IEA-Task 50 – 1st Industry Workshop, Lund, Sweden

new daylighting solutions for old buildings - Renovation of the Friedrich-Fröbel-School in Olbersdorf

daylighting.de

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Location of Olbersdorf

specific annual delivered heating energy use		
before renovation	calculated	212 kWh/(m²a)
after renovation	targeted	35 kWh/(m²a)
	measured	32 kWh/(m²a)

Source of map: Wikipedia

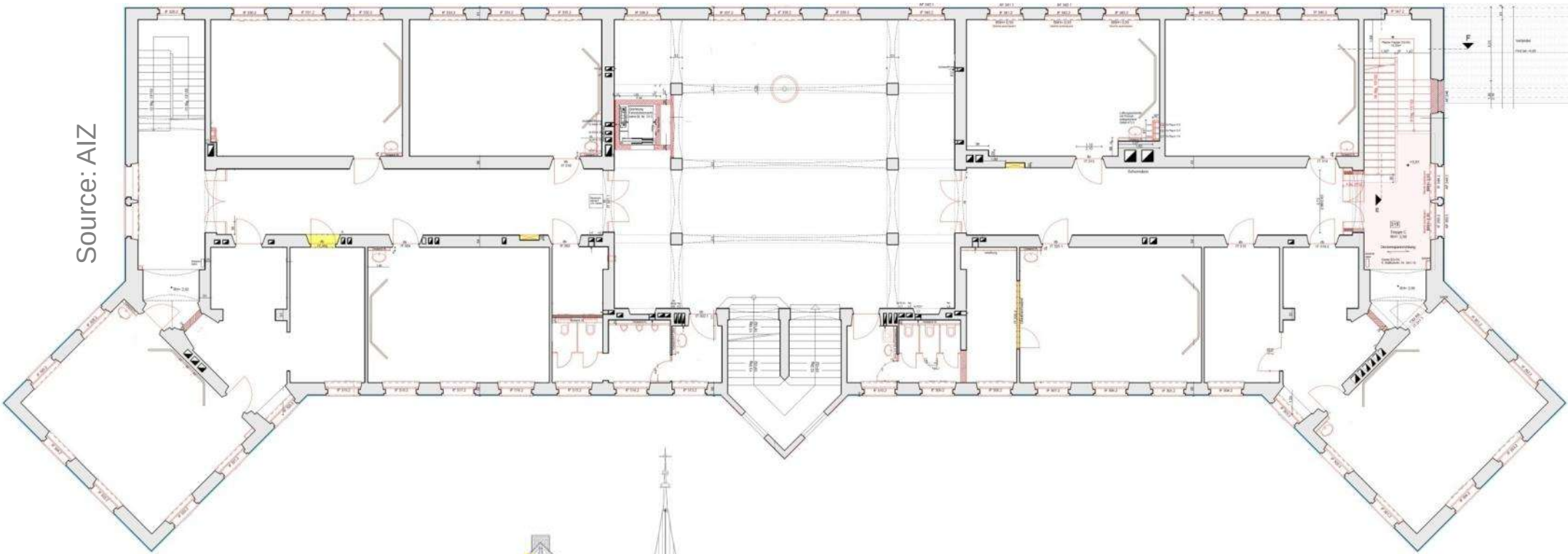
Timeline of school

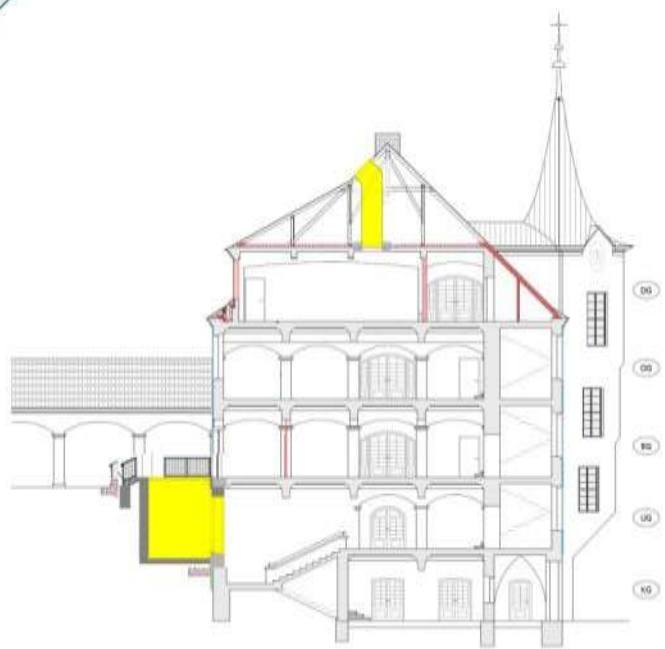
1927	Architectural competition, Winner: Prof. Jost, Dresden Start of construction
1929	Inauguration as primary school
1941	Camp for repatriates
1943	Military hospital
1945	Barracks of soviet army
1945	Reuptake of education
1958	Extension: polytechnic centre
1968	Extension: Kindergarten
1990	Conversion to middle school
2006	Closure of School
2007	Decision to renovate and to reopen as special school
2011	Reopening as special school

2nd floor plan and cross section

North

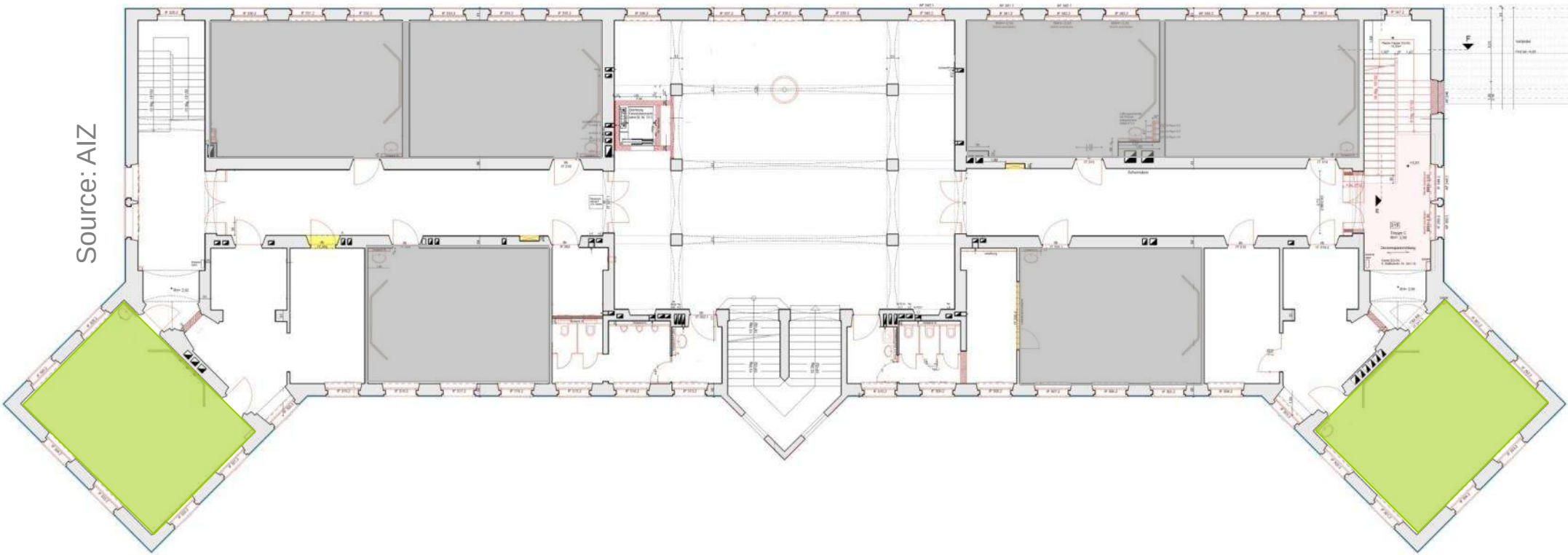
Source: AIZ





Daylight level before renovation

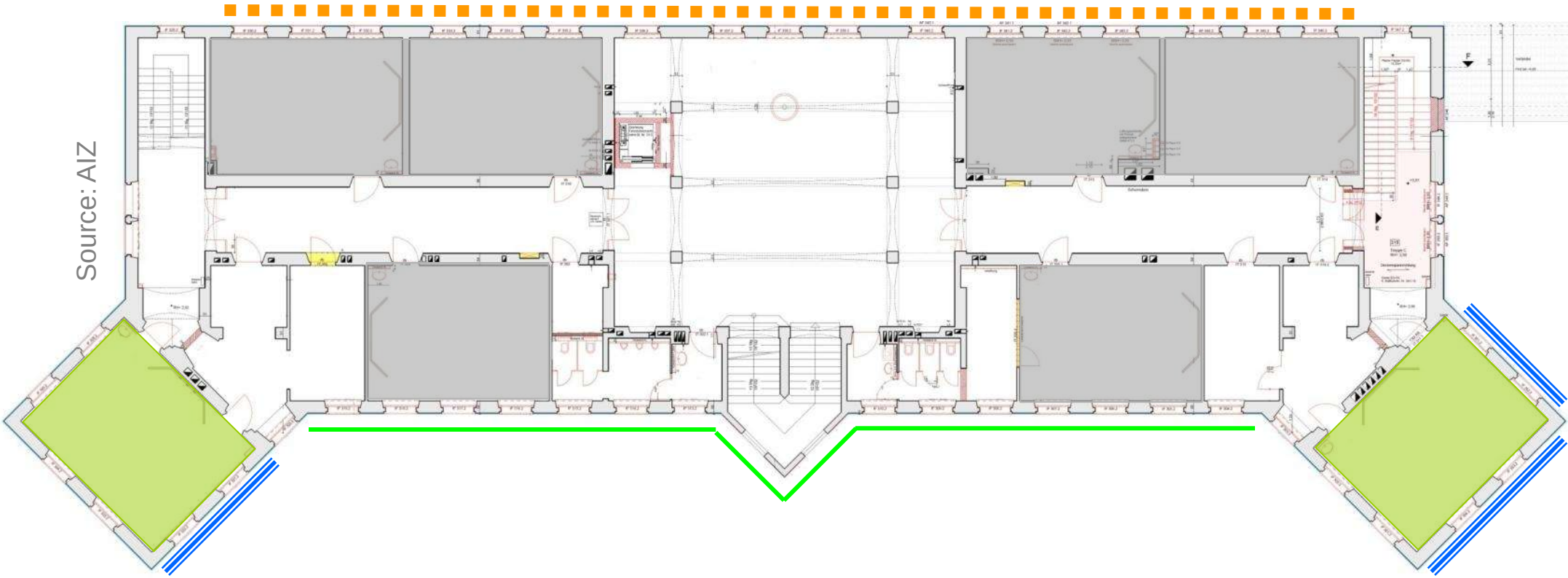
Source: AIZ



low daylight level (window to floor area ratio = 17%, DF 1,3%)

adequate daylight level (window to floor area ratio = 32 %, DF 2,4%)

