FORSKNINGSMÆSSIGE FOKUSOMÅDER MOD 2020

- VENTILATION I NÆSTEN ENERGINEUTRALT BYGGERI

PER HEISELBERG
INSTITUT FOR BYGGERI OG ANLÆG

AALBORG UNIVERSITET

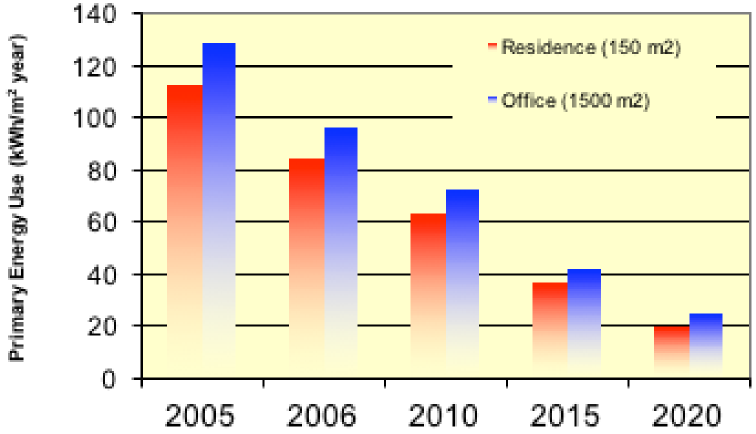
FIRST PHASE IN THE GREEN TRANSITION OF THE ENERGY SYSTEM (BUILDINGS ROLE)

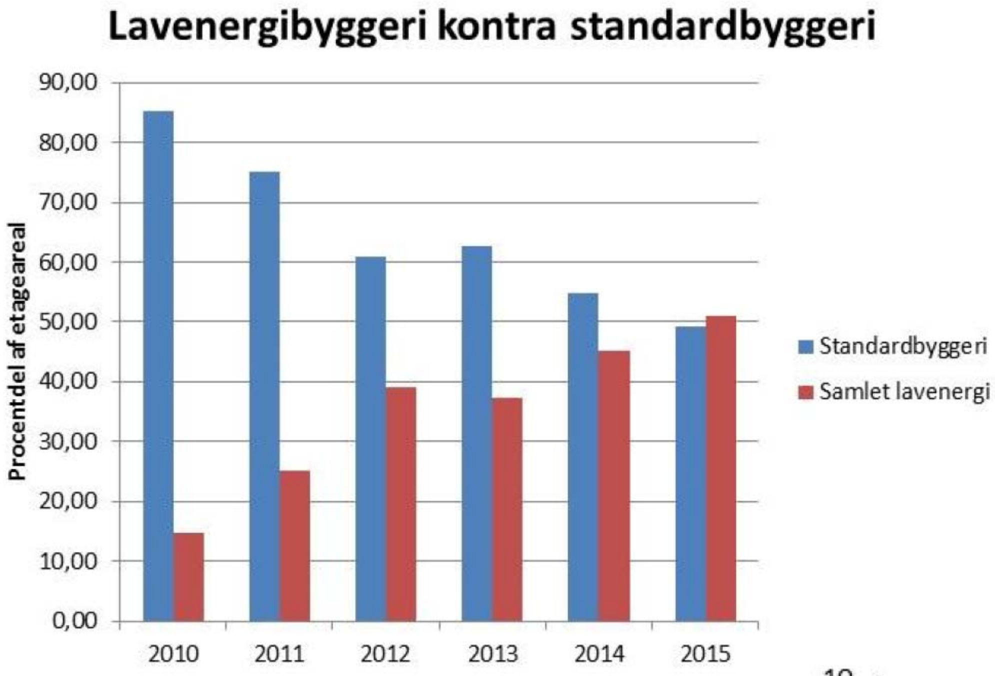
FOCUS ON IMPROVED ENERGY EFFICIENCY OF NEW BUILDINGS

FOCUS ON “ENERGY RENOVATION” OF THE EXISTING BUILDING STOCK

FOCUS OM INCREASING RENEWABLE ENERGY PRODUCTION

FOCUS ON COST OPTIMALITY ON BUILDING LEVEL





Reference: Niels Bruus Varming,
Trafik- og Byggestyrelsen

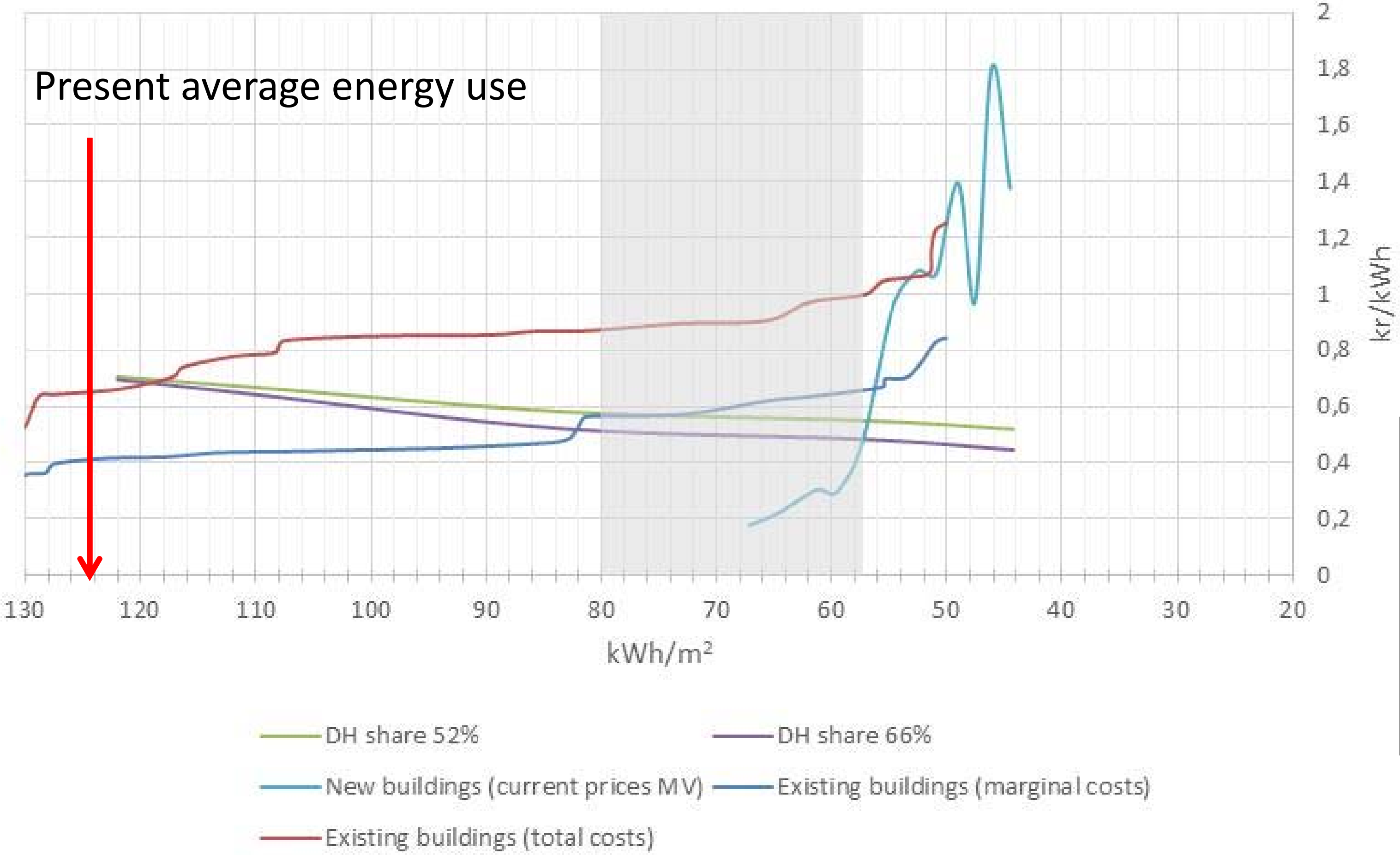
NEXT PHASE IN THE GREEN TRANSITION OF THE ENERGY SYSTEM (BUILDINGS ROLE)

FOCUS ON **REALIZING ENERGY EFFICIENCY** IMPROVEMENTS AND ENERGY SAVINGS

FOCUS ON **COST OPTIMALITY ON SYSTEM LEVEL**

FOCUS ON MORE EFFICIENT USE OF RENEWABLE ENERGY PRODUCTION, PEAK POWER REDUCTION AND SECURE POWER CAPACITY THROUGH **ENERGY FLEXIBLE AND GRID-SUPPORTIVE BUILDINGS**

OPTIMUM HEAT ENERGY SAVINGS IN THE BUIDLING SECTOR



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Ref.: IDA'S Energy Vision 2050

WHAT WILL BE THE MAIN DRIVING FACTORS FOR FUTURE DEVELOPMENT OF HVAC SYSTEMS

CONTINUOS DEVELOPMENT IN REQUIREMENTS FOR REDUCED ENERGY USE IN BUILDINGS (PRIMARY ENERGY)??

