓ 6.5°C to 33.1°C from 39.6°C
5	Insulation	Building Material	Prevents Heating	Free Cooling	Max ST ↓ 5.0°C to 30.0°C from 35.0°C
6	Radiant Barrier				Max ST ↓ 2°C to 28.7°C from 30.7°C
7	Double Roof				Max ST ↓ 4°C to 30.7°C from 34.7°C
8	Cool Roof				Max ST ↓ 8.0°C to 29.3°C from 37.3°C
9	Attic Ventilation	Ventilation System	Removes Heat	Free Cooling	Max OT ↓ 1.9°C to 34.8°C from 36.7°C
10	Cross Ventilation				Max AT ↓ 2.8°C to 34.0°C from 36.8
11	Nocturnal ventilation				Avg. OT ↓ 1.8°C to 27.8°C from 29.6°C
12	Phase Change material (PCM)	Advance System	Stores Coolth	Low Energy Cooling	Max OT ↓ 5°C to 29.0°C from 34.0°C
13	Earth Air Heat Exchange (EAHE)		Cooling		Max AT ↓ 7°C to 23.0°C from 30.0°C
14	Indirect Evaporative Cooling (IEC)		Cooling		Max AT ↓ 5.1°C to 30.1°C from 35.2°C

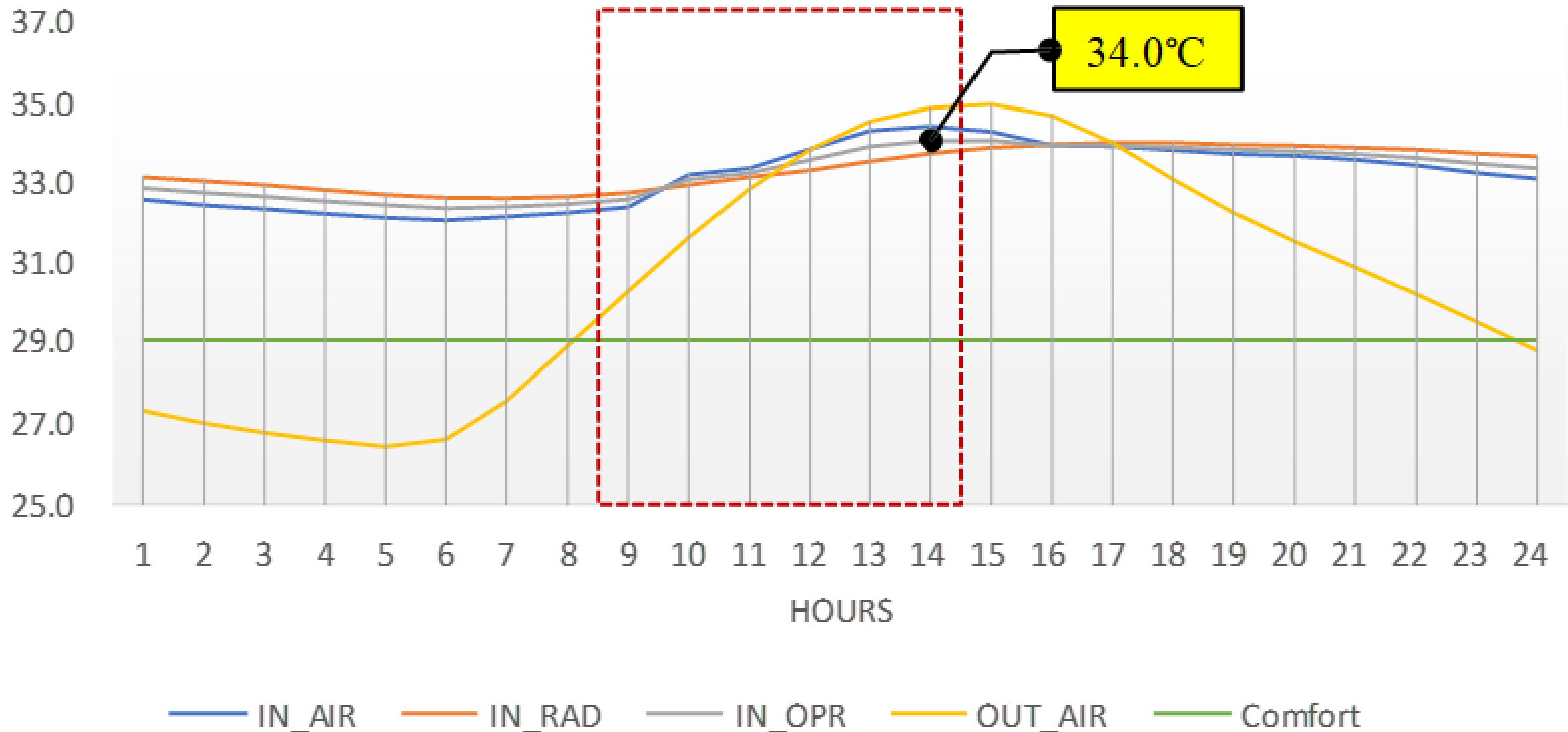
Note: ST-Surface Temperature; AT-Air Temperature; and OT-Operative Temperature

