OVERHEATING AND DAYLIGHTING EVALUATION FOR FREE-RUNNING CLASSROOM DESIGNS

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Zero Emission and Plus Energy Buildings
Towards carbon neutral built environments

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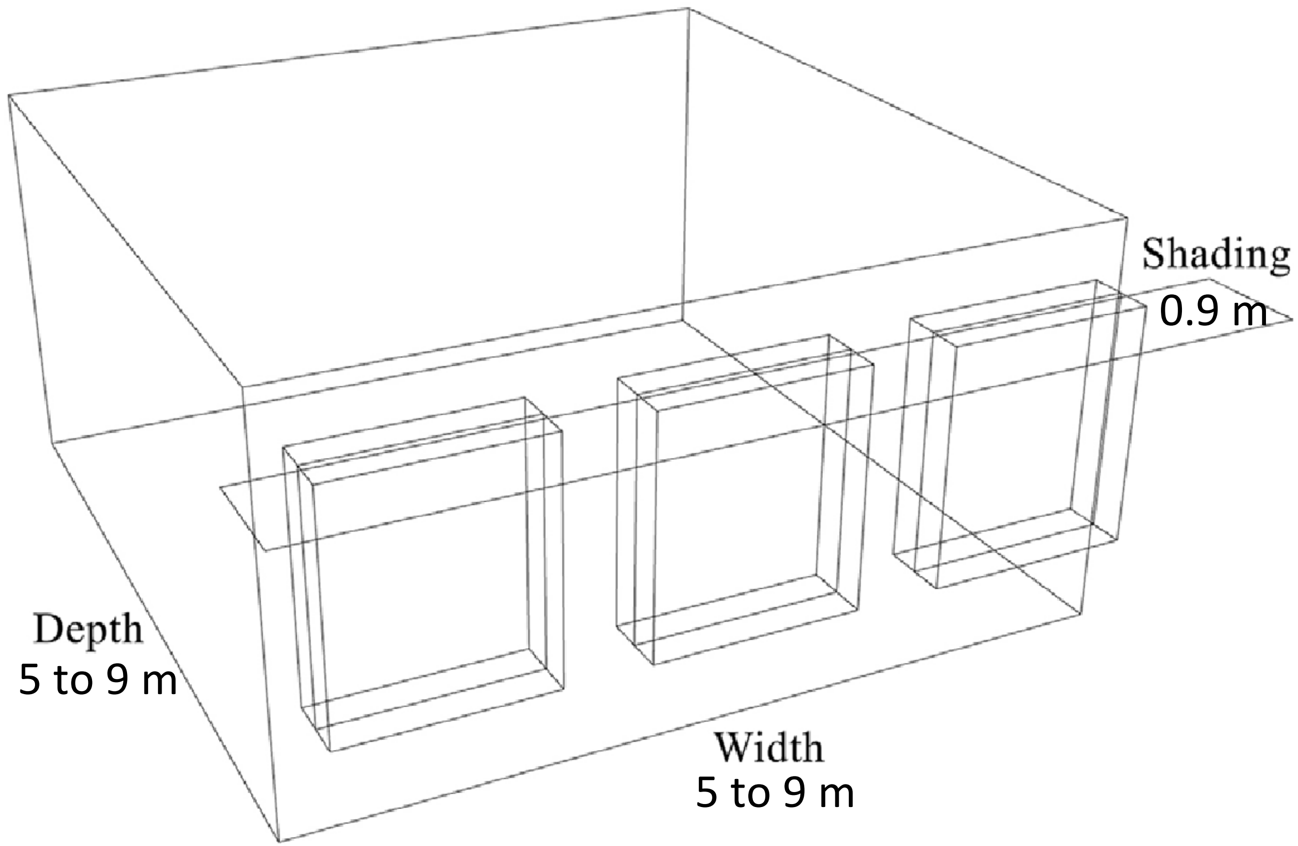
INTRODUCTION

- Indoor temperature and lighting conditions affect study performance
- Optimal daylighting can reduce lighting energy consumption and the need for space cooling.
- School buildings are not used during summertime
- Can nZEB school building classrooms in Estonia (temperate climate) be designed without active room cooling (incl supply air cooling) while ensuring sufficent daylighting and preventing overheating?