PERFORMANCE TEST, OPERATION AND MAINTENANCE??

INCREASED DEMAND FOR APPLICATION OF LOW VALUED AND RENEWABLE ENERGY SOURCES ??

TIGHTENING OF REQUIREMENTS FOR INDOOR ENVIRONMENTAL QUALITY ??

TECHNOLOGICAL BREAKTHROUGHS??

NEW MATERIALS??

FOKUSOMRÅDER MOD 2020

VENTILATION RELATIVT HØJT ENERGIFORBRUG

Lavt tryktab (varmegenvinding/filtrering, korte føringsveje anvendelse af bygning, lokale/decentrale systemer)

Bedre effektivitet, behovsstyring (lokal eller personlig ventilation, brugbare kriterier for komfort og sundhed for både boliger og arbejdspladser)

VARMELASTER STORE I FORHOLD TIL TAB

Naturlig køling med udeluft, natkøling, vinduesudluftning, "små" luftmængder med lave temperaturer i brugstiden, udjævning (energiforbrug og indeklima) ved bygningens termisk masse

OPTIMERING AF DRIFT

Intelligent og integreret styring med andre tekniske systemer (solafskærmning, naturlig ventilation, udluftning, termisk masse, ….)

Behovsstyring (temperatur, luftkvalitet)

Løbende optimering af funktion (billige sensorer, datanetværk, ..)

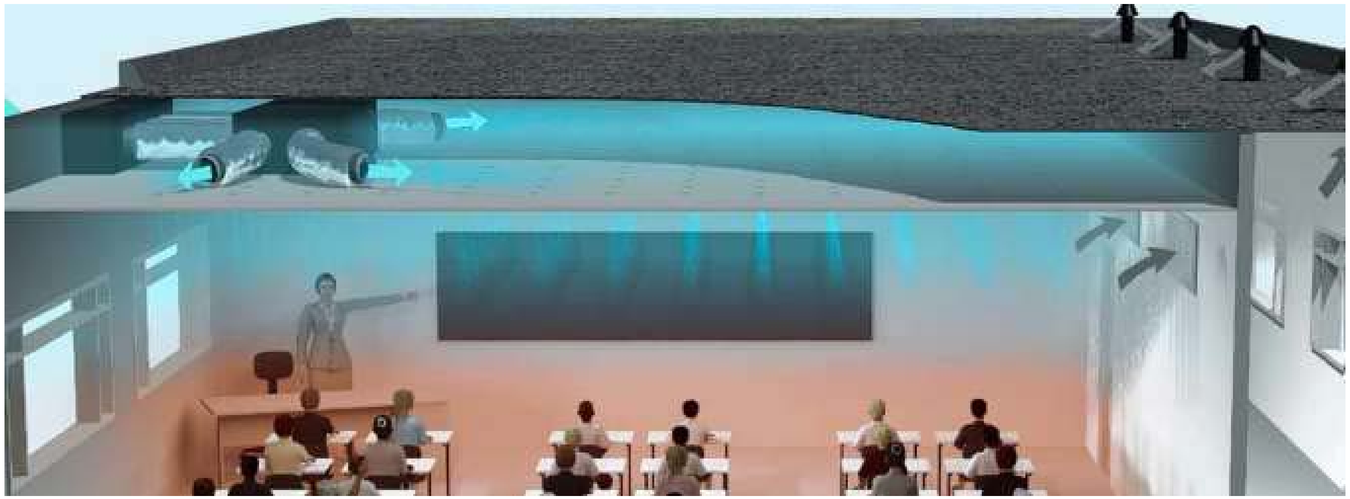
Diffuse Ceiling Supply

AALBORG UNIVERSITY
DENMARK

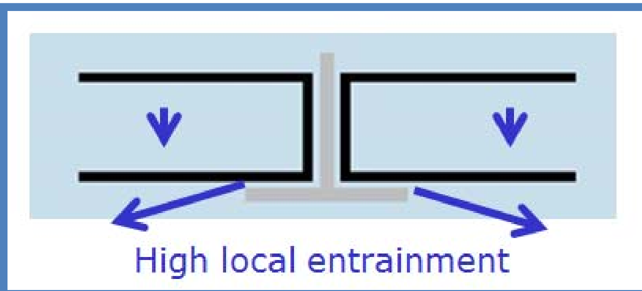
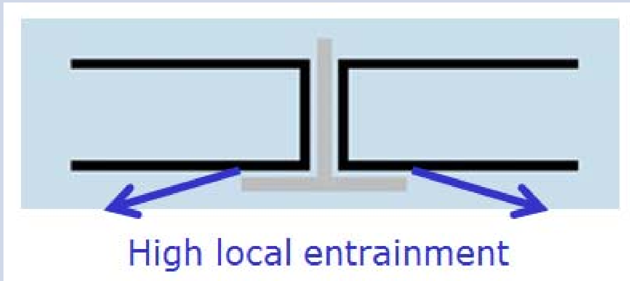
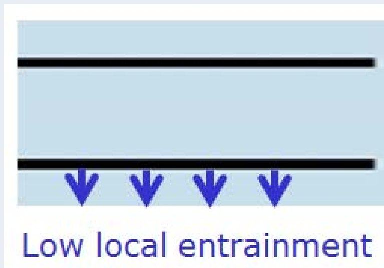
VENTILATIVE COOLING IN COLD CLIMATE - DENMARK

WHAT IS DIFFUSE CEILING VENTILATION

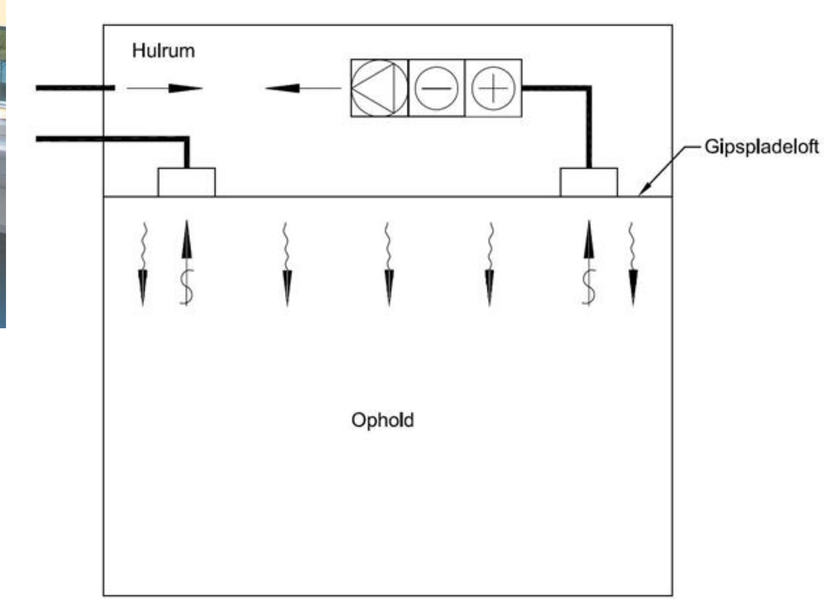
THE SPACE ABOVE A SUSPENDED CEILING IS USED AS A PLENUM AND FRESH AIR IS SUPPLIED TO THE OCCUPIED ZONE THROUGH PERFORATED SUSPENDED CEILING.