# Base Case

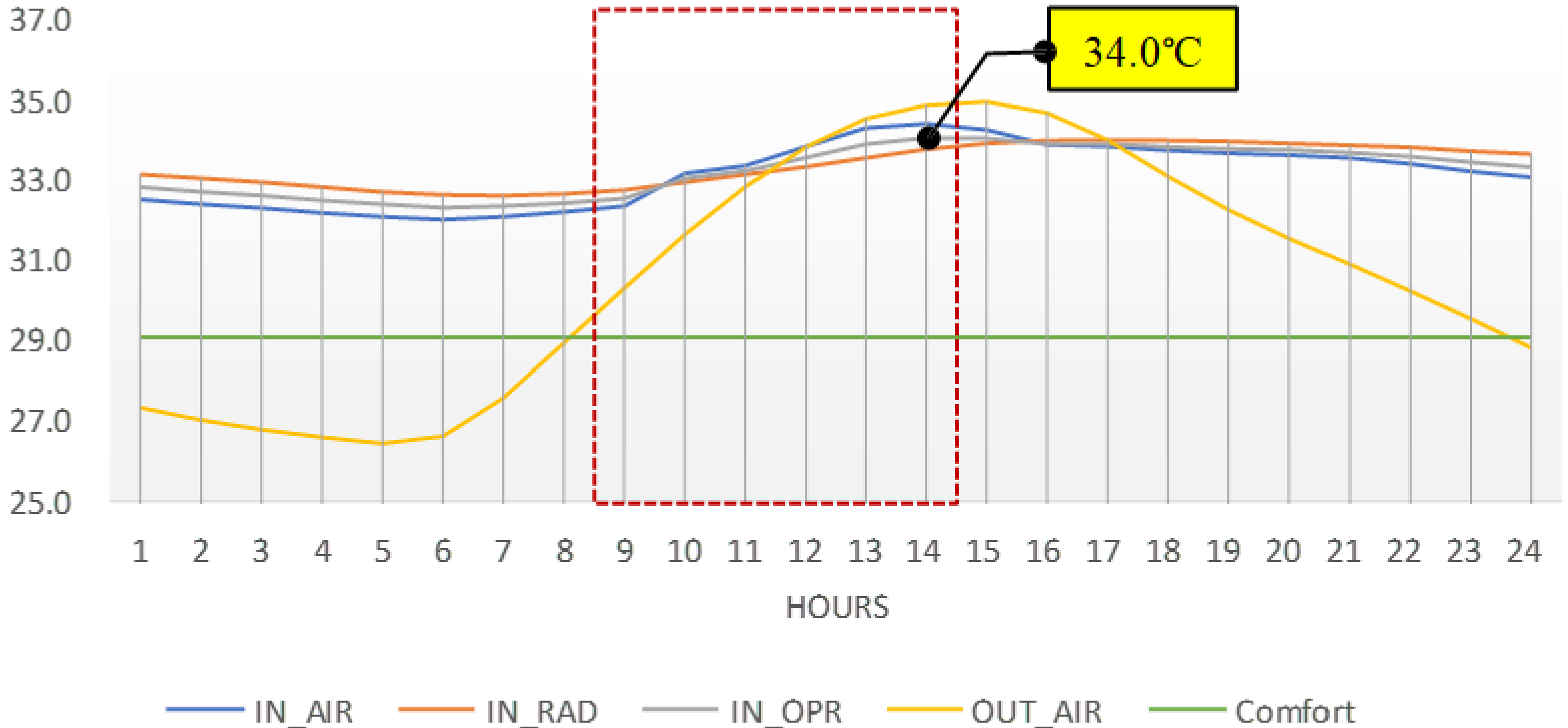


— IN\_AIR — IN\_RAD — IN\_OPR — OUT\_AIR — Comfort

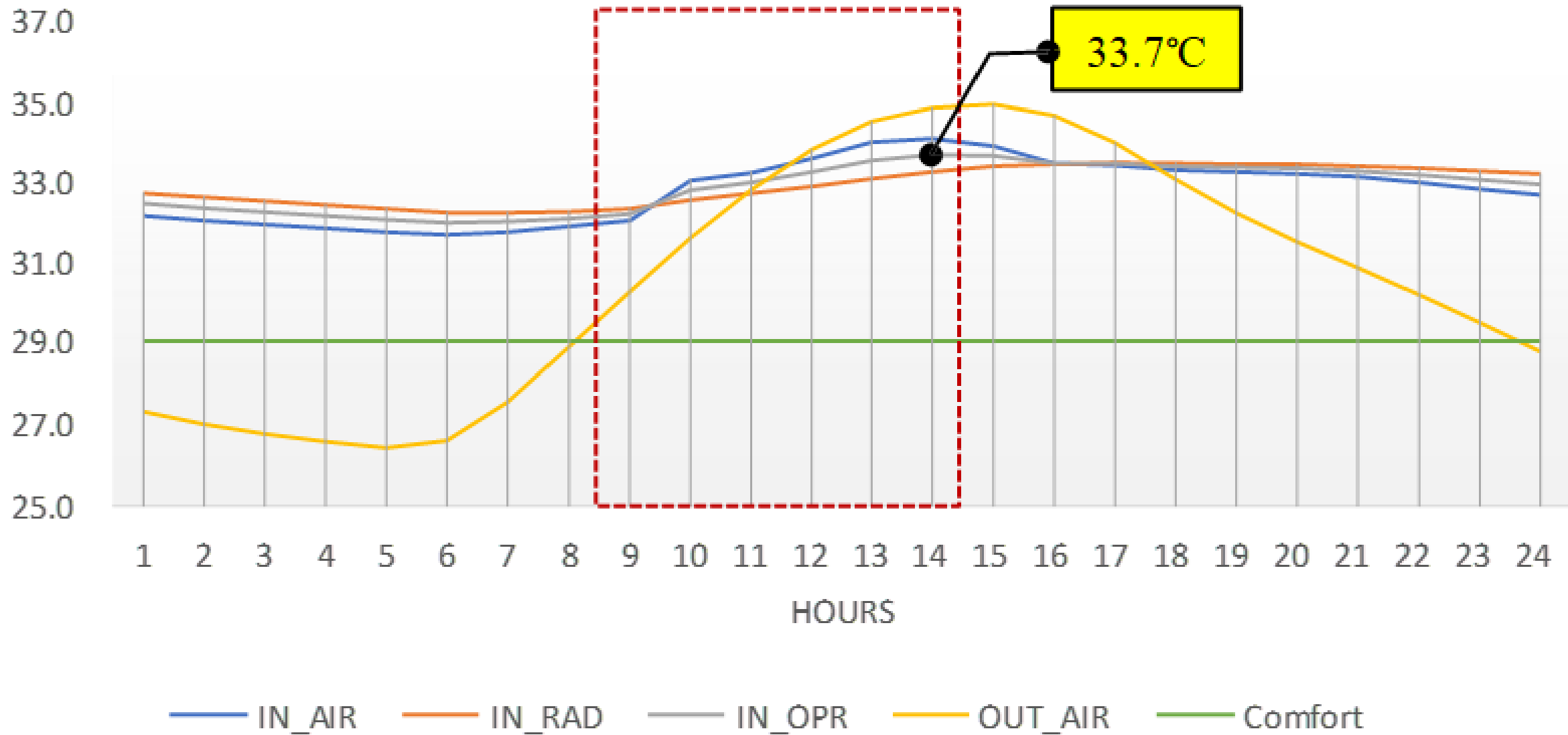