METHODS – PARAMETRIC CLASSROOM MODEL



- Envelope parameters (orientation, wall insulation, window size and number, window recess depth, glazing g and VT values, horizontal shading)
- Estonian Building Code regulations for overheating (internal gains, temperature setpoints, ventilation rate, EstonianTRY climate)
- EVS-EN 15251:2007 for thermal environment class
- EVS 2015 EVS 894:2008/A2:2015 for daylighting (reflectance values)

METHODS – INPUT PARAMETER COMBINATIONS

Table 1. Room and facade parameter combinations.

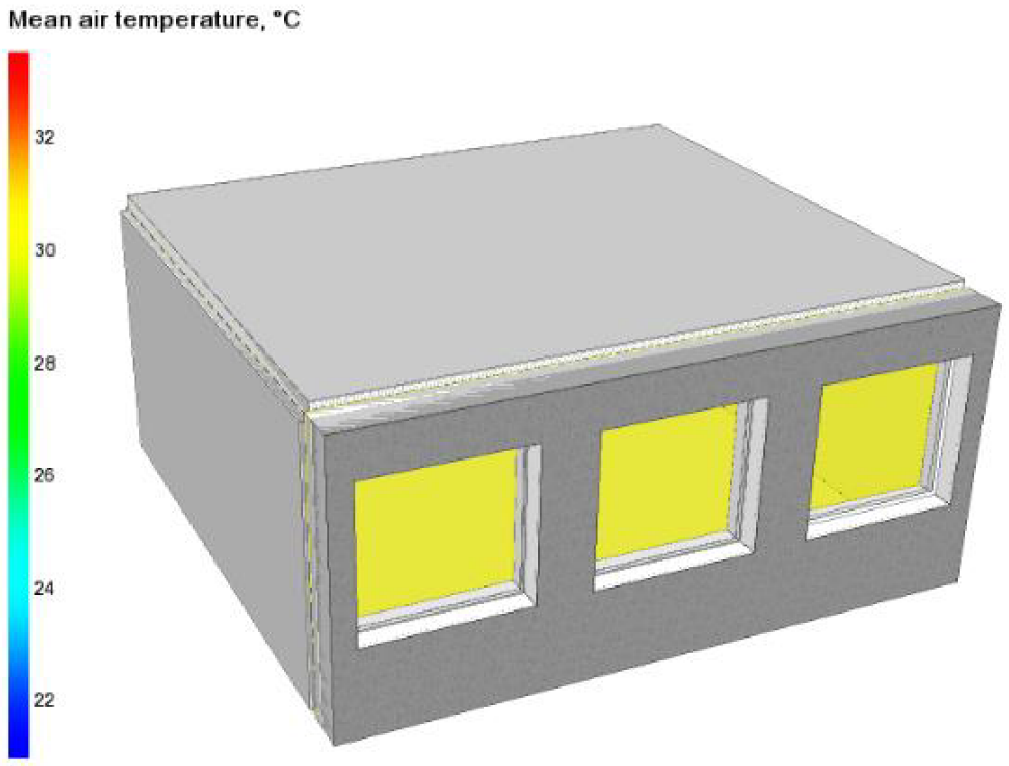
Room dimensions	Envelope	Windows	Window dimensions	Orien-tation	Glazing g-value	Glazing VT (%)	Shading depth (hor.)
Depth, m: 5, 6, 7, 8, 9 Width, m 5, 6, 7, 8, 9	Ext. wall: Concrete 150mm Exp.polystyr. 300mm Concrete 50mm U_{tot} 0,129W/(m²·K) Ext. window perimeter thermal bridge: 0.1W/(m·K) Fixed infiltration: 1.5m³/(h·m²)	Frame fraction 0.34 East/south/west: U_g 0.58W/(m²·K) U_{tot} 0.60W/(m²·K) East/west with shading: U_g 0.70W/(m²·K) U_{tot} 0.71W/(m²·K) North: U_g 0.61W/(m²·K) U_{tot} 0.62W/(m²·K) (north)	Recess depth 0.25m Room width, number of windows-width/height: 5m, 2-1.9/1.7m 6m, 3-1.466/1.7m 7m, 3-1.8/1.7m 8m, 4-1.45/1.7m 9m, 4-1.7/1.7m	E	0.35	0.635	-
					0.42	0.707	0.9m
				S	0.35	0.635	-
							0.9m
				W	0.35	0.635	-
					0.42	0.707	0.9m
				N	0.54	0.733	-