THE PRINCIPLE

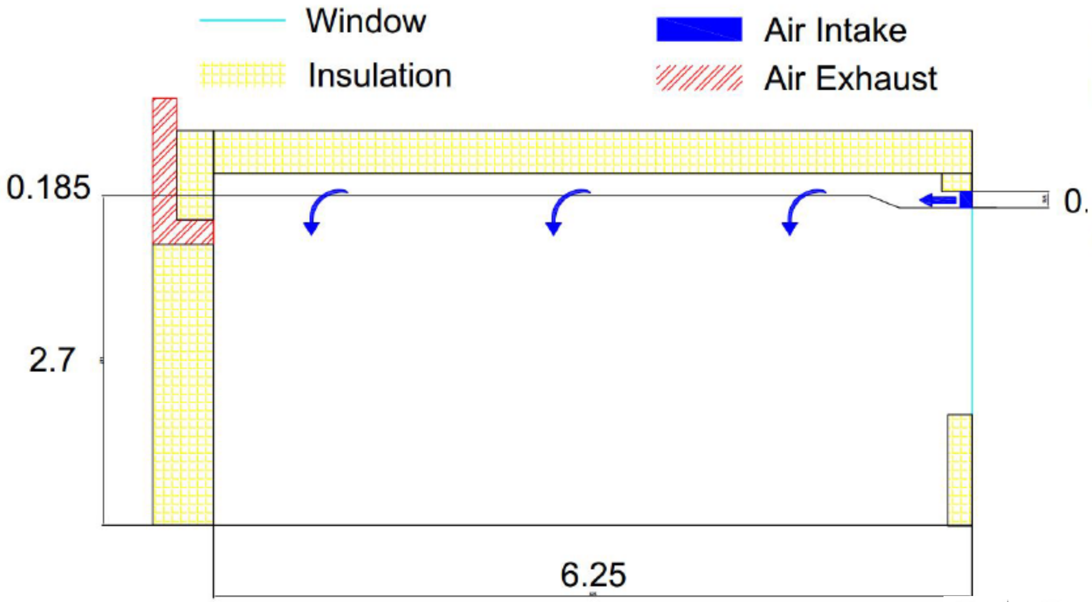
Rockfon / Troldtekt ceiling	
Ecophon ceiling	
Fully diffuse ceiling	