# 1. Building Orientation



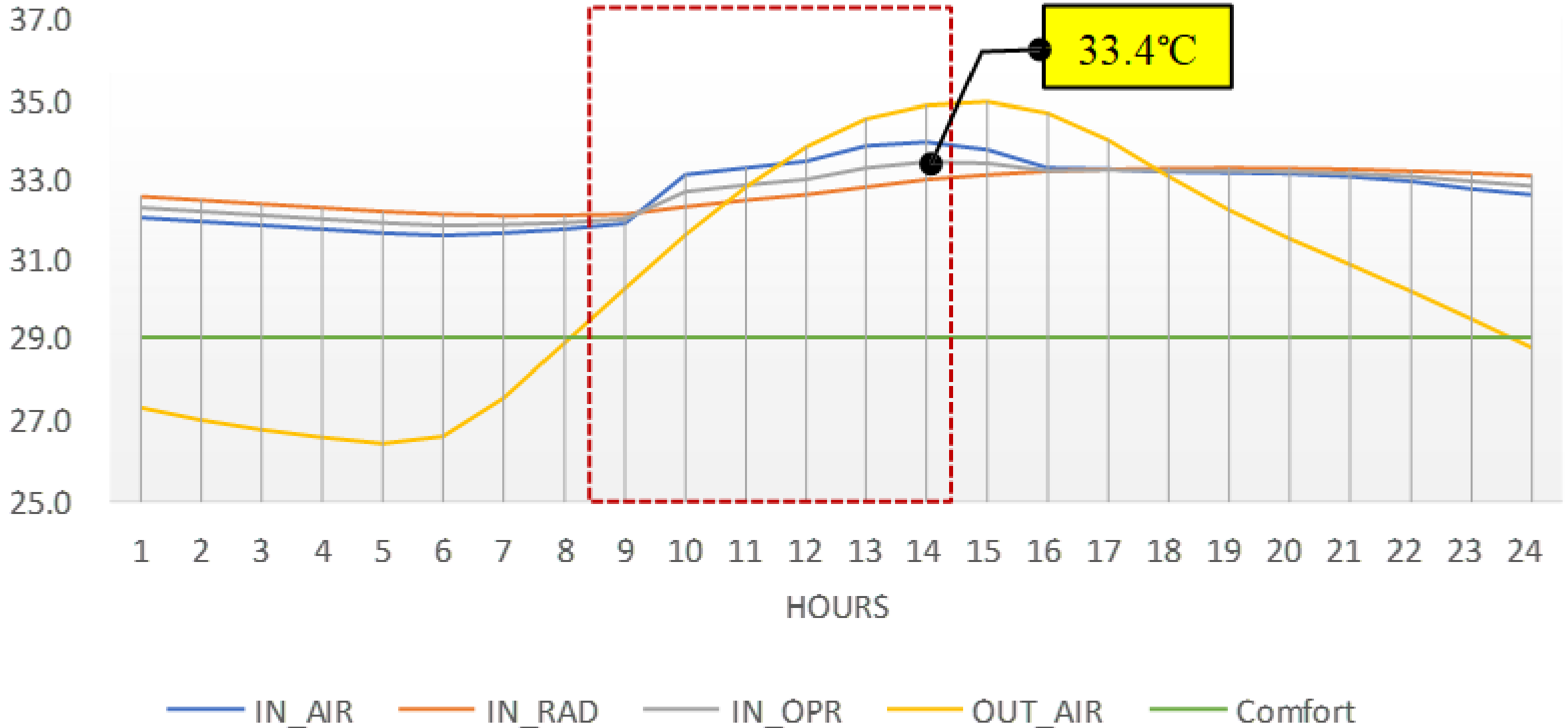
## 2. Building Corridor Position



### 3. Window Shading Device

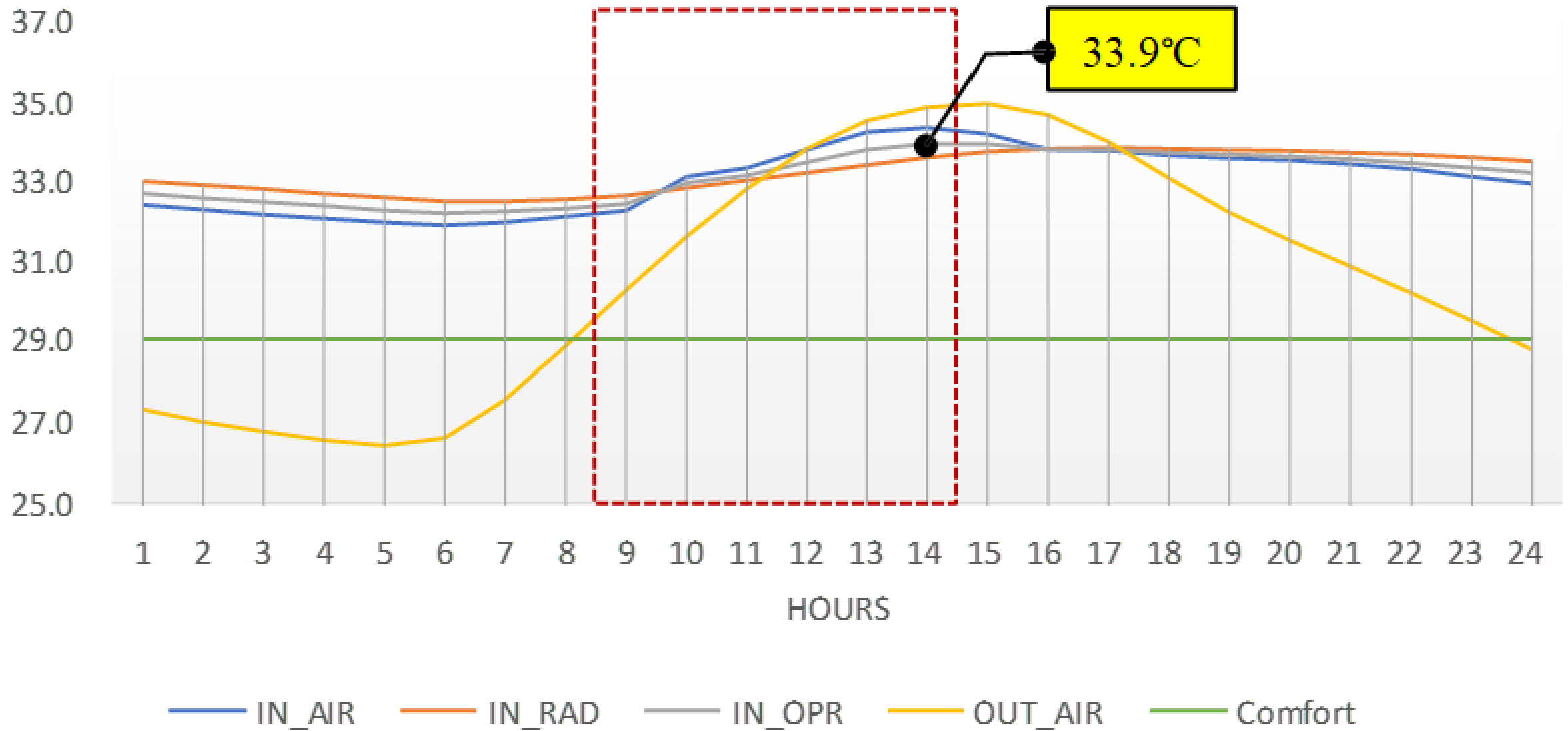