Table 2. Simulation input parameters.

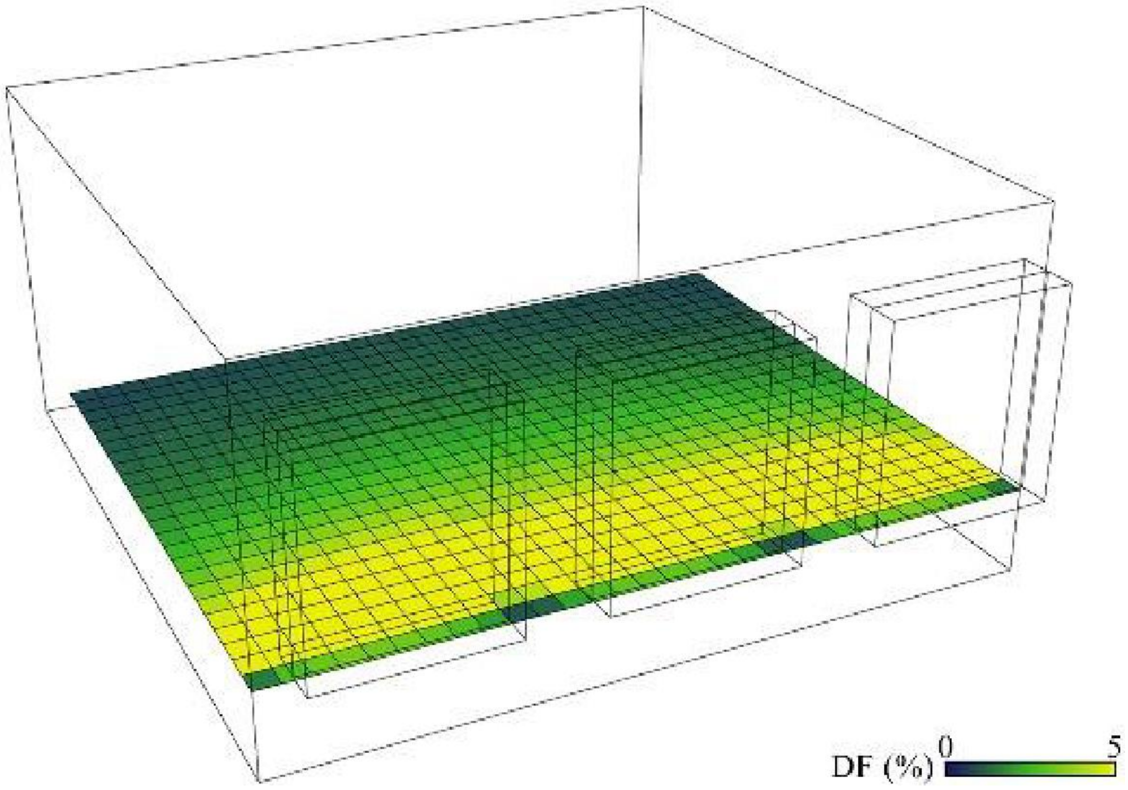
Schedules		Internal gains		HVAC systems			Daylighting
Internal gains	**Ventilation**	**Occupancy**	**Lighting / Equipment**	**Temp. setpoint**	**Supply air temperature**	**CAV air exchange**	**Reflectance values (%)**
00:00-07:00 – 0.0 07:00-17:00 – 1.0 17:00-00:00 – 0.0	00:00-08:00 – 0.036 08:00-12:00 – 0.8 12:00-13:00 – 0.5 13:00-16:00 – 0.8 16:00-00:00 – 0.036	35W/m² 2.1m²/occ. 1.0 MET 0.85±0.25 CLO	5.0W/m² 12.0W/m²	+21°C … +25°C	>+16°C (without cooling)	4.2 l/(s·m²) idle 0.15 l/(s·m²)	Walls 50 Floor 20 Ceiling 70 Shading 35 Ground 20