Glazing of double windows



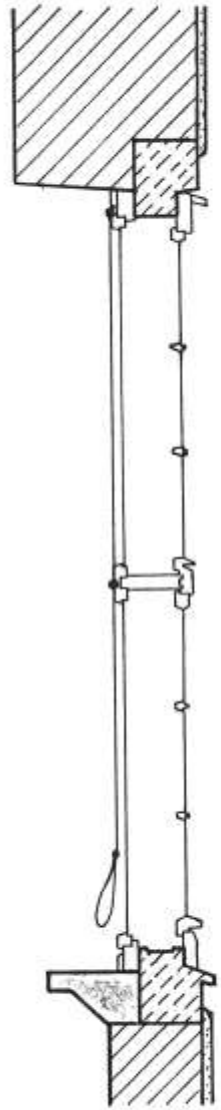
Source: AIZ

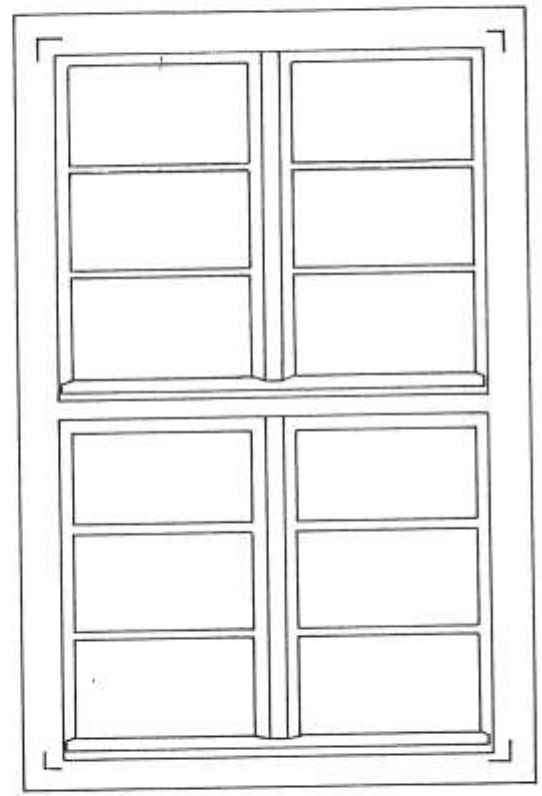
Interior: double low-E, exterior: single white glass

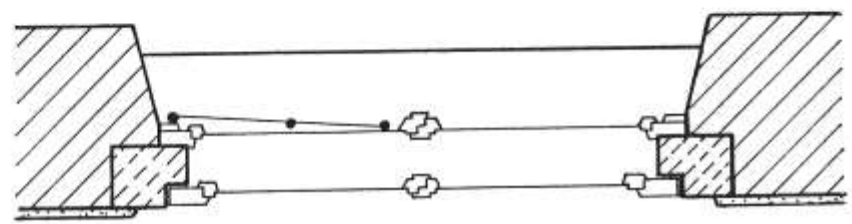
Interior: double low-E , exterior: Electrochromic glazing

windows already had been changed before renovation (double low-E)

Window, old, mock-up a







Window, old and new

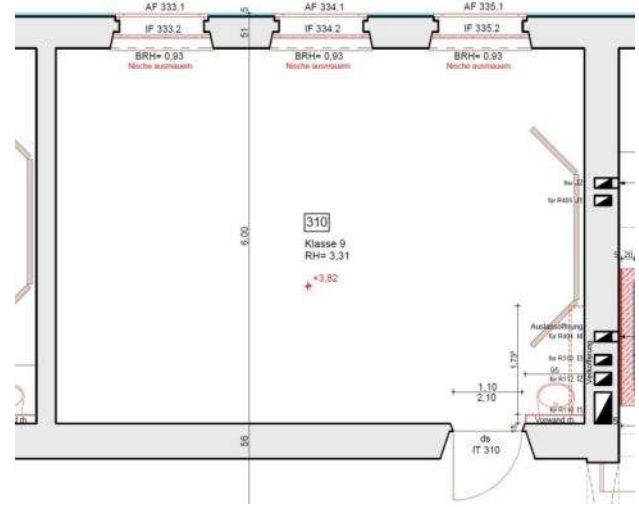
mock up with different glazing and daylighting systems

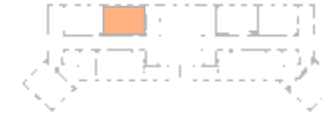
exterior upper window: daylight redirecting glass “Okasolar W”; exterior lower window: electrochromic glazing; interior window: double low-E

exterior and interior glazing: double low-E; shading system: Blinds: Warema Genius E 50 (white)

exterior and interior glazing: double low-E; shading system: Blinds: Warema Genius C/E 50 (mirrored aluminum)

standard classroom – metrics on window system





Southeast orientation,
glazing:
interior: double low-E ,
exterior: single white
shading: blinds in double-window

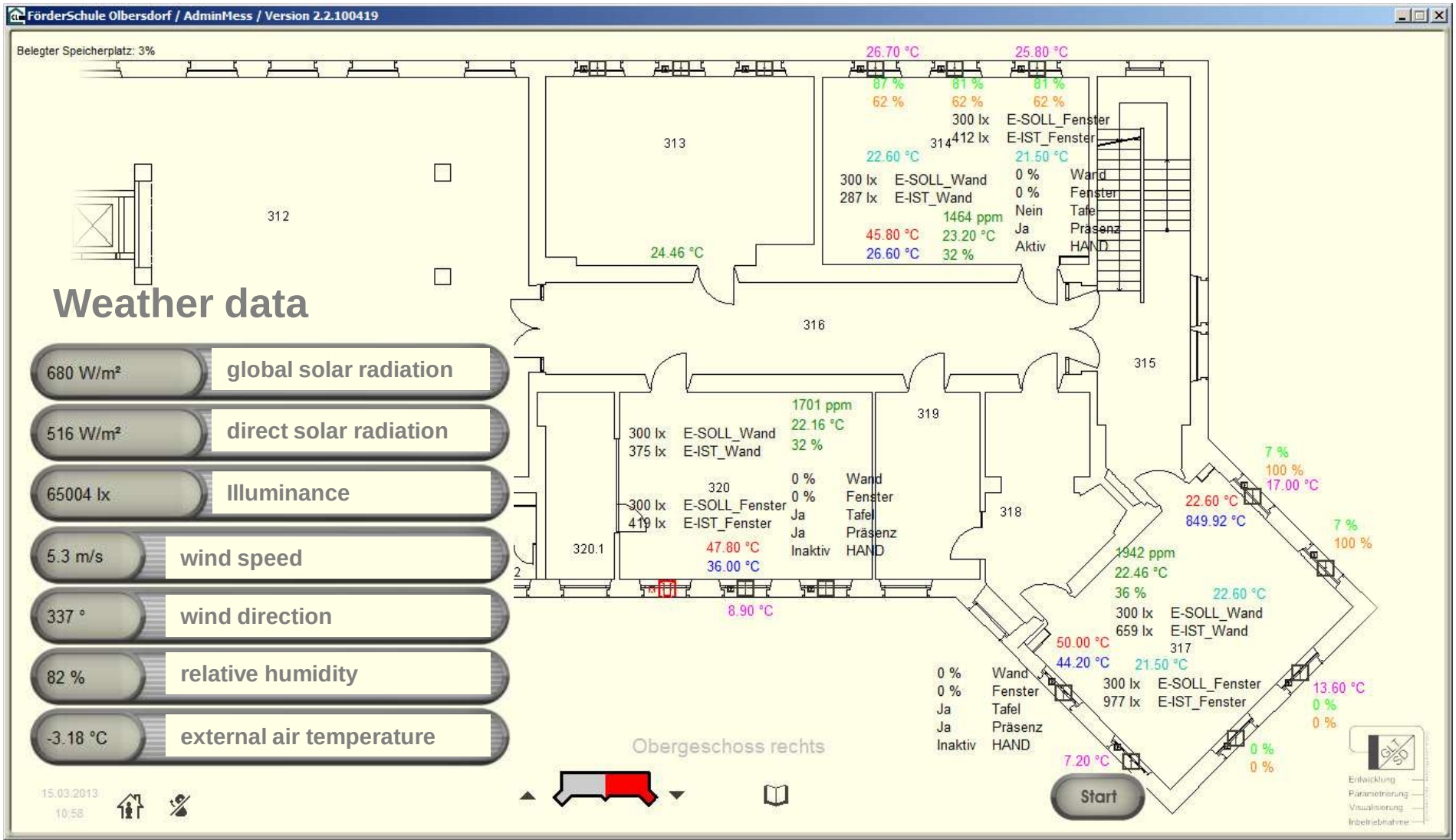
	before renovation	after renovation	
area of classroom	50,76 m²	50,76 m²	
opening area (gross)	8,70 m²	8,70 m²	
opening to floor area ratio	17%	17%	
reduction factor of frame	0,60	0,55	
glazing area	5,24 m²	4,79 m²	-9%
glazed to floor area ratio	10%	9%	
visible transmission of glazing	0,84	0,76	-10%

Metrics on Window-System before and after renovation

	before renovation	after renovation
Center	1,3%	1,4%
Reference point left side (half depth, 1 m from left sidewall)	1,1%	0,9%
Reference point right side (half depth, 1 m from right sidewall)	0,9%	0,8%

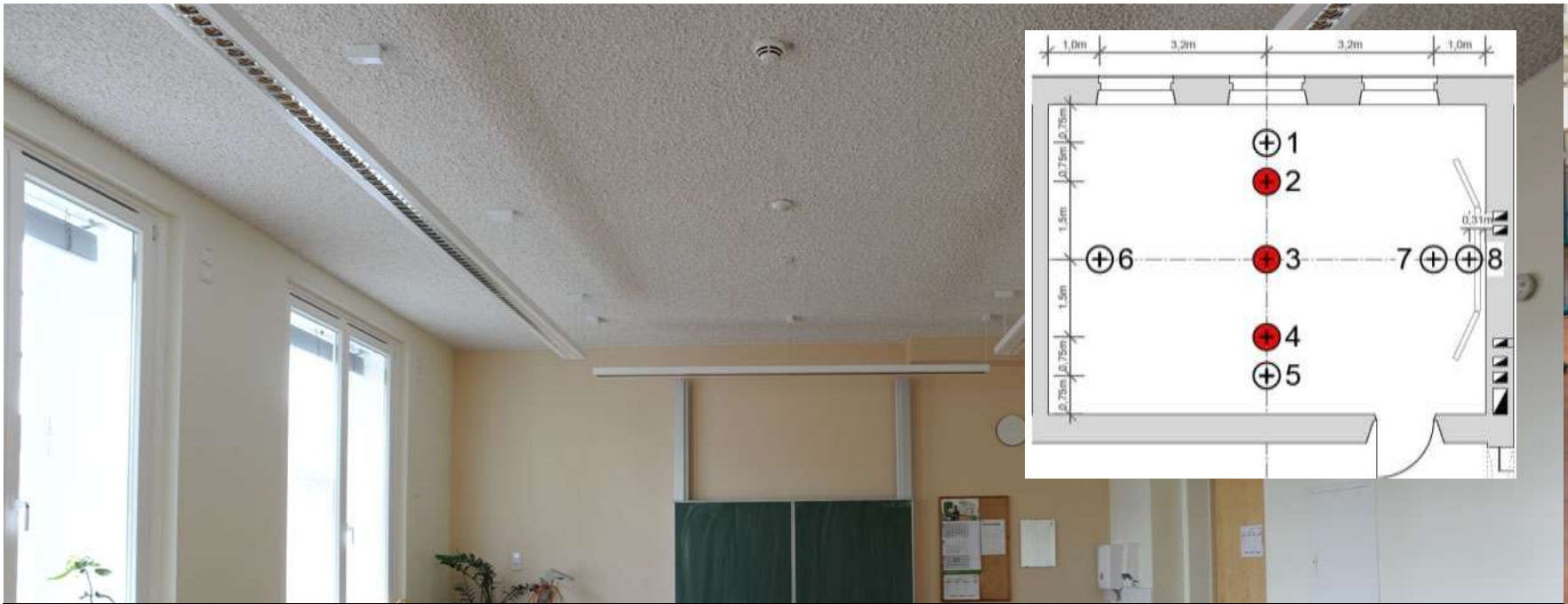
Daylight factor before and after renovation