## 4. Window Wall Ratio (WWR)

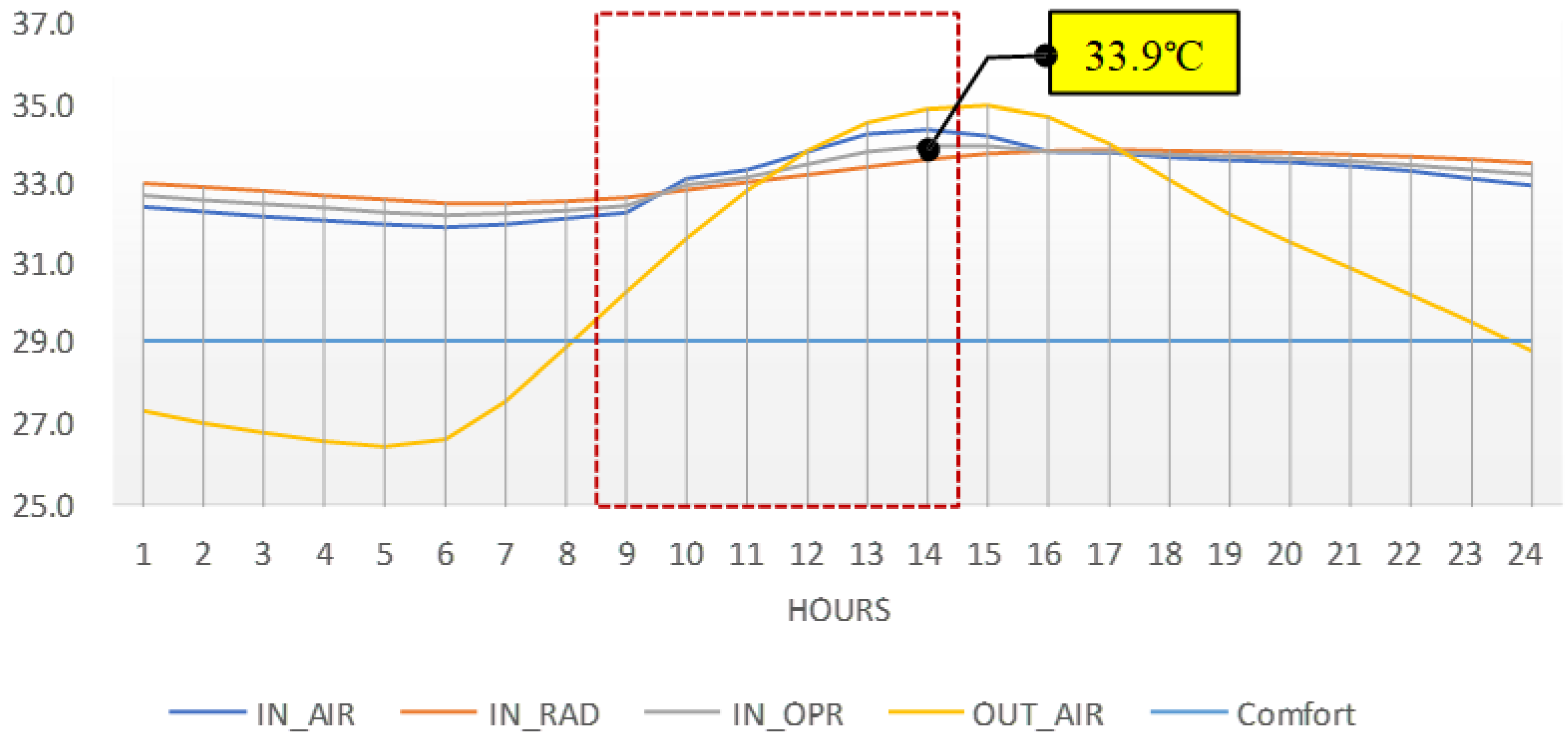




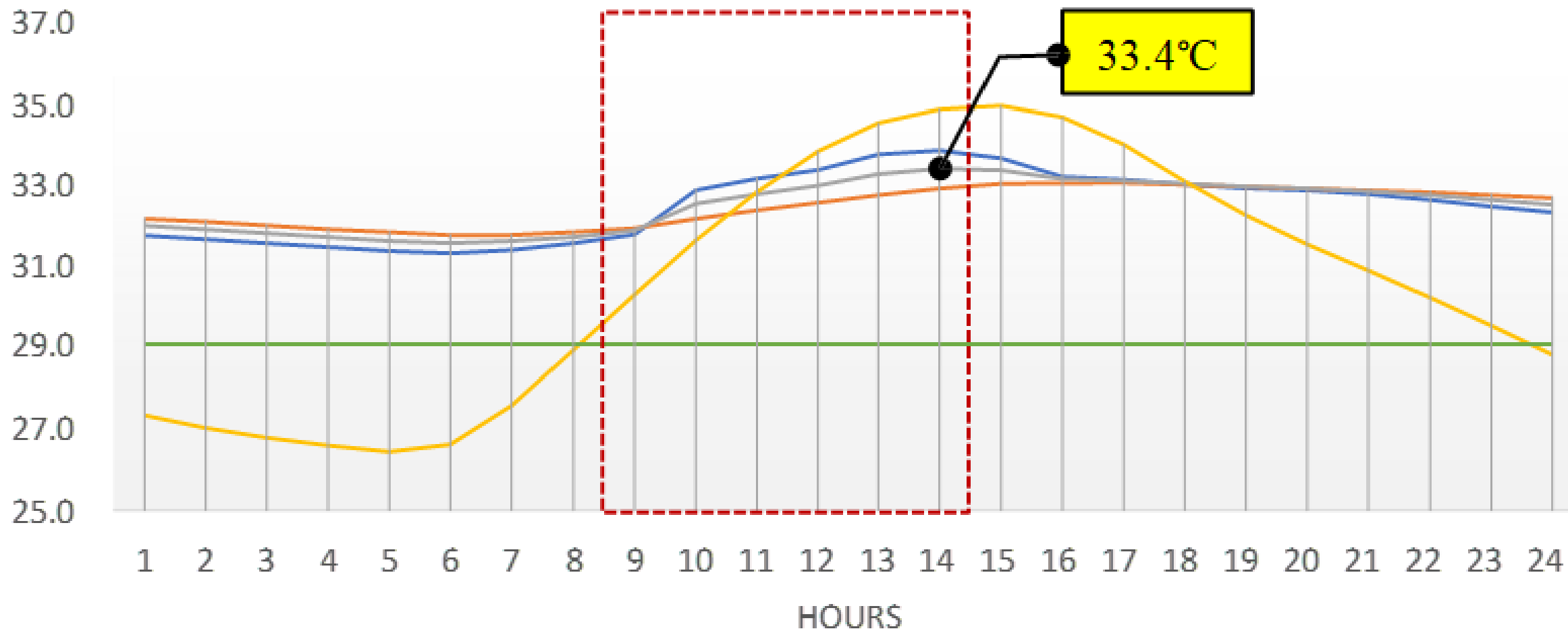
# 5. Roof Insulation



# 6. Radiant Insulation