METHODS - SIMULATIONS

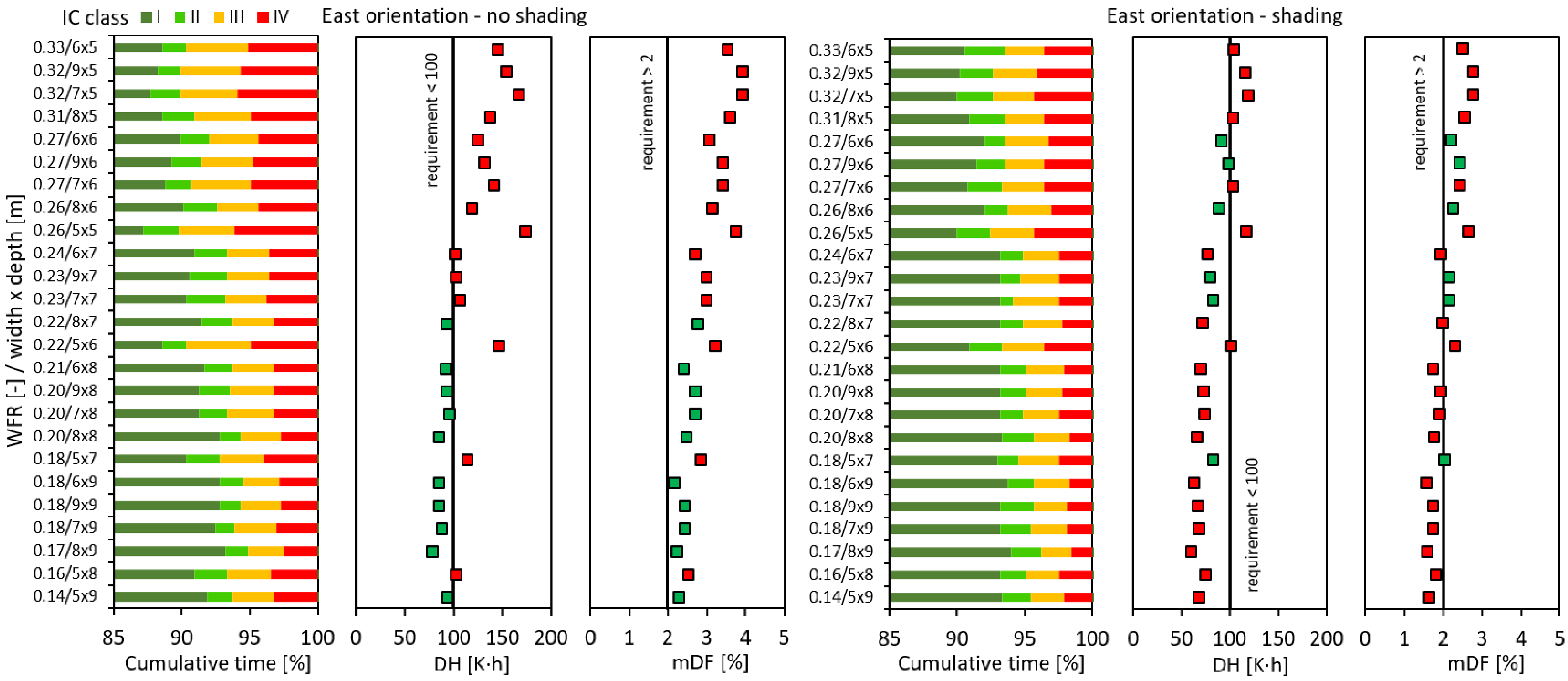
IDA ICE - temperature