Screen dump of monitoring system on 15th of March, 2013 10:58



monitoring of 549 data points in the lighting scan

standard classroom – interior view



	window (point 2)	middle (point 3)	corridor (point 4)
relative usable lighting contribution (spring / fall*, 9. am – 2 pm, base: 300 lx)	99,5%	92,4%	85,2%
relative period of use (spring / fall*, 9. am – 2 pm, base: 300 lx)	96,4%	71,7%	62,7%
cylindric / horizontal illuminance	66,2%	87,5%	100,9%

*) monitoring was performed from 20.10.2011 until 25.10.2011 and from 11.02.2012 until 16.02.2012.

standard classroom – control system

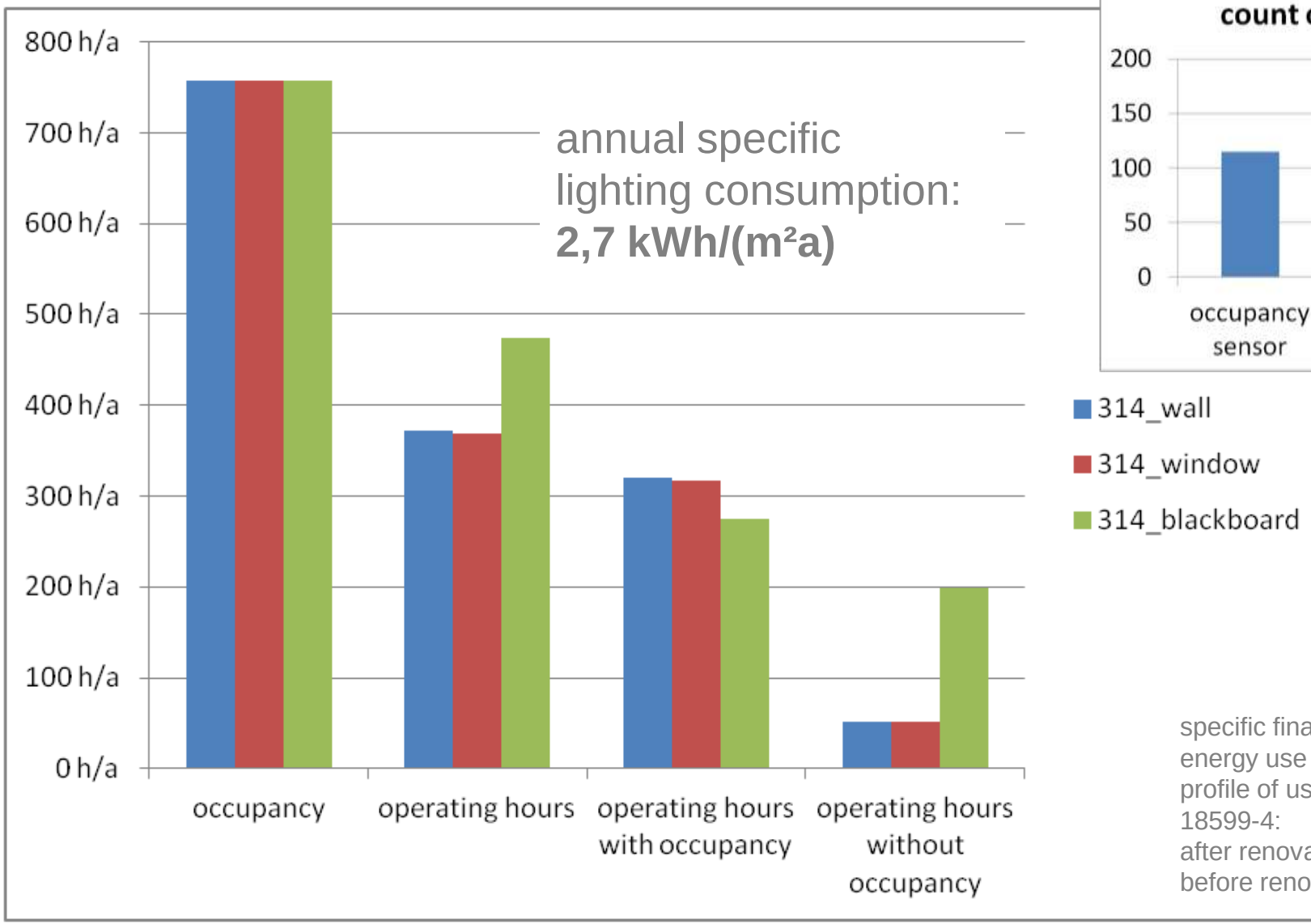
light switch;
location: next to entrance.

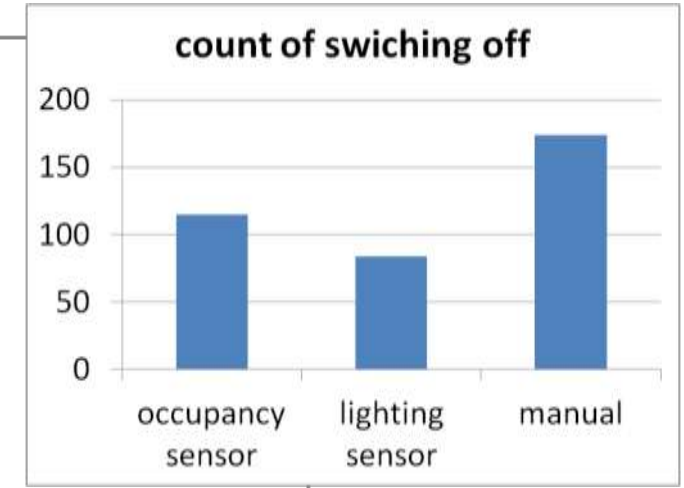
Activation of room-lighting:

daylighting systems and electric lighting systems are adjusted in order to safeguard the set-point-illuminance.
In case of direct sunlight automated louver-blinds prevent from glare.

Control panel for teacher;
location: next to blackboard
secured by keyswitch.

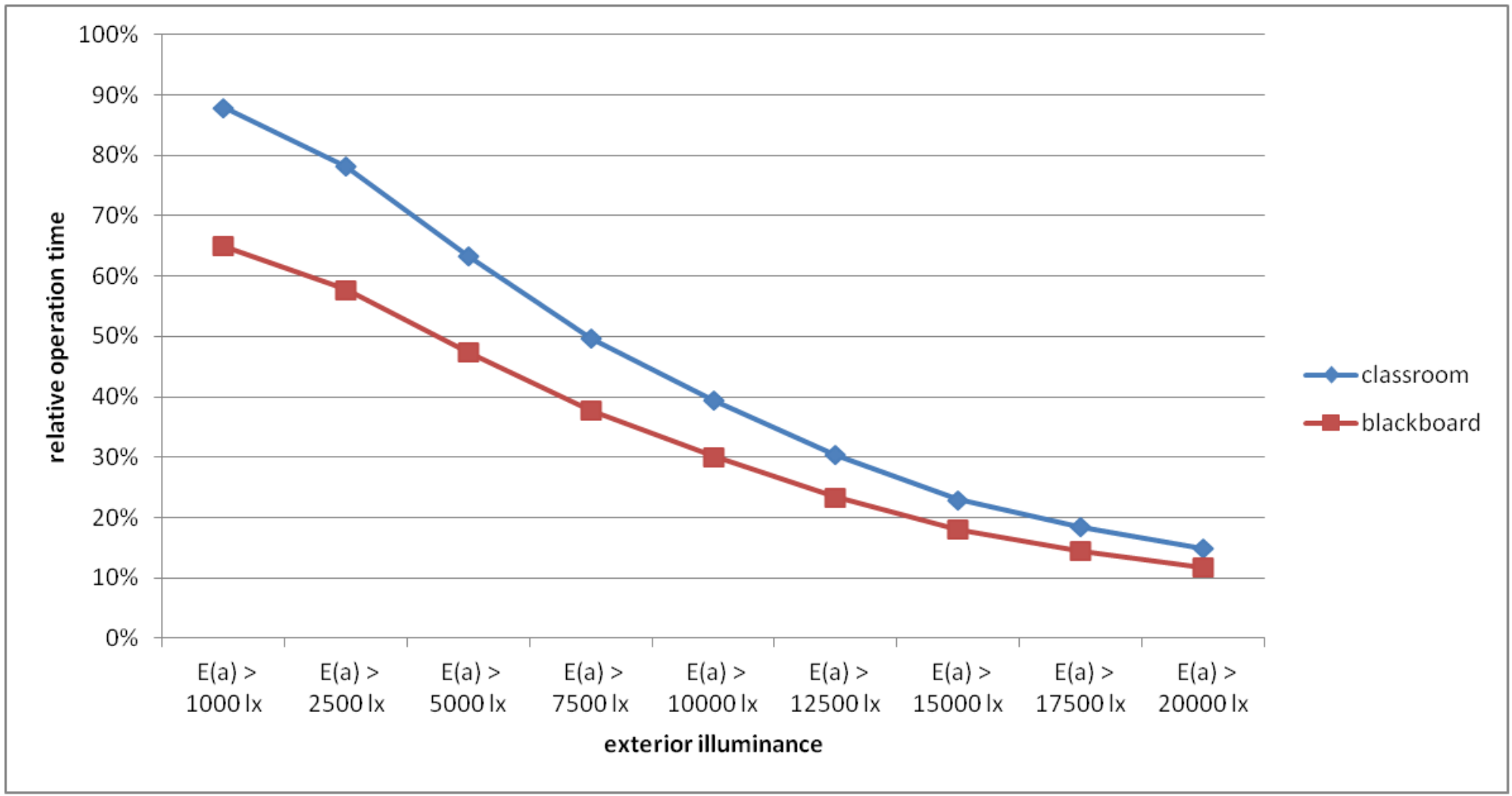
occupancy & operating hours of electric lighting