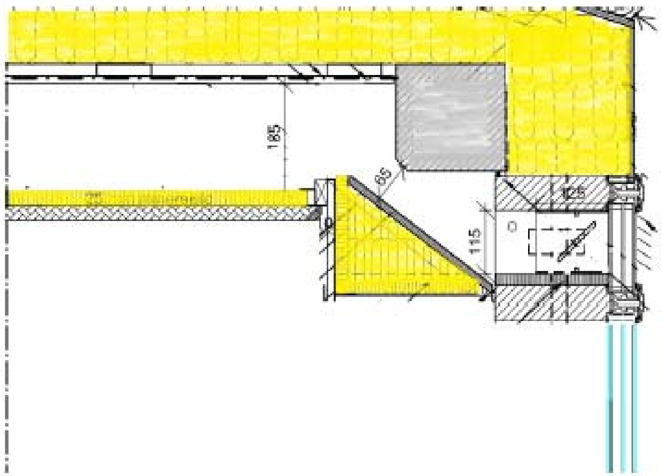
WIDEX / WESSBERG A/S

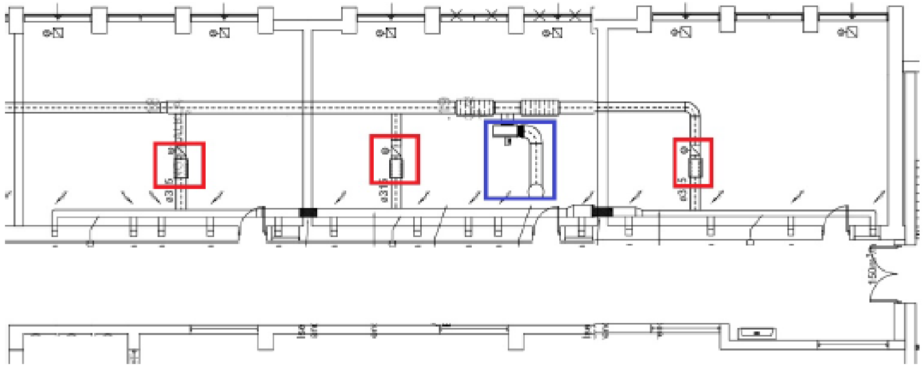


SOLBJERGSKOLEN SOUTHWEST OF ÅRHUS

SYSTEM PRINCIPLE

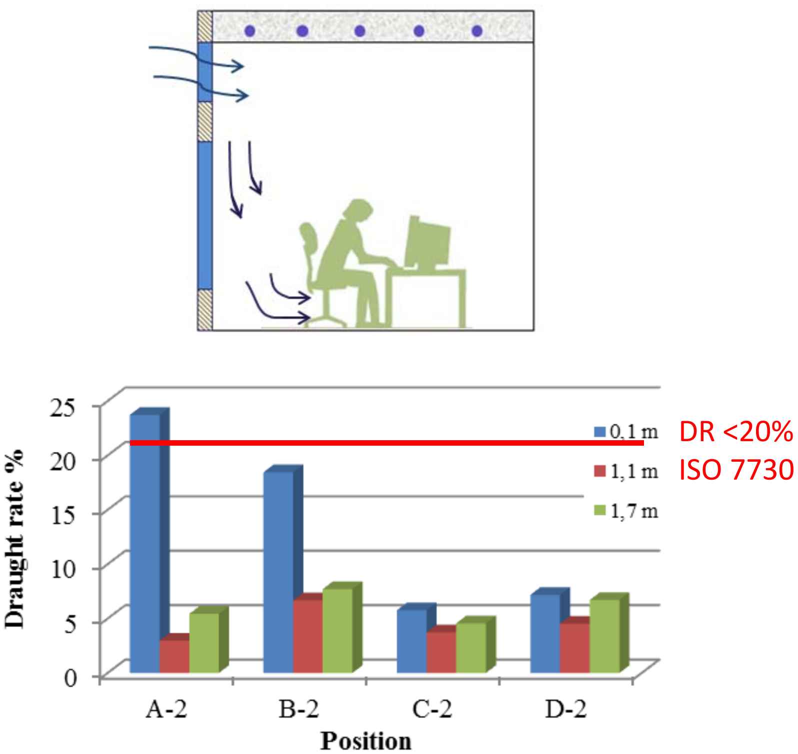


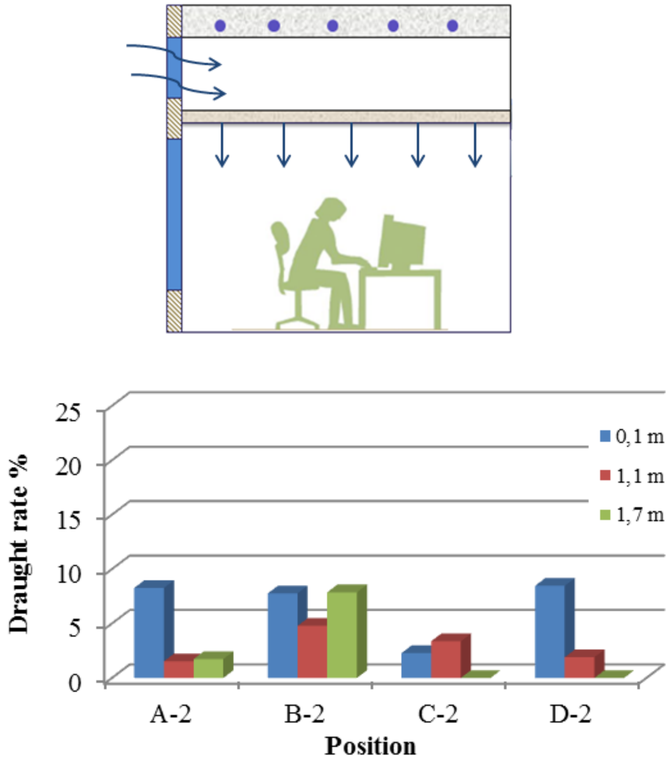




DRAUGHT RISK

Extreme winter condition: supply air temperature -8 °C, ACH =4





Night Cooling

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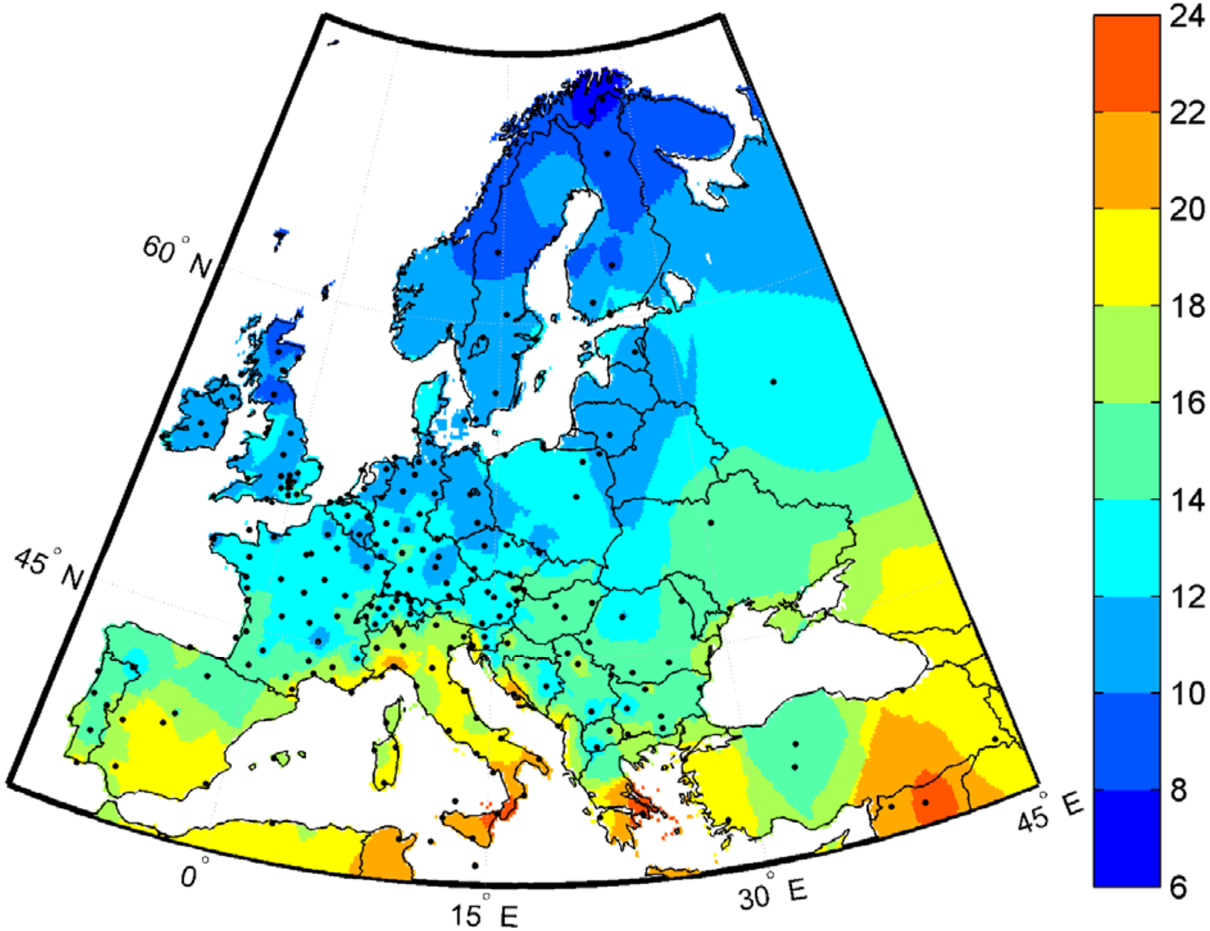
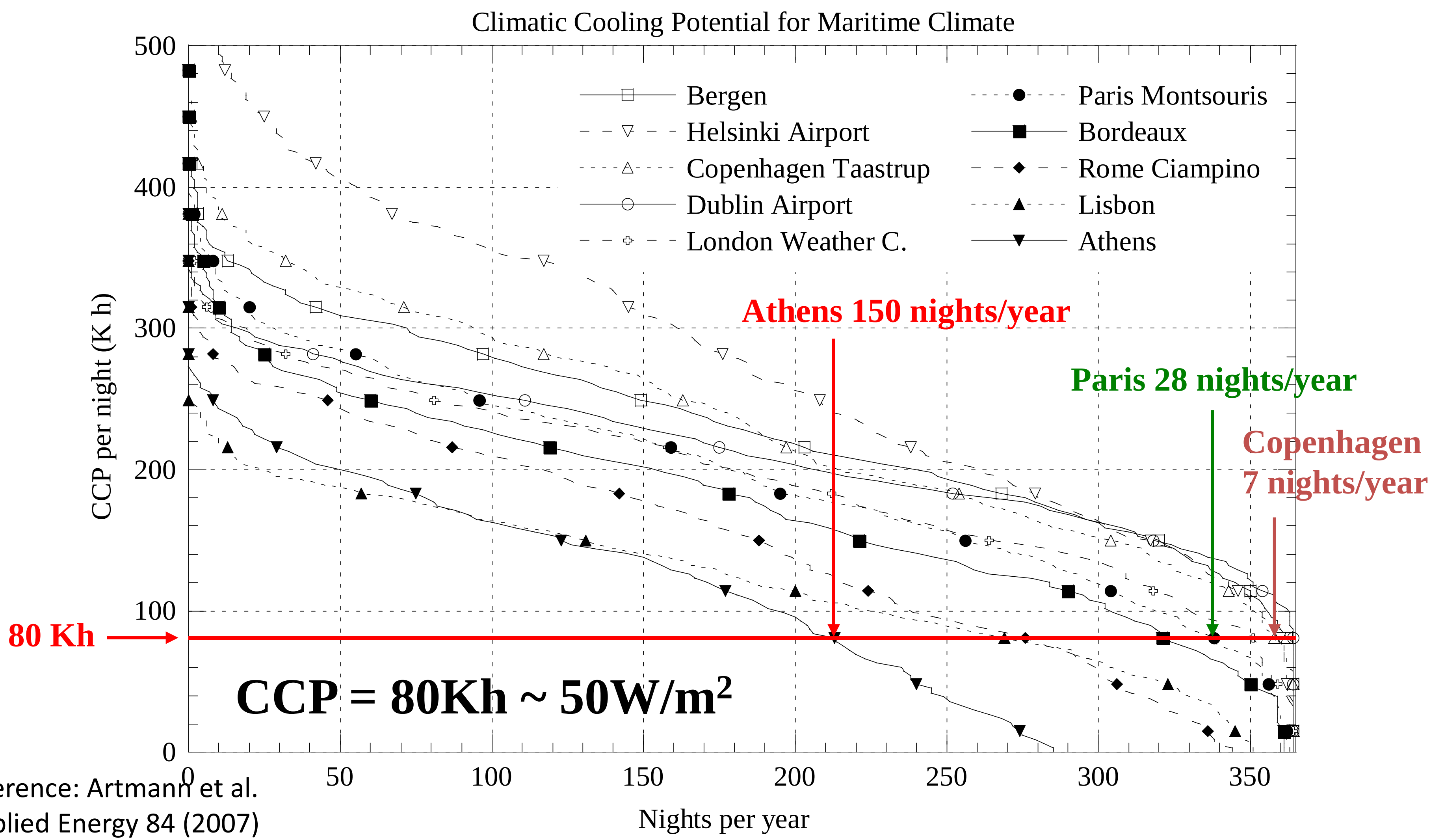
DAILY MINIMUM TEMPERATURE JULY