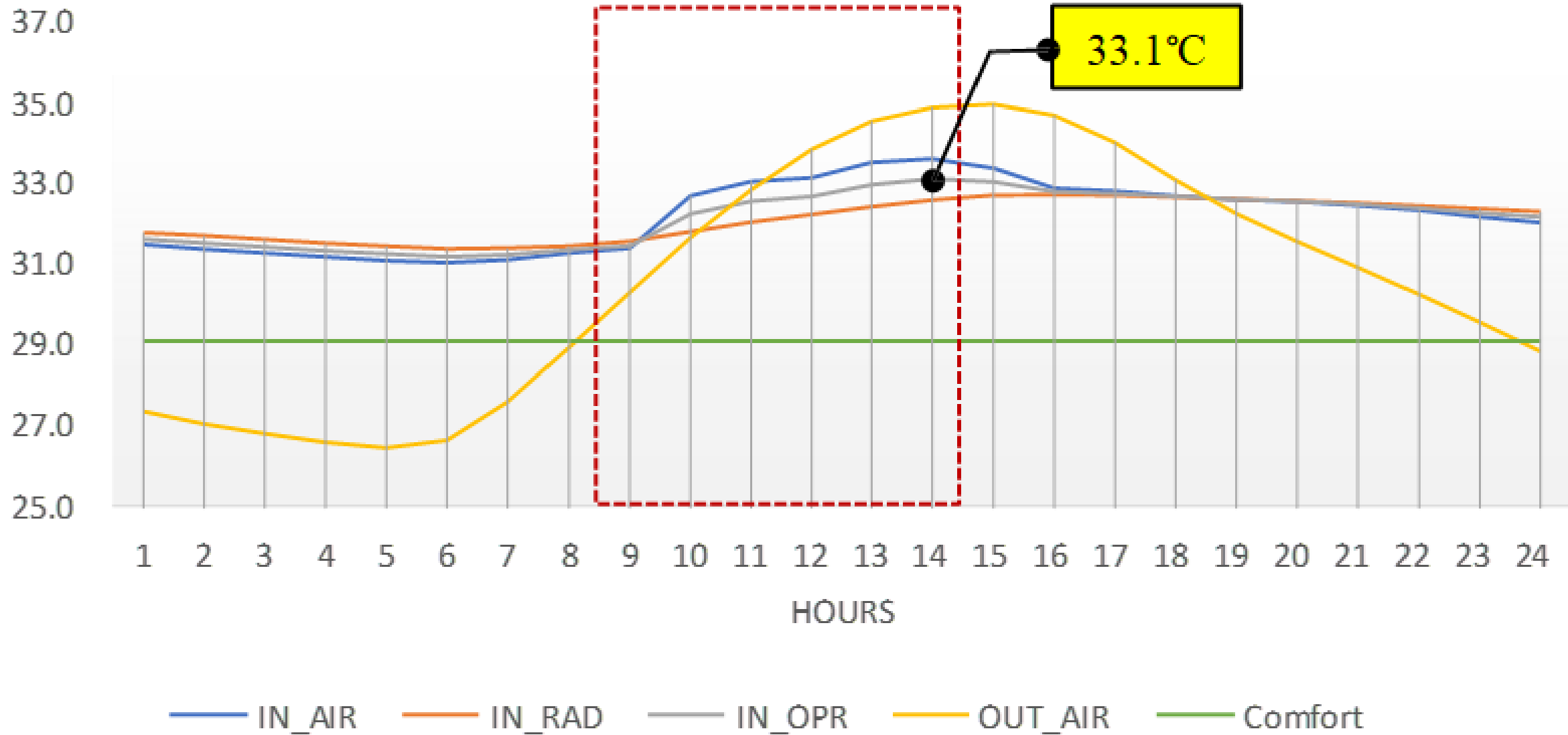


# 7. Double Roof

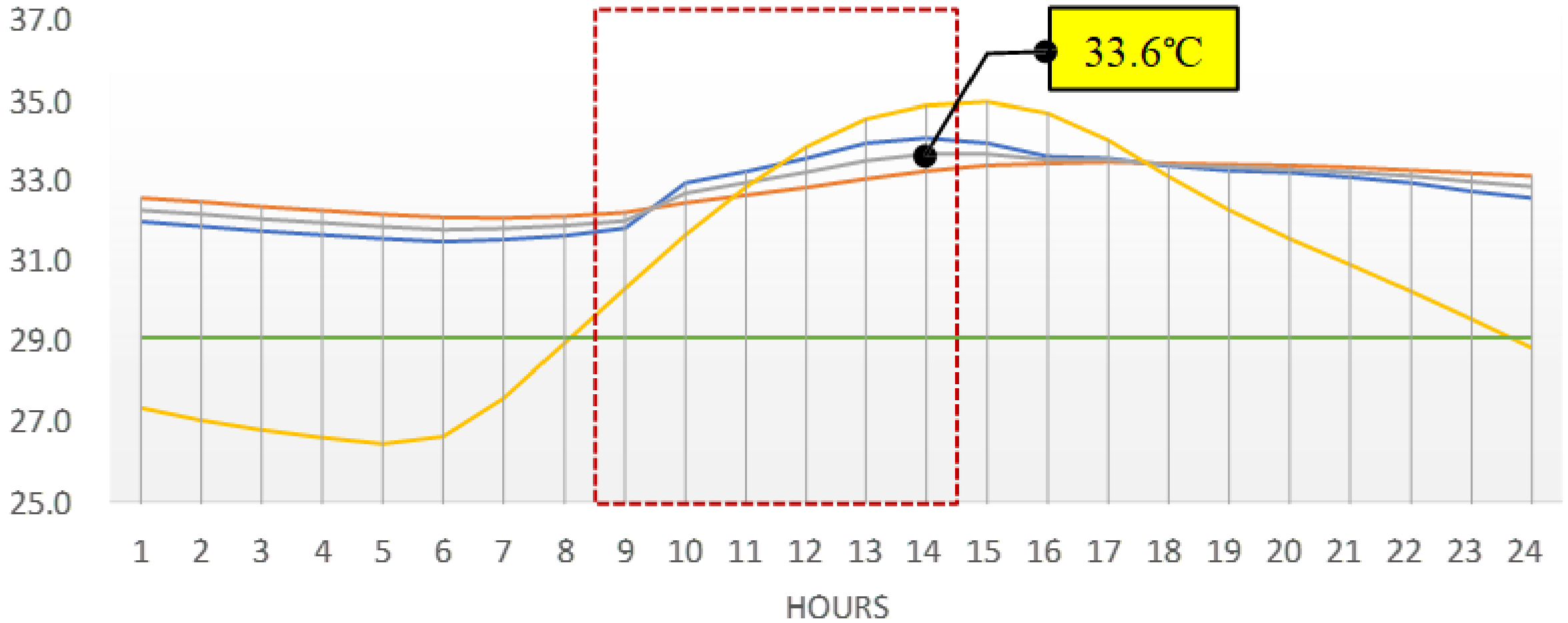


— IN\_AIR — IN\_RAD — IN\_OPR — OUT\_AIR — Comfort