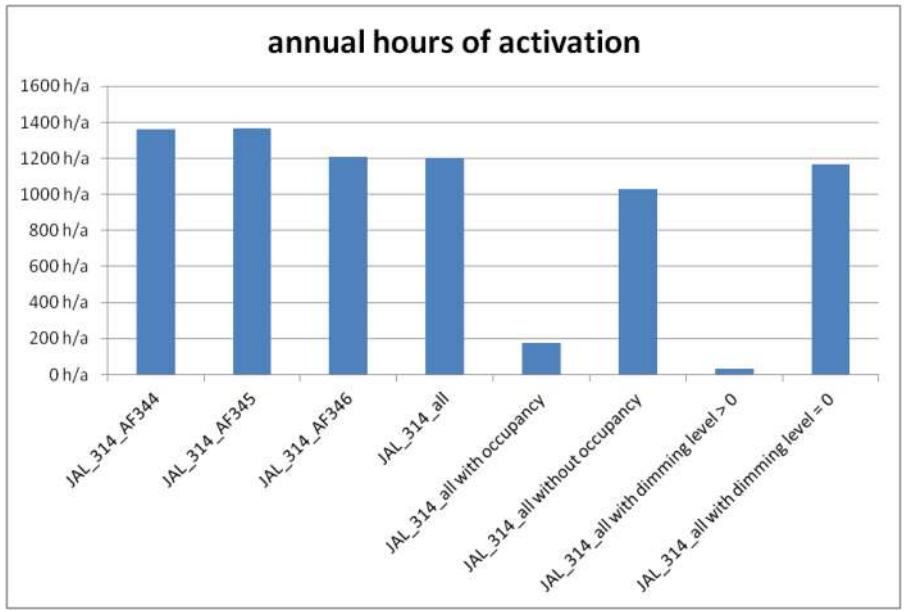


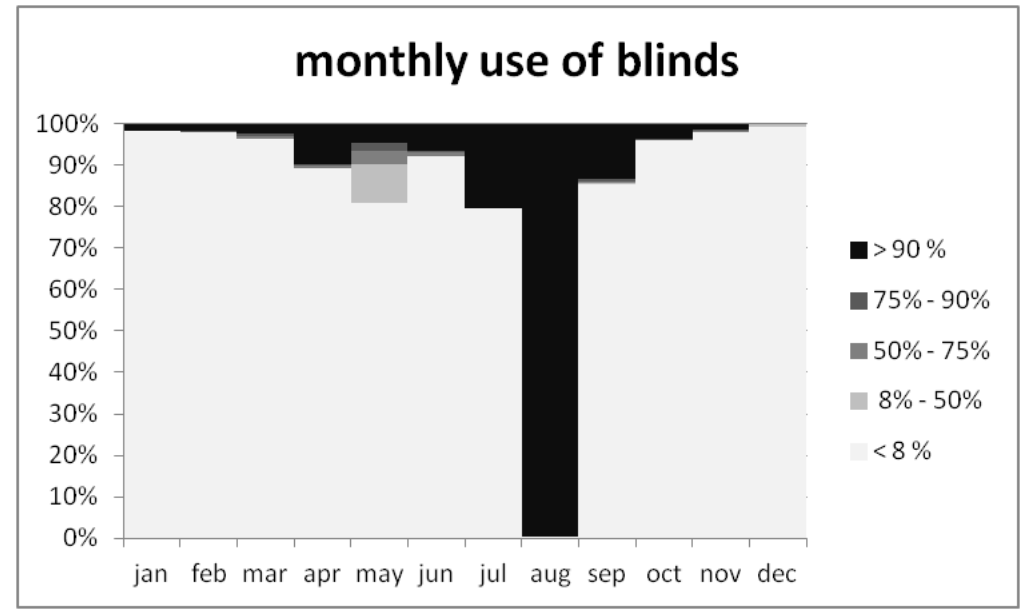
specific final annual energy lighting energy use calculated with adjusted profile of usage according to DIN V 18599-4:
after renovation: **2,73 kWh/(m²a)**
before renovation**: 10,95 kWh/(m²a)**

daylight & operating hours of electric lighting



Shading systems – Blinds (Southeast-facing)

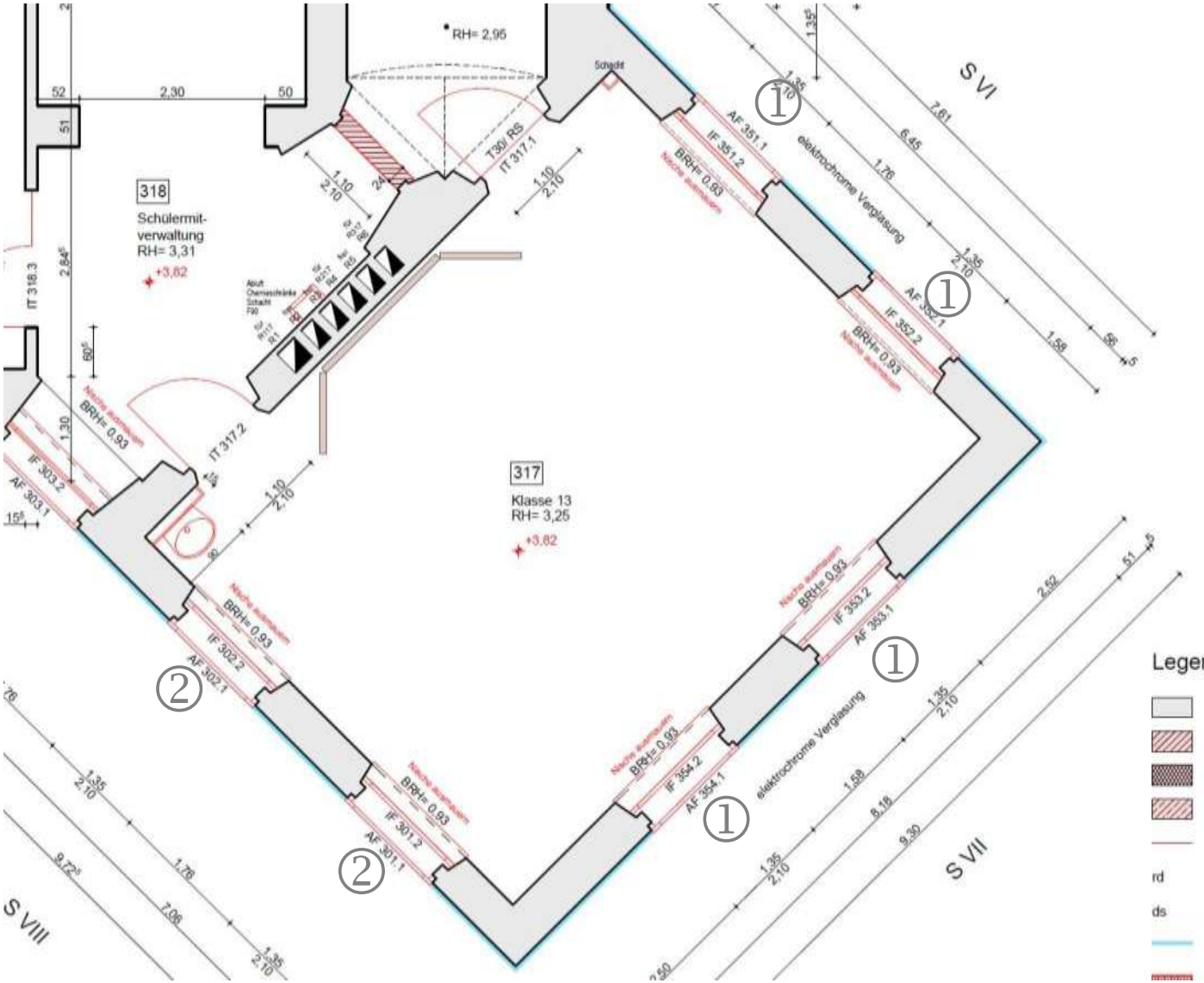




monthly relative period of relative extension of blinds
(<8%: recessed; >90 blinds completely cover the window)