Meteonorm Data

CUMULATIVE FREQUENCY DISTRIBUTION OF CCP

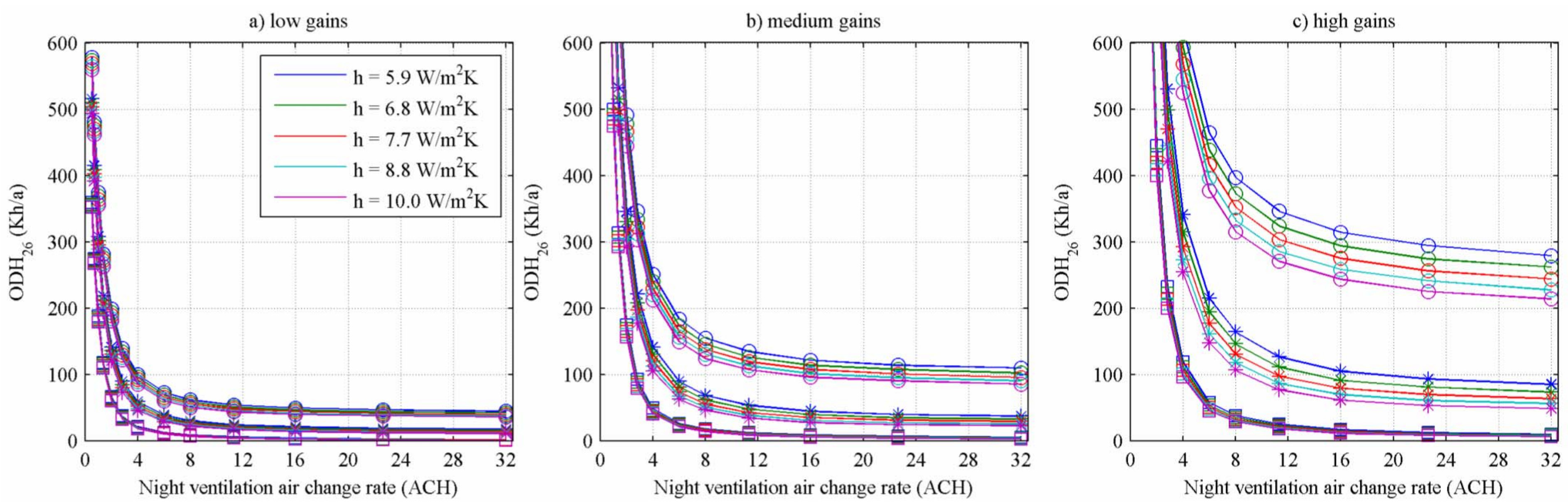


Reference: Artmann et al.
Applied Energy 84 (2007)

OVERHEATING DEGREE HOURS ABOVE 26 °C

FOR ZURICH CLIMATIC DATA

- ANETZ 1996-2005);
- for a light (o), medium (*) and heavy (□) mass construction



OVERHEATING DEGREE HOURS ABOVE 26 °C

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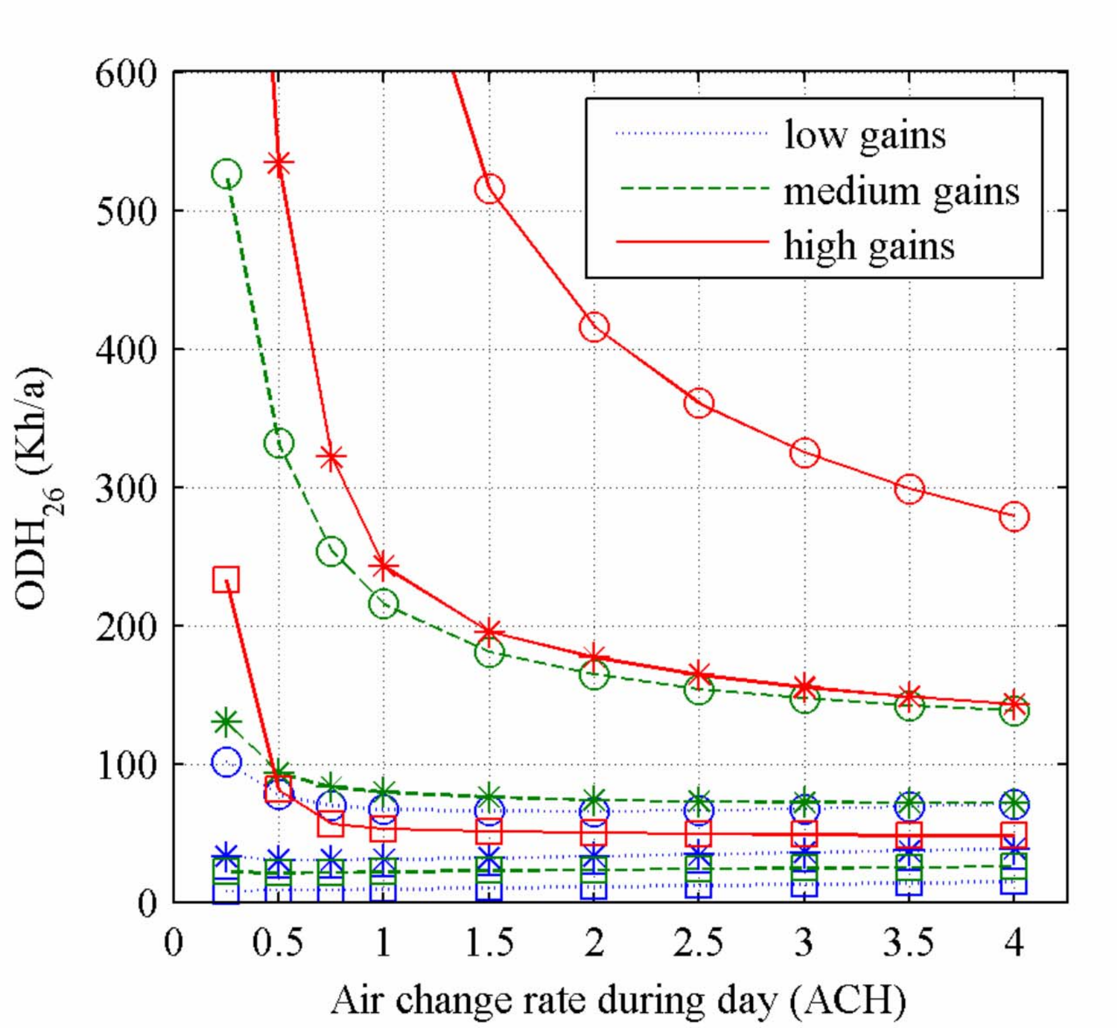


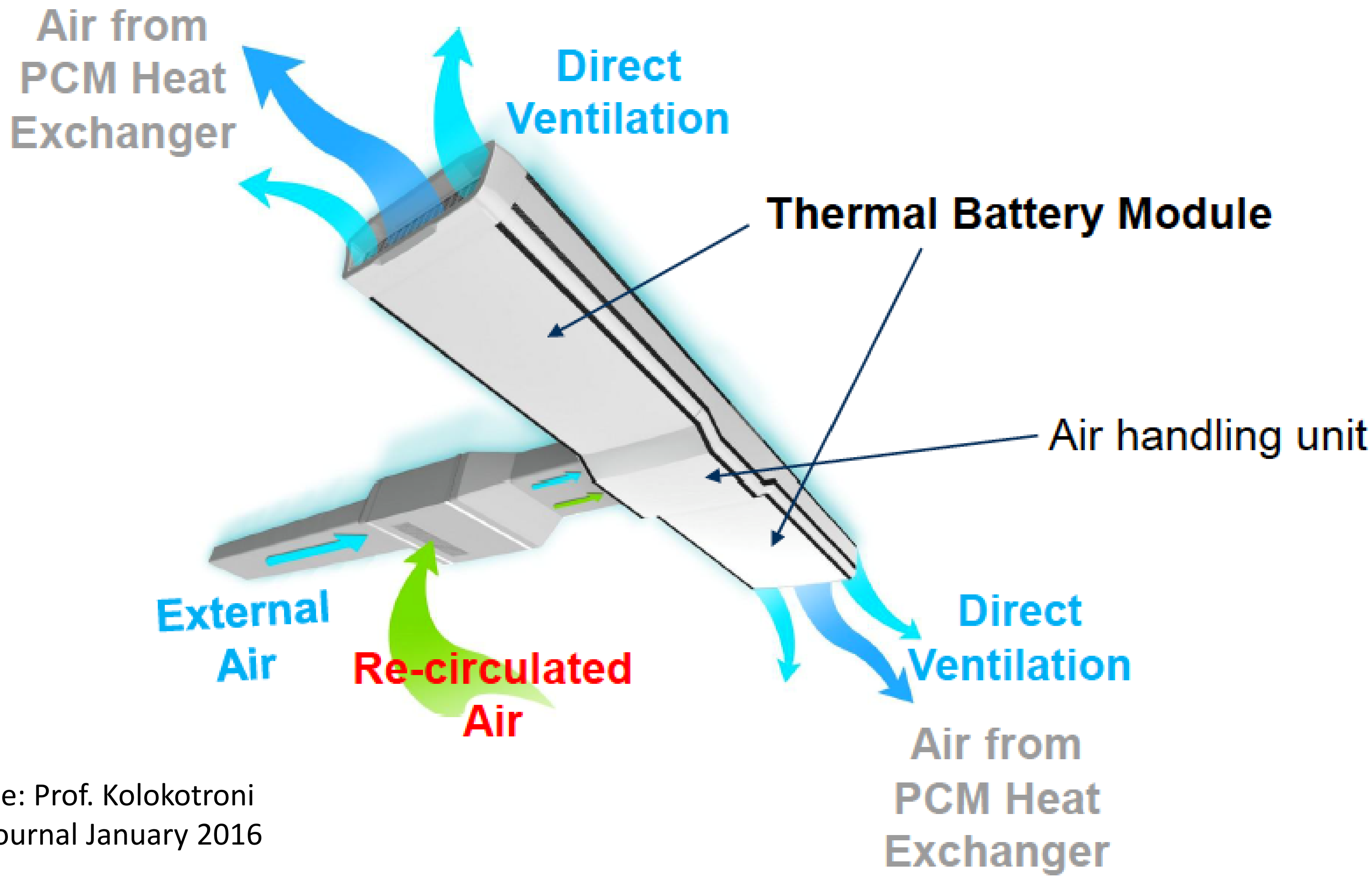
Thermal Storage in Computer Seminar Room