# 8. Cool Roof

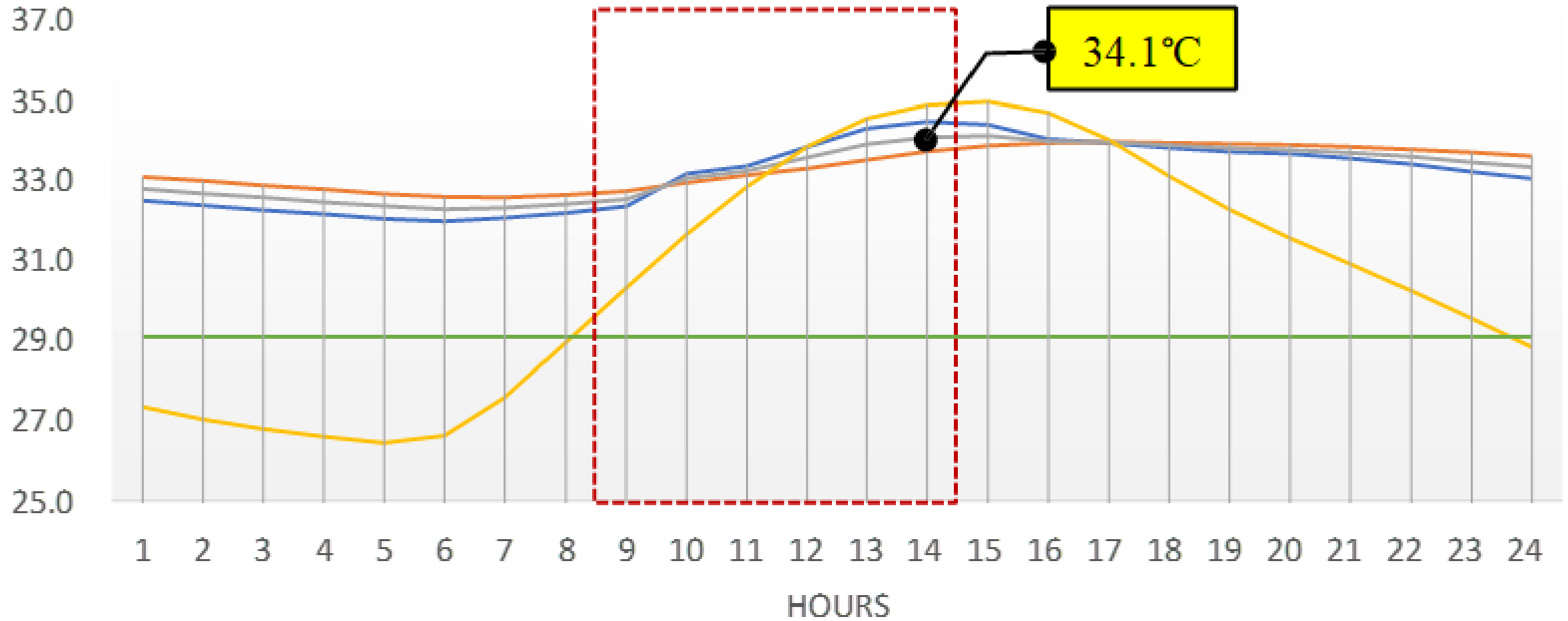


# 9. Attic Ventilation



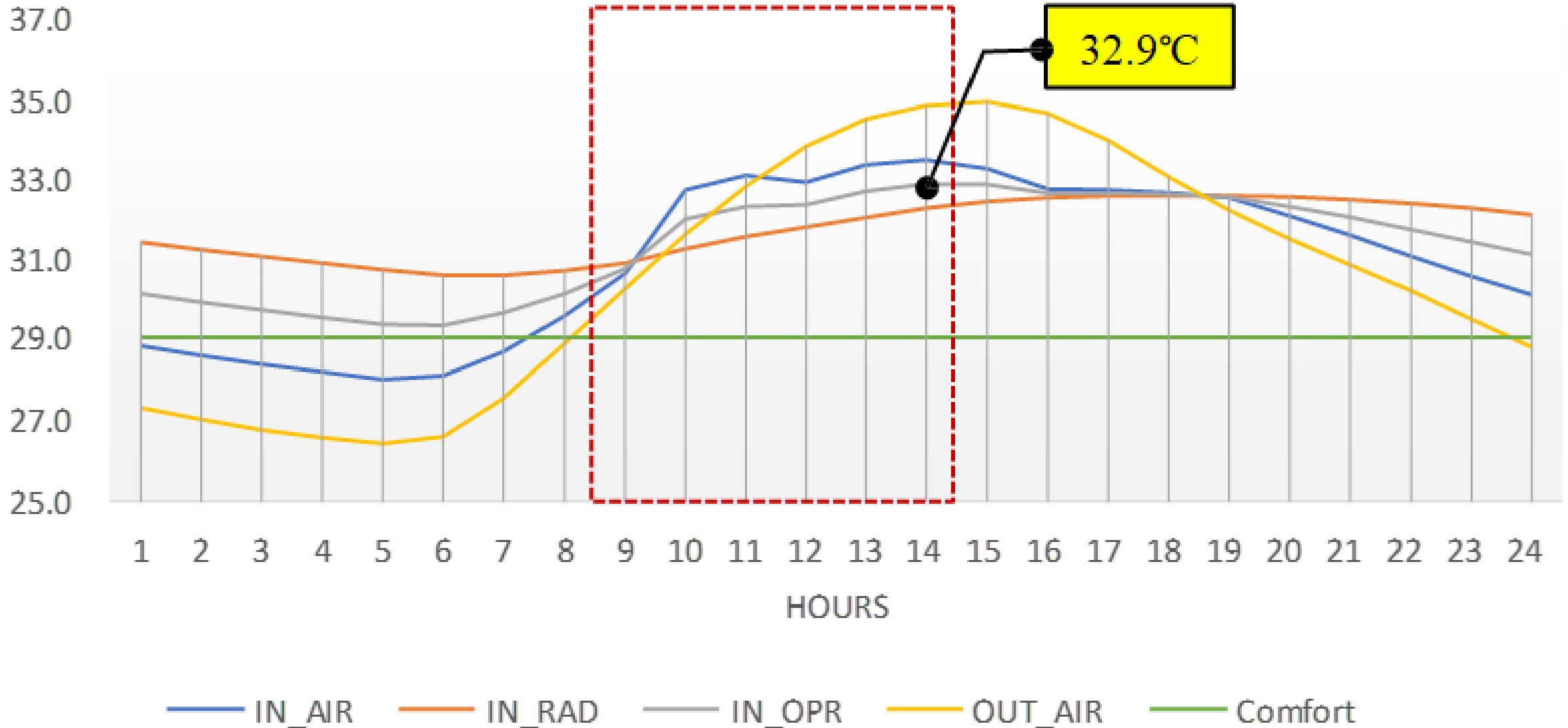
— IN\_AIR — IN\_RAD — IN\_OPR — OUT\_AIR — Comfort