floor plan of classroom with three facades

Source: AIZ



① South and West:
glazing:
interior: double low-E ,
exterior: electrochromic

shading: blinds in double-window

② North:
glazing:
interior: double low-E ,
exterior: single white

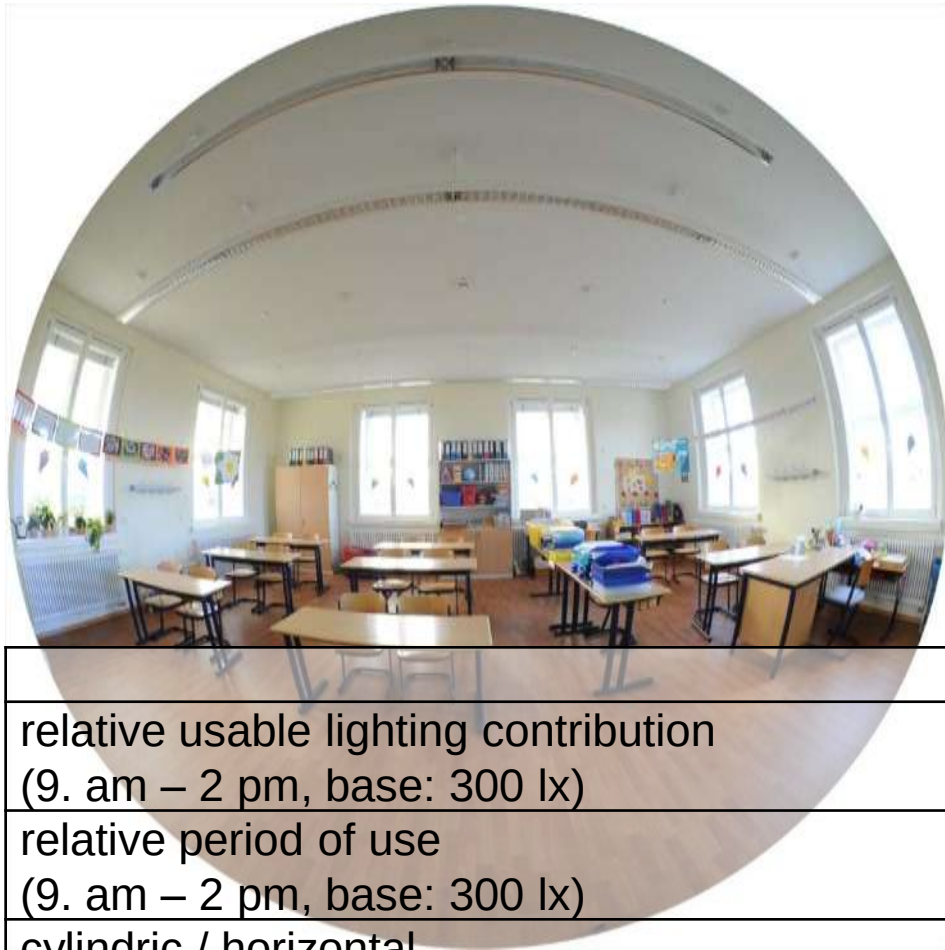
shading: none

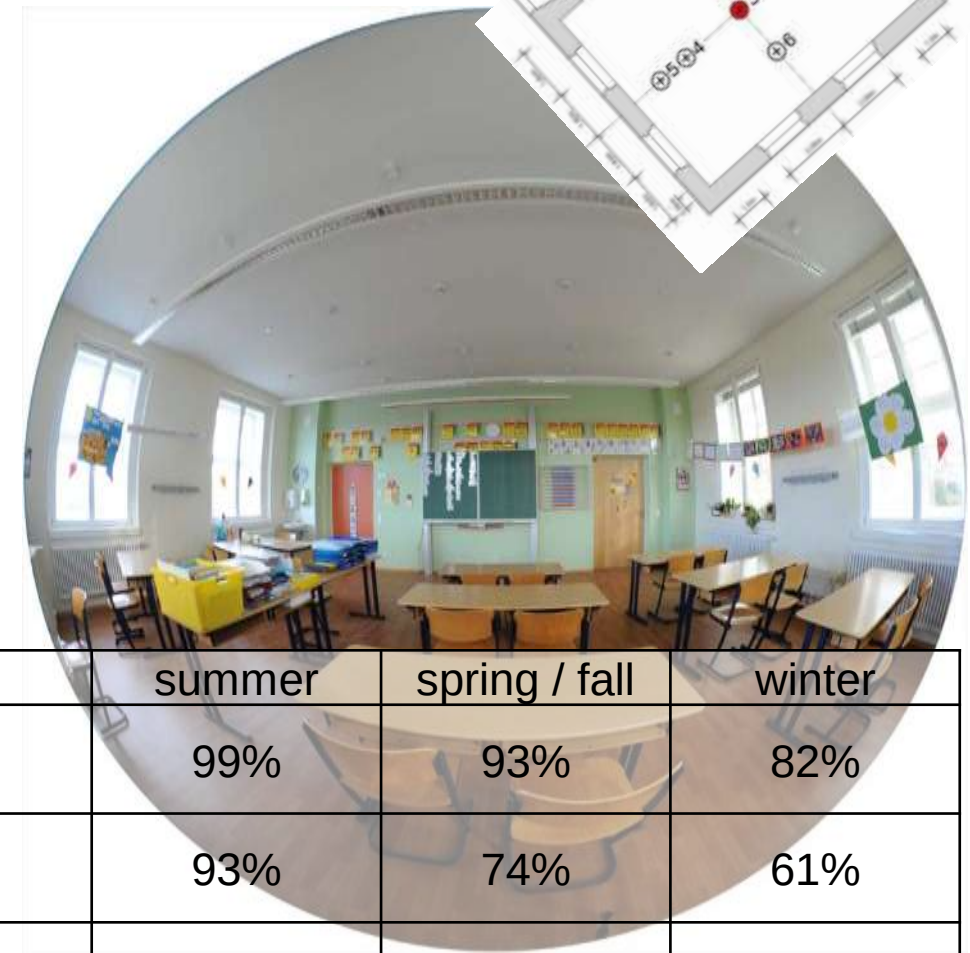
Electrochromic glass

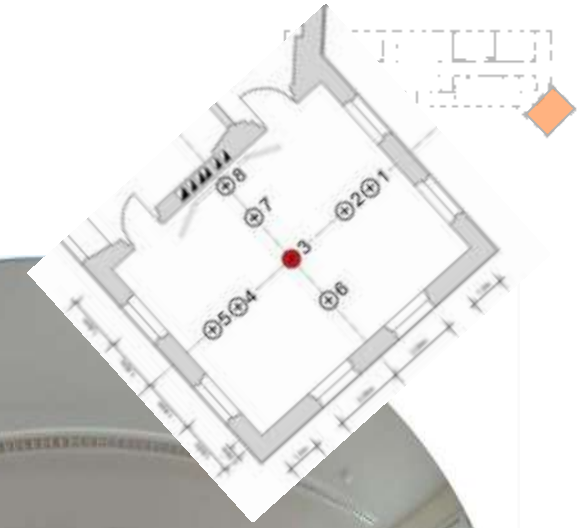
Distortion of view at the edge of electrochromic glazing

	total energy transmittance	visible transmission τ_{D65}
clear	36 %	50 %
tinted	12 %	15 %

Classroom with three facades

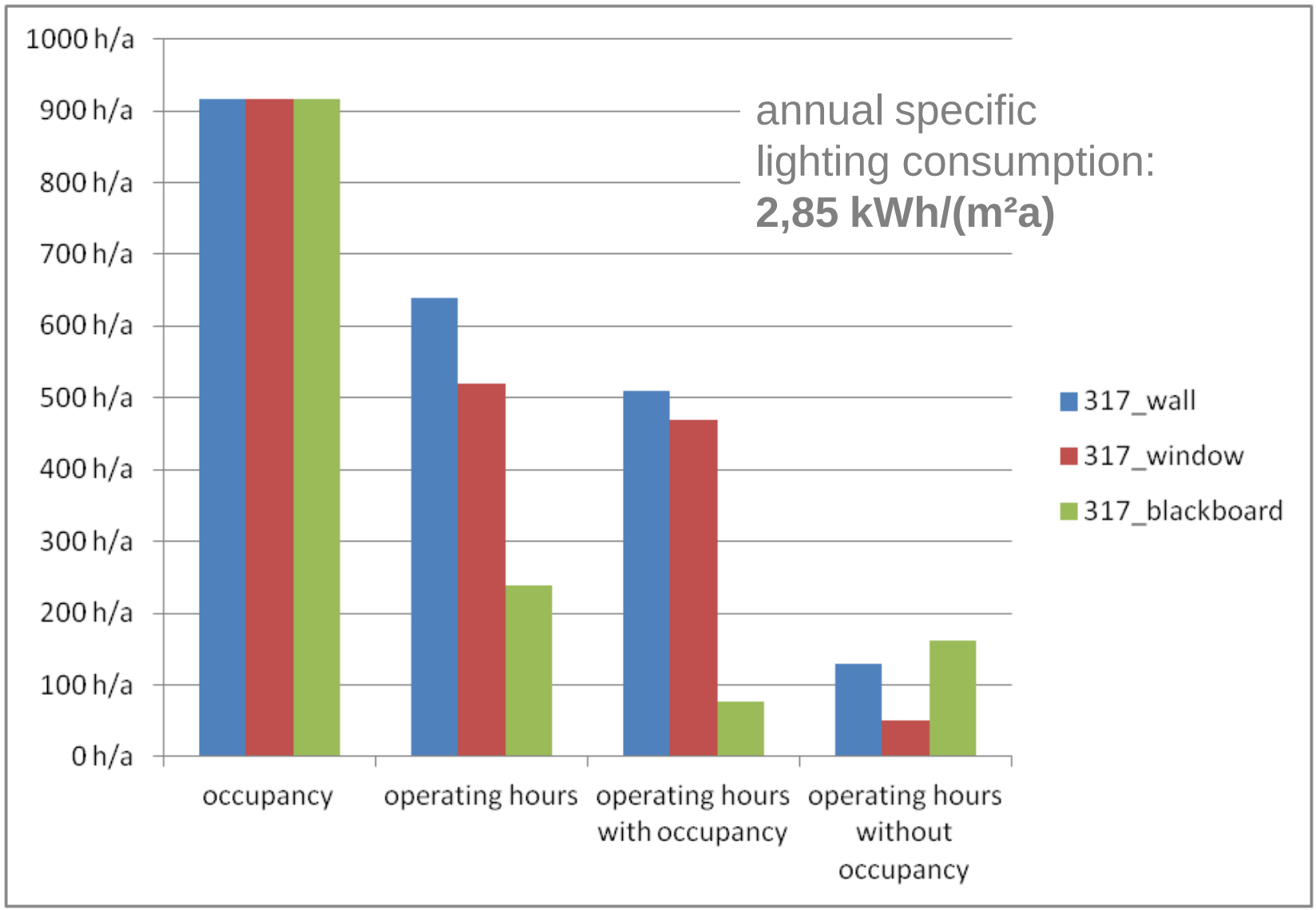




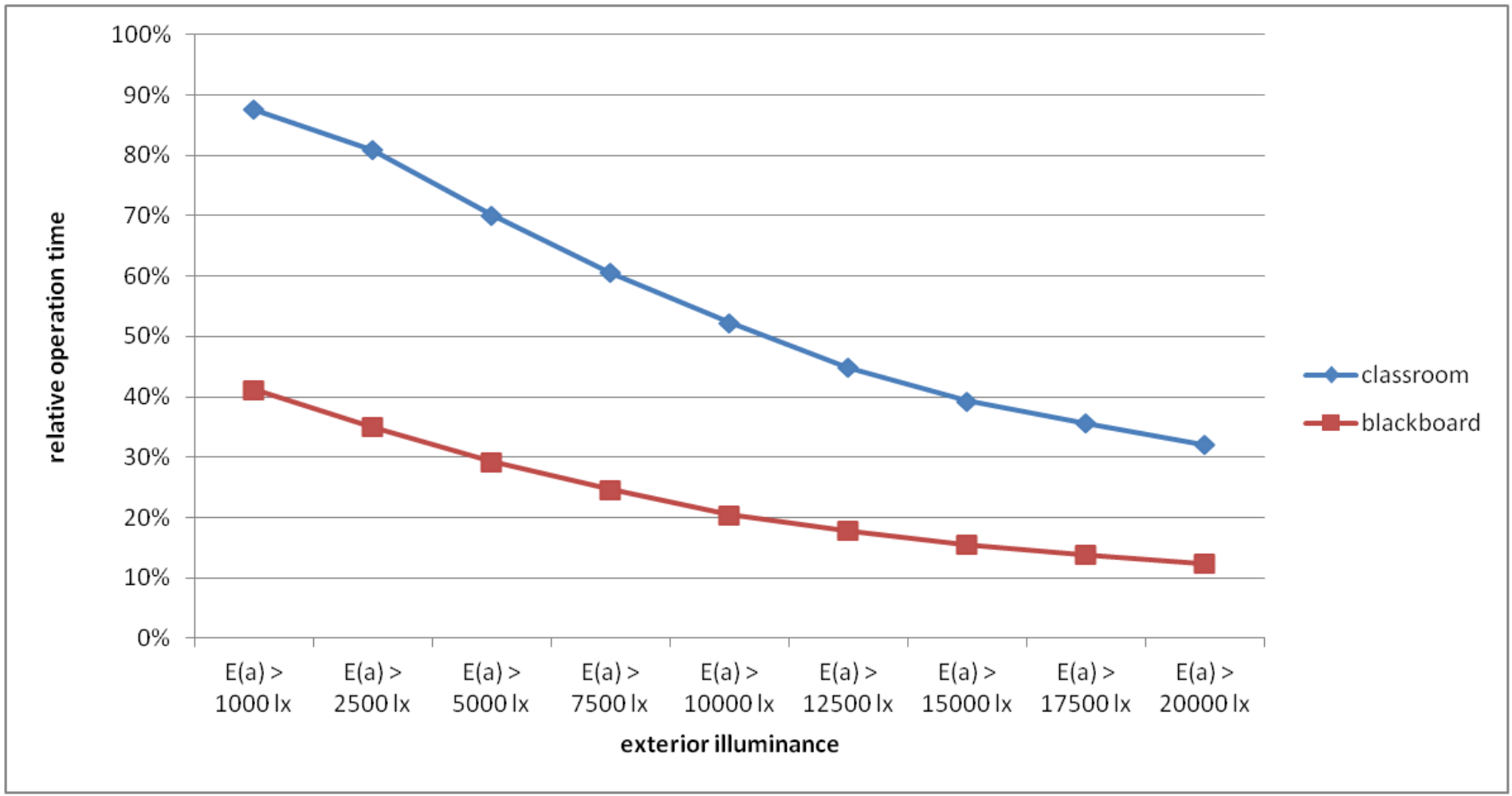


	summer	spring / fall	winter
relative usable lighting contribution (9. am – 2 pm, base: 300 lx)	99%	93%	82%
relative period of use (9. am – 2 pm, base: 300 lx)	93%	74%	61%
cylindric / horizontal illuminance	100%	98%	106%

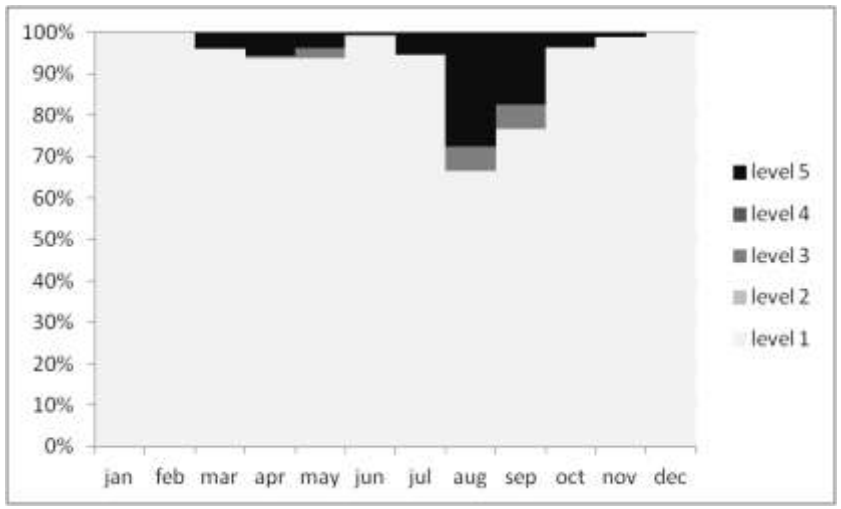
occupancy & operating hours of electric lighting