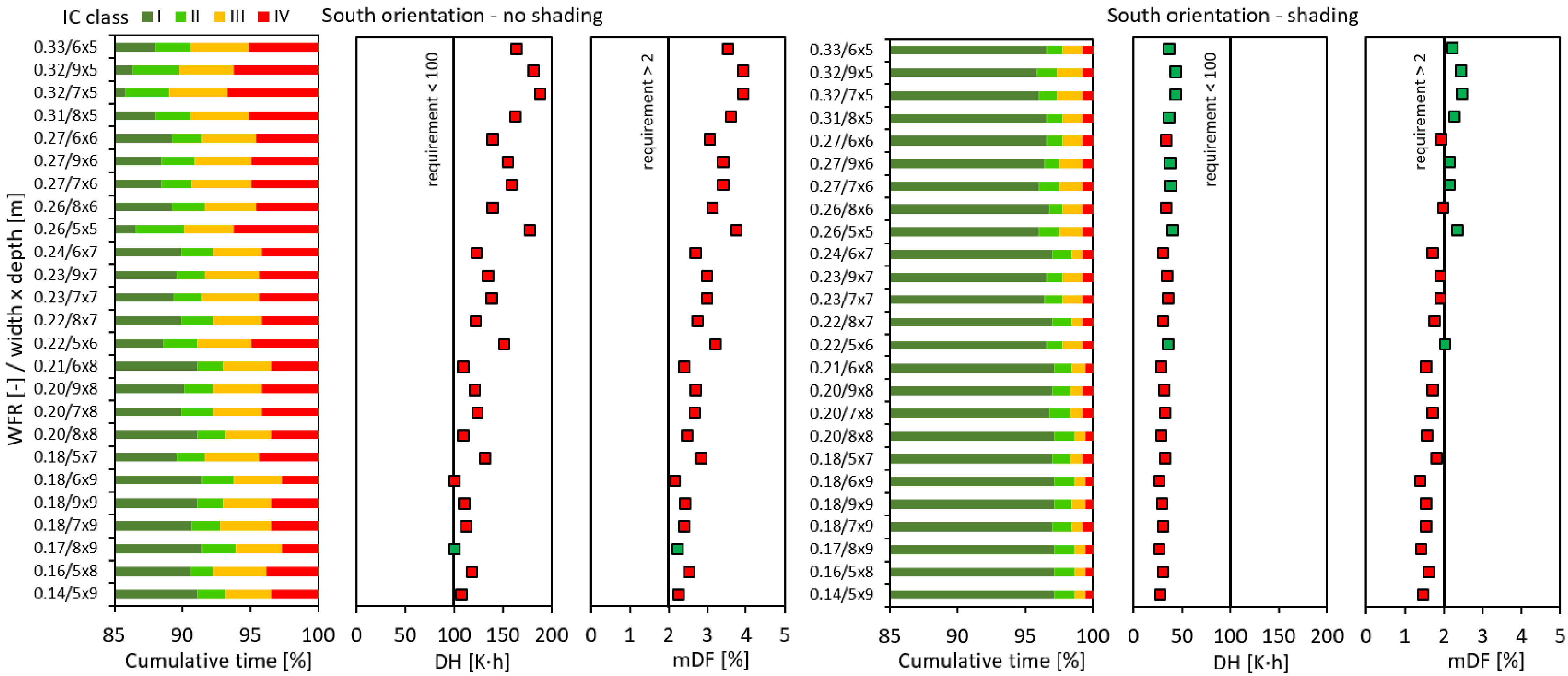
DIVA4 (Rhinoceros), Grasshopper (Radiance) - daylight