# 10. Cross Ventilation



— IN\_AIR — IN\_RAD — IN\_OPR — OUT\_AIR — Comfort

# 11. Nocturnal Ventilation

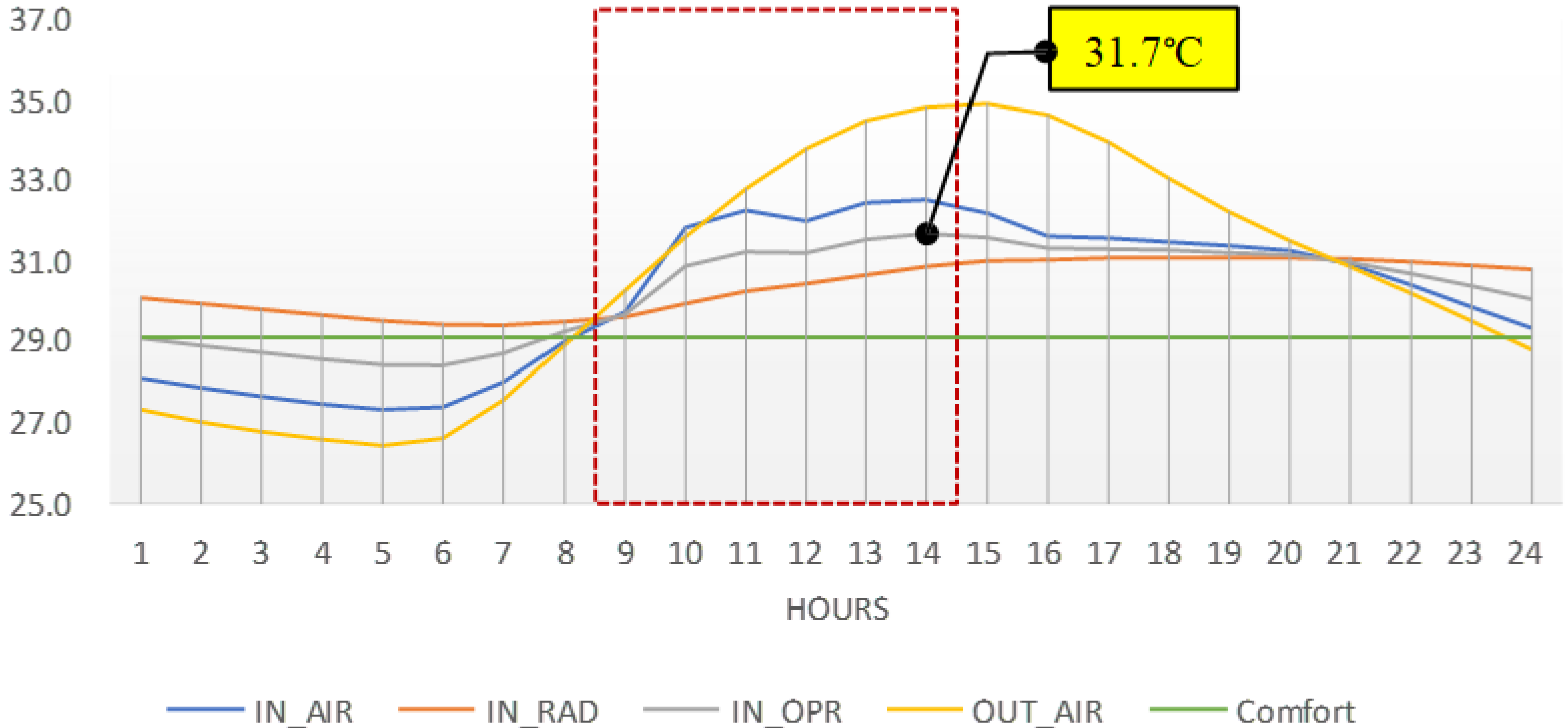


# 12, 13, 14. PCM, EAHE, and IEC

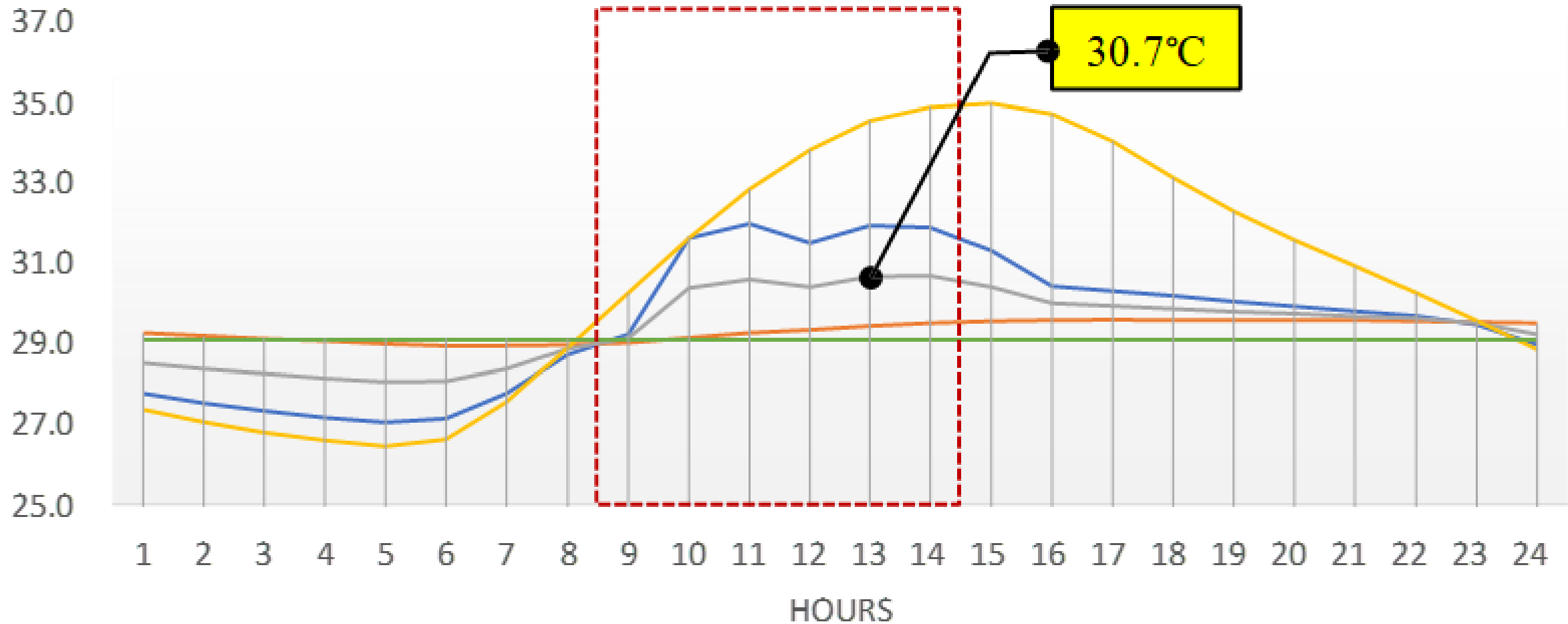




# Combination 1- WWR + Cool Roof + Nocturnal Ventilation

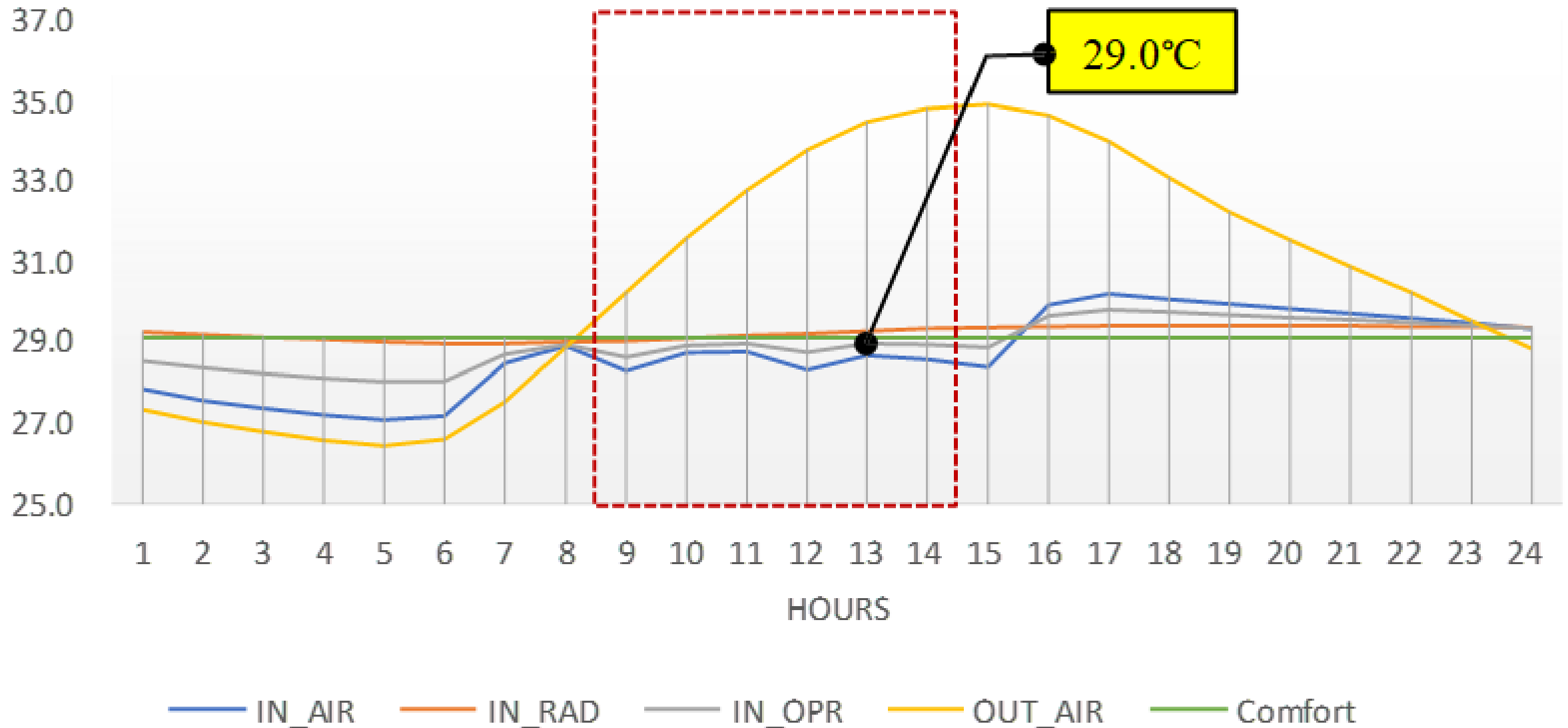


# Combination 2- WWR + Cool Roof + Noc Vent + PCM



IN\_AIR IN\_RAD IN\_OPR OUT\_AIR Comfort

# Combination 3- WWR + Cool Roof + Noc Vent + PCM + EAHE



# Conclusion

- Thermal comfort can be achieved only with passive strategies in naturally ventilated school buildings in warm-humid climate.
- Sustainable school buildings will save the environment, cost, and people.
- Importance of research – specific cases must be studied in depth for reliable solutions.