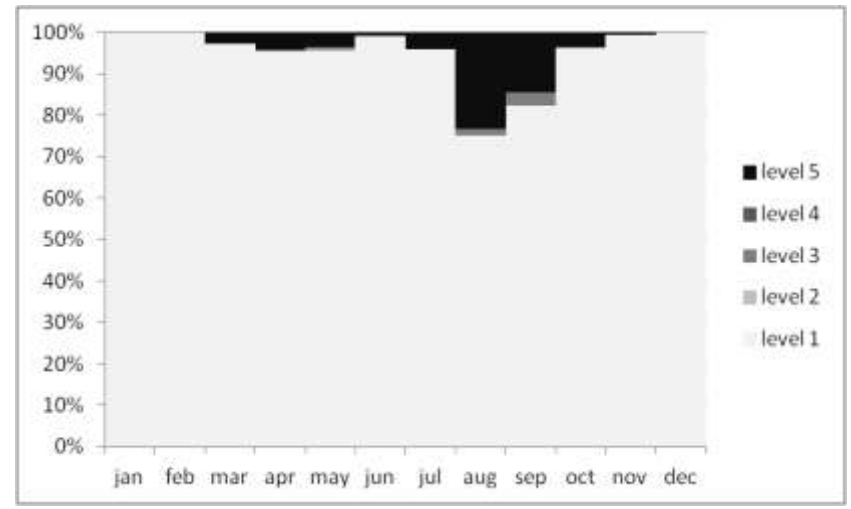
daylight & operating hours of electric lighting



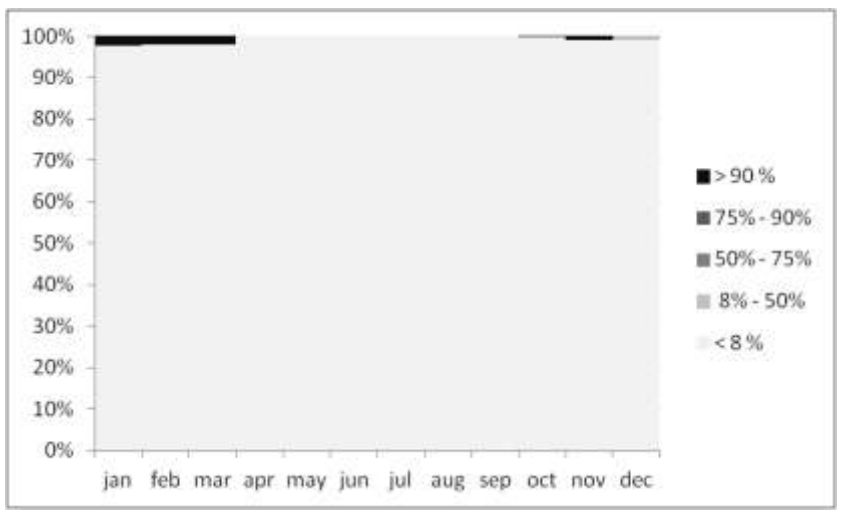
Shading systems



EC-Glass – South facing
(automated + manual override)



EC-Glass – West facing
(automated + manual override)

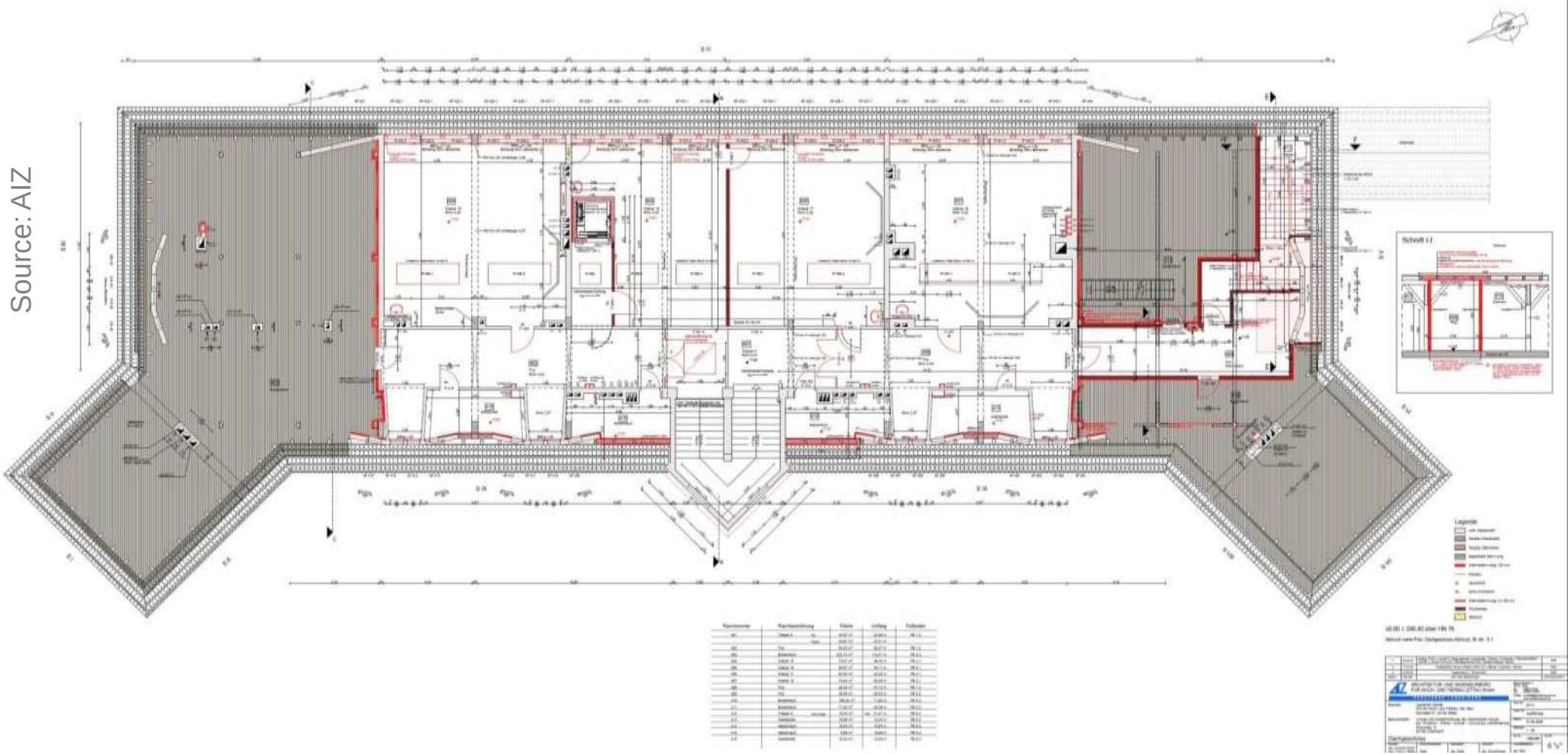


Blinds – South facing
(operated manually)

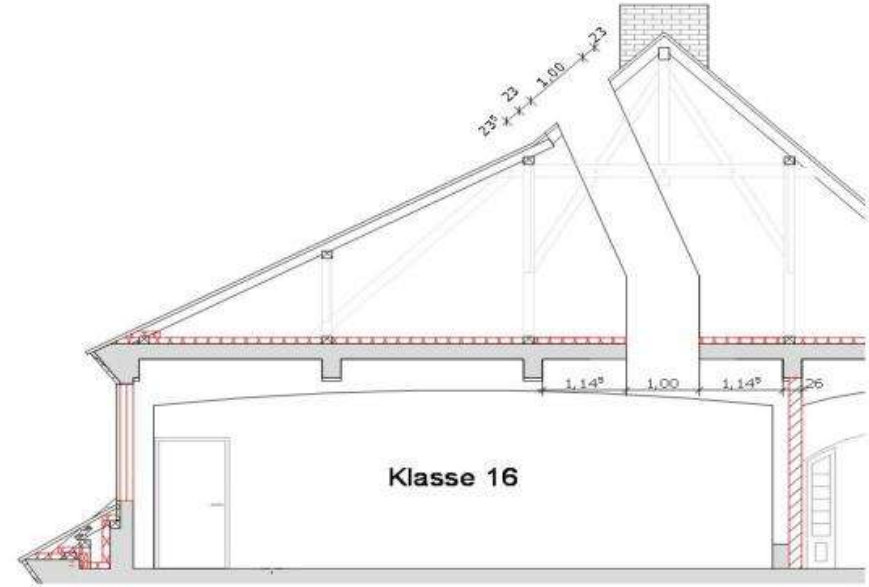
Blinds – West facing
(operated manually)

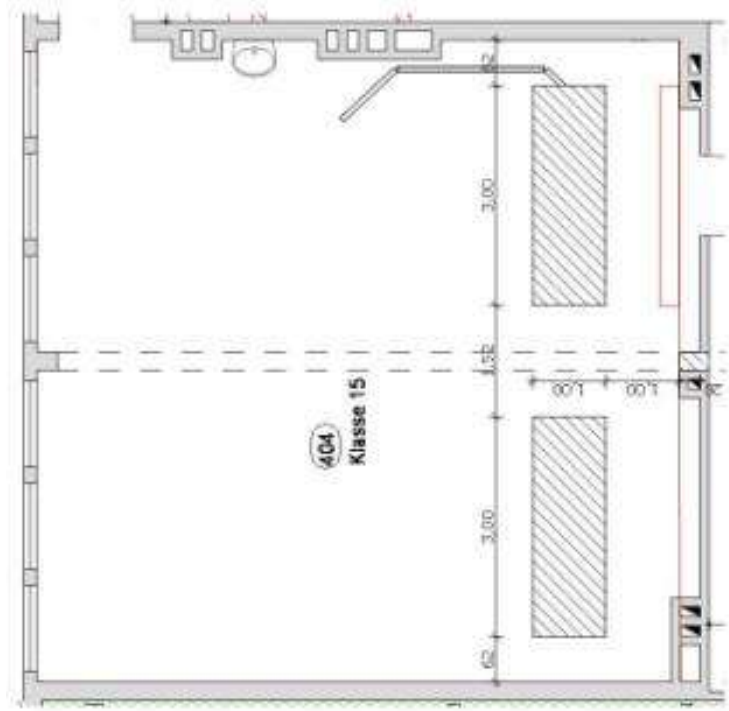
Floor plan of the attic

Source: AIZ

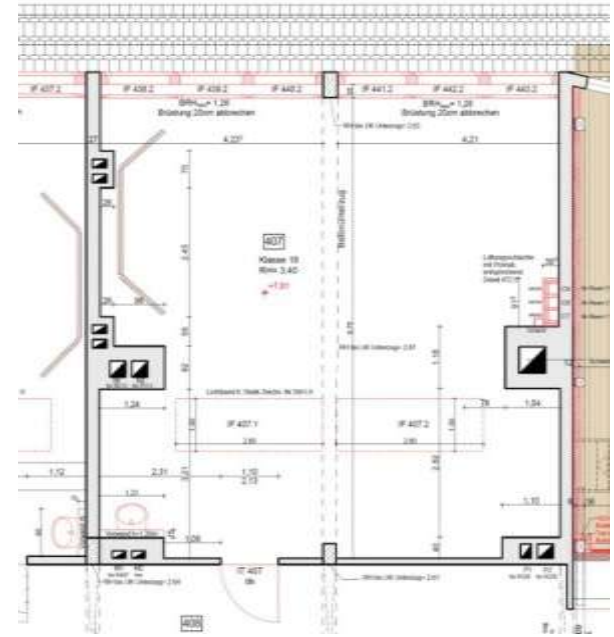


new rooflight





Classroom in the attic



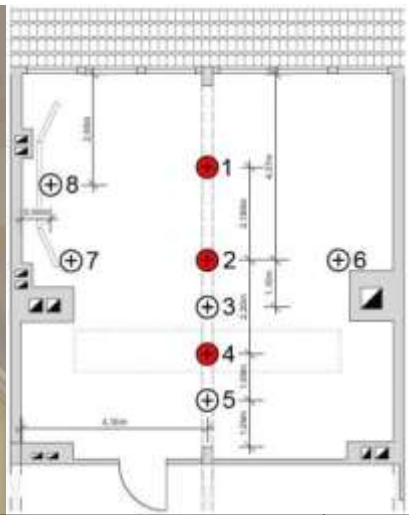
	before renovation	after renovation
area of classroom	75 m²	75 m²
opening area (gross)	8,03 m²	17,32 m²
opening to floor area ratio	11%	23%
glazing area	5,08 m²	11,09 m²
glazed to floor area ratio	7%	15%