AALBORG UNIVERSITET

Ventilation system: CoolPhase by Monodraught

A Cool-Phase® system by Monodraught Ltd was installed in May 2013 to provide ventilation for indoor air quality and cool the air for thermal comfort.

The Cool-Phase® system uses the concept of a thermal battery consisting of Phase Change Material (PCM) plates within the ventilation path to capture and store heat

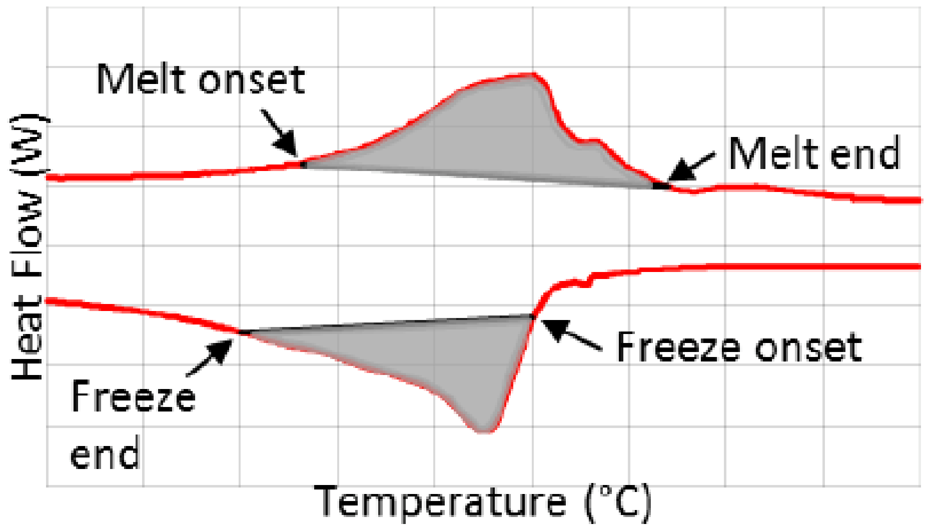


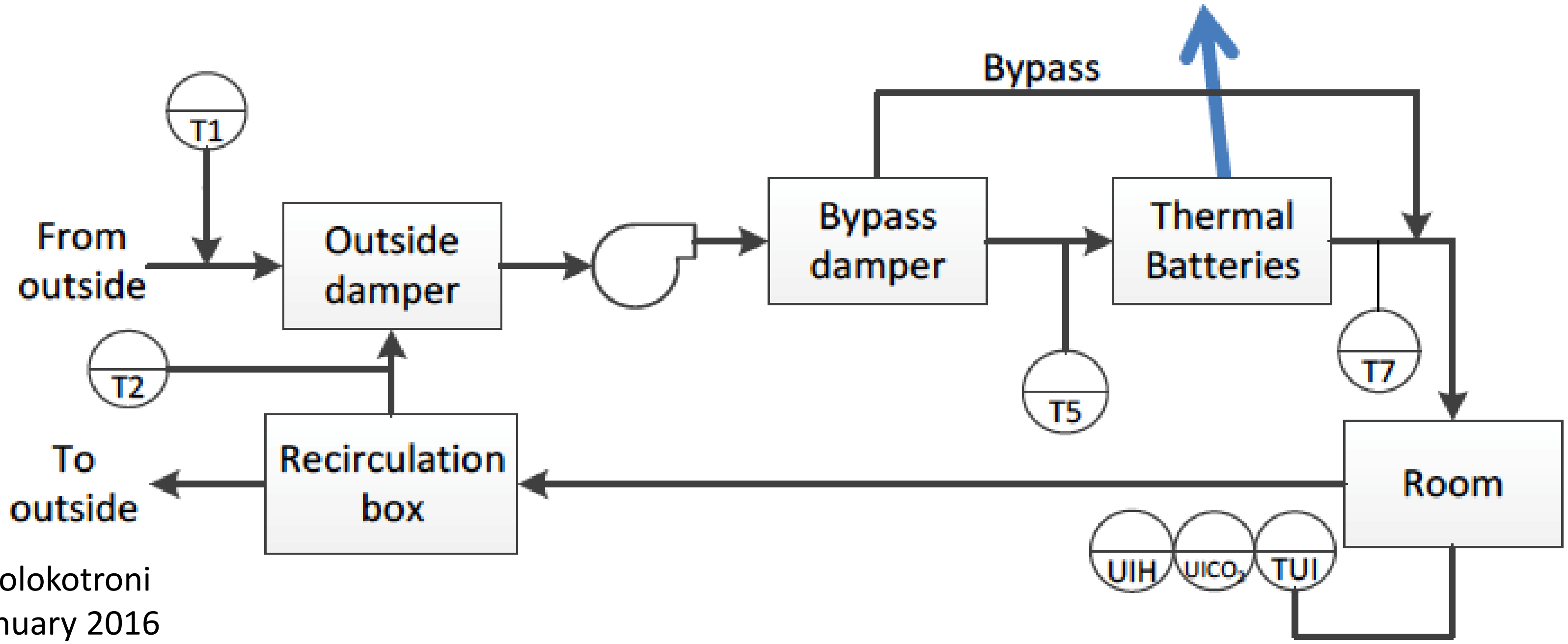
Reference: Prof. Kolokotroni
REHVA Journal January 2016

Ventilation system

Sensor points analysed in this work
T1= Outside Air
T2= Recirculation Air
T5= Air before battery
T7= Air after battery

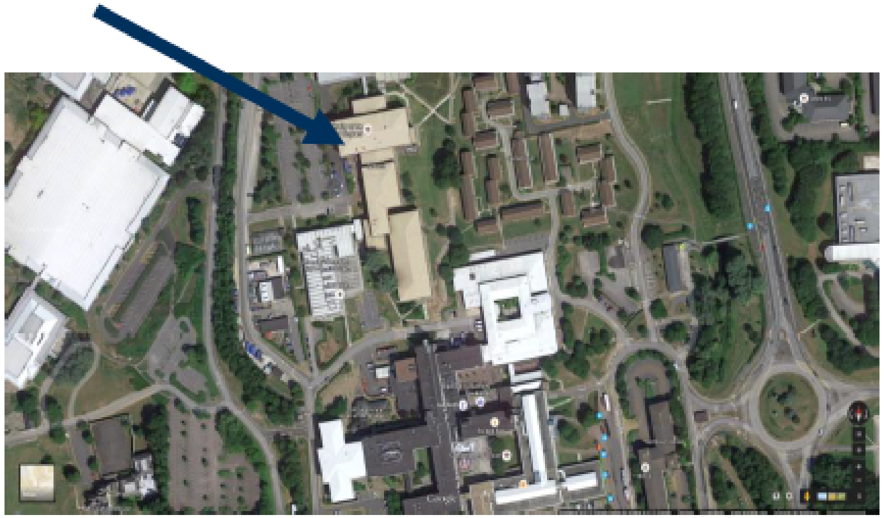
UIH, $UICO_2$, TUI =
air temperature, relative humidity, CO2 concentration inside the room