RESULTS - EAST



RESULTS - SOUTH



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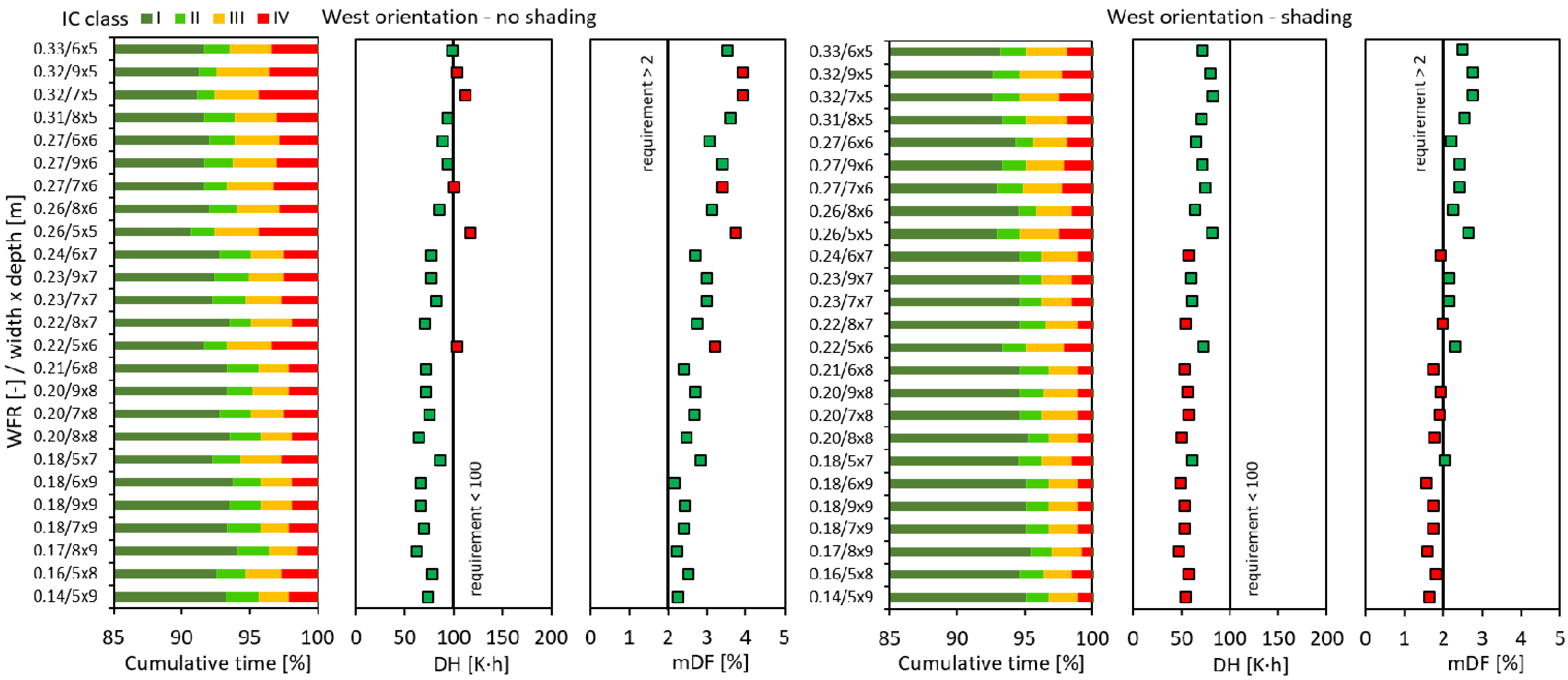
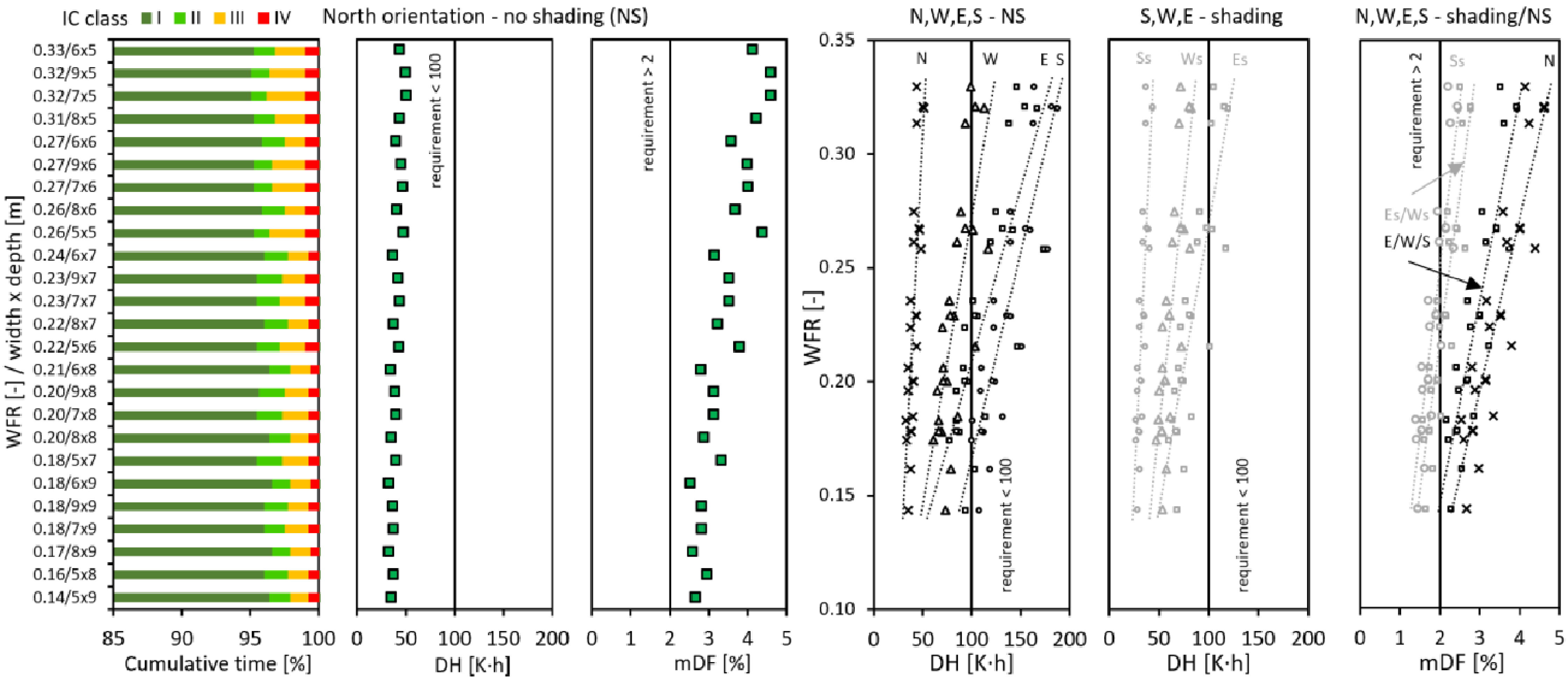
RESULTS - WEST



RESULTS – NORTH & OVERALL



CONCLUSIONS

- Overheating and daylighting should be analysed jointly
- Results show that as window-to-floor ratio increases, the room receives more daylight but also becomes more vulnerable to temperature rise and overheating
- In the other hand, with increasing depth, overheating risk lowers and daylight level decreases
- Temperature excess overheating method results correlates well with daylight result distribution
- Proper design requires skillful analysis of suitable combination of room dimensions, window sizes, glazing parameters and shading options to meet both overheating and daylight requirements

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