Metrics on Window-System before and after renovation

	before renovation	after renovation
middle axis, distance from window: 2,26 m	2,5%	1,2%
center of room	1,3%	1,1%
middle axis, distance from window: 6,77 m	0,6%	1,7%

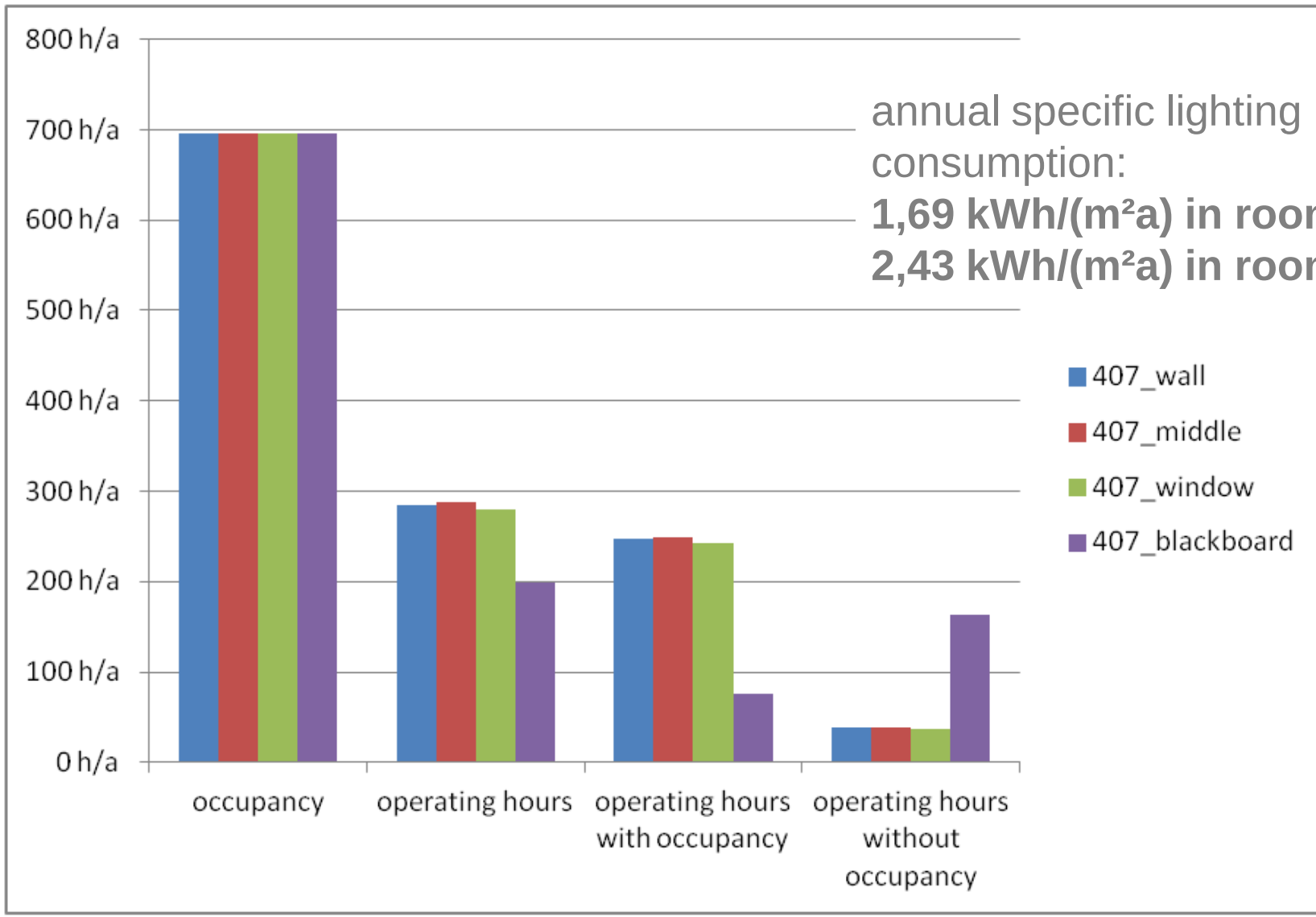
Daylight factor before and after renovation

Classroom in upper storey



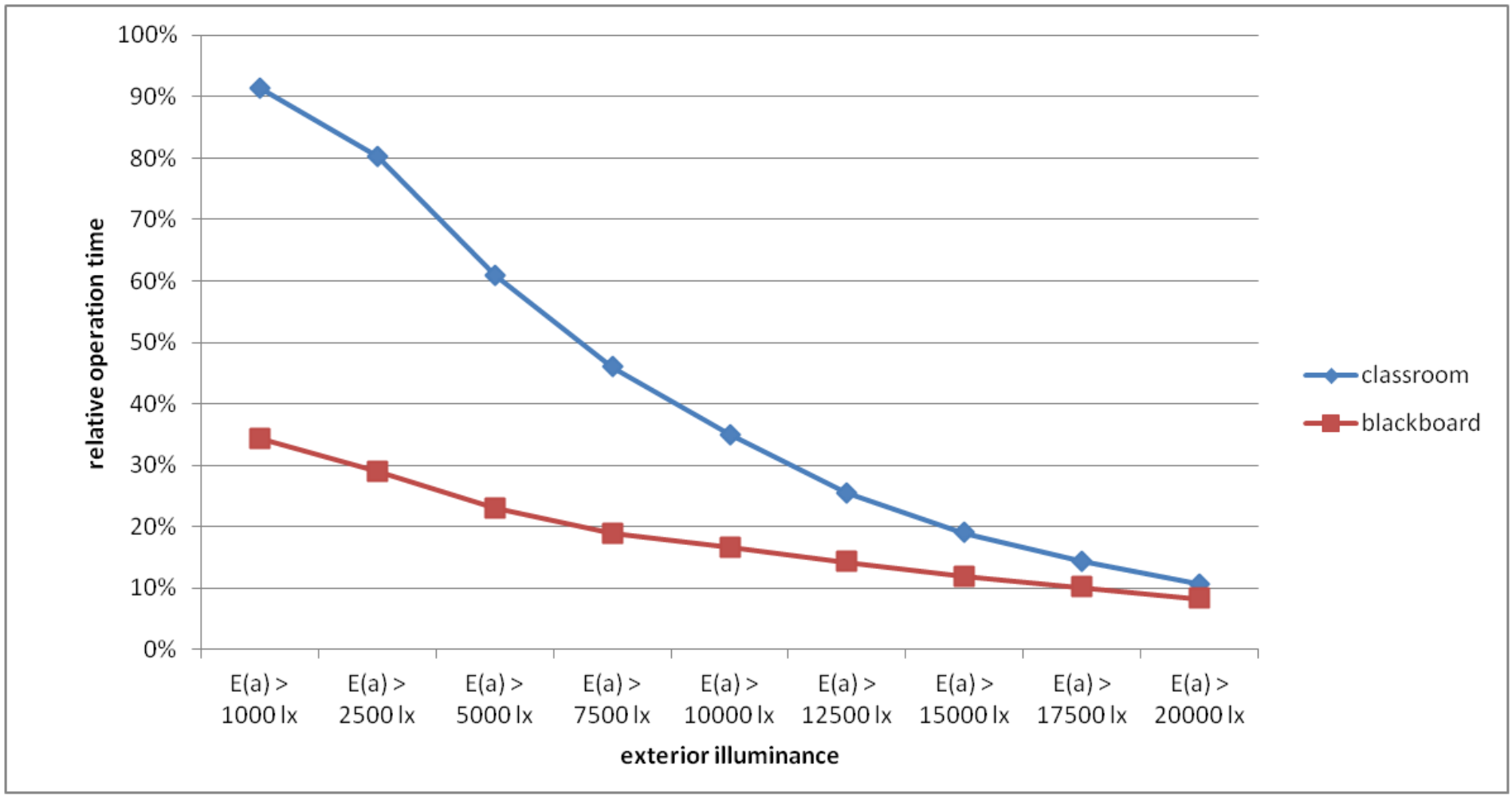
		corridor (point 4)	middle (point 2)	window (point 1)
relative usable lighting contribution (9. am – 2 pm, base: 300 lx)	summer	92%	80%	79%
	spring	94%	91%	88%
	winter	40%	33%	37%
relative period of use (9. am – 2 pm, base: 300 lx)	summer	74%	53%	50%
	spring	86%	78%	73%
	winter	8%	8%	10%
cylindric / horizontal illuminance	summer	34%	66%	65%
	spring	39%	59%	78%
	winter	48%	75%	75%

occupancy & operating hours of electric lighting

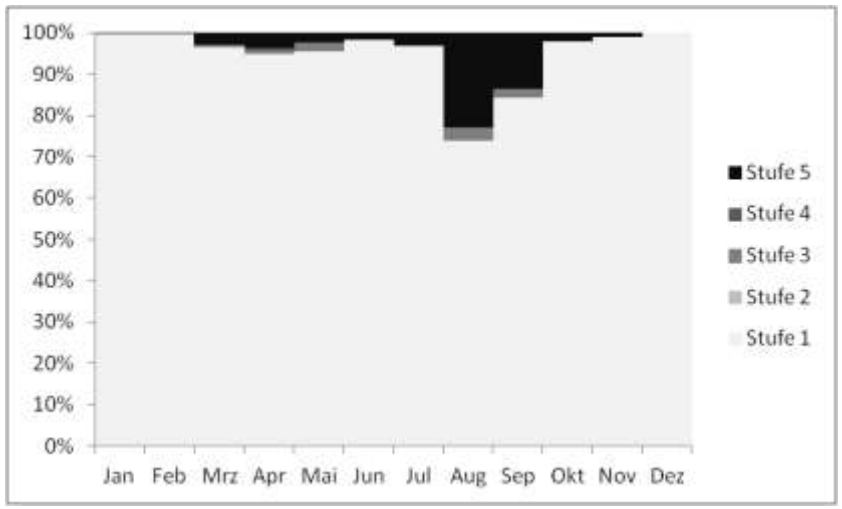


annual specific lighting consumption:
1,69 kWh/(m²a) in room 407;
2,43 kWh/(m²a) in room 405