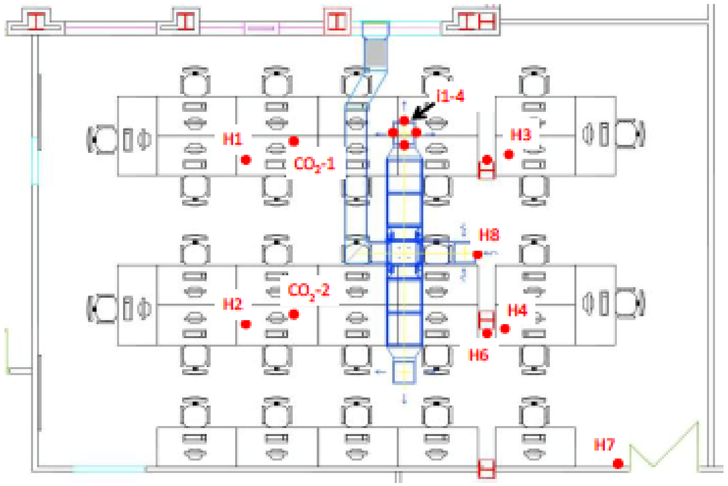


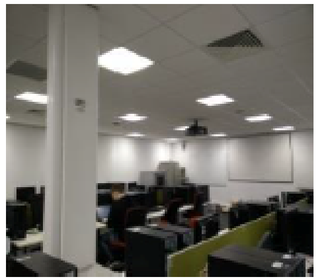
Reference: Prof. Kolokotroni
REHVA Journal January 2016

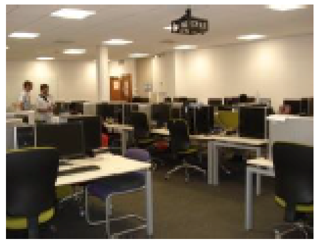
Location and building description



Location	
Country	UK
City/Town/Others	Bristol
Longitude	-2.549130
Latitude	51.501753
Building and fabric data	
Building type	University
Total room area	117 m^2
Mean occupant density	26
Hours of occupancy	9:30 –
Window U-value	1.82 W/m^2 K
Window g-value	0.43
Exterior wall U-value	0.56
Base floor U-value	1.75
Roof U-value	0.56
Lighting gains	1170 W
Additional Equipment Gains	3320 W