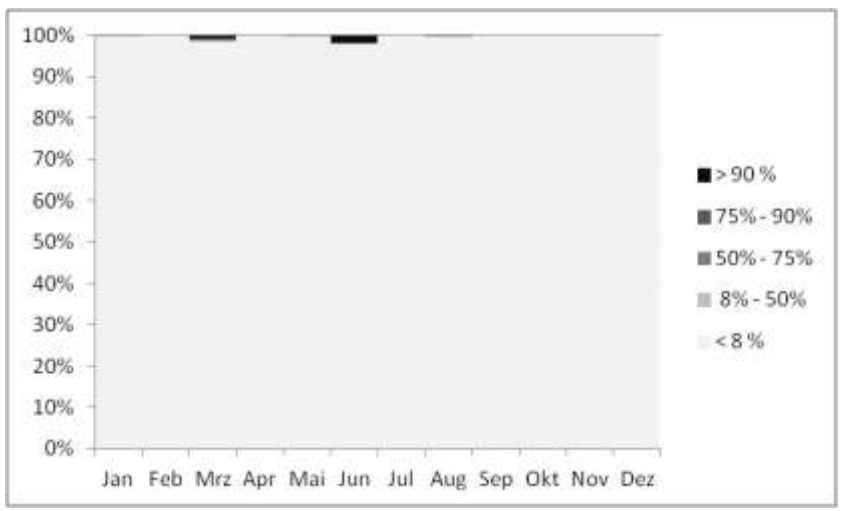
daylight & operating hours of electric lighting



Shading systems

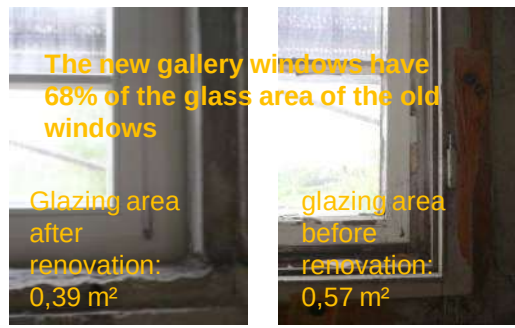


EC-Glass – Southeast facing
(automated + manual override)



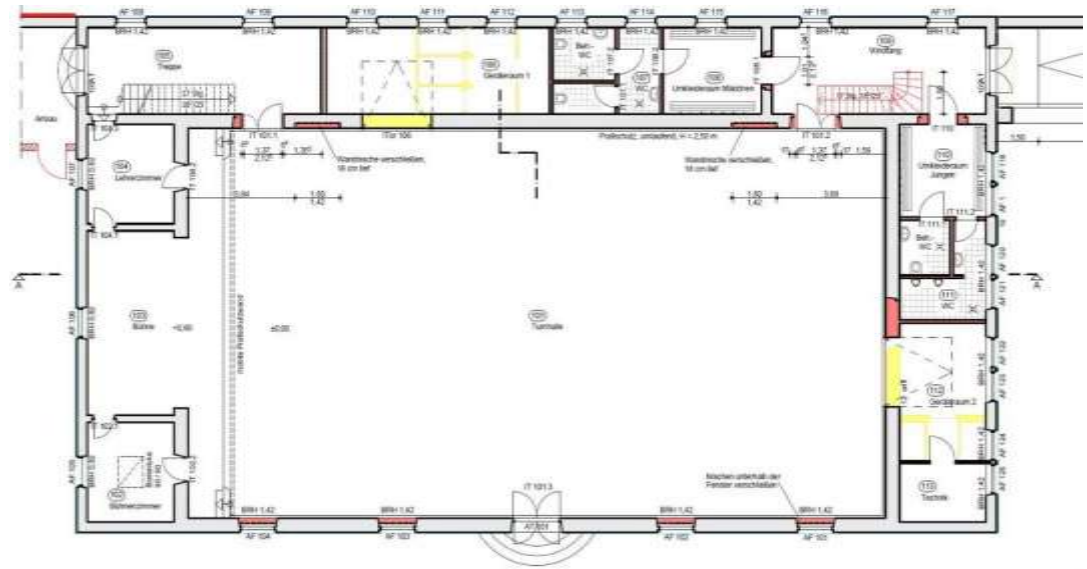
Blinds – Southeast facing
(operated manually)

Olbersdorf special school, sports hall before refurbishment



Sports hall – construction of new rooflight

Sports hall



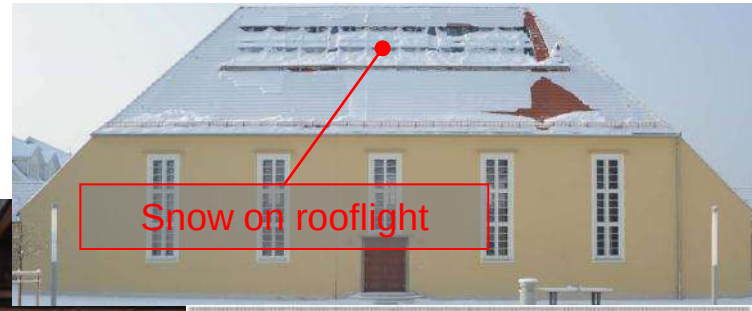
	before renovation	after renovation
floor area	350 m²	350 m²
opening area (gross)	39,3 m³	80,2 m²
opening to floor area ratio	11%	23%
glazing area	21,17 m²	58,02 m²
glazed to floor area ratio	6%	17%

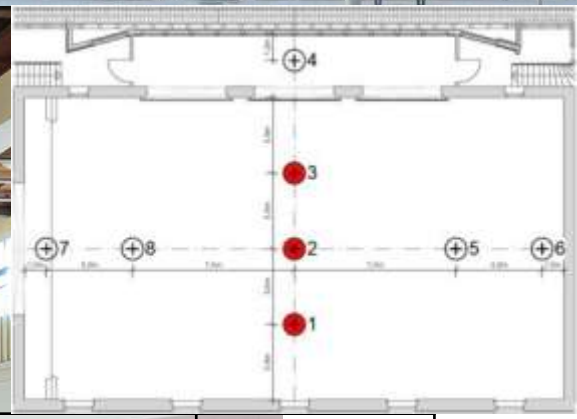
Metrics on Window-System before and after renovation

	before renovation	after renovation
middle axis, window area	1,0%	2,7%
center of room	0,7%	3,1%
middle axis, rear side	0,3%	2,0%

Daylight factor before and after renovation

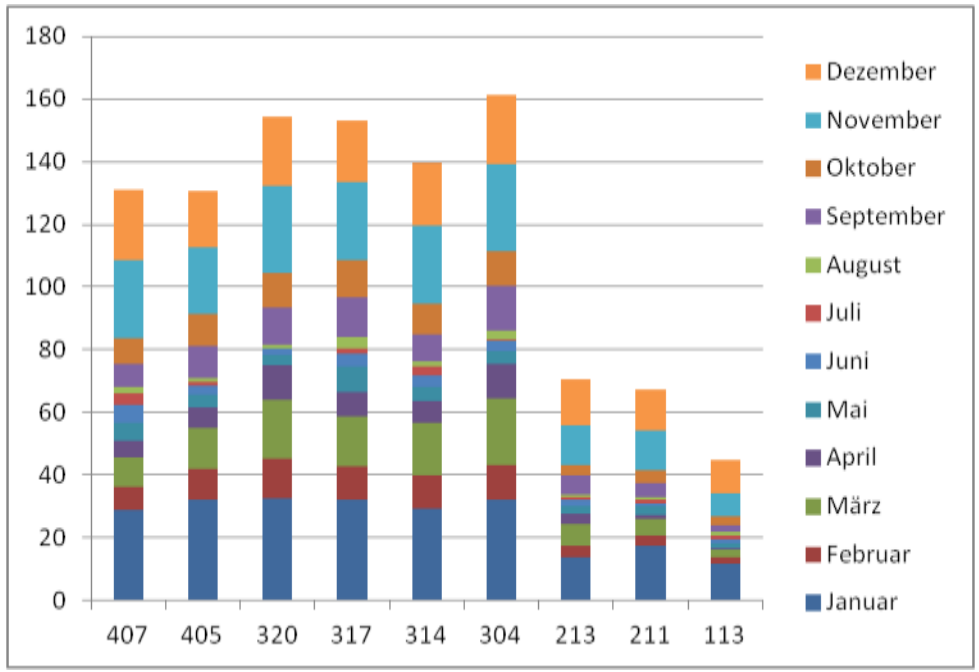
Sports hall with new rooflight



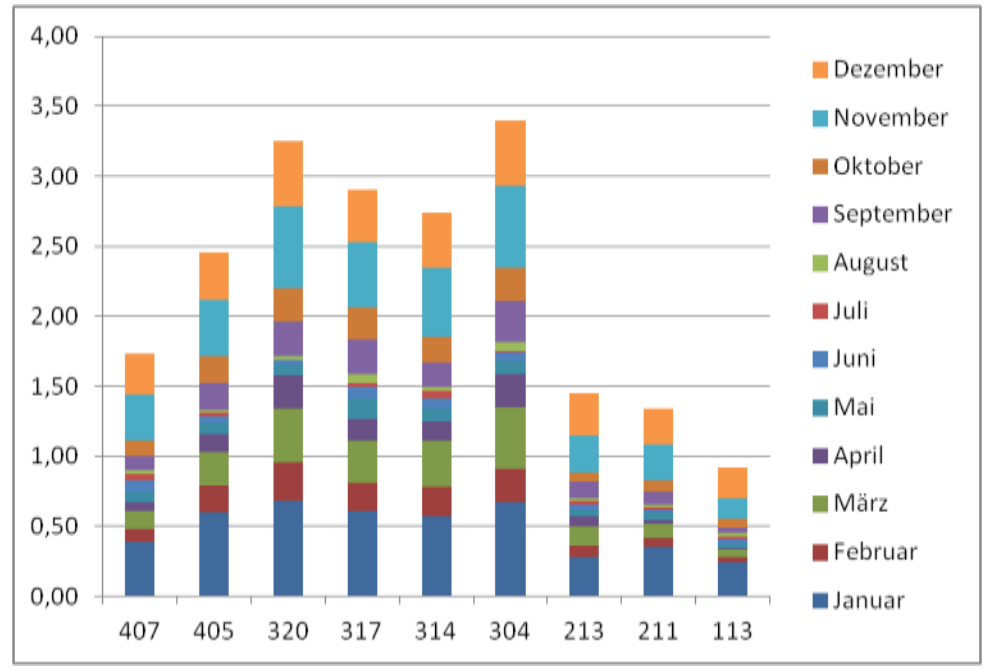


		window (point 1)	middle (point 2)	next to gallery (point 3)
relative usable lighting contribution (9. am – 2 pm, base: 300 lx)	summer	100%	100%	99%
	spring	96%	97%	91%
	winter	55%	60%	42%
relative period of use (9. am – 2 pm, base: 300 lx)	summer	98%	98%	97%
	spring	79%	85%	68%
	winter	12%	18%	3%
cylindric / horizontal illuminance	summer	42%	42%	49%
	spring	48%	47%	51%
	winter	40%	40%	46%

classrooms, lighting energy consumption



lighting energy consumption in classrooms in the first year of operation [kWh]



Specific lighting energy consumption in classrooms in the first year of operation [kWh/m²]

T h a n k Y o u !

Involved Institutions	
Client	Landkreis Görlitz
Leader of Research Project	HS Zittau/Görlitz, Fakultät Bauwesen, Lehrgebiet Bauklimatik, Prof. Dr. Bolsius
Subcontractor for Lighting	TU-Dresden, Fakultät Architektur, Institut für Bauklimatik
Subcontractor of Subcontractor for Lighting	Roman Jakobiak (Werkvertrag)
Projektbegleitung	Projektträger Jülich
Architect	AIZ - Architektur- und Ingenieurbüro für Hoch- und Tiefbau Zittau GmbH
Electrical enginieering	ILM - Ickrath Land Messner, Ingenieurbüro für Elektroenergieanlagen