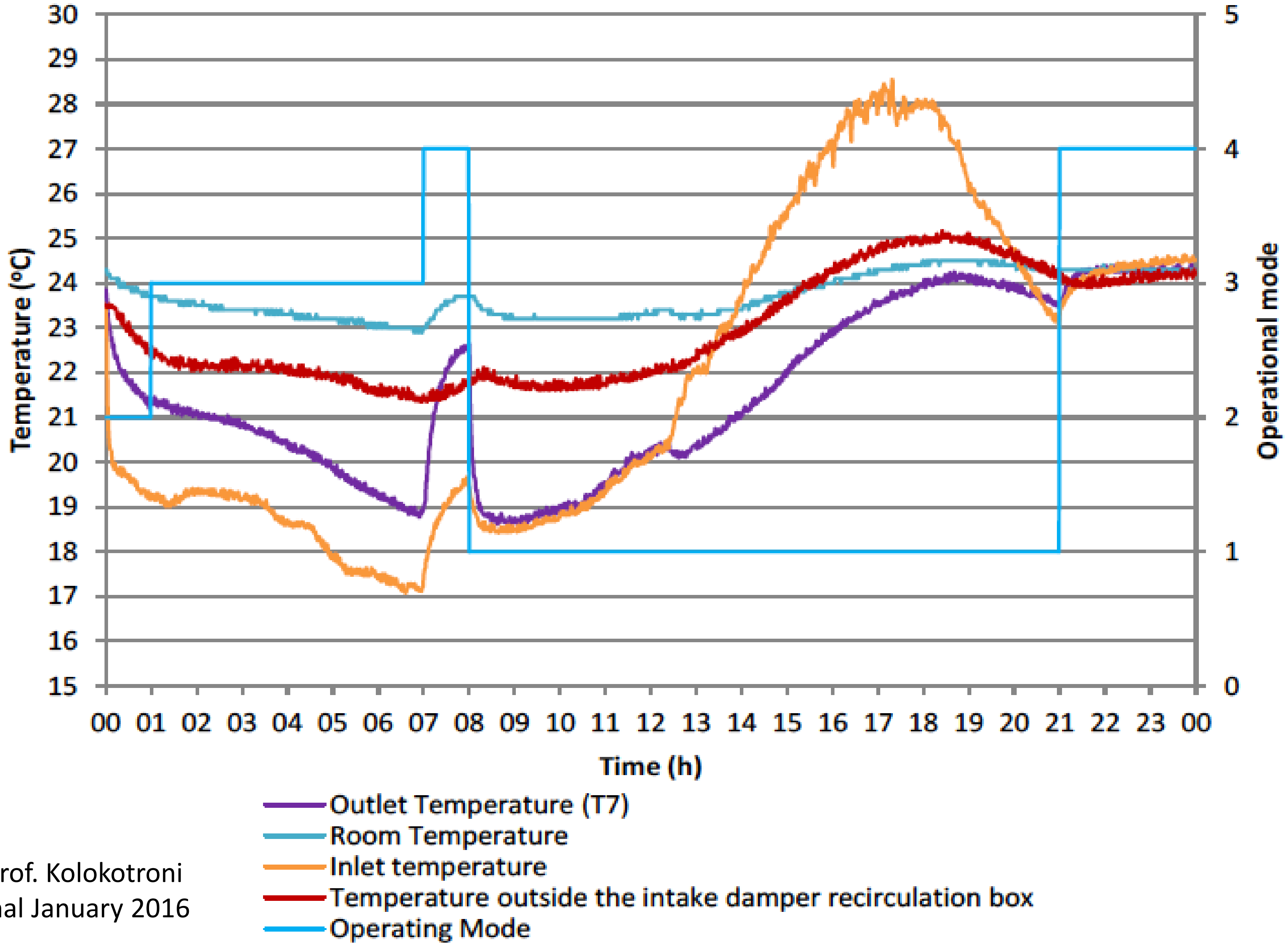






Reference: Prof. Kolokotroni
REHVA Journal January 2016

System operation on a summer day 2013 based on system data

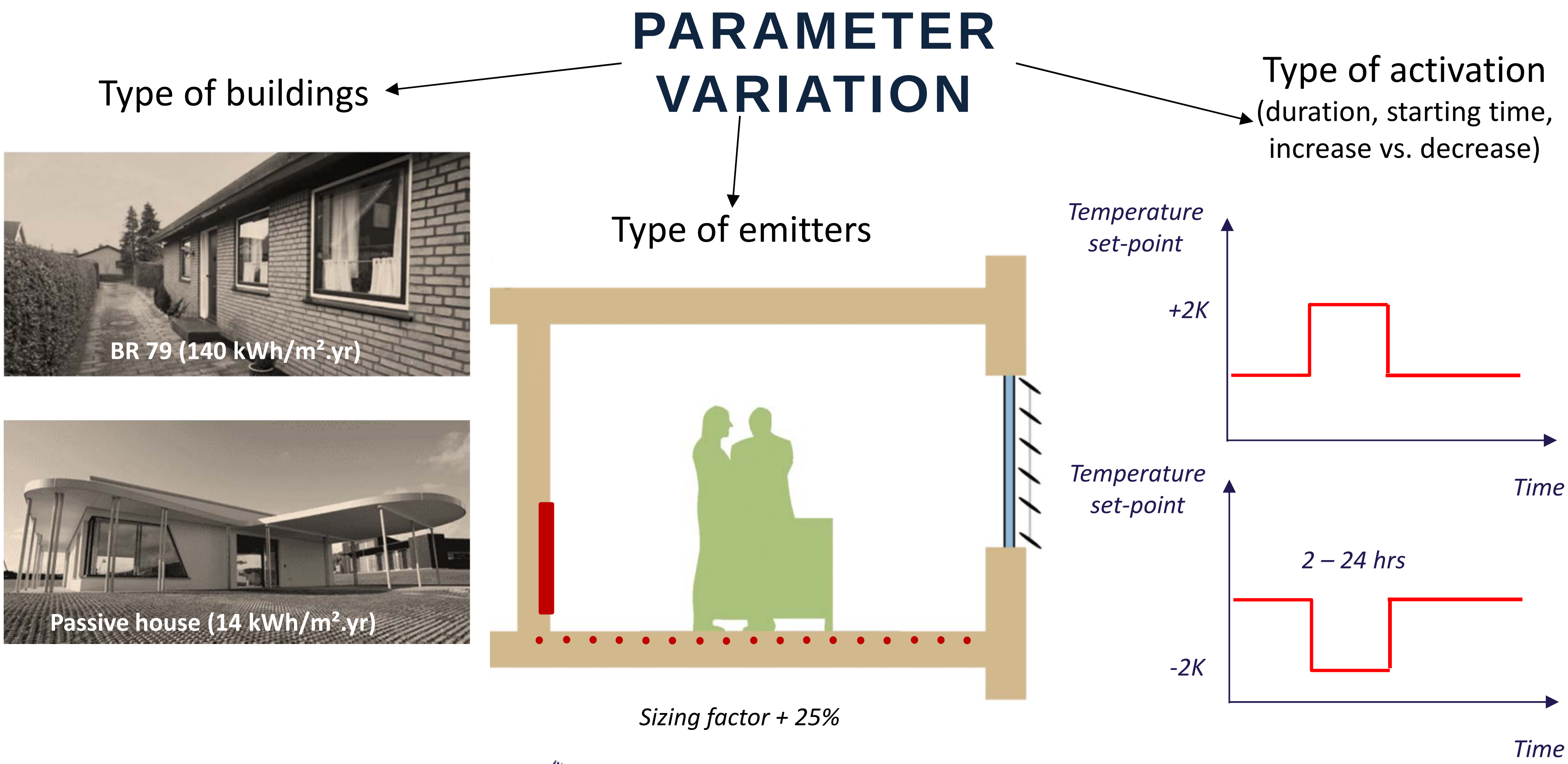


Reference: Prof. Kolokotroni
REHVA Journal January 2016

Heating Energy Flexibility

AALBORG UNIVERSITET

HEATING FLEXIBILITY USING BUILDING THERMAL MASS FOR STORAGE



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Source:: Le Dreau and Heiselberg
To be published

CONTROL SCENARIOS FOR FLEXIBLE DEMAND

SCENARIO # 1 (4 HRS CONSERVATION) : THE SET-POINT IS DECREASED BY 2 K IN PERIODS WITH HIGH PRICES, BUT FOR A MAXIMUM PERIOD OF 4 HOURS. THIS MODULATION CAN BE REPEATED OVER THE DAY AFTER A WAITING PERIOD OF 4 HOURS.

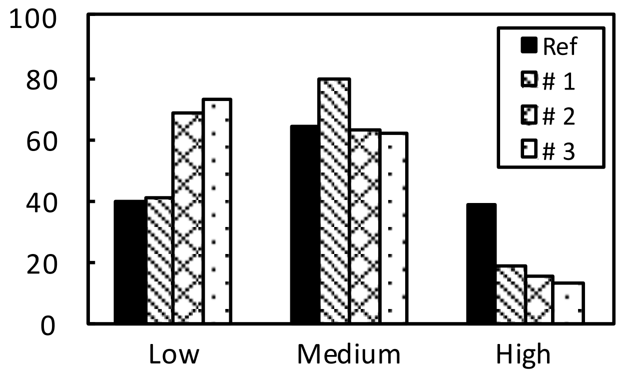
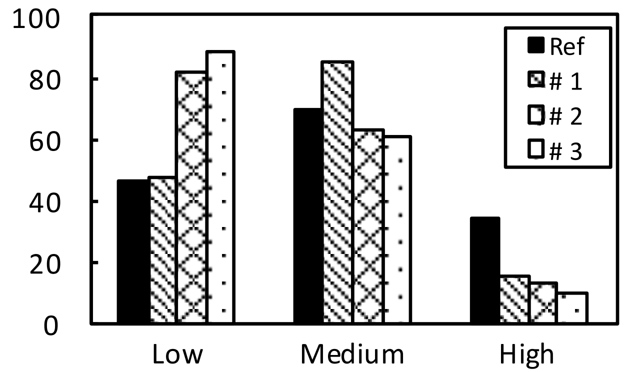
SCENARIO # 2 (4 HRS STORAGE AND CONSERVATION) : THE SET-POINT IS DECREASED BY 2 K IN PERIODS WITH HIGH PRICES OR INCREASED BY 2 K IN PERIODS WITH LOW PRICES, BUT FOR A MAXIMUM PERIOD OF 4 HOURS. THESE MODULATIONS CAN BE REPEATED OVER THE DAY AFTER A WAITING PERIOD OF 4 HOURS.

SCENARIO # 3 (6 HRS STORAGE AND CONSERVATION) : SIMILAR TO SCENARIO # 2, BUT WITH 6 HRS.

$$Flexibility\ factor = \frac{\sum q_{heating\ need\ \{low\}} - \sum q_{heating\ need\ \{high\}}}{\sum q_{heating\ need\ \{low\}} + \sum q_{heating\ need\ \{high\}}}$$

Source:: Le Dreau and Heiselberg
To be published

EXAMPLE OF FLEXIBILITY ACHIEVED (SINGLE-FAMILY HOUSE 80'S).

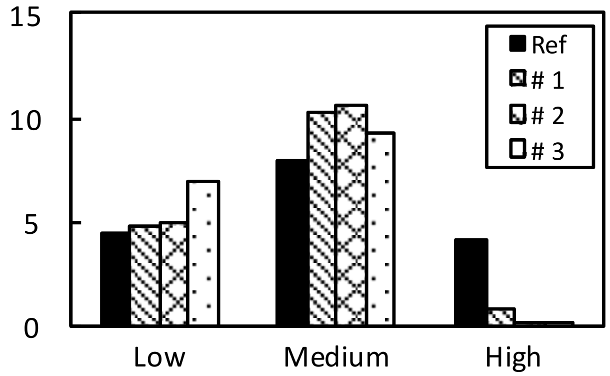
	Radiator				Underfloor heating			
	Ref.	# 1	# 2	# 3	Ref.	# 1	# 2	# 3
mean(T_{op}) (°C)	22.1	21.8	22.3	22.3	22.0	21.9	22.2	22.2
min(T_{op}) (°C)	22.0	20.0	20.0	20.0	21.7	20.4	20.4	20.0
max(T_{op}) (°C)	23.1	23.1	24.4	24.5	22.6	22.7	24.3	24.5
Heating need (kWh/m².year)	142	139	147	148	150	148	157	159
Share of tariff (kWh/m².year)								
Flexibility factor (-)	0	0.38	0.63	0.69	0.15	0.51	0.73	0.80

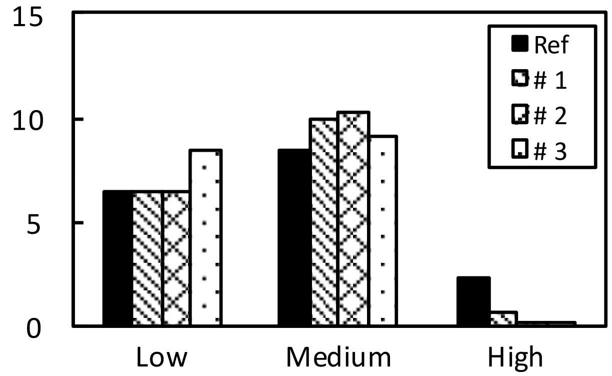
Source:: Le Dreau and Heiselberg
To be published

EXAMPLE OF FLEXIBILITY ACHIEVED (PASSIVE HOUSE).

	Radiator				Underfloor heating			
	Ref.	# 4	# 5	# 6	Ref.	# 4	# 5	# 6
mean(T_{op}) (°C)	22.2	22.1	22.0	22.2	22.1	22.1	22.0	22.1
min(T_{op}) (°C)	22.0	20.7	20.3	20.3	21.8	21.3	21.0	21.0
max(T_{op}) (°C)	24.4	24.3	24.3	24.4	23.5	23.5	23.5	23.6
Heating need (kWh/m².year)	16.4	15.9	15.7	16.4	17.1	17.0	16.9	17.5

Share of tariff (kWh/m².year)





	Radiator Ref.	Radiator # 4	Radiator # 5	Radiator # 6	Underfloor Ref.	Underfloor # 4	Underfloor # 5	Underfloor # 6
Flexibility factor (-)	0.03	0.69	0.92	0.95	0.46	0.81	0.96	0.97

Source:: Le Dreau and Heiselberg
To be published


Tak for opmærksomheden